The Verification Experts

USER MANUAL

TX300s-100GX

100G Test Module

Please direct all questions to your local VeEX® Sales Office, Representative, or Distributor. Or, contact VeEX technical support at www.veexinc.com.

 D07-00-151P RevA00

Table of Contents

Go back to top

1.0 General Information

This user manual is suitable for novice, intermediate, and experienced users and is intended to help use the features and capabilities of VeEX products successfully. It is assumed that the user has basic computer experience and skills, and is familiar with telecommunication and other concepts related to VeEX product usage, terminology, and safety.

Every effort was made to ensure that the information contained in this user manual is accurate. Information is subject to change without notice and we accept no responsibility for any errors or omissions. In case of discrepancy, the web version takes precedence over any printed literature. The content in this manual may vary from the software version installed in the unit. For condition of use and permission to use these materials for publication in other than the English language, contact VeEX, Inc.

This manual describes software and/or a device that uses software either developed by VeEX Inc. or licensed by VeEX, Inc. from third parties. The software is confidential and proprietary of VeEX, Inc. The software is protected by copyright and contains trade secrets of VeEX, Inc. or VeEX's licensors. The purchaser of this device and/or software, downloaded or embedded, agrees that it has received a license solely to use the software as embedded in the device and/or provided by VeEX Inc., and to use it solely as intended and described in this manual. The purchaser is prohibited from copying, reverse engineering, decompiling, or disassembling the software.

Go back to top Go back to TOC

1.1 Customer Support

For more technical resources, visit www.veexinc.com.

For assistance or questions related to the use of this product, call or e-mail our customer care department for customer support. Before contacting our customer care department, have the product model, serial number, and software version ready. Please locate the serial number on the back of the chassis. Please provide this number when contacting VeEX, Inc. customer care.

Support hours may vary depending on the product.

Product Technical Support

Support is generally available 8:00 AM to 8:00 PM, Eastern Standard Time, Monday to Friday.
Phone: +1 510 651 0500
E-mail: customercare@veexinc.com

MPA Product Technical Support

Support is generally available 8:30 AM to 5:30 PM, Eastern Standard Time, Monday to Friday.
Phone: +1 877 929 4357
International: +1 727 475 1206
E-mail: serviceandsupport@veexinc.com

Go back to top Go back to TOC

1.2 Warranty

For warranty information on VeEX products, go to https://www.veexinc.com/Support/Warranty.

To activate the warranty, please register your product at https://www.veexinc.com/Support/ProductRegistration.

Go back to top Go back to TOC

1.3 Patent Information

VeEX product hardware and software may be protected by one or more patents on file with the United States Patent Office.

Go back to top Go back to TOC

1.4 Documentation Conventions

Icons used in this manual:

	Marks a helpful tip (action or method), which can save time and improve usability of the product.
	Provides important information needed to use this product and avoid missteps.
	Cautions against and action or inactivity, which can hinder productivity.
	Strongly warns against a condition, an action, or inactivity which can lead to a health hazard, injury, equipment damage, data loss, and/or financial losses.
	Stop and read before continuing.

Go back to top Go back to TOC

2.0 Safety Information

Safety precautions should be observed during all phases of operation of this instrument. The instrument has been designed to ensure safe operation however please observe all safety markings and instructions. Do not operate the instrument in the presence of flammable gases or fumes or any other combustible environment. VeEX Inc. assumes no liability for the customer's failure to comply with safety precautions and requirements.

Optical Connectors

The test sets display a laser warning icon when the laser source is active to alert the user about a potentially dangerous situation. It is recommended to:

1. Deactivate the laser before connecting or disconnecting optical cables or patchcords.
2. Never look directly into an optical patchcord or an optical connector interface (SFP+) while the laser is enabled. Even though optical transceivers are typically fitted with Class 1 lasers, which are considered eye safe, optical radiation for an extended period can cause irreparable damage to the eyes.
3. Never use a fiber microscope to check the optical connectors when the laser source is active.

Lithium-ion Battery Precautions

Lithium-ion (Li-ion) battery packs are compact and offer high capacity and autonomy, which make them ideal for demanding applications, like providing long lasting power to portable test equipment. For safety reasons, due to their high energy concentration, these batteries packs and products containing them must be used, charged, handled, and stored properly, according to the manufacturer’s recommendations.

Li-ion battery packs contain individual Li-ion cells as well as battery monitoring and protection circuitry, sealed in its plastic container that shall not be disassembled or serviced.

The test set unit's battery pack is also fitted with a safety connector to prevent accidental short circuits and reverse polarity.

- Always charge the unit's battery pack inside the test platform battery bay using the AC/DC adapter supplied by VeEX.
- Do not charge or use the battery pack if any mechanical damage is suspected (shock, impact, puncture, crack, etc).
- Do not continue charging the battery if it does not recharge within the expected charging time
- Storage: For long term storage, the battery pack should be stored at 20°C/68°F (room temperature), charged to about 30 to 50% of its capacity. Spare battery packs should be charged and used at least once a year to prevent over-discharge (rotate them regularly).
- It is recommended to charge and use battery packs at least every three months. Battery packs shall not go without recharging (reconditioning) for more than six months.
- After extended storage, battery packs may reach a deep discharge state or enter into sleep mode. For safety reasons, Li-ion batteries in deep discharge state may limit the initial charging current (pre-recharge) before starting their regular fast charging cycle. The pre-charging state may take several hours.
- Air transportation of Li-ion batteries is regulated by United Nations' International Air Transportation Association (IATA) Dangerous Goods Regulations and by country-specific regulations. Please check local regulations and with common carriers before shipping Li-ion battery packs or products containing relatively large Li-ion battery packs.

Electrical Connectors

Telephone lines may carry dangerous voltages. Always connect the electrical test ports to known test interfaces which carry low level signals.

ESD: Electrostatic Discharge Sensitive Equipment

Test modules could be affected by electrostatic discharge. To minimize the risk of damage when replacing or handling test modules, make sure to follow proper ESD procedures and dissipate any electrostatic charge from your body and tools and the use proper grounding gear.

- Perform all work at a workplace that is protected against electrostatic build-up and discharging.
- Never touch any exposed contacts, printed circuit boards or electronic components.
- Always store test modules in ESD protected packaging.
- Wear ESD protection and grounding gear when:
    - Inserting, extracting, or handling test modules.
    - Inserting or removing SFPs, XFPs, QSFPs from the platform.
    - Connecting or disconnecting cables from modules or platform.

Go back to top Go back to TOC

3.0 Introduction

3.1 TX300s-100GX Overview

The TX300s-100G, with the latest technology in pluggable physical interfaces, is a perfect complement to the TX300s Platform, extending its testing range to 100 Gbps. Compatibility with the companion TX340s option offers a complete 64k to 100G test solution in a compact portable package.

Installation, commissioning, monitoring and maintenance of Ethernet, OTN and SDH/SONET networks is simplified thanks to a combination of intuitive features and powerful test functions. Fast troubleshooting and comprehensive analysis of transmission problems can be performed using its common graphical user interface. Novice users benefit from the easy-to-use GUI, while experienced users will appreciate an array of advanced features such as OTL/PCS, CAUI-4/XLAUI Lane BERT, Service Disruption, overhead monitor/control, Tandem Connection Monitoring, Protocol Capture/Decode, BERT, Throughput test, and much more.

3.2 Key Features

General

- QSFP28/QSFP+, SFP28/SFP+ and RJ45 test ports
- 10 Mbps to 100GE testing in one module
- Can be combined with a TX340s[1] module
- Soft LED indicators
- GPS timing and location
- Atomic clock[2]

Ethernet

- 10Gbps and 100 Gbps, Ethernet testing
- Supports IEEE 802.3bj Clause 91 RS-FEC[3]
- Optical Lane BERT and CAUI-4/XLAUI Lane BERT[3]
- PCS Layer Testing with Skew generation/monitoring[3]
- Multi-stream testing up to 32 independent streams[3]
- IEEE 802.3ah, ITU-T Y.1731, IEEE 802.1ag, MPLS-TP OAM support
- Q in Q (VLAN stacking), MPLS, MPLS-TP, PBB, EoE support[3]
- MAC flooding
- RFC2544 and V-SAM (Y.1564) testing
- V-PERF (stateful TCP performance testing) from 1GE to 100GE[3]
- V-Test (Internet speed testing) and V-FTP (FTP Performance testing[3]
- Service Disruption Measurements
- IPv4 and IPv6 traffic generation
- BERT and Throughput testing at Layer 2 and Layer 3
- Smart Loopback mode for Layer 2 and Layer 3
- One-Way-Delay latency measurement (GPS assisted)
- Line rate packet capture with Wireshark™ decode
- Error and Alarm Injection[3]

Fibre Channel

- 1G to 32G Layer FC-1 and FC-2 Throughput Testing
- RFC2544
- Fabric port login: FLOGI/PLOGI

OTN Testing

- OTN testing for OTU3 and OTU4
- Complete multi-stage Mapping/Multiplexing
- Ethernet over OTN
- Service Disruption measurements
- Tandem Connection Monitoring

- Overhead monitoring and byte decoding
- Terminate, Payload Through and Line Through test modes
- Per-lane optical power and frequency measurements
- External clock reference interface
- Histogram Analysis

QSFP28 Support

- Optical lane BERT
- PCS layer testing with skew generation/monitoring
- Transmit and receive optical power measurement
- Module status display

Test Interfaces

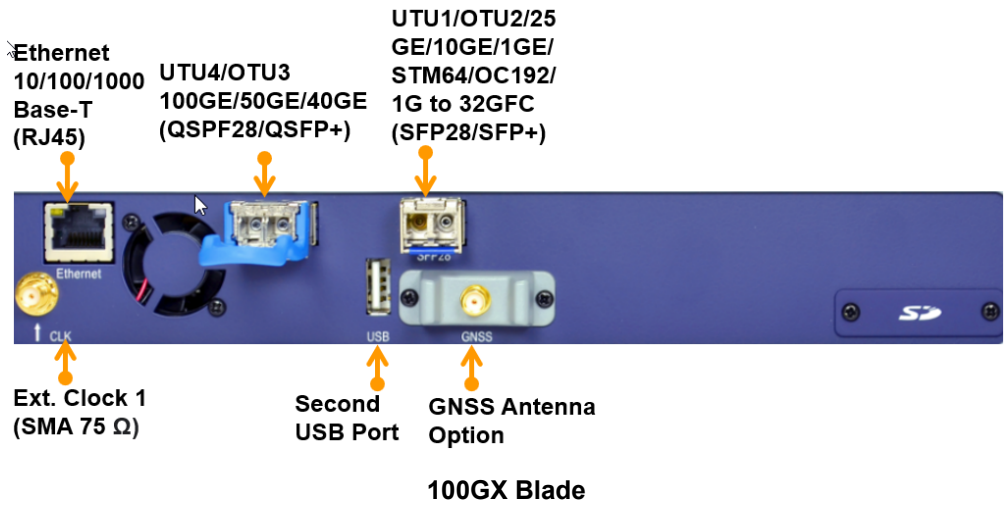
	TX300s-100GX (Single Module)	TX340s-100GX (with TX340Sm)
Test Ports		
QSFP28/QSFP+	1	1
SFP28/SFP+	1	1
RJ-45	1	No*
Applications		
100GE	Yes	Yes
40GE	Yes	Yes
25GE	Yes	Yes
OTU4	Yes	Yes
32G FC	Yes	Yes
10GBASE-X	Yes	No*
100FX/1000BASE-X	Yes	No*
10/100/1000BASE-T	Yes	No*
1G to 16G FC	Yes	No*

**Supported by the TX340sm module*

1. *Reference the TX340s module spec sheet for details*
2. *Configuration dependent*
3. *Data rate dependent*

3.3 Connector Panels & Test Ports

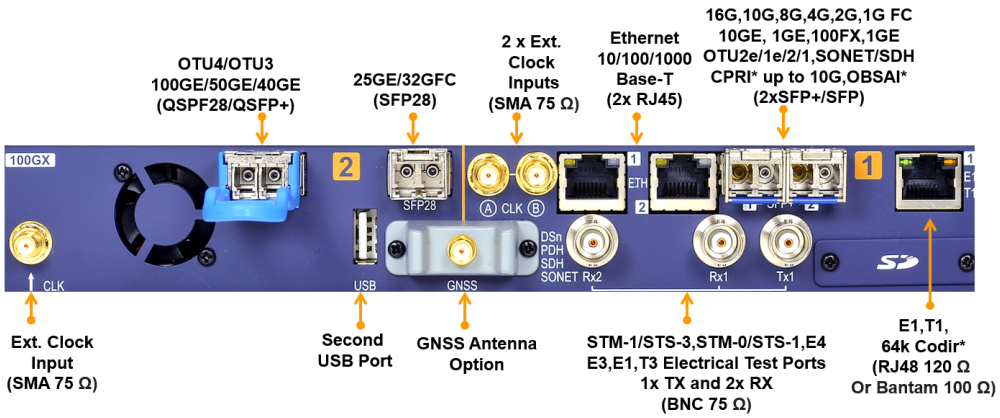
TX300s with 100GX blade



100GX Blade

Go back to top Go back to TOC

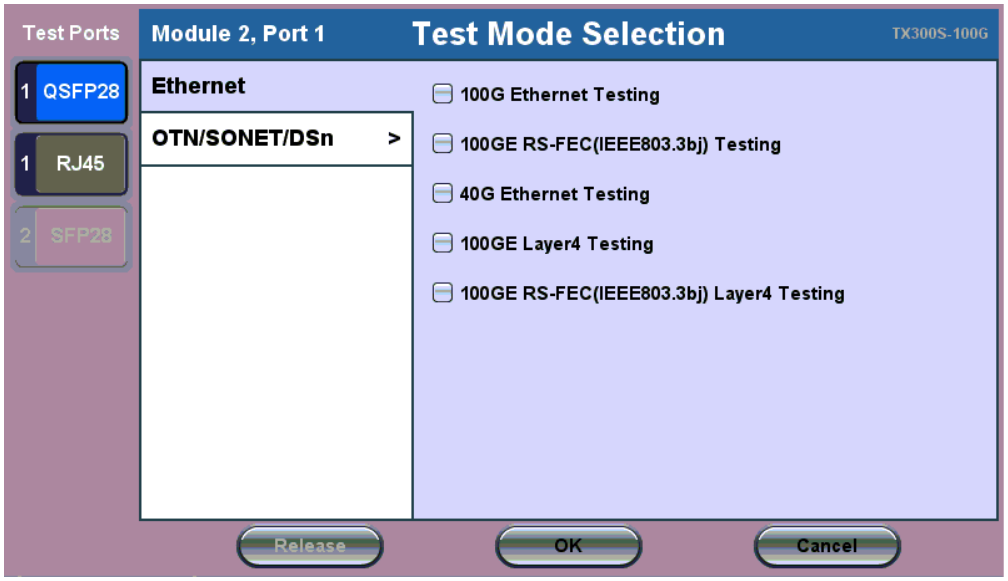
TX340s with 100GX blade



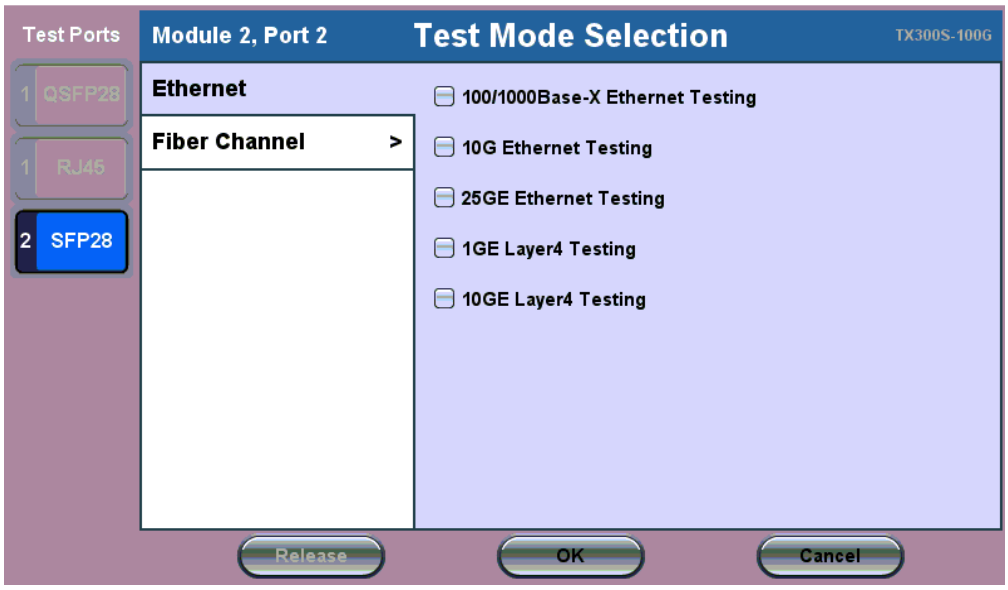
TX340s with 100GX Blade

Test Mode Selection for TX300s with 100GX and TX340s with 100GX blade

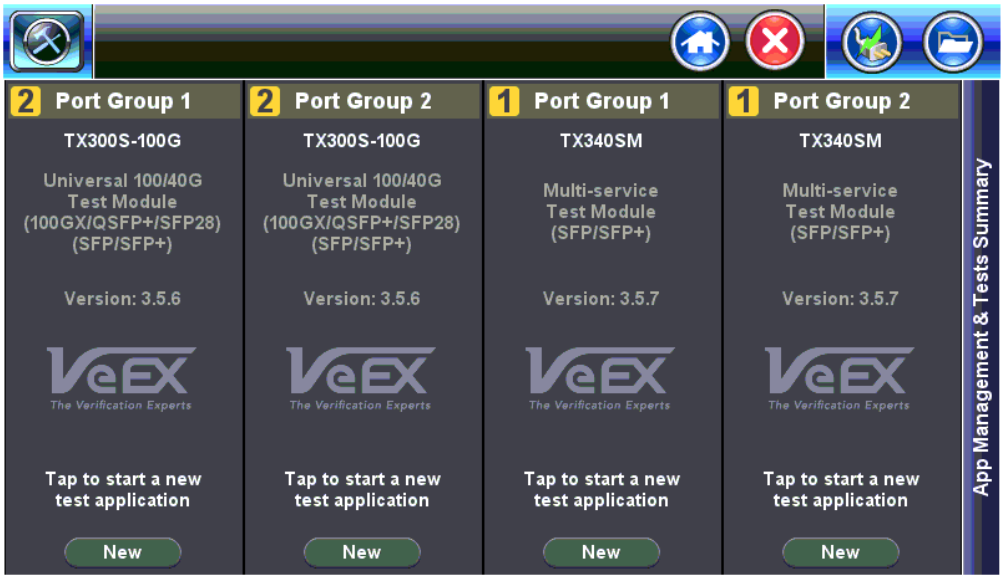
Test Port Selection for TX300s with 100GX



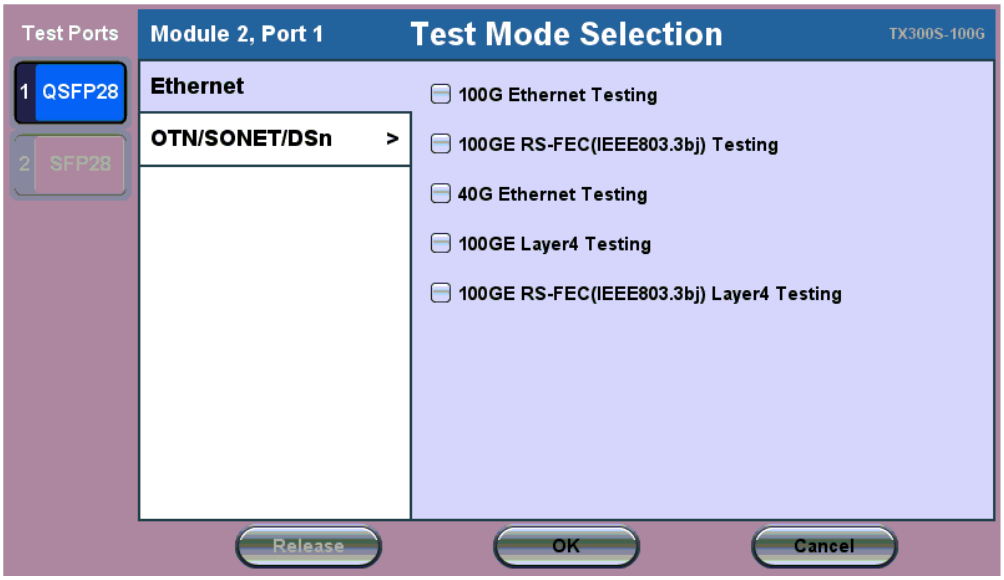
Test Mode Selection Port 1



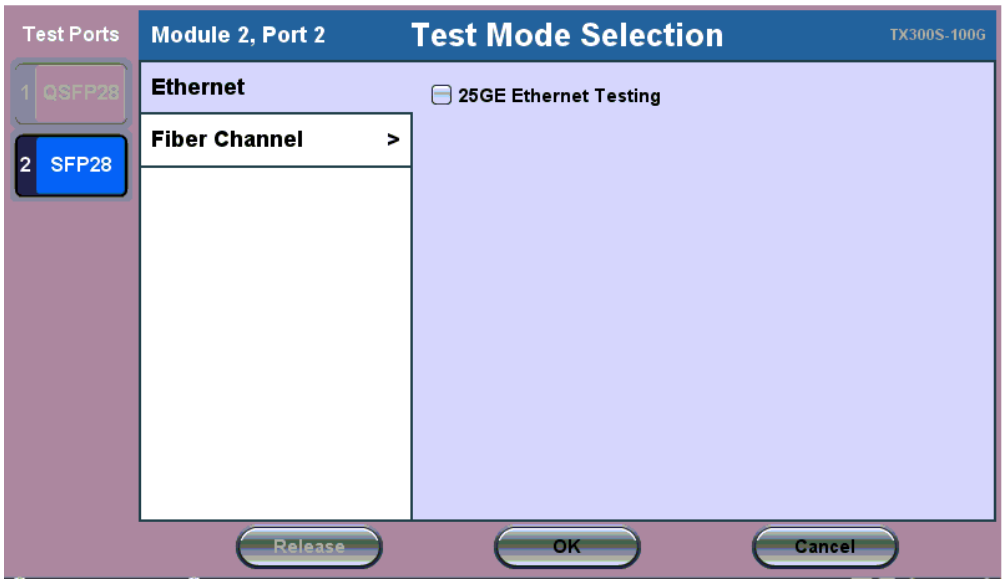
Test Mode Selection Port 2



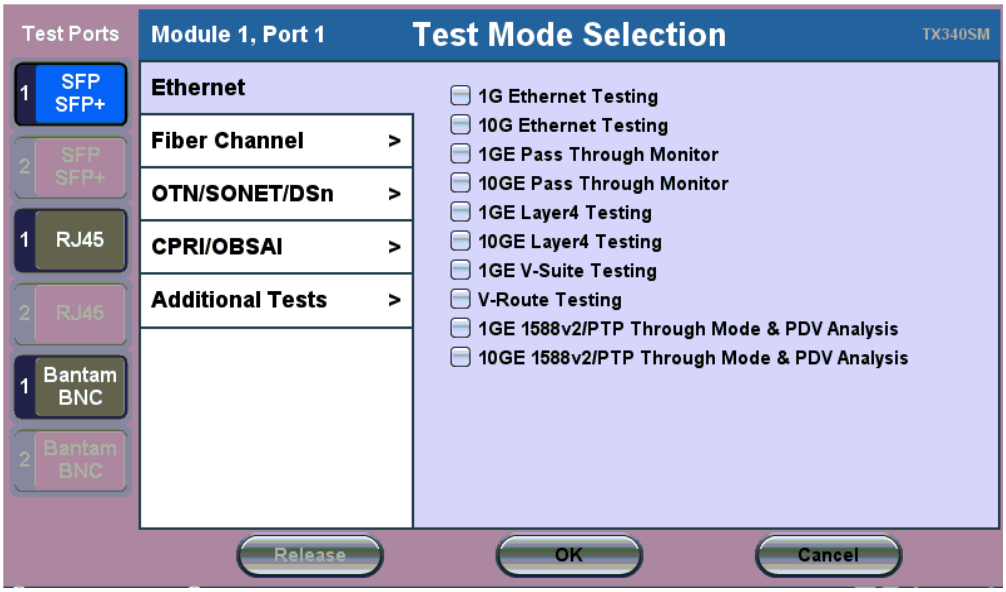
Test Port Selection for TX340s-100GX



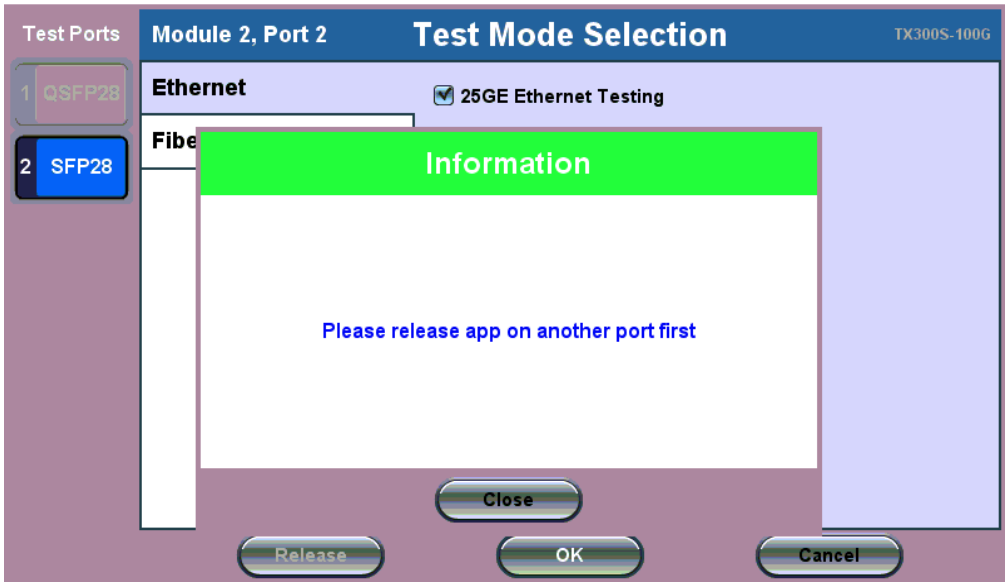
Test Mode Selection Port 1



Test Mode Selection Port 2



TX340s Test Mode Selection Port 1



Test Mode Selection Release

For TX340s-100GX there are only 2 test cards present: Module 2 Port 1 and Module 2 Port 2 (on 100GX module). If application is loaded on a port, and the user tries to load the application on a second port, a notification pops up, asking to release the app on another port first.

Go back to top Go back to TOC

4.0 Basic Operations

Refer to the **TX300s, MTTplus, RXT-1200, or UX400 platform manuals** for information about Basic Operations, Home menu, Launching Test Applications etc.

4.1 Utilities

Refer to the **TX300s, MTTplus, RXT-1200, or UX400 platform manuals** for information about all Utilities and Tools available.

Go back to top Go back to TOC

5.0 Ethernet Test Application

(This chapter applies to 1G, 10G, 25G, 40G and 100G)

Refer to the RXT-1200, TX300s, or UX400 platform manuals for information on launching test applications and assigning test modules (UX400 only).

When first starting the test application, the soft LEDs might be red. Soft LEDs that are steady green indicate that the module is ready to perform different tests. This may require turning the **LASER On** button for optical interfaces or tapping the **History** tab to clear blinking LED reminders of past Errors and Alarms (test results are not affected).

Available test configurations will vary based on the test platform and installed module.

Ethernet Home Menu

Go back to top Go back to TOC

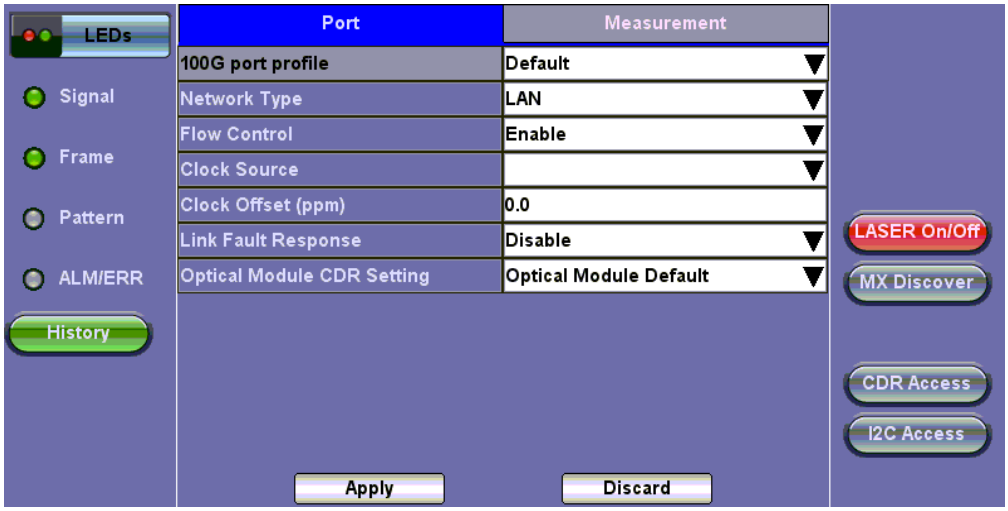
5.1 Setup

5.1.1 Port Setup

Port setup configuration is accessed from the **Setup** menu located on the Ethernet home menu. The available configuration settings depend on the interface selected in the Test Mode selection.

Select the operation mode and the interfaces that will be used to carry out tests. Once the operating mode and interfaces are selected, independently configure the auto-negotiation, speed, duplex, and flow control settings for each port (where applicable).

After configuring settings, tap **Apply** to save changes. Tap **Discard** to revert to previous selections.



TX300s-100GX Ethernet Test App Setup

100G Port, TX300s-100GX:

- **100G port profile**: Lock, Delete, Save, Save as..., Default, Last configuration
- **Network Type**: LAN
- **Flow Control**: Enable/Disable
- **Clock Source**: Internal
- **Clock Offset (ppm)**: Can be configured; range is +/- 150ppm
- **Link Fault Response:** Disable or Enable (also enables Local link and failure, remote, failure)
- **Eye Clk** (100G only)

Status

The **Status** tab lists current port settings. Please note that the Status tab is only available if a fiber port option is selected from the **Test Port Selection** menu.

Test units shipped before January 2012 support up to +/- 50 ppm offset only. Units shipped from 2012 onwards, support up to +/- 150 ppm offset. This applies to both 10GE WAN and 10GE LAN modes.

Go back to top Go back to TOC

5.1.2 Measurement Setup

The measurement and event log settings are configured on this screen.

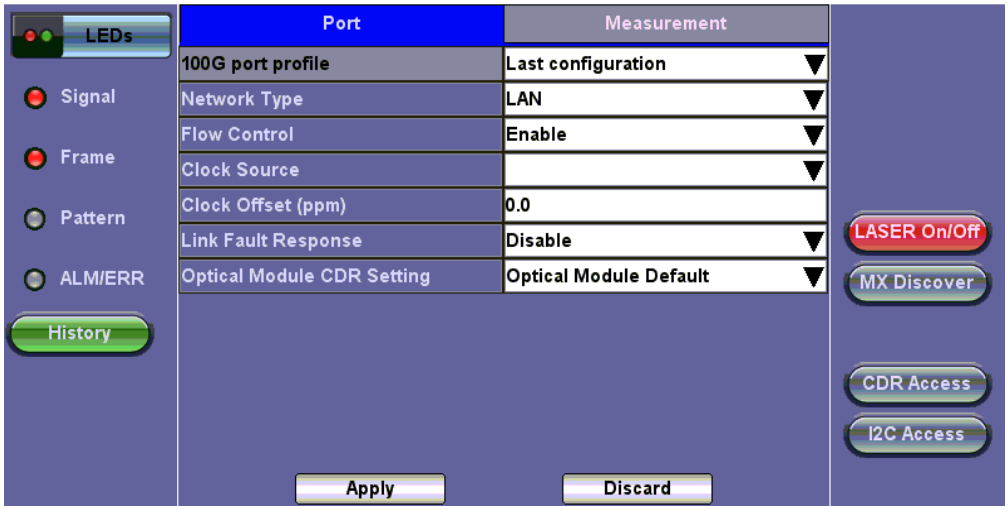
- **Profile**: Delete, Save, Save as..., Default.
- **Mode**: Manual, Timed
  - Manual mode: Starts and stops the measurements manually.
  - Timed mode: Defines the duration of the test; after the test is started, the test will run for the configured duration and stop automatically.
- **TX Start**: Separated and Coupled. Configure how the measurements are started when in BERT and Multiple Streams test modes.
  - Separated: Independent control (Start/Stop) of the transmitter is enabled. At the start of the test only the receiver is turned on -- the user must start the transmitter manually.
  - Coupled: Transmitter and receiver are turned on at the same time, and the Tx and Rx measurements start at the same time at the start of the test.
- **Clock (ToD) Synchronization Device:** Disable, GPS. Select the device to be used to synchronize the clock to perform the One Way Delay measurement.

When a device is selected the following fields can be seen on the screen:

- **External Clock Input:** 1pps (SMA Port). The SMA Port must be used for the 1pps signal.
- **UTC ToD:** Displays the Coordinated Universal Time (UTC) Time of Day once it is acquired.
- **Clock Sync Time:** Time field to configure the UTC ToD that both test sets, carrying out a one-way delay test between each other, will be synchronizing their internal time stamping at.
  Note: *Both test sets must be configured to the same Clock Sync Time.*

Clock Synchronization is not supported on all the test set models. Check with customer care for availability.

- **Gratuitous ARP**: ON or OFF. If set to ON, a gratuitous ARP is performed. When the test port has an IP connection, an ARP request will be transmitted at regular intervals to keep the router/gateway ARP table aware of the test set's IP address. This setting is useful for long-term L3 routed testing.
- **Results Auto Save**: ON or OFF. If set to ON, results will be saved automatically



Measurement Setup

Go back to top Go back to TOC

5.1.3 MX Discover and Control

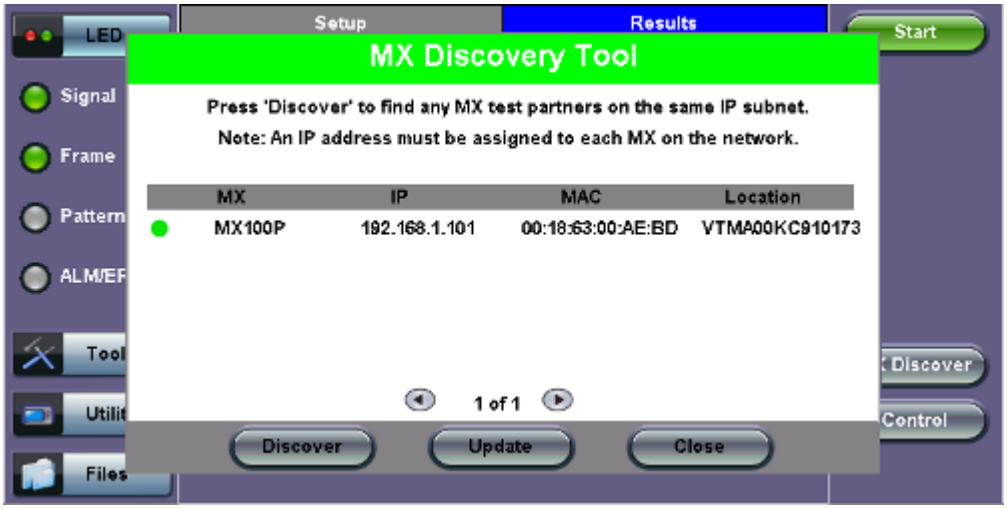
Before proceeding with MX Discover or Control, be sure to assign an IP address to each test port. To assign an IP address, proceed to the home menu and select the IP icon.

If using OAM Discover, it is unnecessary to assign an IP address to the local or remote unit.

Using MX Discover

MX Discover enables the test set to discover other VeEX VePal test sets and devices with an assigned IP address on the same subnet. To discover other devices using **MX Discover**:

1. Tap on the **MX Discover** button and then press **Discover**.
2. A list of discovered devices on the same IP subnet will appear. Select a unit to connect to from the list of devices.
3. Tap on **Close** to exit the window.



MX Discovery Tool

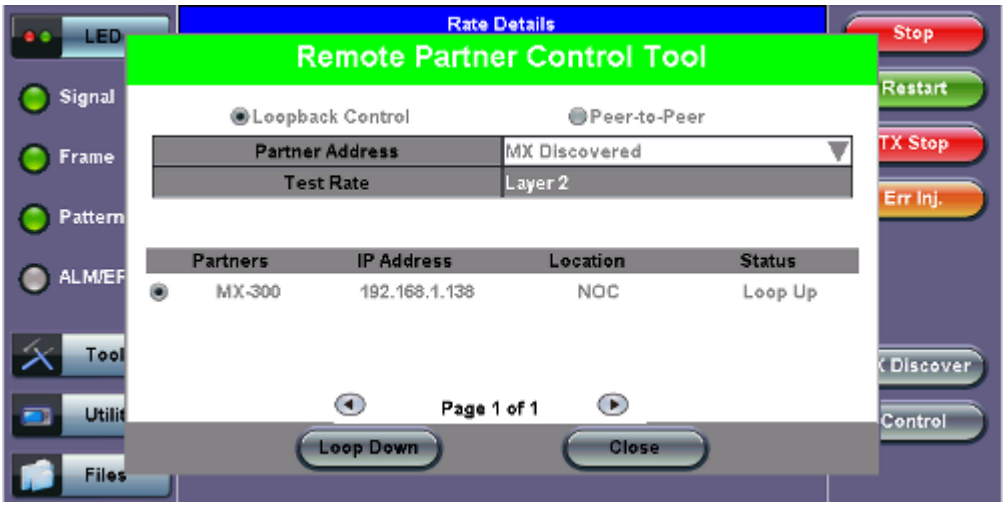
Loop Control

The **Loop Control** button becomes available on the right side menu when any Ethernet application (V-SAM, RFC 2544, Throughput, BERT) is selected. Press the **Loop Control** button to configure loop up and loop down commands necessary to control a far-end unit. The loop up command contains information about the test layer. Looping back test traffic is possible as follows:

- **Layer 1:** All incoming traffic is looped back unchanged
- **Layer 2:** All incoming unicast traffic is looped back with the MAC source and destination addresses swapped
- **Layers 3 & 4:** All incoming unicast traffic is looped back with MAC/IP source and destination addresses swapped

To configure loopback control on the unit, select from the following options under **Partner Address**:

- **MX Discovered:** Lists MX discovered devices. Select from the list of discovered devices to loop up/down
- **User Defined:** Input the destination IP address of the far-end device
- **OAM Discover**: Lists OAM discovered devices. Select from the list of discovered devices to loop up/down
- **X-Loop:** Loops non-VeEX networking equipment.
- **VL2-Loop**: Input the Mac address or VLAN ID and Pri of the far-end device



Remote Partner Control

Go back to top Go back to TOC

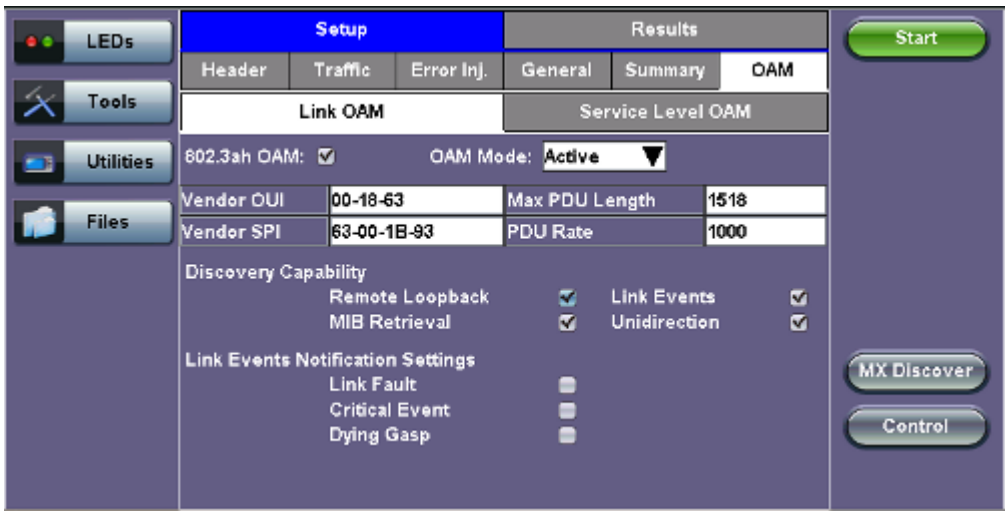
OAM Discover

Like MX Discover, OAM Discover can also be used to discover far-end test units without manually configuring the local or remote unit's destination address. If OAM is enabled on the test set, any link partner that supports the IEEE 802.3ah protocol will be

discovered automatically and displayed under the **OAM Discover** tab. To access OAM Discover:

1. Go to **Throughput** > **OAM** > **Link OAM** and tap on the 802.3ah check box to activate Link OAM. Select Active from the **OAM Mode** drop-down menu (only Active mode can send loop commands).
2. Tap **OAM Loopback Loop Control** button and select the **OAM Discover** tab to see a list of discovered OAM devices. You can also see a list of OAM devices by tapping the **Loop Control** button and selecting **OAM Discover** tab. Select an OAM device and press **Loop Up** to send a loop up command to the selected remote unit.

For detailed descriptions of Discovery Capabilities, Link Events, and Notification Settings, refer to Ethernet OAM Testing.



Activating 802.3ah Link OAM

Go back to top Go back to TOC

5.1.4 ViPAG/V-Route Test

ViPAG/V-Route can be accessed from the Test Mode menu. Refer to the TX300s, UX400, or RXT-1200 platform manual for information on launching test applications from the Test Mode menu.

The following selections are available on the unit:

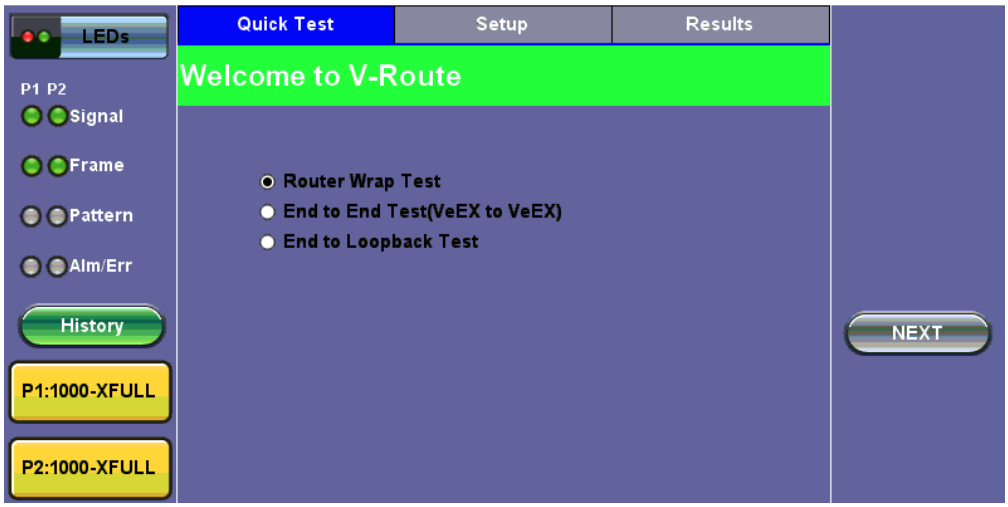
- **Router Wrap Test:** "On local unit" testing on a single unit
- **End to End Test:** (VeEX to VeEX)
- **End to Loopback Test:**

Router Wrap Test is the default selection for test sets.

ViPAG/V-Route is not available so far on 100GX module. It is only available on TX340s module.

Go back to top Go back to TOC

ViPAG/V-Route Setup



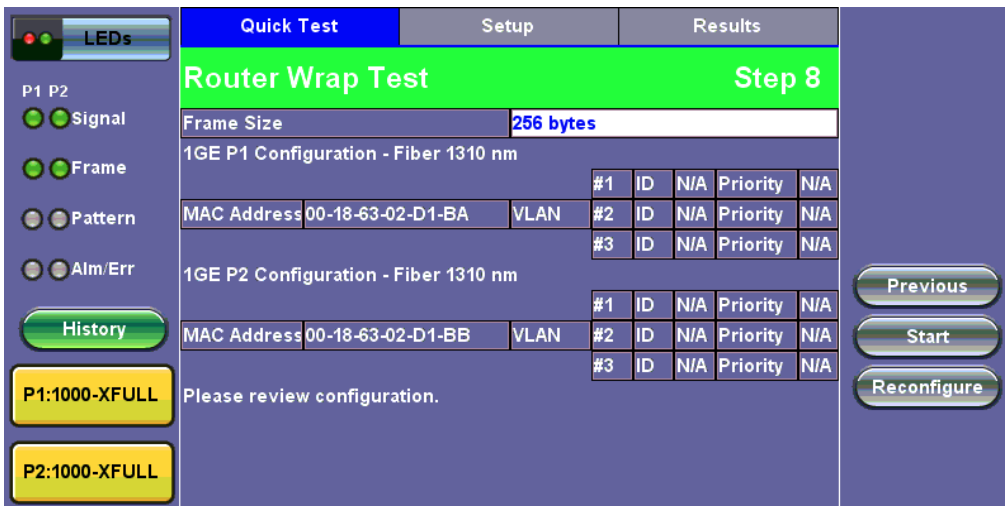
Quick Test Setup Welcome Page

Quick Test menu options may vary depending on the unit you are using.

Quick Test Setup

Fill out each screen and press **NEXT** to proceed to the next page or **Previous** to go back to the previous screen.

- **Select the test type**: Router Wrap Test
- **Step 1:** Select the router test interface. "Local unit" denotes a router wrap test while "end-to-end" conducts an end-to-end test. For End-to-End testing, select whether this unit will be a ***Controller*** or ***Responder***. For **End to Loopback** testing, select whether this unit will be Generating Traffic or in Loopback Mode. The frame size for each option listed below is 256 bytes.
- **Step 2 (Router Wrap only):** Layer 2 is selected by default.
- **Step 3:** Configure port settings for port 1. Refer to Port Setup for detailed instructions.
- **Step 4:** Configure port settings for port 2.
- **Step 5:** Enable up to 3 VLAN tags. Configure ID, Priority, Type, and Drop Eligible.
- **Step 6:** Enter the frame size. The default frame size for each option is 256 bytes.
- **Step 7:** Review the settings for both ports. Press **Start** to begin testing. Pressing **Reconfigure** will restart the Quick Test Setup and return the screen to Step 1.

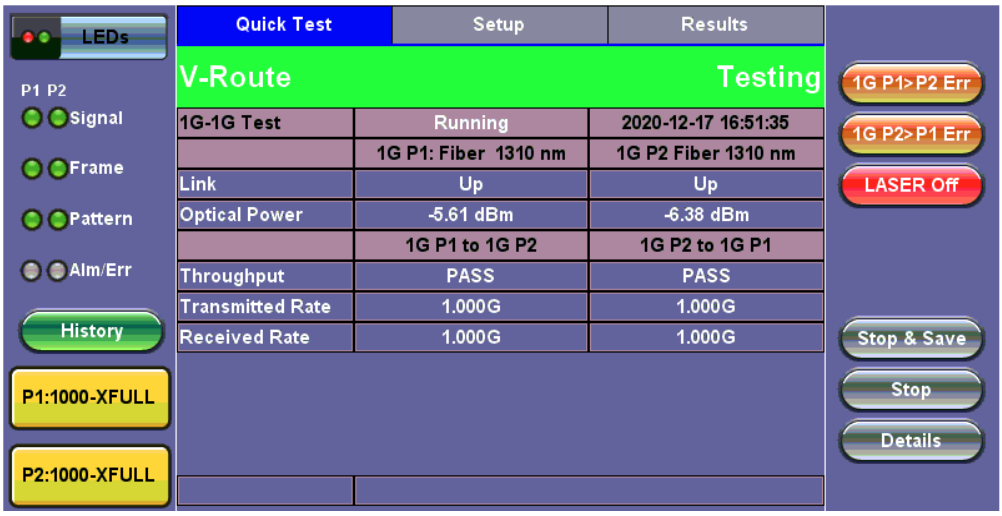


Router Wrap Test Configuration Summary

Quick Test View

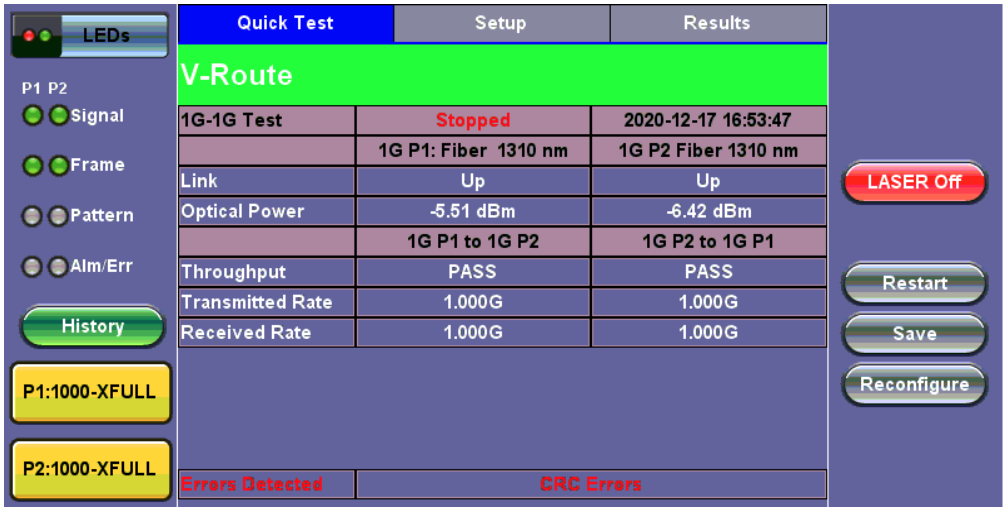
After starting the test, the Error Injection button for each port (P1->P2 Error and P2->P1 Error) becomes available and the screen displays Quick Test view and the following results for both ports:

- Link Up/Down status
- Optical Power
- Transmitted Rate
- Received Rate
- Throughput - Pass/Fail status



Quick Test Results Summary

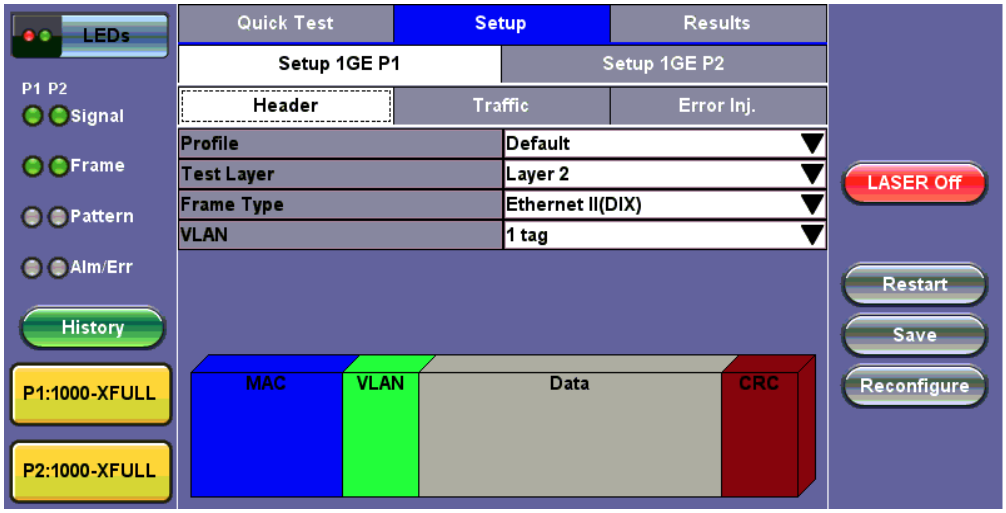
Stop & Save stops the test and enables naming of saved test results. **Details** brings up the **Results** screen.
In case of link or IP related test failure, V-Route will indicate the possible failure in red text and give instructions on what to check for.



Test Failure

Setup

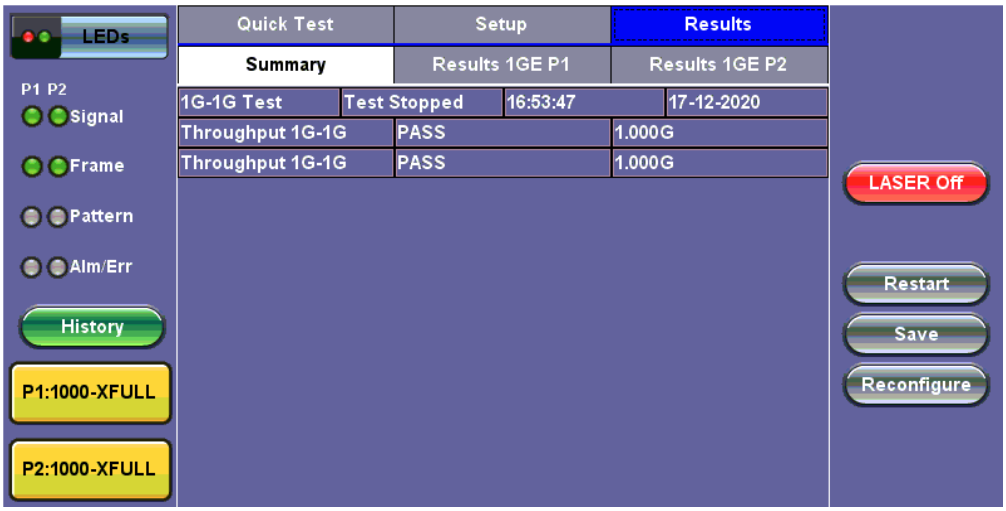
Test sets come preconfigured. To customize settings for both ports, go to the **Setup** tab. For configuration instructions, please refer to BERT.



Setup

Go back to top Go back to TOC

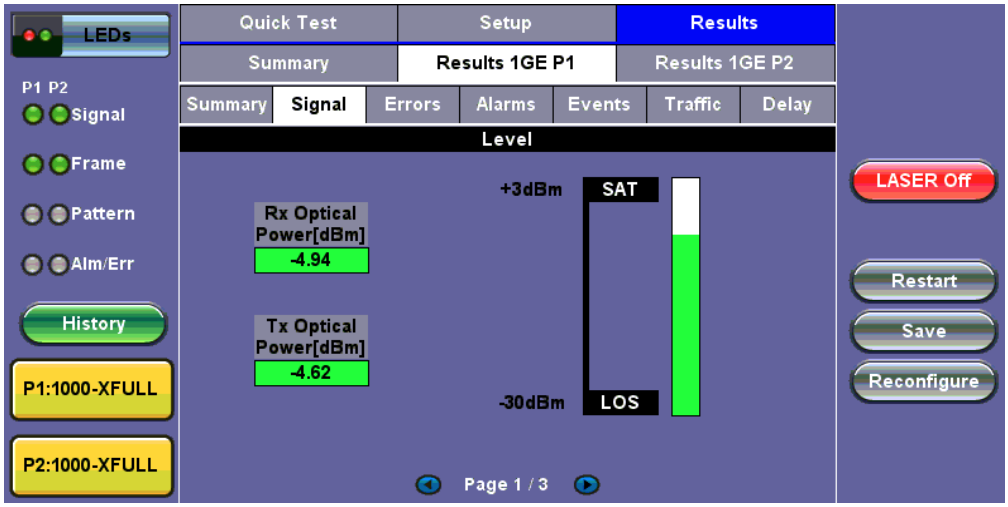
Results



Results Summary

The **Summary** tab lists the Pass/Fail status of the Throughput test for each port along with test measurements.

The **Results** tabs for each port lists statistical results similar to those featured in the BERT Results section. Please see BERT Results for more information.



Port Results - Signal

Go back to top Go back to TOC

5.2 IP

5.2.1 IP Connection

Port setup and IP connection are required prior to performing the following Ethernet applications: Ping, Trace Route, Web/FTP, ARP Wiz, VoIP, IPTV testing, and 688v2 (except Layer 2).

