User Guide

ETS-1000

Ethernet Tester Analyzer

www.EXFO.com

Telecom Test and Measurement

EXFO

EXPERTISE REACHING OUT

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Units of Measurement

Units of measurement in this publication conform to SI standards and practices.

April 10, 2014

Version number: 2.0.0

Certification Information

Federal Communications Commission (FCC) and Industry Canada (IC) Information

Electronic test and measurement equipment is exempt from FCC Part 15 compliance in the United States and from IC ICES 003 compliance in Canada. However, EXFO Electro-Optical Engineering Inc. (EXFO) makes reasonable efforts to ensure compliance to the applicable standards.

The limits set by these standards are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the user guide, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

European Union (CE) Information

Electronic test and measurement equipment is subject to the EMC Directive in the European Union. The EN61326 standard prescribes both emission and immunity requirements for laboratory, measurement, and control equipment. This unit has been tested and found to comply with the limits for a Class A digital device. See *CE Declaration of Conformity* on page iv.

Note: *If the equipment described herein bears the CE symbol, the said equipment complies with the applicable European Union Directive and Standards mentioned in the Declaration of Conformity.*

CE Declaration of Conformity

EXFO CE DECLARATION OF CONFORMITY

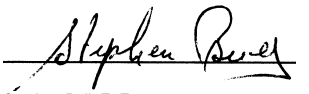
Application of Council Directives:	2006/95/EC - The Low Voltage Directive 2004/108/EC - The EMC Directive 2006/66/EC - The Battery Directive 93/68/EEC - CE Marking And their amendments
Manufacturer's Name:	EXFO Inc.
Manufacturer's Address:	400 Godin Avenue Quebec, Quebec Canada, G1M 2K2
Equipment Type:	Information Technology Equipment (ITE)
Trade Name/Model No.:	Ethernet Analyzer / ETS-1000

Standard(s) to which Conformity is Declared:

EN 55022: 2006	**Information technology equipment — Radio disturbance characteristics — Limits and methods of measurement**
EN 55024 :1998 + A1: 2001 + A2: 2003	**Information Technology Equipment - Immunity Characteristics - Limits and Methods of Measurements**
EN 61010-1:2001 Edition 2.0	**Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.**
EN 60825-1:2007 Edition 2.0	**Safety of laser products – Part 1: Equipment classification and requirements**
EN 61000-3-2:2006	**Electromagnetic compatibility (EMC). Limits for harmonic current emissions (equipment input current < 16 A per phase)**
EN 61000-3-3:1995 + A1: 2001 + A2: 2005	**Electromagnetic compatibility (EMC). Limits. Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection**

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directives and Standards.

Manufacturer

Signature: 

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Date:	February 08, 2010

Contents

1 Introducing the ETS-1000

Ethernet/Gigabit ETS-1000 (referred to as unit or analyzer) is intended for performing analysis and diagnostic tests according to the RFC 2544 [5] methodology, checking the state of a cable, and checking link connectivity.

In addition, the analyzer supports operations in the loopback mode, and statistics collection for received and transmitted traffic.

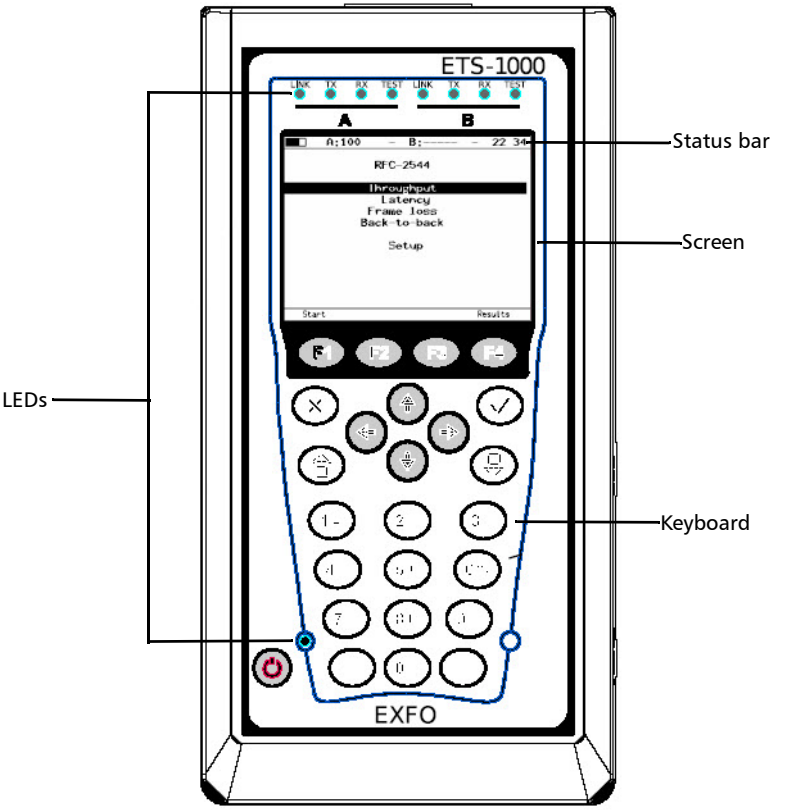
ETS-1000 analyzer provides the following options:

- Generating and analyzing traffic at the data link (MAC) and network (IP) layers.
- Collecting and displaying statistics for traffic received and transmitted at the physical, data link, and network layer.
- RFC-2544 measurements: Throughput, Latency, Frame Loss, and Back-to-Back.
- Diagnosing the copper cable faults.
- Ethernet loopback for physical, data link, and network layers of the OSI model.
- Loopback control via OAM protocol.
- Bit Error Rate Testing (BERT).
- Packet jitter measurements.
- IP testing (ping, trace route, telnet/http requests).

Signal Connectors and LEDs

This section describes all connectors (ports), controls, and LEDs available on the ETS-1000 Analyzer.

Front Panel



LEDs Description

The LED panel located on the front of your ETS-1000 provides you with the status of your unit.

LED	Status	Color	Description
LINK	On	Green	Connection to DUT is successfully established.
	Off	Red	No connection.
Tx	Blinking or Constant Light	Green	Data is transmitted.
	Off	Off	No data is transmitted.
Rx	Blinking or Constant Light	Green	Data packets are received.
	Off	Off	No data is received.
Test	On	Green	Test is running.
	Blinking	Green	Loopback mode is running.

LEDs in the bottom part of the front panel light up when the power supply unit is connected:

- Green: Indicates the battery is charged.
- Green (blinking): Indicates the battery is charging.
- Green (twinkling): Indicates the analyzer software is getting updated.

Status bar Description

Displays information about the following parameters (left to right)

- Battery charge state
- Transmission rate for the port A

Note: *If you connect SFP-module, white color of this inscription will be changed to yellow.*

- Currently running test on port A
- Transmission rate for the port B

Note: *If you connect SFP-module, white color of this inscription will be changed to yellow.*

- Currently running test on port B
- current time

The type of test running via port A(B) is marked in the status bar with the following abbreviations:

THR	Throughput Analysis
LAT	Latency Analysis
BTB	Back-to-Back Test
FRL	Frame Loss Test
LB1	Loopback at the Physical Layer (Layer 1).
LB2	Loopback at the Data Layer (Layer 2).
LB3	Loopback at the Network Layer (Layer 3).
LB4	Loopback at the Transport Layer (Layer 4).
BER	Bit Error Rate Test
PJ	Packet Jitter Analysis
GEN	Test Flow Generation
J+G	Packet Jitter Analysis and Test Flow Generation on the Same Port
PTH	Pass Through Mode

Keyboard Description

	**Power button**: Switches unit on/off. Press and hold the button for 1 to 2 seconds.
	**Main Menu**: Returns to the main menu.
	**Enter**: Opens the corresponding menu and displays the corresponding screen.
	**Cancel/Escape**: Returns to the previous screen or menu. In edition mode, it cancels the data-entry.
	**Infobar**: Displays the LEDs captions (background color corresponds to the LED's color).
	**Function Keys**: Located under the screen, the three function keys F1, F2, F3 are used to select the tabs on the screen positioned directly above each key (for example, F1 is used to select the left-most tab).
	**Function Arrows:** Indicates the cursor moving buttons.
	**Digits, letters, and symbols input buttons:** Indicates digits from 1 to 10, letters from a to z, and symbols input buttons shown in the table below.

Buttons	Digits	Letters	Symbols
	1	- - -	- - -
	2	a b c	- - -
	3	d e f	- - -
	4	g h i	- - -
	5	j k l	- - -
	6	m n o	- - -
	7	p q r s	- - -
	8	t u v	- - -
	9	w x y z	- - -
	0	- - -	. , : ;
	- - -	- - -	*

External Connectors

Your unit is equipped with the communication ports shown below:

➤ **Top panel**

➤ **Side panel**

Tester connectors and equipments to be connected are described in the table below:

Designation	Description	Connected Equipment
A,B	RJ-45 connectors to connect to the tested network or equipment (supported rates 10/100/1000 Mbps)	Ethernet cable
	SFP-module connectors	SFP-module
LAN	Remote control connector (supported rates 10/100 Mbps)	Ethernet cable
USB	Connect to PC via USB-interface	USB cable
12 V	External power unit connector	Power supply unit

Optical Transceivers

The following table lists the compatible SFPs that can be ordered through EXFO.

EXFO part Number	Description
FTB-8592	1000Base-ZX, 1550 nm, 80 Km
FTB-8591	1000Base-LX, 1310 nm, 10 Km
FTB-8590	1000Base-SX, 850 nm, 550 m
FTB-8597	1000Base-BX10-U, Bi-directional 1310 nm TX, 1490 nm RX, 10 Km
FTB-8596	1000Base-BX10-D, Bi-directional 1490 nm TX, 1310 nm RX, 10 Km

Conventions

Before using the product described in this guide, you should understand the following conventions:

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in *death or serious injury*. Do not proceed unless you understand and meet the required conditions.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in *minor or moderate injury*. Do not proceed unless you understand and meet the required conditions.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in *component damage*. Do not proceed unless you understand and meet the required conditions.

IMPORTANT

Refers to information about this product you should not overlook.

2 Safety Information

Laser Safety Warnings

WARNING

Do not install or terminate fibers while a laser source is active. Never look directly into a live fiber, and ensure that your eyes are protected at all times.

WARNING

This product may employ pluggable SFP lasers.

WARNING

When the LASER LED is on, the ETS-1000 is receiving/emitting an optical signal.

Installation Instructions Warnings

CAUTION

No user serviceable parts are contained inside. Contact the manufacturer regarding service of this equipment.

IMPORTANT

All wiring and installation must be in accordance with local building and electrical codes acceptable to the authorities in the countries where the equipment is installed and used.

CAUTION

Electrostatic Discharge (ESD) Sensitive Equipment:

To minimize the risk of damage, dissipate static electricity by touching a grounded unpainted metal object

- **before connecting or disconnecting cables to/from the module.**
- **before inserting or removing SFPs to/from the analyzer.**

IMPORTANT

Unauthorized modifications to this equipment shall void the user's authority to operate this equipment.

3 Getting Started

Before setting up the procedures and performing tests on your ETS-1000 analyzer, turn the unit on.

To turn the unit on:

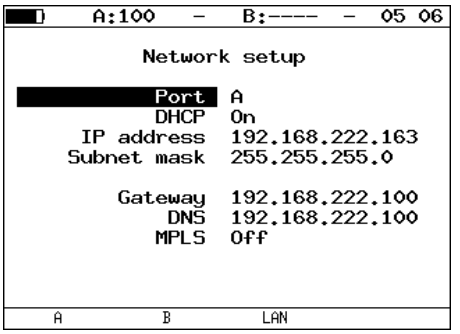
1. Get the tester from the box and make the external examination.
2. Keep the tester in normal environmental conditions for at least 2 hours (if the tester has been previously kept in conditions distinct from normal).
3. Connect the power supply unit to the electric network (if you use mains voltage 110–240V with the 50/60Hz frequency).
4. Turn the unit on.

4 Setting up your Unit

You can configure the network, test interface, and other unit settings for your ETS-1000 analyzer before testing.

Network setup

Configure the Network parameters from the **Network setup** menu as explained below.



Port A:

- **Port**: select port (A, B, or LAN).
- **DHCP**: if enabled, all parameters (IP address, subnet mask, gateway IP address, and the DNS server IP address) are provided automatically by the DHCP server.
- **IP address**: port IP address.
- **Subnet Mask**: specifies which part of the IP address is the network address and which part is the host address.
- **Gateway**: gateway IP address.

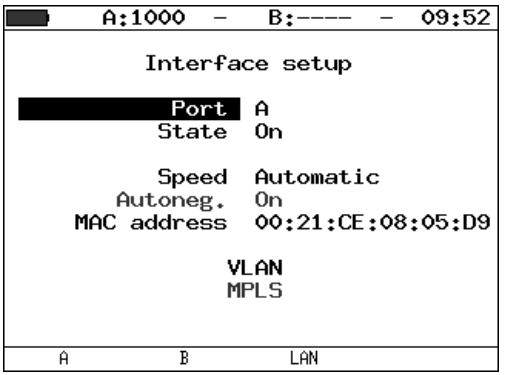
- **DNS—**IP: address of the DNS-server.
- **MPLS**: on/off frames with label transmitting for port A (B) (for LANport MPLS does not supported). If a value of the MPLS field will be set to Off MPLS field (Interface setup menu) will become inaccessible for editing.

Note: *Note: gateway IP address and IP address of the DNS-server are established independently for each port.*

Interface setup

The Interface setup is used to configure the local test interface. The required parameters correspond to the physical, data link, and network layers. The parameters are globally configured and applied to all the tests and tools. Ensure that these parameters are set before running any tests or tools.

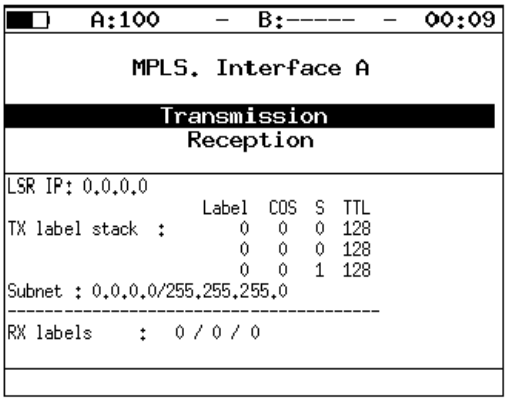
Configure the interface parameters from the Interface setup menu as explained below.



- **Port**: Select the **Port** to customize.
- **State:** switch on/off the port. You can switch off unused port to save the power.
- **Speed**: select transmission rate. If you selected Automatic, then transmission rate will be determined automatically (any of the 10/100/1000 Mbit/s values can be used). Also, in this case a value of the Autoneg. Field will be set to On and become inaccessible.

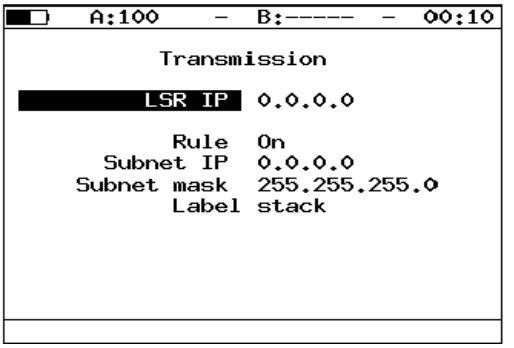
- **Autoneg**: enabling the auto-negotiation mode. If enabled, you need to select the preferable rate (or set Automatic, any of the 10/100/1000Mbit/s values that can be used) and set the Auto-negotiation parameter to On. The connection will be established only if the auto-negotiation mode is enabled also on remote end, and at least one of the parameters is set to the same value.
- **MAC address**: MAC address of the port (A, B, or LAN), which can be specified.
- **VLAN**: Enabling/Disabling **VLAN** parameters setup.
- **ID**: 12-bit VLAN identifier (integer in the range 0–4095).
- **Priority**: traffic priority.
- **MPLS:** switch to the MPLS. Interface A menu (MPLS. Interface B)**.**

Note: *if you use SFP-modules, then the Speed should be always set to the 1Gb/s value.*

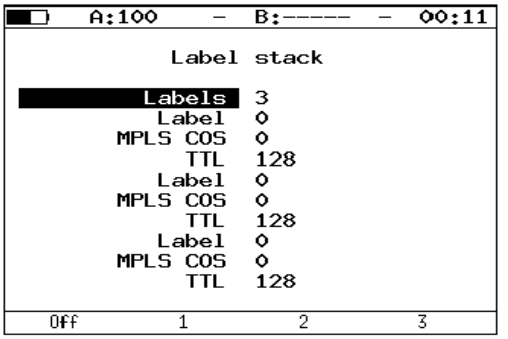


- **Transmission:** switch to the Label stack menu.
- **Reception:** switch to the Reception rules menu.

Values specified in the Transmission and Reception rules menu are also displayed on the screen.

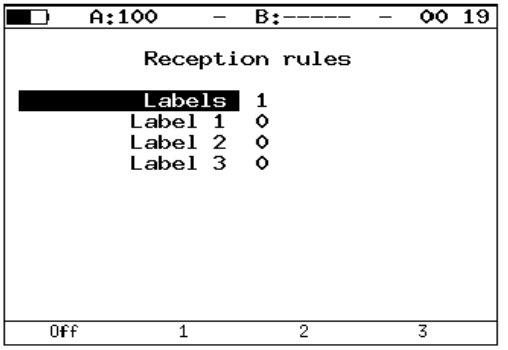


- **LSR IP**: IP address of router interface to which the ETS-1000 is connected. LSR realize label switching.
- **Rule:** on/off the rule for sending packets in the subnet parameters of which defines below.
- **Subnet IP:** subnet IP address
- **Subnet mask:** subnet mask.
- **Label stack:** switch to the label stack menu.



- **Labels:** number of labels (1–3).

- **Label:** Table value.
- **MPLS cos:** class of service for datagram.
- **TTL:** time to live for datagram.
- **Labels:** number of labels (1–3).



- **Label 1, Label 2, Label 3:** label value.

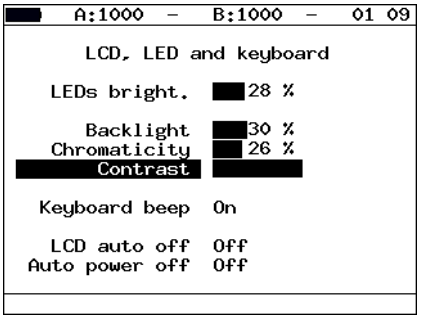
Unit Setup

Configure the unit parameters from the **Unit setup** menu as explained in the below unit.

Display Settings

To fit your work environment, you may adjust the LED, LCD display settings, keyboard beeping etc.