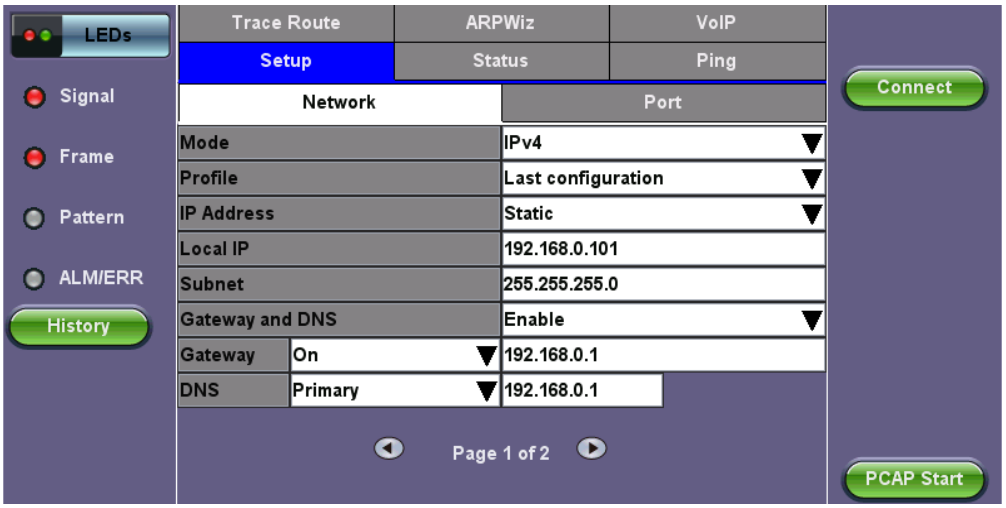
Tap on **IP** from the Ethernet home menu to access Port and IP settings.

5.2.1.1 Setup

Select PPoE, IPv4, or IPv6 from the Mode menu.

Point-to-Point Protocol over Ethernet (PPoE)

- **Authentication:** PAP, CHAP, or CHAP & PAP.
- **VLAN:** Off or 1 Tag.
- **ID:** VLAN ID. Enter value 0 to 4095.
- **Pri:** VLAN priority 0 to 7.
- **DNS:** Selecting Manual DNS opens another menu. Select from Off, Primary, or Primary & Secondary. Enter the Primary and/or Secondary DNS if required.



IP Setup - IPv4

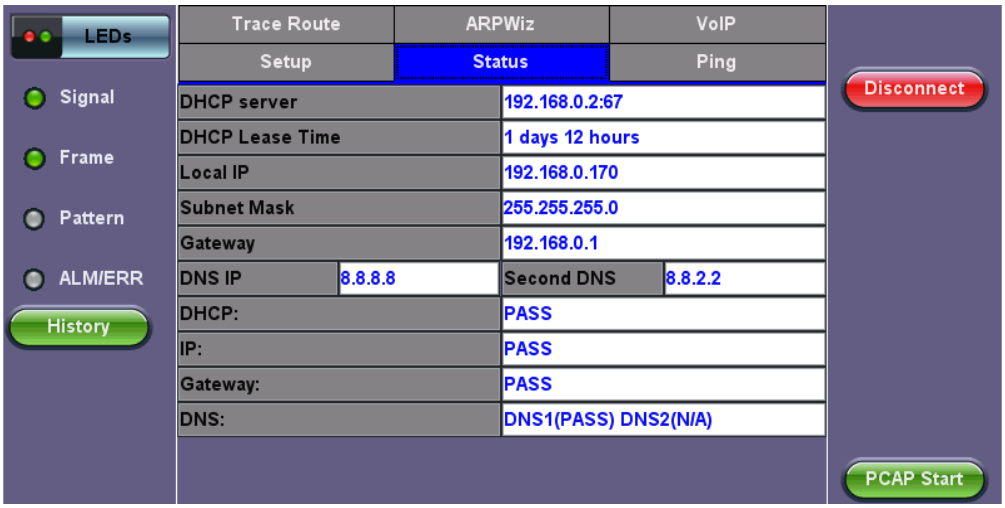
IPv4 or IPV6

- **IP Type:** IPv4 or IPv6
- **IP Address:** Static, DHCP (IPv4 only) or AUTO (IPv6 only)
- **Static:** The user is required to enter a Local IP, Gateway address, and Subnet. All Static fields can be filled by tapping on the section to access an alphanumeric keyboard
    - **Local IP:** IPv4/IPv6 address of the test set
    - **Gateway:** IPv4/IPv6 address of the network gateway
    - **CIDR** (IPv6 only)**:** The user can enter a Classless Inter -domain Routing Network
    - **Subnet** (IPv4 only)**:** The user can enter a subnet mask
- **DNS:** Off, Manual, or Auto. If Manual is selected, a DNS IP is required in order to use the URL as a destination. Enter the IP address of the Domain Name System (DNS) Server providing domain name translation to IP addresses.
- **VLAN:** Off, 1 Tag, 2 Tags. For each VLAN tag, enter the following:
    - **ID:** VLAN ID. Enter value 0 to 4095.
    - **Pri:** VLAN priority 0 to 7.

Go back to top Go back to TOC

5.2.1.2 Status

Ensure the Status is PASS before continuing with any IP tests. If the connection fails, go back to the setup screen to verify that the parameters are entered correctly. Verify that the Ethernet cable is properly connected on the management port on the left hand side of the unit.



Pass Status

- **DHCP:** PASS indicates that an IP address has successfully been assigned.
- **IP:** PASS indicates that the IP address assigned has been verified to be unique in the network.
- **Gateway:** PASS indicates that the gateway IP address is valid.
- **DNS:** PASS indicates that the DNS IP address is valid.

Go back to top Go back to TOC

5.2.2 Trace Route

Trace Route is a common method used to find the route to the destination IP address or URL.
Refer to **Trace Route** in the **TX300s, MTTplus, RXT-1200, or UX400 platform manuals** for more information on this feature including setup and results.

Go back to top Go back to TOC

5.2.3 ARP Wiz

ARP Wiz uses the Address Resolution Protocol (ARP) to verify the status of each IP address in a user-selectable IP range. It is the standard method for finding a host's hardware address when only its network layer address is known.
Refer to **ARP Wiz** in the **TX300s, MTTplus, RXT-1200, or UX400 platform manuals** for more information on this feature including setup and results.

Go back to top Go back to TOC

5.2.4 Ping

Ping is a popular computer network tool used to test whether a particular host is reachable across an IP network. A ping is performed by sending an echo request or ICMP (Internet Control Message Protocol) to the echo response replies.
Refer to **Ping** in the**TX300s, MTTplus, RXT-1200, or UX400 platform manuals** for more information on this feature including setup and results.

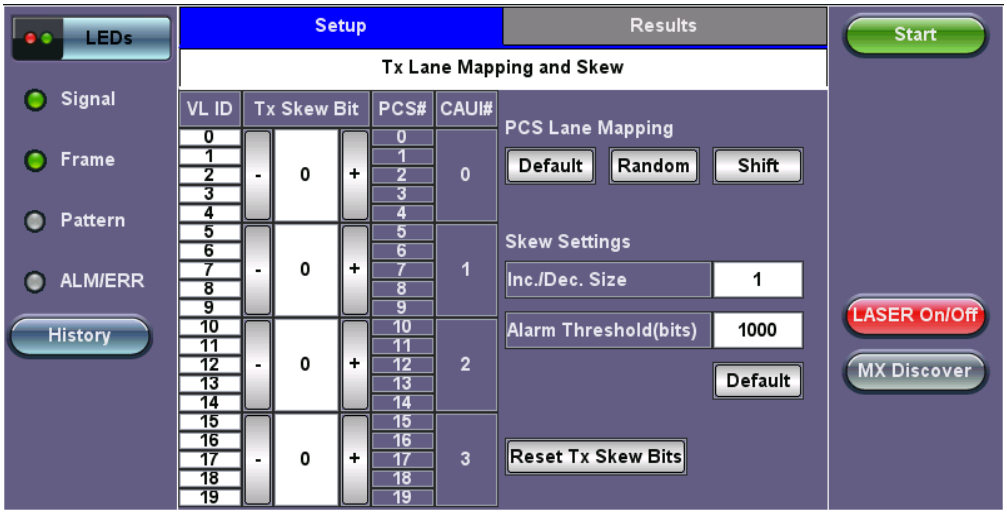
Go back to top Go back to TOC

5.3 PCS

5.3.1 Setup

5.3.1.1 Tx Lane Mapping and Skew

- **PCS to CAUI lanes configurable mapping:**
  - Defines the alignment markers ID that will be assigned to each lane
  - Default, random or manual setting
  - Receivers must be able to reorder and reassemble any mapping of PCS lanes into single stream
- **Lane Skew generation (up to 16000 bits time)**
  - Enter relative delay that will be introduced for the PCS lane pair (CAUI lane)
  - Stresses the de-skew function on the receiver side
- **Skew alarm threshold value:** User configurable threshold for Skew alarm

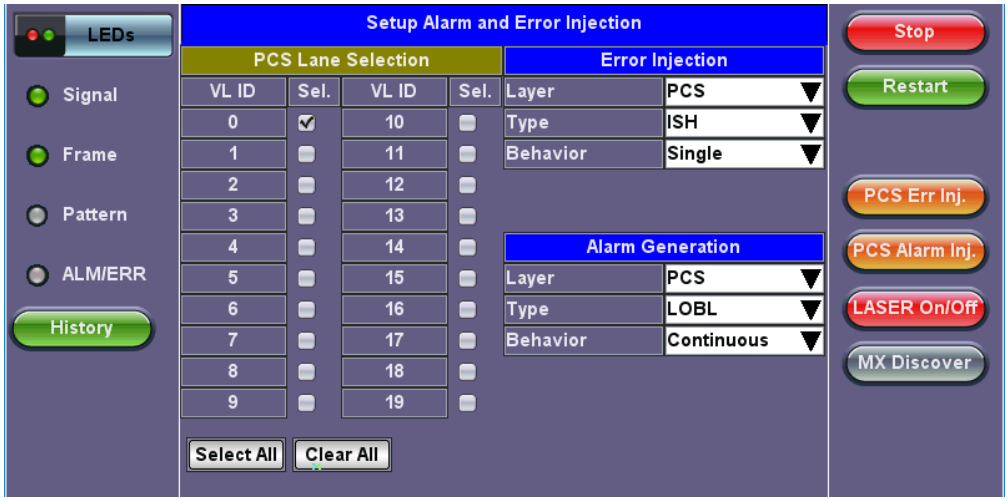


PCS Setup - Tx Lane Mapping and SkewGo

Go back to top Go back to TOC

5.3.1.2 Alarm/ Error Injection

- **Error Injection per PCS lane:**
  - **Invalid Sync header:** first 2 bits of the 64/66 block header
  - **Invalid alignment marker:** inserted every 16383 block on each virtual lane it contains the Virtual lane identifier
  - **BIP:** generates bit interleave parity error
- **Alarm Generation:**
  - **LOBL:** Loss of block lock
  - **LOA:** Loss of Alignment marker
  - **HI-BER:** high bit error rate of sync header

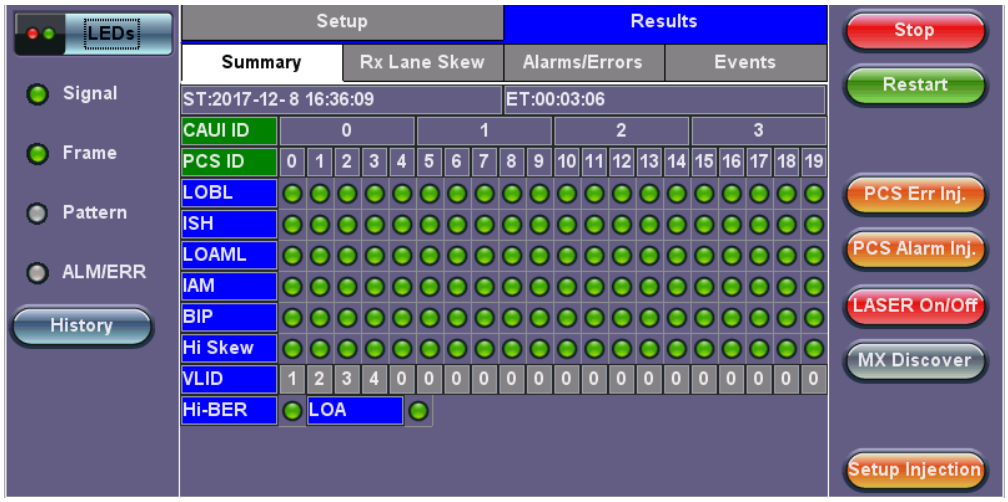


PCS Setup - Alarm/ Error Injection

Go back to top Go back to TOC

5.3.2 Results

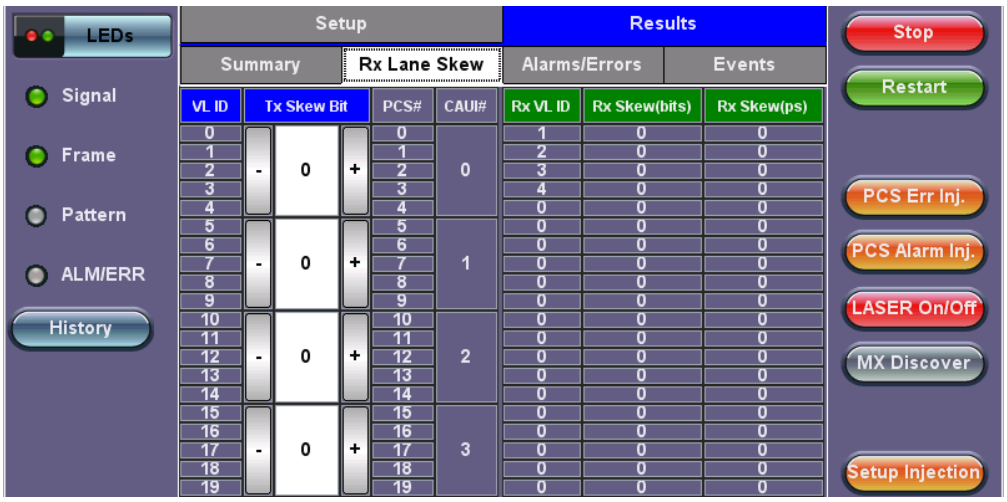
5.3.2.1 Summary



PCS Results - Summary

Go back to top Go back to TOC

5.3.2.2 Rx Lane Skew

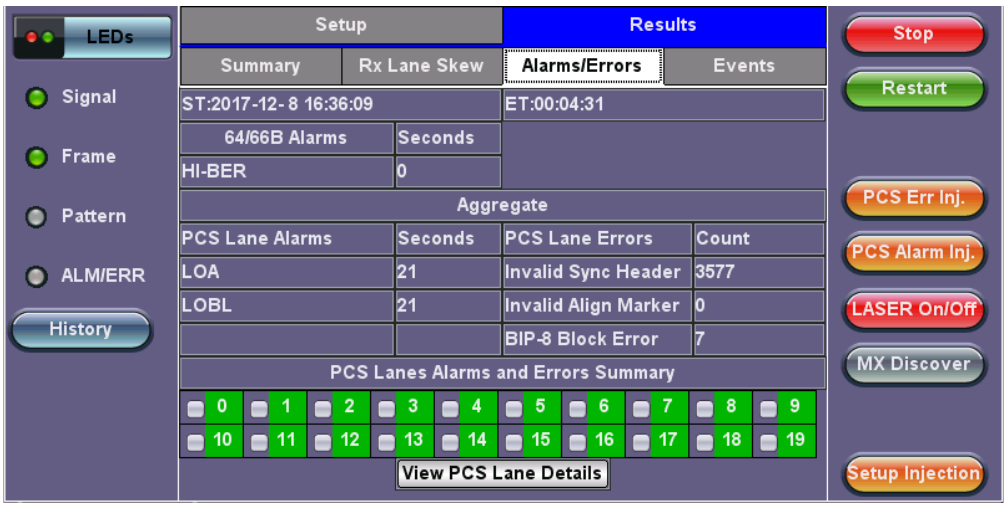


VL ID	Tx Skew Bit	PCS#	CAUI#	Rx VL ID	Rx Skew(bits)	Rx Skew(ps)
0	- 0 +	0	0	1	0	0
1		1		2	0	0
2		2		3	0	0
3		3		4	0	0
4		4		0	0	0
5	- 0 +	5	1	0	0	0
6		6		0	0	0
7		7		0	0	0
8		8		0	0	0
9		9		0	0	0
10	- 0 +	10	2	0	0	0
11		11		0	0	0
12		12		0	0	0
13		13		0	0	0
14		14		0	0	0
15	- 0 +	15	3	0	0	0
16		16		0	0	0
17		17		0	0	0
18		18		0	0	0
19		19		0	0	0

PCS Results - Rx Lane Skew

Go back to top Go back to TOC

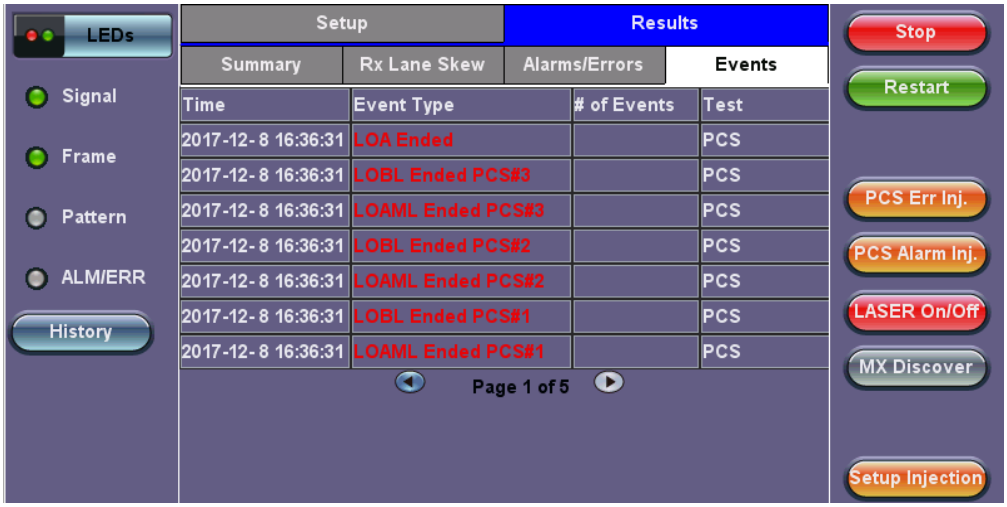
5.3.2.3 Alarms/Errors



PCS Results - Alarms/Errors

Go back to top Go back to TOC

5.3.2.4 Events



PCS Results - Events

Go back to top Go back to TOC

5.3.3 Saving PCS Results

Once the test has been stopped the results can be saved by pressing the Save key on the platform's keypad.

A window will open giving the option of naming the results file. Enter the desired name for the file and tap apply. The results will be saved.

PCS Results Save

Once the results are saved, they can be viewed or renamed by going to **Tools / System Settings screen> Files**. Refer to the **File Manager** section in the RXT1200, TX300s or UX400 Platform manual for more information on managing saved test results.

Go back to top Go back to TOC

5.4 BERT

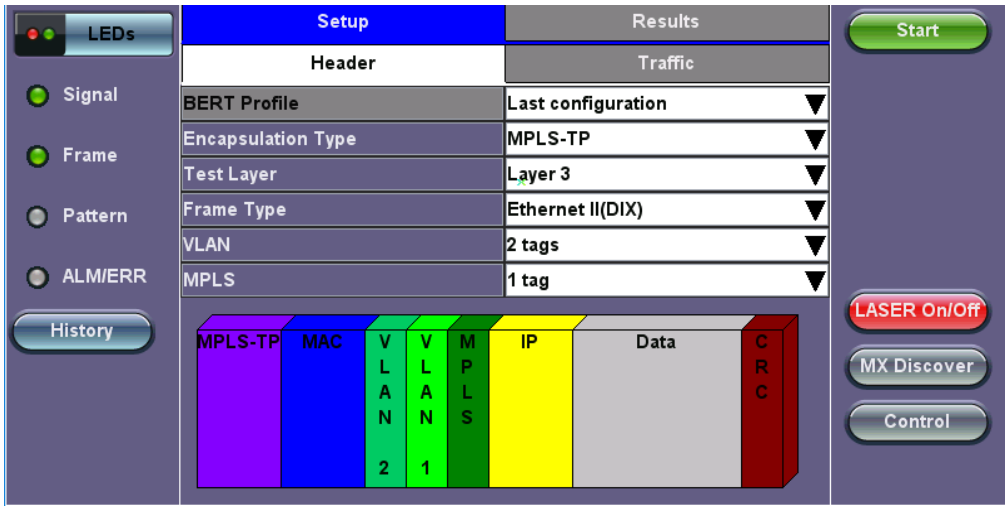
5.4.1 BERT Setup

Tap on **Advanced Tools** (Home Menu) > **BERT** icon to access BER testing features.

Overview:
BER testing at Layer 2 and 3 is supported. The BERT can be configured to use either regular PRBS test patterns, stress patterns (specifically for 10Gigabit Ethernet) or user defined test patterns to simulate various conditions. The test layer, frame header, traffic profile, error injection, and control settings of the far-end device (if applicable) must be configured prior to testing.

- **Layer 2:**
  - **Framed BERT:** Test pattern is encapsulated into a valid Ethernet frame with SOF, Preamble, and CRC field
  - **MAC Address:** A default or user configured Media Access Control (MAC) address is added to the frame

- **Layer 3:** Framed BERT
  - **MAC Address:** A default or user configured Media Access Control (MAC) address is added to the frame
  - **IP Address:** A default or user configured IP address is added to the frame



BERT Setup - Header (Layer 3)

Go back to top Go back to TOC

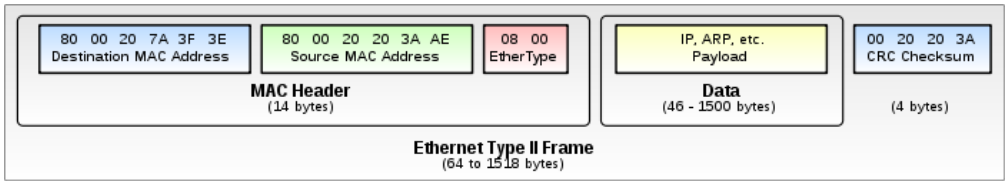
5.4.1.1 Header Settings

- **BERT Profile:** Load a previously configured test profile or create a new profile from existing settings. Currently its set to "Default". Please see the **Profiles** section in the **ReVeal MTX300 manual** for more details on how to create new profiles using ReVeal software.
- **Encapsulation Type:** None, MPLS-TP, Provider Backbone Bridge (PBB-TE), or EoE (Ethernet over Ethernet). Tap on theencapsulation type block to configure the settings. All encapsulation type fields are configurable:

  Tap on the encapsulation type block (PBB-TE, MPLS-TP,) to configure the settings: All encapsulation type fields are configurable:

  - MAC Source
  - MAC Destination
  - Ethernet Type
  - I-SID (PBB-TE only)
  - LSP, PW (MPLS-TP only)
  - TTL (EoE only)
  - VLAN ID, Priority, Type
- **Test:** Select the test layer to perform the BERT
  - Options are Layer 2 and Layer 3
- **Frame Type:**
  - Layer 2: 802.3 Raw (IEEE 802.3 frame without LLC) and Ethernet II (DIX) (named after DEC, Intel, and Xerox, this is

the most common frame type today)
    - Layer 3: Ethernet II (DIX)
- **MAC/IP:** Tap the MAC and IP blocks on the Frame image to access the setup menus
    - Set the Source and Destination MAC address for Layer 2
    - Set the Source and Destination MAC and IP addresses for Layer 3
- **VLAN:** Off, 1 tag, 2 tags, 3 tags
    - The user is able to configure up to 3 VLAN tags (VLAN stacking, for Q-in-Q applications)
      Note: VLAN stacking is an option
- **MPLS:** (For Layer 3 only) Off, 1 tag, 2 tags, 3 tags
    - The user is able to configure up to 3 MPLS tags
      MPLS tag configuration is only available when the MPLS option is purchased



The most common Ethernet Frame format, Type IIGo

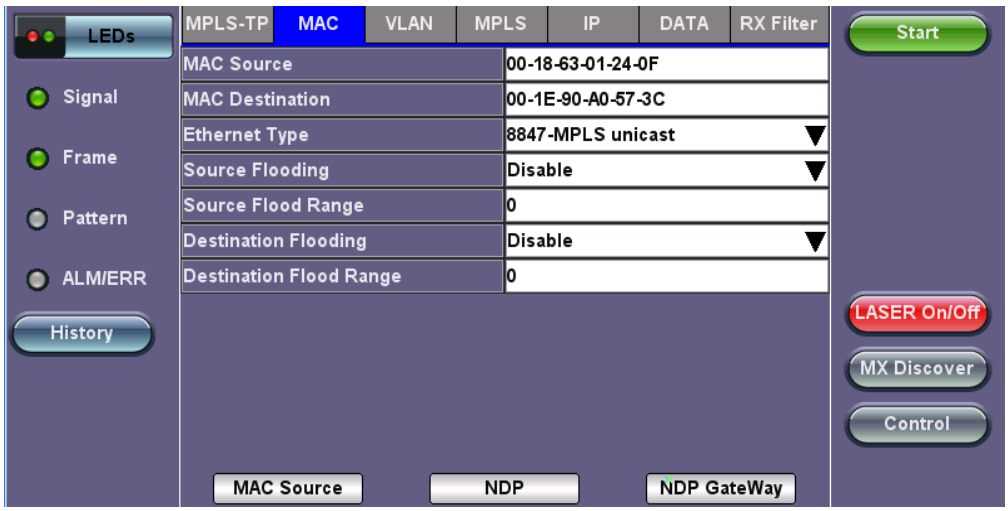
Go back to top Go back to TOC

MAC, VLAN, MPLS, IP, and Test Pattern Configurations:

To configure the MAC addresses, IP addresses, VLAN tag(s), MPLS tag(s), and test pattern, tap on the frame image displayed on the screen. This brings up the configuration screens for all the header fields.

- **MAC Header Tab:**
    - **MAC Source:** Use the default source address of the test set or configure a new or different address.
    - **MAC Destination**: Configure the destination MAC address of the far-end partner test set or use the ARP or ARP GW keys to determine the MAC address of the destination IP address (ARP) or the Gateway (ARP GW). Note that a valid IP connection needs to be up to use these functions. Refer to IP Connection for instructions on establishing IP connection.
    - **Ethernet Type:** For Layer 3 testing, the Ethertype is set to 0800-IP. For Layer 2, it can be typed in.
    - **Source (SRC) and Destination (Dest) flooding**: Enable or Disable.
    - **Flood Range**: Specifies the number of MAC source and/or destination addresses. Enter a number from 0-4095. The source and/or destination MAC addresses will be incremented by 1 until it reaches the number of times entered in the flood range.

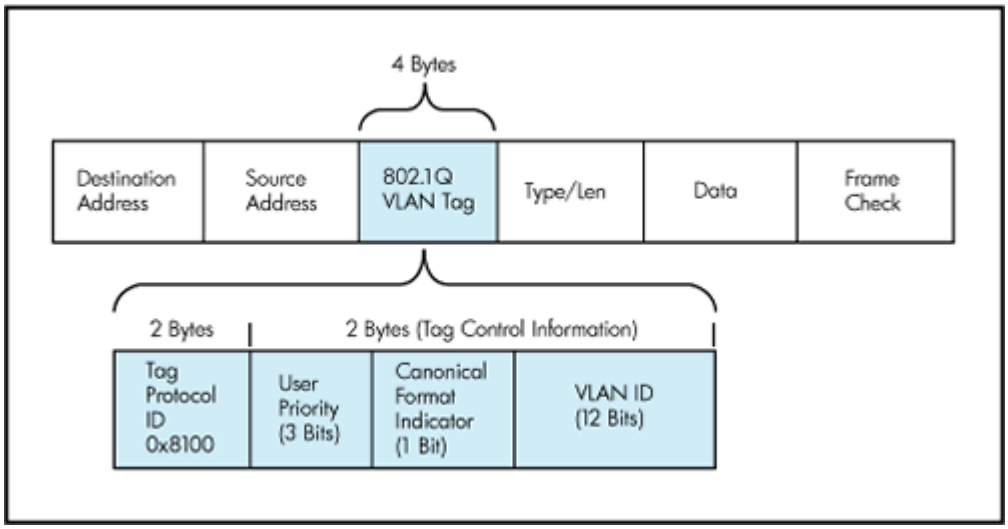
Tap on **Mac Source**, **ARP**, and **ARP Gateway** buttons to populate the fields with default test port settings.



BERT Setup MAC Layer 3

Go back to top Go back to TOC

- **VLAN Tab:** In the VLAN tab the following parameters are configured:
    - **VLAN ID:** Configurable in the range 1 to 4094.
        - VLAN ID is the identification of the VLAN, which is basically used by the standard 802.1Q.
        - It has 12 bits which allows the identification of 4096 (2^12) VLANs.
        - Of the 4096 possible VIDs, a VID of 0 is used to identify priority frames and value 4095 (FFF) is reserved.
        - Maximum possible VLAN configurations are therefore set to 4094.
    - **VLAN Priority:** Configurable in the range 0 to 6
        - Set by the Priority Code Point (PCP), a 3-bit field which refers to the IEEE 802.1p priority.
        - It indicates the frame priority level from 0 (lowest) to 7 (highest), which can be used to prioritize different classes of traffic (voice, video, data, etc.).
    - **Type:** The following selections are possible:
        - 8100 (IEEE 802.1Q tagged frame)
        - 88a8 (IEEE 802.1ad Provider Bridging)
        - User Defined
    - **Drop Eligible:** If enabled, drop eligibility flag will be set.



IEEE 802.1Q VLAN Tag in an Ethernet Frame

BERT Setup - VLAN Tag configuration (Layer 2 & 3)

Go back to top Go back to TOC

- **MPLS Tab (Only for Layer 3):** In the MPLS tab the following parameters are configured:
    - **MPLS label:** Configurable in the range 16 through 1,048,575 (labels 0 to 15 are reserved).
      Composed of 20 bits which allows for the creation of over one million labels.
    - **CoS:** Configurable in the range 0 to 6.

This field is three bits in length and maps directly to IP Precedence TOS bits to provide Class of Service (COS).

- **S-bit:** Configurable 0 or 1.

  The S field is one bit in length and is used for stacking labels. This is important as it is used to indicate the last label in the label stack.
- **TTL:** Configurable in the range 0 to 255. The default setting is 128 hops.

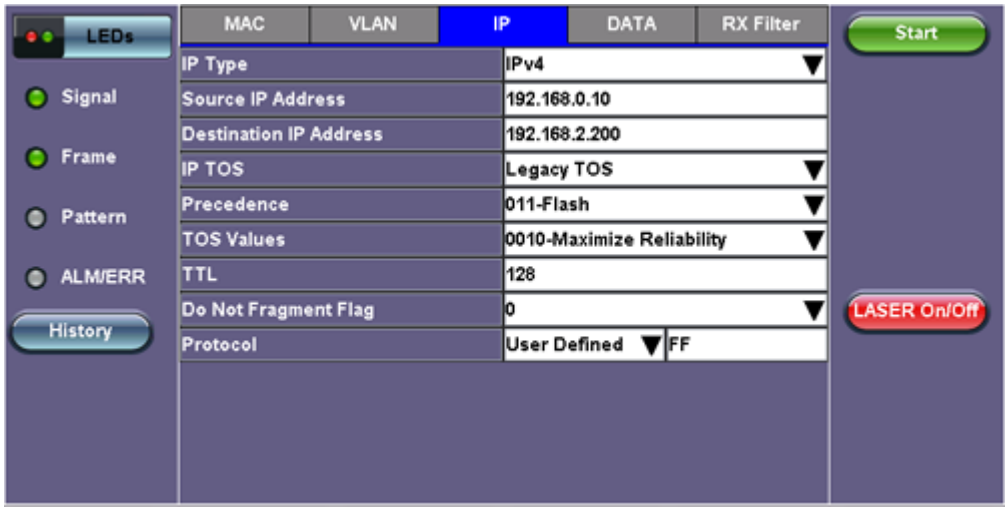
  Used to decrement the time-to-live counter.

BERT Setup - MPLS configuration (Layer 3)

Go back to top Go back to TOC

- **IP Tab:** In the IP tab the user must configure the destination IP address and source address. The user may also configure the following IP header fields:
  - **IP Type:** IPv4, IPv6
  - **IP Source and IP Destination:**For IP Src, if the IP connection is up, refer to to IP Connection. The source address is fixed to the IP address from the IP setup menu.
  - **IP TOS (for Quality of Service testing):** Legacy TOS or DSCP
    - **Legacy TOS :** The first three bits of the IP TOS field can be edited:
      - **Precedence:**
        - 000 - Routine
        - 001 - Priority
        - 010 - Immediate
        - 011 - Flash
        - 100 - Flash Override
        - 101 - Critical
        - 110 - Internetwork Control
        - 111 - Network Control
      - **TOS Values:**
        - 1000 - Minimize Delay
        - 0100 - Maximize Throughput
        - 0010 - Maximize Reliability
        - 001 - Minimize Monetary Cost
        - 0000 - Normal Service
    - **DSCP (Differentiated Services Code Point):** The first six bits of the IP TOS can be edited to provide more granular service classification.
    - **Time To Live (TTL):** Configurable in the range 0 to 255.
    - **Fragment offset byte:** Configurable in the range 0 to 65.528.

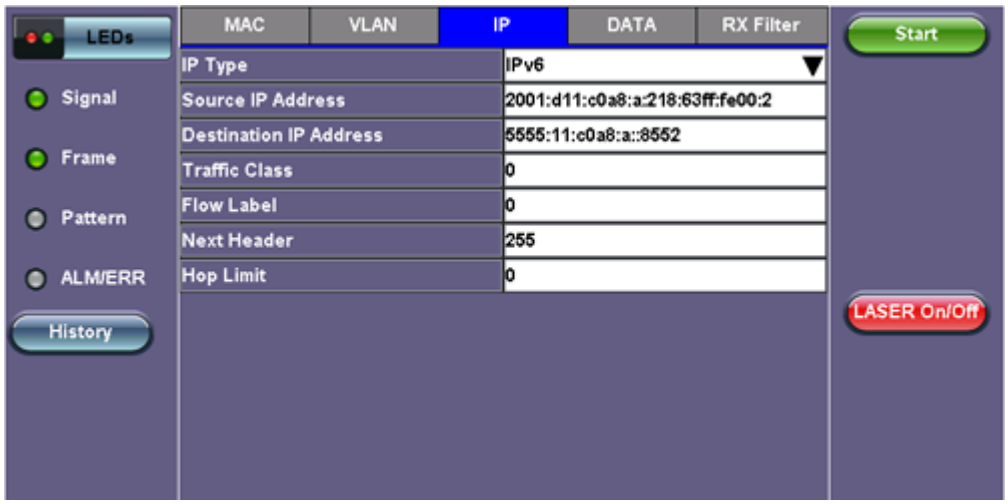
      The fragment offset field, measured in units of eight-byte blocks, is 13 bits long and specifies the offset of a particular fragment relative to the beginning of the original unfragmented IP datagram.
    - **Protocol field:** UDP (0x11), TCP (0x06), User Defined.



BERT Setup - IP Address Setting Layer 3 (IPv4 Legacy TOS)

IPv6:

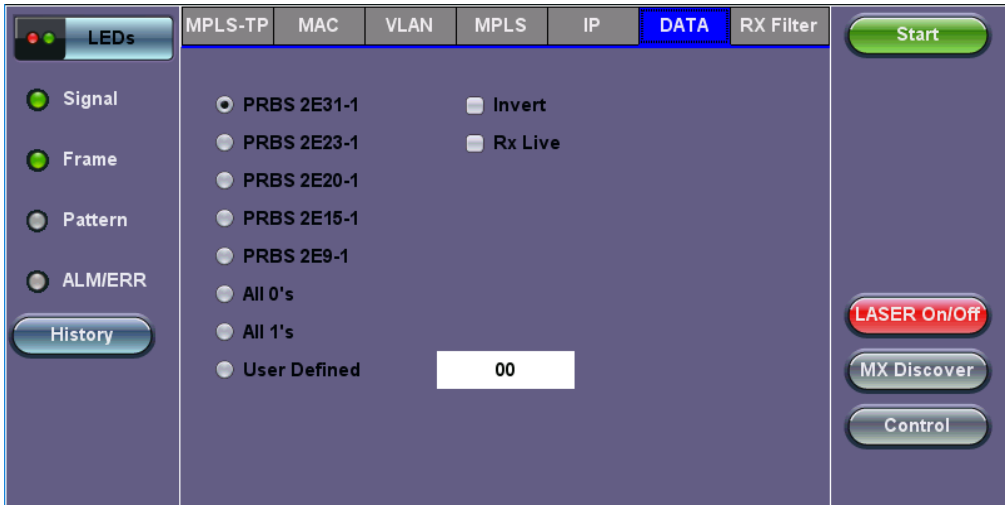
- Source IP Address
- Destination IP Address
- Traffic Class
- Flow Label
- Next Header
- Hop Limit



BERT Setup - IP Address Setting Layer 3 (IPv6)

Go back to top Go back to TOC

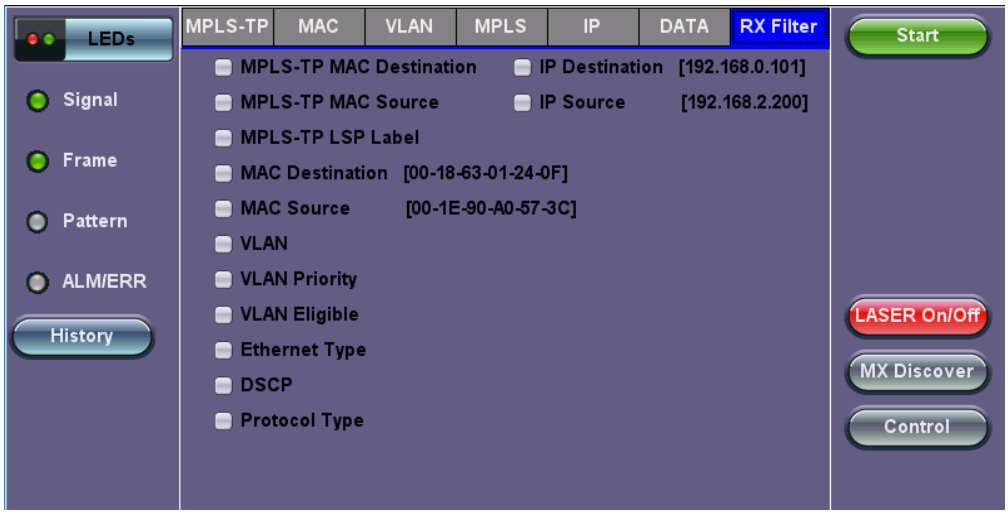
- **Data Tab:** User selects a test pattern that will be encapsulated in the Ethernet frame payload (for framed mode). For both Layer 2 and 3 the following pattern is available:
  - **PRBS:**
    - 2^31 -1
    - 2^23 -1
    - 2^15 -1
    - 2^11 -1
    - 2^9 -1
  - **Fixed:** All 0s or All 1s
  - **User Defined pattern:** Length depends on size of frame
  - **Inversion:** Normal or inverted
  - **RX Live**



BERT Setup - Data selection

Go back to top Go back to TOC

- **RX Filter Tab:** Allows the user to filter incoming streams. When checked, the incoming traffic flows not matching these criteria will not be considered for these results.
  - MAC Destination address
  - MAC Source address
  - VLAN
  - VLAN Priority
  - VLAN Eligible
  - Frame Type
  - Traffic Class (for Layer 3)
  - Flow Label (for Layer 3)
  - Next Header (for Layer 3)



BERT Setup RX Filter (Layer 3)

Go back to top Go back to TOC

5.4.1.2 Traffic Settings

The user configures the traffic profile for the stream, including traffic flow, frame size, frame type, and transmit rate.

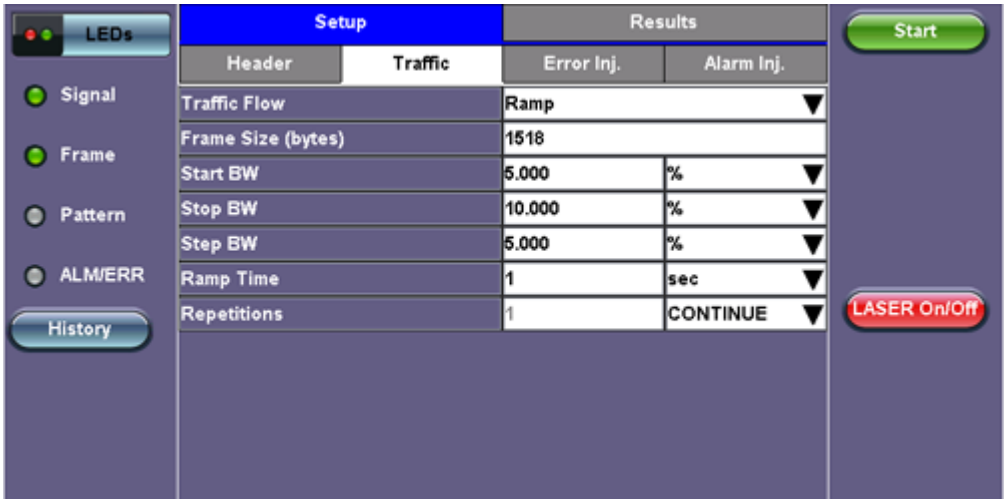
- **Traffic Flow:** Select from the following traffic flows:
  - **Constant:** The selected frame is transmitted continuously according to the selected bandwidth %.
  - **Ramp:** The selected frame is transmitted at maximum bandwidth according to the selected duty cycle and burst period.
  - **Burst:** The selected frame is transmitted in a staircase profile according to user selectable step time, number of steps,

and maximum bandwidth.
    - **Single Burst:** Configure the number of frames to be transmitted in the burst along with the bandwidth. For example, if 100000 frames are transmitted at 12.5% of bandwidth, on a 1Gbps line, 100000 frames will transmit at a rate of 125Mbps and then the burst will stop.

- **Frame Size Type:** Fixed or Uniform min and max frame length values. Uniform traffic is traffic generated with a uniform distribution of frame lengths.

- **Frame Size (bytes):**
    - Frame sizes can be from 64 bytes to 1518 bytes, in addition to jumbo frames up to 10000 bytes

- **BW (Transmit Bandwidth):** Configure the transmit rate for the test
    - When traffic flow is equal to Burst, two burst bandwidths are configured with burst time
    - When traffic flow is equal to Ramp, starting and an ending bandwidth are configured along with the bandwidth step size and duration



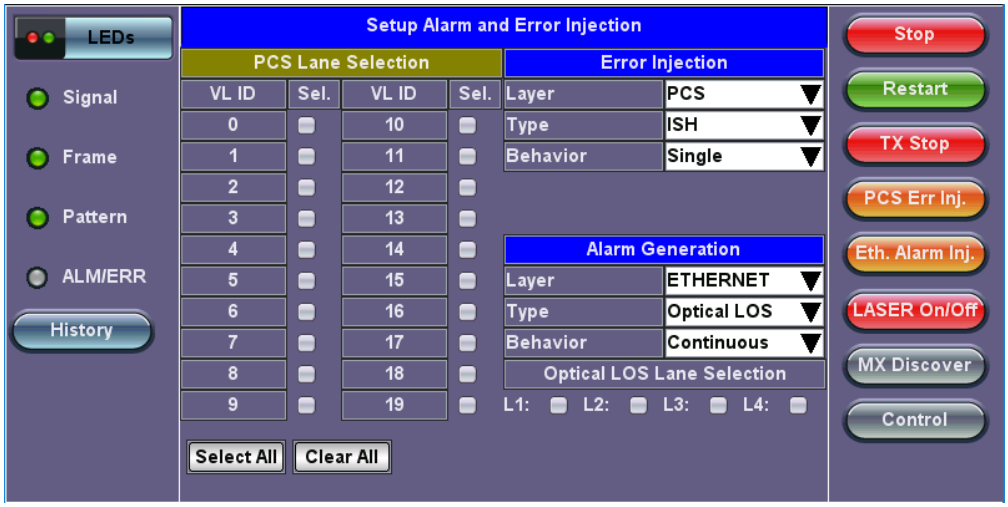
BERT Setup - Ramp TrafficGo

Go back to top Go back to TOC

5.4.1.3 Error Injection

Error injection can be performed during testing. The error type and injection rate are configured in the **Setup Injection** tab, which appears after pressing **Start**. Once the test is running, error injection can be performed by pressing the **Err Inj.** button on the right side of the screen.

- **Layer:** Ethernet or PCS
    - **Error type:** Select from CRC, IP Checksum, Pause, Bit, and Runt. With Pause selected, the unit will transmit a pause frame when **Error Injection** icon is pressed. The Pause time duration is configurable in units of 512 bit time. At Gigabit Ethernet speed, this is equivalent to 512 ns. For example, if pause time is set to 1000, the pause duration will be set to 1000x512 ns.
- **PCS**
    - **Type**: ISH, IAM, and BIP. Use the checkbox to select the PCS Lanes for error injection.
- **Behavior:** The error injection flow determines how the selected errors will be injected.
    - Select a single, single burst, or rate error injection.
- **Count:** Configures the error count via a numeric keypad for single burst injection.
- **Error Rate:** Configure the error injection rate for rate error injection.



BERT Setup - Error Injection

Go back to top Go back to TOC

5.4.1.4 Alarm Injection Settings

Alarm injection can be performed during testing. The type of alarms and alarm injection are configured in the Setup Injection tab. Once the test is running, alarm injection can be performed by pressing the **Alarm Inj.** button on the right side of the screen.

- **Layer:** Select from Ethernet or PCS
- **Ethernet**
  - **Type:** Local Fault, Remote Fault, Optical LOS. Four optical LOS lanes are available for selection.
- **Alarm Flow:** The alarm flow determines how the selected alarms will be injected. Single burst or continuous can be selected.
- **Duration:** Duration for single burst flow; 1s, 10s, or 100s.

Go back to top Go back to TOC

5.4.1.5 Starting/Stopping a BERT

Once all configurations have been made, the user can start the BERT test (press the **Start** icon on the top right section of the screen). The following are three scenarios of how to prepare and start the unit for BERT testing.

If testing on the fiber ports, make sure the LASER is turned on before starting the test.

- **End-to-End Testing**
  - Connect the UX400 to another unit that supports BERT testing.
  - After configuring test settings on both units, start the tests.

- **Far-End Unit in Manual Loopback Mode**
  - If the far-end unit is already in a manual loopback mode, do not send a loop up command since it is not necessary.
  - Once the correct control settings are configured, the user can start the test.

The selected tests will run automatically. When all the tests are complete the test will stop automatically. If the BERT test suite needs to be stopped before they are done, then simply press the **Stop** button, located in the actions drop-down menu. The status of each selected test can be seen in the Results tab.

- **Far-End Unit Controlled with Loop Up/Down Commands**
  - If the far-end unit is not manually looped back, then it must first receive a loop up command from the control unit before the BERT test suite can be started.
  - To loop up the far-end unit with the manual mode loop up/down commands, configure the control settings mode to manual.
  - Enter the MAC and/or IP address of the far-end unit.
  - Send the loop up command by pressing **Loop Up**.

Once the far-end unit has been looped back, start the test by pressing the **Start** button. When all of the selected test are completed, the BERT test suite will stop automatically. Once all tests have been completed and there is no need to test again, go back to the

Control tab, and press the **Loop Down** button. This will send a loop down command to the far-end unit to remove the loopback that is in place.

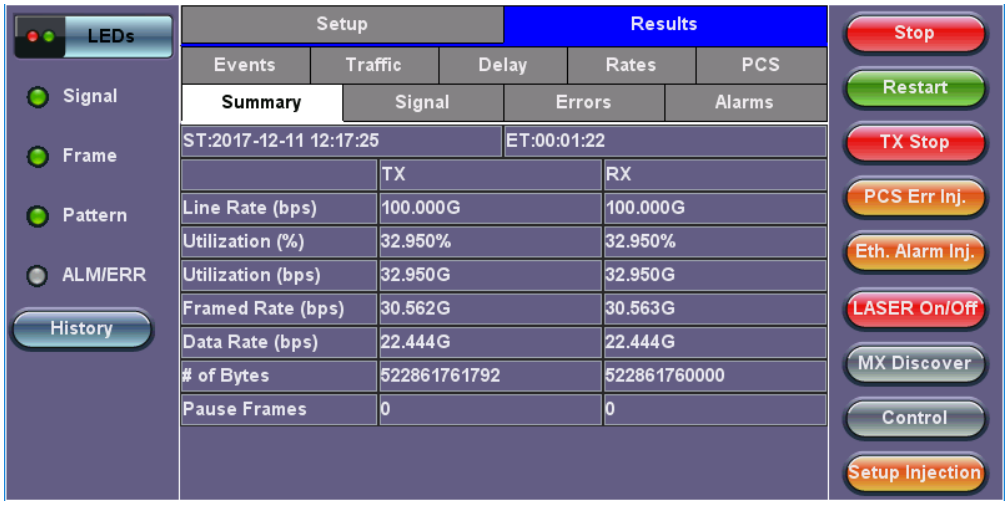
Go back to top Go back to TOC

5.4.2 BERT Results

5.4.2.1 Summary

Summary tab: The following results including the Start (ST) and Elapsed (ET) times are displayed:

- **Line Rate** (Mbps)**:** Negotiated rate of the interface (10M, 100M, or 1000M). This value is always fixed since it depends on the maximum capacity of the link under test, hence the test interface that is configured.
- **Utilization:** % of Line Rate. For example, if we transmit 100Mbps on a 1Gbps interface then the utilization value is 10% (or 100Mbps) of the total link capacity (or Line Rate).
- **Utilization (bps)**
- **Framed Rate:** (Payload + MAC/IP Header + VLAN Tag + Type/Length + CRC) / (Payload + Total Overhead) * Line Rate % (in Mbps).
- **Data Rate:** Payload / (Payload + Total Overhead) * Line Rate %.
- **Number of bytes**
- **Pause Frames:** Total number of transmitted and received ethernet pause flow-control frames.



BERT Results - Summary

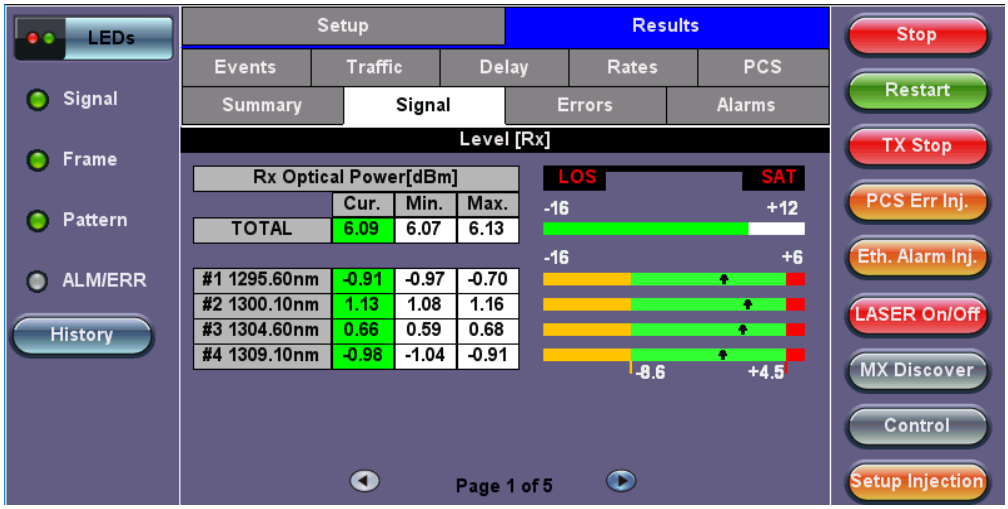
Go back to top Go back to TOC

5.4.2.2 Signal

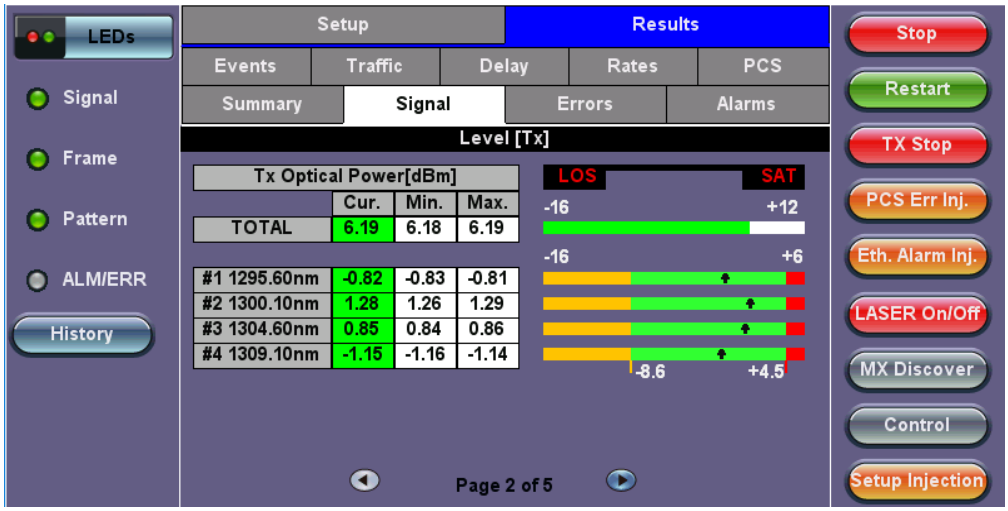
Signal (Page 1-2)

The Signal tab (fiber ports only) displays the receiving (RX) and transmitting (TX) optical level measured by the QSFP28, or QSFP+ (40G), depending on the 100G module in use.

Loss of Signal (LOS) and the Saturation level for optical signals are shown graphically including the level measurement in dBm for each lane.



BERT Results - Signal (Page 1)

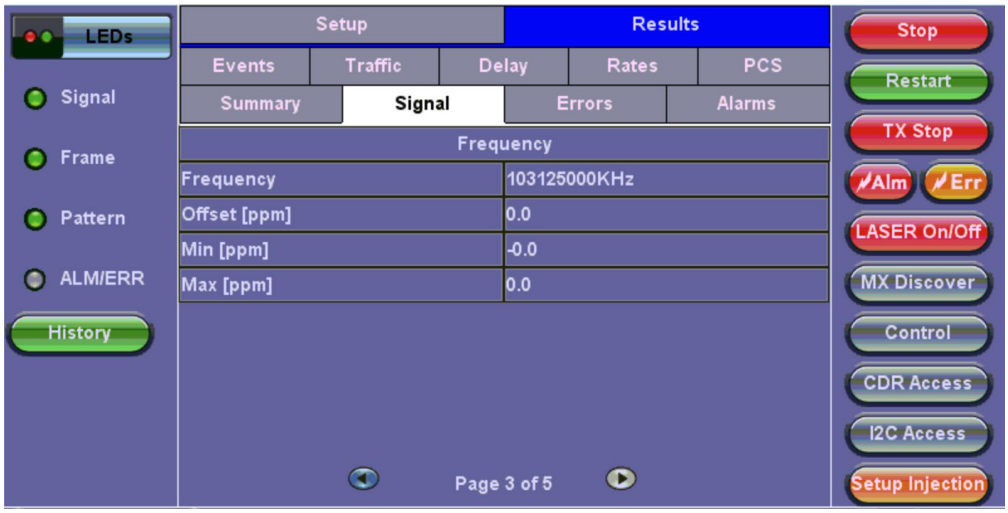


BERT Results - Signal (Page 2)

Signal (Page 3)

The received signal frequency and offset is measured and performed on the optical interface. The latest test sets and software versions may display signal measurements for each lane, depending on supported versions.

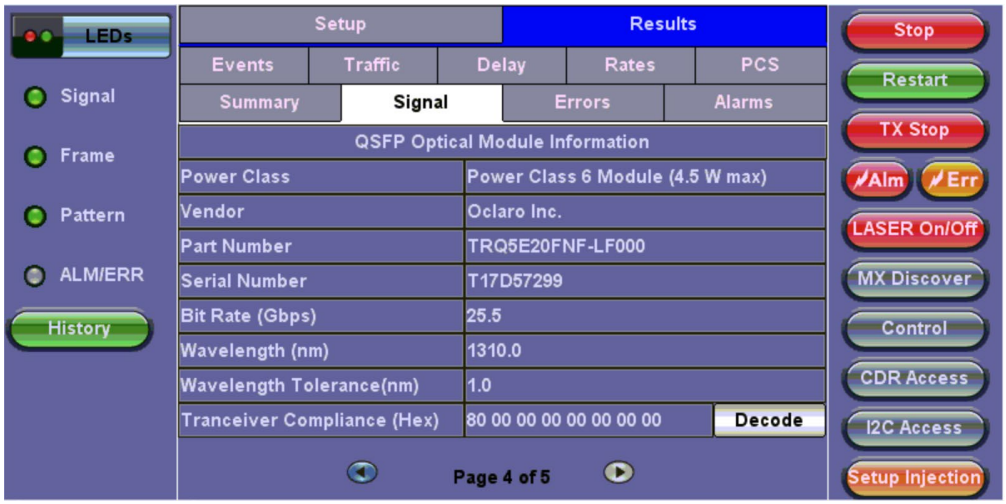
- **Frequency:** Indicates the frequency of the input signal.
- **Offset:** Indicates the difference between the standard rate and the rate of the input signal.
- **Min (ppm):** Indicates the difference between the standard rate and the minimum deviation detected in the input signal.
- **Max (ppm):** Indicates the difference between the standard rate and the maximum deviation detected in the input signal.



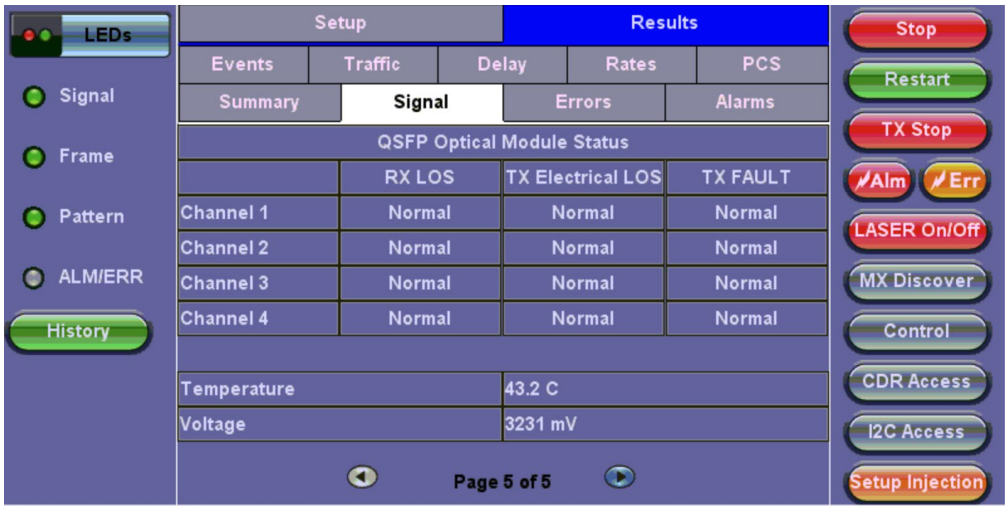
BERT Results - Signal (Page 3)

Signal (Page 4-5)

Page 4-5 displays the Optical module information and status.



BERT Results - Signal (Page 4)



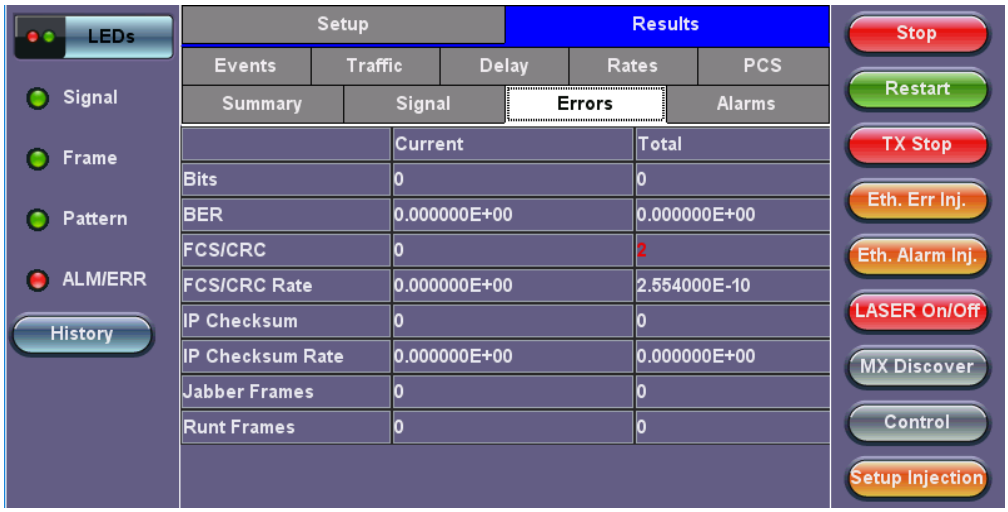
BERT Results - Signal (Page 5)

Go back to top Go back to TOC

5.4.2.3 Errors

Errors tab: The following errors (Current and Total) are displayed:

- **Bits:** Indicates errors related to test pattern (Bit Error or LSS [Pattern Loss])
- **BER:** Bit Error Ratio
- **Symbol:** Declared when an invalid code-group in the transmission code is detected
- **FCS/CRC:** Number of received frames with an invalid FCS
- **IP Checksum** (Layer 3 only)
- **Jabber frames:** Number of received frames larger than 1518 bytes containing an invalid FCS
- **Runt frames:** Number of received frames smaller than 64 bytes containing an invalid FCS



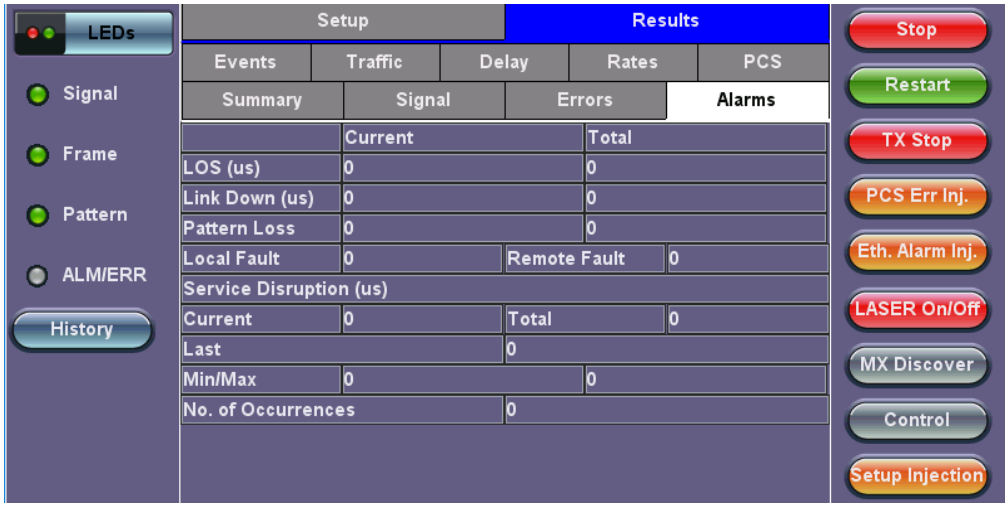
BERT Results - Errors

Go back to top Go back to TOC

5.4.2.4 Alarms

Alarms tab: The following Alarms (Current and Total) are displayed:

- **LOS:** Loss of Signal
- **LOS Sync:** Loss synchronization
- **Pattern Loss:** Indicates errors related to test pattern
- Service disruption associated with loss of signal:
  - **Current:** Duration of the current service disruption
  - **Total:** Total accumulated duration of the service disruptions
  - **Last:**
  - **Min/Max:** Minimum and maximum duration of the service disruption events
  - **No. of Occurrences:** Counter of service disruption events
  - **Local Fault**
  - **Remote Fault**

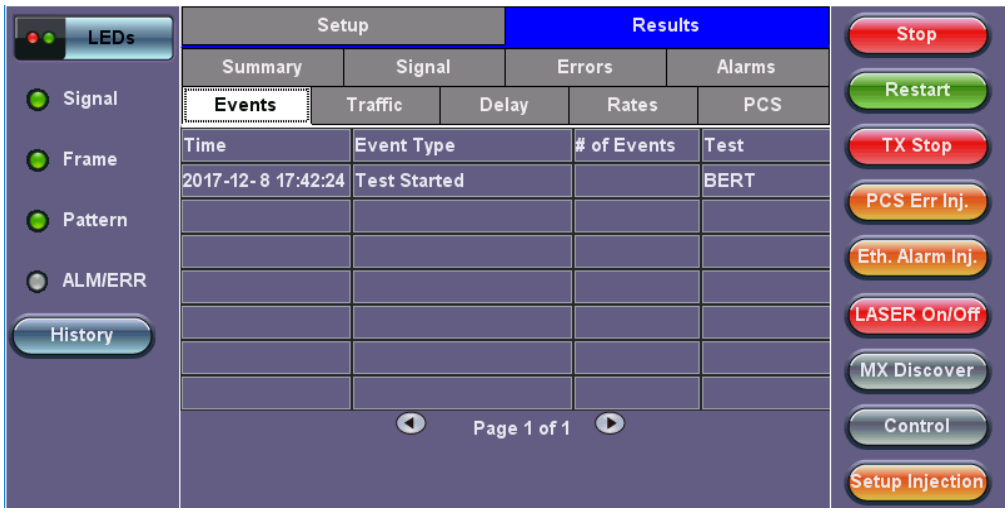


BERT Results - Alarms

Go back to top Go back to TOC

5.4.2.5 Events

Events tab: A time stamped record or log of anomalies, alarms, test status (start/stop) and test application are displayed.



BERT Results - Events

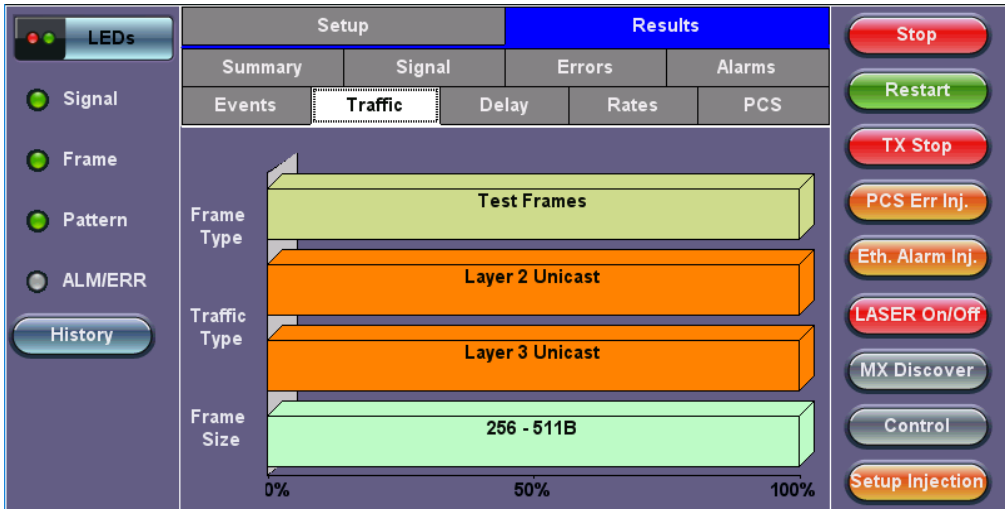
Go back to top Go back to TOC

5.4.2.6 Traffic

Traffic tab: The following Traffic statistics are displayed:

- **Frame type:** Test and non-test frames
- **Traffic type:** Layer 2 and Layer 3 Unicast, Broadcast, and Multicast frame percentage
- **Frame size distribution**

Tap on the graph for detailed screens.

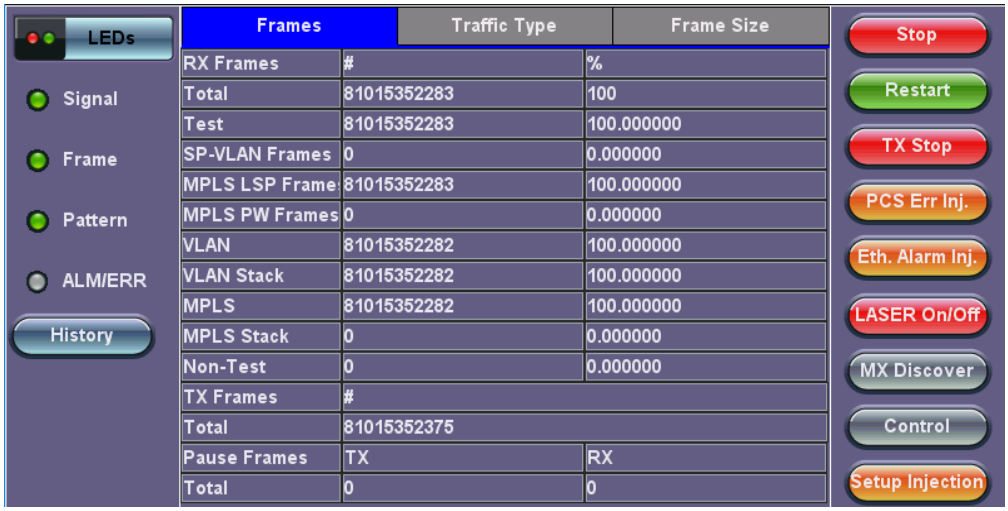


BERT Results - Traffic

Go back to top Go back to TOC

Frames tab: The following Frame distribution statistics are displayed in Count (#) and Percentage (%):

- **Received (RX) frames:**
  - Total frames
  - Test frames
  - VLAN tagged frames
  - Q-in-Q VLAN stacked frames
  - Non-test frames
- **Transmitted (TX) frames:**
  - Total frame - Total # frames transmitted
- **Pause frames:** Total number of transmitted and received Ethernet pause flow-control frames

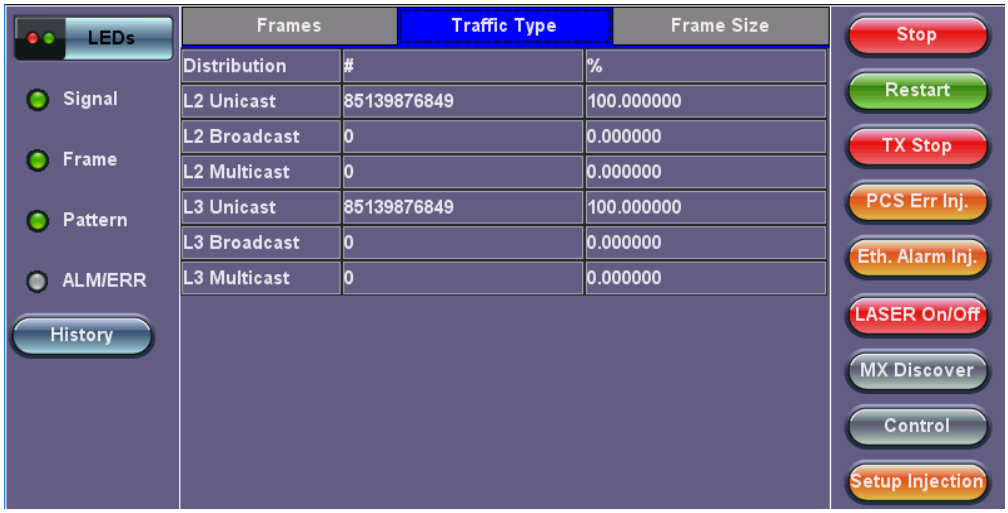


BERT Results - Frames

Go back to top Go back to TOC

Traffic Type tab: The following Traffic distribution statistics are displayed in Count (#) and Percentage (%):

- **Layer 2 Unicast frames:** Number of Unicast frames received without FCS errors.
- **Layer 2 Broadcast frames:** Number of Broadcast frames received without FCS errors. Broadcast frames have a MAC address equal to FF-FF-FF-FF-FF-FF.
- **Layer 2 Multicast frames:** Number of Multicast frames received without FCS errors.

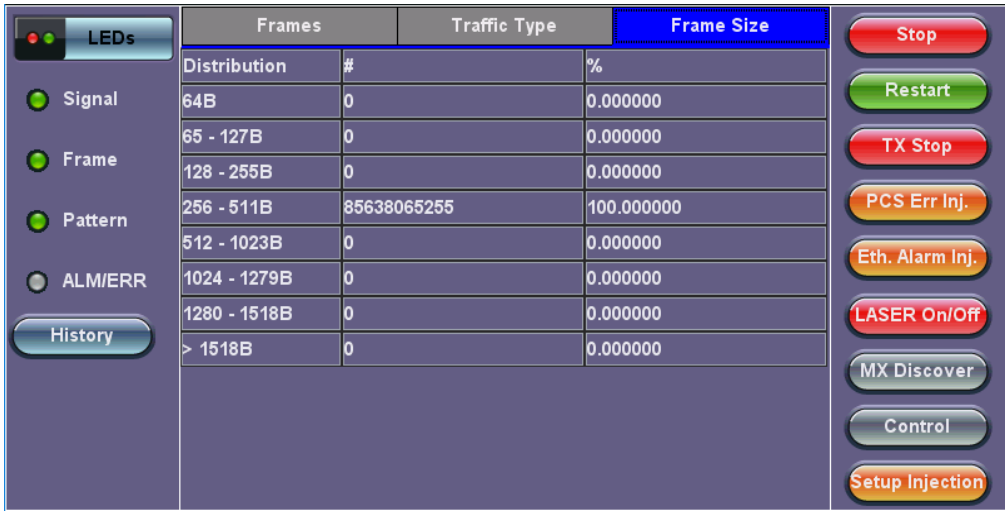


BERT Results - Traffic Type

Go back to top Go back to TOC

Frame Size tab: The following Frame distribution statistics are displayed in Count (#) and Percentage (%):

- 64 bytes frames
- 64-127 byte frames
- 128-255 byte frames
- 256-511 byte frames
- 512-1023 byte frames
- 1024-1279 byte frames
- 1280-1518 byte frames
- > 1518 byte frames - Jumbo frames



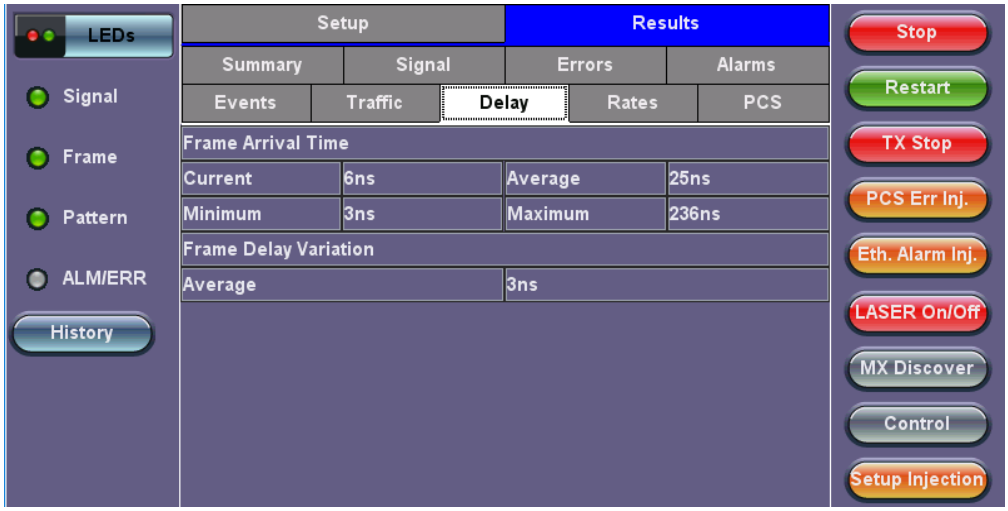
BERT Results - Frame Size

Go back to top Go back to TOC

5.4.2.7 Delay

Delay tab: Delay measures the interpacket gap, start of the frame, and preamble duration. Frame arrival statistics are displayed in tabular format:

- Current
- Minimum
- Maximum
- Variation (Current) - Interframe delay variation



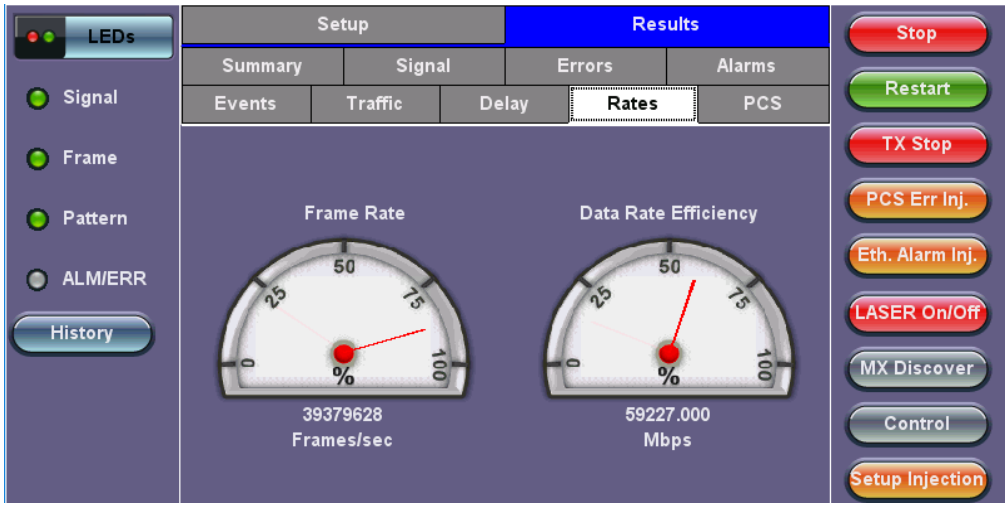
BERT Results - Delay

Go back to top Go back to TOC

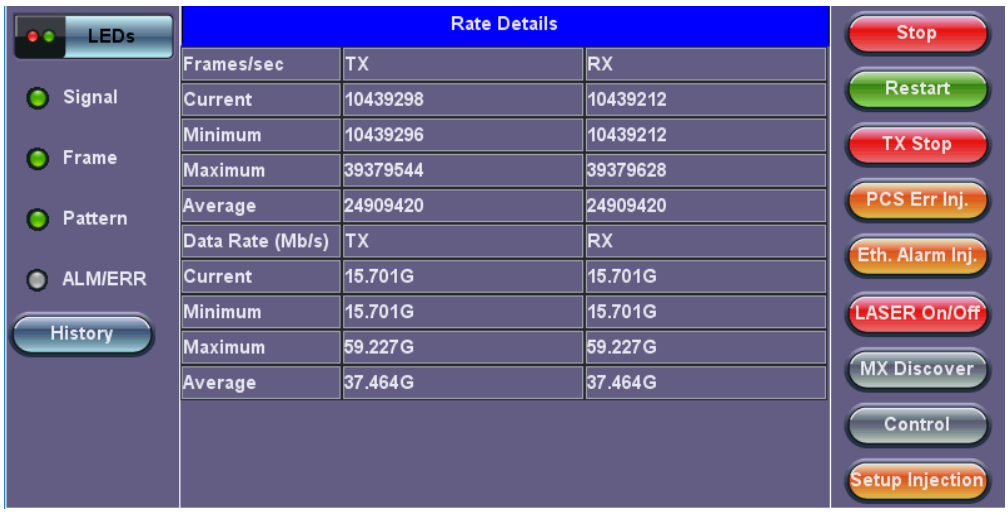
5.4.2.8 Rates

Rates tab: Rate statistics are displayed in a graph format. Tap on either gauge to see rate details in table form. The table shows transmitted **(Tx)** and received **(Rx)** current, minimum, maximum and average frame rates **(FPS)** and Data Rates **(Mbps)**.

- **Frame rate in Frames per second (FPS):** Number of received frames (including bad frames, Broadcast frames and Multicast frames)
- **Data rate in Mbps:** Received data rate expressed in Mbps



BERT Results - Rates

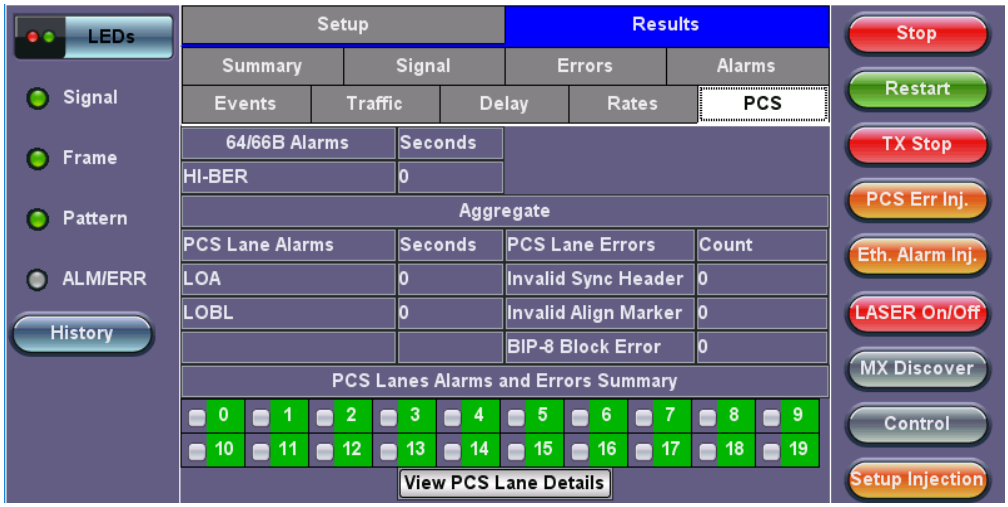


Go back to top Go back to TOC

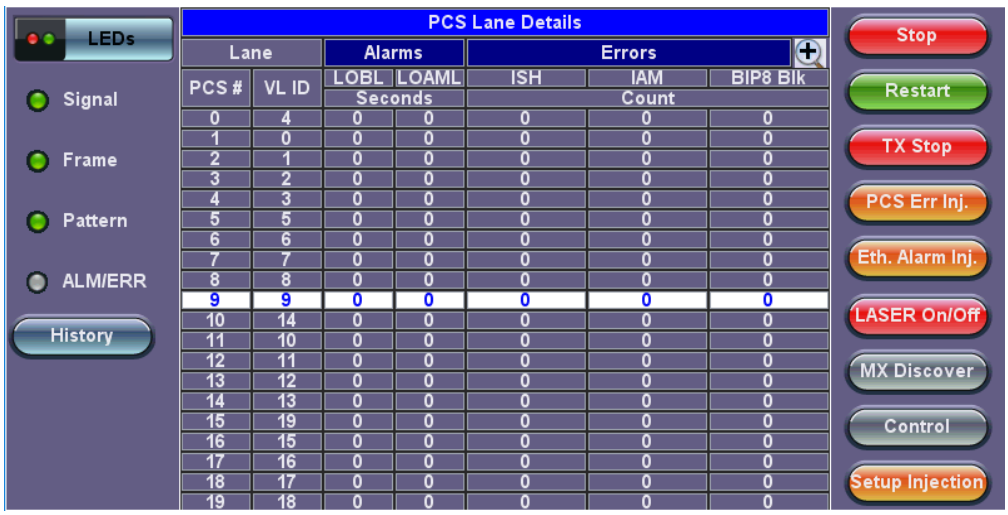
5.4.2.9 PCS

- **HI-BER:** high bit error rate of sync header
- **LOA:** Loss of Alignment marker
- **LOBL:** Loss of block lock
- **Invalid Sync header:** first 2 bits of the 64/66 block header
- **Invalid alignment marker:** inserted every 16383 block on each virtual lane it contains the Virtual lane identifier
- **BIP:** generates Bit Interleave Parity Error

Tap on **View PCS Lane Details** to see additional details such as PCS # and VL ID for each alarm/error. The magnifying glass displays Count and Rate error details.



BERT Results - PCS



BERT Results - PCS Lane Details

Go back to top Go back to TOC

5.4.3 Saving BERT Results

Once the test has been stopped the results can be saved by pressing the Save key on the platform's keypad.

A window will open giving the option of naming the results file. Enter the desired name for the file and tap apply. The results will be saved.

BERT Results Save

Once the results are saved, they can be viewed or renamed by going to **Tools / System Settings screen> Files**. Refer to the **File Manager** section in the RXT1200, TX300s or UX400 Platform manual for more information on managing saved test results.

Go back to top Go back to TOC

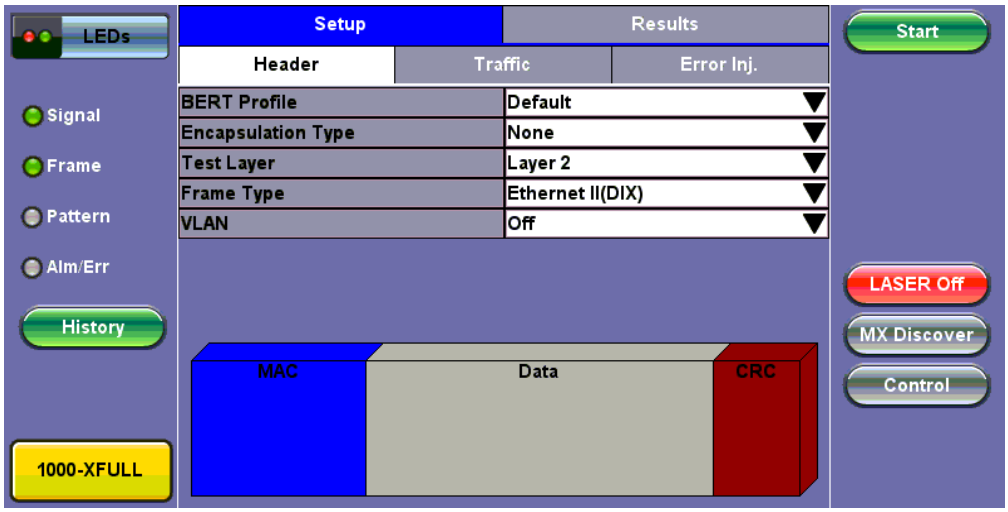
5.5 RFC2544

5.5.1 Setup

Overview:
RFC 2544 recommendations are well accepted in the test and measurement industry for network performance testing. The RFC 2544 test suite consists of and performs a set of four automated tests (throughput, latency, frame loss, and burst or back-to-back) to qualify the performance of a network link under test. The tests are especially popular for the verification of network links with certain service level agreements (SLA).

The following settings must be configured prior to RFC 2544 testing:

- Test layer (Layer 2 & 3)
- Frame header (MAC, VLAN, IP, UDP, and Data)
- Test frames selection
- Pass/fail thresholds (optional)
- Throughput
- Latency
- Frame loss
- Burst (back-to-back)



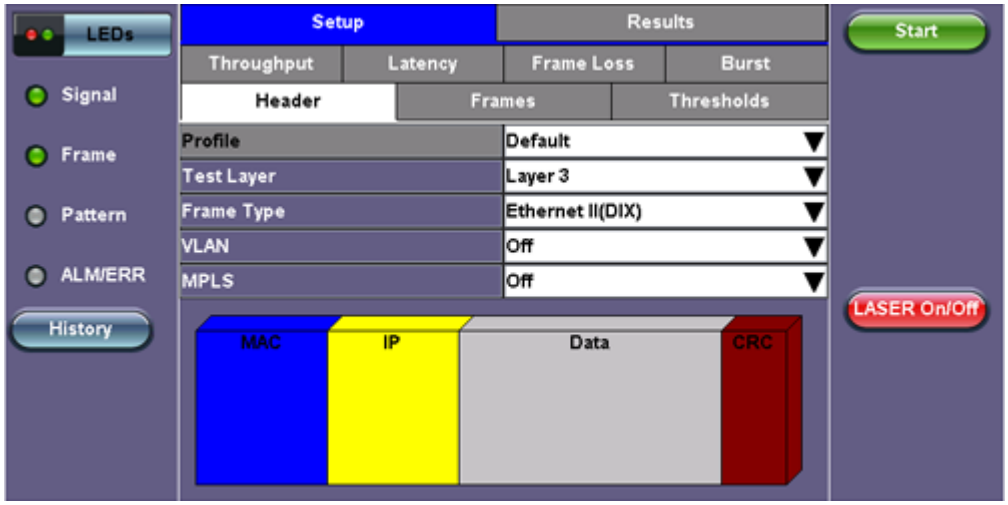
RFC2544 Home

Go back to top Go back to TOC

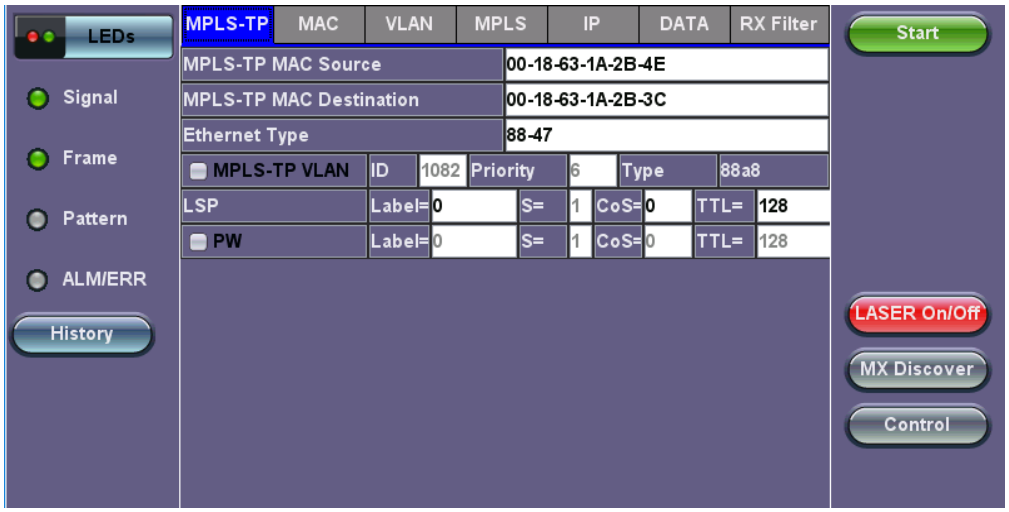
5.5.1.1 Header Settings

Unless otherwise noted, Frame Header setup is identical to the setup described in the BERT Application. Refer to the BERT application for details.

Go back to top Go back to TOC



RFC2544 Setup Layer 3



RFC2544 Setup MPLS-TP

RFC 2544 Header Setups

The MAC, VLAN, MPLS, and IP configuration procedures are the same as in BERT mode. Please refer to the BERT Application section for details.

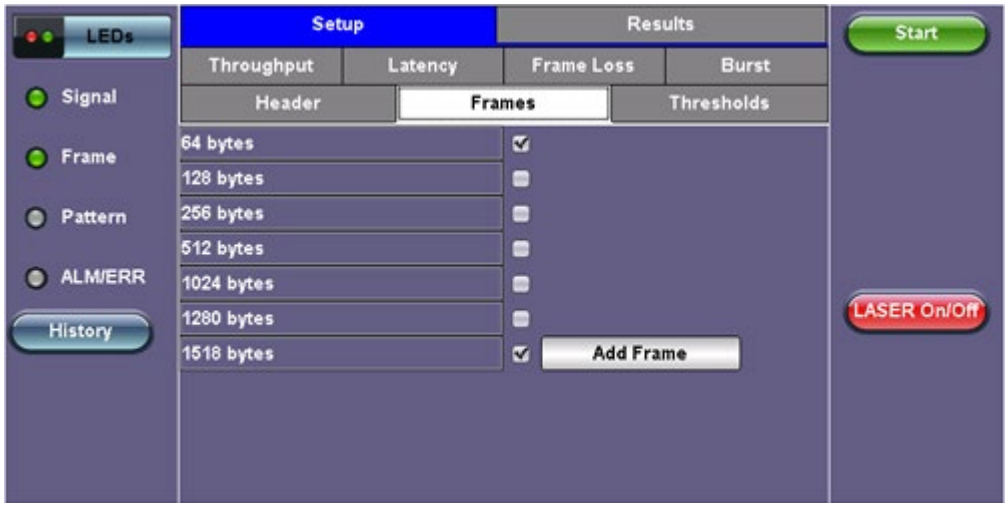
Go back to top Go back to TOC

5.5.1.2 Frames Settings

The following can be configured under the Frames tab of the RFC2544 Setup:

- **Preset Frames:** Select from a list of recommended test frame sizes defined in RFC 2544:
  - Test frames are 64, 128, 256, 512, 1024, 1280, and 1518 bytes.
  - The default selected frame is 1518 bytes.
  - To select/deselect any of the recommended test frames, check the box to the right of the desired frame.
- **Add frame:** Two additional user configurable test frames of any size ranging from 64 bytes to 9000 bytes can be added.
  - To add additional test frames, tap the **Add Frame** button.
  - Enter the frame size using the numeric keypad and click apply.
  - Press the back button to return to the frames screen.

- The new custom frame size is displayed (it can be enabled or disabled as needed).



RFC2544 Frames Setup

Go back to top Go back to TOC

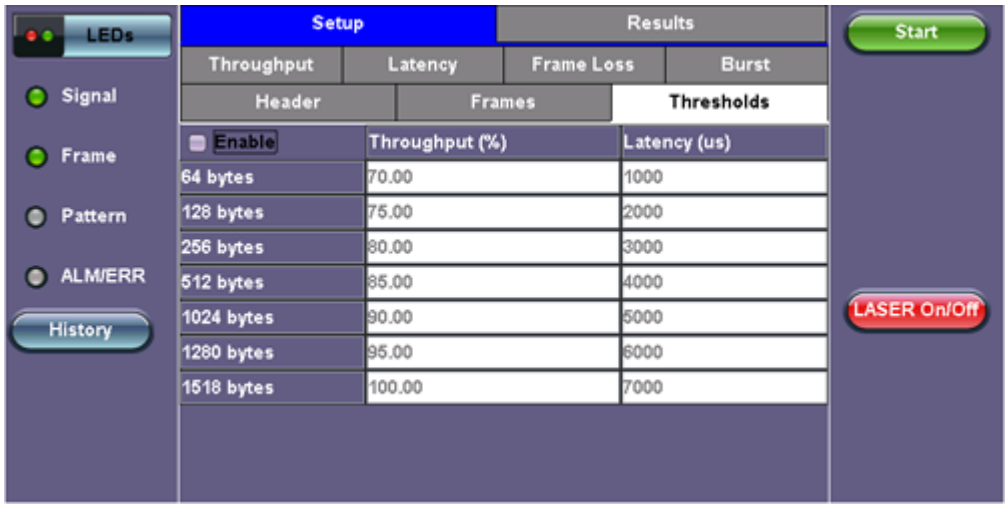
5.5.1.3 Threshold Settings

Threshold settings can be enabled or disabled for the throughput and latency tests.

When enabled, threshold settings can be configured for all of the test frames selected in the frame settings tab.

A Pass/Fail criteria will be applied when the threshold settings are enabled. For example, if the throughput threshold value for a 64 byte frame is configured for 80%, then a Pass criteria is assigned if the throughput rate is 80% or better.

The threshold values for Throughput and Latency can be customized per user requirements. Tap on the selected value to edit.



RFC2544 Thresholds Setup

Go back to top Go back to TOC

5.5.1.4 Throughput, Latency,Frame Loss and Burst Settings

The RFC 2544 test suite allows the user to run all four tests, one of the four tests, or a combination of any of the four tests. The user simply has to enable/disable which tests to perform by checking/unchecking a selection box in the respective tab for each test. By default all four tests are enabled. Throughput test can not be disabled.

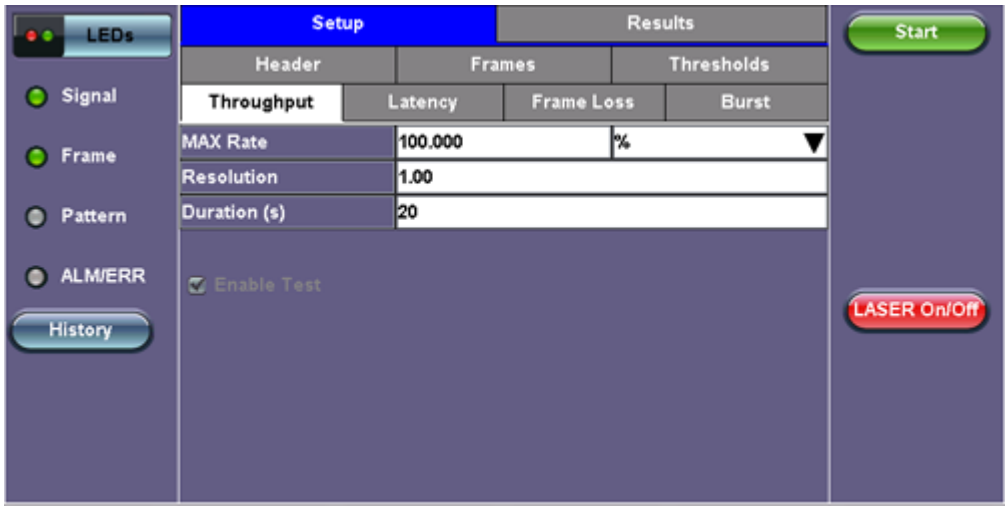
The following parameters must be configured before running the RFC 2544 conformance test suite.

Throughput:

- **Max Rate:** Up to 100% of the negotiated line rate. The default value is 100%.
  - This is the maximum transmit rate to perform the throughput test for each test frame size.
  - This rate may be configured as a % of the total line rate or in Mbps. For example the Max Rate is configured to be 90% and the negotiated line rate of the link is 100Mbps, then the maximum transmit rate will be 90Mbps or 90% of the line rate.

- **Resolution:** Input any value between 0.001% and 1%. The default value is 1%. Resolution refers to the resolution in searching for the throughput rate. If 1% is selected, the throughput rate will be searched with ±1% accuracy.

- **Duration:** 5 to 999 seconds. The default value is 20 seconds.
  - The duration is the amount of time the throughput test is run for, for each frame size at a given rate.



RFC2544 Throughput Settings

Go back to top Go back to TOC

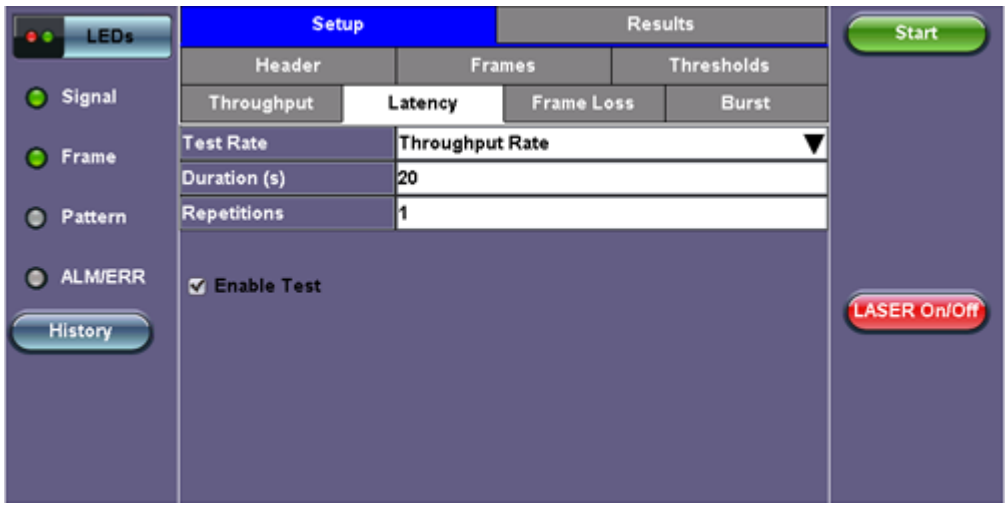
Latency: The following parameters can be configured:

- **Test Rate:** Throughput Rate or Custom Rate. The default value is Throughput.
  - **Throughput rate**: Latency test will be performed at the Throughput rate found for each of the tested frame sizes.
  - **Custom rate:** A custom rate in % or Mbps can be configured.

- **Rate:** Only available if Custom Rate is selected. Enter up to 100% of the negotiated line rate or enter the rate in Mbps.

- **Duration:** 5 to 999 seconds. The default value is 20 seconds.
  This is the amount of time that the latency test will be performed for each test frame size.

- **Repetitions:** 1 to 100. The default value is 1.
  This is the amount of times that the latency test will be repeated for each test frame size.



RFC2544 Latency Settings

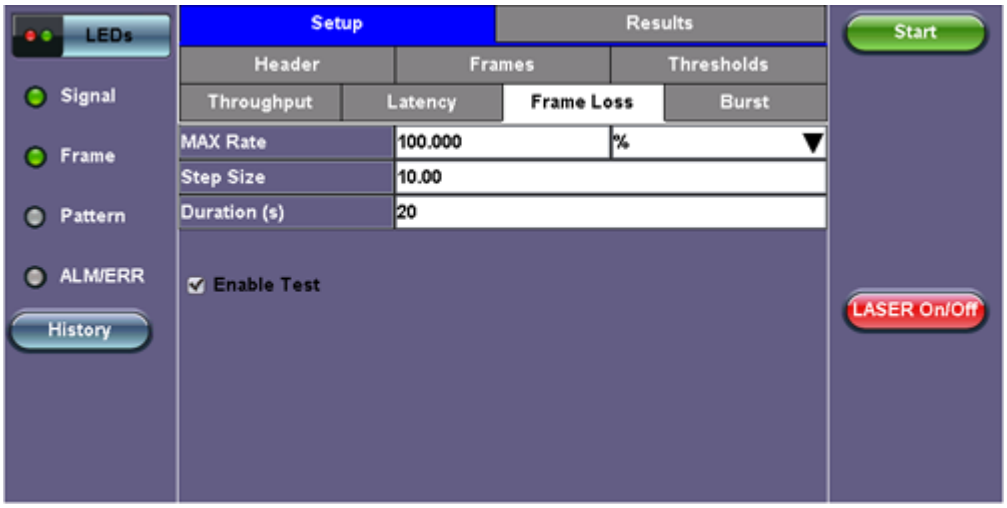
Go back to top Go back to TOC

Frame Loss: The following parameters can be configured:

- **Max Rate:** Up to 100% of the negotiated line rate. The default value is 100%.
  This is the maximum transmit rate to perform the frame loss test for each test frame size. The user may configure this rate as a % of the total line rate or in Mbps. For example if the user configures the Max Rate to be 90% and the negotiated line rate of the link is 100Mbps, then the maximum transmit rate will be 90Mbps or 90% of the line rate.

- **Step Size:** 1 to 10%. The default value is 10%.
  The step size is the rate % that the frame loss test will be reduced by in the event of any frame loss. For example if the Max Rate is 100Mbps (or 100%) and frames are lost at this rate, then the transmit rate will be reduced to 90Mbps (or 90%). The frame loss test will now be performed at the new rate until there is zero frame loss at two consecutive rate settings. This means that the test will have to be performed at 80% (assuming that there was zero frame loss at 90%).

- **Duration:** Selectable in the range 5 to 999 seconds. The default value is 20 seconds.
  The duration is the amount of time the throughput test is run for, for each frame size at a given rate.



RFC2544 Frame Loss Settings

Go back to top Go back to TOC

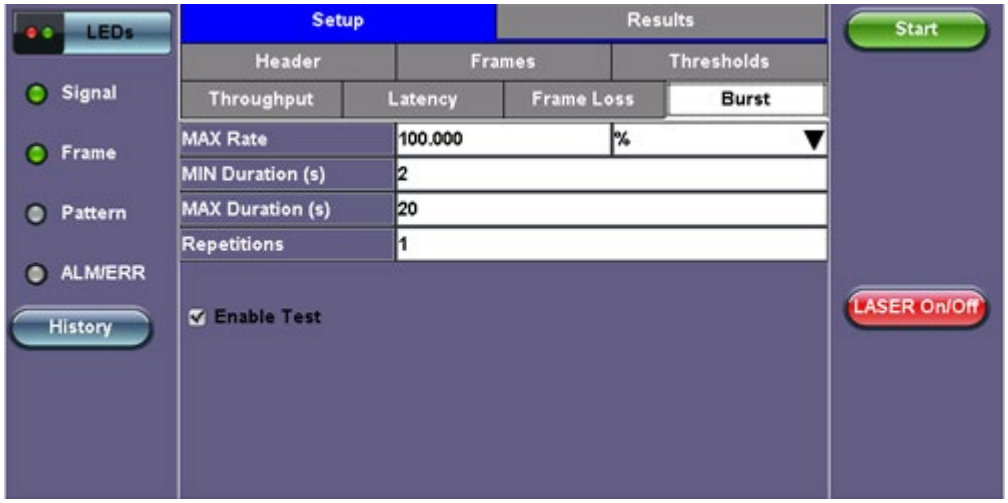
Burst (Back-to-Back): The following parameters can be configured:

- **Max Rate:** The default value is 100%.
  In the burst test, frames are always transmitted at the maximum rate for a given minimum and maximum burst duration.

- **Minimum Duration:** Selectable in the range 2 to 999 seconds. Default value is 2 seconds.
  This is the duration of the first burst.

- **Maximum Duration:** Selectable up to 999 seconds. The default value is 20 seconds.
  This is the duration of the second burst, which must be greater than the minimum burst.

- **Repetitions:** Selectable in the range 1 to 100. The default value is 1.
  This is the amount of times that the burst test will be repeated for each test frame size.



RFC2544 Burst Settings

Go back to top Go back to TOC

5.5.1.5 Starting/Stopping a RFC 2544 Measurement

Once all configurations have been made, tap the **Start** button on the right section of the screen to start the measurements.

Note: If testing on the fiber ports, make sure the LASER is turned On before starting the test.

The selected tests will run automatically. When all the tests are complete the test will stop automatically. If the RFC 2544 test suite needs to be stopped before they are done, then simply tap the **Stop** button. The status of each selected test can be seen in the Results tab.

Go back to top Go back to TOC

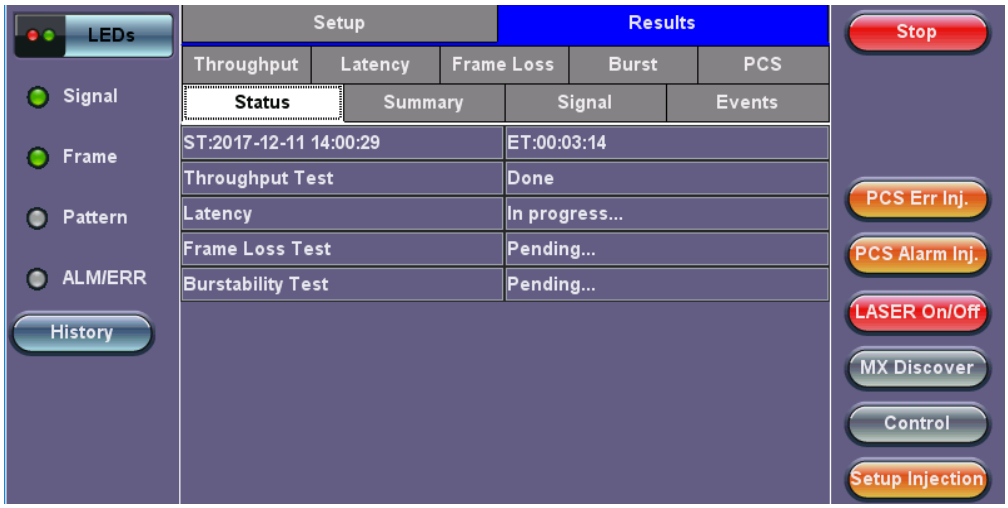
5.5.2 Results

The progress and current result of the RFC 2544 can be viewed as the test is in progress.

Navigate the respective sub-tabs (throughput, latency, frame loss, or burst) to view the results for each test. For the burst test, the results can be viewed in summary table format or test log format.

Go back to top Go back to TOC

5.5.2.1 Status: The status of each test is displayed including a stamped log of each test.

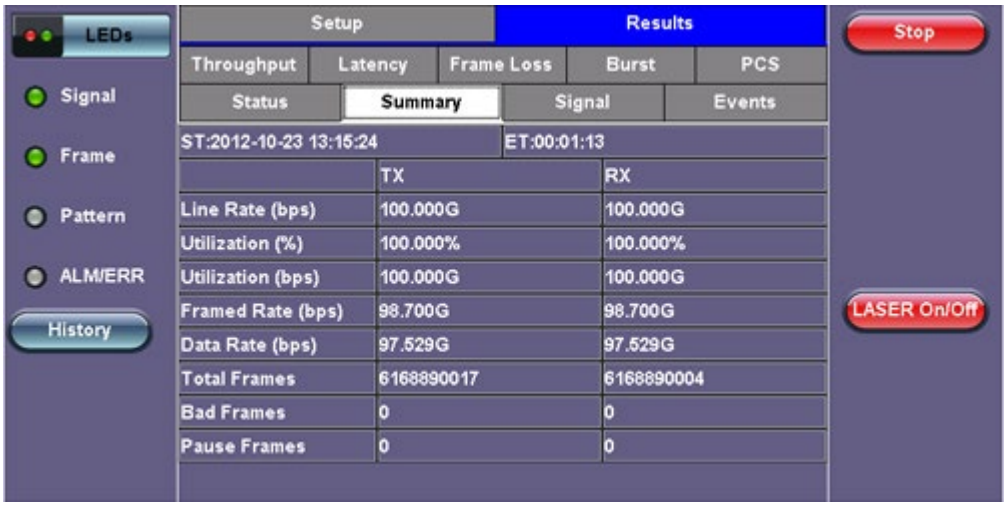


RFC2544 Results Status

Go back to top Go back to TOC

5.5.2.2 Summary: The following results including the Start (ST) and Elapsed (ET) times are displayed:

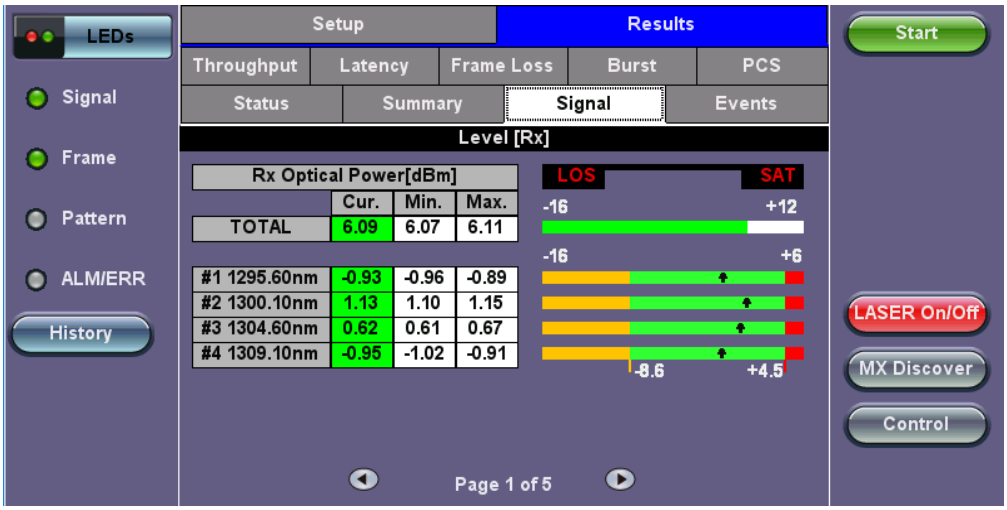
- **Line Rate (bps):** Negotiated rate of the interface (10M, 100M, or 1000M). This value is always fixed since it depends on the maximum capacity of the link under test, hence the test interface that is configured.
- **Utilization:** % of Line Rate. For example, if we transmit 100Mbps on a 1Gbps interface then the utilization value is 10% (or 100Mbps) of the total link capacity (or Line Rate).
- **Utilization (bps)**
- **Framed Rate:** (Payload + MAC/IP Header + VLAN Tag + Type/Length + CRC) / (Payload + Total Overhead) * Line Rate % (in Mbps).
- **Data Rate:** Payload / (Payload + Total Overhead) * Line Rate %.
- **Total Frames**
- **Bad Frames**
- **Pause Frames:** Total number of transmitted and received ethernet pause flow-control frames.