Configure the display parameters from the **LCD, LED and Keyboard** menu as explained below.



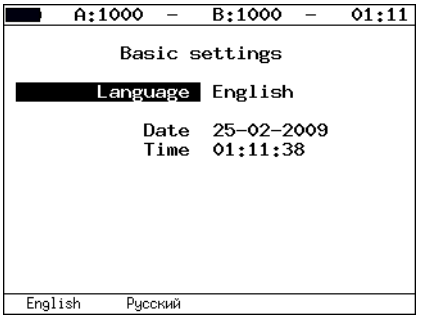
- **LEDs bright**: Select **LEDs bright.** to customize the LED brightness.
- **Backlight**: Select **Backlight** to customize the screen backlight brightness.
- **Chromaticity**: Select **Chromaticity** to customize display chromaticity.
- **Contrast**: Select **Contrast** to customize display contrast.
- **Keyboard beep**: Enable (**On**) or Disable (**Off**) the keyboard beeping.

- **LCD auto off**: Select **LCD auto off** for switching off the display automatically. The available options are:
  - Off
  - 20 sec
  - 40 sec
  - 60 sec

  To increase the autonomous action period, select the minimum value.
- **Auto power off**: Select **Auto power off** for switching off the tester automatically. The available options are:
  - Off
  - 1 minute
  - 5 minutes
  - 10 minutes

Basic Settings

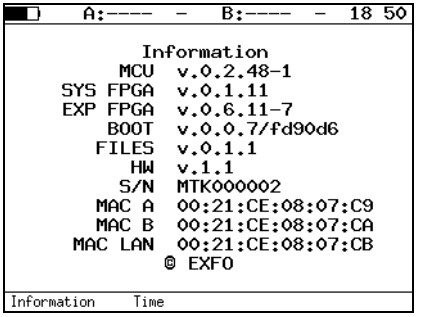
Configure the language, date and time from the **Basic Settings** menu as explained below.



- **Language**: Set the interface language.
- **Date**: Enter or select the current date.
- **Time**: Enter or select the current time.

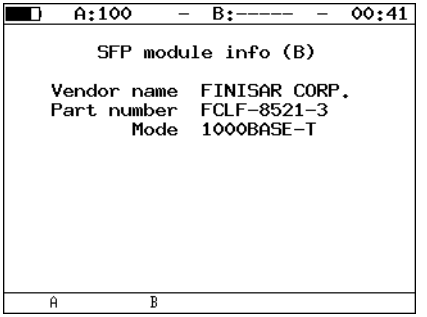
Information

Displays the software versions, serial number, and MAC addresses of the unit ports.



SFP Information

The optical interface on the module is made available via a Small Form Factor Pluggable Module (SFP). For a list of supported SFPs, refer to *Optical Transceivers* on page 10- The SFP Information displays the following information about the SFP-module:

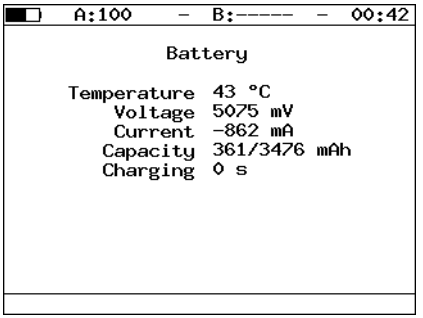


- **Vendor name**
- **Part number**: SFP model
- **Mode**: supported data transfer mode

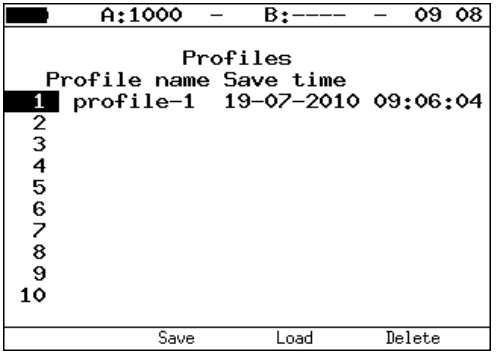
To select the port, press F1 for port A or F2 for port B.

Battery

Displays the following data about the current condition of the internal battery: temperature (°C), voltage (mV), current (mA), current/maximum capacity (mAh), and the charging time (period of time passed after the charging start) in seconds.



Profiles



ETS-1000 allows to create up to 10 profiles with tools and tests settings.

User can create profile with settings of:

- RFC-2544, BERT, Packet jitter, Complex traffic, Test traffic;
- network interfaces;
- IP utilities: PING, Traceroute, TCP client.

To create the profile it is necessary to execute needed settings, switch to the menu Profiles and press (Save). Remote control commands are described in the appendix C

Event Log

Event log provides events messages display in the ETS-1000. Setup Log menu and also in console terminal by connection to the device via USB-interface and by remote control via TELNET protocol.

Logged events are listed below:

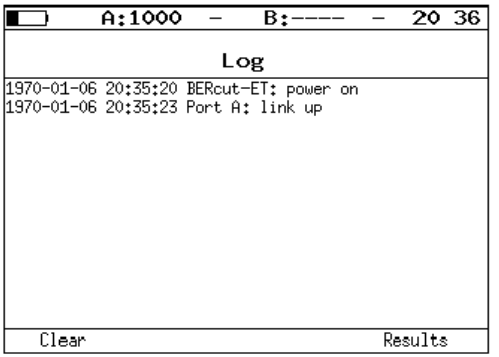
- start/stop of the test;
- Loopback mode is switched on/off;
- change of connection state;
- remote test is running;
- device is switched on/off;
- low battery.

If one of these events occurred, the following message will be displayed in the console terminal/Log menu.

<date> <time> <sender> <message>

For example, if you switch on Loopback mode at the 2nd layer on port B, the following message will be displayed:

By default the function of messages displaying via USB interface and via TELNET protocol is switched off. To switch on/off use log on/off remote control command.



To clear the buffer press F1 (Clear). To save messages about occurred events switch to the results menu (press F4 (Results)).

If you save results of any test, the messages are also saved.

Managing Options

Option is an additional functionality of the ETS-1000 analyzer that is not bundled in the basic shipment.

To activate an option, you need to get an activation key, which is generated for the particular serial number of a unit. Enter the key in the **Options** menu or via remote control using the ats command (see Remote Control Commands *on page 141* for details).

Option	Description
ETIP	**TCP/IP network diagnostics (routing, nodes availability, DNS).**
ETWEB	**HTTP-connections testing (requires ETIP option enabled).**
ETJT	**Packet jitter measurements.**
ETRC	**Remote control for the ETS-1000 via TELNET protocol and WWW-interface.**
ETMM	**Complex traffic generating**
ETMPLS	**MPLS support**
ETAT	**Asymmetric test support**

5 Typical Tasks and Solutions

Typical Tasks

The main task for Ethernet-network testing is the compliance validation of service level agreements (SLAs) between operators and subscribers. Quality of Service (QoS) must be verified. This can be accomplished by performing the RFC2544 test which provides throughput, frame loss rate, latency, and back-to-back measurements. When multiple services/QoS levels are provided, the performance is best verified via a multiple stream test. Other utility tools such as Ping and Trace Route provide basic network connectivity information. Finally in order to perform end-to-end tests, the Loopback mode allows re-directing traffic at the physical, data link, network and transport OSI layers.

RFC 2544 Methodology

The RFC 2544 methodology defines a specific set of tests to measure and report the performance characteristics of network unit. According to the RFC 2544, for Ethernet-network test the following frame sizes are recommended to be used: 64, 128, 256, 512, 1024, 1280, and 1518 bytes. Taking into consideration the tests defined by the methodology (throughput, latency, frame loss rate, and back-to-back), this methodology is the de-facto standard for analyzing the Ethernet-network performance.

ETS-1000 analyzer supports four standard tests defined by the RFC 2544 methodology.

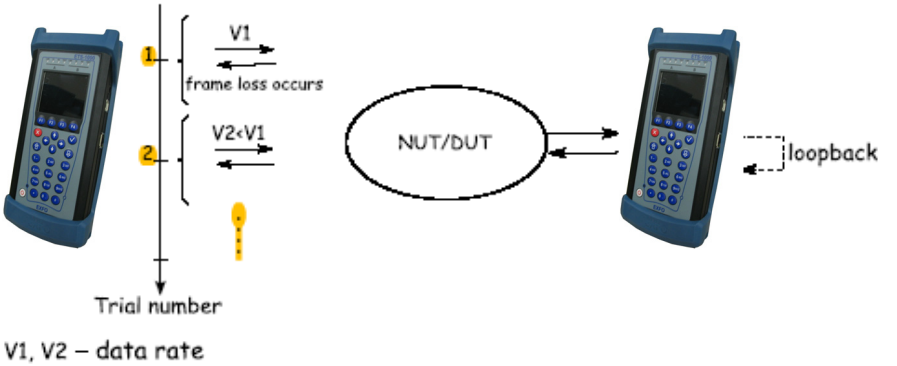
Throughput

This test allows to determine the maximum possible rate for the Ethernet-networks equipment.

Throughput: the fastest rate at which the number of test frames transmitted by the DUT is equal to the number of test frames sent to it by the test equipment.

When measuring the throughput, specific number of frames with minimum interframe gap is sent to DUT. Then, the analyzer counts the frames that are transmitted by the DUT. If the fewer frames are received than transmitted, the interframe gap is increased and the test reruns.

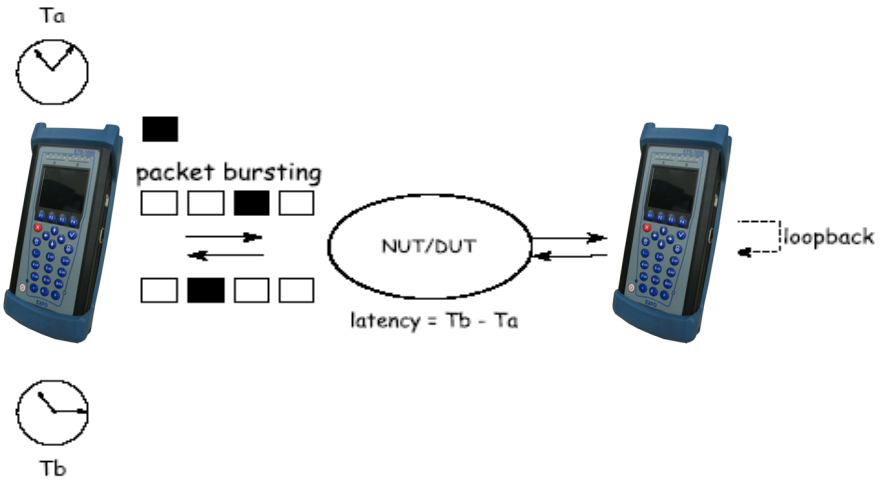
Note: *The relation between interframe gap and load is inverse, thus, the bigger the gap value is the lesser the load is.*



Latency

This test allows to analyze the time it takes for a frame to be transmitted from the source to destination and then back to the source. The latency is one of the major parameters for real-time applications running over Ethernet networks.

When analyzing the latency, the throughput for DUT at each of the listed frame sizes is determined first. Then, a stream of frames at a particular frame size is sent through the DUT at the determined throughput rate to a specific destination. The minimum duration of the stream transmission is set as 120 seconds (user can specify alternative value in the range of 1–2886 seconds). In a specific time, an identifying tag is included into one frame with the type of tag being implementation dependent. The time at which this frame is fully transmitted is recorded as a tag time stamp value. The receiver port of the analyzer then recognizes the tag information in the frame stream and records the time at which the tagged frame was received (Tb value).
The latency value is the difference between time stamp Tb and time stamp Ta values.
The test is repeated at least 20 times (user can specify alternative value from 1 to 30).



Frame Loss Rate

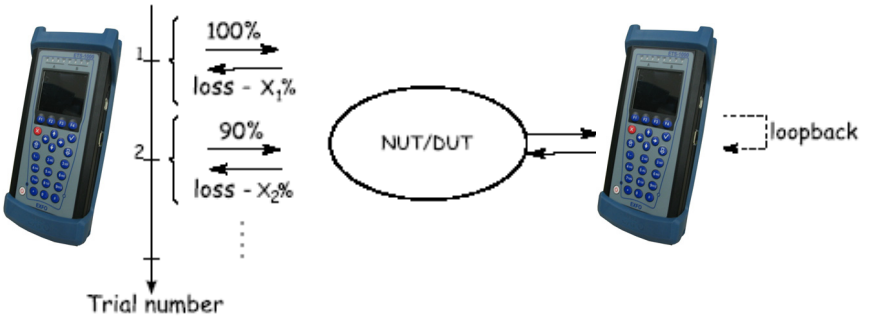
This test allows to estimate network's ability to support real-time operating applications because the big loss percentage will result in service quality degrading.

Frame loss test allows to count the percentage of frames that have not been transmitted by DUT due to lack of hardware resources.

To test the frame loss rate, a specific number of frames (input count) is sent at a specific rate through the DUT to be tested and then the analyzer counts the frames that are transmitted by the DUT (output count). The frame loss rate at each point is calculated using the following equation:

100 × (input count - output count) / (input count)

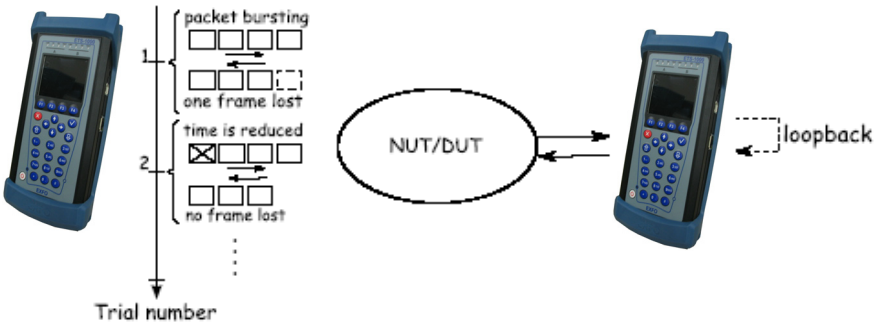
The first trial should be run for the frame rate that corresponds to 100% of the maximum rate for the frame size on the input media. Repeat the procedure for the rate that corresponds to 90% of the maximum rate used and then for 80% of this rate. The trials are continued with 10% reducing intervals (a finer granularity is supported) until there are two successive trials in which no frames are lost.



Back-to-back

The test allows estimating the time during which the DUT is capable to manage the maximum load.

The analyzer sends a burst of frames with minimum interframe gap to the DUT and then counts the number of frames forwarded by the DUT. If the count of transmitted frames is equal to the number of frames forwarded, the time of transmission is being increased and the test is being rerun until there are two trials succeeded with no frame lost. If the number of forwarded frames is less than the number of transmitted ones, the time of transmission is being reduced and the test is being rerun.



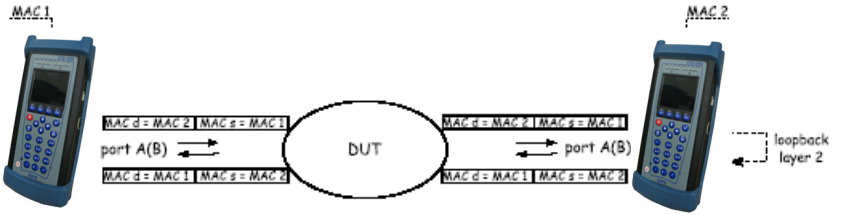
6 Connecting Unit

The ETS-1000 Analyzer units unit can be connected using different connection schemes as described in this chapter.

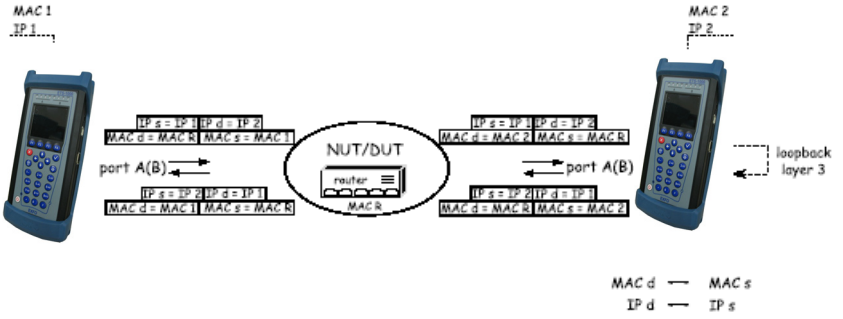
Unit Connection Schemes

The units can be connected in four different ways

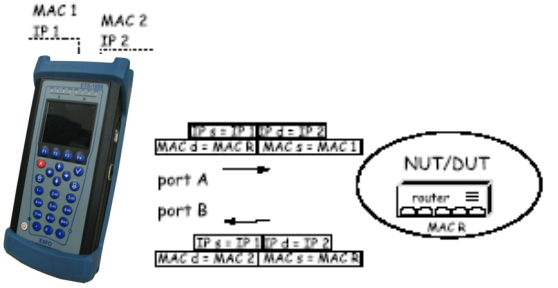
Unit Connection Scheme 1



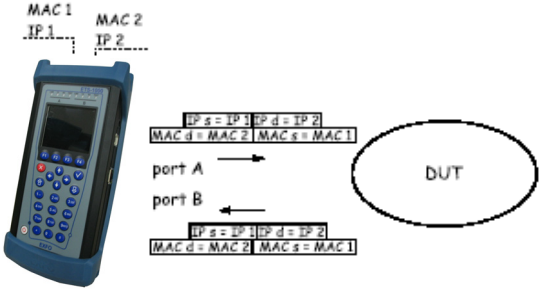
Unit Connection Scheme 2



Unit Connection Scheme 3



Unit Connection Scheme 4



The scheme 1 shows the connection of the analyzer (using one analyzer's port) to the network with equipment operating on the Data Link layer (for example, network switch). In this case, generated test traffic should be rerouted back to the analyzer via the loopback. At the DUT, source and destination MAC addresses are swapped in the incoming packets, and the test stream is retransmitted back to the source port on the analyzer.

All the connection schemes use the following notation:

- MAC s — source MAC address
- MAC d — destination MAC address
- MAC R — gateway MAC address
- IP s — source IP address
- IP d — destination IP address

The figure above shows analyzer connection to a network with equipment operating on both the Data Link and Network layers (for example, switches and routers). Unlike the first case, with this connection scheme both source and destination MAC and IP addresses are swapped and the traffic is returned to the source port.

In the case of testing networks/equipment with capability of IP-traffic routing, two unit ports are used. Packets are rerouted from one port to another via a router. In addition, ETS-1000 can be connected to a network switch.