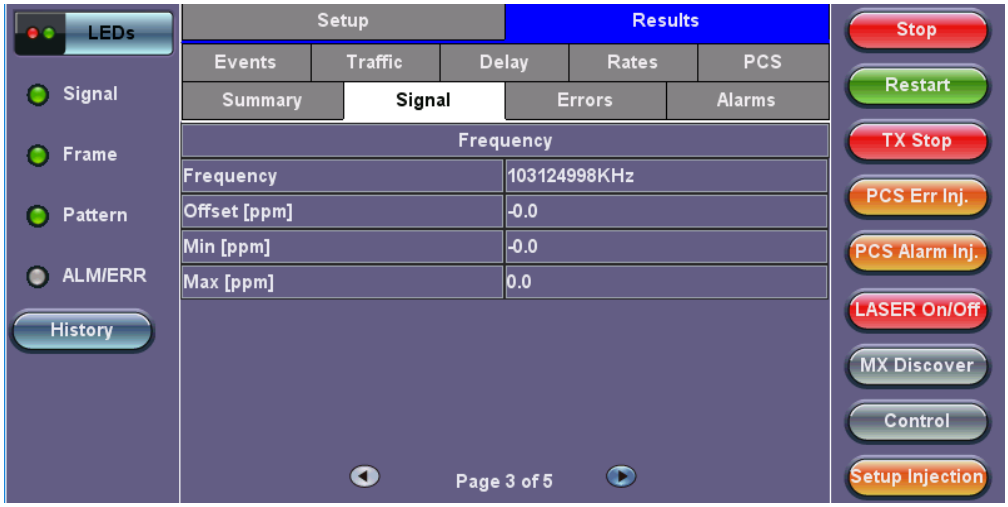
RFC 2544 Results Summary

Go back to top Go back to TOC

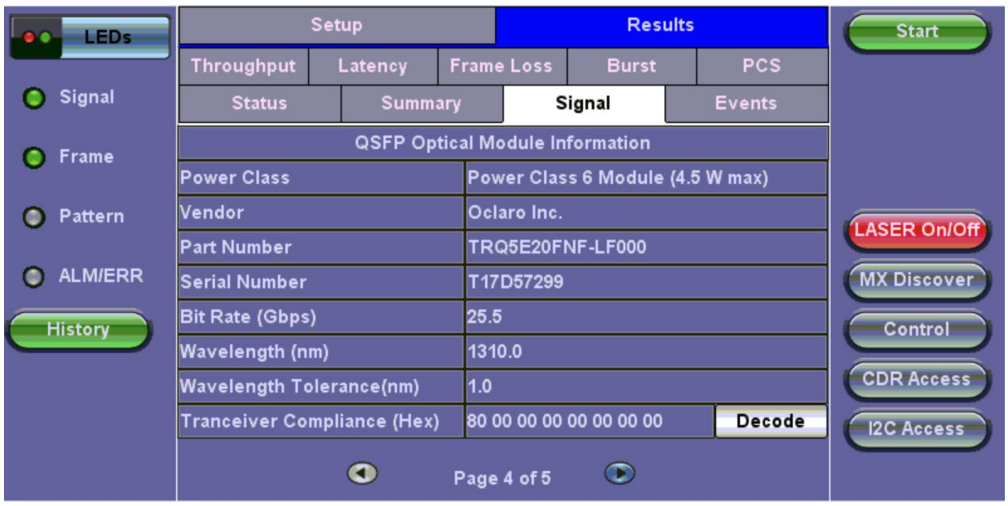
5.5.2.3 Signal: The Signal tab displays the optical level measured by the QSFP+ transceiver.



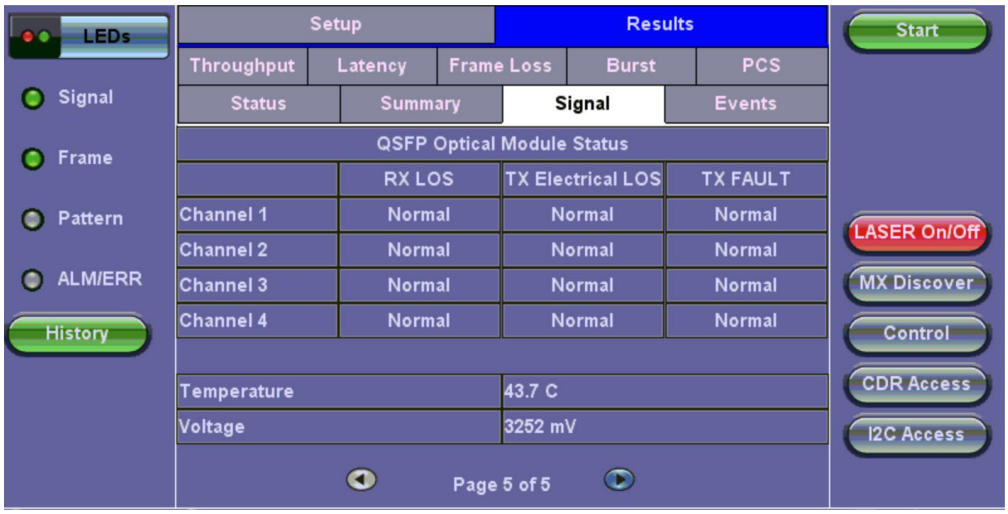
RFC2544 Results Signal Page 1



RFC2544 Results Signal Page 3



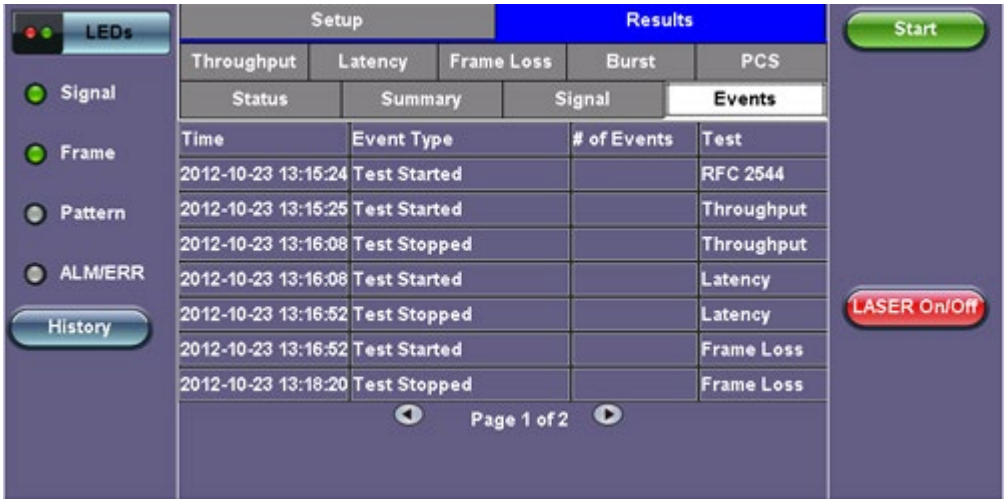
RFC2544 Results Signal Page 4



Signal (Page 5) Optical Module Status

Go back to top Go back to TOC

5.5.2.4 Events: A time stamped log of each test is displayed.



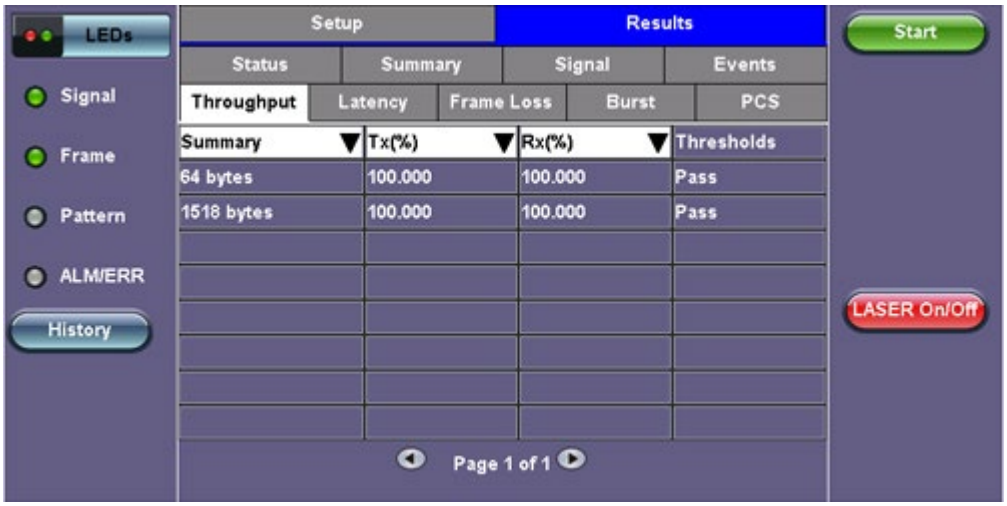
RFC 2544 Results Events

Go back to top Go back to TOC

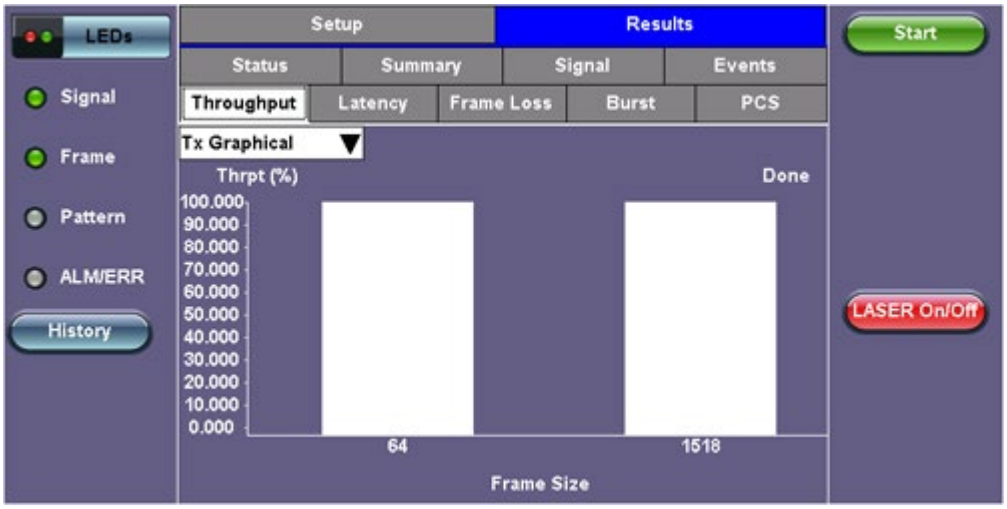
5.5.2.5 Throughput:

The Throughput tab displays the maximum throughput rate of the link under test. Results are displayed in graphical and table formats. Use the drop-down menu to change the display format.

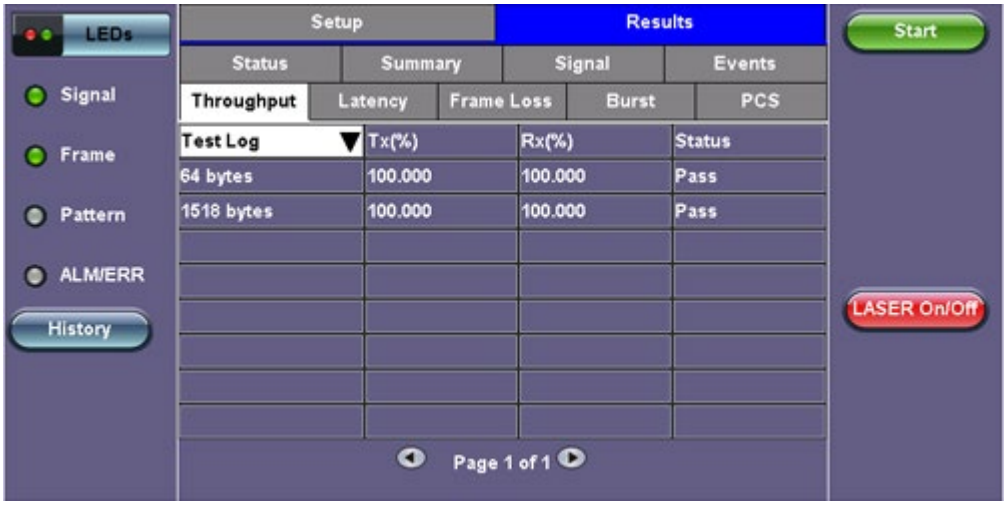
- **Graphical:** Throughput results are displayed in a bar graph form
- Summary table and test log table display:
  - byte size
  - **Tx(%):** Percentage of test frames transmitted by the unit
  - **Rx(%):** Percentage of test frames received by the unit
  - **P/F:** Pass/Fail test status determined by test criteria set in the Threshold tab



RFC2544 Results Throughput Summary



RFC2544 Results Throughput Tx Graphical



RFC2544 Results Throughput Test Log

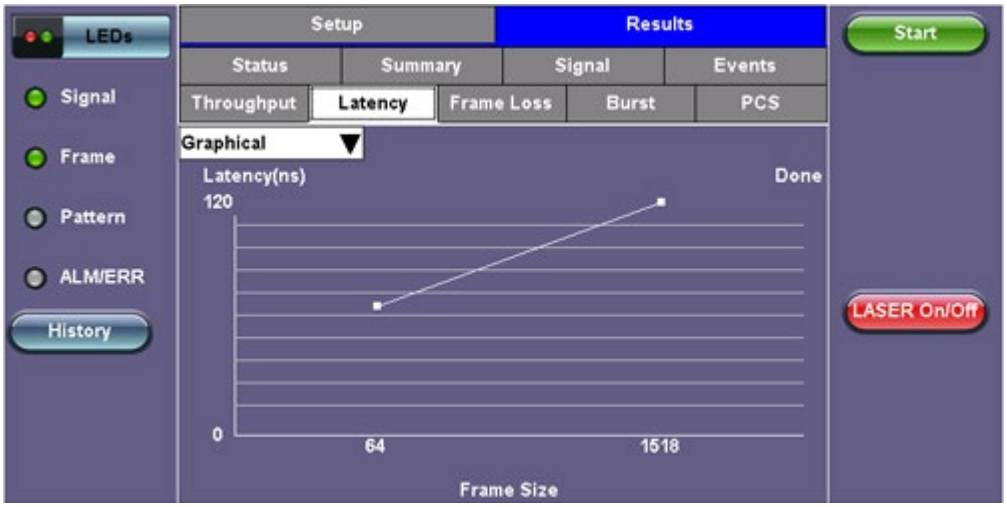
Go back to top Go back to TOC

5.5.2.6 Latency and Jitter

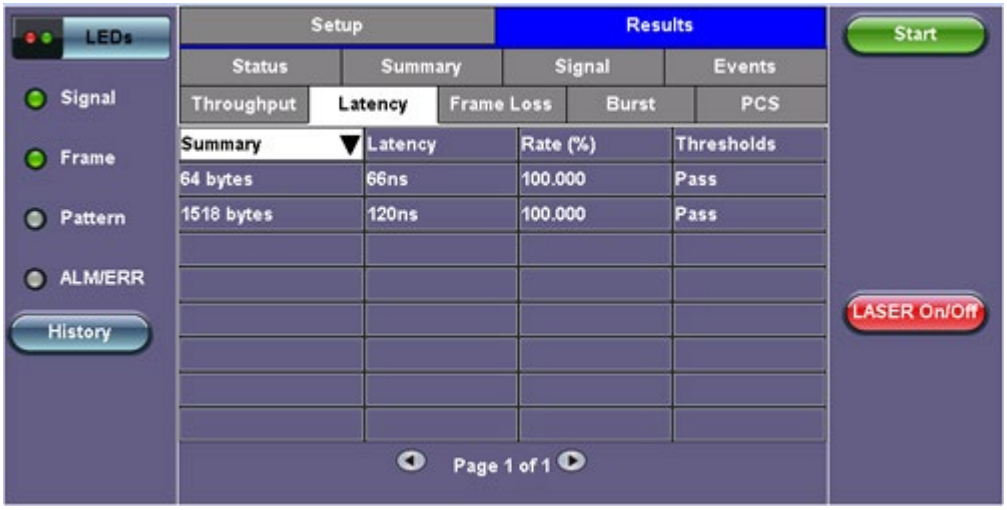
Latency and frame jitter measurements results are displayed under the Latency tab in the following formats:

- **Graphical:** Latency results displayed in line graph form (Latency [us] vs Frame size [bytes]).
- **Summary** and **Test Log** tables display:
  - byte size
  - **Latency (us):** Round trip delay latency.
  - **Rate (%):** Percentage of frames transmitted. Data rate used for latency test.
  - **Pass/Fail** test status.

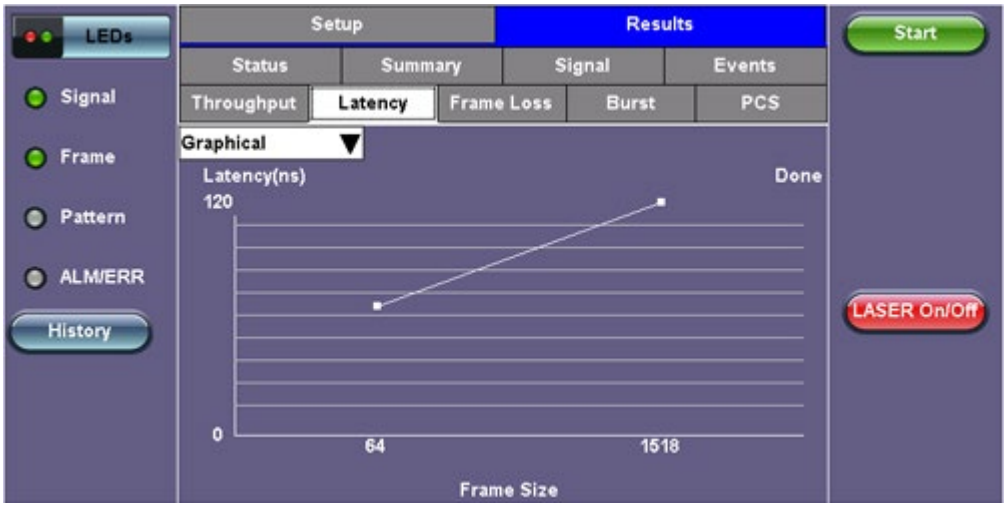
Use the drop-down menu to select the Latency format.



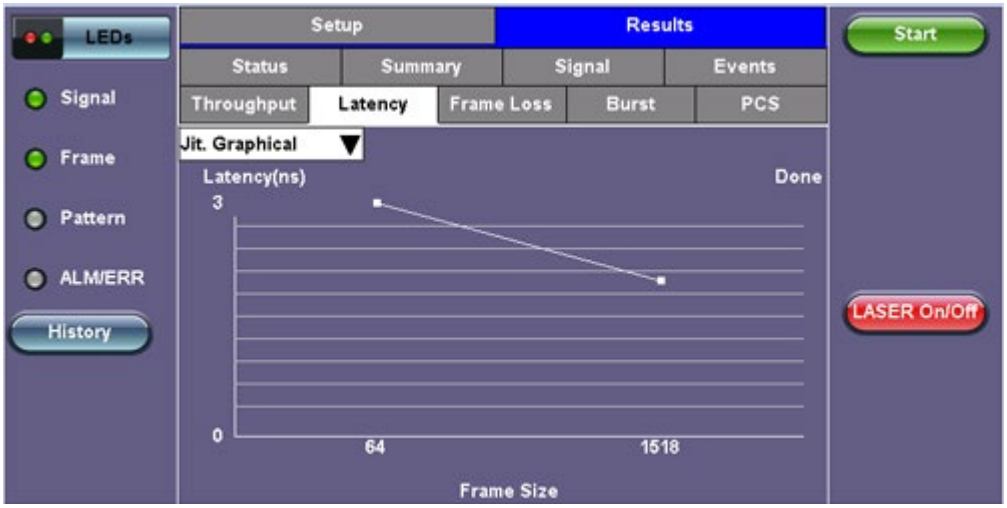
RFC2544 Latency Results Graphical



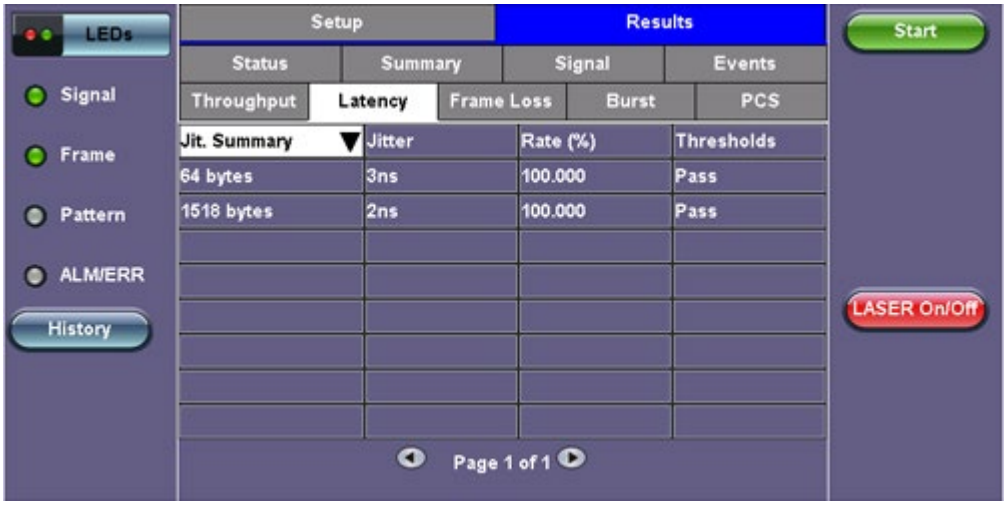
RFC2544 Latency Results Summary



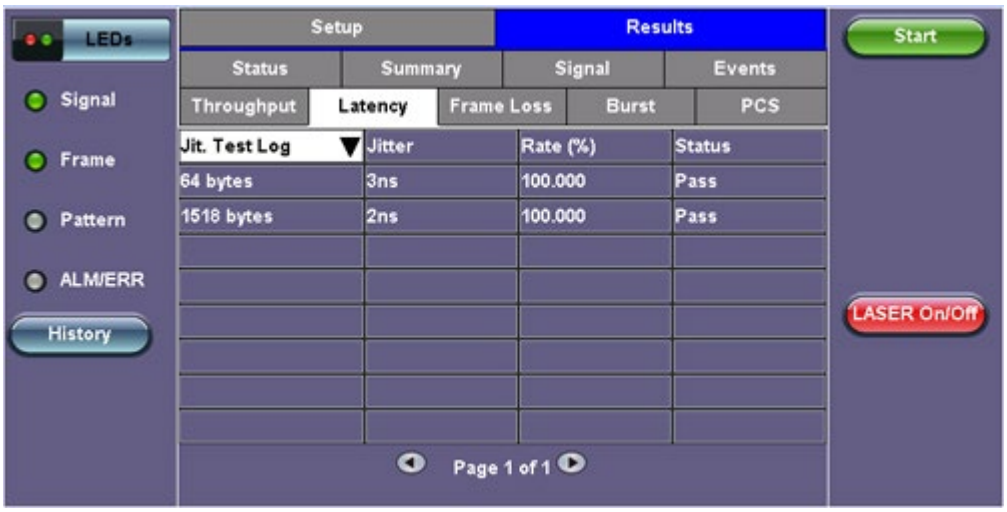
RFC2544 Latency Results Test Log



RFC2544 Jitter Results Graphical



RFC2544 Jitter Results Summary



RFC2544 Jitter Results Test Log

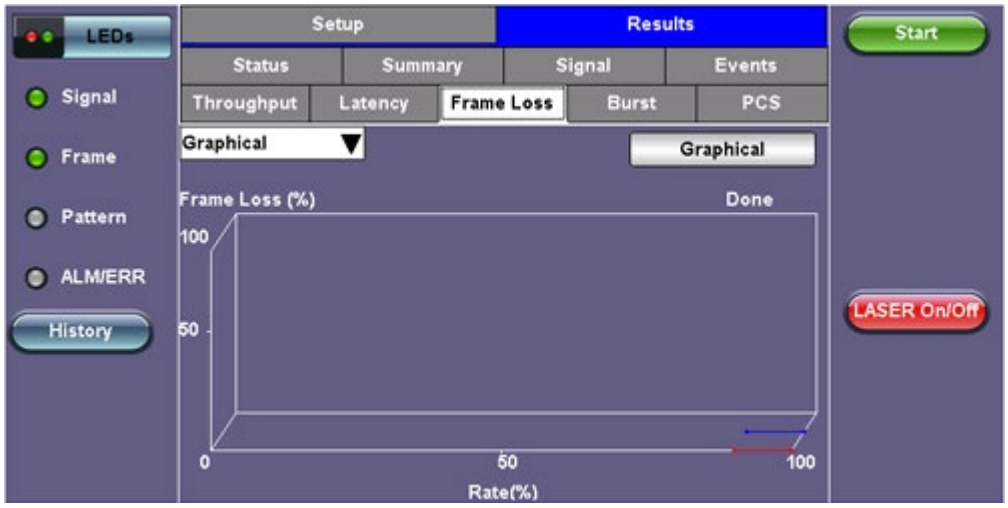
Go back to top Go back to TOC

5.5.2.7 Frame Loss

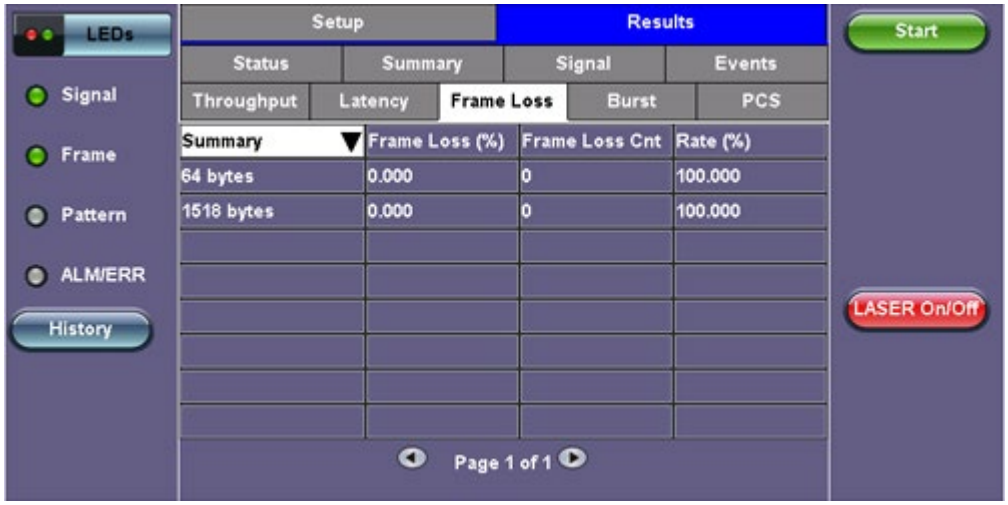
Frame loss displays the percentage of frames not received. Use the drop-down menu to select the Frame Loss format:

Summary and Test log tables display test frame length, byte size, **frame loss (%)** from received traffic, and **rate (%)** transmitted.

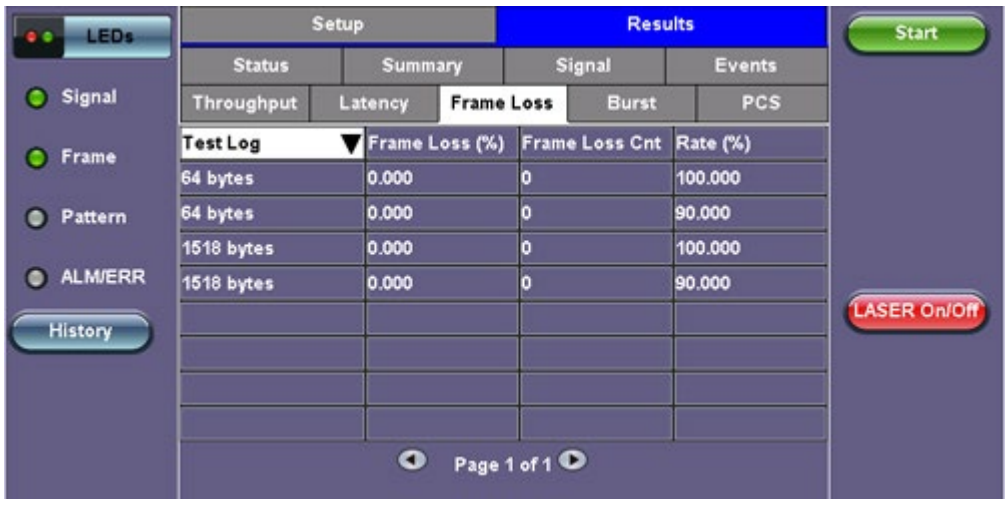
- **Graphical:** Frame Loss displayed in line graph form (Frame size [bytes] vs Rate [%]). Tap the **Graphical** button to see the legend.



RFC2544 Results - Frame Loss Graphical



RFC2544 Results - Frame Loss Summary



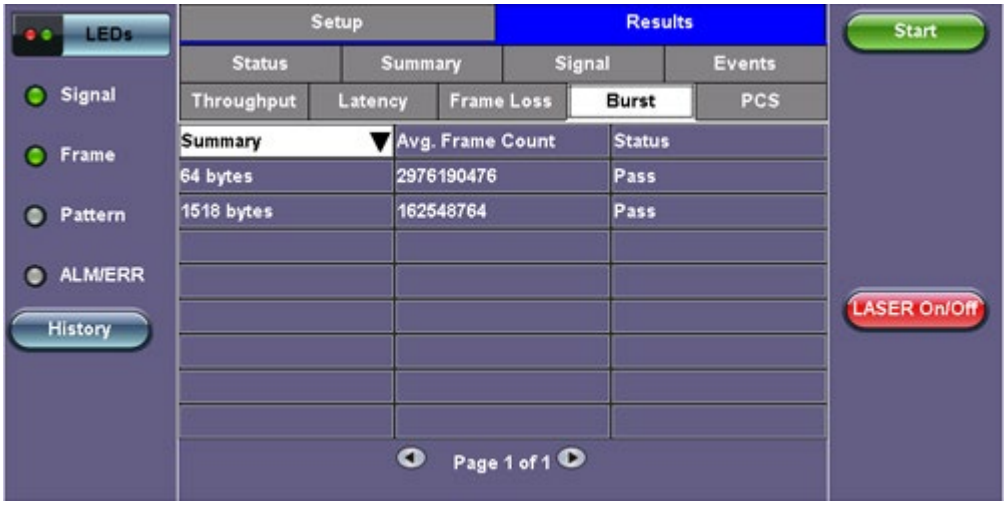
RFC2544 Results - Frame Loss Test Log

Go back to top Go back to TOC

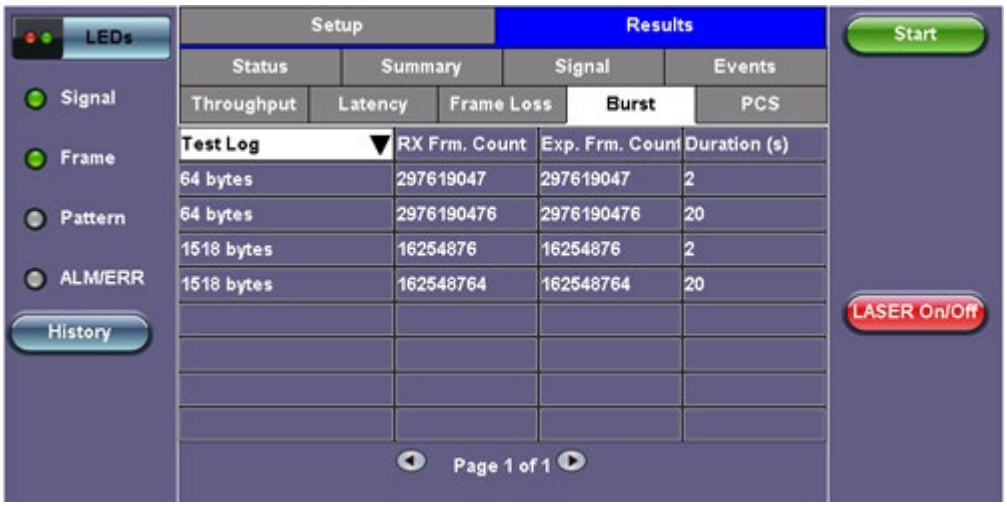
5.5.2.8 Burst

Burstability (back-back) results are the number of frames successfully transmitted/received at the line rate. It is displayed in the following formats:

- **Summary table:** Displays **Average Frame Count** received for each test frame length
- **Test log table:** Displays **Average Frame Count** and **Duration** (seconds) for each test frame length



RFC2544 Results - Burst Summary



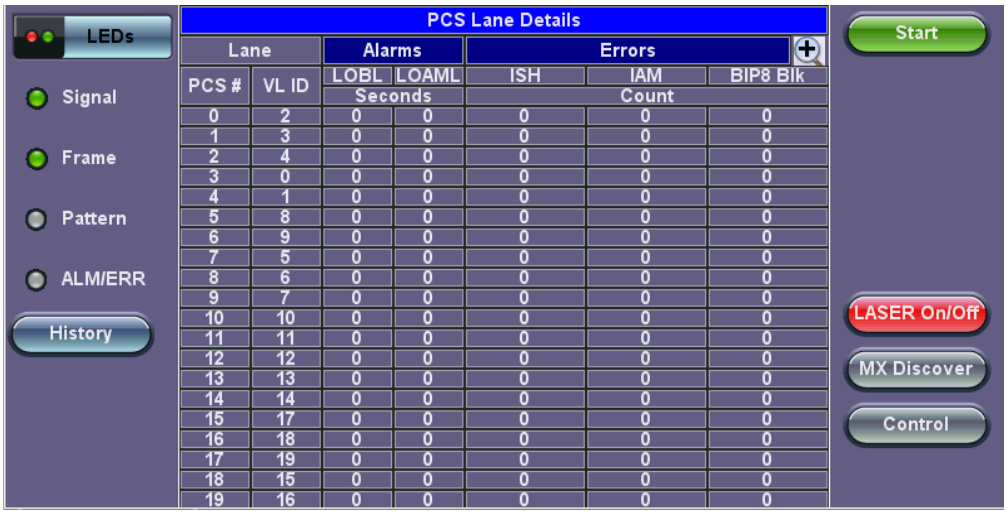
RFC2544 Results - Burst Test Log

Go back to top Go back to TOC

5.5.2.9 PCS

- **HI-BER:** high bit error rate of sync header
- **LOA:** Loss of Alignment marker
- **LOBL:** Loss of block lock
- **Invalid Sync header:** first 2 bits of the 64/66 block header
- **Invalid alignment marker:** inserted every 16383 block on each virtual lane it contains the Virtual lane identifier
- **BIP:** generates bit interleave parity error

RFC2544 Results - PCS



RFC2544 Results - PCS Lane Details

Go back to top Go back to TOC

5.5.3 Saving RFC 2544 Results

Once the test has been stopped the results can be saved by pressing the **Save** key on the platform's keypad.

A window will open giving the option of naming the results file. Enter the desired name for the file and tap apply. The results will be saved.

RFC2544 Results Save

Once the results are saved, they can be viewed, renamed, or exported to USB in the **Utilities** > **Files** > **Saved** section. Refer to the **File Manager** section in the RXT1200, TX300s, or UX400 Platform manual for more information on managing saved test results.

Go back to top Go back to TOC

5.6 V-SAM

Overview

V-SAM (VeEX Service Activation Methodology) is an automated Ethernet service activation test feature conforming to the ITU-T Y.1564 standard, created to address and solve the deficiencies of RFC 2544:

• RFC 2544 was limited to test at the maximum throughput line rate for a single service. SAM is able to run multiple services on a single 10/100/1000 or 10G Ethernet line at a bandwidth ranging from 0 to the line rate, allowing for more realistic stream testing

• The Frame Delay Variation, also known as (packet) jitter was not included in RFC 2544. Jitter is a critical parameter for real time voice and video services. It is now part of the SAM test suite.

• RFC 2544 validates the service parameters like frame loss, throughput and latency, one after the other, while SAM allows testing all the service critical parameters simultaneously. This results in significant time saving compared to RFC 2544.

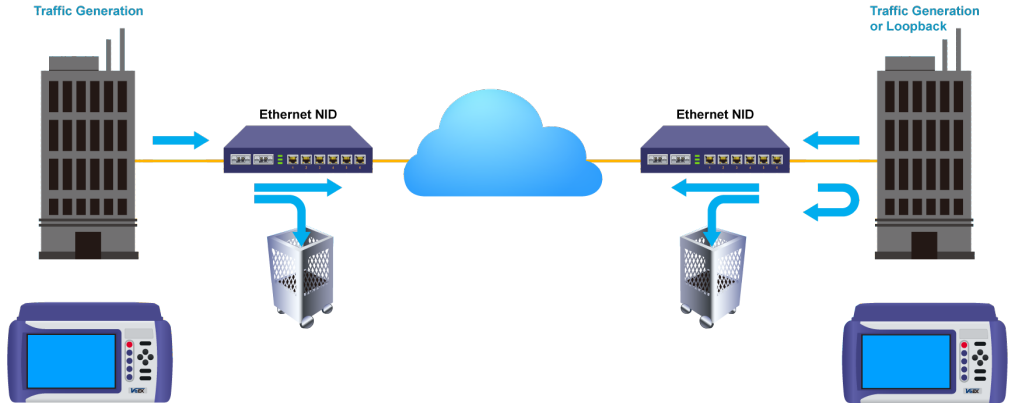
	RFC2544	Y.1564
Key Test Objective	Device performance	Network Service verification/activation
Service validation	One service at a time	Multiple services simultaneously
Throughput	Yes	Yes
Latency	Yes	Yes
Frame Loss	Yes	Yes
Burstability	Yes	Yes
Packet Jitter	No	Yes
Multiple Streams	No	Yes
Test Duration	Long (serialized test procedure)	Short (simultaneous test/service)
Test Result	Link performance limit	Related to SLA, fast, simple, Pass/Fail

Comparison of RFC 2544 and Y.1564

Test Methodology

The purpose of the SAM test suite is to verify that the service is compliant to its Bandwidth Profile and Service Acceptance Criteria. The test is broken down into two phases:

- **Phase 1: Service Configuration test**: The services running on the same line are tested one by one to verify the correct service profile provisioning.
- **Phase 2: Service Performance test**: The services running on the same line are tested simultaneously over an extended period of time, to verify network robustness.



Test Application

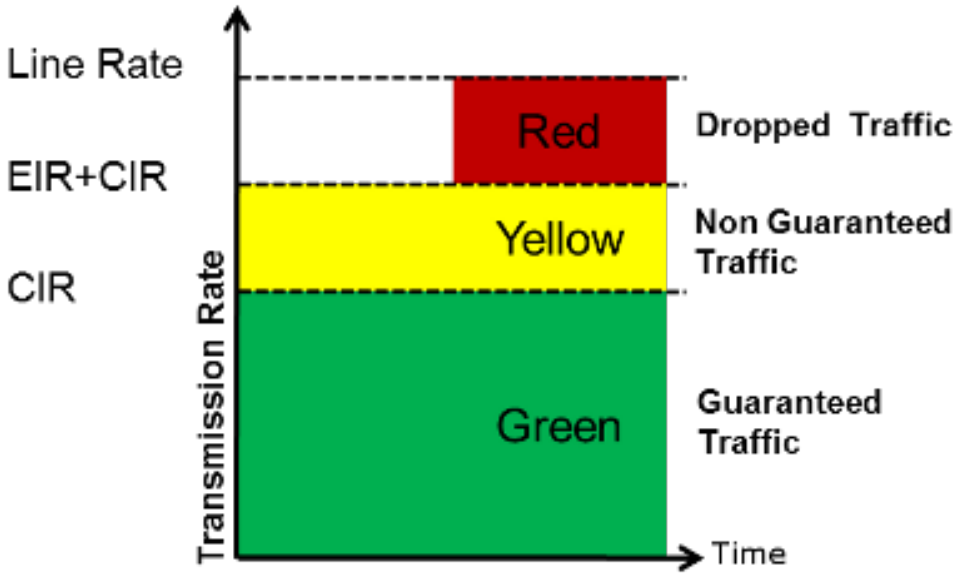
Phase 1: Service Configuration Test

The service configuration test is broken down into three steps. The steps are tested individually for all the services delivered on the same line.

- **Step 1: Committed Information Rate (CIR) Test**: Traffic is transmitted at the CIR for a short period of time and the received traffic is evaluated against the Service Acceptance Criteria (FLR, FTD, FDV) measured simultaneously. The CIR test passes if the measurements on the received traffic stay below the performance objectives.
- **Step 2: Excess Information Rate (EIR) Test**: Traffic is transmitted at the CIR+EIR rate for a short period of time; the EIR test passes if the received traffic rate is between the CIR (minus the margin allowed by the FLR) and CIR+EIR.

- **Step 3: Traffic Policing (Overshoot Test)**: The purpose of the Traffic Policing Test is to ensure that when transmitting at a rate higher than the allowed CIR+EIR, the excess traffic will be appropriately blocked to avoid interference with other services. For this test, traffic is transmitted at 25% higher than the CIR+EIR for a short period of time. The test passes if the received traffic rate is at least at the CIR (minus the margin allowed by the FLR) but does not exceed the allowed CIR+EIR.
- At this time the **Committed Burst Size (CBS)** and **Excess Burst Size (EBS)** tests are considered experimental and not an integral part of the standard.

Service Bandwidth Profile



Phase 2: Service Performance Test

Services running on the same line are tested simultaneously over an extended period of time, to verify network robustness. Service Acceptance Criteria (SAC) including Frame Transfer Delay (FTD), Frame Delay Variation (FDV), Frame Loss Ratio (FLR) and Availability (AVAIL) are verified for each service.

Go back to top Go back to TOC

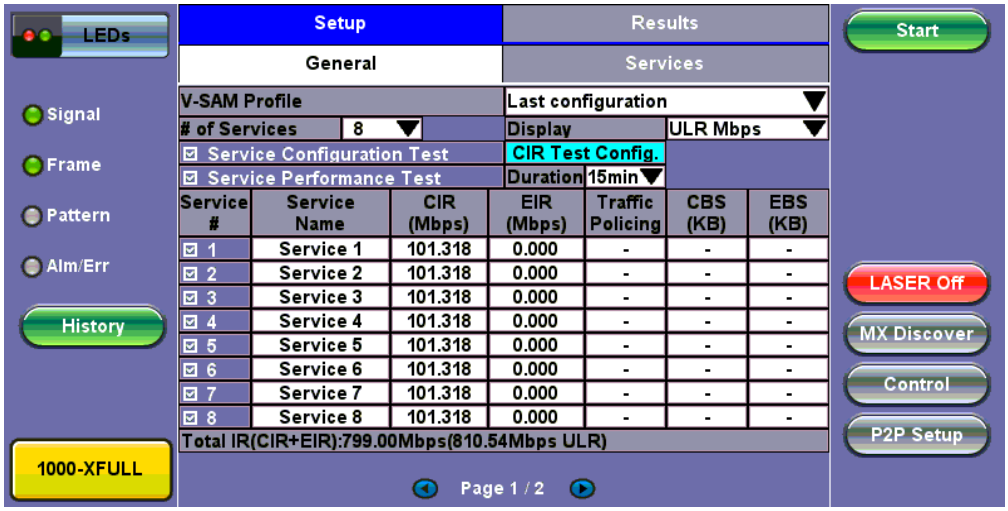
5.6.1 V-SAM Setup

General (Page 1 and 2)

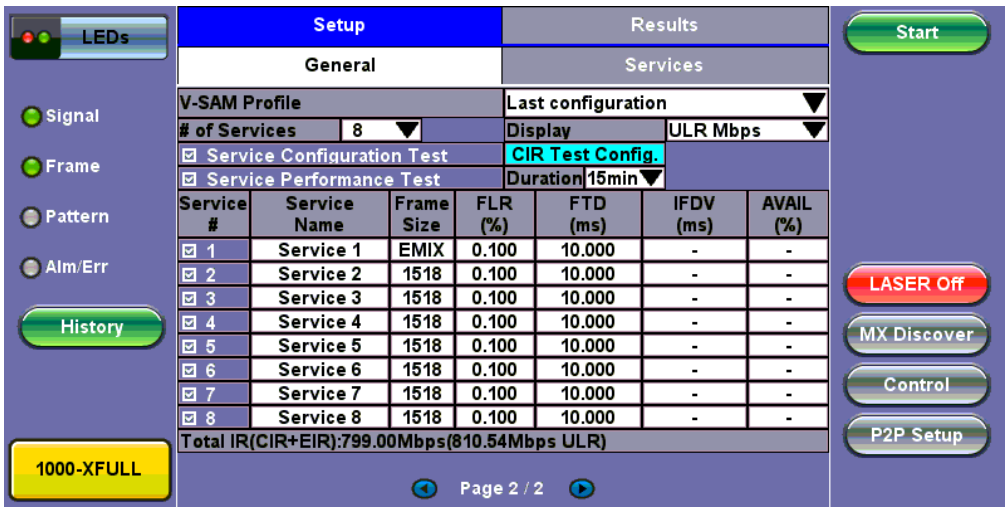
- **V-SAM Profile:** Delete, Save, Save as..., Default, or Last Configuration.
- **# of Services:** Select the number of services to run. Up to 8 services can be chosen for a 1 GE interface and up to 10 services can be chosen for a 10 GE interface.
- **Display:** ULR or IR. See the Service Attributes section for more information.
- **Service Configuration Test:** Enable or Disable the configuration test.
- **Service Performance Test:** Enable or Disable the performance test.
- **Service Configuration** and **Performance Tests** can be enabled independently.
- **CIR Test Config:** Tap on the box to configure the Committed Information Rate Test on another screen.
- **Duration:** Select the **Service Performance Test** duration. Options are 15min, 30min, 1hr, 2hr, 24hr or user defined. If user-defined is selected, input a duration between 1-10000 min.

Enabling/Disabling Tests

A check next to the Service number in the Service Summary table indicates that the test for the corresponding service is set to run. Tap on the box to remove the check and cancel the test for that service.



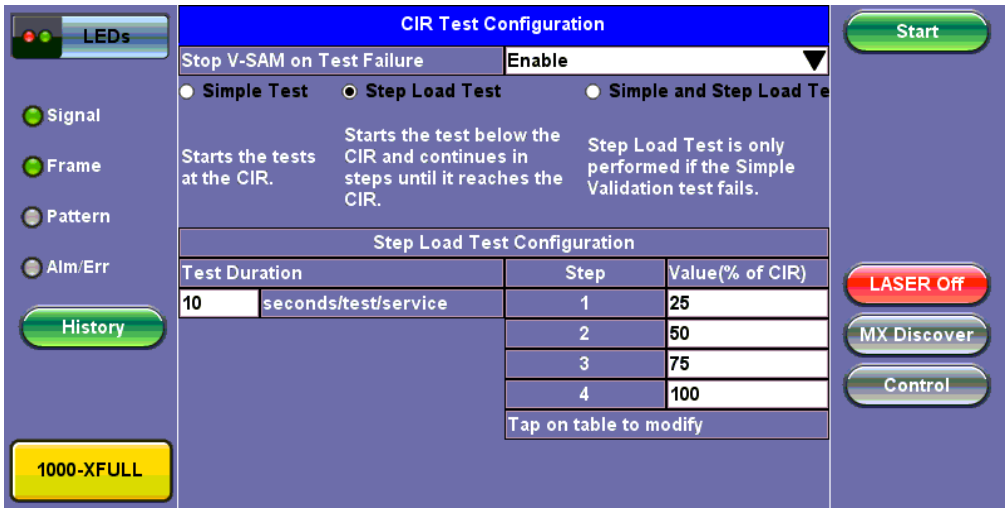
V-SAM - Setup - General (Page 1)



Go back to top Go back to TOC

CIR Test Configuration

- **CIR Test Config.:** Select Simple Test, Step Load Test, or Simple and Step.
  - **Simple Test:** Starts the tests at the CIR.
  - **Step Load Test:** Starts the test below the CIR and continues in steps until it reaches the CIR.
  - **Simple and Step Load Test:** Step Load Test performs only if the Simple Validation test fails.
- Tap on the **Test Duration** box to input a test duration (test duration must be less than 999 sec).
- Tap on the table to modify the CIR value percentage for each step.



CIR Test Config

Go back to top Go back to TOC

5.6.1.1 Header Settings

- **Service #:** Select a service to configure
- **Service Name:** Assign a name to the service if desired.
- **Frame Size Type:** Fixed or EMIX (1GE only). A fixed frame size is chosen as default
- **Frame Size:**
  - **For Fixed Traffic Flow:** Input a fixed frame size within the range of 64-10000 bytes by tapping the value box.
  - **For EMIX (1GE only):** The default value is abceg. Tap the zoom (magnifying glass) icon to define other values. Select the values from the drop down lists on the next screen.

    Any EMIX configuration of 5 frames is allowed.
- **Encapsulation Type:** None, Provider Backbone Bridge (PBB-TE), or Multiprotocol Label Switching (MPLS-TP). MPLS-TP is a simplified version of MPLS. Provider Backbone Bridge MAC-in-MAC (IEEE 802.1ah) encapsulation are configured trunks that add resiliency and configurable performance levels in the provider backbone network. Both options are available for 1GE Copper/Fiber and 10GE port for all Ethernet tests (Layer 2,3 and 4) - BERT, RFC2544, Throughput, V-SAM.

  Tap the PBB or MPLS-TP block to configure the settings. All fields are configurable.

  PBB:

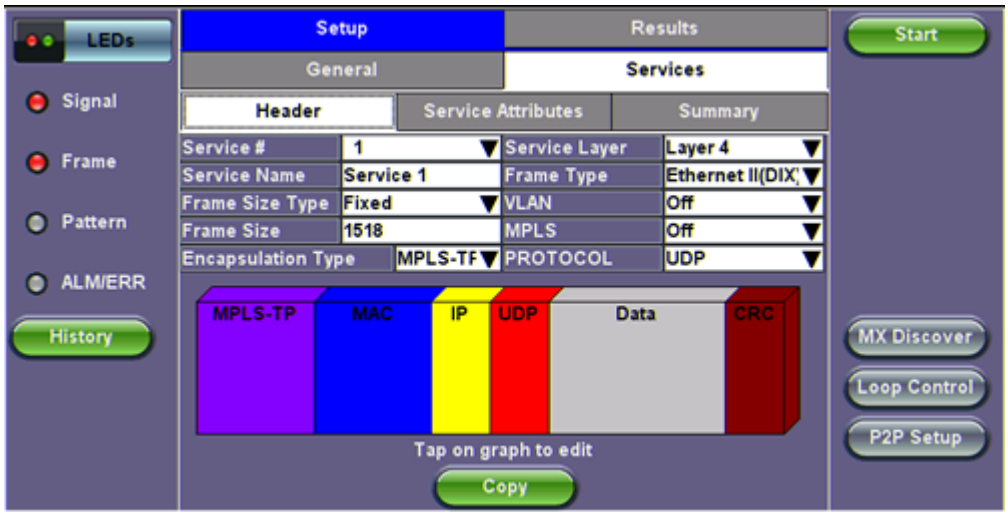
  - Backbone MAC Source
  - Backbone MAC Destination
  - Ethernet Type
  - I-SID
  - VLAN ID, Priority, Type

  MPLS-TP:

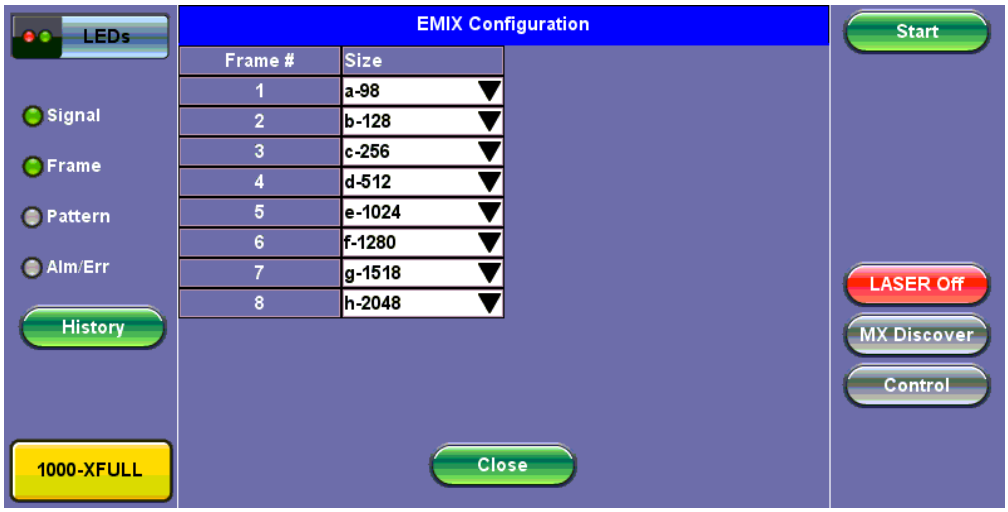
  - MPLS-TP MAC Source

- MPLS-TP MAC Destination
- Ethernet Type
- VLAN ID, Priority, Type
- LSP, PW, CW

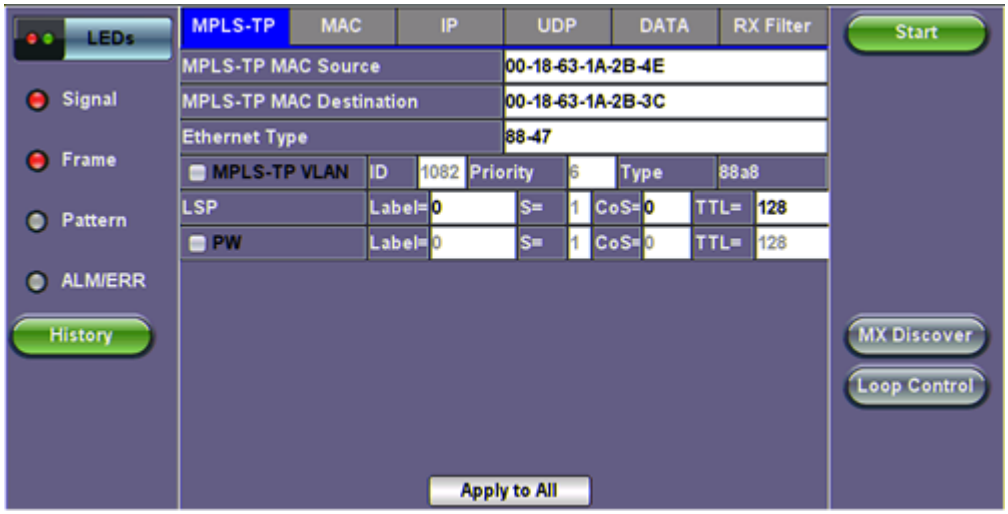
After making changes, tap **Apply to All**, for MPLS-TP configuration.
Please see RFC 2544 Setup and follow the setup procedure to configure the remaining Header Settings for V-SAM.



V-SAM Setup - Services - Header Settings



V-SAM Setup - Services - EMIX Frame Size Settings



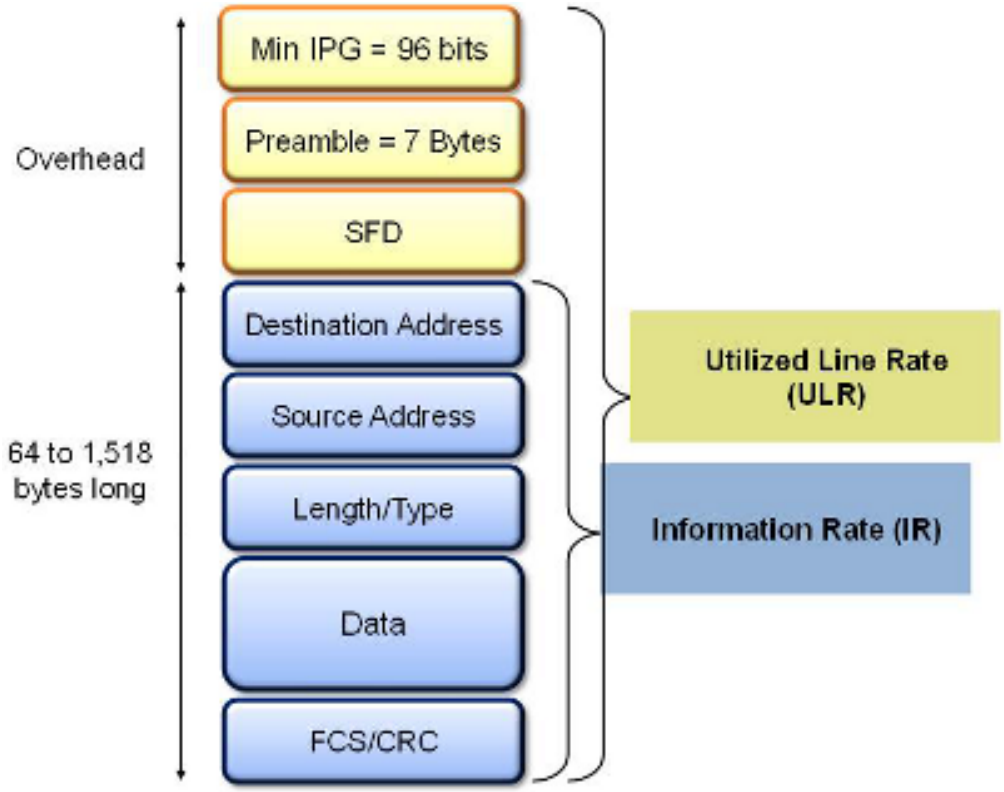
Go back to top Go back to TOC

5.6.1.2 Service Attributes

Bandwidth Profile Parameters

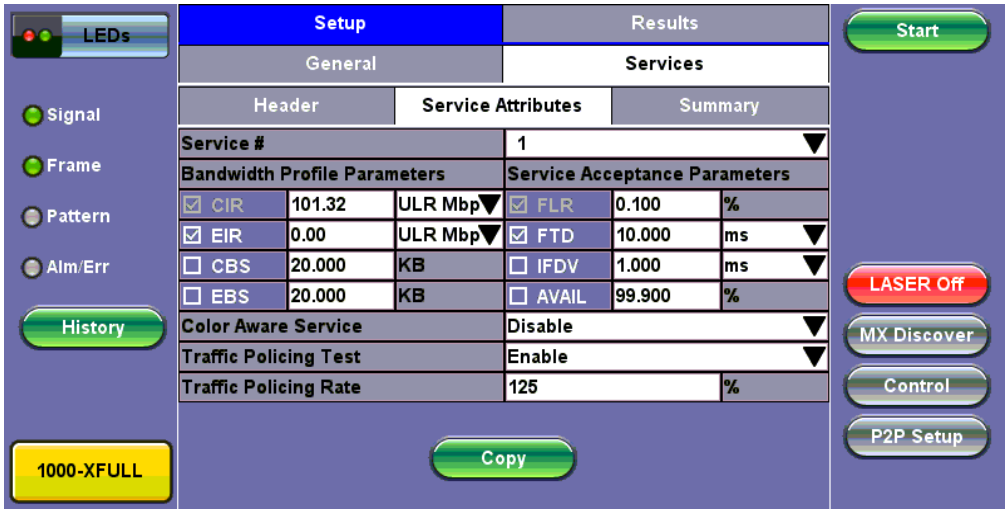
The Bandwidth Profile specifies how much traffic the customer is authorized to transmit and how the frames are prioritized within the network. In the Bandwidth table, the user specifies the following bandwidth criteria:

- **CIR:** Committed Information Rate. This is the guaranteed maximum rate at which the customer can send frames that are assured to be forwarded through the network without being dropped. Tap on the box to enter a rate and choose between **IR Mbps** or **ULR Mbps**. Allowed values range from 0.01Mbps to the line bandwidth.
  - **Information Rate (IR):** Measures the average Ethernet frame rate starting at the MAC address field and ending at the CRC.
  - **Utilized Line Rate (ULR):** Measures the average Ethernet frame rate starting with the overhead and ending at the CRC.



V-SAM Services - Header

- **Excess Information Rate (EIR):** Maximum rate above the CIR at which the customer can send frames that will be forwarded on a best effort basis, but may be dropped in the event of congestion within the network. The combined CIR and EIR must not exceed the line bandwidth. Traffic beyond CIR + EIR will be dropped when it enters the carrier's network. Tap on the box to enter a rate. EIR is expressed in terms **IR Mbps** or **ULR Mbps**. Select a term to express EIR or select **Disable** to disable the test.
- **Traf. Policing:** Enable or Disable the traffic policing test. For this test, traffic is transmitted at 25% higher than the CIR+EIR. The Policing test fails if the higher traffic rate is allowed through the network.
- **Color Aware:** Enable, Disable. When Color Aware is enabled, the Drop Eligible parameter in the VLAN header configuration screen is not available for configuration. If no VLAN is configured for the service traffic, the Color Aware parameter is ignored.
- **CBS** and **EBS**: Committed Burst Size (CBS) and Excess Burst Size (EBS).
  - CBS can be enabled without enabling EBS
  - If EBS is enabled, then CBS is automatically enabled too
  - Values between 4 KBytes and 100 KBytes can be input for both CBS and EBS



V-SAM Setup - Services - Service Attributes

Enabling/Disabling Tests

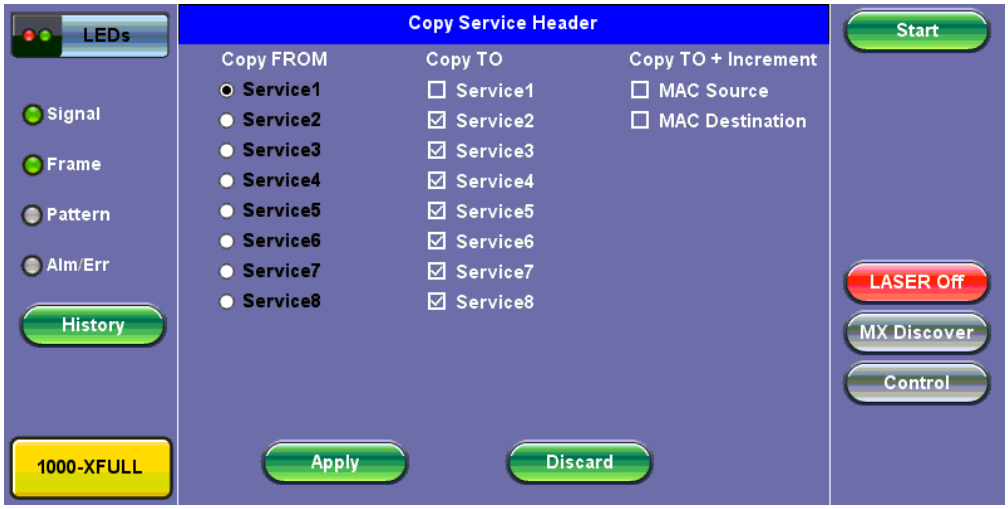
A check next to the parameters in the Service Attributes table indicates that the test for the corresponding service is set to run. Tap on the box to remove the check and cancel the test for that service.

Go back to top Go back to TOC

Service Acceptance Parameters

The user establishes Pass/Fail test criteria for the following Service Acceptance Criteria. Values define the minimum requirements to ensure that the service meets the Service Level Agreement (SLA):

- **FLR:** Maximum ratio of lost frames to the total transmitted frames allowed to still be compliant with the SLA. FLR is only guaranteed for traffic conforming to the CIR. Enter a percentage from 0-100.
- **FTD:** Maximum transfer time that the frames can take to travel from source to destination, and still be compliant with the SLA. FTD is only guaranteed for traffic conforming to the CIR. Values are measured in us, ms, or sec. Input a value within the digital range of .001-999 and 1 us-999sec. The user can also choose to **Disable** the FTD threshold evaluation. FTD will be measured anyway but the value will not contribute toward passing or failing the service.
- **IFDV:** Maximum frame jitter allowed to still be compliant with the SLA. FDV is only guaranteed for traffic conforming to the CIR. Values are measured in us, ms, or sec. Input a value within the digital range of .001-999 and 1 us-999sec. The user can also choose to **Disable** the IFDV threshold evaluation. IFDV will be measured anyway but the value will not contribute toward passing or failing the service.
- **AVAIL:** Minimum percentage of service availability allowed to still be compliant with the SLA. The service becomes unavailable if more than 50% of the frames are errored or missing in a one second interval. Availability is only guaranteed for traffic conforming to the CIR. Enter a percentage from 0-100. The user can also choose to **Disable** the AVAIL threshold evaluation. AVAIL will be measured anyway but the value will not contribute toward passing or failing the service.



Copying Services

Copying Services

Tap on the **Copy** button on the bottom of the **Header** or **Service Attributes** tabs to copy frame parameters specific to that tab to other services. For example, pressing Copy on the Header tab will only transfer header parameters to other services.

Go back to top Go back to TOC

MX Discover and Control Settings

For instructions on how to loop up/down the test set with another test set or device, please refer to MX Discover and Control.

The **Control** button offers additional loopback control settings including User Defined and OAM Discover. These features are described in **MX Discover and Control**.

Peer-to-Peer Setup

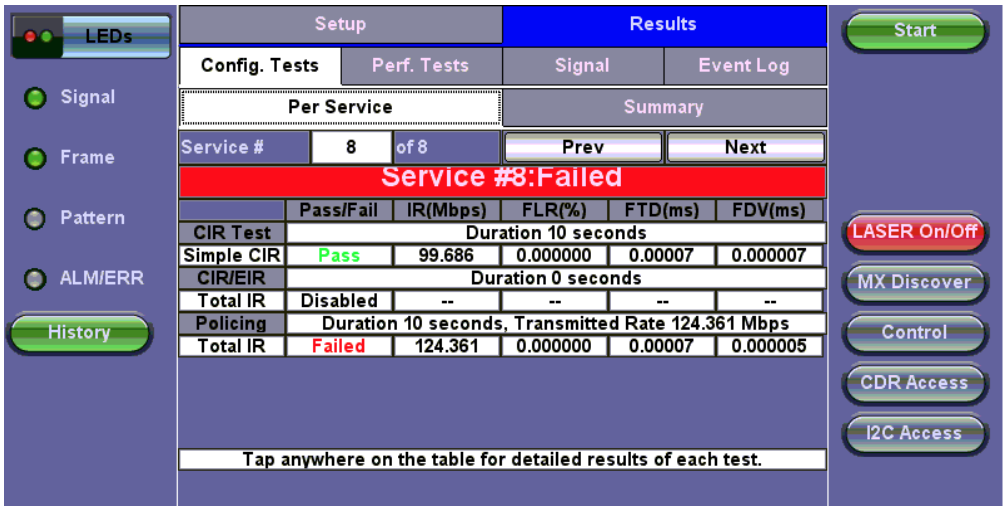
Peer-to-Peer and asymmetric testing via the **P2P Setup** button is also available. Refer to Peer-to-Peer and Asymmetric Testing section for more information.

Packet Capture

To capture packets, tap on **P1 Cap Start**. Stopping packet capture automatically names and saves results in pcap format. A message displays the name of the saved file located in **Files** > **Saved** section of the test set. The file and can be exported to a PC and analyzed using Wireshark. Refer to **Files** > **Viewing Saved Files and Results** section in **TX300s, MTTplus, RXT-1200, or UX400 platform manuals** for more information on retrieving and managing saved files.

Go back to top Go back to TOC

5.6.2 Results



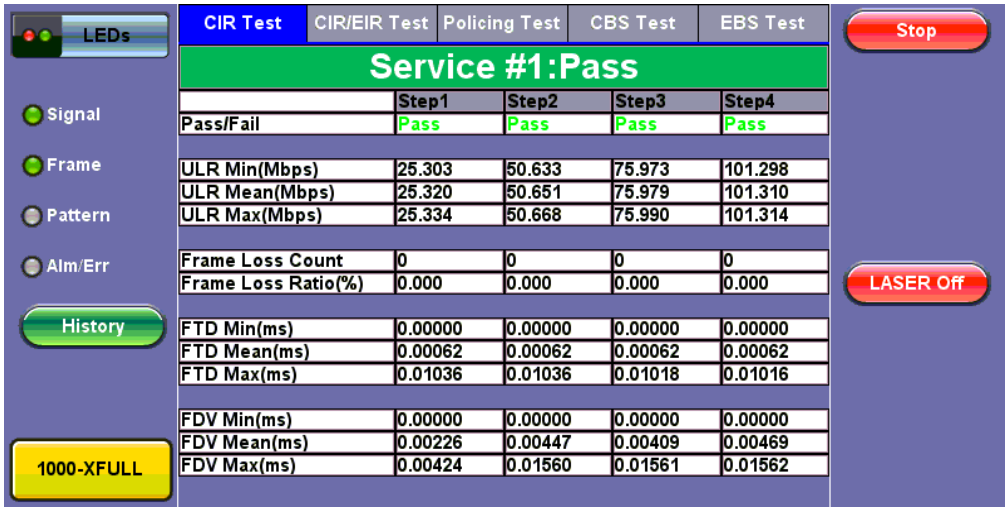
Results - Config. Tests - Service 1

To run the test, make sure that traffic is being looped back at the far-end of the network under test.

Configuration Test

The **Config. Tests** tab lists the Pass/Fail status of each service and test. Tapping on the table brings up a screen with **CIR**, **CIR/EIR** and **Policing Test** results for the chosen Service. **CIR**, **CIR/EIR Test**, and **Policing** tabs display min, mean, and max values for **IR Mbps**, **FTD**, **FDV**, **Frame Loss Count**, and **Frame Loss Ratio (%).** If Step Load was selected for the CIR Test, these values will be displayed for each step. If any measured values do not meet the service test parameters set in the Bandwidth and Threshold tabs, the test fails.

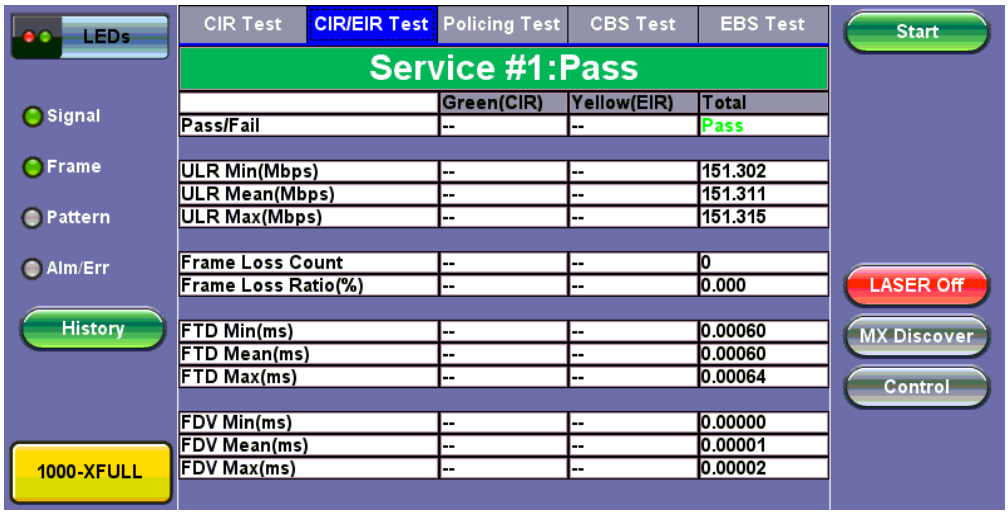
- **IR Mbps:** Information Rate. Measures the average Ethernet frame rate starting at the MAC address field and ending at the CRC.
- **FTD:** Measures the time that the frames can take to travel from source to destination.
- **FDV:** Measures the frame jitter.
- **Frame Loss Count:** Counts the number of lost frames.
- **Frame Loss Ratio:** Ratio of lost frames to the total transmitted frames.



CIR Test - Service 1

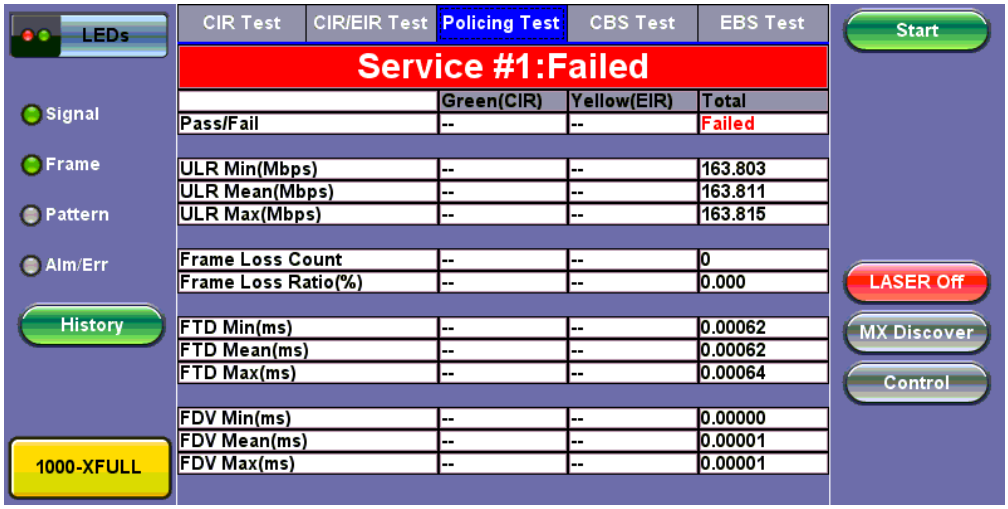
CIR test: The test passes if all measured values are below the thresholds configured If a threshold is disabled, it will not be

evaluated towards pass/fail criteria.



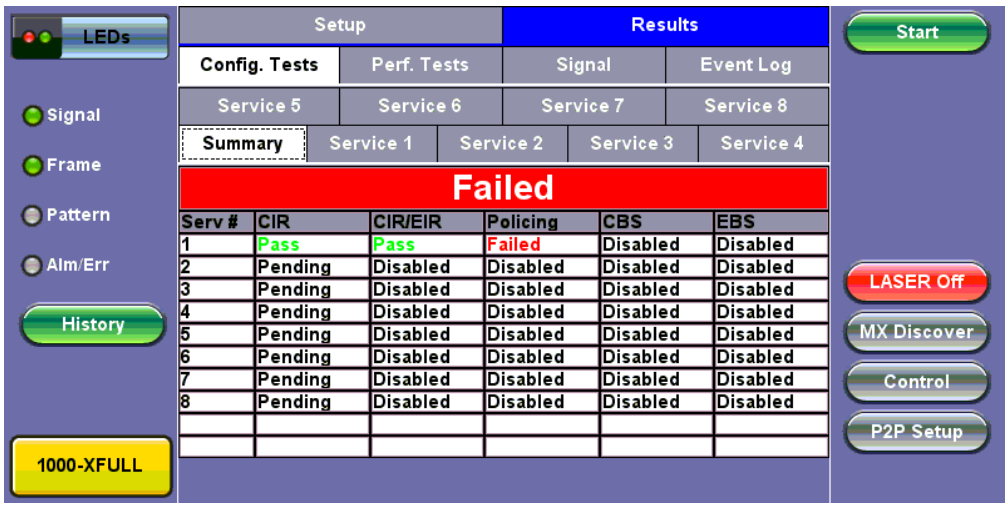
CIR/EIR Test - Service 1

CIR/EIR test: The test passes if the received IR value is between the CIR (minus the margin allowed by the FLR) and CIR+EIR.



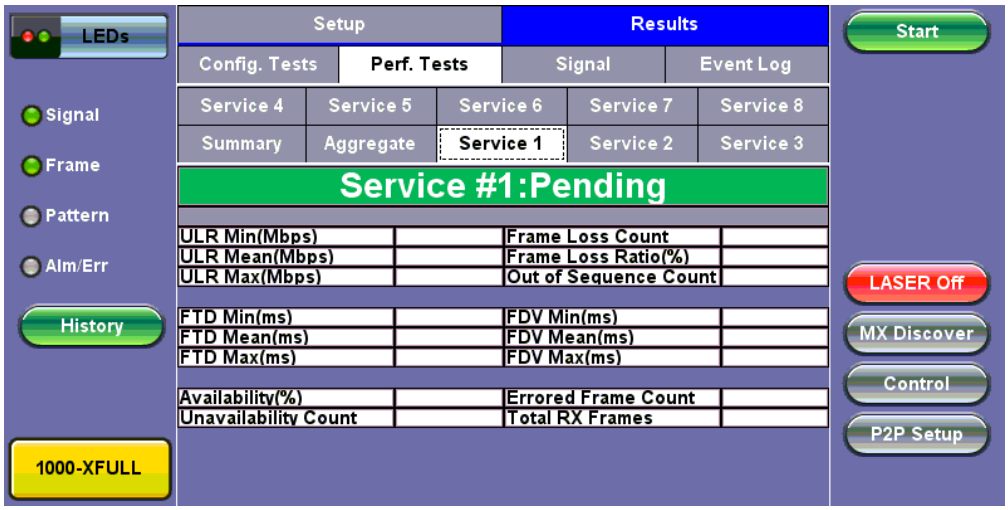
Policing Test - Service 1

Policing test: The test passes if the received traffic rate is at least at the CIR (minus the margin allowed by the FLR) but does not exceed the allowed CIR+EIR.



Results - Config. Tests - Summary

Summary: The Summary tab displays the status of each service and test as Pass, Failed, Pending, or Disabled.



Perf. Test - Service 1

Go back to top Go back to TOC

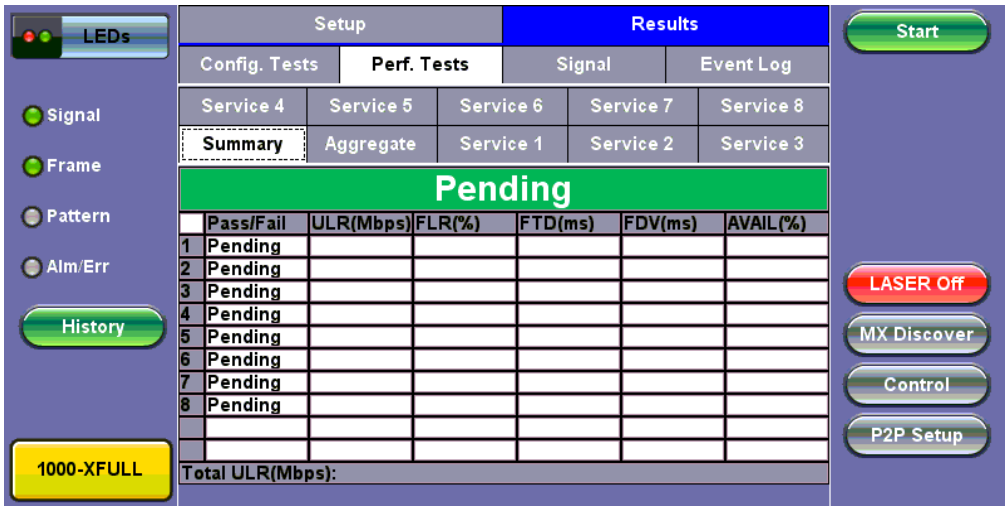
Performance Test

The **Service #** tabs display min, mean, and max values for **IR Mbps**, **FTD**, **FDV**, **Frame Loss Count**, **Frame Loss Ratio (%)**, **Availability**, and **Errored Frame Count**. Pass/Fail/Pending status of each test is displayed on the top of each table.

- **IR Mbps**, **FTD**, **FDV**, **Frame Loss Count**, **Frame Loss Ratio (%)** definitions are listed in the **Configuration Test** section.
- **Availability:** Minimum percentage of service availability allowed to still be compliant with the SLA. The service becomes unavailable if more than 50% of the frames are errored or missing in a one second interval. Availability is only guaranteed for traffic conforming to the CIR.
- **Total RX Frames:** Total number of frames received
- **Errored Frame Count:** Number of frames with CRC or IP Checksum errors

Measured values that do not meet the service test parameters set in the Bandwidth and Threshold tabs cause the test to fail.

The **Summary** tab displays the status of each service and test as **Pass**, **Failed**, **Pending**, or **Disabled**.

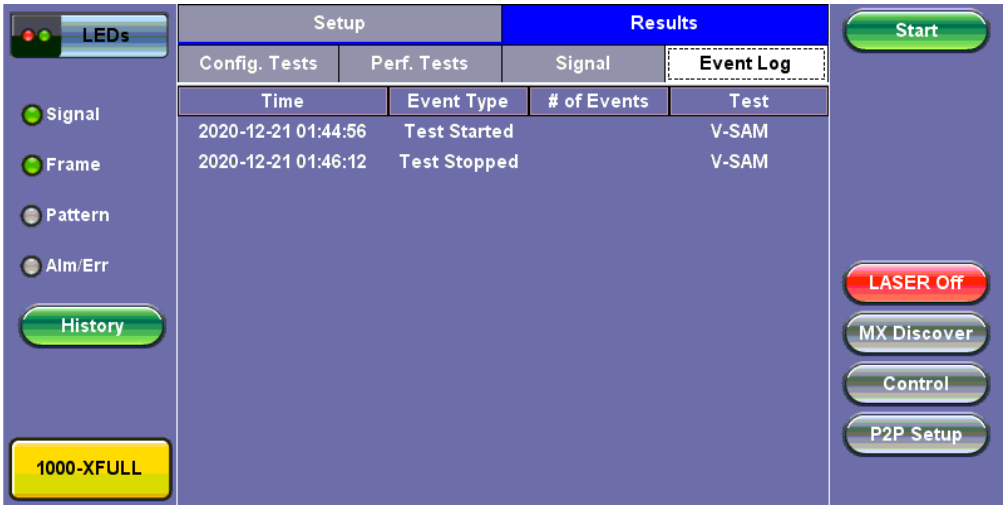


Perf. Tests - Summary

Go back to top Go back to TOC

Event Log

A time stamped record or log of test types and test statuses (start/stop).



Event Log

Go back to top Go back to TOC

5.7 Throughput Testing

5.7.1 Setup

Overview:

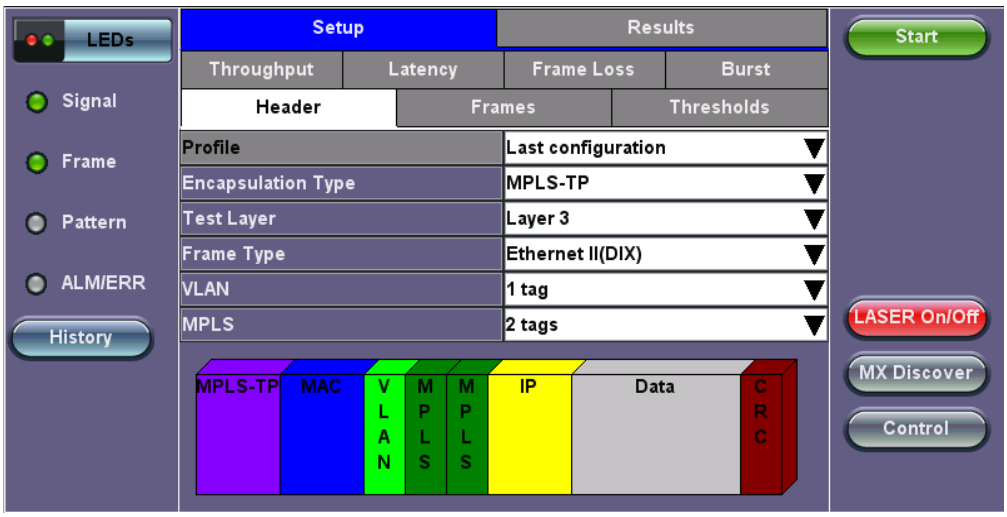
The Throughput application performs the following measurements: Throughput performance, Frame Loss analysis, Delay analysis, Frame/Packet arrival analysis, received Traffic Type analysis, and received Traffic Frame Size analysis. On the transmit side, the Throughput application currently allows only one stream with its MAC and IP address, VLAN tags (up to 3), bandwidth/rate, frame size, and L2 and/or L3 quality of service (QoS) parameters. On the receiver end the traffic is analyzed on a per stream basis as well as a global or aggregate measurement.

This application is very useful in verifying the transport of traffic with different prioritization settings across a network link. The test helps verify that the network can handle high priority traffic and low priority traffic accordingly.

Go back to top Go back to TOC

5.7.1.1 Header Settings

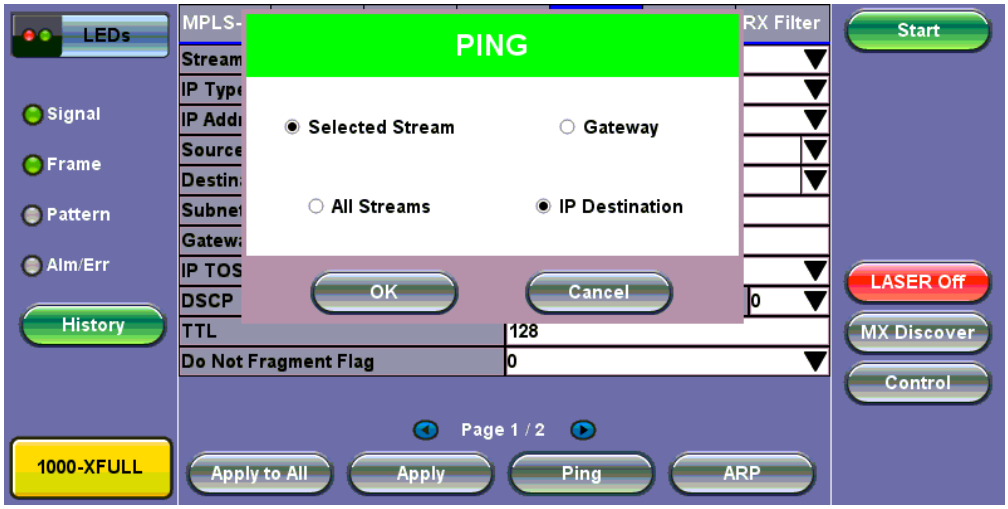
Unless otherwise noted, Frame Header, MAC, VLAN, MPLS, and IP configuration procedures are identical to the setup described in RFC 2544 and BERT. Refer to the BERT application for details. The following parameters must be configured prior to performing a Throughput test:



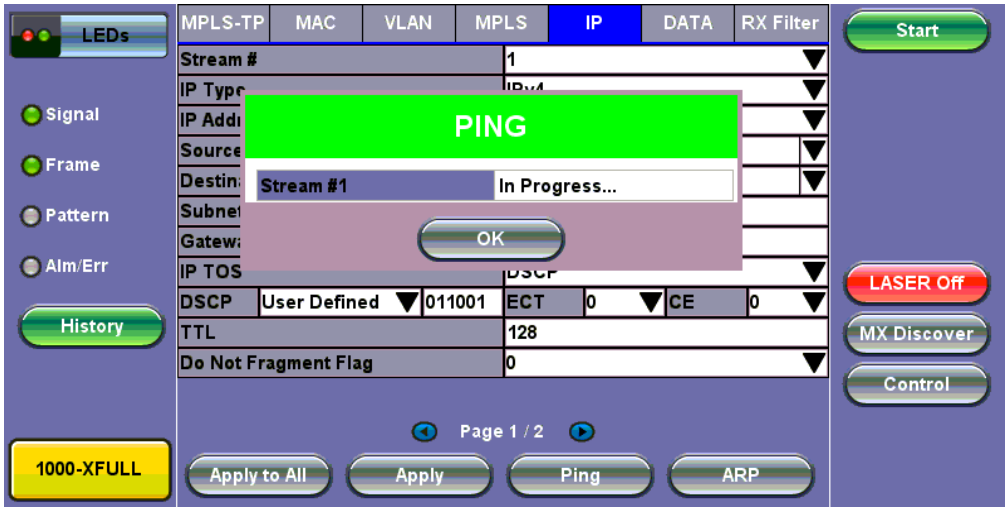
Throughput Header Settings

- Number of streams (See **General Settings** below)
- Bandwidth per stream (See **General Settings** below)
- Test layer
- Frame Type
- VLAN tag(s)
- MPLS tag(s)
- Frame header per stream (if applicable)
- Traffic profile per stream (if applicable)
- Error injection per stream (if applicable)
- Control settings of the far-end device(s) (if applicable)

The IP header features additional **Ping** and **ARP** features which can be applied to selected streams or all streams by Gateway or IP Destination. Refer to the **UX400 40G/100G**, **TX300s-100G**, or **RXT-1200 platform manual** for information on setup and results for Ping and ARP.



Throughput Header - IP - Ping Settings



Throughput Header Settings

Multiple Streams - MAC/IP Address Setup

If all of the streams are going to the same far-end unit, then the MAC/IP destination addresses must be the same on all of the streams.

If any of the traffic streams are going to more than one far-end unit then ensure the correct MAC/IP destination addresses are configured for the respective streams.

Go back to top Go back to TOC

5.7.1.2 Traffic Settings (Per Stream Configuration)

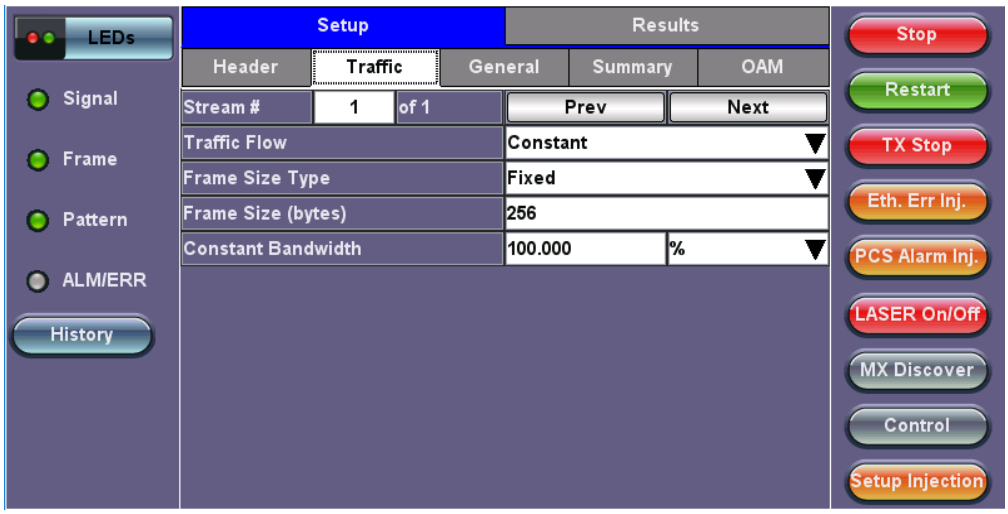
In the Traffic tab the user is able to configure the traffic profile per stream, including frame size selection, traffic type, and transmit rate.

- **Stream #:** Select a stream number to configure.
- **Traffic Flow:** Select from Constant, Ramp, Burst, or Single Burst traffic flow.
- **Frame Size (Type):** Fixed, increment, decrement, random
- **Frame Size (bytes):** If a fixed frame size is chosen, this option is enabled. Enter the frame size when a Layer 2 or 3 is selected. Frame sizes can be from 64bytes to 1518bytes, in addition to jumbo frames up to 9k bytes.

Bandwidth: Configure the transmit rate for the stream. The parameters depend on the Traffic Flow selected.

- Constant Traffic Flow: Constant Bandwidth
- Ramp: Start BW, Stop BW, Step BW, Ramp Time, Repetitions
- Burst: Burst 1 Bandwidth, Burst 1 Time, Burst 2 Bandwidth, Burst 2 Times
- Single Burst: Single Burst Bandwidth

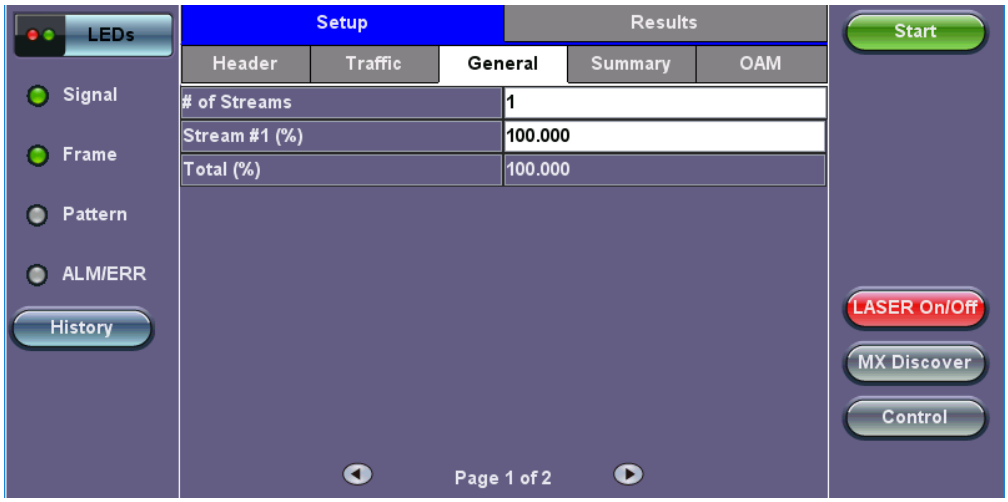
*The bandwidth allocation per stream is already configured in the **General Settings** tab, but can be modified in this screen as well.*



Throughput Traffic Settings

5.7.1.3 General Throughput Settings (Global Configuration)

- **# of Streams:** Only 1 for now. 256 in the future.
- **Stream #:** Allocated Bandwidth per Stream: The total bandwidth for all streams cannot exceed 100%.
- **Total (%):** Sum of all stream rates in %.



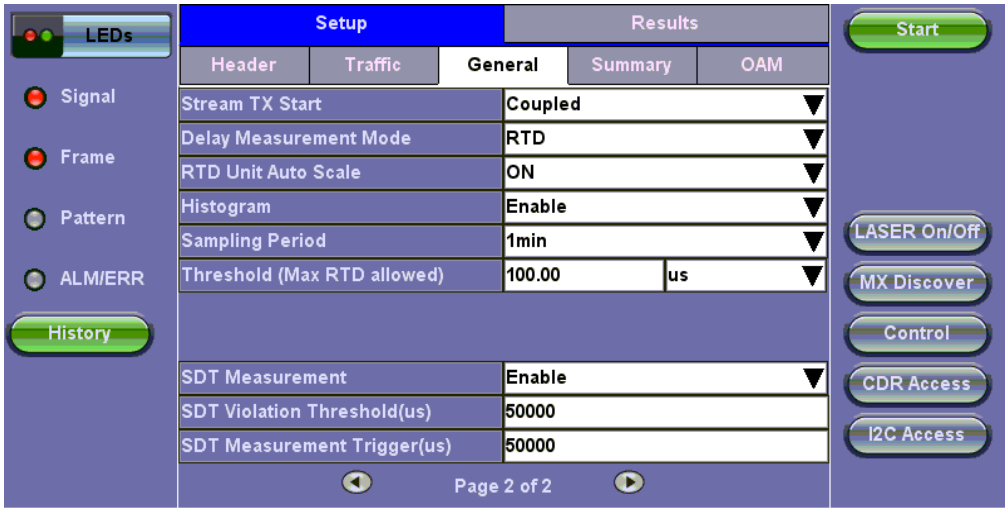
Throughput General Setup

Page 2 features Round Trip Delay (RTD) measurement and Service Disruption Test (SDT) measurement settings.

- **Delay Measurement Mode:** Enable/disable the round trip delay measurement. It should only be enabled when running the test to a remote loopback.
- **RTD Unit Auto Scale:** ON/OFF
- **Histogram:** Enable / Disable
- **Sampling Period:** 1sec, 10secs, 30secs, 1min, 10min, 30min, 1hr. Defines how often the RTD (round trip delay) measurement is evaluated against the RTD threshold.
- **Threshold (Max RTD allowed):** Input the value in us, ms or sec. Defines the maximum allowed round trip delay value. If the

RTD value exceeds the threshold, an event is logged with corresponding time stamp.

- **Save Histogram:** Enable/Disable
- **SDT Measurement**: Enable/Disable. The Service Disruption Test is triggered based on user established thresholds.
    - ***SDT Violation Threshold (us)***:Triggers an SDT Violation event in the event log. This is helpful for historical purposes during any given test. If the measured SDT is equivalent or greater than the configured threshold an SDT Violation event is counted.
    - ***SDT Measurement Trigger (>us)***: Any inter-frame gap that is equivalent or greater than the configured threshold will trigger the SDT measurement. This is useful if a known threshold is expected from a given network under test. For example, if the known switchover time is 50ms, the trigger can be set to a value slightly below 50ms to assure that the SDT is measured.



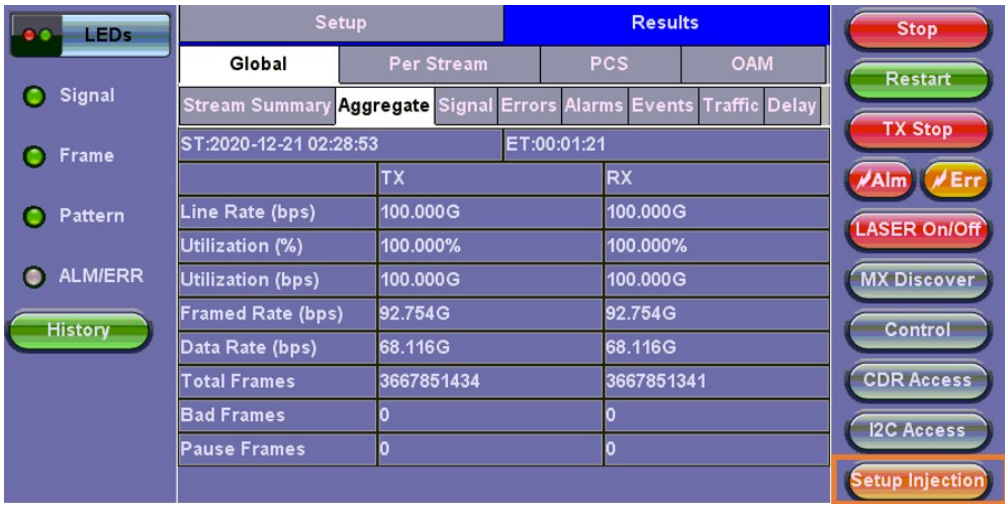
Throughput General Setup - Round Trip Delay (RTD), Service

Multiple Streams

All streams are configured for the same test layer - if Layer 2 is selected, all streams will be Layer 2 traffic.

Go back to top Go back to TOC

5.7.1.4 Error Injection Settings (Per Stream Configuration)

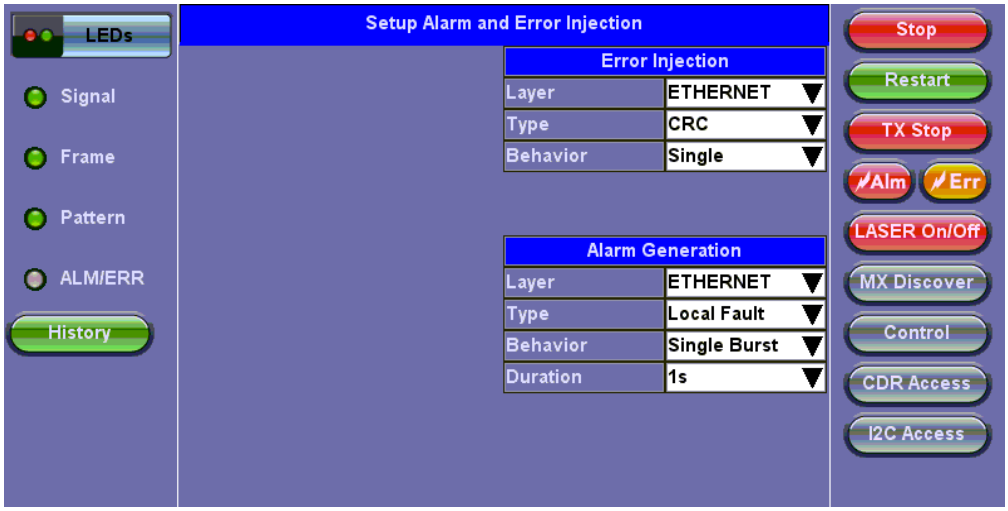


Setup Error Injection

Error injection can be performed during test. The type of errors and error injection are configured in the Error Injection tab. Once the

test is running, error injection can be performed by pressing the **Error Inject** button on the right side of the screen.

- **Stream #:** Select the stream to configure.
- **Error type:** Select from CRC, Pause, or Bit. With Pause selected, the unit will transmit a pause frame when the **Error Inj.** icon is pressed. The Pause time duration is configurable in units of 512 bit time. At Gigabit Ethernet speed, this is equivalent to 512 ns. For example, if pause time is set to 1000, the pause duration will be set to 1000x512 ns.
- **Injection Flow:** The error injection flow determines how the selected errors will be injected. The user can select a single error or a specific count.
- **Count:** Set a count using the numeric keypad.



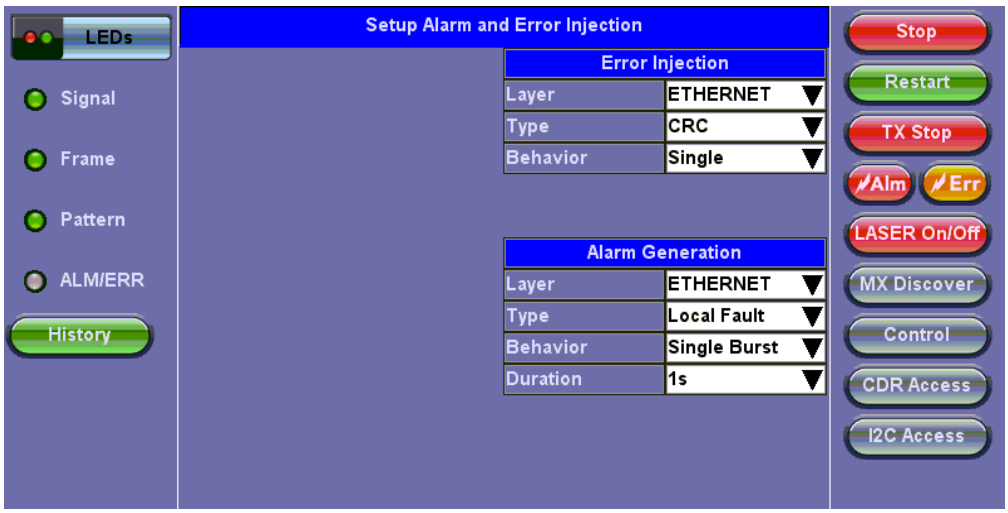
Throughput Error Injection Setup

Go back to top Go back to TOC

5.7.1.5 Alarm Injection Settings

Alarm injection can be performed during test. The type of alarms and alarm injection are configured in the Alarm Injection tab. Once the test is running, alarm injection can be performed by pressing the **Alarm Inj.** button on the right side of the screen.

- **Alarm Type:** Local Fault, Remote Fault, Laser 1 Off, Laser 2 Off, Laser 3 Off, Laser 3 Off, Laser 4 Off
- **Alarm Flow:** The alarm flow determines how the selected alarms will be injected. A specific Count or Conitnue (continuous) can be selected.
- **Alarm Length:** 1s, 10s, or 100s.

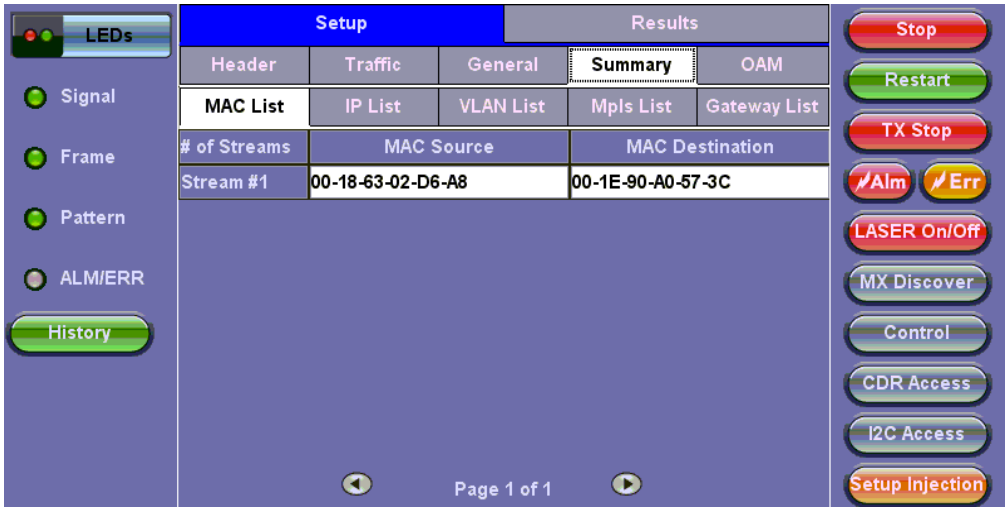


Throughput Alarm Injection Setup

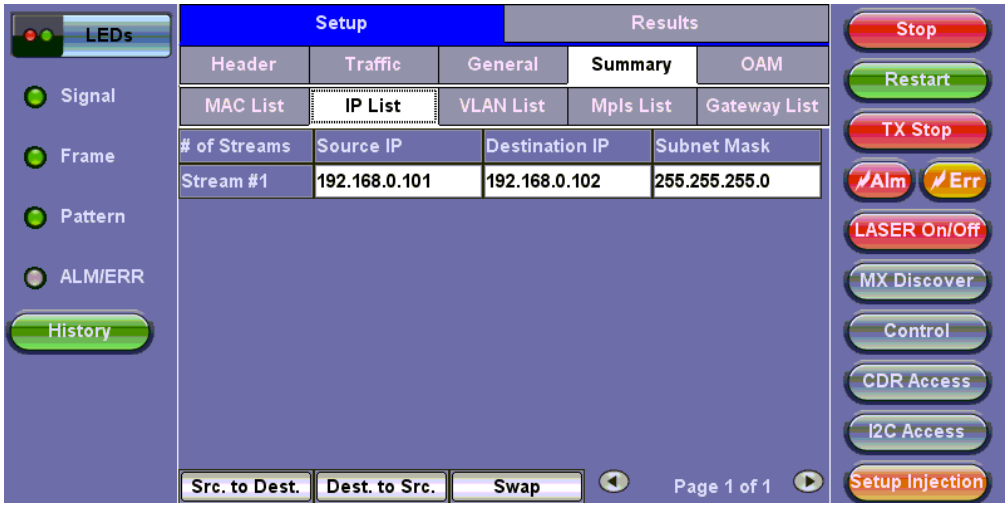
Go back to top Go back to TOC

5.7.1.6 Summary

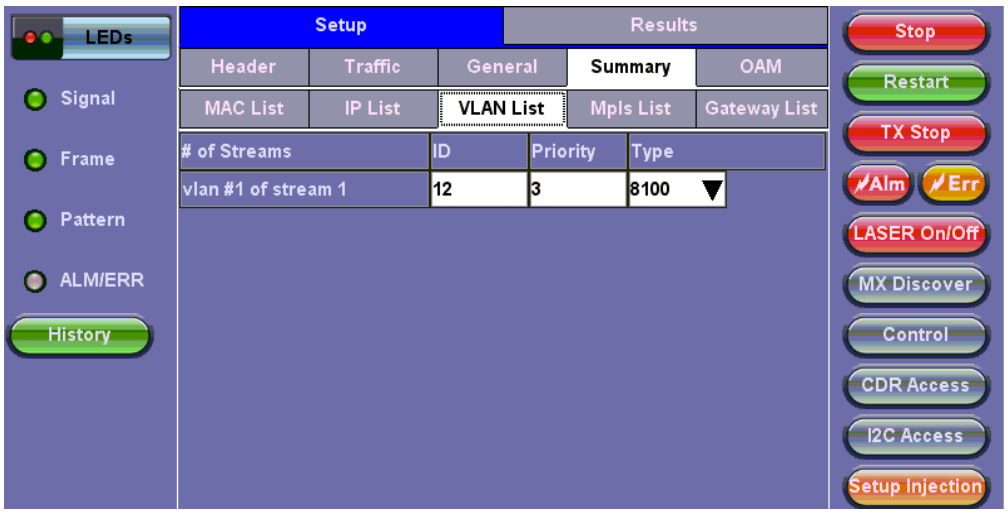
The summary screen lists the MAC source, MAC destination and VLAN information of each stream. Tap on the appropriate box of each tab to reconfigure the source, destination, or VLAN information if desired.



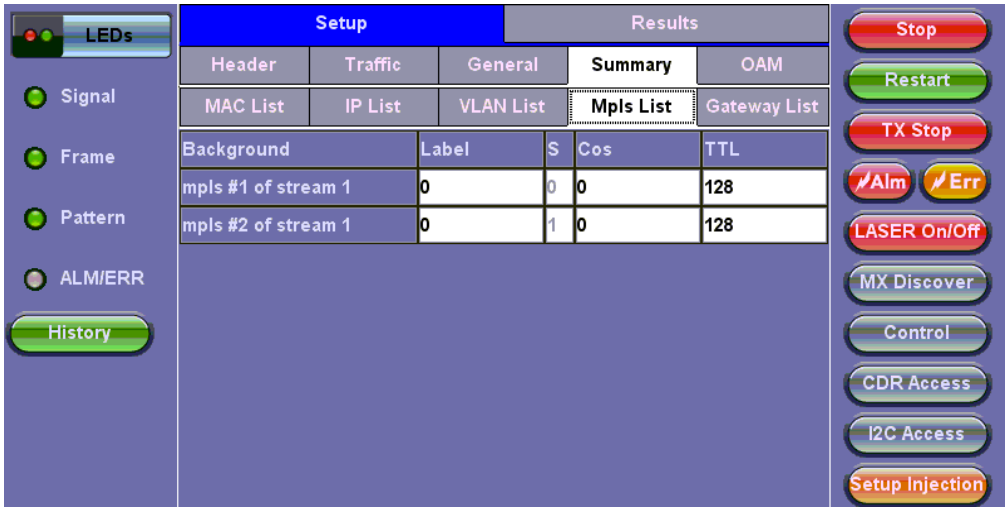
Throughput Summary MAC List



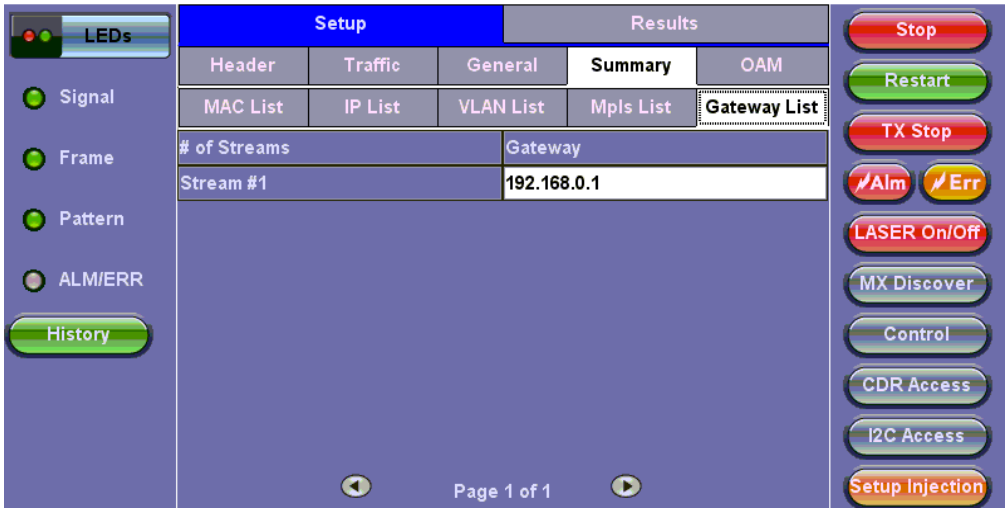
Throughput Summary IP List



Throughput Summary VLAN List



Throughput Summary MPLS List



Throughput Summary Gateway List

Go back to top Go back to TOC

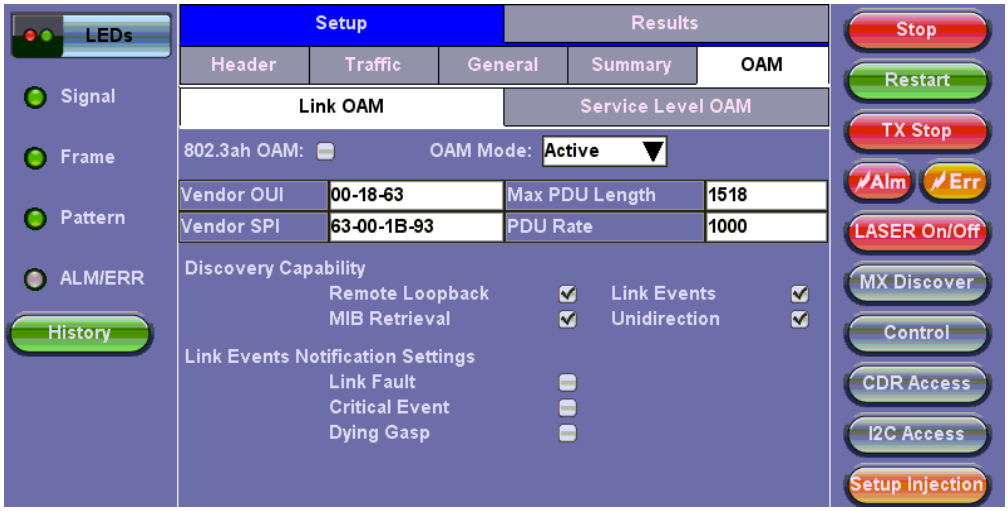
OAM Discover

Like MX Discover, OAM Discover can also be used to discover far-end test units without manually configuring the local or remote unit's destination address. If OAM is enabled on the test set, any link partner that supports the IEEE 802.3ah protocol will be discovered automatically and displayed under the OAM Discover tab.