7 Configuring and Starting a Test

The ETS-1000 analyzer allows performance testing as per RFC 2544, including the following subtests:

- Throughput
- Latency
- Frame loss
- Back-to-back

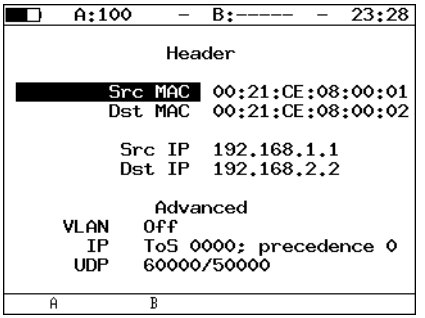
Before performing the above tests, the test parameters are required to be configured. You can also view the test results from your ETS-1000 analyzer.

RFC 2544 General Settings

Configure the following RFC 2544 general settings in your ETS-1000 analyzer.

Setting Up the Header

Configure the following parameters from the **Header** menu as explained below.



- **Src MAC**: Enter the MAC address of a source interface.

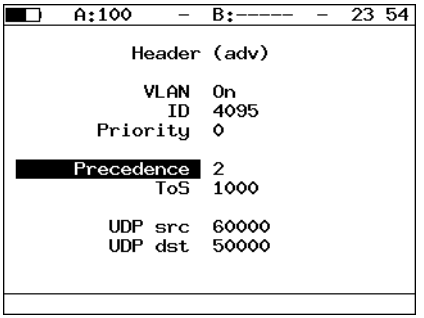
- **Dst MAC**: Enter the destination MAC address.
  - If a transmitter and receiver are connected directly, without using any router, enter the MAC address of the receiver interface.
  - If there is at least one router between the sender and the receiver, enter the MAC address of the router that is nearest to the receiver.
- **Src IP**: Enter the source IP address.
- **Dst IP**: Enter the destination IP address.

Note: *ETS-1000 can also setup the MAC and IP addresses automatically.*

- To substitute the current MAC address value with the A (B) port MAC address specified in the **Information** menu, press F1 (F2).
- To substitute the current IP address value with the A (B) port IP address specified in the **Network setup** menu, press F1 (F2).
- Upon pressing F3 button (with Dst MAC selected), the ARP-request will be performed. As a result of the request, instead of the destination MAC address, the MAC address corresponding to the destination IP address will be used.

Values specified in the **Header (adv)** menu are also displayed.

Setting Up the Header (advanced)



➤ **ID**: Enter the VLAN ID. The accepted range is 0 to 4095. The 12-bit VLAN identifier is a number, that explicitly defines VLAN to which the packet belongs.

The null VLAN ID indicates that the tag header contains only user priority information and no VLAN identifier is present in the frame.

If the VLAN ID is set to 1, then while transmitting through the router's port, the VLAN ID will be automatically set equal to the VLAN ID of this port.

➤ **Priority**: Select the VLAN **Priority**. Eight values of priority ([1]) are supported.

Correspondence between priority and traffic type are as follows:

Value	Description
1	Background
0	(Default) Best Effort
2	Excellent Effort
3	Critical Applications
4	Video
5	Voice
6	Internetwork Control
7	Network Control

Priority 0 is reserved for the best transmission and is assigned if none other class has been specified. Priority values 1 to 3 are intended for use with different tasks from the streaming applications to the FTP traffic that can cope with possible data loss. Priority values 4 and 5 can be used for latency sensitive traffic such as video or speech.

Priority values 6 and 7 (Internetwork Control and Network Control traffic types) are intended for network management messages.

➤ **Precedence**: Frame priority field. In accordance with RFC 791 [2], eight priority values are available. Sender can specify any priority value from the table shown below.

Value	Description
0	Routine
1	Priority
2	Immediate
3	Flash
4	Flash Override
5	CRITIC/ECP
6	Internetwork Control
7	Network Control

➤ **ToS (Type of Service)**: the field determines type of service for datagram. The source can set any value from the table below in accordance with RFC 1349 [4] methodology.

Value	Description	Notes
1000	Minimize delay	Use the value if a period of packet delivery from the source to destination (latency period) is the main priority and must be minimum.
0100	Maximize throughput	Use the value to specify that the packet must be routed through the link with the maximum throughput.
010	Maximize reliability	Use the value to ensure the packet is delivered without retransmission
001	Minimize monetary cost	Use the value to minimize the monetary cost of the data delivery
000	All normal	In this case packet routing is left at the discretion of a provider.

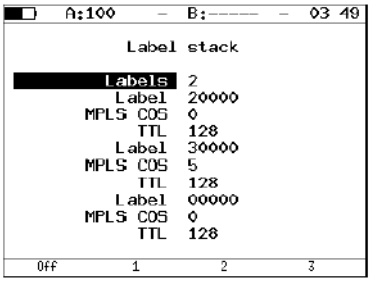
➤ **UDP src**: Enter the source UDP port.

➤ **UDP dst**: Enter the destination UDP port.

RFC 2544 MPLS Settings

The Label stack for networks testing can be specified in the **Label stack** menu. Configure the following parameters from the **Label Stack** menu as explained below.

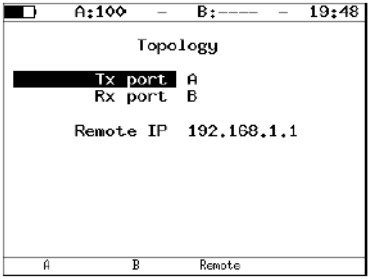
Press **Tests**, select **RFC 2544**, **Setup**, **Header**, **Advanced**, and **MPLS**.



- **Labels**: Enter the number of labels. Choices are from 1 to 3.
- **Label**: Enter the **Label** value.
- **MPLS COS**: Select the Class of Service (**COS**) for datagram.
- **TTL**: Enter the Time to Live (**TTL**) value for datagram.

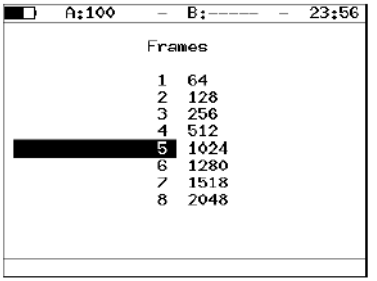
Test Topology

Use the **Topology** menu to specify receiving and transmitting ports. The same port can be used for both data transmission and receiving (for example, with the Loopback feature). If you use asymmetric test function you must select Remote as receiving/transmitting port.



Selecting Frame Size

Configure the frame sizes as explained below.



To perform tests, user can do any one of the following.

- Select standard sizes of transmitted frames in accordance to the RFC 2544 methodology by pressing F4. The standard default frame sizes are **64**, **128**, **256**, **512**, **1024**, **1280**, **1518 bytes**.
- Enter any frame size from the acceptable range of **64** to **9600 bytes**.

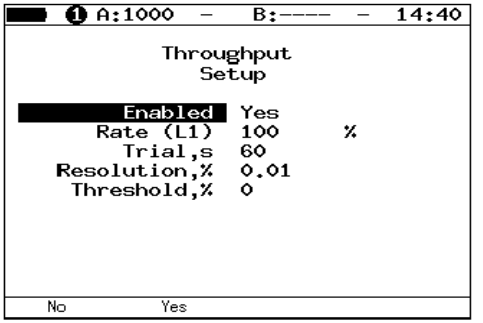
RFC 2544 Test Parameters Setup

Configure the test parameters for the Throughput, Latency, Frame loss and Back-to-back tests.

Throughput Test Settings

The objective of this test is to find the throughput of the unit under test for which there is no frame loss. Starting at the specified maximum rate (Maximum Rate), the rate converges towards the highest throughput without frame loss with the test having a predefined duration (Test Time).

The throughput measurement is performed for each defined frame size.



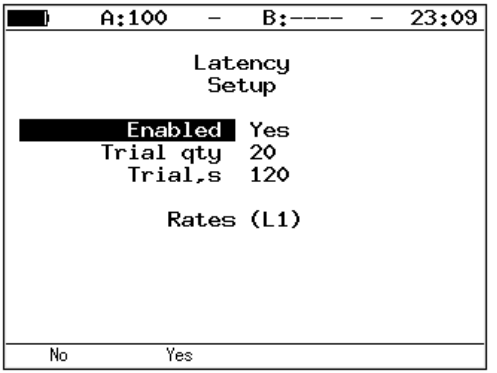
- **Enabled**: Enable (**Yes**) or Disable (**No**) the throughput analysis.
- **Rate,**%: indicates the load value, specified in the percentage of the test flow rate. The accepted range is 1 to 100 %.
- **Trial, s**: indicates the period of time during which the test is performed for each of the specified frame sizes. The accepted range is **1** to **2886** seconds.

- **Resolution**, **%**: throughput analysis resolution value. Possible values: 10 (F1), 1 (F2), 0.1 (F3), 0.01 (F4). Lesser resolution value is, the bigger throughput analysis accuracy is.
- **Threshold, %:** throughput analysis threshold of loss value in percent of current load. Possible values: 0 - 10 %. Trial is successful if loss doesn't exceed the threshold. This feature allows to determine through-put of channel with invariable loss. As per rfc2544 trial is successful if loss is 0.

Latency Test Settings

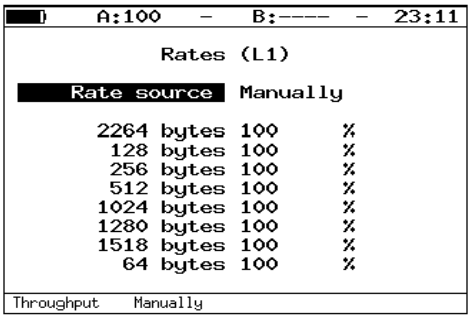
The objective of this test is to find the time required for the sent frame to go through the unit under test and return to the ETS-1000 analyzer. Starting by sending a stream of frames for the predefined duration and rate at a particular frame size, an identifying dependent tag is included in one frame. The time at which this frame is transmitted is recorded (timestamp A). When the tagged frame comes back, the time is recorded again (timestamp B) and the Latency result is: timestamp B - timestamp A. The test is repeated for the defined number of times and the average result is calculated.

The Latency test is performed for each defined frame size.



- **Enabled**: Enable (**Yes**) or Disable (**No**) the latency analysis.
- **Trial qty**: indicates the number of test trials performed for each specified frame size.
- **Trial, s**: indicates the period of time during which the test is performed for each of the specified frame sizes. The accepted range is 1 to 2886 seconds.
- **Rates (L1):** switched to Rates (L1) menu.

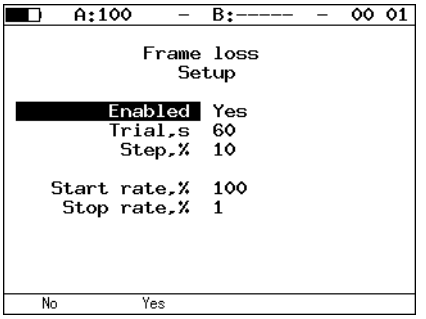
➤ **Rate source:** if you press button (F1) (Throughput), Latency test will be performed with rates values that are a result of Throughput test. If you press button (F2) (Manually), Latency test will be performed with physical (L1) rates value defined by user in percent (F1), in kbps (F2) or in Mbps (F3).



Frame Loss Test Setting

The objective of this test is to find the percentage of frames that are lost due to lack of resources. The test is performed for a specific frame size and for the specified duration.

The Frame loss test is performed for each defined frame size.

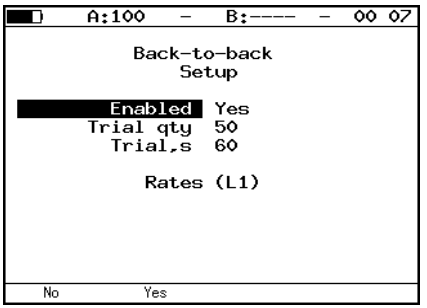


- **Enabled**: Enable (**Yes**) or Disable (**No**) the Frame loss analysis.
- **Trial, s**: indicates the period of time during which the test is performed for each of the specified frame sizes. The accepted range is 1 to 2886 seconds.
- **Steps, %:** indicates the number of rate changing steps in percentage. The accepted range is from **1** to **10** %.
- **Start rate, %:** indicates the range of physical rates value at which the test starts for each of the specified frame sizes.
- **Stop rate, %:** indicates the range of physical rates value at which the test stops for each of the specified frame sizes.

Back-to-back Test Settings

The objective of this test is to find the maximum number of frames at maximum rate that can be sent without frame loss. A number of frames are sent with minimum inter-frame gaps to the unit under test and the number of forwarded frames are counted. If the count of transmitted frames is equal to the number of forwarded frames, the length of the time is increased and the test is rerun. If the number of forwarded frames is less than the number of transmitted frames, the duration is reduced and the test is rerun. The back-to-back value is the number of frames in the longest time that the device under test (DUT) can handle without any frames loss. The test performs the number of defined trials.

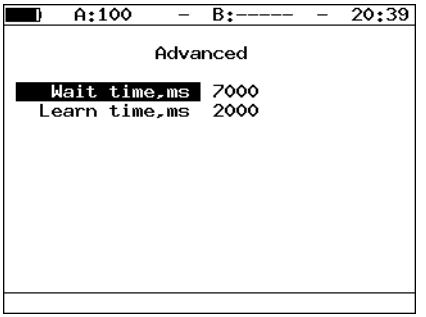
The back-to-back test is performed for each defined frame size.



- **Enabled**: Enable (**Yes**) or Disable (**No**) the Back-to-back analysis.
- **Trial qty**: indicates the number of test trials performed for each specified frame size.
- **Trial, s**: indicates the period of time during which the test is performed for each of the specified frame sizes. The accepted range is 1 to 2886 seconds.
- **Rates (L1):** switched to Rates (L1) menu.

Advanced

Configure the advanced menu as explained below.



➤ **Wait time, ms:** Specify the period between the end of test traffic generation and the end of trial.

Note: *In accordance with RFC 2544 methodology, the wait time is 7000 ms and learn time is 2000 ms.*

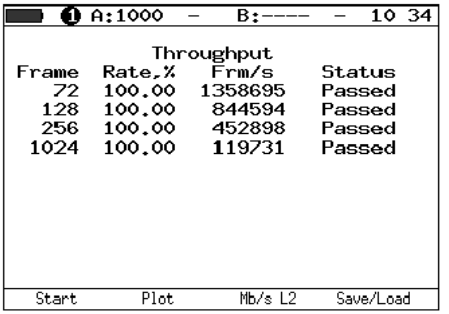
➤ **Learn time, ms:** Specify the period between learning frame sending and trial start.

Note: *User can specify arbitrary values of wait time within 100–7000 ms range. Learn time must be within 100–2000 ms range.*

RFC 2544. Performing Analysis

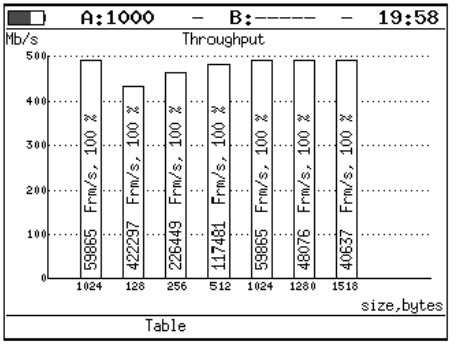
Throughput Test Results

➤ Table



Test results are displayed as a table that contains the following values: frame size (bytes), throughput value (percents), measured value for the throughput (select unit measure by pressing (F3): Frm/s, Mb/s L2, Mb/s L3, Mb/s L4).

➤ Graph



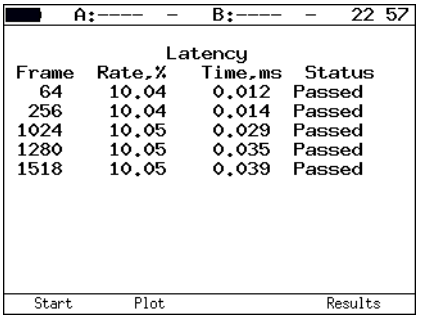
The diagram shows throughput values for each specified frame size. The measured throughput value in Frm/s and in percentage (relatively to the specified rate) is displayed on the diagram vertical bars.

The results may be displayed in two ways (press button):

1. The maximum value marked on the Y axis is the maximum transmission rate value. The X axis shows frame size value. Empty bars display maximum theoretical rate value. Completed bars display measured rate value.
2. The maximum value marked on the Y axis is the maximum measured rate value. The X axis shows frame size value.

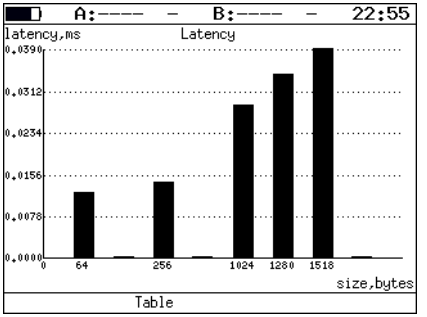
Latency - Test Results

➤ Table



The table shows mean value for the latency (ms) for each of the specified frame sizes, and the corresponding value of the throughput (percent) measured as a result of the Throughput test.

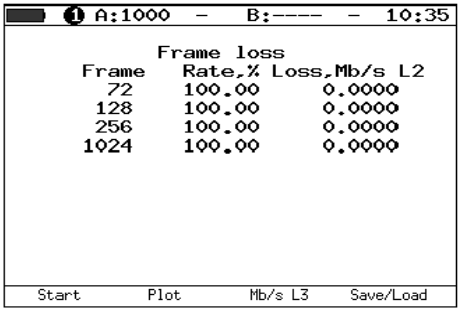
➤ Graph



On the diagram, for each of the frame sizes a vertical bar shows the mean value of the latency (ms).

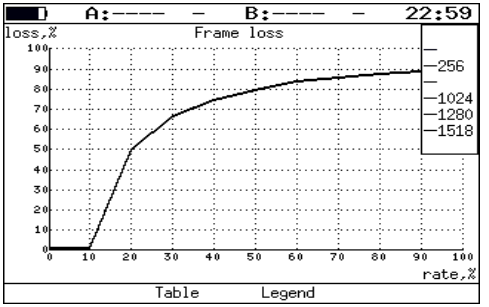
Frame Loss - Test Results

➤ Table



The table shows the frame loss value (percent) for each of the specified frame sizes (in bytes) and the rate value (percent, Mb/s L2, Mb/s L3, Mb/s L4).

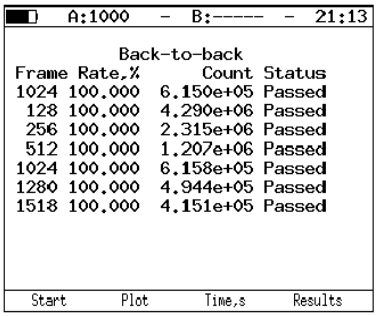
➤ Graph



On the diagram, for each of the specified frame sizes the relation between frame loss (percent) and the rate (percent) is shown.