To Access OAM Discover:

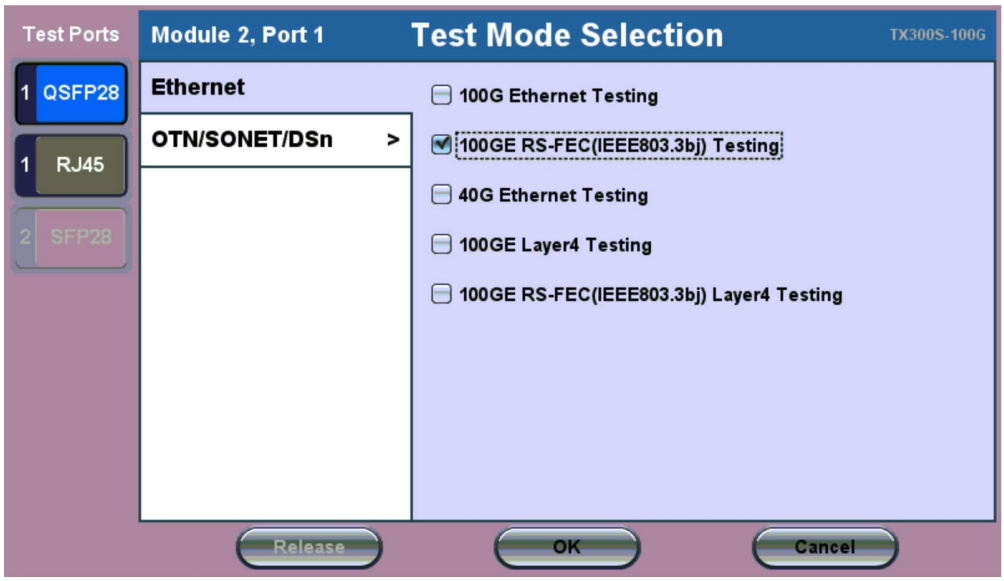
1. Go to **Throughput** > **OAM** > **Link OAM** tab. Tap on the 802.3ah check box to activate Link OAM.
2. Select **Active** from the **OAM Mode** drop-down menu (only Active mode can send loop commands).
3. Tap on the **Loop Control** button and select **OAM Discover** from the **Partner Address** drop-down window to see a list of discovered OAM devices.
4. Select an OAM device and press the **Loop Up** button to send a loop up command to the selected remote unit.

For detailed descriptions of Discovery Capabilities and Link Events Notification Settings, see the Link Level 802.3ah OAM Setup section.
For information on Service Level OAM setup, see the Service Level OAM section.

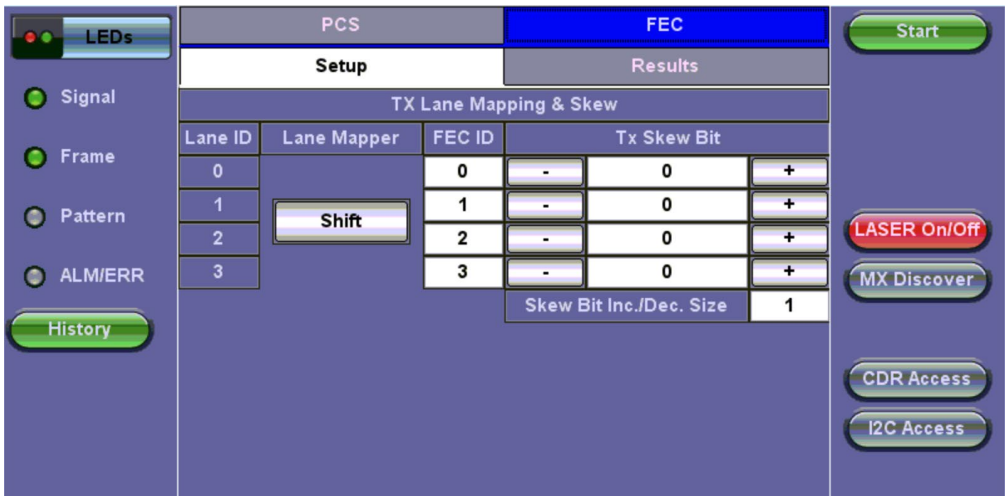


Activating 802.3ah Link OAM

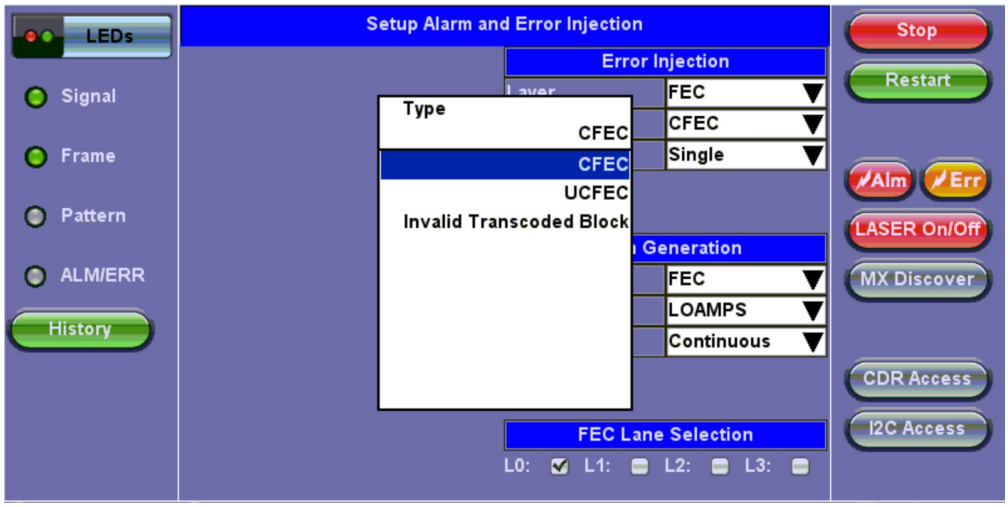
5.7.1.7 FEC



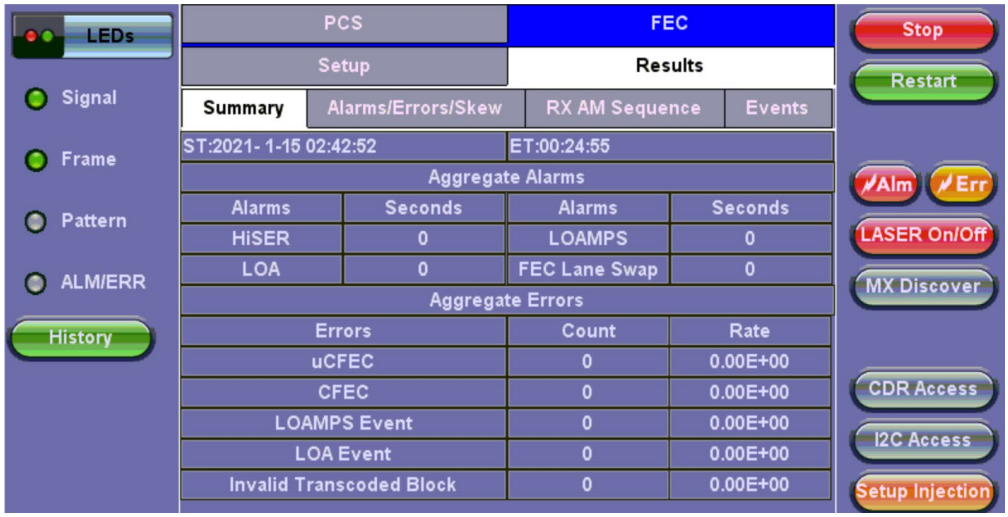
Test Mode Selection



FEC Setup

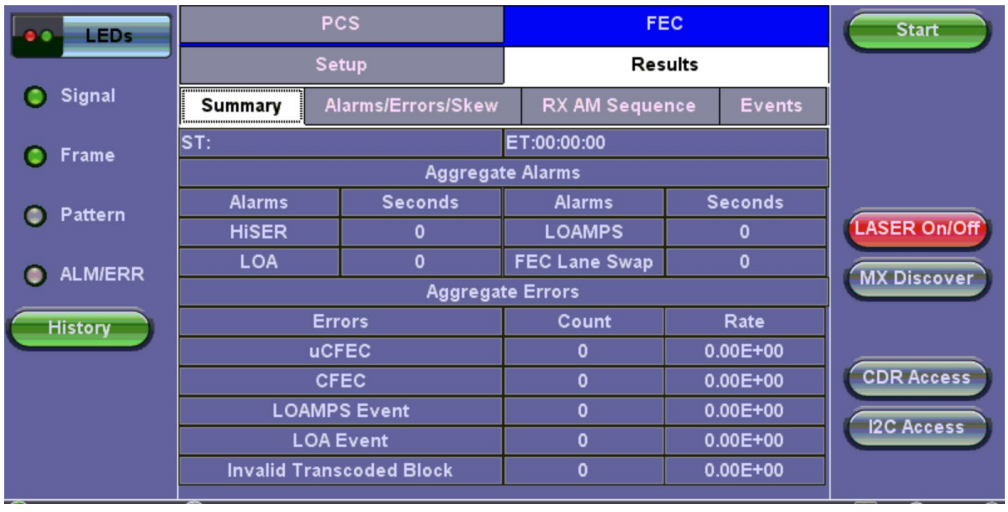


FEC test in Progress

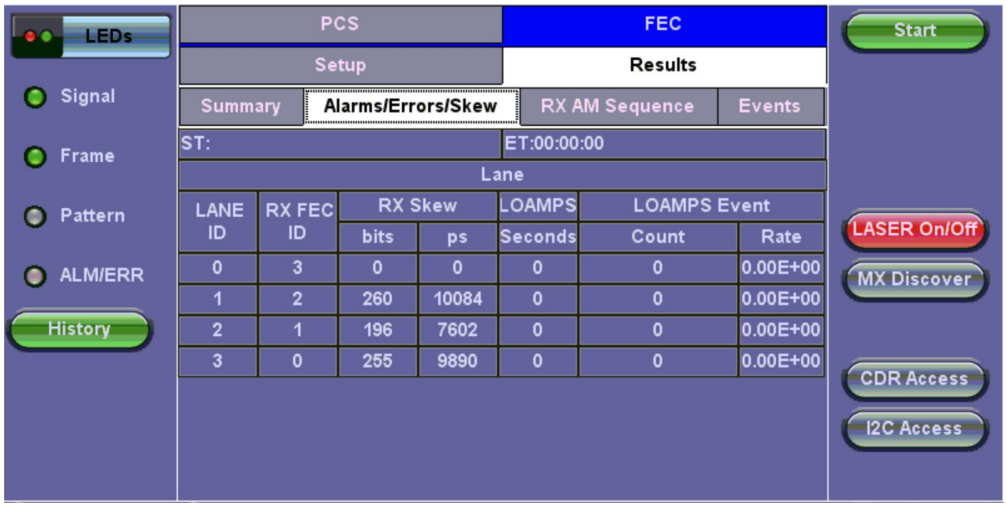


Setup Alarm and Error Injection

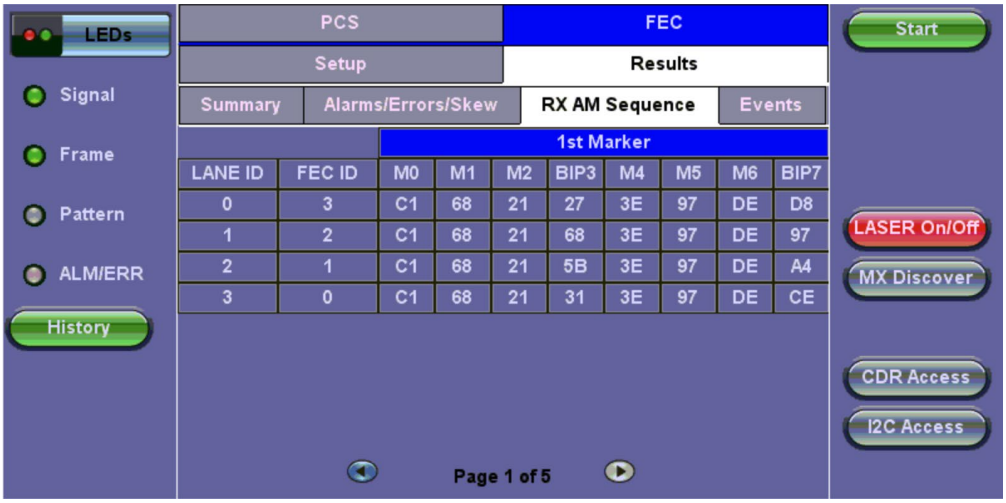
For the FEC there are 3 types of errors that can be injected:
CFEC - controlled Forward Error Correction
UCFEC - uncontrolled Forward Error Correction
Invalid Transcoded Block



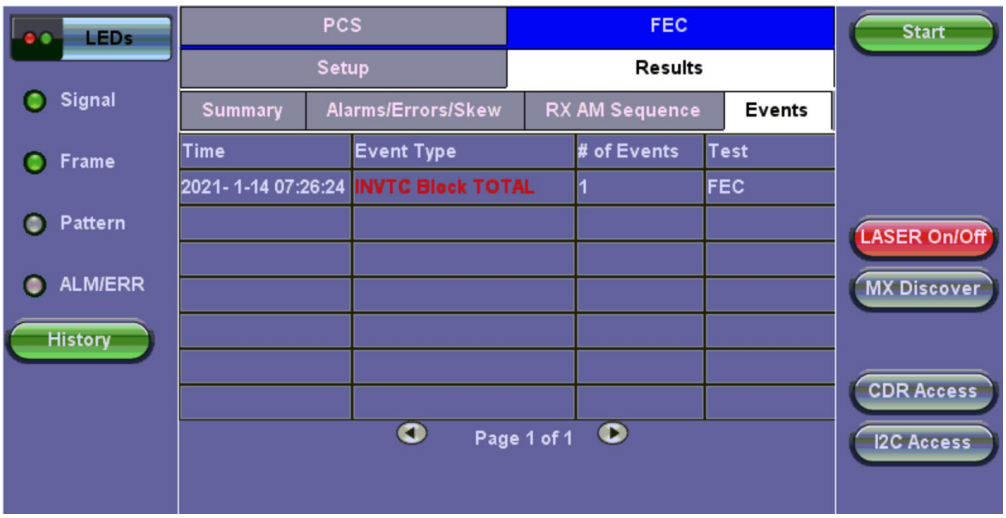
FEC Results Summary



FEC Alarms/Error/Skew



FEC - Results RX AM Sequence



FEC - Results/Events

5.7.1.8 Starting/Stopping a Throughput (Multiple Streams) Test

Once all configurations have been made, tap the **Start** button on the right section of the screen to start the measurements.

The following are three scenarios of how to prepare and start the unit for Throughput testing.

If testing on the fiber ports, make sure the LASER is turned On before starting the test.

- **End-to-End Testing**
  - Connect the test set to another unit that supports BERT testing.
  - After configuring test settings on both units, start the tests.

- **Far-End Unit in Manual Loopback Mode**
  - If the far-end unit (another MX) is already in a manual loopback mode, do not send a loop up command since it isnot necessary.
  - Once the correct control settings are configured, the user can start the test.

The selected tests will run automatically. When all the tests are complete the test will stop automatically. If the Throughput test suite needs to be stopped before they are done, then simply tap the **Stop** button. The status of each selected test can be seen in the Results tab.

- **Far-End Unit Controlled with Loop Up/Down Commands**
  - If the far-end unit is not manually looped back, then it must first receive a loop up command from the control unitbefore the Throughput test suite can be started.
  - To loop up the far-end unit with the manual mode loop up/down commands, configure the control settings mode to manual.
  - Enter the MAC and/or IP address of the far-end unit.
  - Send the loop up command by tapping on the **Loop Control** button and pressing **Loop Up**.

Once the far-end unit has been looped back, start the test by pressing the **Start** button. When the all of the selected test are completed, the Throughput test suite will stop automatically. Once all tests have been completed and there is no need to test again, go back to the Control tab, and press the **Loop Down** button. This will send a loop down command to the far-end unit to remove the loopback that is in place.

Go back to top Go back to TOC

5.7.2 Throughput Results

When the test is first started, the screen automatically changes to the Global/Aggregate results screen.

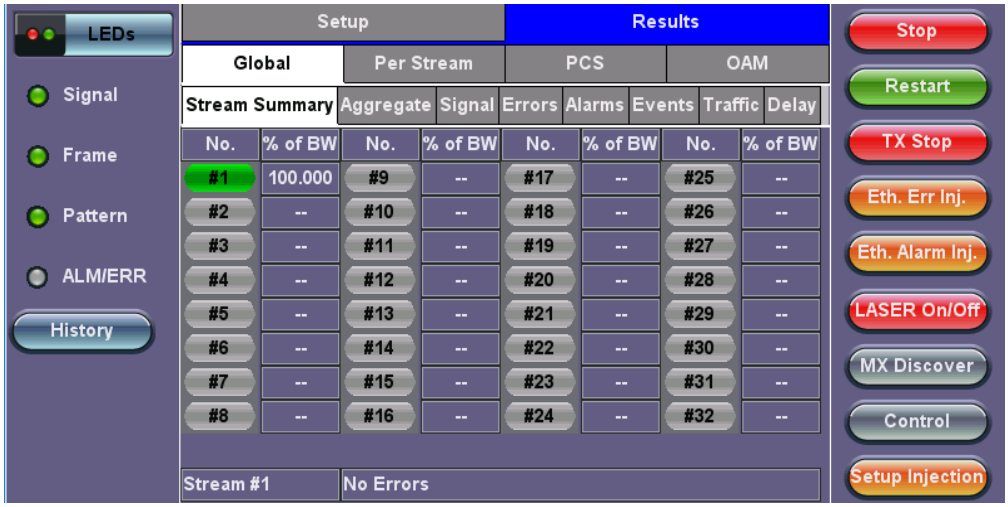
Go back to top Go back to TOC

5.7.2.1 Global/Aggregate Results

The Global results pages display measurements for all traffic streams as well as non test traffic.

The **Global Stream Summary** screen displays:

- Stream number (#)
- % of bandwidth per stream
- Errors/alarms associated with the stream
- Quality of Service (QoS) performance verification associated with each stream



Throughput Results - Global Stream Summary

QoS

QoS values are based on packet statistic thresholds for roundtrip delay, jitter, frame loss, and IP checksum from the ITU-T Y.1541 standard. Below is a list of IP network QoS class definitions and network performance objectives from Y.1541.

"U" denotes "unspecified" or "unbounded" and signifies that no objective was established for this parameter and default Y.1541 objectives do not apply. Parameters designated with "U" are occasionally inconsistent and poor.

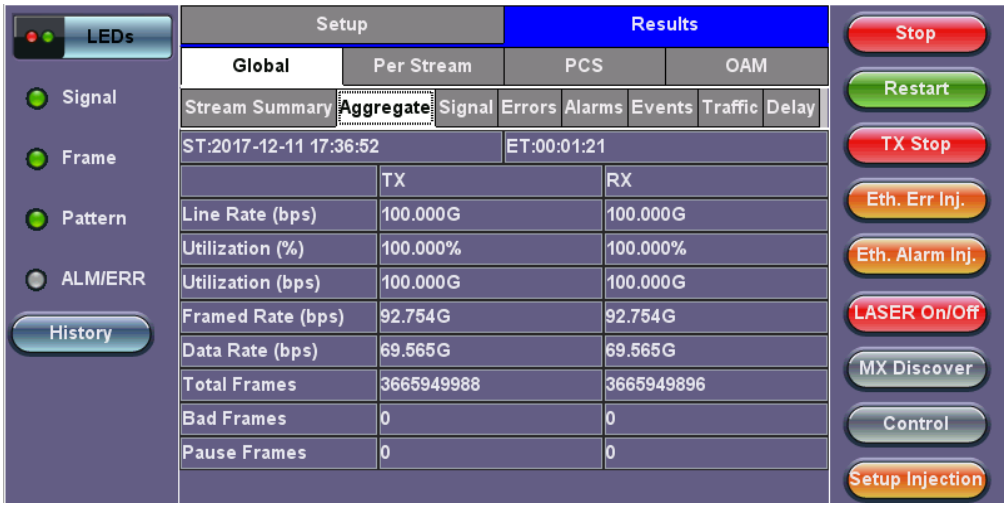
IP Network QoS Class Definitions and Network Performance Objectives (Classes 0-3)				
Network Performance Parameter	**QoS Classes**			
	Class 0	**Class 1**	**Class 2**	**Class 3**
IPTD	≤ 200 ms/2 (100 ms one-way)	≤ 800 ms/2 (400 ms one-way) AND > 200 ms/2	≤ 200 ms/2 (100 ms one-way)	≤ 800 ms/2 (400 ms one-way) AND > 200 ms/2
IPDV	≤ 50ms	≤ 50ms	U	U
IPLR	> 1/100,000 AND ≤ 1/1000	> 1/100,000 AND ≤ 1/1000	> 1/100,000 AND ≤ 1/1000	> 1/100,000 AND ≤ 1/1000
IPER	> 1/1,000,000 AND ≤ 1/10,000	> 1/1,000,000 AND ≤ 1/10,000	> 1/1,000,000 AND ≤ 1/10,000	> 1/1,000,000 AND ≤ 1/10,000

IP Network QoS Class Definitions and Network Performance Objectives (Classes 4-7)				
Network Performance Parameter	**QoS Classes**			
	Class 4	**Class 5**	**Class 6**	**Class 7**
IPTD	≤ 2 s /2 (1 s one-way) AND > 800 ms/2	U	≤ 200 ms/2 (100 ms one-way)	≤ 800 ms/2 (400 ms one-way) AND > 200 ms/2
IPDV	U	U	≤ 50ms	≤ 50ms
IPLR	> 1/100,000 AND ≤ 1/1000	U	≤ 1/100,000	≤ 1/100,000
IPER	> 1/1,000,000 AND ≤ 1/10,000	U	≤ 1/1,000,000	≤ 1/1,000,000

Go back to top Go back to TOC

The **Aggregate** screen displays these parameters:

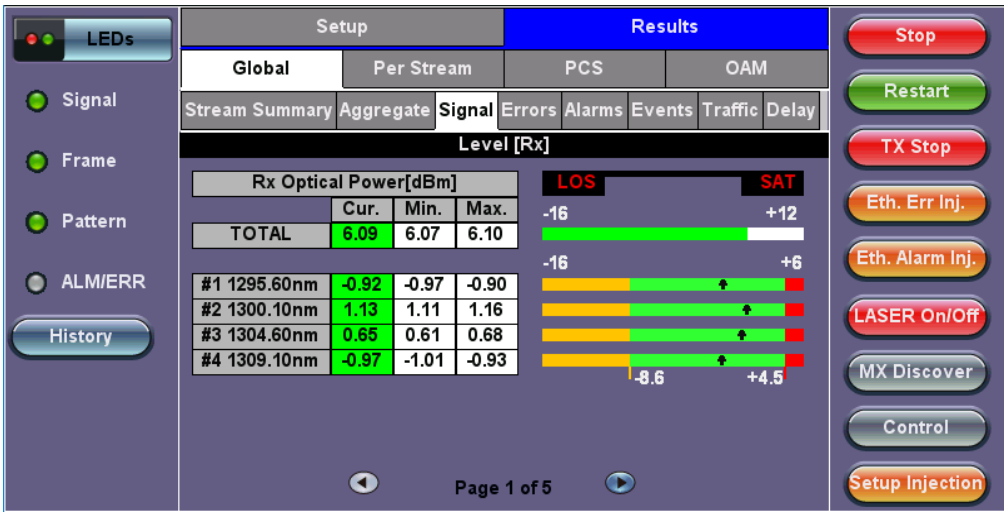
- **Line Rate** (bps)**:** Negotiated rate of the interface (10M, 100M, or 1000M). This value is always fixed since it depends on the maximum capacity of the link under test, hence the test interface that is configured.
- **Utilization:** % of Line Rate. For example, if we transmit 100Mbps on a 1Gbps interface then the utilization value is 10% (or 100Mbps) of the total link capacity (or Line Rate).
- **Utilization (bps)**
- **Framed Rate:** (Payload + MAC/IP Header + VLAN Tag + Type/Length + CRC) / (Payload + Total Overhead) * Line Rate % (in Mbps).
- **Data Rate:** Payload / (Payload + Total Overhead) * Line Rate %.
- Total # of frames, bad frames, and pause frames.



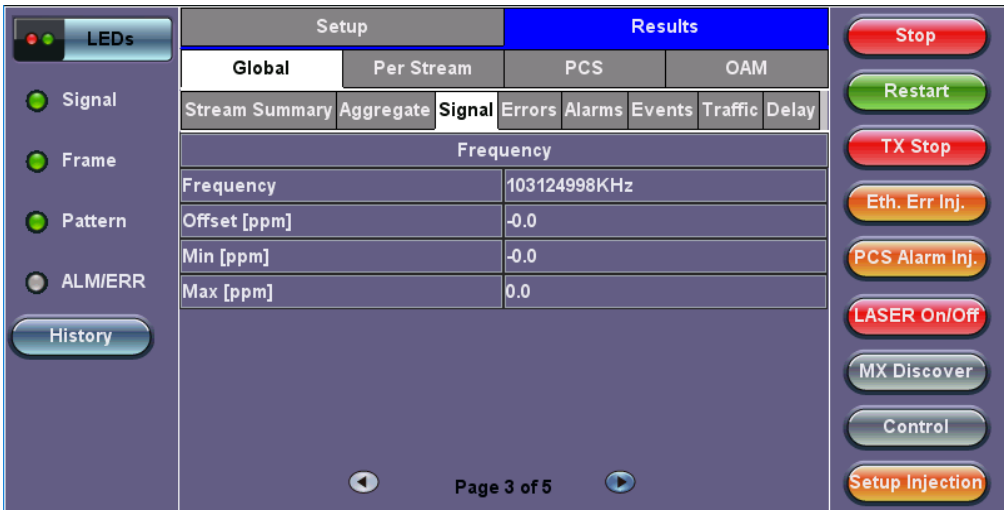
Throughput Results - Global Aggregate

Go back to top Go back to TOC

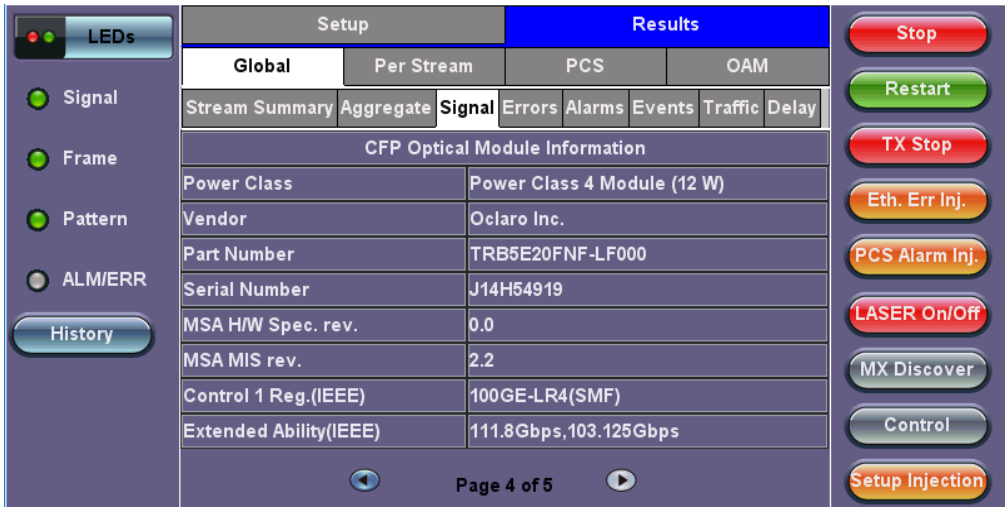
The **Global Signal** screen (fiber ports only) displays the optical level measured by the QSFP+ transceiver.



Throughput Results - Global Signal Page 1



Throughput Results - Global Signal Page 3

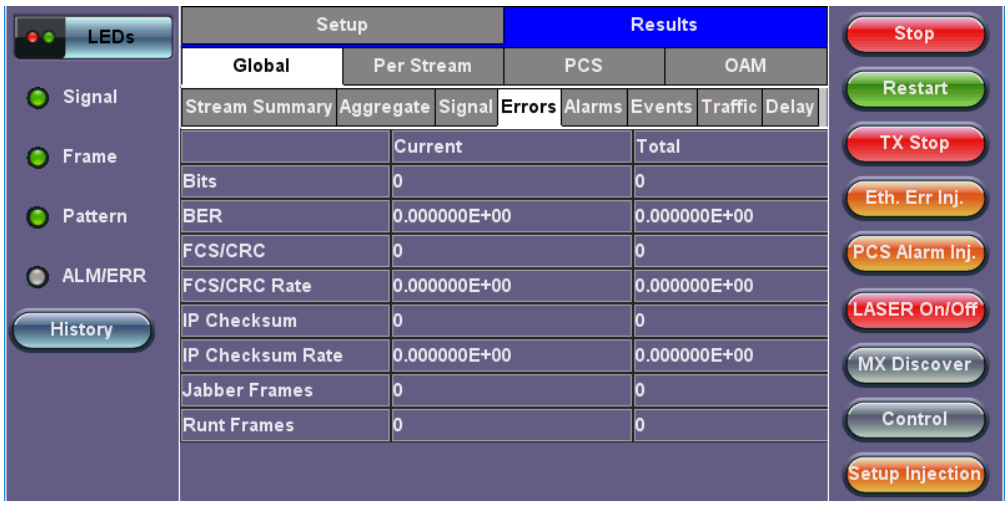


Throughput Results - Global Signal Page 4

Go back to top Go back to TOC

The **Global Errors** screen displays the Current and Total error count of all streams:

- Sync Header Error
- Block Type Error
- **FCS/CRC:** Number of received frames with an invalid Frame Check Sequence (FCS)
- **IP Checksum:** Invalid IP Frame Check sequence
- **TCP/UDP Checksum** (Layer 4 only)
- **Jabber frames:** Number of received frames larger than 1518 bytes containing an invalid FCS
- **Runt frames:** Number of received frames smaller than 64 bytes containing an invalid FCS
- **Giant frames** (Advanced Monitoring - Pass Through Results only): Number of received frames larger than 1518 bytes



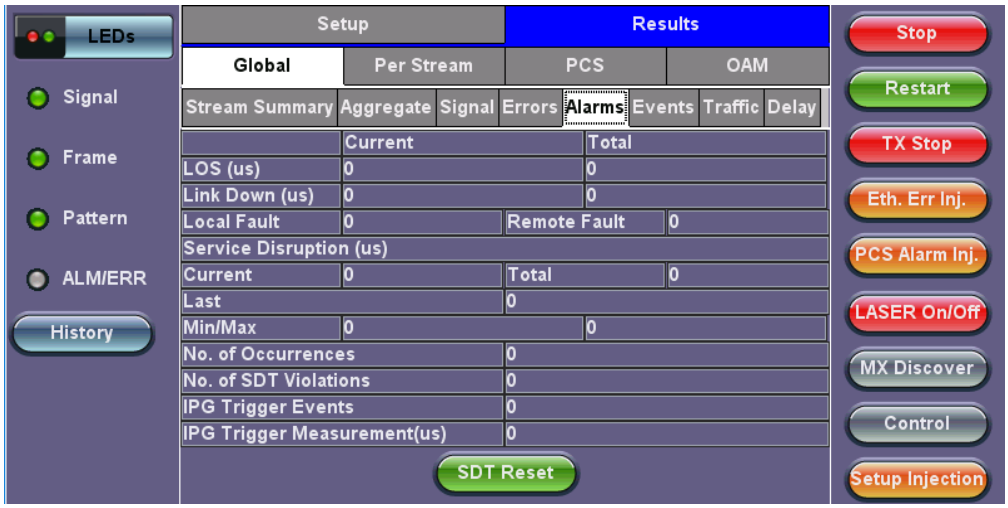
Throughtput Results - Global Errors

Go back to top Go back to TOC

The **Global Alarms** screen displays the Current and Total alarm count of all streams:

- **LOS (ms):** Loss of Signal
- **Link Down (ms)**
- **Service disruption** associated with loss of signal:
  - **Current:** Duration of the current service disruption
  - **Total:** Total accumulated duration of the service disruptions
  - **Min/Max:** Minimum and maximum duration of the service disruption events
  - **No. of Occurrences:** Counter of service disruption events

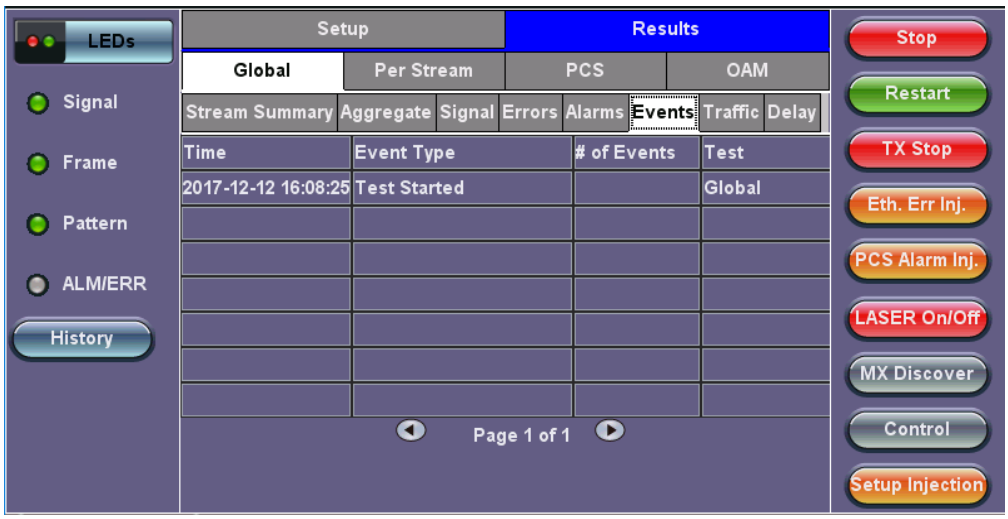
- **Local/Remote Fault**
- **SDT alarm measurements**



Throughtput Results - Global Alarms

Go back to top Go back to TOC

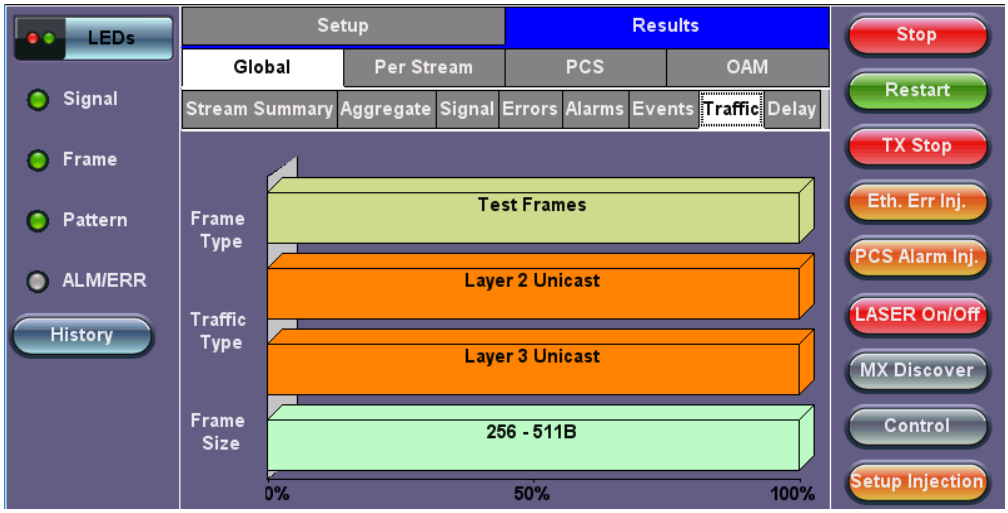
The **Global Events** screen displays the **Time**, **Event Type**, **Number of Events**, and **Test Type**.



Throughtput Results - Global Events

The **Global Traffic** screen displays:

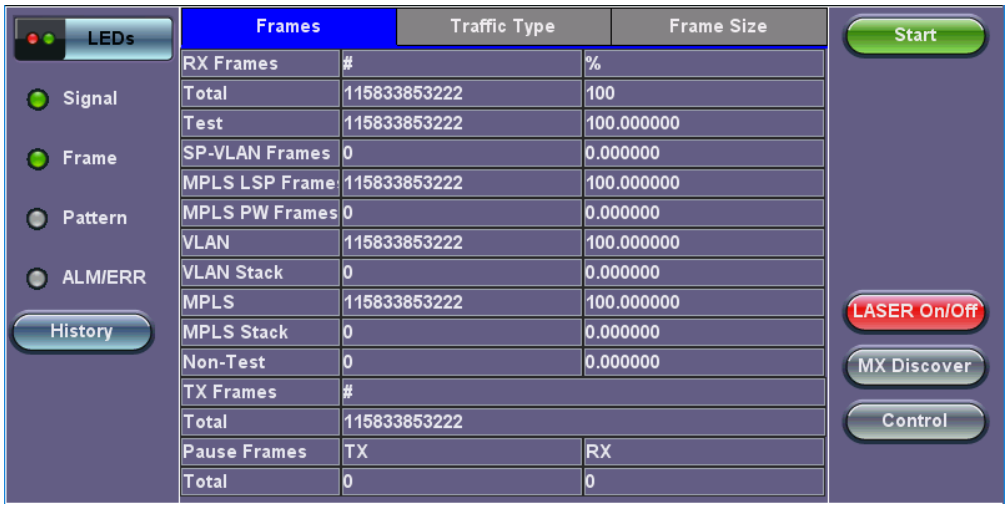
- Frame Type of all streams
- Traffic Type of all streams
- Frame size of all streams



Throughtput Results - Global Traffic

Tap on the bar graph for frame and traffic distribution statistics.
Frames tab: The following Frame distribution statistics are displayed in Count (#) and Percentage (%):

- Received (RX) frames: Total frame
- Total/Test frames
- VLAN tagged frames
- Q-in-Q VLAN stacked frames
- Non-test frames
- Transmitted (TX) frames: Total frame - Total # frames transmitted
- Pause frames: Total number of transmitted and received Ethernet pause flow-control frames



RX Frames	#	%
Total	115833853222	100
Test	115833853222	100.000000
SP-VLAN Frames	0	0.000000
MPLS LSP Frame	115833853222	100.000000
MPLS PW Frames	0	0.000000
VLAN	115833853222	100.000000
VLAN Stack	0	0.000000
MPLS	115833853222	100.000000
MPLS Stack	0	0.000000
Non-Test	0	0.000000
TX Frames	#	
Total	115833853222	
Pause Frames	TX	RX
Total	0	0

Throughtput Results - Global Traffic Details

Traffic Type tab: The following Traffic distribution statistics are displayed in Count (#) and Percentage (%):

- Layer 2/3 Unicast frames: Number of Unicast frames received without FCS errors.
- Layer 2/3 Broadcast frames: Number of Broadcast frames received without FCS errors. Broadcast frames have a MAC address equal to FF-FF-FF-FF-FF-FF.
- Layer 2/3 Multicast frames: Number of Multicast frames received without FCS errors.

Frame Size tab: The following Frame distribution statistics are displayed in Count (#) and Percentage (%):

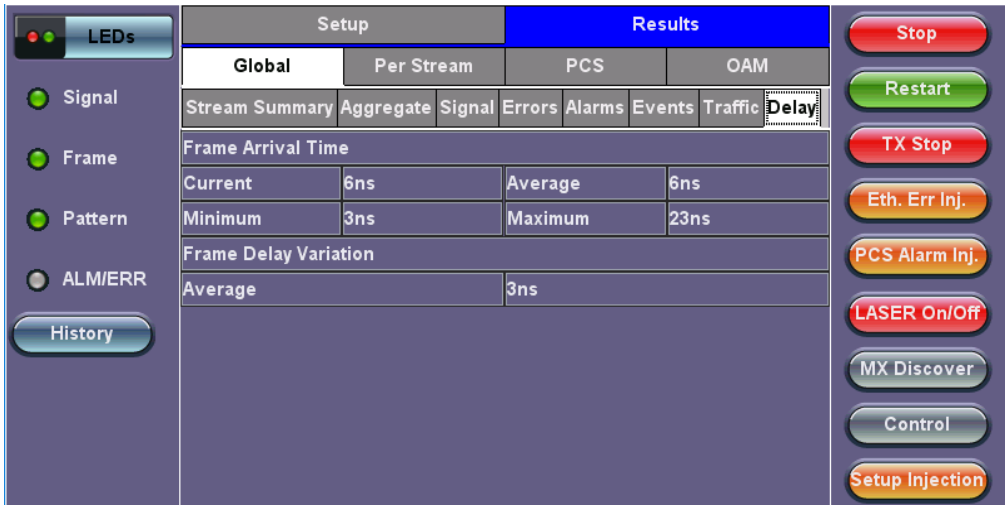
- < 64 bytes frames
- 64-127 byte frames
- 128-255 byte frames
- 256-511 byte frames
- 512-1023 byte frames
- 1024-1279 byte frames

- 1280-1518 byte frames
- > 1518 byte frames - Jumbo frames

Go back to top Go back to TOC

The **Global Delay** tab: Delay measures the interpacket gap, start of the frame, and preamble duration. Frame arrival statistics are displayed in tabular format:

- Frame Arrival Time:
  - Current, minimum, average, and maximum frame arrival time
- Frame Delay Variation:
  - Average



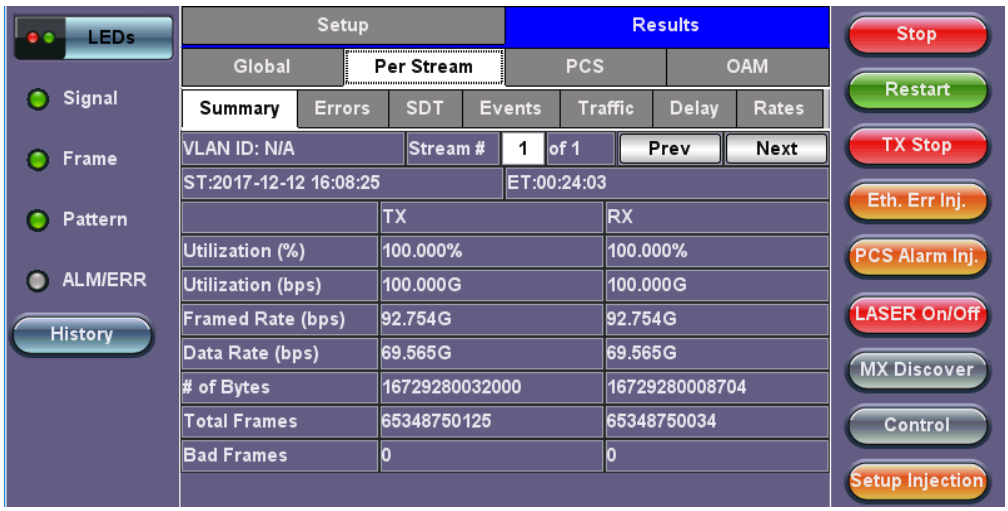
Throughput Results - Global Delay

Go back to top Go back to TOC

5.7.2.2 Per Stream Results

The **Per Stream** tab displays the same type of statistics as seen in Global Results, but for each stream. For descriptions of the parameters in each tab, with the exception of **Rates**, please refer back to the corresponding section in Global/Aggregate Results.

- **Summary:** Framed rate, data rate, # of bytes, total # of frames associated with each stream.
- **Errors:** Errors associated with each stream.
- Service Disruption Test results for each stream.
- **Events:** Events associated with each stream.
- **Traffic:** Traffic statistics associated with each stream.
- **Delay:** Delay associated with each stream. ***Note:*** *Round Trip Delay measurements are only available in the per-stream results screen. Round trip delay measurement requires a traffic loop at the far-end.*
- **Rates:** Rate information associated with each stream.

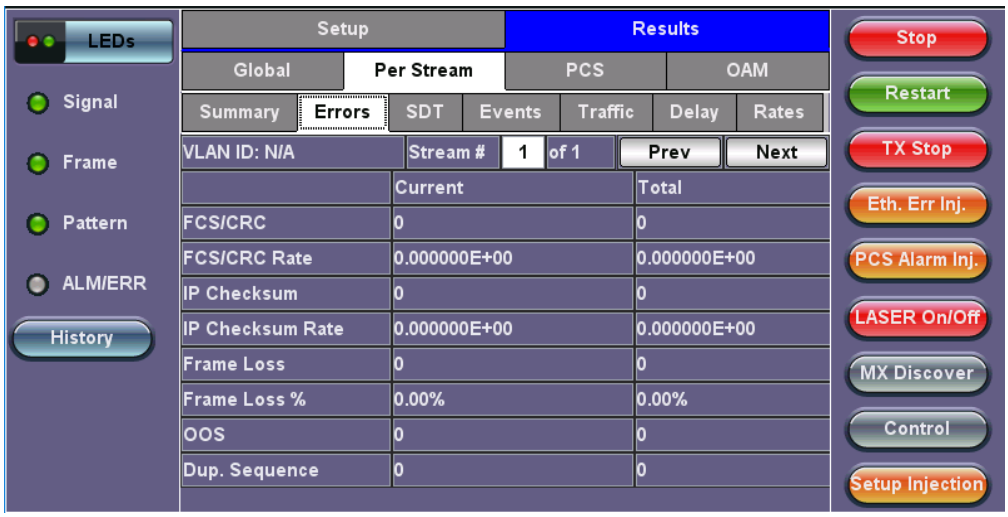


Throughtput Results - Per Stream Summary

Go back to top Go back to TOC

The **Per Stream Errors** screen displays the Current and Total error count of each stream.

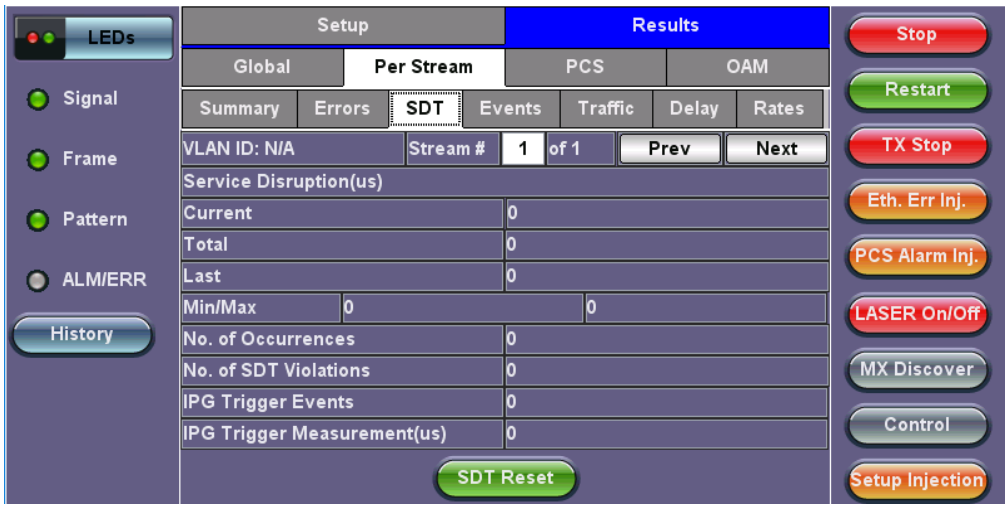
- **Bit:** Indicates errors related to test pattern (Bit Error or LSS [Pattern Loss])
- **BER:** Bit Error Ratio
- **FCS/CRC:** Number of received frames with an invalid Frame Check Sequence (FCS)
- **IP Checksum:** Invalid IP Frame Check sequence
- **TCP/UDP Checksum** (Layer 4 only)
- **Jabber frames:** Number of received frames larger than 1518 bytes containing an invalid FCS
- **Runt frames:** Number of received frames smaller than 64 bytes containing an invalid FCS
- **Frame Loss**
- **Frame Loss %**
- **OOS**
- **Duplicate Sequence**



Throughtput Results - Per Stream Errors Page 1

Service Disruption Test

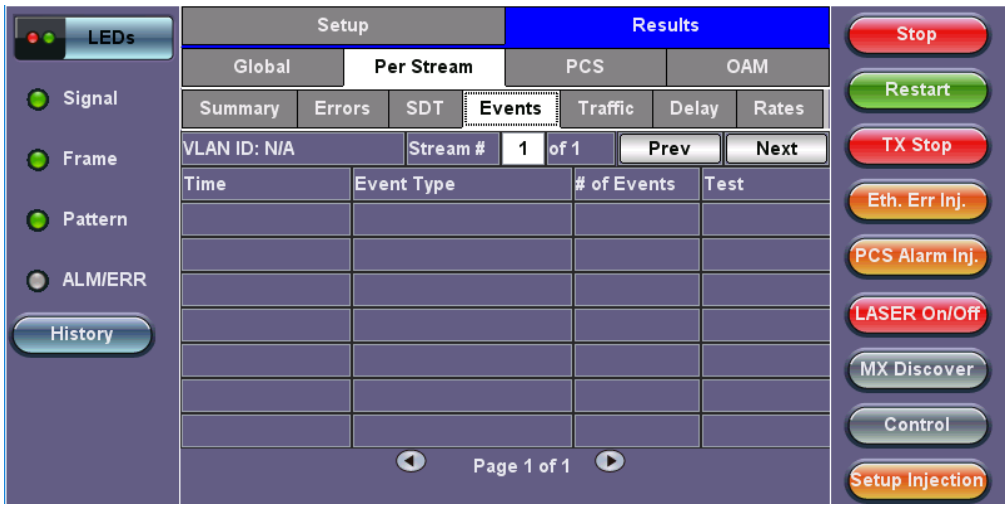
- **Total:** Total cumulative service disruption for the duration of the test.
- **Last:** Last SDT measured during the test.
- **Min/Max:** Minimum and maximum SDT measured during the test.
- **No. of Occurrences:** Number of service disruption events (SDTs).
- **No. of SDT Violations:** Number of instances the SDT threshold was met or exceeded.



Throughtput Results - Per Stream Errors Page 1

Go back to top Go back to TOC

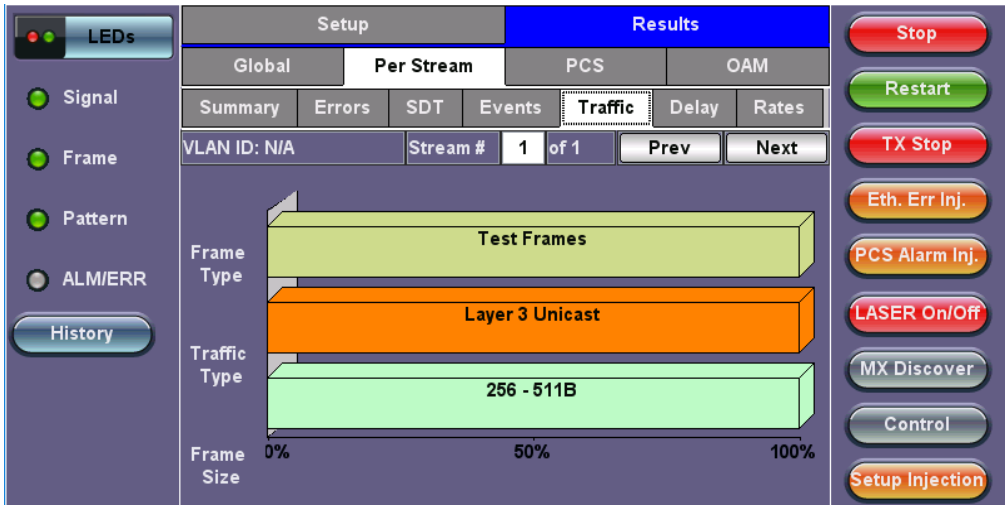
The **Per Stream Events** screen displays a Date and Time stamped record of bit errors, alarms and other anomalies pertaining to each stream.



Throughtput Results - Per Stream Events

Go back to top Go back to TOC

The **Per Stream Traffic** screen displays the frame type and frame size distribution pertaining to each stream.

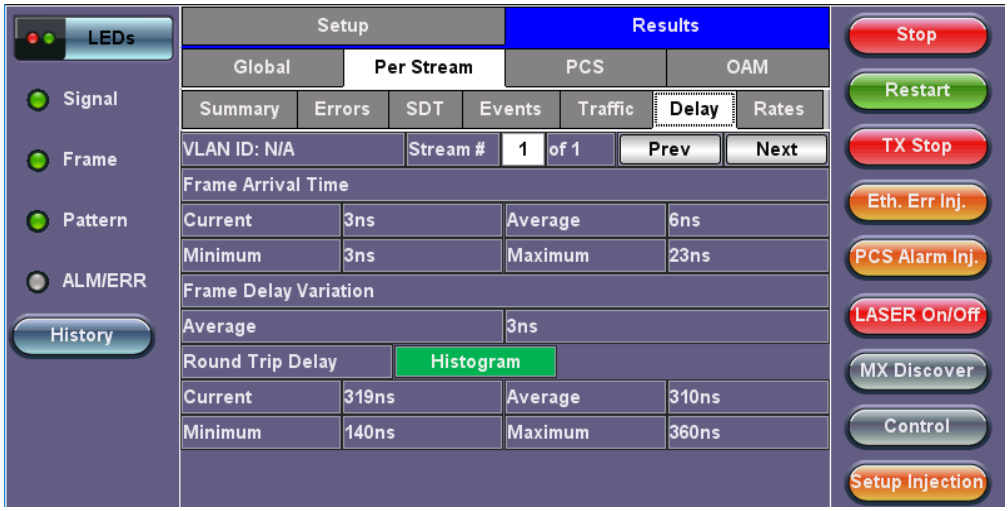


Throughtput Results - Per Stream Traffic

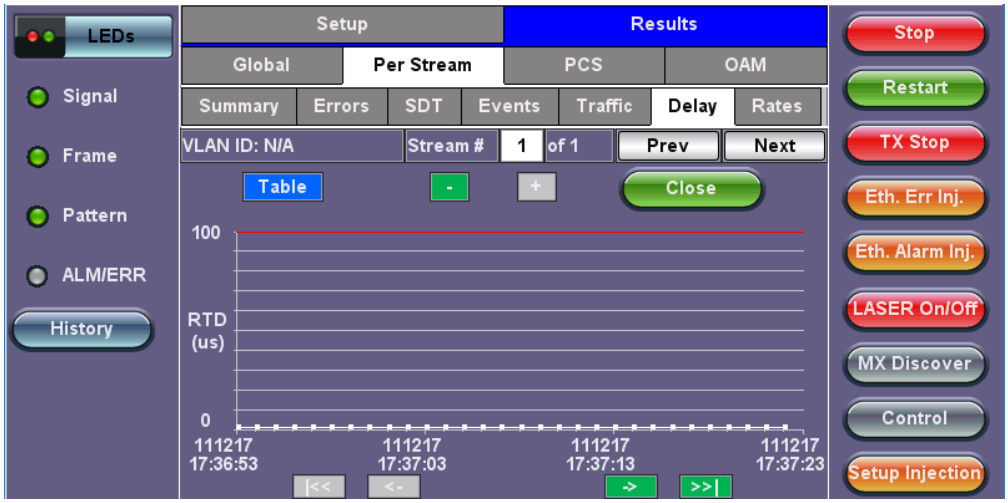
Go back to top Go back to TOC

The **Per Stream Delay** screen displays the frame delay information pertaining to each stream.

The Histogram shows the sampling points for the delay.