Back-to-back - Test Results

➤ Table.

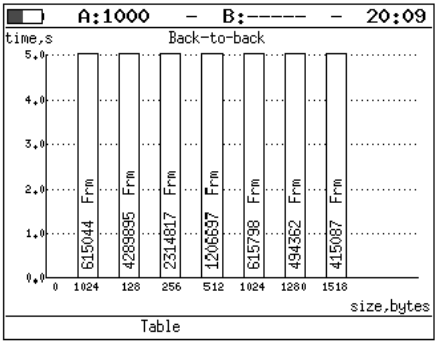


For each of the specified frame sizes, the table shows period of time during which the tested equipment is coping with peak load.

If this time is not detected, the error messages are shown in the test stage column and dashes appear in the Time, s column.

If you press (F3) button (Frames), the Count column will be shown instead Time, s column.

➤ Graph



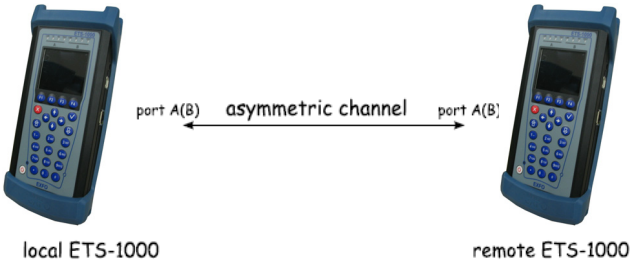
On the diagram, for each of the specified frame sizes a vertical bar shows measured value of the time during which the tested equipment was coping with peak load. The count of frames that are transmitted during the test is displayed on the diagram vertical bars.

Asymmetric Test

Asymmetric test function 4 is used to check operability of communication link that has different transmitting and receiving rates.

For asymmetric test, two ETS-1000 unit should be used: local and remote. On the local unit the test parameters are set. The remote unit is on the other end of asymmetric channel. Test traffic generation can be performed in two ways:

- **From local unit to remote:** In this case the port A(B) is set as a source port. Port Remote is selected as a destination one.
- **From remote unit to local:** In this case the port Remote is set as a source port. Port A(B) is selected as a destination one.

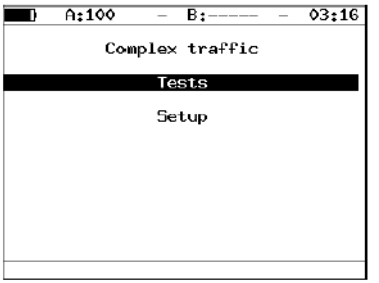


Tests for which the function is available are listed below:

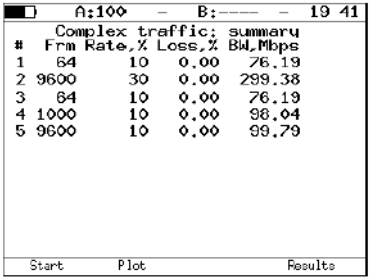
- RFC 2544: throughput, frame loss, back-to-back.
- BERT (L2, L3, L4).
- Complex traffic.

Complex Traffic

Function of complex traffic generation allows to generate up to 10 data streams with different settings. Using this function you can emulate various types of rates, check priority accuracy in the tested equipment.



➤ **Tests:** Switch to the summary menu of Complex traffic (test start, results display).



To start test, press F1 button (Start).

After the end of testing, the following parameters will be displayed:

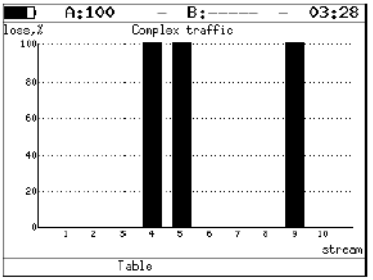
➤ specified frame size (in Bytes).

➤ specified rate (in %).

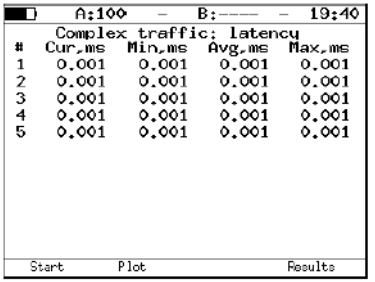
➤ frame loss (in %).

➤ bandwidth (in Mbps).

To switch to the screen that contains graphical representation of test results, press F2 button (Plot).



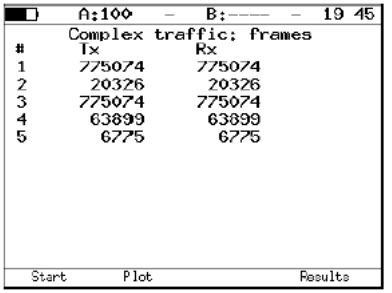
On the diagram, for each stream a vertical bar shows measured loss value. To switch to the **Results** menu, press F4 button (Results). To switch to the **Complex traffic**: **latency** screen, press → button.



All the latency values for complex traffic use the following notation:

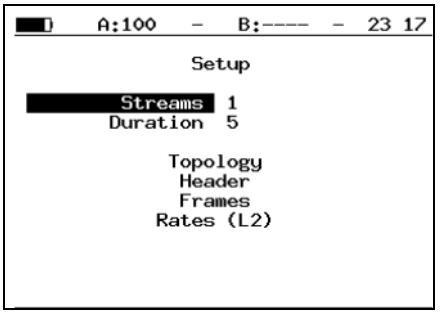
- Curr, ms: Current value of latency (in ms)
- Min, ms: Minimum value of latency (in ms)
- Avg, ms: Average value of latency (in ms)
- Max, ms: Maximal value of latency (in ms)

To switch to the screen that contains information about number of transmitted and received frames, press button.



For each of the streams information about number of transmitted (Tx) and received (Rx) frames is displayed on the screen.

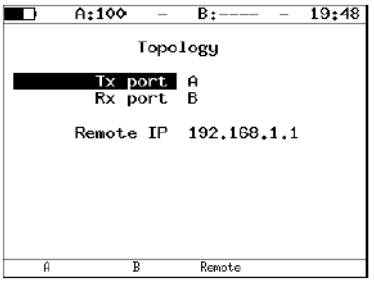
➤ **Setup**: switch to the Setup menu.



➤ **Streams:** number of data streams (1–10).

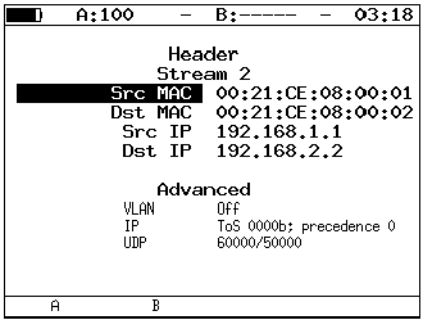
➤ **Duration:** time of data streams generation (1–2886 s).

➤ **Topology:** switch to the Topology menu.

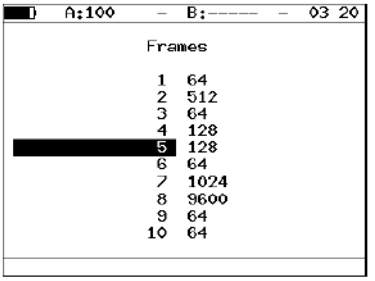


Use the **Topology** menu to specify receiving and transmitting ports.The same port can be used for both data transmission and receiving (for example, with the Loopback feature). If you use asymmetric test function you must select Remote as receiving/transmitting port.

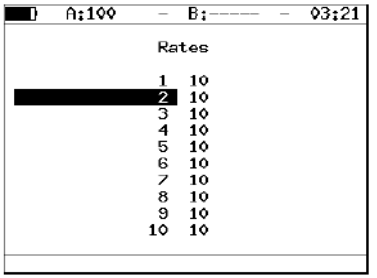
➤ **Header:** Switches to the **Header** menu. To select stream number, press ◄ or ► buttons.



➤ **Frames**: Switches to the **Frames** menu. Frame size for every stream ranges from **64** to **9600** bytes.



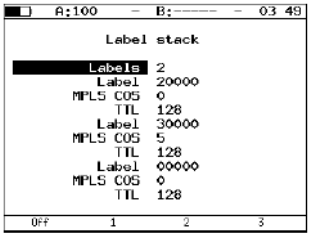
➤ **Rates (L2)**: Switches to the **Rates** menu. Framed rate value are specified in percent (F1), in kbps (F2) or in Mbps (F3).



Complex Traffic - MPLS Settings

The Label traffic for networks testing can be specified in the **Label traffic** menu. Configure the following parameters from the **Label traffic** menu as explained below.

Press **Tests**, select **Complex traffic**, **Setup**, **Header**, **Advanced**, and **MPLS**.



- **Labels:** Enter the number of labels. Choices are from **1** to **3**.
- **Label**: Enter the Label value.
- **MPLS COS:** Select the Class of Service (COS) for datagram.
- **TTL:** Enter the Time to Live (TTL) value for datagram.

Loopback

The Loopback function is necessary for networks testing in compliance with the RFC 2544, as well as for a number of other tasks. This function allows to test the network without changing its settings. Network testing with the Loopback function can be performed at the following OSI layers.

- At the Physical layer (L1) all the incoming traffic is re-transmitted backward without change; statistics are gathered for the incoming traffic.
- At the Data link layer (L2), all the incoming frames are re-transmitted backward with swapping destination and source MAC addresses or without swapping MAC addresses. ETS-1000 supports substitution of destination and/or source MAC address with user-defined MAC address. Both incoming and outgoing traffic statistics are gathered.

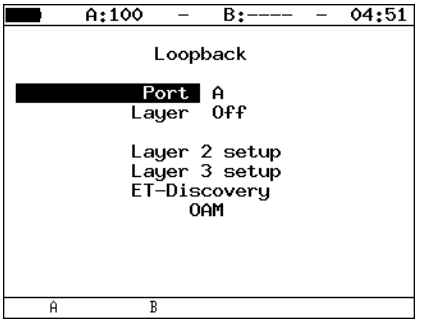
Note: *For the loopback at the L2 or L3 layers, packets with identical destination and source MAC addresses as well as OAM protocol data units (OAMPDU) and ARP-requests, are not re-transmitted.*

- At the Network layer (L3) all incoming packets are re-transmitted backward with source and destination IP addresses swapping. ETS-1000 supports substitution of destination and/or source IP address with user-defined IP address. Both incoming and outgoing traffic statistics are gathered.

Note: *if the incoming packet contains the label, it will be retransmitted without changing it's value*

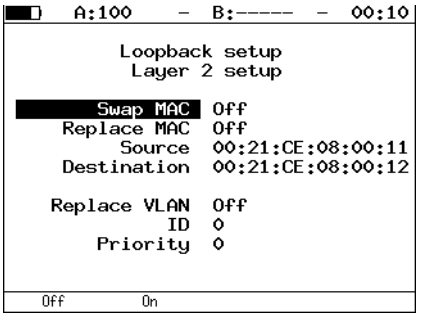
- At the Transport layer (L4) all incoming packets are being retransmitted backward (without error packets) with source and destination IP addresses and source and destination TCP/UDP port numbers swapping.

Note: *if the incoming packet contains the label, it will be retransmitted without changing it's value.*

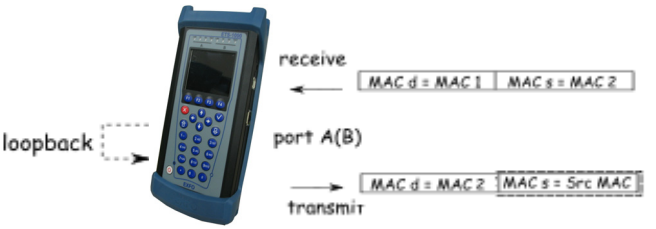


- **Port**: Select the Port (A or B) to enable the Loopback function.
- **Type**: Select the layer at which the traffic will be retransmitted.
  - Physical Layer
  - Data Link Layer (MAC)
  - Network Layer (IP)
  - Transport (TCP/UDP)
- **OAM**: Switches to OAM menu.

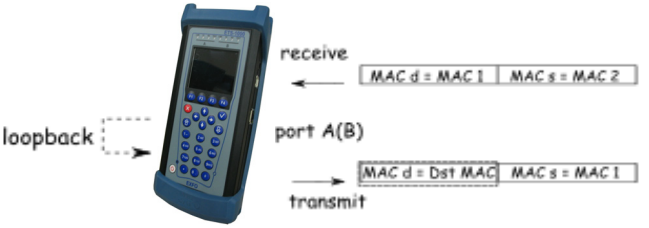
Configuring L2 Loopback



- **Swap MAC**: Enable (**On**) or Disable (**Off**) the substitution of destination and source MAC addresses in the incoming packets.
- **Replace MAC**: Select MAC address substitution mode.
  - **Off**: MAC address substitution is disabled
  - **Source**: Substitute Source MAC Address value



➤ **Destination**: Substitute Destination MAC Address value.



➤ **Src+Dst**: Substitute both Source MAC Address and Destination MAC Address values.

➤ **Source**: Specify a MAC address that will substitute the Source MAC Address of an Ethernet frame.

➤ **Destination**: Specify a MAC address that will substitute the Destination MAC Address of an Ethernet frame.

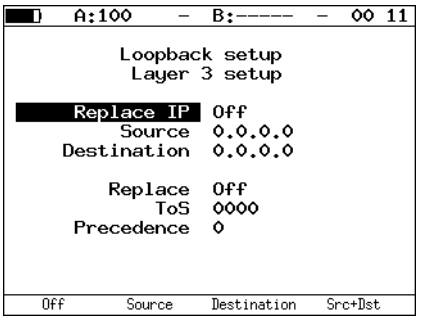
➤ **Replace VLAN**: Select VLAN-tags substitution mode:

- ➤ **Off**: VLAN-tags substitution is disabled
- ➤ **ID**: Substitute VLAN ID values
- ➤ **Priority**: Substitute VLAN priority values
- ➤ **ID+Pr**: Substitute both VLAN ID and VLAN priority values

➤ **ID**: Specify the value that will substitute VLAN ID of an Ethernet frame.

➤ **Priority**: Specify the value that will substitute VLAN priority of an Ethernet frame.

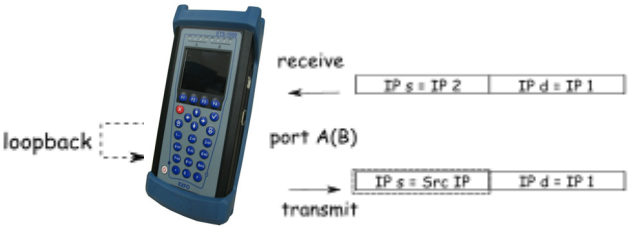
Configuring L3 Loopback



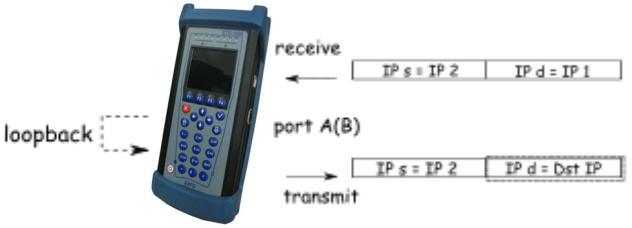
➤ **Replace IP**: Select the mode of IP addresses substitution.

➤ **Off**: IP address substitution is disabled

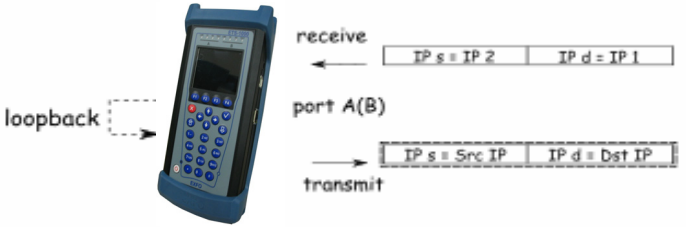
➤ **Source**: Substitute Source IP address



➤ **Destination**: Substitute Destination IP address.



➤ **Src+Dst**: Substitute both Source IP address and Destination IP address.



➤ **Source**: Specify IP address that will substitute the Source IP Address of an Ethernet frame.

➤ **Destination**: Specify IP address that will substitute the Destination IP Address of an Ethernet frame.

Replace: Select the mode of ToS substitution.

➤ **Off**: Substitution of Type of Service and Precedence values is disabled

➤ **ToS**: Substitute Type of Service values

➤ **Precedence**: Substitute Precedence values

➤ **ToS+Prec**: Substitute both Type of Service and Precedence values

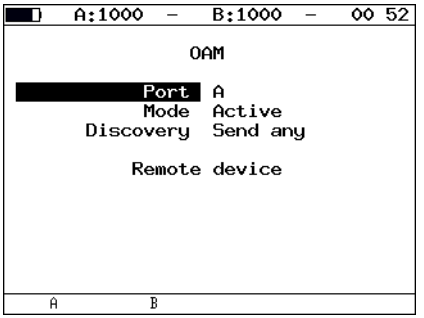
- **ToS**: Specify the value that will substitute Type of Service of an Ethernet frame.
- **Precedence**: Specify the value that will substitute Precedence of an Ethernet frame.

OAM

An important task for service providers is to provide high quality of administrating and maintenance for Ethernet-networks. To regulate these tasks the IEEE 802.3ah [8] standard (also known as Ethernet in the First Mile (EFM) OAM) was worked out.

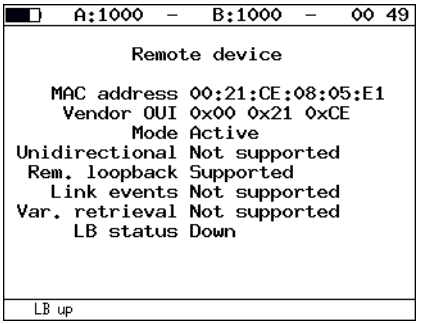
OAM (Operations, Administration, and Maintenance) is a protocol of monitoring the link state. The protocol operates at the Data Link Layer of OSI model. To transmit data between two Ethernet-units, OAM protocol data units (OAMPDU) are used. Both unit should support the IEEE 802.3ah standard and should be connected directly.

An important feature of the OAM protocol is providing the ability to use Loopback mode for the remote end.



➤ **Port**: Select a **Port** for OAM configuring.

- **Mode**: Select **Mode** for OAM configuring. The available OAM states are:
  - **Active**: In active mode, the selected port can send commands to locate remote unit, to enable the Loopback mode on the remote unit, and to respond to the Ethernet OAM commands from the remote unit.
  - **Passive**: In passive mode, the port can only respond to the Ethernet OAM commands from the remote unit, but cannot initiate the Loopback mode.
  - **Off**: OAM disabled.
- **Discovery**: Select the state of locating the remote unit. Available states are:
  - **Fault**
  - **Send local**
  - **Passive wait**
  - **Send loc/rem**
  - **Send loc/rem ok**
  - **Send any**
- **Remote unit**: Press to switch to the Remote unit screen.



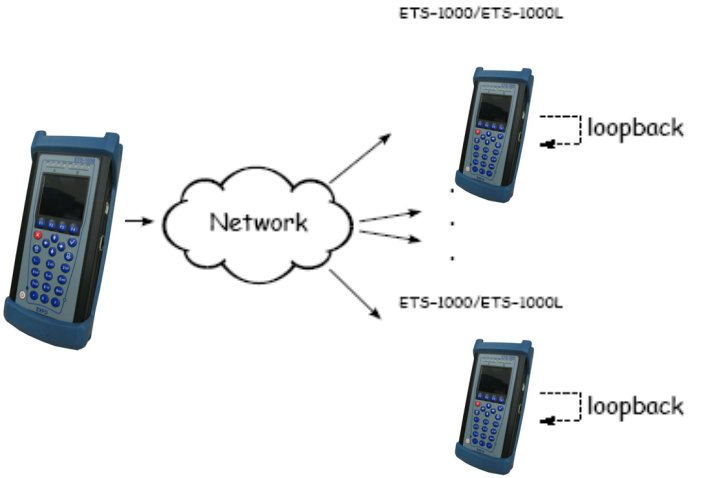
  - **MAC address**: MAC-address of a remote unit

- **Vendor OUI**: Organization unique identifier used to generate the MAC-address
- **Mode**: OAM state of the remote unit
- **Unidirectional**: Unidirectional connection support
- **Rem. loopback**: Support of the Loopback mode for the remote unit
- **Link events**: Connection errors notification support
- **Var. retrieval**: Support of reading variables that are used for estimation of data link quality
- **LB status**: Loopback mode state at the remote unit.

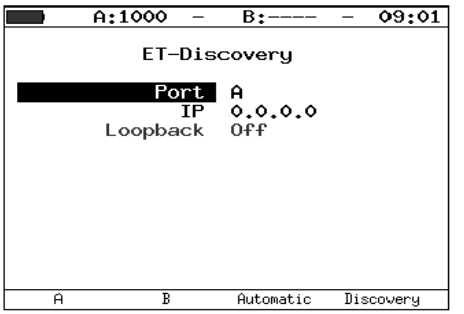
To switch on/off the Loopback mode on a remote unit, press F1.

ET Discovery

ET discovery function allows to switch loopback mode on at the data link, network or transport layer on remote unit ETS-1000 or ETS-1000L.



In accordance with connection diagram it is possible to switch loopback mode on for several units ETS-1000 and/or ETS-1000L in series. The units may be in the same or in the different subnets.



To receive data about remote unit and to switch loopback on:

➤ Connect the unit to a network.

➤ In IP field, enter IP address of remote unit.

➤ Press F4 (Discovery) button.

If discovery is successfully completed, IP address, host name and MAC address will be represented on the screen. **Loopback** menu item will become accessible for editing.

Buttons for loopback level selection are described below:

➤ F1 : switch off loopback mode.

➤ F2 : switch on loopback at the data link layer.

➤ F3 : switch on loopback at the network layer.

➤ F4 : switch on loopback at the transport layer.

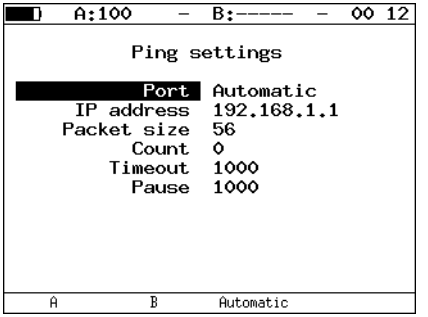
Note: *To transmit data UDP protocol is used. Number of server UDP port is 0×8018. Number of client UDP port is 0×8019.*

Testing TCP/IP

All the tests described in the current section are required for testing through routable networks. Using these tests, you can detect network configuration problems, check server availability, check operability and estimate load of data link.

Ping

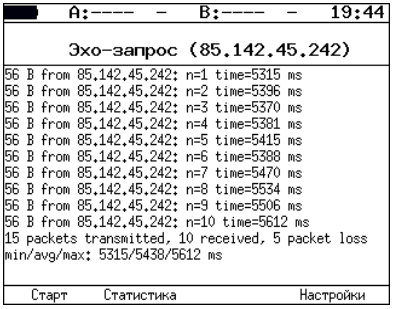
Ping test allows to check availability of specified address inside or outside of a subnet. This feature is not available in the basic configuration and should be ordered additionally. Ping utility sends requests to the specified network host and registers incoming responses. This procedure is based on the IP and ICMP protocols of datagram transmission, and allows to check the operability and measure load level of data links and intermediate units.



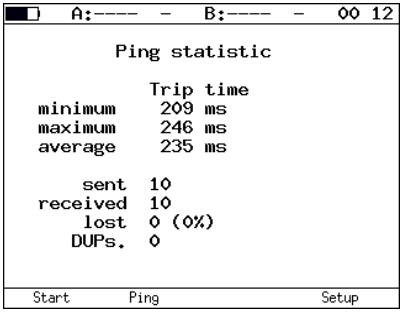
- **Port**: Select a port to send requests from. If Automatic is set, the port will be selected automatically.
- **IP address**: Enter the IP address of a network host to be tested for availability.
- **Packet size**: Enter the size of a transmitted frame, in bytes.
- **Count**: Enter the number of packets to be sent. The accepted range is 0 to 9999. If zero is selected, the ping test will be performed until F1 button (Stop) is pressed.

- **Timeout**: Enter the duration of time to wait for response for a ping request (ms).
- **Pause**: Enter the duration to pause between two successive requests (ms).

Ping Results



Ping Statistics

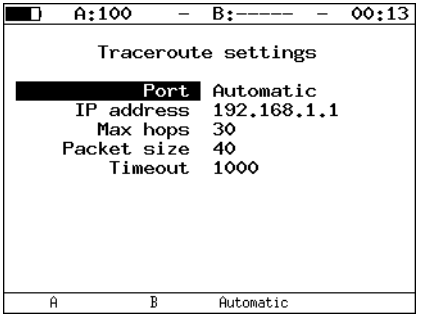


Collected statistics show information about the following parameters:

- Minimum, maximum, and average time between sending requests and receiving responses.
- Number of sent, received, lost, and repeated (with the same sequential number) packets.

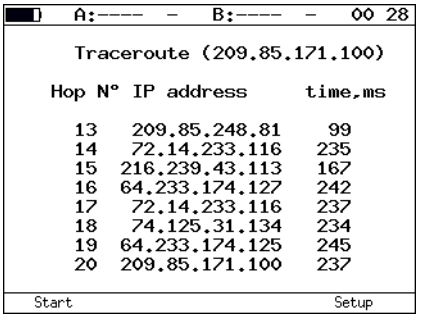
Traceroute

Traceroute utility is used to determine data transmission routes in TCP/IP networks. This feature is not available in the basic configuration and should be ordered additionally. The utility sends sequence of datagramms to a specified network host, and registers data about all intermediate routers that sent datagramms passed through during transmission. Thus, Traceroute utility allows the diagnostics of all intermediate network equipment on a data transmission path.



- **Port**: Select a port to send requests from. If Automatic is set, the port will be selected automatically.
- **IP address**: Enter the IP address of the tested host.
- **Max hops**: Enter the maximum number of routers from which the packets can be transmitted through.
- **Packet size**: Enter the frame size in bytes.
- **Timeout**: Enter the duration of time to wait for response.

Traceroute Results

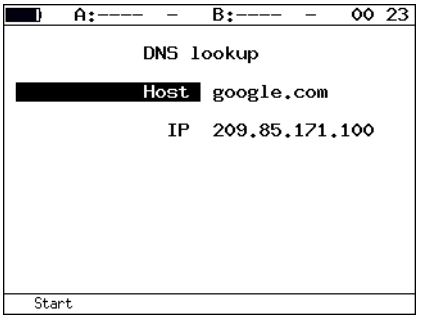


- **Hop N°**: Number of a transitional node.
- **IP address**: IP address of a transitional host.
- **time, ms**: Response waiting time.

DNS (DNS lookup)

DNS (Domain Name System) — distributed database that is able to determine an IP address of a network host upon a request with the host's domain name. DNS lookup feature allows to detect errors in NS-servers operation. This feature is not available in the basic configuration and should be ordered additionally.

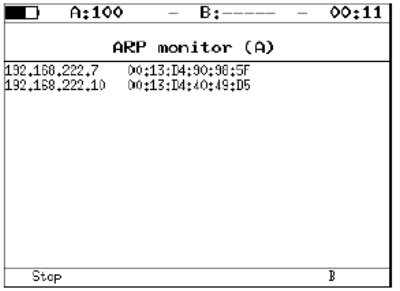
DNS lookup test is performed for specified domain name. If requested IP address cannot be retrieved, all bits in IP address will be set to null.



- **Host**: Enter the name of the host of which the IP address is to be determined.
- **IP**: Display the IP address of the host.

ARP Monitor

ARP monitor utility allows to observe ARP replies that are transmitted in the network and to get the IP and MAC addresses they contain.

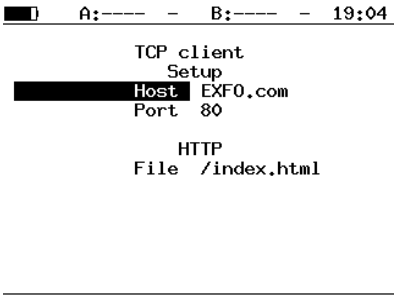


If any of entries presented in the table is not updated within one minute, it will be deleted from the table.

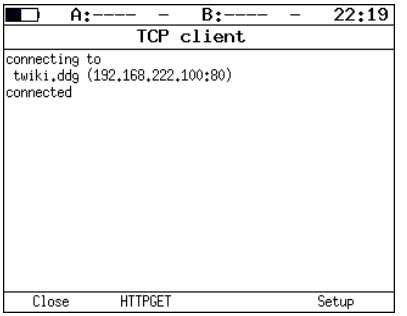
To select port, press F4 button.

TCP-client

TCP-client option allows to check whether tested server responses to HTTP-requests. This feature is not available in the basic configuration and should be ordered additionally. Content of the specified resource can be retrieved using HTTPGET method.

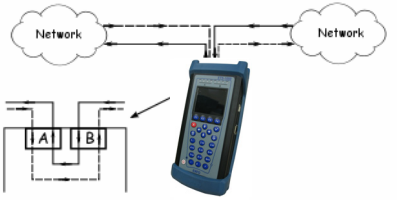


- **Host**: Enter the domain name or IP address of a host.
- **Port**: Enter the receiving port number.
- **File**: Enter the name of a file with content that will be displayed in the results window if the request is successful.



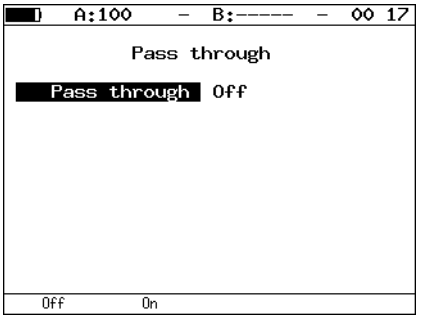
Pass Through

In the Pass through mode, the tester joins in line between two tested units. All the traffic incoming to port A(B) is retransmitted to the port B(A). A connection example is shown below.



During traffic retransmission from one port to another, the tester gathers statistics on transmitted traffic. Statistics results are shown in the **Statistics** menu.

When counting statistics data, damaged packets are not taken into consideration.



Cable Diagnostics

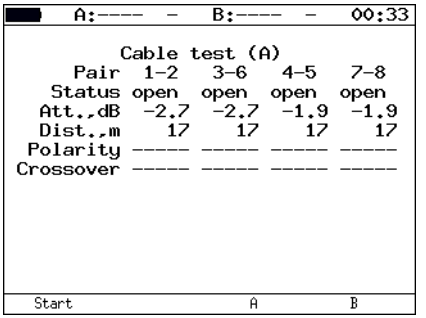
ETS-1000 allows to perform diagnostics of twisted-pair cable by basic operating characteristic measuring and by analyzing its state and type.

To perform the test, it is necessary to execute the following actions:

- Switch to the **Cable test** screen.
- Connect cable to **ETS-1000** using RJ-45 connector.
- By pressing F2 (A) and F3 (B) buttons, select port the cable is connected to.
- Press F1 (Start) button.

To determine cable type, it is necessary to execute the following actions:

- Switch to the **Cable test** screen.
- One end of the cable connect to the port A(B) of ETS-1000, another one to the port B(A).
- By pressing F2 (A) and F3 (B) buttons, select port one end of the cable is connected to.
- Compare testing results displayed in the menu item Crossover for port A and port B with values presented in the tables below.



➤ **Status**: Displays the current state of the cable.

The possible states of the remote module are as follows:

➤ **Att., dB:** Indicates the signal attenuation value.

State	Description
test	test is running
norm	normal state
open	lack of continuity between the pins at each end of the twisted-pair cable
short	two or more conductors are short-circuited together
fail	test failed.
5	Voice
6	Internetwork Control
7	Network Control

➤ **Dist.,m:** Indicates the distance to the defect.

➤ **Polarity:** Indicates the polarity of twisted pairs.

The possible states of the polarity of twisted pair are as follows:

State	Description
<+>	positive polarity (normal state)
<->	negative polarity (two conductors in a twisted-pair are connected with reverse polarity)

➤ **Crossover**: Indicates the cross-connection of twisted-pairs (MDI/MDI-X). These values allow to define the cable type.

In the table below, speed (Mbit/s) for the port A and port B can be specified in the **Interface setup** menu.

Speed, Mbit/s	Pair	Value in menu item Crossover for the port A	Value in menu item Crossover for the port B	Cable type
10/100	1-2 3-6 4-5 7-8	MDI	MDI	crossover
	1-2 3-6 4-5 7-8	MDI-X MDI-X — —	MDI-X MDI-X — —	crossover
	1-2 3-6 4-5 7-8	MDI-X MDI-X — —	MDI MDI — —	straightthrough
	1-2 3-6 4-5 7-8	MDI MDI — —	MDI-X MDI-X — —	straightthrough

Speed, Mbit/s	Pair	Value in menu item Crossover for the port A	Value in menu item Crossover for the port B	Cable type
1000	1-2	MDI	MDI	crossover
	3-6	MDI	MDI	
	4-5	MDI	MDI	
	7-8	MDI	MDI	
	1-2	MDI-X	MDI-X	crossover
	3-6	MDI-X	MDI-X	
	4-5	MDI-X	MDI-X	
	7-8	MDI-X	MDI-X	
	1-2	MDI-X	MDI	straightthrough
	3-6	MDI-X	MDI	
	4-5	MDI-X	MDI	
	7-8	MDI-X	MDI	
	1-2	MDI	MDI-X	straightthrough
	3-6	MDI	MDI-X	
	4-5	MDI	MDI-X	
	7-8	MDI	MDI-X	

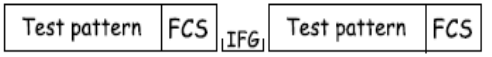
BERT

BERT (Bit Error Rate Test) test allows to measure bit error rate, the ratio of errored bits to the total number of bits transmitted. To perform the test, a specific binary pattern (known both to the source and destination) is encapsulated into an Ethernet frame which is to be transmitted.

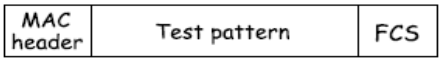
At the destination, the sent pattern is compared to the source one and then the bit error rate is counted. To connect to the TDM-network, the interface converter is used to convert packet network (Ethernet) traffic into the TDM traffic format.

Testing can be performed at four layers of the OSI model.

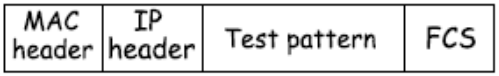
➤ At the **Physical layer** (Level 1) test data is send piecemeal with specified interframe gap (IFG). In this case the test is performed from the port A(B) to the port B(A) or using the Loopback function.



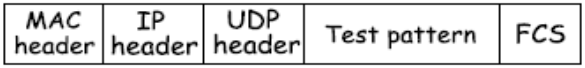
➤ At the **Data Link layer** (Level 2), all data is encapsulated into an Ethernet frame thus allowing to transmit test packets through a network with the OSI's second-layer equipment (for example, network switch).

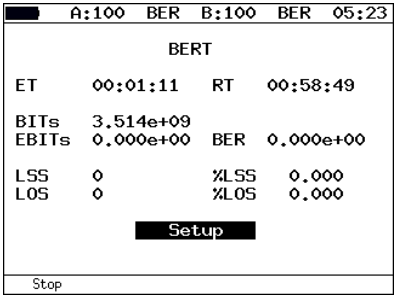


➤ At the **Network layer** (Level 3), all data is encapsulated into IP packet, and then into Ethernet-frame thus allowing to transmit test packets through a network with both OSI's second- and third-layer equipment (for example, network switch, network router).



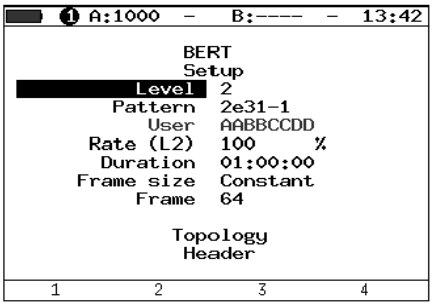
➤ At the **Transport layer** (Level 4)**,** test data is encapsulated into an UDP header, then into IP header and an Ethernet frame thus allowing to transmit test pattern using transport protocols.





ET	time elapsed since the test started.
RT	time remained till test finish.
BITs	number of received bits.
EBITs	number of bits with errors.
BER	ratio of the EBITs value to the BITs value.
LSS	duration of the synchronization loss.
%LSS	ratio of LSS duration to the elapsed time (ET), percentage.
LOS	duration of signal loss.
%LOS	ratio of LOS duration to the elapsed time (ET), percentage.
Setup	Switches to the BERT Setup menu.

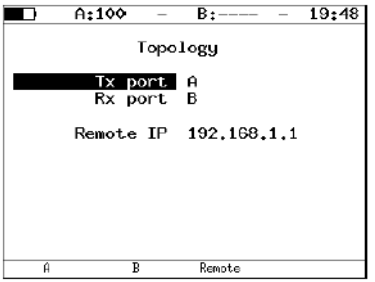
To switch to the **Results** menu, press F4 button (Results).