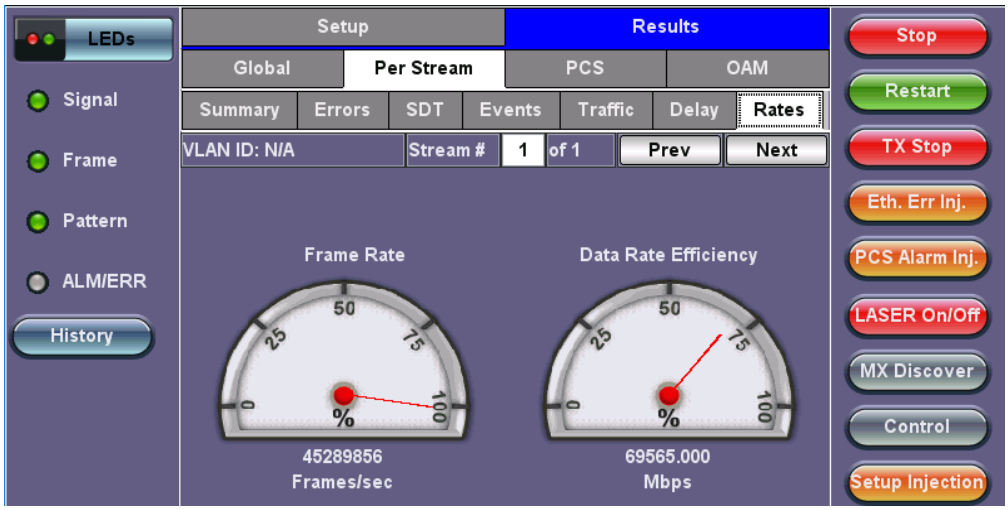
Throughtput Results - Per Stream Delay



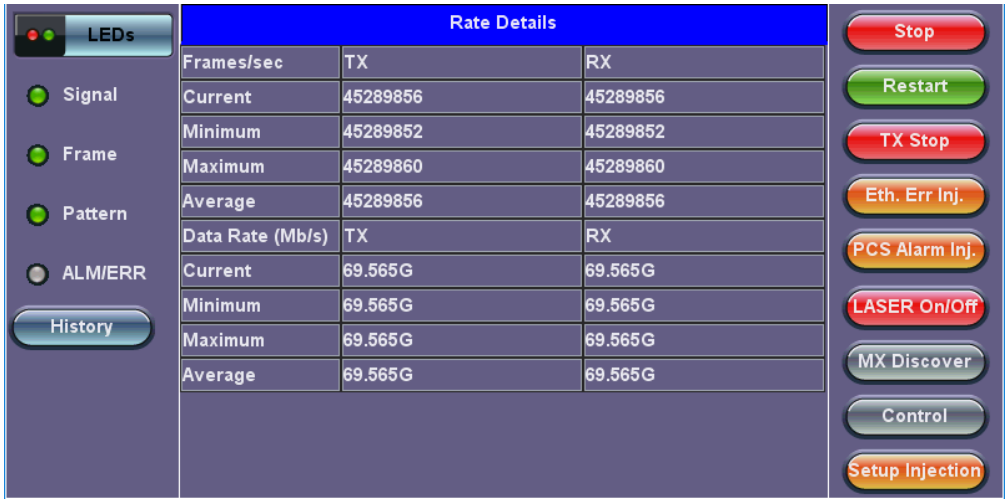
Throughtput Results - Per Stream Delay - Histogram

Go back to top Go back to TOC

The **Per Stream Rates** screen displays the frame rate and data rate pertaining to each stream. Tap on either dial to see rate details.



Throughtput Results - Per Stream Rates



Throughtput Results - Per Stream Rate Details

Go back to top Go back to TOC

5.7.3 Saving Throughput Results

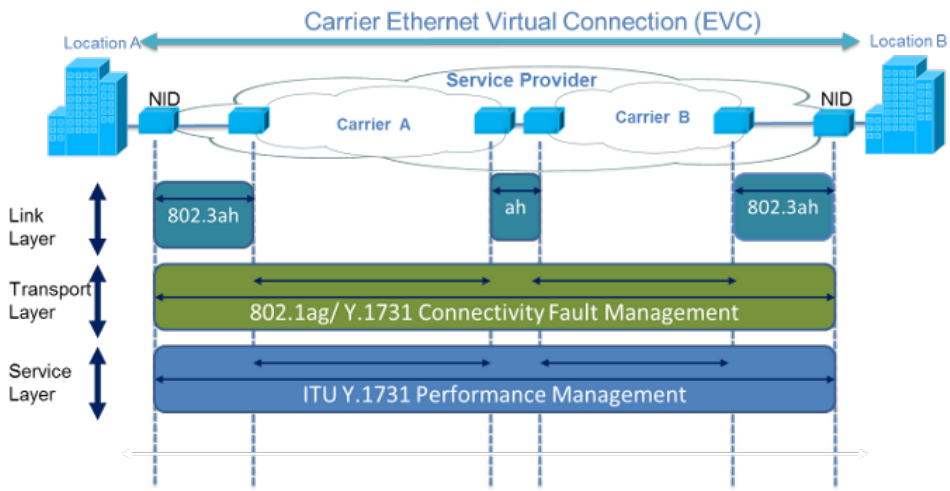
Once the test has been stopped the results can be saved by pressing the Save key on the platform's keypad.

A window will open giving the option of naming the results file. Enter the desired name for the file and tap apply. The results will be saved. For more information on retrieving saved test results, refer to **File Management** in the **TX300s**, **MTTplus**, **RXT-1200**, or **UX400** platform manuals for more information.

Throughput Results Save

Go back to top Go back to TOC

5.8 Ethernet OAM Testing



Ethernet OAM provides automatic defect detection, fault management and performance monitoring tools for network links and end-to-end Ethernet Virtual Circuits (EVC). The OAM service supports IEEE 802.3ah, IEEE 802.1ag, ITU-T Y.1731, and G.8113.1.

Go back to top Go back to TOC

5.8.1 OAM Setup

5.8.1.1 Link Level 802.3ah OAM Setup

802.3ah functions include:

- Discovery
- Link Performance Monitoring
- Remote loopback
- Fault detection

Link OAM Setup

- **802.3ah OAM**
  Tap on the check box to start 802.3ah protocol testing. Transmission of OAM PDUs starts as soon as the box is checked.

- **OAM Mode**
  Select Active or Passive mode from the drop-down menu. Active and passive mode determines the type of actions the test set will take. For more on acceptable Active/Passive mode combinations and actions, see section 802.3ah OAM Discovery.

- **Vendor OUI and SPI**
  Organization Unique identifier and Vendor specific information (similar to MAC address fields).

- **Max PDU Length**
  Advertised Max OAM PDU size (64 to 1518). After Discovery, the lowest of the local and remote will be used.

- **PDU Rate**
  100 to 10000 ms between consecutive OAM PDUs.

- **Discovery Capability**
  Enables OAM enabled devices to exchange their OAM capabilities, configuration, and identity to link partners. Check on the boxes to advertise selected capabilities during Discovery.

- **Link Events Notification Settings**
  Enable Event Notifications for Link Fault, Critical Event, and Dying Gasp.

Go back to top Go back to TOC

802.3ah OAM Discovery

Discovery is the first phase of the 802.3ah protocol. During Discovery, local and remote units exchange Information OAM PDUs indicating capabilities and configuration information (mode, PDU size, loopback support, etc.). After successful negotiation the OAM protocol is enabled on the link. If no OAM PDU is received after 5 seconds, Discovery is restarted. The device can be configured in Active or Passive mode combinations.

Action	Mode Passive	Mode Active
Initiates OAM discovery	No	Yes
Responds to OAM discovery	Yes	Yes
Peer must be in active mode	Yes	Yes
Sends Information OAM PDU	Yes	Yes
Sends Event Notification OAM PDU	Yes	Yes
Sends Variable Request OAM PDU	No	Yes
Sends Loopback Control	No	Yes
Reacts to Loopback Control	Yes	Yes

OAM Mode Active/Passive Actions

	Local Active	Local Passive
Remote Active	Yes	Yes
Remote Passive	Yes	No

OAM Mode - Acceptable Active/Passive Combinations

Notice that each device can be placed in any mode as long as the remote and local device are not both in passive mode.

Discovery Capabilities: Capabilities advertised during discovery process

- Remote Loopback
- Link Events: Supported, but no stateful
- MIB Retrieval: Can be advertised but is not supported in current release
- Unidirection

Remote Loopback: The user can transmit a loopback command to place the remote unit into loopback mode. Every frame received is transmitted back on the same port to ensure the quality of links during installation or troubleshooting and for fault isolation testing.

Link Events: Event OAMPDU is transmitted when the link error exceeds the threshold. Events may be sent once or multiple times. In the current software release, link events are only transmitted upon user request, not based on threshold crossing.

MIB Retrieval: Retrieves information on network devices and interfaces.

Unidirection: Checks for unidirectional transmission.

Go back to top Go back to TOC

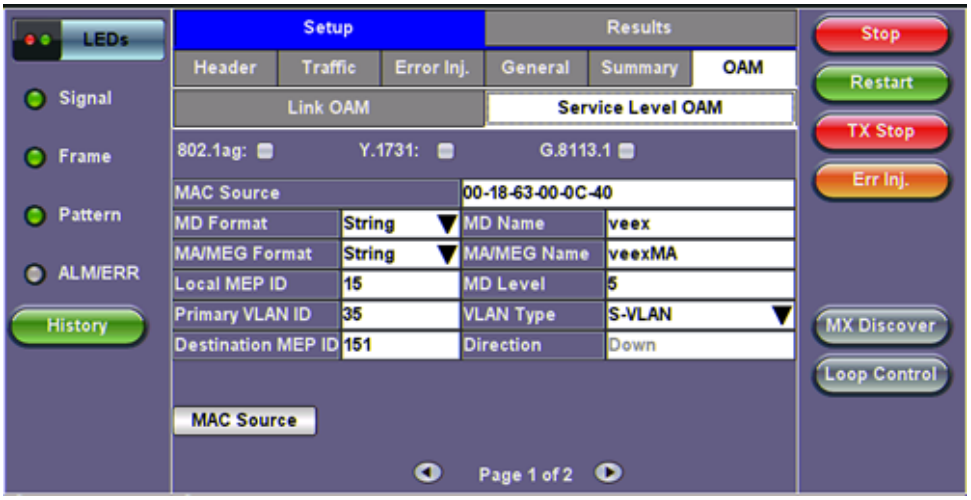
5.8.1.2 Service Level OAM: 802.1ag/Y.1731/G.8113.1 Setup

Under the **Service Level OAM** tab, the user has the option of starting the 802.1ag, Y.1731, or G.8113.1 test.

- Fill out the given parameters.

  MD Name, **MA Name**, **VLAN**, and **MD Level** input values must match for both connected OAM devices in order for the test to work. The **Destination MEPID** and **Local MEP ID** must also be inverted for the tests to work.

- Tap the box next to 802.1ag, Y.1731, or G.8113.1 to start the selected test. The transmission of OAM PDUs become active as soon as the checkmark is added to the test.



OAM - Service Level OAM (Page 1)

Service Level OAM Configuration Parameters

- **MAC Source:** Enter the source address of the test set or tap the **MAC Source** button to assign a default MAC address.
- **MD Format:** Configure the format of the Maintenance Domain Name:
  - **None**: No Maintenance Domain name
  - **MAC+2octet**: User configurable MAC address + 2 octets
  - **String**: User configurable ASCII character string
- **MD Name:** Name of the Maintenance Domain (only for 802.1ag)
- **MA/MEG Format:** Configure the format of the Maintenance Association name:
  - **VID**: User configurable ASCII character string
  - **String**: User configurable ASCII character string
  - **2 octet**: 2 octet integer
  - **ICC-Based**: User configurable ITU-T Y.1731 ITU Carrier Code (ICC) based
- **MA/MEG Name:** Enter the name of the 802.1ag MA or Y.1731 MG
- **Local MEP ID:** Local end point identifier along the path (1 to 8191)
- **MD Level:** Maintenance domain level (0 to 7)
- **MEP ID:** End point identifier (1 to 8191)
- **Primary VLAN ID:** VLAN ID associated with the MA or MEG
- **VLAN Type:** C-VLAN, S-VLAN, or None
- **Destination MEP ID:** MEP ID of the MEP end point
- **Direction**
  - **Up:** Inward facing MEP used for MA/MEG with a wider reach (i.e., end-to-end, beyond a single link)
  - **Down:** Outward facing MEP used for MA/MEG spanning a single link

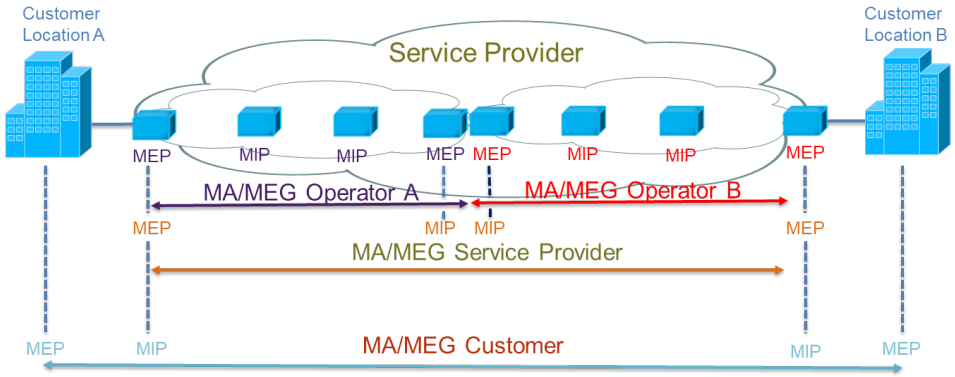
Differences between 802.1ag, Y.1731, and G.8113.1

Selecting **802.1ag** enables Continuity Check Messages (CCM), Loopback Message (LBM) and Link Trace Message (LTM). **ITU-T Y.1731** provides all of the 802.1ag functionality with additional performance monitoring capabilities including Frame Loss (LM), and Delay (DM). **ITU-T G.8113.1** provides further monitoring of MPLS-TP traffic.

IEEE 802.1ag Definitions

Maintenance Domain (MD) : Management space on a network that is owned and operated by a single network provider. There is a maintenance level (from 0 to 7) to define the hierarchical relationship between domains. Maintenance domains can be nested but never intersect. MD is defined by Operational or Contractual Boundaries (e.g., Customer/Service Provider/Operator).

- **Maintenance Association (MA):** Association of Maintenance. Elements that comprise the Maintenance domain.
- Maintenance Elements can either be MEPs (End points) or MIPs (Intermediate Points)
  - MEPs are at the edge of the network. They can generate and respond to OAM messages. A point-to-point EVC has only 2 MEPs, a multi-point EVC has multiple MEPs.
  - MIPs are located between the MEPs and can be used to isolate network problems. MIPs cannot generate OAM messages but can respond.
- **Maintenance Level:** Identifies the network hierarchy. Higher Level = Largest network. Level information present in all OAM PDU frames.
  - Level 0,1,2 = Operator domain
  - Level 3,4 = Service Provider domain
  - Level 5,6,7 = Customer domain



Some terms differ between IEEE 802.1ag and ITU Y.1731 protocols.The chart below describes the differences.

IEEE 802.1ag	ITU Y.1731 / G.8113.1
Maintenance Domain (MD)	No equivalent
Maintenance Association (MA)	Maintenance Entity Group (MEG)
Maintenance End Point (MEP)	Maintenance entity Group End Point (MEP)
Maintenance Intermediate Point (MIP)	Maintenance entity Group Intermediate Point (MIP)

Definition Equivalencies

Function	MEP	MIP
Initiates CCM messages	Yes	No
Initiates Loopback and Linktrace messages	Yes	No
Responds to Loopback and Linktrace messages	Yes	Yes
Y.1731 Performance Management messages (AIS,LCK, TST,LM, etc) initiates and responds	Yes	No
Forwards messages	Yes (upper maintenance layer) No (lower maintenance layer)	Yes (upper maintenance layer) No (lower maintenance layer)

Maintenance Point Roles

Go back to top Go back to TOC

OAM Services Setup

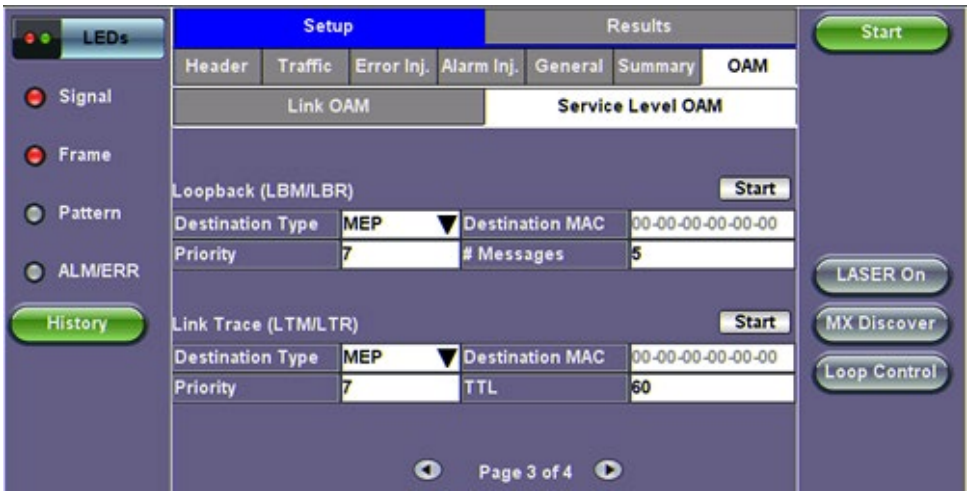
Under the same tab, OAM Services pertaining to 802.1ag, Y.1731, and/or G.8113.1 can be enabled. The tests listed include:

- Continuity Check (CCM)
- Loopback (LBM/LBR)
- Link Trace (LTM/LTR)
- Loss Measurement (LMM/LMR) (Y.1731 and G.8113.1)
- Delay Measurement (DMM/DMR) (Y.1731 and G.8113.1)
- Multi Protocol Label Switching Transport Profile (MPLS-TP) (G.8113.1 only)

General Setup

- To run any 802.1ag/Y.1731/G.8113.1 test, tap on the checkbox next to the corresponding test.
- To initiate testing for individual OAM services, press **Start** next to the desired service (NOT the green start button which initiates Throughput testing).
- **CCM** testing is initiated by selecting Enable from a drop-down menu.

Details on individual test parameters will be listed in the specified section.



Pressing Start next to Loopback (LBM/LBR) initiates testing for that OAM service

802.1ag/Y.1731/G.8113.1 Connectivity Fault Management Functions

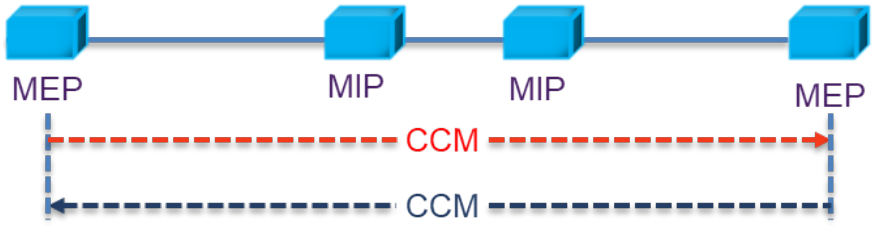
Connectivity Fault Management Functions supported by the test set are as listed:

- Fault Detection – Continuity Check:
  - CCM "heartbeat" messages are transmitted at a configurable periodic interval by MEPs.
- Network/Path Discovery – Link trace message:
  - Equivalent to a traceroute test. MIPs and MEPs along the path send a response.
- Fault verification and isolation – Loopback:
  - Verify connectivity to a specific point in the message. Equivalent to ping test.

Continuity Check Messages (CCM)

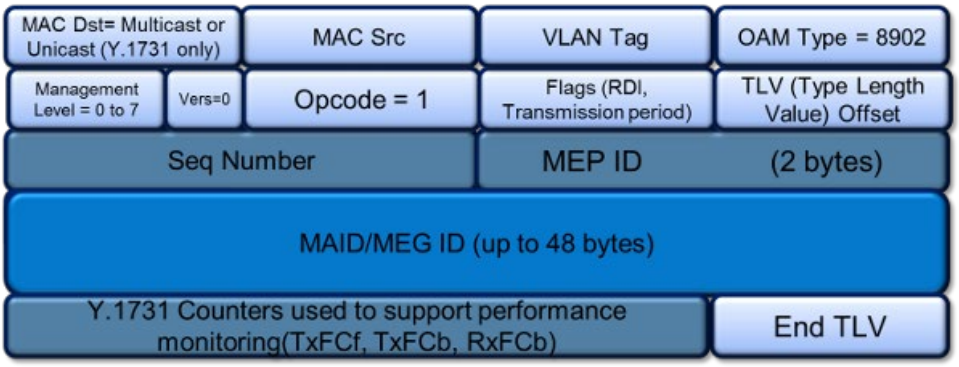
CCM Messages are multicast messages sent from MEP to MEP at configurable intervals. Loss of continuity is detected after no CCM is received for 3.5 times the CCM interval.

There can be 4,094 VLANs per port and up to eight maintenance levels. This yields a worst case CCM transmission rate of 9.8 million CCMs per second if 3.3ms interval is used.



Continuity Check Message (CCM)

RDI Flags added in CCM Messages indicates loss of continuity in the remote direction.

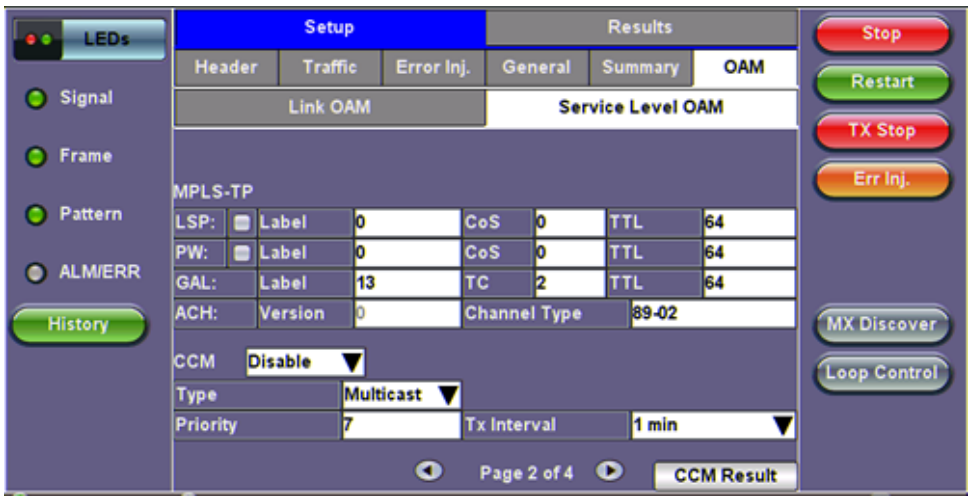


CCM Message Format

CCM Configuration Parameters

- **CCM:** Enable/Disable sending Continuity Check messages.
- **Type:** Unicast/Multicast. If CCM is set to Enable, this field is ignored. In unicast mode you must enter the MAC address of the destination unit.
- **Priority:** 802.1p priority in the CCM VLAN Tag.
- **Tx Interval:** Choose from the supported CCM intervals: 1 s, 10 s, 1 min, 10 min.

The **CCM Result** button is a shortcut that brings the user directly to the CCM Results tab.

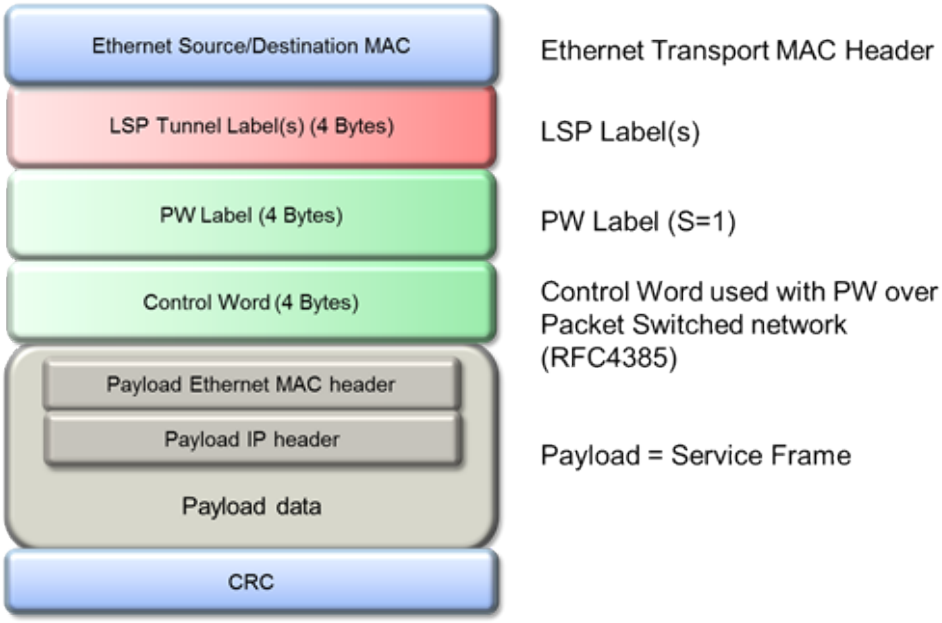


MPLS-TP, CCM Settings - Service Level OAM (Page 2)

Go back to top Go back to TOC

G.8113.1 Performance Management Functions

MPLS-TP



MPLS-TP over Ethernet with PW Label

MPLS-TP is a Layer 2 technology that combines the benefits of MPLS and removes the complexity of IP networking. It uses the MPLS Label switching mechanism, but with static route provisioning (no Label Distribution Protocol LDP or RSVP-TE). MPLS-TP supports an advanced set of OAM functions and path protection mechanisms. In-band OAM traffic is on the same path as data traffic.

Multi Protocol Label Switching Transport Profile (MPLS-TP) Configuration Parameters

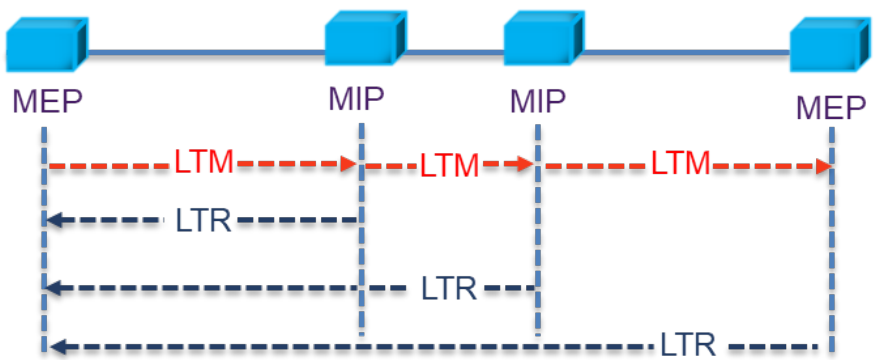
- For the path and tunnel, select **LSP** (Label Switched Path) and **PW** (Pseudowire).
  - **Label**: Configure in the range of 16-1,048,575 (labels 0-15 are reserved).
    Composed of 20 bits which allows for the creation of over one million labels.
  - **CoS**: Enter the Classes of Service.
  - **TTL**: Enter the Time to Live. It will be decremented by 1 each time it crosses a hop. Frame is not forwarded after TTL reaches 0.
- **ACH** : Enter the Generic Associate Label
  For Pseudowires, the ACH used the first four bits of the PW control word.
- **Version**: Enter the G-Ach version. The default is set to 0.
- **Channel Type**: Enter the channel type (16-bit field).

Go back to top Go back to TOC

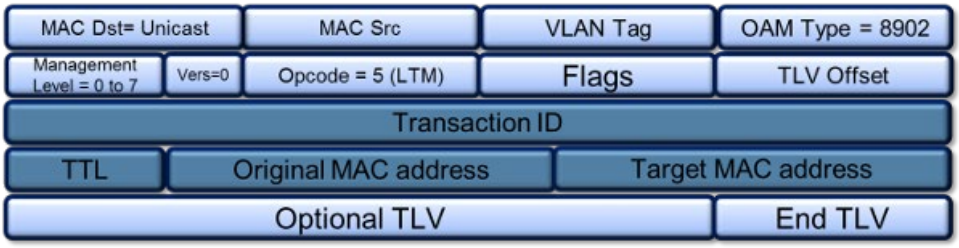
Link Trace and Loopback Messages

Link Trace Messages (LTM/LTR)

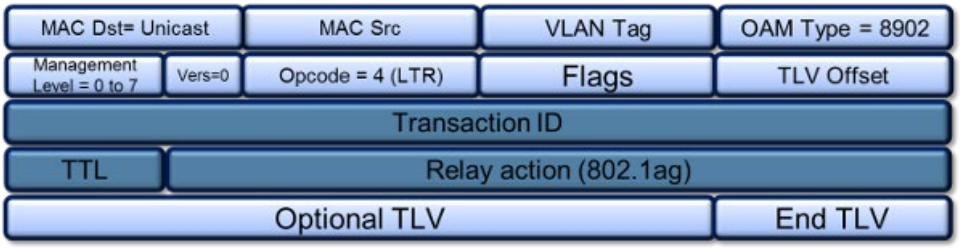
LTM (Link Trace Message) Multicast messages are transmitted on demand to a destination MAC address. All MIPs and destination MEPs respond with LTR (Link Trace Reply) and forward the LTM on to its destination.



LTM Diagram (LTM/LTR)



Link Trace Message Format

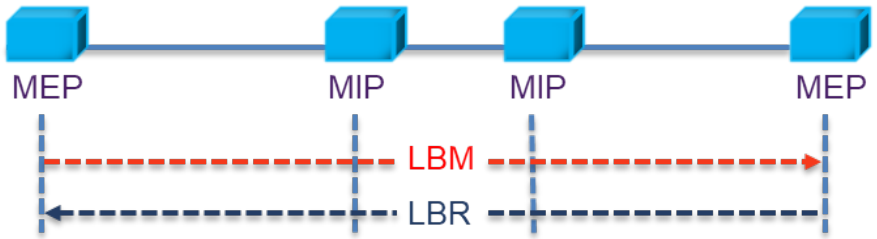


Link Trace Response Format

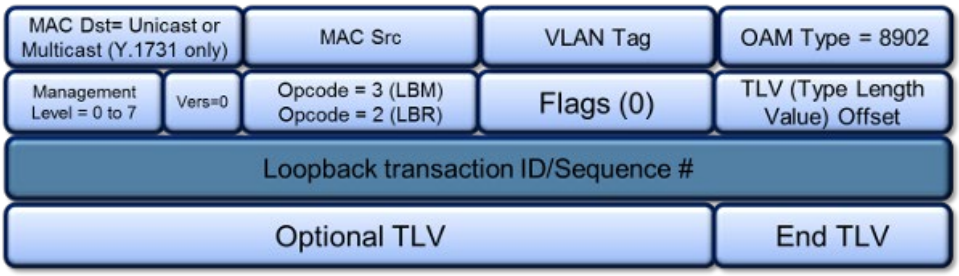
Go back to top Go back to TOC

Loopback Message (LBM/LBR)

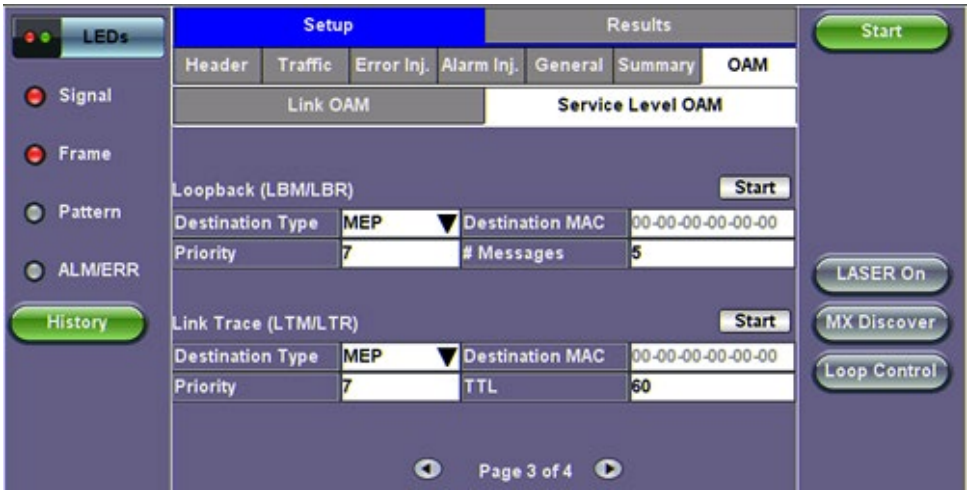
LBM (Loopback Message) are unicast messages transmitted on demand to a destination MAC address. A destination address responds with an LBR (Loopback Reply Message).



LBM Diagram (LBM/LBR)



Loopback Message Format



LBM/LBR, LTM/LTR Settings - Service Level OAM (Page 3)

Go back to top Go back to TOC

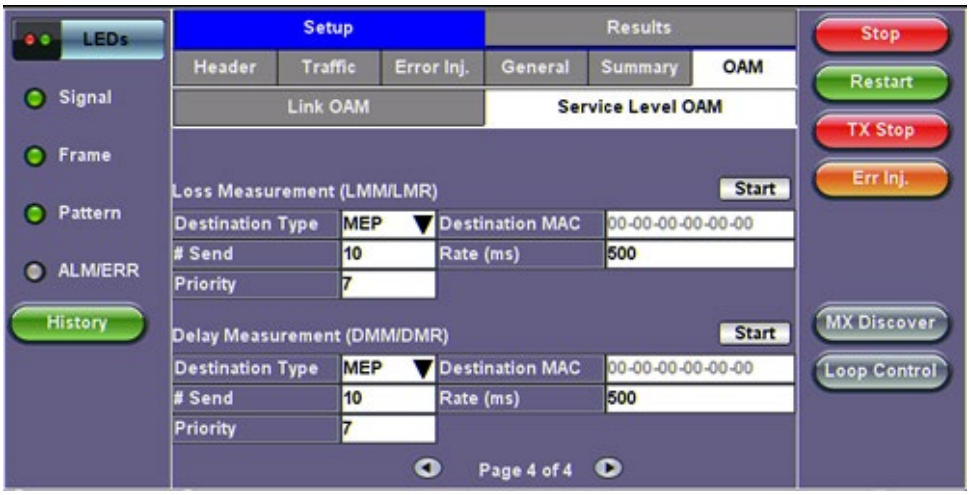
Link Trace (LTM/LTR) and Loopback Message (LBM/LBR) Config. Parameters

- **Destination**
  - **MEP**: Sends LTM/LBM to the destination MEP as configured on Page 1.
  - **MAC**: Sends LTM/LBM to a destination MAC address.
- **Priority:** 802.1p priority in the LTM/LBM VLAN Tag.
- **Destination MAC:** Configure the destination MAC address used for the LTM/LBM. This field is only used if Destination is set to MAC. If destination is set to MEP, this field is ignored.
- **# Messages:** Enter the number of Loopback messages to be sent (LBM test only).
- **TTL:** Enter the Time to Live field in the LTM message. TTL will be decremented each time it crosses a hop (MIP) (LTM test only).

Press **Start** to initiate testing.

Go back to top Go back to TOC

Y.1731/G.8113.1 Performance Management Functions



OAM - Service Level OAM (Page 4)

Loss (LMM/LMR) and Delay Measurement (DMM/DMR) Configuration Parameters

- **Destination**
  - **MEP**: Sends LMM/DMM to the destination MEP as configured on Page 1
  - **MAC**: Sends LMM/DMM to a destination MAC address
- **Priority**: 802.1p priority in the LMM/DMM VLAN Tag
- **Destination MAC:** Configure the destination MAC address used for the LMM/DMM. This field is only used if Destination is set to MAC. If destination is set to MEP, this field is ignored.
- **# Send** - Configure the number of LMM/DMM frames to send up to 50

- **Rate:** Configure the LMM/DMM frame interface rate (min: 100 ms; max: 10 seconds)

Press **Start** to initiate testing.

Frame Loss Measurement

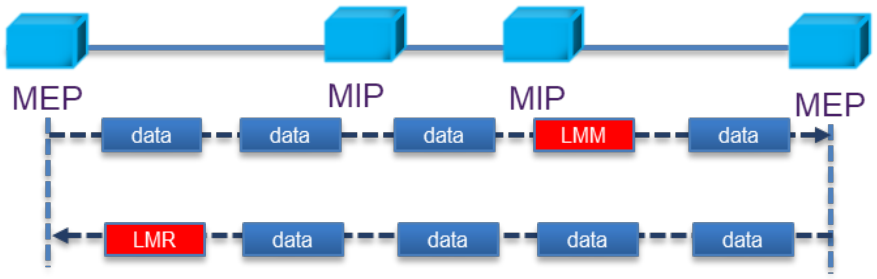
Two local counters for each peer MEP:

- TxFCf: Counter for in-profile data frames transmitted towards peer MEP
- RxFCf: Counter for in-profile data frames received from peer MEP

Single-ended ETH-LM:

- On demand OAM
- MEP sends LMM frame (Unicast DA or Multicast Class 1 DA) and receives LMR frame (Unicast DA) with counters

CCM frames contain frame counters.



Single Ended Frame Delay Measurement

LMM frames contain frame counters.

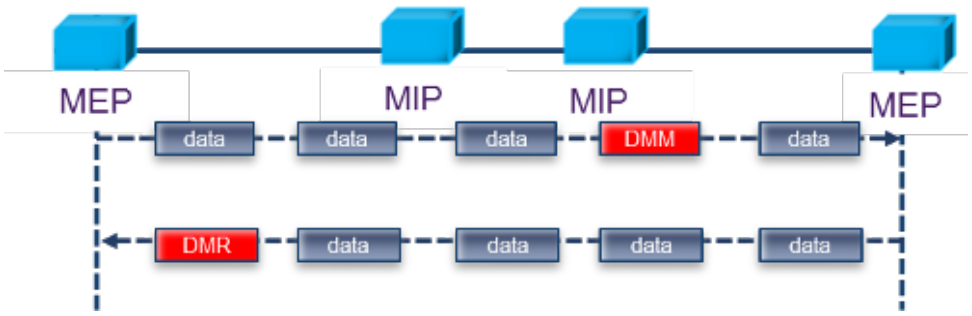
Delay Measurement

On demand OAM for measuring Frame Delay (FD) and Frame Delay Variation (FDV):

- TxTimeStampf = Timestamp transmission of DMM frame
- RxTimef = Reception time of the DMM frame
- RxTimeb = Reception of DMR frame

Two-way ETH-DM:

- DMM frame (Unicast DA or Multicast Class 1 DA for multipoint measurement) & DMR frame (Unicast DA)
- FD = RxTimeb – TxTimeStampf



Dual Ended Frame Delay Measurement

DMM and DMR frames contain timestamp info.

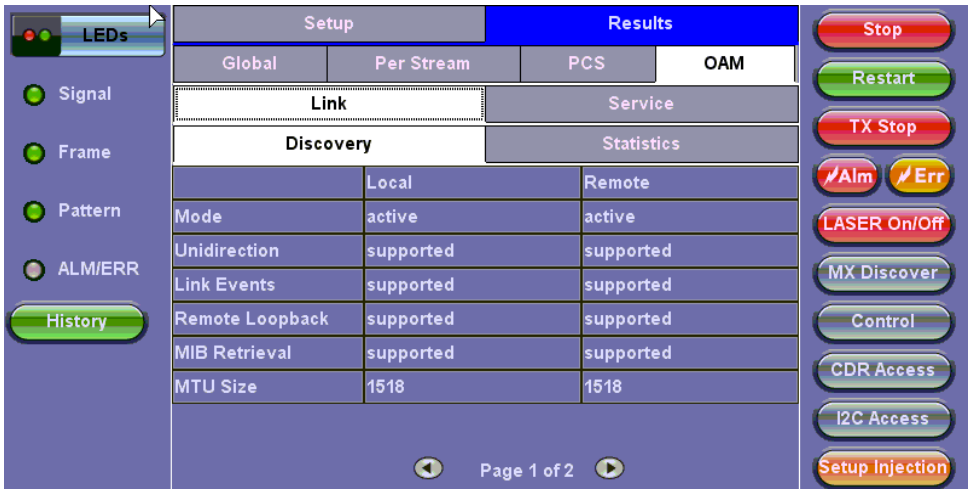
Go back to top Go back to TOC

5.8.2 OAM Results

5.8.2.1 Link OAM Results

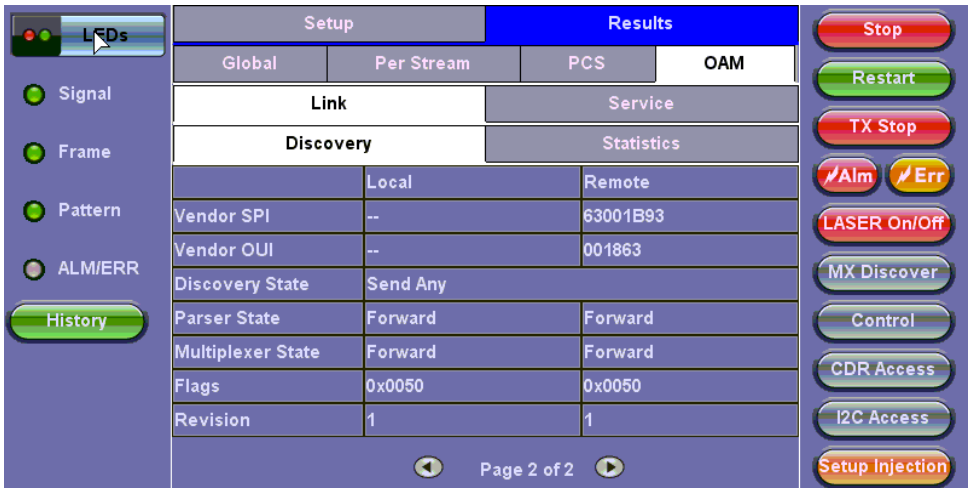
Link OAM Discovery

The discovery page lists **Local** (the current test unit) and **Remote** (far-end device) parameters.



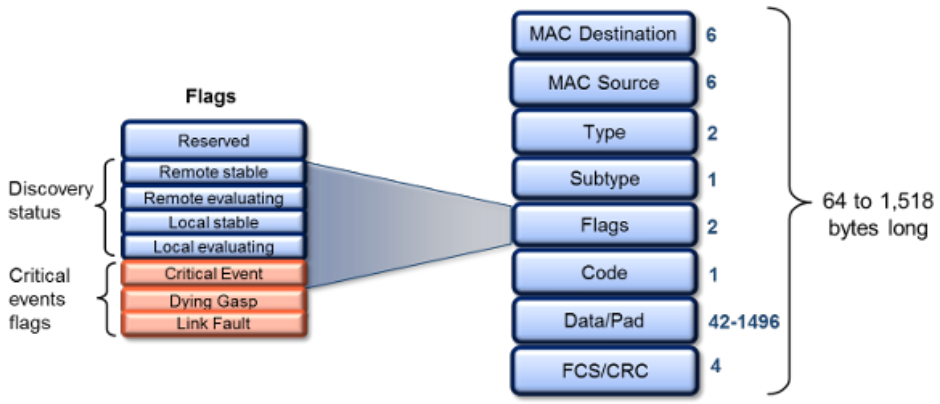
OAM - Link - Discovery (Page 1)

- **Mode:** Lists Active or Passive mode configuration.
- Supported and unsupported capabilities advertised during Discovery are listed, including: Unidirection, Link Events, Remote Loopback, MIB Retrieval, and MTU Size.

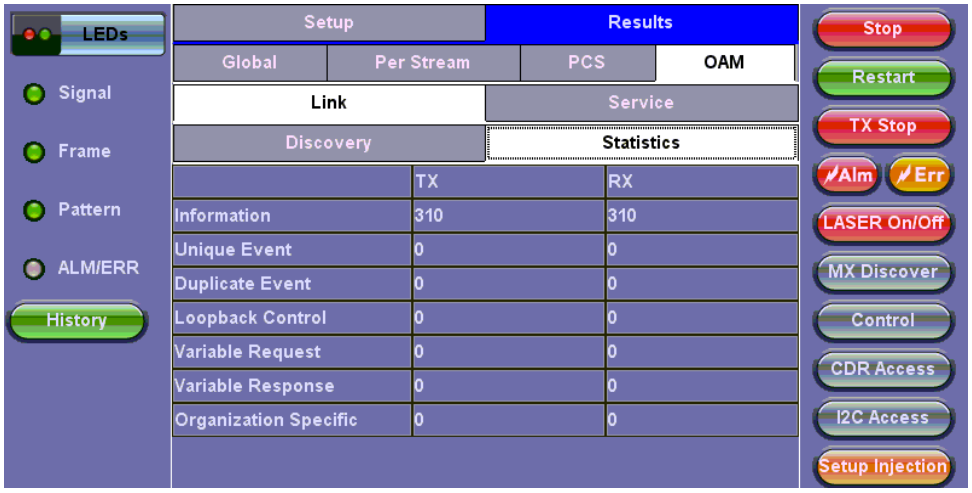


OAM - Link - Discovery (Page 2)

- **Vendor SPI and OUI:** Organization Unique identifier and Vendor specific information (similar to MAC address fields).
- **Discovery State:** Send Any indicates the device was successfully discovered.
- **Parser/Multiplexer state:** Forward indicates the device is forwarding regular traffic transmission. **Loopback/drop** indicates loopback is enabled.
- **Flags:** Flag decode is listed in the graphic below.
- **Revision:** Number of times the configuration has been modified since discovery.



Flag Decode



OAM PDU

Go back to top Go back to TOC

OAM PDU

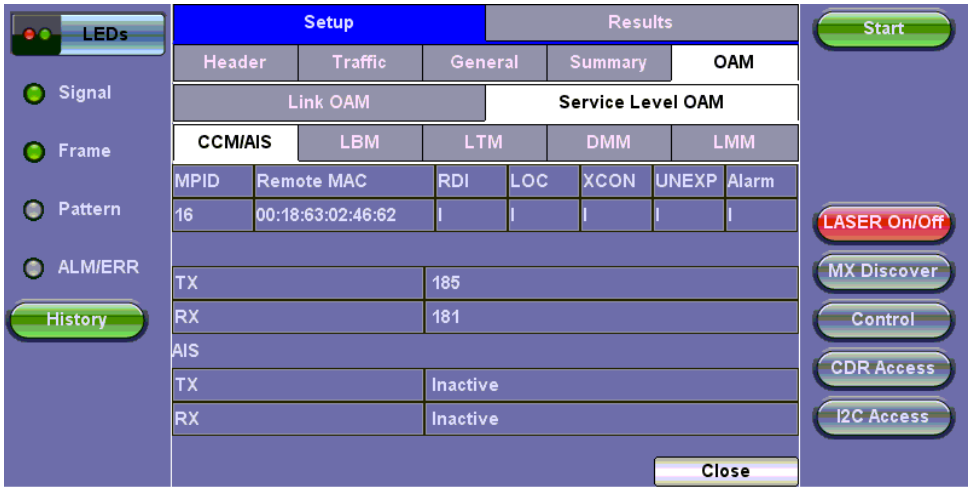
Transmitted and received 802.3ah OAM PDU are displayed with other Link OAM statistics:

- **Information:** Information OAM PDU acts as a "heartbeat" message. Discovery must be restarted if no OAM PDU is received after 5 seconds.
- **Unique** and **Duplicate** Events are Threshold crossing events not supported in the current test set release.
- Number of **Loopback Control** frames.
- **Variable Request** and **Response** are MIB query messages not supported in the current test set release.

Go back to top Go back to TOC

5.8.2.2 OAM Service Results

802.1ag/Y.1731/G.8113.1 Connectivity Fault Management Functions Results



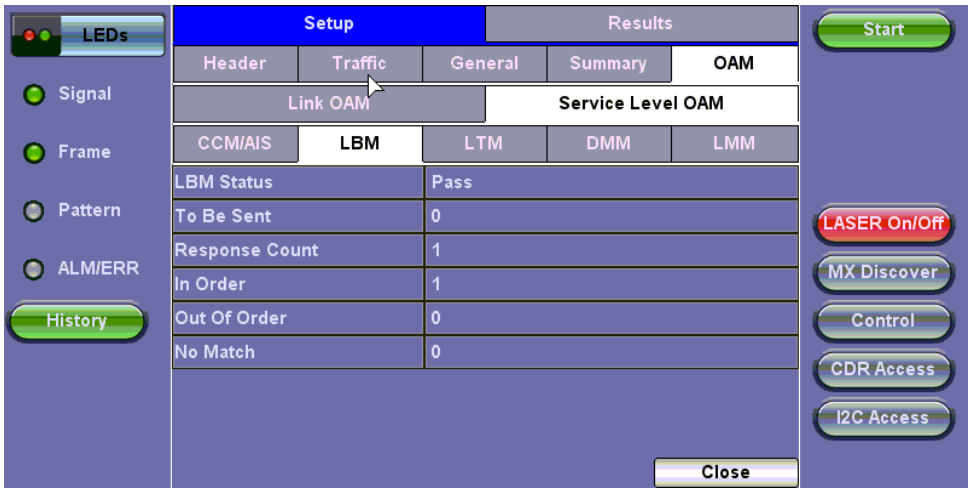
OAM - Service - CCM

OAM CCM Results

RDI, **LOC**, **XCON**, **UNEXP**, and **Alarm** will display an I or A status with **I = Inactive**, **A = Active**.

- **MPID:** MEP ID of the remote MEP.
- **Remote MAC:** MAC address of the remote MEP.
- **RDI:** The CCM received contains the RDI flag set.
- **LOC:** The MEP detects loss of connectivity.
- **XCON:** Possible cross-connect, the CCM received could be from another MA.
- **UNEXP:** Unexpected MEP ID or non-matching CCM interval.
- **Alarm:** A fault alarm is triggered if a defect is present for a time period of 10s. The fault alarm is cleared if a defect condition is not present for a time period of 10s.

Go back to top Go back to TOC

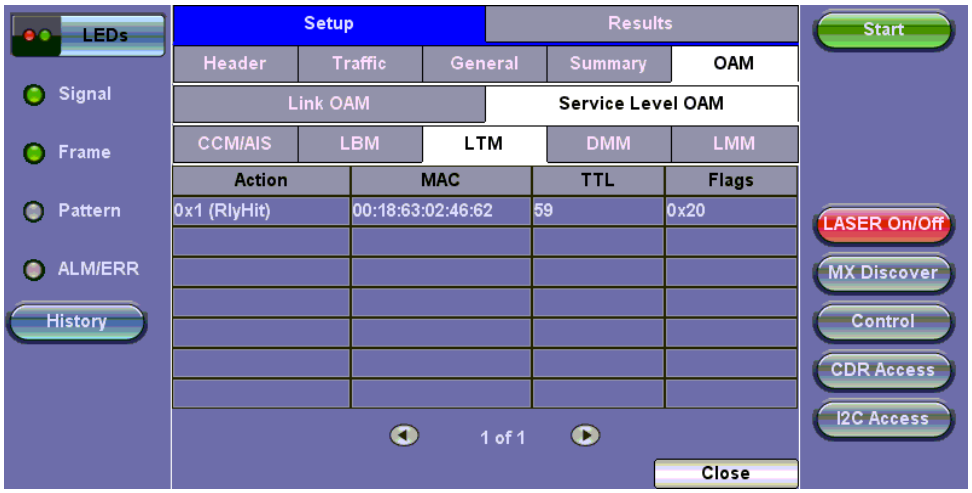


OAM - Service - LBM

OAM LBM Results

- **LBM Status**
  - **Pass**: At least 1 Loopback response received
  - **Fail**: No Loopback responses received
- **To be sent:** Outstanding number of LBM to be sent
- **Response Count**
- **In Order:** Number of LBR received in order
- **Out of Order:** Number of LBR received out of order
- **No Match:** The loopback transaction ID between the LBM and LBR do not match

Go back to top Go back to TOC



OAM - Service - LTM

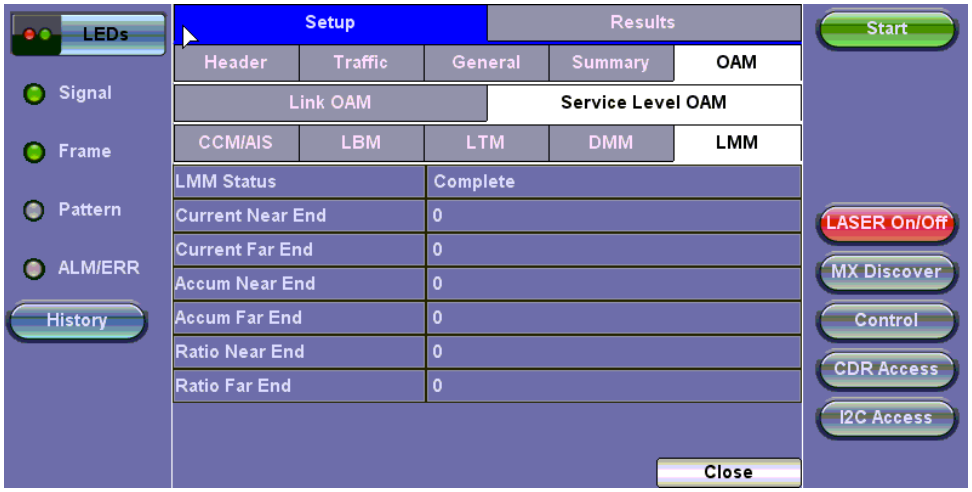
OAM LTM Results

- **Action:** RlyHit indicates that the LTM has reached the destination MAC/MEP (i.e., final point)
- **MAC:** MAC address of the responder
- **TTL:** TTL field on the response, indicated how many hops have been traversed
- **Flags:** If set, indicates that only MAC addresses learned in a Bridge's Filtering Database, and not information saved in the MIP CCM Database, is to be used to determine the Egress Port

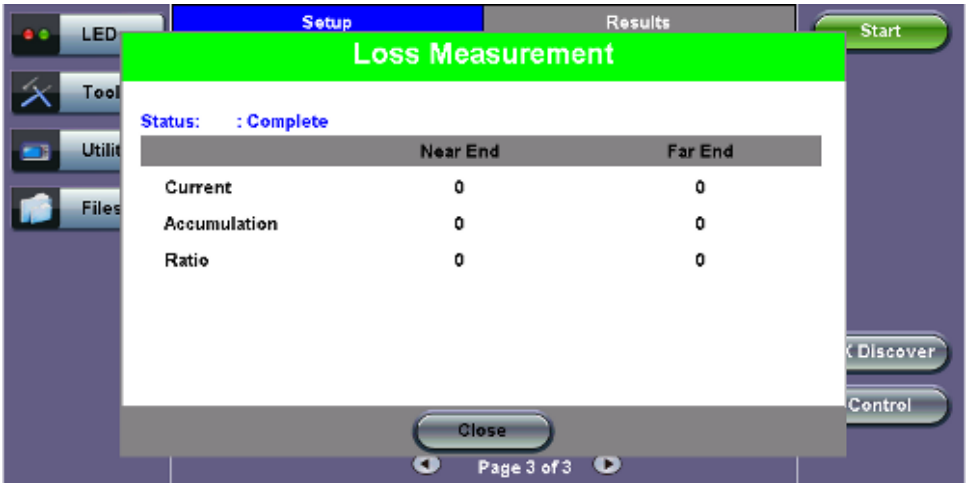
Go back to top Go back to TOC

Y.1731 and G.8113.1 Performance Management Functions Results

OAM LMM



OAM - Service - LMM

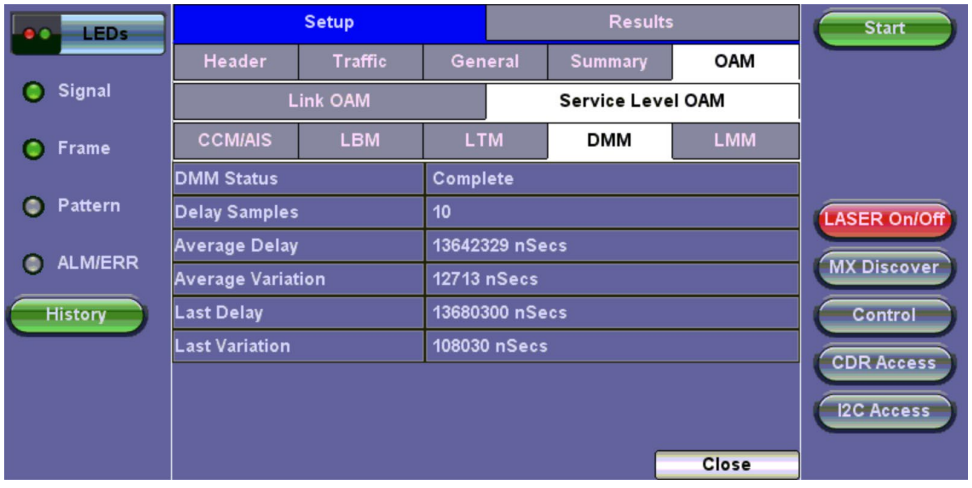


OAM - LMM Message

Parameter	Near End	Far End
Current	Value of the current number frames lost in the receive direction	Value of the current number of frames lost in the transmit direction
Accumulation	Total number of frames lost in the receive direction	Total number of transmitted frames lost in the transmit direction
Ratio	Percentage of frames lost in the receive direction	Percentage of frames lost in the transmit direction

OAM LMM Parameters

Go back to top Go back to TOC



OAM - Service - DMM

OAM DMM Parameters

- **DMM Status:** Lists status (In progress, Fail, or Complete)
- **Delay Samples:** Number of frames transmitted
- **Average Delay:** Average round trip delay over the number of delay samples
- **Average Variation:** Average round trip delay variation over the number of delay samples
- **Last Delay:** Last round trip delay value measured
- **Last Variation:** Last round trip delay variation value measured

Go back to top Go back to TOC

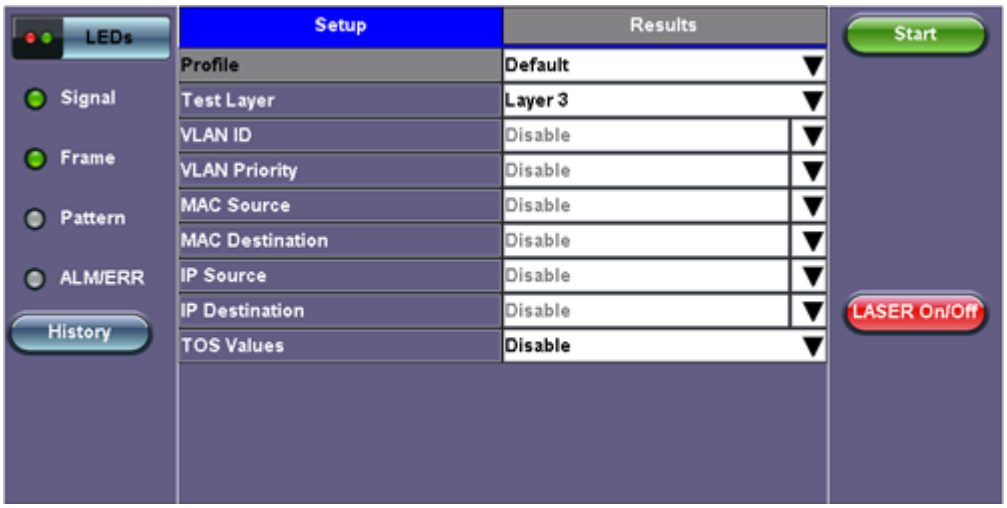
5.9 Loopback

The Loopback application can be accessed from the main menu on the home screen. It allows the user to establish a manual loopback on the test set. The loopback function is used when an end-to-end test needs to be performed with one of the test partners in software loopback mode. The loopback function will loopback the incoming traffic to the test set back into the network under test.