- **Level:** Select OSI model layer to perform test at:
  - Physical layer (Level 1)
  - Data Link layer (Level 2)
  - Network layer (Level 3)
  - Transport layer (Level 4)
- **Pattern:** Select standard or user-defined test pattern.
- **User:** Specify user-defined pattern.
- **Rate (L2):** Specify required rate (in % (F1), in kbps (F2) or in Mbps(F3)).
- **Duration:** Specify test duration.
- **Frame size:**

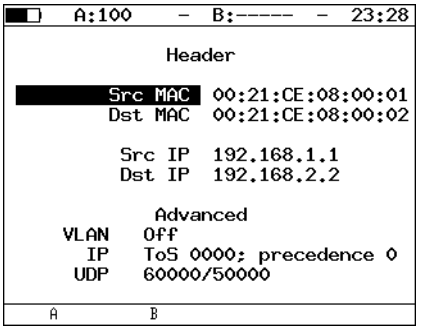
  if you select Random, frame size will change with uniform distribution in specified range (Min frame, Max frame menu items);

  if you select Constant, frames from the Frame menu item will be used for the testing.
- **Frame:** Specify frame size (range between 64 and 9600 bytes).
- **Topology:** Switches to the **Topology** menu.



Use the **Topology** menu to specify receiving and transmitting ports. The same port can be used for data transmission and reception (for example, with the Loopback feature). If you use asymmetric test function you must select Remote as receiving/transmitting port.

➤ Header: Switches to the **Header** menu.



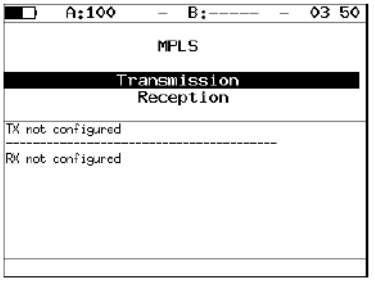
All test patterns used for measurements are in compliance with ITU-TO.150 standard.

Pattern type	Usage (recommended)
2e9-1	Error measurements on data circuits at bit rates up to 14 400 bit/s.
2e11-1	Error and jitter measurements at bit rates of 64 kbit/s and 64×N kbit/s, where N is an integer number.
2e15-1	Error and jitter measurements at bit rates of 1544, 2048, 6312, 8448, 32 064 and 44 736 kbit/s).
2e20-1	Error measurements on data circuits at bit rates up to 72 kbit/s.
2e23-1	Error and jitter measurements at bit rates of 34 368 and 139 264 kbit/s.
2e29-1	Errors detection (for higher-speed data links (transmission rate is over 139 264 kbit/s)).
2e31-1	

BERT MPLS Settings

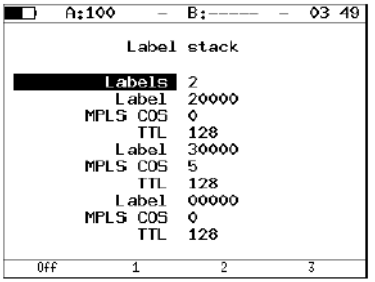
The Label stack for networks testing and reception rules can be specified in the **MPLS** menu. Configure the following parameters from the **MPLS** menu as explained below.

Press **Tests**, select **BERT**, **Setup**, **Header**, **Advanced**, and **MPLS**.



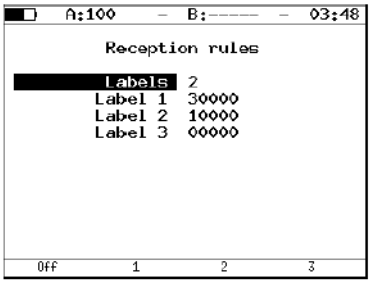
- **Transmission**: Switches to the **Label stack** menu.
- **Reception**: Switches to the **Reception rules** menu.

Values specified in the Label stack and Reception rules menu are also displayed on the screen.



- **Labels**: Enter the number of labels. Choices are from 1 to 3.
- **Label**: Enter the **Label** value.
- **MPLS COS**: Select the Class of Service (**COS**) for datagram.

➤ **TTL**: Enter the Time to Live (**TTL**) value for datagram.



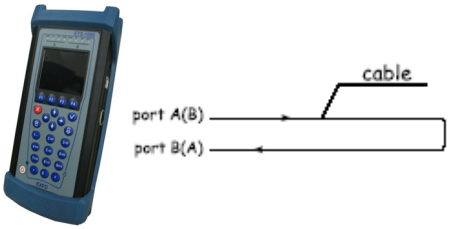
➤ **Labels:** Enter the number of labels. Choices are from 1 to 3.

➤ **Label 1, Label 2, Label 3:** Enter the **Label** value.

Connection Schemes

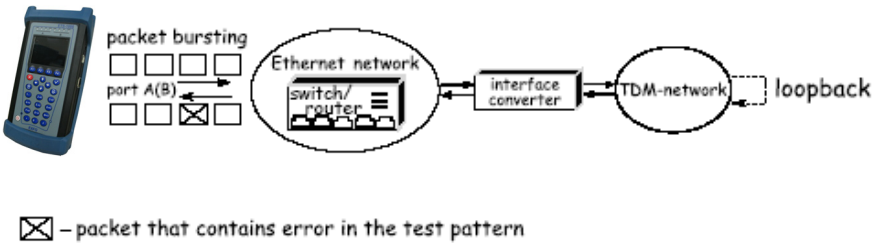
The ETS-1000 Analyzer units can be connected using different connection schemes as described in this chapter. The connection schemes for the physical layer testing and data link/network layer testing are explained below:

The Physical layer testing (scheme 1) is shown below:

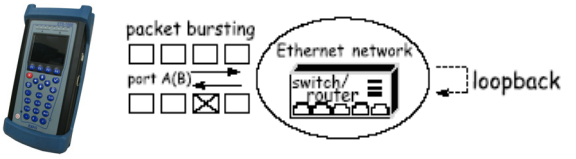


The Physical layer testing (scheme 2) is shown below:

The Data link/Network layer testing (scheme 1) is shown below:

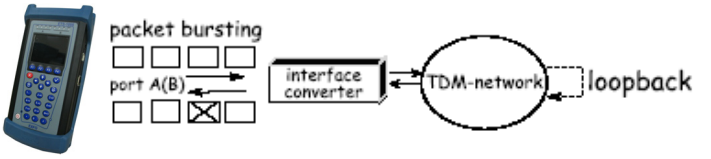


The Data link/Network layer testing (scheme 2) is shown below:



☒ – packet that contains error in the test pattern

The Data link/Network layer testing (scheme 3) is shown below:

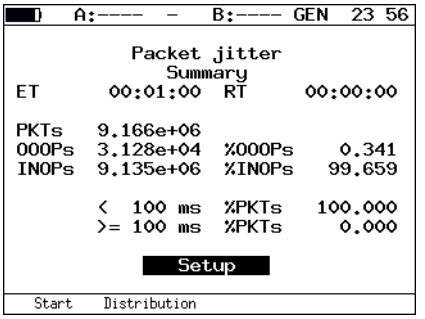


☒ – packet that contains error in the test pattern

Packet Jitter

Another important task for Ethernet-network testing is the packet jitter measurements. According to the RFC 4689 methodology, the packet jitter is the absolute value of the difference between the forwarding delay of two consecutive received packets belonging to the same stream. This parameter is used to estimate transmission capability of latency-sensitive traffic such as video and voice data.

Packet jitter measurement is an optional feature.

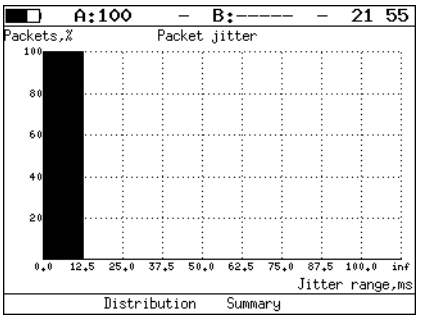


- **ET:** Indicates the time elapsed since the test started.
- **RT:** Indicates the time remained to the test finish.
- **PKTs:** Indicates the summary number of received packets.
- **OOOPs:** Indicates the number of received out-of-order packets.
- **%OOOPs:** Indicates the quantity of received out-of-order packets (percentage of PKTs).
- **INOPs:** Indicates the number of packets received in the same order they were transmitted.
- **%INOPs:** Indicates the quantity of packets received in the same order they were transmitted (percentage of PKTs).
- **< ms%PKTs:** Indicates the number of packets (percentage of PKTs) with jitter value which is less than specified threshold.

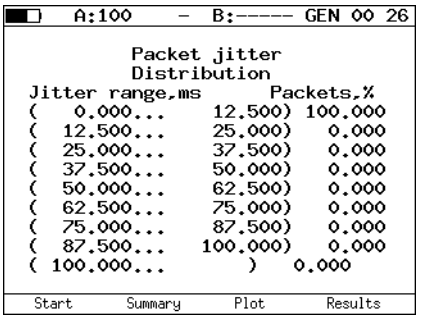
- **>= ms%PKTs:** Indicates the number of packets (percentage of PKTs) with jitter value exceeding or equal to the specified threshold.
- **Setup:** Switches to the **Setup** menu.

When the measurement starts, all settings of the menu become unavailable for editing.

To switch to the **Packet jitter Plot** screen, press the F1 button (Plot).



To switch to the **Packet jitter Distribution** screen, press the F2 button (Distribution).



At the screen two columns are shown. In the first one, intervals are displayed, the second one shows the quantity of packets (percentage) that lies within the corresponding interval.

Upper limit of an interval can be specified in the **Packet jitter - Setup** menu. Interval between null and the threshold value is divided into defined number of sub-intervals. As a result of the test, in the right column the percentage of packets with jitter within corresponding sub-interval limits is displayed.

To switch to the **Results** menu, press F4 button (Results).

- **Rx port**: Select a port to measure the jitter at.
- **Threshold, ms**: Enter the jitter threshold value.
- **Duration**: Specify the jitter measurements duration.
- **Test traffic:** Switches to the **Test traffic** menu.

Test Traffic

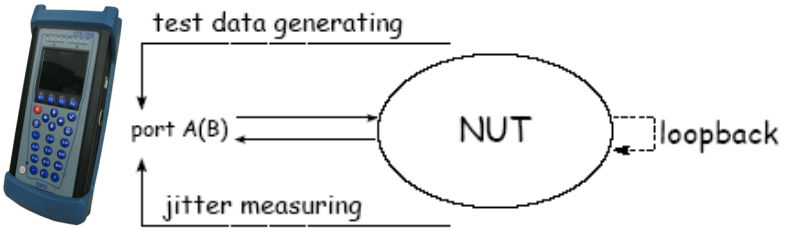
Test traffic generating feature is to be used for the packet jitter measurements.

The analyzer supports generating the test data flow in two following modes:

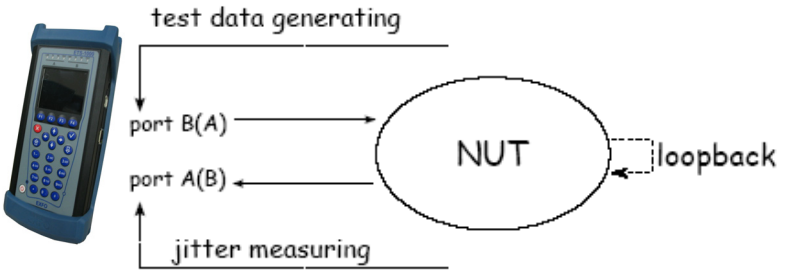
- test traffic is generated and then jitter is measured at the same port.
- test traffic is generated at one port, and then jitter is measured at another one. In this case, destination port could be a port at a remote unit.

When generating the test traffic has been started, all settings in the menu become inaccessible for editing.

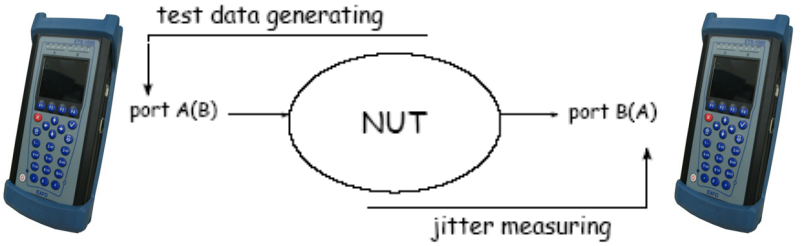
The Jitter measurements scheme 1 is shown below:



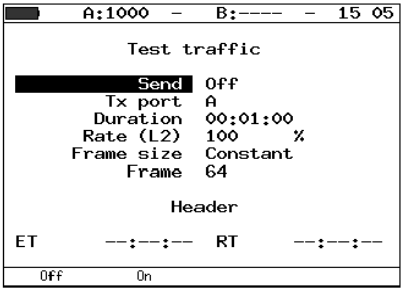
The Jitter measurements scheme 2 is shown below:



The Jitter measurements scheme 3 is shown below:



Test traffic menu is shown below:



- **Send:** Enable or disable test traffic generating.
- **Tx port:** Select the port to generate test traffic at.
- **Duration:** Indicates the duration of the test traffic generating.
- **Rate (L2):** Enter the rate in percent (F1), in kbps (F2) or in Mbps (F3). The accepted range is from **00:00:01** to **23:59:59.**
- **Frame size:**

  if you select Random, frame size will change with uniform distribution in specified range (Min frame, Max frame menu items);

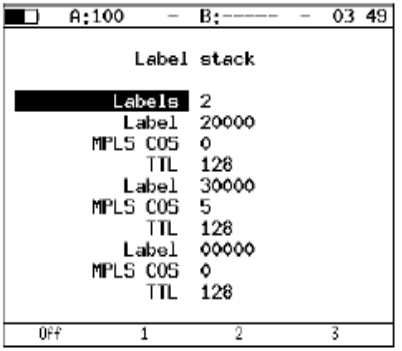
  if you select Constant, frames from the Frame menu item will be used for the testing.

- **Frame:** Enter the frame size. The range of values is from 64 to 9600 bytes.
- **Header:** Switches to the **Header** menu.
- **ET:** Indicates the time elapsed since the traffic generating has started.
- **RT:** Indicates the time remained to the traffic generating finish.

Test Traffic - MPLS Settings

Label Stack and reception rules can be specified in the **Label stack** menu. Configure the following parameters from the **Label Stack** menu as explained below.

Press **Tests**, select **Test traffic**, **Header**, **Advanced**, and **MPLS**.



- **Labels:** Enter the number of labels. Choices are from 1 to 3.
- **Label:** Enter the Label value.
- **MPLS COS:** Select the Class of Service (COS) for datagram.
- **TTL:** Enter the Time to Live (TTL) value for datagram.

Statistics

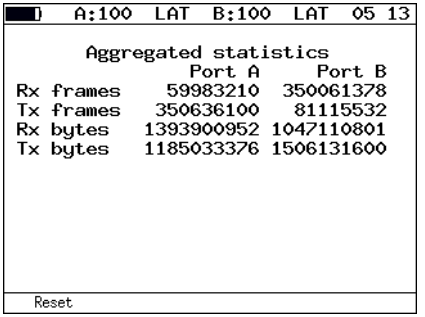
To navigate between screens, use ◄ / ► and F2 / F3 buttons.

➤ **Function keys**

F1 (Reset) — Indicates statistics reset.

In all screens apart from **Aggregated statistics** screen, to select port, press F4 button.

Aggregated statistics for ports A and B



➤ **Rx frames**: Indicates the number of received frames.

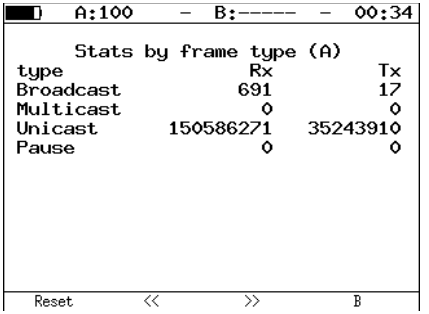
➤ **Tx frames:** Indicates the number of transmitted frames.

➤ **Rx bytes:** Indicates the number of received bytes.

➤ **Tx bytes:** Indicates the number of transmitted bytes.

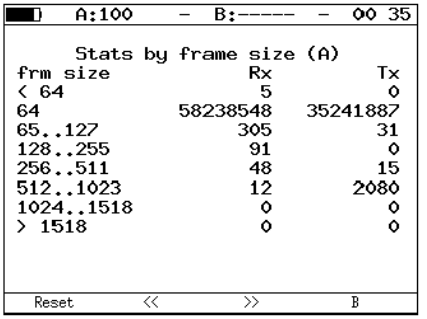
➤ **Rx Kb/s:** Indicates that this field shows the number of kilobits per second received on port.

Stats by Frame Types



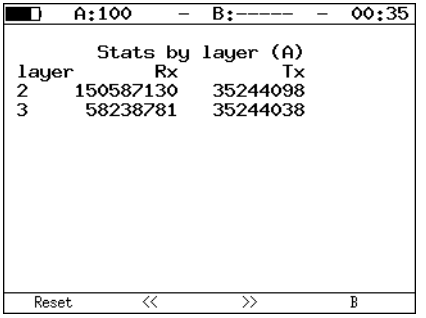
- **Broadcast**: Indicates the number of broadcast frames.
- **Multicast**: Indicates the number of multicast frames.
- **Unicast**: Indicates the number of unicast frames.
- **Pause**: Indicates the number of unicast frames.
- **Rx**: Indicates the number of received frames.
- **Tx**: Indicates the number of transmitted frames.

Stats by Frame Size



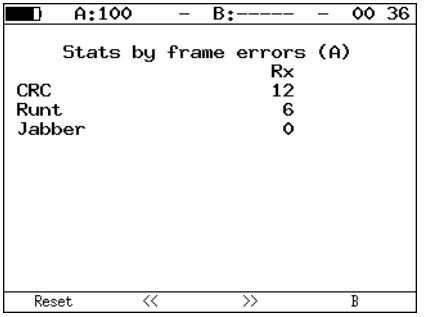
- **Frm size:** frame size (in bytes).
- **Rx:** number of received frames.
- **Tx:** number of transmitted frames.

Stats by Layer



- **layer 2**: Indicates the number of received (Rx) and transmitted (Tx) frames at the Data Link layer.
- **layer 3**: Indicates the number of received (Rx) and transmitted (Tx) frames at the Network layer.

Stats by Frame Errors



- **CRC:** Indicates the number of frames with FCS error.
- **Runt**: Indicates the number of packets less than 64 bytes with FCS error.
- **Jabber:** Indicates the number of packets larger than 1518 bytes with FCS error.

8 Saving Test Results

In the RFC 2544, BERT and Packet jitter tests modes, ETS-1000 analyzer supports viewing information about previously saved measurement results (F2), saving test settings and results (F3), and loading previously saved test configurations and results (F4). To perform any of these operations, while in the RFC 2544 testing mode, press F4 button (Data) to switch to the corresponding menu.

To save the data:

1. Select a number you want to save the entry with.
2. Press ✓.
3. Enter a name for the entry to save.
4. Press ✓.
5. Press F3 (Save).

To load previously saved test results and settings:

1. Select the number of an entry.
2. Press F4 (Load).

9 Remote Control

ETS-1000 analyzer allows to connect to a personal computer (PC) via USB 1.1/2.0 interface or via a LAN-port.

To connect the analyzer to a PC via USB-interface, you have to first install Virtual COM Port driver.

Note: *Please note that installation of the driver is necessary for the correct initialization of ETS-1000 analyzer in your system.*

Download the latest version of the VCP driver from the official site of FTDI Chip company (http://www.ftdichip.com) and extract the archive to any suitable folder.

Please refer to the http://www.ftdichip.com/Drivers/VCP.htm page for the distribution archives for different operation systems.

Management in the Terminal Mode

An interaction with the analyzer can be performed using HyperTerminal, the standard Microsoft Windows 95/98/XP/2000/2003 utility.

To update the ETS-1000 microcode, the terminal utility should provide file transmission via the X-modem protocol.

Terminal Mode Connection Settings

1. Make sure that the unit is turned on.
2. Connect ETS-1000 to a USB-port using the USB-cable from the kit.

3. If you use HyperTerminal utility, perform the following steps:

3a. Create new connection (**File** > **New Connection** menu).

3b. In the **Connection Description** dialog box, enter a name and choose an icon for the connection. Click **OK**.

3c. In the **Connect To** dialog box, choose the COM port of the PC that ETS-1000 is connected to. Click **OK**.

3d. Set the following properties of the COM-port:

Bits per second - 57600

Data bits - 8

Parity - None

Stop bits - 1

Flow control - None

3e. Click **OK**, and HyperTerminal utility will attempt to connect to ETS-1000. To check the connection, type AT command; the unit should respond with **OK**.

When successfully connected, user can manage the analyzer using commands described in Remote Control Commands *on page 141*.

Updating Analyzer Software

IMPORTANT

False actions during the software update can lead to the unit part malfunctioning which can be repaired in the service-center only.

Latest versions of the ETS-1000 software are available for downloading. Current software versions are shown in the Information menu (ETS-1000 **Settings >Information**).

The order of update procedures for FPGA microcode and MCU program does not matter. In addition, only one of those can be updated if there is no new version for another one.

To update the FPGA:

1. Connect the ETS-1000 to PC via USB (see Terminal Mode Connection Settings *on page 117*). Check the connection using AT command.
2. Enter ATR command. Select either system FPGA or expansion FPGA. In the Transfer, send **File** menu of HyperTerminal utility, specify the path to a FPGA microcode file (with .bin extension) in the **Filename** window and select the Xmodem in the **Protocol** window. Click **Send**. Estimated duration of the update procedure is 1 minute for the system FPGA and 4 minutes for the Expansion FPGA. If the data displayed previously on the screen has been restored, the update procedure is completed successfully.

To updated the MCU program:

1. Connect the ETS-1000 to PC via USB (see Terminal Mode Connection Settings *on page 117*). Check the connection using AT command.
2. Type in ATR command. Select MCU. In the Transfer, send **File** menu of HyperTerminal utility, specify the path to a MCU program file (with .bin extension) in the **Filename** window; and select the Xmodem in the **Protocol** window. Click Send. Estimated duration of the update procedure is 1 minute. If the data displayed previously on the screen has been restored, the update is completed successfully.

Note: *If MCU program version is not compatible with versions of the system FPGA and expansion FPGA microcodes, then you will get a warning message and the expected version number. In this case, the expected version should be installed instead of the current version.*

Note: *When FPGA microcodes and MCU are updated it is recommended to press the hardware restart button with any thin blunt pin.*

Remote Control via TELNET

TELNET (Telecommunication Network) is a protocol to access and interact with a remote network unit. To configure test properties, to view the current settings, and to perform measurements, use the commands described in the Appendix Remote Control Commands *on page 141*.

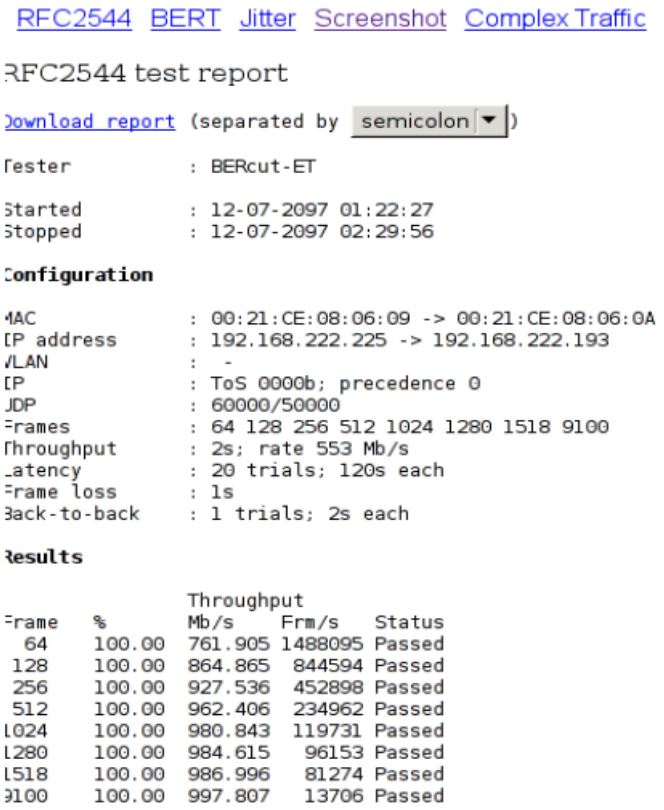
Remote control via TELNET is an optional functionality. It is not available in the basic configuration and should be ordered additionally. To control remotely ETS-1000 via TELNET protocol, connect to the unit via A(B) port or the LAN port and then type in the following command in a console telnet IP-address of the port.

Default username and password: admin

Remote Control via WWW-interface

Remote control via WWW-interface function allows to view and save on PC all the settings and results of the major tests. It is not available in the basic configuration and should be ordered additionally.

To view results, connect to ETS-1000 via A(B) port or the LAN port, and type the IP-address of connected port into the address line of your web-browser.



Remote control via WWW-interface2 function allows to view and save on PC all the settings and results of the major tests.

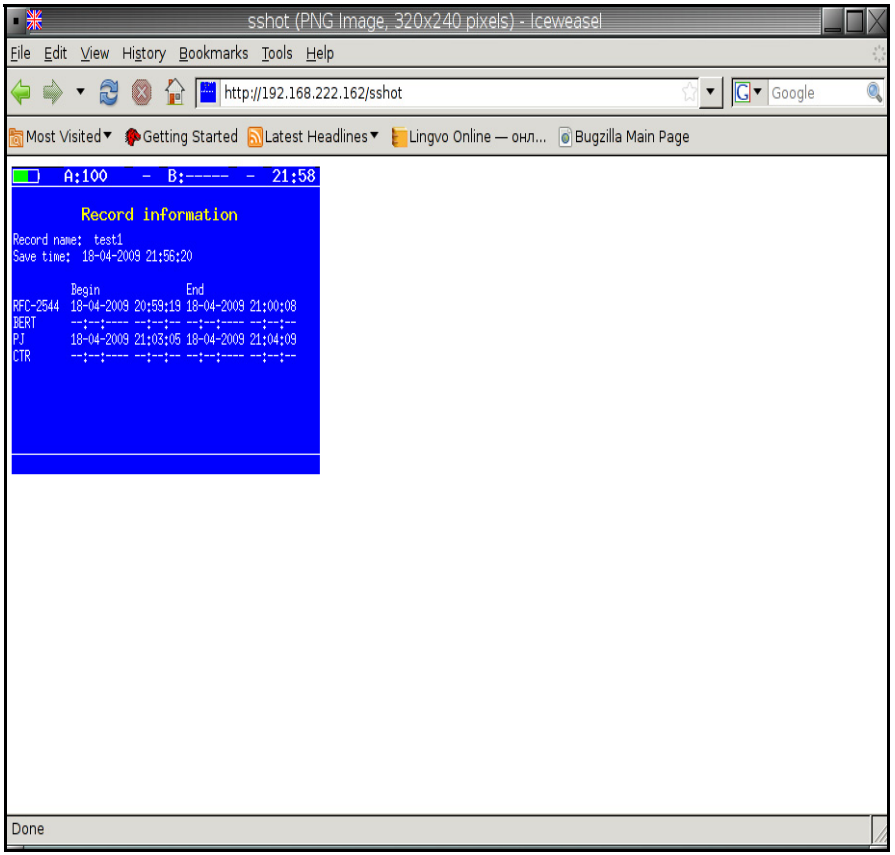
To view results, connect to ETS-1000 via A(B) port or the LAN port, and type the IP-address of connected port into the address line of your web-browser.

To save the data press Download report. The data will be saved with

.csv extension.

Screen Shot

To get screen shot, connect to ETS-1000 via A(B) port or the LAN port, and type into the address line of your web-browser: http://IP-address_of_connected_port/sshot.



10 Maintenance

To help ensure long, trouble-free operation:

- Always inspect fiber-optic connectors before using them and clean them if necessary.
- Keep the unit free of dust.
- Clean the unit casing and front panel with a cloth slightly dampened with water.
- Store unit at room temperature in a clean and dry area. Keep the unit out of direct sunlight.
- Avoid high humidity or significant temperature fluctuations.
- Avoid unnecessary shocks and vibrations.
- If any liquids are spilled on or into the unit, turn off the power immediately, disconnect from any external power source, remove the batteries and let the unit dry completely.

WARNING

The use of controls, adjustments and procedures, namely for operation and maintenance, other than those specified herein may result in hazardous radiation exposure or impair the protection provided by this unit.

Recycling and Disposal (Applies to European Union Only)

For complete recycling/disposal information as per European Directive WEEE 2012/19/UE, visit the EXFO Web site at www.exfo.com/recycle.

11 Troubleshooting

Solving Common Problems

Before calling EXFO's technical support, please read the following common problems that can occur and their respective solution.

Problem	Possible Cause	Solution
Incorrect system time.	➤ Hardware reset button is pressed.	➤ Set the system time in the **Basic settings** menu.
You cannot power on the unit.	➤ The battery is discharged.	➤ Connect the power supply unit and charge the battery.
	➤ Software failure.	➤ Press the hardware reset button (the pin-hole next to the 12V connector on the side panel of the unit).
The battery is not charged from the external power supply.	➤ Power supply unit failure, broken wire, battery failure.	➤ Check the power supply unit or the battery and if necessary send the unit for service at the service center.

Contacting the Technical Support Group

To obtain after-sales service or technical support for this product, contact EXFO at one of the following numbers. The Technical Support Group is available to take your calls from Monday to Friday, 8:00 a.m. to 7:00 p.m. (Eastern Time in North America).

Technical Support Group
400 Godin Avenue
Quebec (Quebec) G1M 2K2
CANADA

1 866 683-0155 (USA and Canada)
Tel.: 1 418 683-5498
Fax: 1 418 683-9224
support@exfo.com

For detailed information about technical support, and for a list of other worldwide locations, visit the EXFO Web site at www.exfo.com.

If you have comments or suggestions about this user documentation, you can send them to customer.feedback.manual@exfo.com.

To accelerate the process, please have information such as the name and the serial number (see the product identification label), as well as a description of your problem, close at hand.

Transportation

Maintain a temperature range within specifications when transporting the unit. Transportation damage can occur from improper handling. The following steps are recommended to minimize the possibility of damage:

- Pack the unit in its original packing material when shipping.
- Avoid high humidity or large temperature fluctuations.
- Keep the unit out of direct sunlight.
- Avoid unnecessary shocks and vibrations.

12 Warranty

General Information

EXFO Inc. (EXFO) warrants this equipment against defects in material and workmanship for a period of one year from the date of original shipment. EXFO also warrants that this equipment will meet applicable specifications under normal use.

During the warranty period, EXFO will, at its discretion, repair, replace, or issue credit for any defective product, as well as verify and adjust the product free of charge should the equipment need to be repaired or if the original calibration is erroneous. If the equipment is sent back for verification of calibration during the warranty period and found to meet all published specifications, EXFO will charge standard calibration fees.

IMPORTANT

The warranty can become null and void if:

- **unit has been tampered with, repaired, or worked upon by unauthorized individuals or non-EXFO personnel.**
- **warranty sticker has been removed.**
- **case screws, other than those specified in this guide, have been removed.**
- **case has been opened, other than as explained in this guide.**
- **unit serial number has been altered, erased, or removed.**
- **unit has been misused, neglected, or damaged by accident.**

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL EXFO BE LIABLE FOR SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

Liability

EXFO shall not be liable for damages resulting from the use of the product, nor shall be responsible for any failure in the performance of other items to which the product is connected or the operation of any system of which the product may be a part.

EXFO shall not be liable for damages resulting from improper usage or unauthorized modification of the product, its accompanying accessories and software.

Exclusions

EXFO reserves the right to make changes in the design or construction of any of its products at any time without incurring obligation to make any changes whatsoever on units purchased. Accessories, including but not limited to fuses, pilot lamps, batteries and universal interfaces (EUI) used with EXFO products are not covered by this warranty.

This warranty excludes failure resulting from: improper use or installation, normal wear and tear, accident, abuse, neglect, fire, water, lightning or other acts of nature, causes external to the product or other factors beyond the control of EXFO.

IMPORTANT

In the case of products equipped with optical connectors, EXFO will charge a fee for replacing connectors that were damaged due to misuse or bad cleaning.

Certification

EXFO certifies that this equipment met its published specifications at the time of shipment from the factory.

Service and Repairs

EXFO commits to providing product service and repair for five years following the date of purchase.

To send any equipment for service or repair:

1. Call one of EXFO's authorized service centers (see *EXFO Service Centers Worldwide* on page 135). Support personnel will determine if the equipment requires service, repair, or calibration.
2. If equipment must be returned to EXFO or an authorized service center, support personnel will issue a Return Merchandise Authorization (RMA) number and provide an address for return.
3. If possible, back up your data before sending the unit for repair.
4. Pack the equipment in its original shipping material. Be sure to include a statement or report fully detailing the defect and the conditions under which it was observed.
5. Return the equipment, prepaid, to the address given to you by support personnel. Be sure to write the RMA number on the shipping slip. *EXFO will refuse and return any package that does not bear an RMA number.*

Note: *A test setup fee will apply to any returned unit that, after test, is found to meet the applicable specifications.*

After repair, the equipment will be returned with a repair report. If the equipment is not under warranty, you will be invoiced for the cost appearing on this report. EXFO will pay return-to-customer shipping costs for equipment under warranty. Shipping insurance is at your expense.

Routine recalibration is not included in any of the warranty plans. Since calibrations/verifications are not covered by the basic or extended warranties, you may elect to purchase FlexCare Calibration/Verification Packages for a definite period of time. Contact an authorized service center (see *EXFO Service Centers Worldwide* on page 135).

EXFO Service Centers Worldwide

If your product requires servicing, contact your nearest authorized service center.

EXFO Headquarters Service Center
400 Godin Avenue
Quebec (Quebec) G1M 2K2
CANADA

1 866 683-0155 (USA and Canada)
Tel.: 1 418 683-5498
Fax: 1 418 683-9224
support@exfo.com

EXFO Europe Service Center
Winchester House, School Lane
Chandlers Ford, Hampshire S053 4DG
ENGLAND

Tel.: +44 2380 246800
Fax: +44 2380 246801
support.europe@exfo.com

EXFO Telecom Equipment (Shenzhen) Ltd.
3rd Floor, Building 10,
Yu Sheng Industrial Park (Gu Shu Crossing), No. 467,
National Highway 107,
Xixiang, Bao An District,
Shenzhen, China, 518126

Tel: +86 (755) 2955 3100
Fax: +86 (755) 2955 3101
support.asia@exfo.com

A Specifications

IMPORTANT

The following technical specifications can change without notice. The information presented in this section is provided as a reference only. To obtain this product's most recent technical specifications, visit the EXFO Web site at *www.exfo.com*.

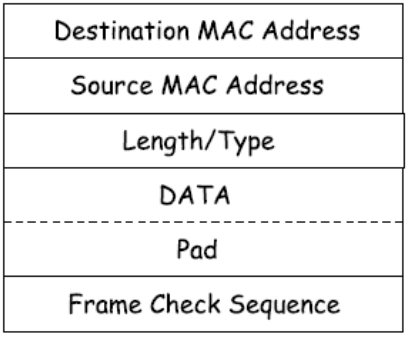
Specifications	Values
Display	Color graphic display, 320×240 pixels
Keyboard	Film keyboard (25 keys)
Connect to PC interface	USB-client
External power supply unit voltage	12 V
Operating current	Not more than 1,5 A
Battery	NiMH with 4.8 V rated voltage and capacity of 4300 mAh
	internal safety unit 5 A
Gigabit Ethernet interfaces	2×10/100/1000Base-T and SFP
Control interfaces	USB, LAN 10/100 Ethernet
	3 (when operated from batteries)[a]
Overall size	200×101×44 mm
Weight	0,640 kg

a. Equipment normally protected against exposure to direct sunlight, precipitations and full wind pressure.

Specifications	Values
Tests according to RFC 2544	Available tests: Throughput, Frame Loss, Back-to-Back, Latency.
	Frame size: 64, 128, 256, 512, 1024, 1280, 1518 bytes,and user-defined.
IP-tests	Ping, Traceroute, DNS lookup, TCP-client.
Loopback	Loopback at the Physical (PHY), Data Link (MAC),and Network (IP) layers with VLAN support and fields swapping capability.
Cable test	Testing a copper cable for break, short-circuit, estimating the distance to the break point.
BERT	Test is used to determine the major data link quality parameter - bit error rate.
Packet jitter	Packet jitter measurements, results are displayed as a table and graph. The test is used to estimate the tested network capability to transmit the latency-sensitive traffic.
Remote control	Remote control of the analyzer in the following modes:terminal, via TELNET protocol, via WWW-interface. With remote control running the tests, parameters setup,getting test results are supported.

B Ethernet Frame Structure

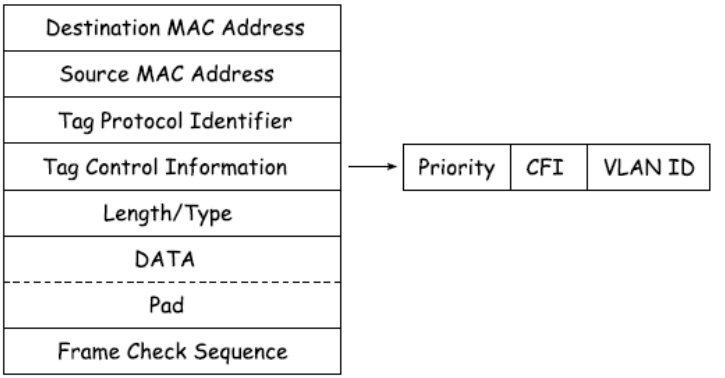
Ethernet Frame Structure



- **Destination MAC Address**: 6 bytes field that contains MAC address of the destination network node.
- **Source MAC Address**: 6 bytes field that contains MAC address of the frame source network node.
- **Length/Type**: The field contains 16-bits integer and possesses either of the following values:
  - If the contained number is less than or equal to 1500, then the value is set to Length and defines the length of the data field.
  - If contained number is more than or equal to 1536, then the value is set to Type value and specifies type of the used protocol.
- **Data**: Data field can contain from 46 or 42 (in the case of a frame with VLAN-tag) to 1500 bytes.
- **Pad**: If the data field is less than 46 bytes then the containing frame is complemented to the minimum allowed length (64 bytes) with the padding field.

➤ **Frame Check Sequence**: 4-bytes field contains the checksum.

Ethernet Frame with VLAN tag structure



➤ **Tag Protocol Identifier**: 16 bits field defines that the frame belongs to the 802.1Q [1] standard.

➤ **Tag Control Information**: TCI field contains three following fields.

- ➤ **Priority**: User (VLAN) Priority. Three bits that contain information about the frame priority (eight possible priority values are available ([1])).
- ➤ **CFI**: Canonical Format Indicator is an one-byte flag which must be equal to 0 (null) for Ethernet frames.
- ➤ **VLAN ID**: VLAN Identifier (VID) is a 12-bit identifier which is defined in the 802.1Q standard [1]. VID uniquely defines VLAN to which the current frame belongs to.

C Remote Control Commands

Command	Description
AT	empty command, used to check connection
ATR	restart the unit (analyzer)
ATM1	RFC 2544 test results and settings output
ATM2	BERT test results and settings output
ATM3	display measurements results and settings for the packet jitter
ATI	display unit information
ATH	display command's help
ATS	enter the option activation key. The key is a decimal number which should be typed in right after the ats command, without any spaces.
ATC	switch to the test configuring and running mode (optional feature)

Command	Information displayed in console
RFC 2544	
show rfc2544 header src udp	source UDP-port number
show rfc2544 header src mac	source MAC address
show rfc2544 header src ip	source IP address
show rfc2544 header dst udp	destination UDP-port number
show rfc2544 header dst mac	destination MAC address
show rfc2544 header dst ip	destination IP address
show rfc2544 header vlan enabled	show whether VLAN parameter is enabled
show rfc2544 header tos	type of service for the packet
show rfc2544 topology port tx	transmitting port
show rfc2544 topology port rx	receiving port
show rfc2544 throughput duration	throughput trial duration
show rfc2544 throughput enabled	show whether throughput test is enabled
show rfc2544 throughput maxrate	maximum rate for the throughput test
show rfc2544 throughput threshold	throughput analysis threshold of loss value

Command	Information displayed in console
sshow rfc2544 frames 1	user-defined frame size (or standard value in accordance with RFC 2544 methodology
show rfc2544 frames 2	
show rfc2544 frames 3	
show rfc2544 frames 4	
show rfc2544 frames 5	
show rfc2544 frames 6	
show rfc2544 frames 7	
show rfc2544 frames 8	
show rfc2544 latency enabled	show whether the latency test is enabled
show rfc2544 latency count	number of trials for latency test
show rfc2544 latency duration	trial duration for the latency test
show rfc2544 frameloss enabled	show whether the frameloss test is enabled
show rfc2544 frameloss duration	trial duration for the frameloss test
show rfc2544 backtoback enabled	show whether the back-to-back test is enabled
show rfc2544 backtoback count	number of trials for the back-to-back test
show rfc2544 backtoback duration	trial duration for the back-to-back test
rfc2544 start	start RFC 2544 tests

Command	Information displayed in console
rfc2544 stop	stop all RFC 2544 tests
rfc2544 results	RFC 2544 test results
Complex traffic	
show ctraf nstreams	number of data streams
show ctraf stream	stream number
show ctraf topology port tx	transmitting port
show ctraf topology port rx	receiving port
show ctraf duration	time of data streams generation
show ctraf header src mac	source MAC address
show ctraf header src ip	source IP address
show ctraf header src udp	source UDP-port number
show ctraf header dst mac	destination MAC address
show ctraf header dst ip	destination IP address
show ctraf header dst udp	destination UDP-port number
show ctraf header precedence	frame priority value
show ctraf header tos	type of service for the packet
show ctraf rate	framed rate value
show ctraf frame	frame size
ctraf start	start complex traffic generation
ctraf stop	start complex traffic generation
ctraf results	Complex traffic test results
BERT	

Command	Information displayed in console
show bert header src mac	source MAC address
show bert header src ip	source IP address
show bert header src udp	source UDP-port number
show bert header dst mac	destination MAC address
show bert header dst ip	destination IP address
show bert header dst udp	destination UDP-port number
show bert header precedence	frame priority value
show bert header tos	type of service for the packet
show bert topology port tx	transmitting port
show bert topology port rx	receiving port
show bert level	at which layer of OSI model BERT will be performed
show bert pattern	standard test pattern
show bert user-pattern	user-defined test pattern
show bert frame type	random or constant frame type
show bert frame random max	maximum frame size value
show bert frame random min	minimum frame size value
show bert frame constant	constant frame size value
show bert rate	user-defined rate (Kbps)
show bert duration	trial duration for BERT
bert start	start BERT
bert stop	stop BERT
bert show	show BERT results
Packet jitter	

Command	Information displayed in console
show jitter port	on which port jitter measurements will be performed
show jitter threshold	treshold (ms)
show jitter duration	measurements duration
jitter start	start Packet jitter test
jitter stop	stop Packet jitter test
jitter slow	Packet jitter test results
Test traffic	
show txgen header src mac	source MAC address
show txgen header src ip	source IP address
show txgen header src udp	source UDP-port number
show txgen header dst mac	destination MAC address
show txgen header dst ip	destination IP address
show txgen header dst udp	destination UDP-port number
show txgen header vlan enabled	show whether VLAN parameter is enabled
show txgen header vlan id	VLAN identifier value
show txgen header	vlan priority traffic priority value
show txgen header	precedence frame priority value
show txgen header tos	type of service for the packet
show txgen port	transmitting port
show txgen frame	user-defined frame size

Command	Information displayed in console
show txgen duration	trial duration
show txgen rate	user-defined rate (Kbps or %)
txgen start	start test traffic generating
txgen stop	stop test traffic generating
txgen show	show test traffic results
Interface setup	
show gbe a speed	show transmission rate for the port A
show gbe b speed	show transmission rate for the port B
Network setup	
show network a dhcp	show whether the DHCP function is enabled for the port A
show network a ip	show IP address of the port A
show network a subnetmask	show subnet mask for the port A
show network b dhcp	show whether the DHCP function is enabled for the port B
show network b ip	show IP address of the port B
show network b subnetmask	show subnet mask for the port B
show network gateway	show gateway IP address
show network dns	show DNS IP address
TCP/IP testing	

Command	Information displayed in console
ping	start ping test
Save/load results	
results save N	save measurements results with number N (N=1 .. 10)
results load N	load measurements results with number N
results show	show current measurements results
results show N	display measurements results saved with number N
results show all	show all saved measurements results
results info	show information about saved measurements results
Common commands	
show version	show firmware number
exit	exit the command mode
reboot	reboot the analyzer
help	show the list of available commands
configure	switch to the configuration mode
username	username change
password	password change
show options	available option view
show time	current time view
show date	current date view

Command	Operation
RFC 2544	
rfc2544 header src udp int	set source UDP-port number
rfc2544 header srcmacXX:XX:XX:XX:XX:XX	set source MAC address
rfc2544 header src ip i.i.i.i	set source IP address
show rfc2544 header dst udp	display destination UDP-port number
rfc2544 header dstmacXX:XX:XX:XX:XX:XX	set destination MAC address
rfc2544 header dst ip i.i.i.i	set destination IP address
rfc2544 header vlan enabled off/on	enable/disable VLAN parameter
rfc2544 header vlan id text	set VLAN identifier
rfc2544 header vlan prior text	set traffic priority
rfc2544 header precedence text	set frame priority
rfc2544 header tos 0000 / 1000 / 0100 / 0010 / 0001	set type of service for the packet
rfc2544 topology port tx a/b	set data transmitting port
rfc2544 topology port rx a/b	set data receiving port
rfc2544 frames user enabled no/yes	enable/disable user-defined frame size

Command	Operation
rfc2544 frames 1 text	set arbitrary frame size
rfc2544 frames 2 text	
rfc2544 frames 3text	
rfc2544 frames 4text	
rfc2544 frames 5 text	
rfc2544 frames 6 text	
rfc2544 frames 7 text	
rfc2544 frames 8 text	
rfc2544 throughput duration text	set trial duration for the throughput analysis
rfc2544 throughput enabled no/yes	enable/disable throughput analysis
rfc2544 throughput maxrate text	set maximum rate value for the troughput analysis
rfc2544 latency enabled no/yes	enable/disable latency analysis
rfc2544 latency count text	set number of trials for the latency analysis
rfc2544 latency duration text	set trial duration for the latency analysis
rfc2544 frameloss enabled no/yes	enable/disable frameloss test
rfc2544 frameloss duration text	set trial duration for the frameloss test
rfc2544 backtoback enabled no/yes enable/disable back-to-back analysis	rfc2544 backtoback count text
set number of trials for the back-toback test	rfc2544 backtoback duration text

Command	Operation
Complex traffic	
ctraf header mpls tx count off / 1 / 2 / 3	select number of tags to transmit
ctraf header mpls tx [1-3] label int	set label value
ctraf header mpls tx [1-3] cos int	set class of service for datagram
ctraf header mpls tx [1-3] ttl int	set time to live for datagram
ctraf nstreams int	set number of data streams
ctraf stream int	set stream number
ctraf topology tx a / b / remote	set transmitting port
ctraf topology rx a / b / remote	set receiving port
ctraf topology ip i.i.i.i	set IP address of remote device
ctraf duration int	set time of data streams generation
ctraf header src mac XX:XX:XX:XX:XX:XX	set source MAC address
ctraf header src ip i.i.i.i	set source IP address
ctraf header src udp int	set source UDP-port number
ctraf header dst mac XX:XX:XX:XX:XX:XX	set destination MAC address
ctraf header dst ip i.i.i.i	set destination IP address
ctraf header dst udp int	set destination UDP-port number
ctraf header precedence int	set frame priority value
ctraf header tos text	type of service for the packet

Command	Operation
ctraf rate int	set framed rate value (in % by de-fault)
ctraf rate int unit	set framed rate value (kbps, Mbps, %)
ctraf frame int	set frame size
BERT	
bert header src mac XX:XX:XX:XX:XX:XX	set source UDP-port number
bert header src ip i.i.i.i	set source IP address
bert header src udp text	set source UDP-port number
bert header dst mac XX:XX:XX:XX:XX:XX	set destination MAC address
bert header dst ip i.i.i.i	set destination IP address
bert header dst udp text	set destination UDP-port number
bert header vlan enabled off/on	enable/disable VLAN parameter
bert header vlan id text	set VLAN identifier
bert header vlan priority text	set traffic priority
bert header precedence text	set frame priority
bert header tos 0000 / 1000 / 0100 / 0010 / 0001	set type of service for the packet
bert topology port tx a/b	set data transmitting port
bert topology port rx a/b	set data receiving port
bert level 1/2/3/4	layer of OSI model at which BERT will be performed

Command	Operation
bert pattern user / crtp / 2e11-1 / 2e15-1 / 2e20-1 / 2e23-1 / 2e29-1 / 2e31-1	select standard or user-defined test pattern
bert user-pattern hex	set user-defined test pattern
bert frame int	set user-defined frame size
bert rate int	set user-defined rate (Kbps)
bert duration hh.mm.ss	set trial duration for BERT
Packet jitter	
jitter port a/b	select port on which jitter measurements will be performed
jitter threshold int	set treshold (ms)
txgen duration hh.mm.ss	set trial duration
Test traffic	
txgen header src mac XX:XX:XX:XX:XX:XX	set source MAC address
txgen header src ip i.i.i.i	set source IP address
txgen header src udp text	set source UDP-port number
txgen header dst mac XX:XX:XX:XX:XX:XX	set destination MAC address
txgen header dst ip i.i.i.i	set destination IP address
txgen header dst udp text	set destination UDP-port number
txgen header vlan enabled off/on	enable/disable VLAN parameter
txgen header vlan id text	set VLAN identifier
txgen rate	set user-defined rate (Kbps or %)

Command	Operation
Loopback	
loopback a / b layer off / 1 / 2 / 3 / 4	select layer to enable loopback func- tion
loopback a / b mac swap off / on	swap MAC address mode switch on/off
loopback a / b mac replace off / source / destination / src+dst	select MAC address replace mode
loopback a / b mac src XX:XX:XX:XX:XX:XX	set source MAC address
loopback a / b mac dst XX:XX:XX:XX:XX:XX	set destination MAC address
loopback a / b vlan replace off / id / priority / id+pr	select VLAN-tags swapping mode
loopback a / b vlan id int	set VLAN ID value
loopback a / b vlan priority int	set VLAN priority value
loopback a / b ip replace off/ source / destination / src+dst	select IP address replace mode
loopback a / b ip src i.i.i.i	set source IP address
loopback a / b ip dst i.i.i.i	set destination IP address
loopback a / b tos replace off / tos / precedence / tos+prec	select ToS swapping mode
loopback a / b tos flags bin	set ToS value

Command	Operation
loopback a / b tos precedence int	set Precedence value
Network setup	
network a dhcp off/on	enable/disable DHCP option for port A
network a ip i.i.i.i	set IP address for the port A
network a subnetmask i.i.i.i	set subnet mask for the port A
network a gateway i.i.i.i	set gateway IP address for the port A
network a dns i.i.i.i	set DNS-server IP-address for the port A
network b dhcp off / on	enable/disable DHCP option for port B
network b ip i.i.i.i	set IP address for the port B
network b subnet i.i.i.i	set subnet mask for the port B
network b gateway i.i.i.i	set gateway IP address for the port B
network b dns i.i.i.i	set DNS-server IP-address for the port B
lan dhcp off / on	DHCP function switch on/off for the LAN port
lan ip i.i.i.i	set IP address for the port LAN
lan subnet i.i.i.i	set subnet mask for the port LAN
lan gateway i.i.i.i	set gateway IP address for the port LAN

Command	Operation
network mpls off / on	switch on/off frames with label transmitting
Interface setup	
gbe a speed automatic/10/100/1000	select the transmission rate for the port A
gbe a state off / on	port A switch on/off
gbe a mac XX:XX:XX:XX:XX:XX	set MAC address for the port A
gbe b speed automatic/10/100/1000	select the transmission rate for the port B
gbe b state off / on	port B switch on/off
gbe b mac XX:XX:XX:XX:XX:XX	set MAC address for the port B
lan mac XX:XX:XX:XX:XX:XX	set MAC address for the port LAN
lan vlan count off / 1 / 2 / 3	set number of VLAN tags
lan vlan 1 / 2 / 3 id int	set VLAN ID value
lan vlan 1 / 2 / 3 priority int	set VLAN priority value
gbe a / b vlan count off / 1 / 2 / 3	set number of VLAN tags
gbe a / b vlan 1 / 2 / 3 id int	set VLAN ID value
gbe a / b vlan 1 / 2 / 3 priority int	set VLAN priority value
gbe a / b mpls tx lsr i.i.i.i	IP address of LSR
gbe a / b mpls tx rule off / on	switch on/off the rule for sending packets in the subnet
gbe a / b mpls tx subnet i.i.i.i	subnet IP address

Command	Operation
gbe a / b mpls tx mask i.i.i.i	subnet mask
gbe a / b mpls tx stack count off / 1 / 2 / 3	set number of VLAN tags
gbe a / b mpls tx stack [1-3] label int	set VLAN tag value
gbe a / b mpls tx stack [1-3] cos int	set class of service for datagram
gbe a / b mpls tx stack [1-3] ttl int	set time to live for datagram
gbe a / b mpls rx count off / 1 / 2 / 3	select number of tags to receive
gbe a / b mpls rx [1-3] label int	set VLAN tag value
Profiles	
profile rename [n] [name]	set profile name
profile save [n]	save current settings to the cell
profile lock [n]	lock the n-th record
profile unlock [n]	set unlock for the cell n
profile load [n]	profile load from the cell n
profile delete [n]	profile load from the cell n
profile list	display the list of saved profiles in format n, name, date, lock
profile show [n]	display profile n content
Common commands	
exit	exit from the configuration mode

Command	Operation
help	show the list of available commands
time HH:MM:SS	set current time
date DD-MM-YYYY	set current date

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NOTICE

通告

CHINESE REGULATION ON RESTRICTION OF HAZARDOUS SUBSTANCES

中国关于危害物质限制的规定

NAMES AND CONTENTS OF THE TOXIC OR HAZARDOUS SUBSTANCES OR ELEMENTS CONTAINED IN THIS EXFO PRODUCT

包含在本 **EXFO** 产品中的有毒有害物质或元素的名称和含量

O	Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006 表示该有毒有害物质在该部件所有均质材料中的含量均在 SJ/T11363-2006 标准规定的限量要求以下。
X	Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in SJ/T11363-2006 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出 SJ/T11363-2006 标准规定的限量要求。

Part Name 部件名称	Toxic or hazardous Substances and Elements 有毒有害物质和元素					
	Lead 铅 (Pb)	Mercury 汞 (Hg)	Cadmium 隔 (Cd)	Hexavalent Chromium 六价铬 (Cr VI)	Polybrominated biphenyls 多溴联苯 (PBB)	Polybrominated diphenyl ethers 多溴二苯醚 (PBDE)
Enclosure 外壳	O	O	O	O	O	O
Electronic and electrical sub-assembly 电子和电子组件	X	O	X	O	X	X
Optical sub-assembly[a] 光学组件 [a]	X	O	O	O	O	O
Mechanical sub-assembly[a] 机械组件 [a]	O	O	O	O	O	O

a. If applicable.
如果适用。

MARKING REQUIREMENTS
标注要求

Product 产品	Environmental protection use period (years) 环境保护使用期限 (年)	Logo 标志
This Exfo product 本 EXFO 产品	10	
Battery[a] 电池 [a]	5	

a. If applicable.
如果适用。

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