The type of traffic that the loopback function loops back will depend on the type of test layer configured (Layer 2 or 3). Additional criteria can be set to allow only messages with specific criteria to be looped back. To specify loopback parameters, select the desired parameter and choose Enable from the drop-down menu. Tap on the box and input a value or select one of the drop-down menu choices.

Layer 2 & 3:

- All incoming test traffic will be looped back.
- The loopback function will swap the MAC destination and MAC Source addresses (for Layer 2) or MAC and IP destination and source addresses (for Layer 3).
- All incoming frames with CRC errors will be dropped, similar to what an Ethernet switch does.
- All broadcast and multicast frames will be dropped including any incoming unicast frames that have the MAC Source address equal to the MAC Destination address.
- **Loopback Parameters:** The following parameters are available on Layer 2, 3 and 4. For more information on the parameters, please see BERT Header Settings in the BERT section. It is possible to enable any of these parameters to create a customer loopback filter. For example, enabling a filter with VLAN 64, Priority 7, will only loop back traffic corresponding to these values.
    - VLAN ID
    - VLAN Priority
    - MAC Source
    - MAC Destination
    - IP Source Address (Layer 3 only)
    - IP Destination (Layer 3 only)
    - TOS Values (Layer 3 only)



Internal SD Card Format

Press Start to begin loopback.  indicates that loopback is in progress. The **Results** tab displays current test results. Per Stream results are available for Multi-stream setup. Results for each stream can be viewed in **Results** > **Per Stream** > **Summary** and selecting the **Stream #**. Please see BERT Results for information on the Results tabs.

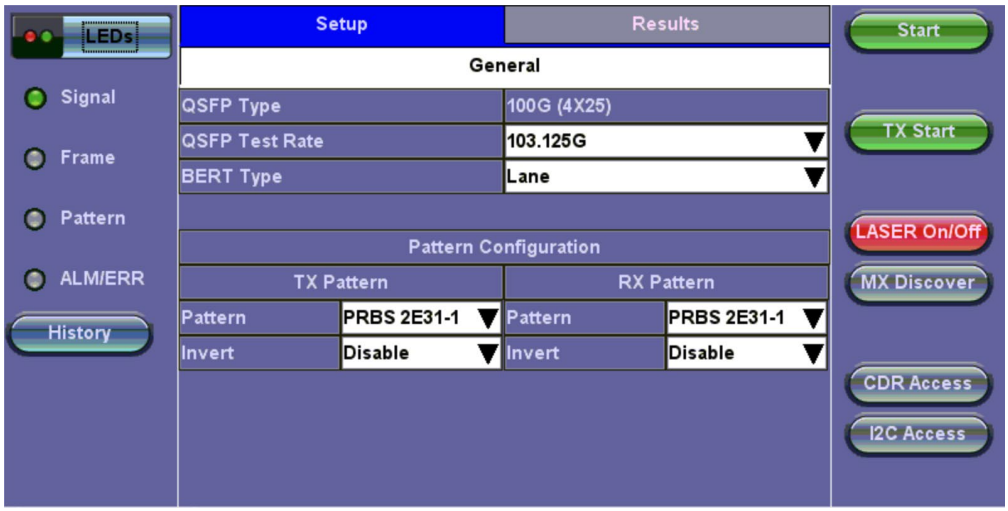
Go back to top Go back to TOC

5.10 Lane BERT

The Lane BERT test is used for validating the physical interface of the optical module (CFP, QSFP28, QSFP+). It helps verify the performance and integrity of the optical module by checking bit error and BER per optical lane and frequency offset measurements per lane. The rates supported are dependent on the optical module capabilities.

5.10.1 Setup

In newer test sets, the unit will be able to toggle between single frequency or per lane frequency measurements.



Setup - General (All Lane)

1. Select the test rate and test pattern. The same test pattern can be configured for all lanes or a different test pattern can be configured per lane.
2. Press **TX Start**, then press Start.

The option to set PRBS patterns per lane or for all lanes is available in newer 40G/100G modules, depending on the test set and software version.

Go back to top Go back to TOC

5.10.2 Results

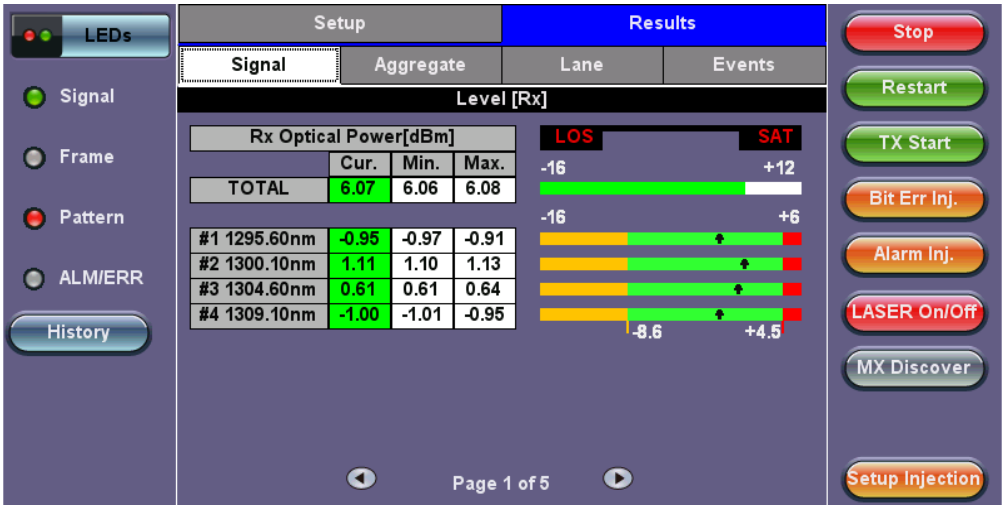
Aggregate and per optical lane BER and bit error count are measured, as well as pattern loss in seconds.

5.10.3 Signal

Signal (Page 1-2)

The Signal tab (fiber ports only) displays the receiving (RX) and transmitting (TX) optical level measured by the QSFP+ transceiver.

Loss of Signal (LOS) and the Saturation level for optical signals are shown graphically including the level measurement in dBm for each lane.

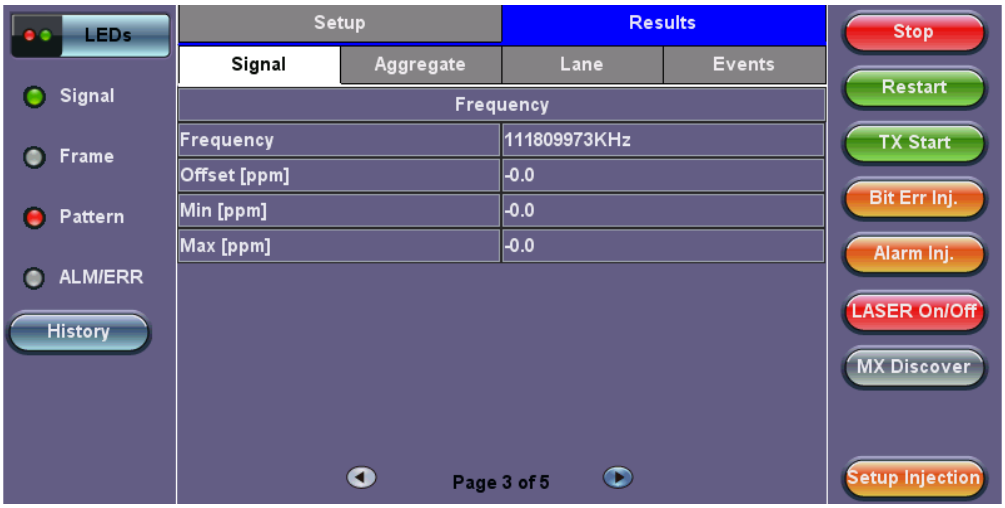


Signal (Page 1)

Signal (Page 3)

The received signal frequency and offset is measured and performed on the optical interface.

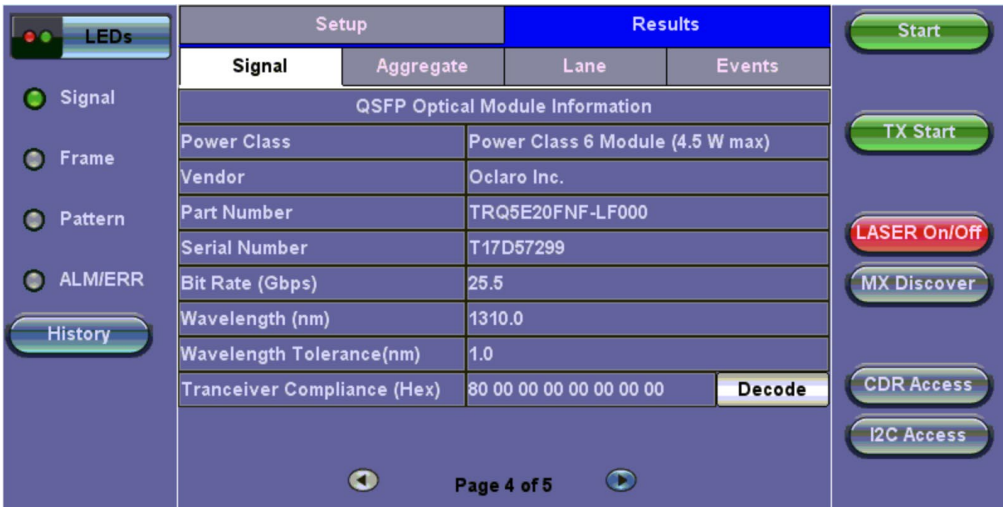
- **Current:** Indicates the frequency of the input signal.
- **Offset:** Indicates the difference between the standard rate and the rate of the input signal.
- **Min (ppm):** Indicates the difference between the standard rate and the minimum deviation detected in the input signal.
- **Max (ppm):** Indicates the difference between the standard rate and the maximum deviation detected in the input signal.



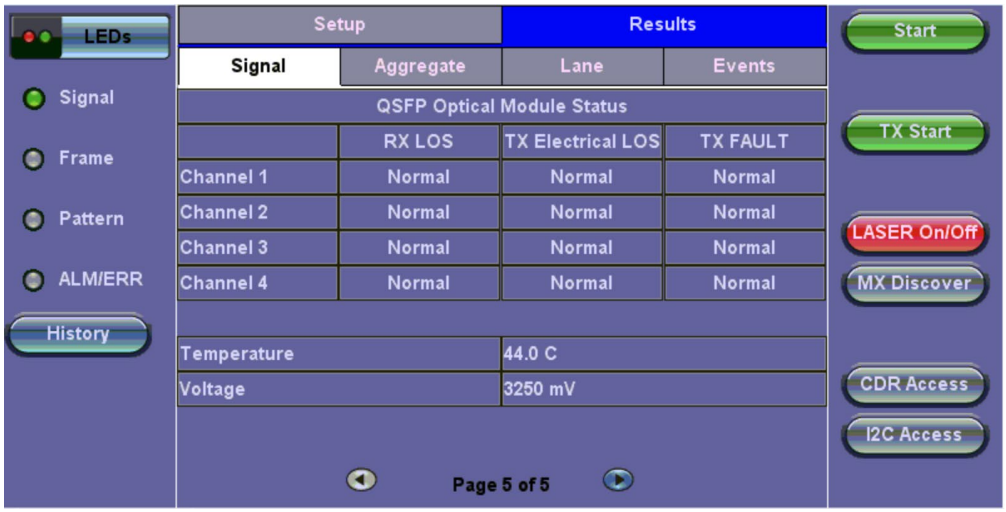
Signal (Page 3)

Signal (Page 4-5)

Page 4-5 displays the Optical module information and status.



Signal (Page 4)

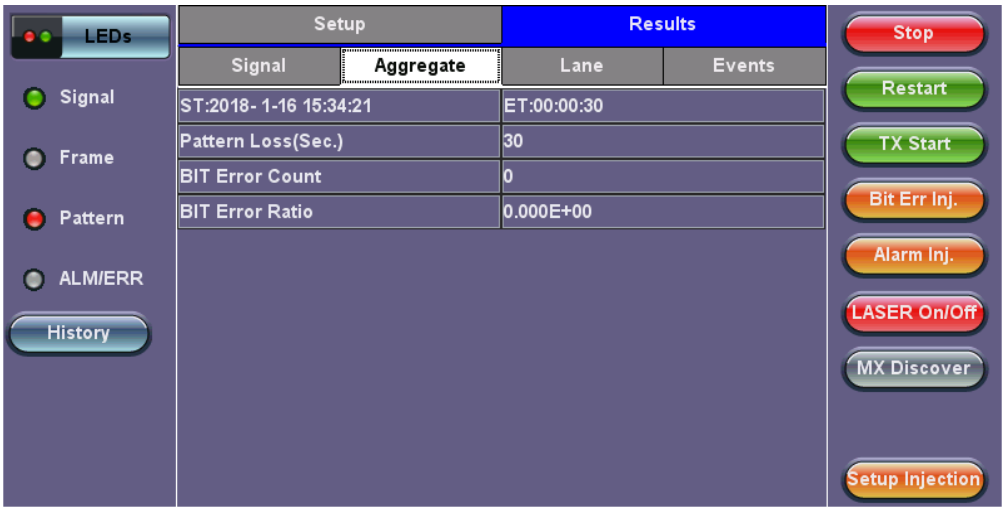


Signal (Page 5)

Go back to top Go back to TOC

5.10.4 Aggregate

The Aggregate tab displays errors related to the test pattern (Bit Error or Pattern Loss).

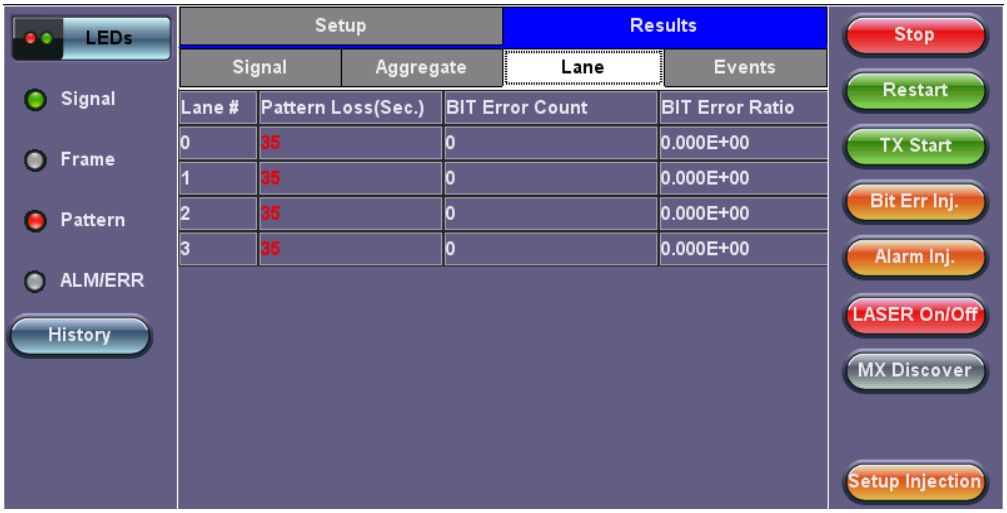


Aggregate

Go back to top Go back to TOC

5.10.5 Lane

The Lane tab displays Pattern Loss and Bit Errors for each lane.

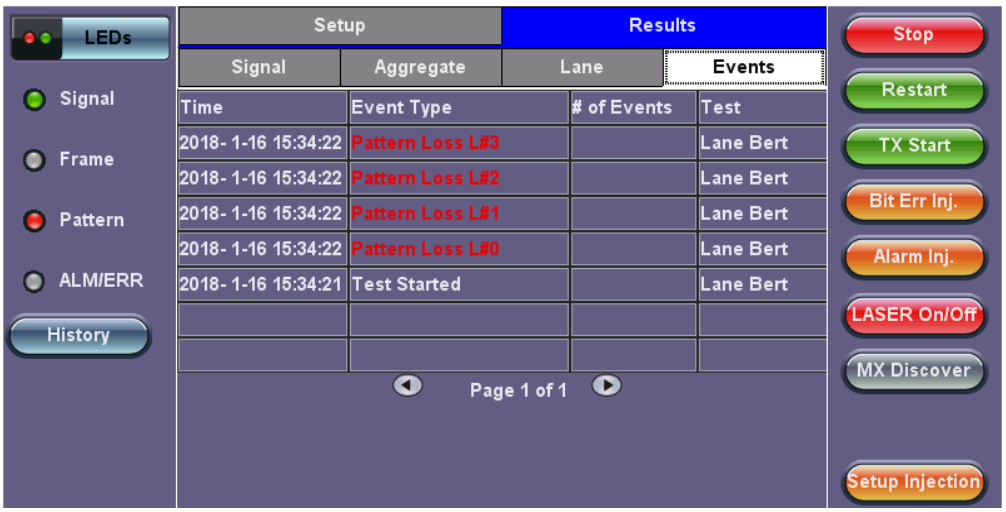


PCS Results - Alarms/Errors

Go back to top Go back to TOC

5.10.6 Events

A time stamped record or log of anomalies, alarms, test status (start/stop) and test application are displayed.



PCS Results - Events

Go back to top Go back to TOC

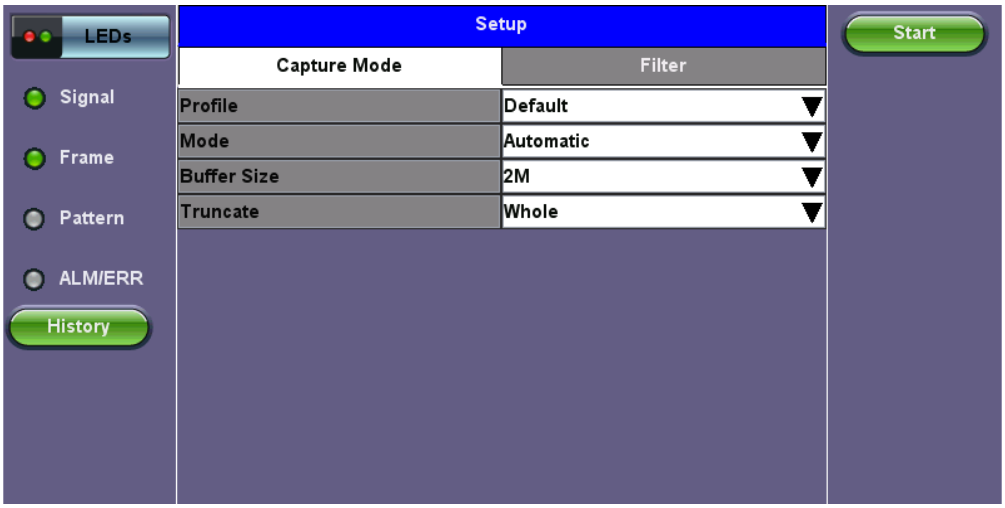
5.11 Packet Capture

5.11.1 Packet Capture Setup

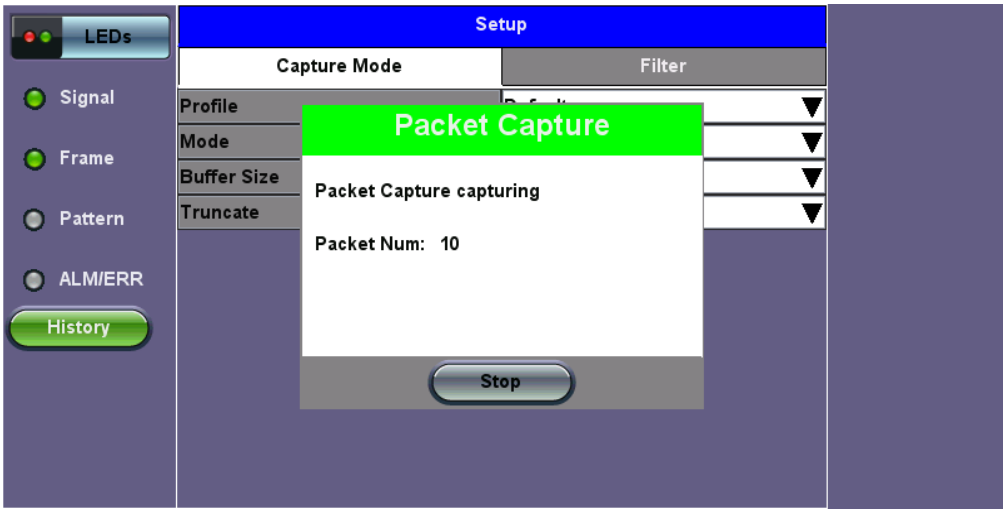
The packet capture function can be used to capture packets to Ethernet test ports. The packet capture format is compatible with Wireshark and can be viewed on a PC.

Configure the following **Capture Mode** parameters:

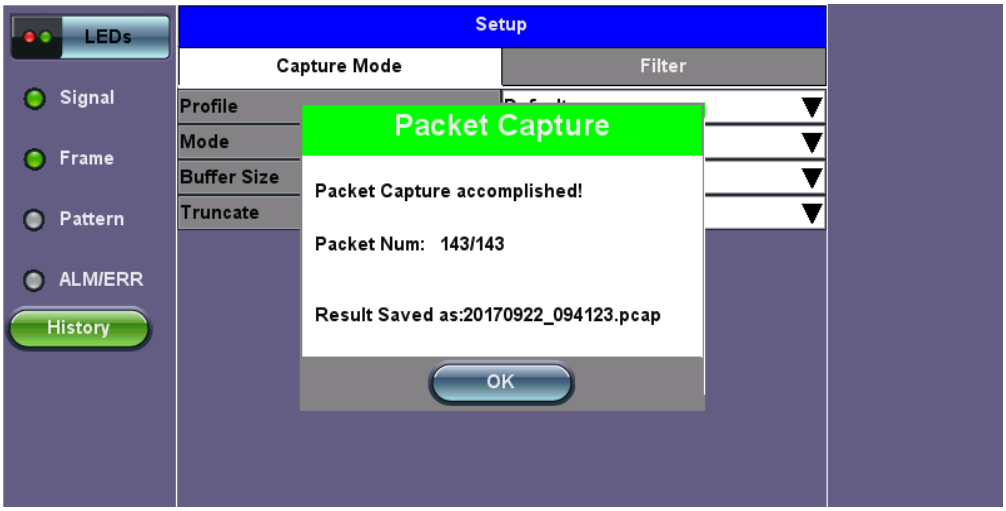
- **Profile:** Drop-down selections are Default, Delete, Save, Save As...
- **Mode:** Automatic. Packet capture is automatically started when pressing the **CAP ON** function key.
- **Buffer Size:** Defines the size of the storage allocated to packet capture.
- **Truncate:** Captures the whole frame or first number of bytes of that frame.



Capture Mode Setup



Packet Capture In Progress



Packet Capture Save

Select from the following Filter options:

MAC and IP Mode

- **Disable:** All IP packets to and from the unit are captured
- **MAC and IP:** Only traffic frames matching the MAC and IP source and destination addresses are captured
- **UDP and TCP:** Only TCP, Only UDP or both TCP/UDP are captured

Press the green Start button to begin packet capture. A display message shows the number of packets being captured.

Go back to top Go back to TOC

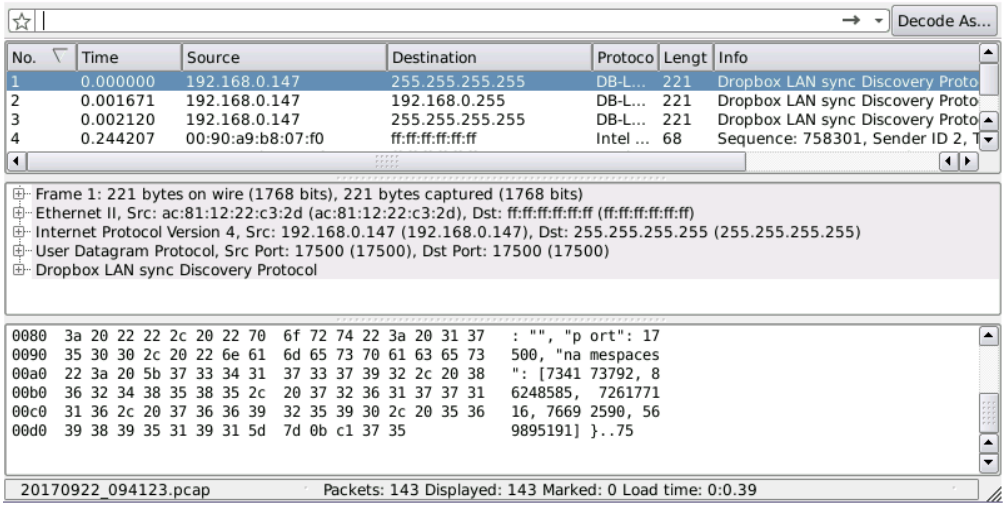
5.11.2 Packet Capture Results

To finish packet capture and manage packet capture results, press **Stop**.

To save result packets and view results, tap YES when asked to view results. Results are saved in PCAP format and are automatically named. Wire shark will launch afterwards and display the results.

The file is stored in the Files folder. It can be viewed on the test set or exported and analyzed on PC Wireshark. Refer to **File Management** in the **TX300s, RXT-1200, or UX400 platform manuals** for instructions on viewing and exporting files.

The Packet Capture results screen is divided into three parts with all details of the capture. The size of each part can be manually adjusted.



Packet Capture Results on Wireshark

Top section:

Time
- Source
- Destination
- Protocol
- Length
- Info

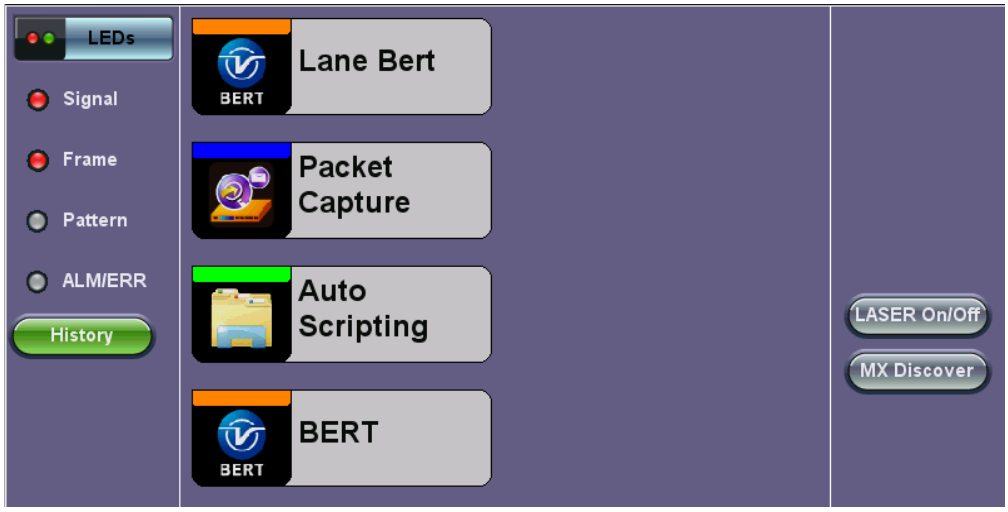
Middle and Lower Sections:

- Frame details
- Ethernet frame details

Go back to top Go back to TOC

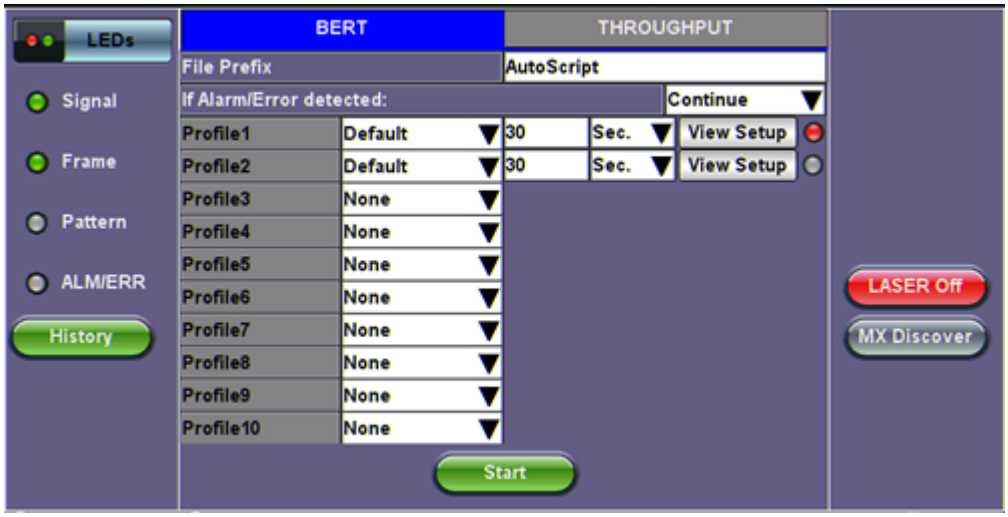
5.12 Autoscripting/Ethernet Auto Profile Testing

Autoscripting is available from the Ethernet Test Mode Selection menu and from within the Advanced Tools menu.



Advanced Tools > Auto Scripting

Autoscripting runs BERT and Throughput test profiles in succession. Profiles are configured from the test application or ReVeal software.



Autoscripting - BERT Setup

Autoscripting Setup

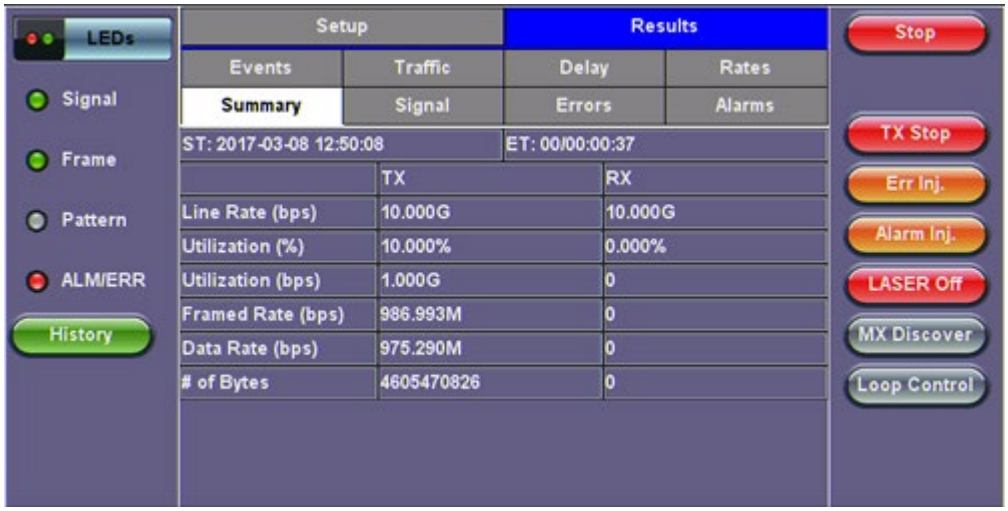
- **File Prefix:** Prefix added to name of test results. The default prefix is "Autoscript."
- **If Alarm/Error detected:** Choose to **Continue** or **Exit** testing if an alarm/error is detected.
- **Profile:** Select Default, Last Configuration, or None.
- Testing duration can be set for seconds, minutes, hours, or days.
- Tap on **View Setup** to view test setup parameters. Setup cannot be configured from this menu.

Tap on the green **Start** button to begin Autoscripting.

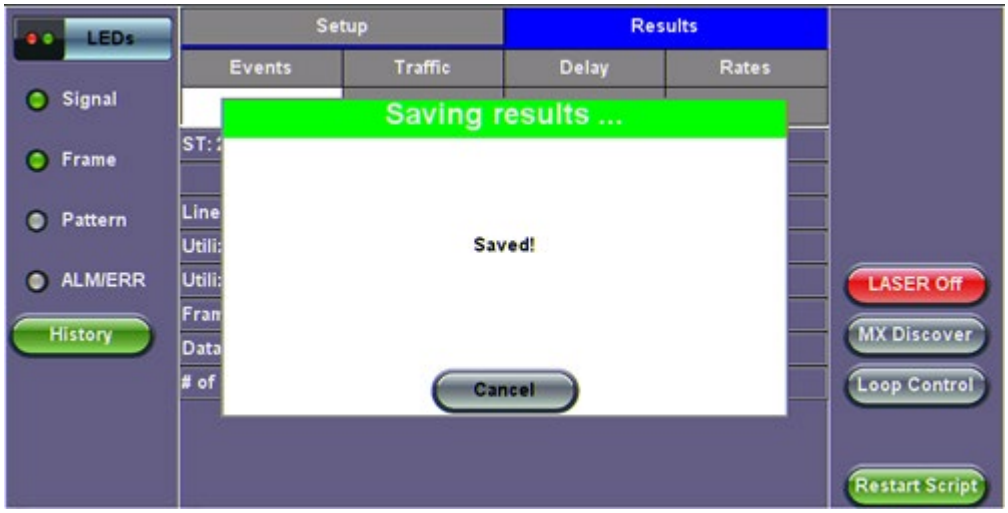
The soft LED light indicates the status of finished tests:

- **Green:** No error or alarm was detected.
- **Red:** An error or alarm was detected.

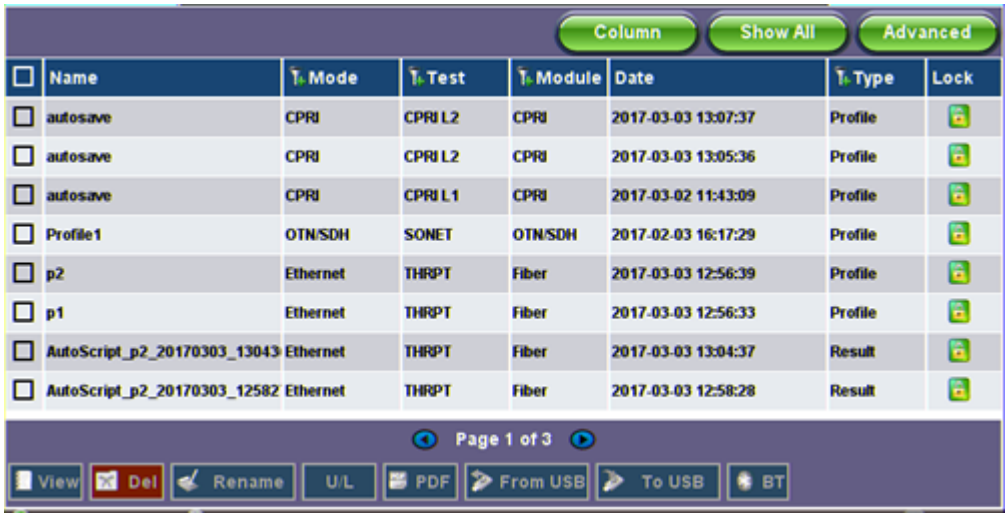
Starting the test brings up the BERT/Throughput Results tab. Test status is displayed in green on the bottom of the screen. When testing finishes, results are automatically saved. Refer to **File Management** in the **TX300s, MTTplus, RXT-1200, or UX400 platform manuals** for information on accessing saved results.



Autoscripting - BERT Results



Autoscripting - Saving Results



File Manager - Saved Results

Go back to top Go back to TOC

6.0 OTU3/OTU4 (Ethernet/Bulk)

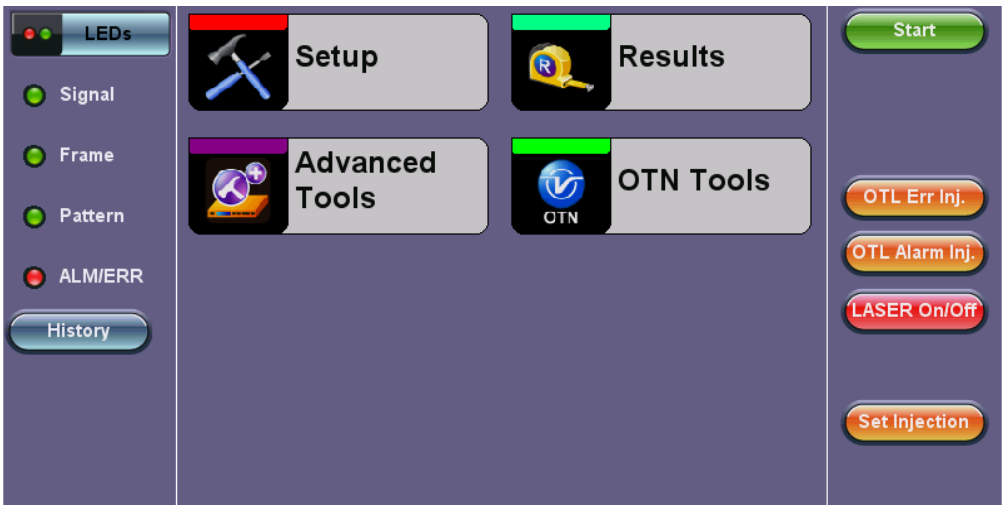
Refer to the TX300s, UX400, or RXT-1200 platform manuals for instructions on assigning test modules or launching test applications.

For safety reasons the transmitter laser is OFF by default. After making all the right connections, tap the **Laser On/Off** button on the right side of the screen.

The Laser On/Off button will turn Red, and the yellow Laser ON warning icon should show on the top of the screen. The soft LEDs for Signal and Frame may start blinking, indicating the historical LOS condition.

Tap the **History** button displayed below the soft LEDs. The LEDs will now turn steady green and the test tab will also turn green, indicating the module is ready to perform different tests.

Actual screens may differ depending on the installed TX, UX, or RXT series module.



OTU4 Setup Home

Go back to top Go back to TOC

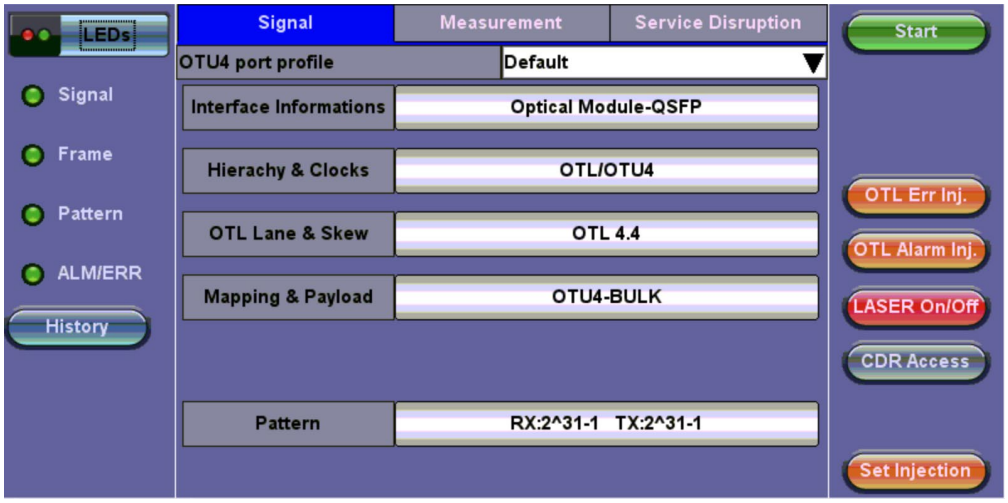
6.1 Setup

6.1.1 Signal

The following Signal parameters can be configured under the **Setup** tab on the OTU4 or OTU3 Home screen:

- Interface Informations
- Hierarchy & Clocks
- OTL Lane & Skew
- Mapping & Payload
- Pattern

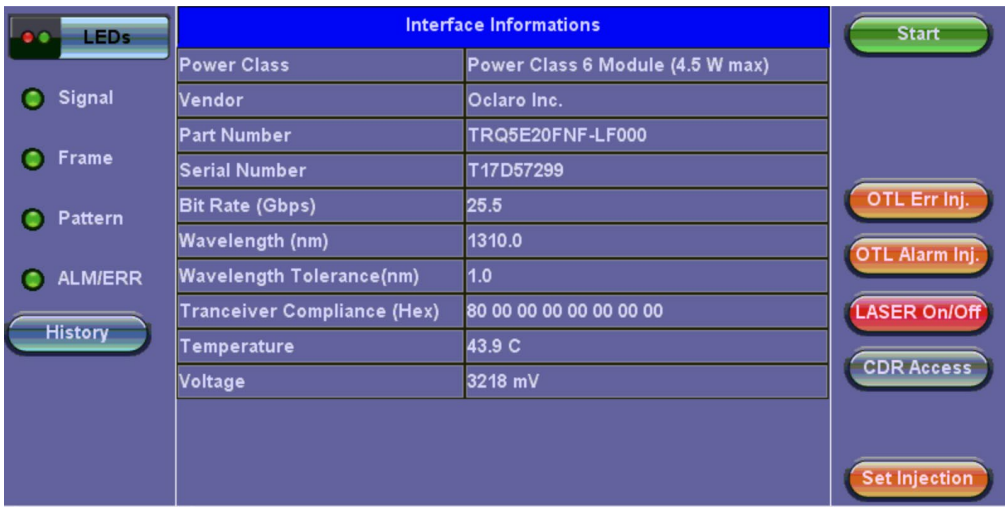
The parameters for TX and RX settings are Coupled. TX and RX configurations are grouped as one block with identical configuration. Tap on a block to configure the parameters applicable to each of the layers.



Signal Setup parameters

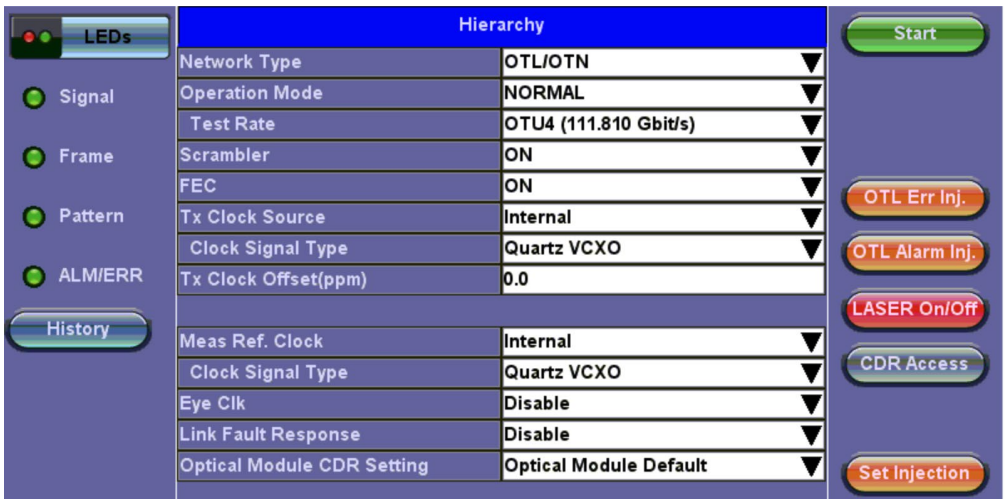
6.1.1.1 Interface Informations

Interface Information displays the capabilities and details relevant to the selected pluggable optical module (QSFP+, QSFP28, etc.).



Interface Informations

6.1.1.2 Hierarchy & Clocks



OTU3/OTU4 Hierarchy & Clocks

Tap the **Hierarchy** tab to enter the configuration screen for the physical test interface. Configuration options for the OTN signal and network types include the bit rate and higher order mapping, if applicable.

From the **Network Type** parameter, select OTL/OTN. Menu options will vary depending on the selected Network Type.

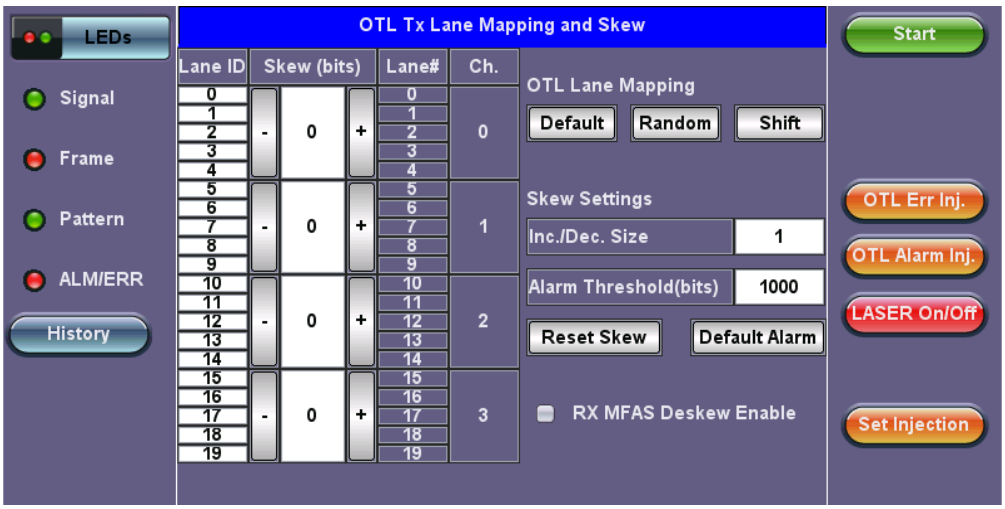
- **Operation Mode** *(OTL/OTN only)*:
  - **Normal:** The test set terminates the link. The test signal and its payload is internally generated by the test set and compared to the received signal.
  - **Payload Thru:** The test set acts as a repeater, regenerating the signal received by the RX port and retransmitting it on its TX port, keeping the payload undisturbed. This allows the test set monitor the overhead bytes, payload and to intrusively modify non-critical overhead bytes to introduce (simulate) error and alarms.
  - **Line Thru:** The test set acts as a transparent repeater, regenerating the signal received by the RX port and retransmitting it on its TX port. The test set can monitor the incoming signal, but no errors or alarms ca be injected, besides using the Laser button to turn it off and generate LOS.
- **Test Rate:** OTU4 (111.819 Gbits/s)
- **Scrambler** *(OTL/OTN only)*: On
- **FEC** *(OTL/OTN only)*: On/Off
- **Tx Clock Source:**
  - **Internal:** The clock for the transmitter is derived from the internal clock. The internal clock has an accuracy of +/- 3.5ppm conforming to G.812 recommendations.
  - **Received:** The clock for the transmitter is derived from the received signal and the jitter of the incoming signal is suppressed.
  - **External (BNC):**
    - **Clock Signal Type:** 1PPS (BNC), 10MHz, 5MHz, 1544KHz, 2048KHz, 2048Kbit/s, 1544Kbit/s, 64 Kbit/s signals are present on the SMA connector.
    - **Line code:** HDB3, B8ZS, AMI
- **Clock Signal Type:** Quartz oscillator (Internal)
- **Measurement Reference Clock:** Internal
- **Eye Clk:** Disable, 1/8 of network lane rate
- **Link Fault Response:** Disable/enable

Go back to top Go back to TOC

6.1.1.3 OTL Lane & Skew

Advanced users can enter the OTL tab on the Setup screen to configure the OTL Tx Lane Mapping and Skew, as well as tolerance thresholds (to generate alarms).

- **Lane ID:** Manually edit and assign specific Lane IDs to Lane #. Use the **Random** button to assign them arbitrarily, the **Shift** button to slide the Lane IS vs Lane # correlation, or the **Default** button to realign them back.
- **Skew (bits):** Enter the desired skew values by tapping directly on the fields or use the **+** and **–** buttons to increment/decrement them by the amount set in the **Inc/Dec Size** field.
- **Alarm Threshold:** Defines the maximum skew value allowed. If the system exceeds the set value, a flag (alarm) is raised by the test set to notify users.

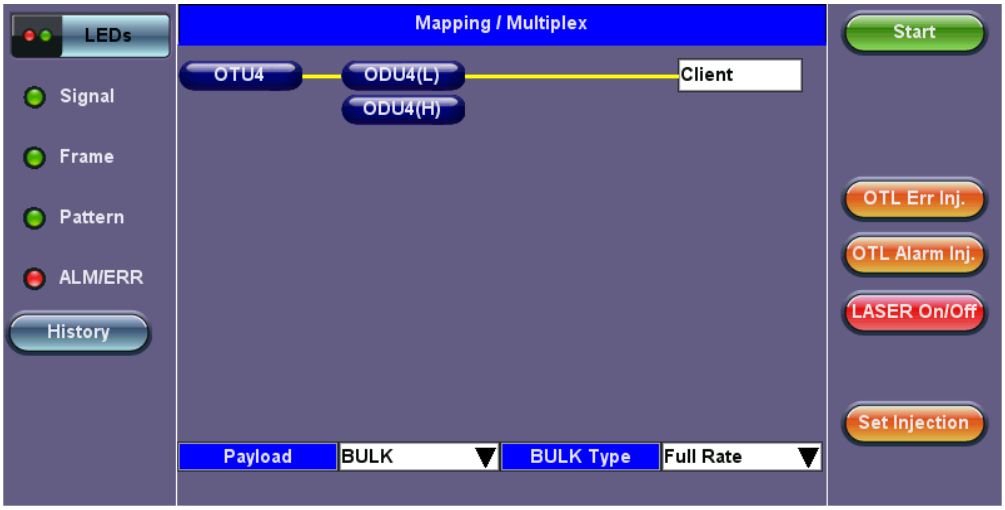


Go back to top Go back to TOC

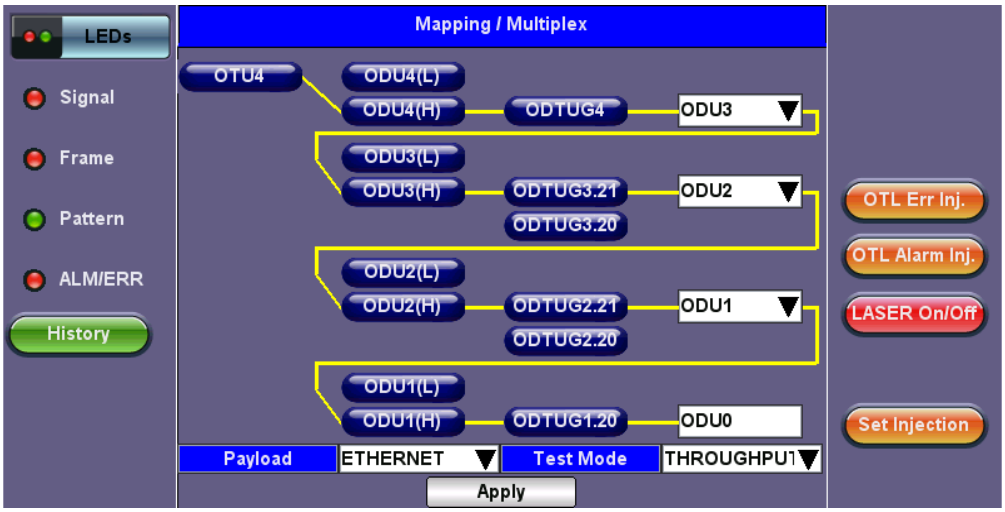
6.1.1.4 Mapping and Payload

The mapping and multiplex structure is displayed. It supports one-stage (direct mapping) to multi-stage mapping and multiplexing.

- Select the ODUk(L) button to add a test payload (client) or ODUk(H) to add another multiplexing level for lower rate clients.
- The payload can be Bulk (PRBS test sequence) or Ethernet. Ethernet payload selection is only available when compatible ODUk(L) containers are selected, such as ODU4, ODU3, ODU2e, or ODU0.
- If an Ethernet test payload is selected, users have the option to run a BERT or Throughput test within the payload;Throughput test is recommended. Make sure to press the **Apply** button to reconfigure the test signal structure.



Mapping & Payload - Single Stage Mapping



Mapping & Payload - Multi-stage Mapping/Multiplexing

Go back to top Go back to TOC

6.1.1.5 OTN Channels and GFP-T Settings

The OTN Channel level (menu block) allows advanced users to modify individual tributary slots (T/S) or channels for the transmitted and received (expected) signal. This also allows users to set the physical port to which lower rate payloads may be mapped to when demultiplexed from the OTU4 test signal. In **Show Channels** mode, the test set offers a **CH# Detect** function that displaysthe channels available in the RX, in case they need to match the existing signal.

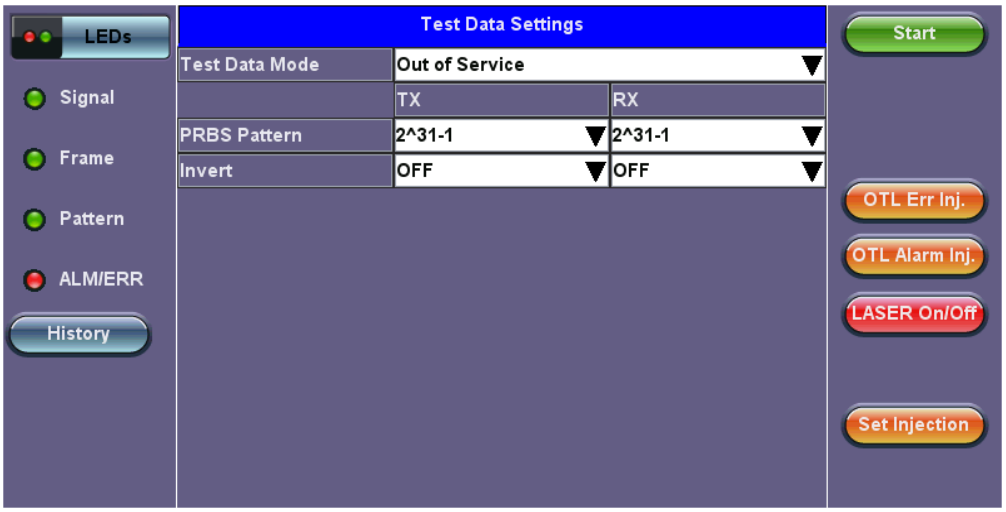
If ODU0 is selected as the Ethernet mapping level, the test set will add a GFP-T sublayer to the signal structure. Advanced users

can use this block if a different payload header type needs to be set (transmitted or expected).

6.1.1.6 Test Pattern (Test Sequence or PRBS)

Tap the **Pattern** tab to configure the Test Data Settings. The following parameters are available:

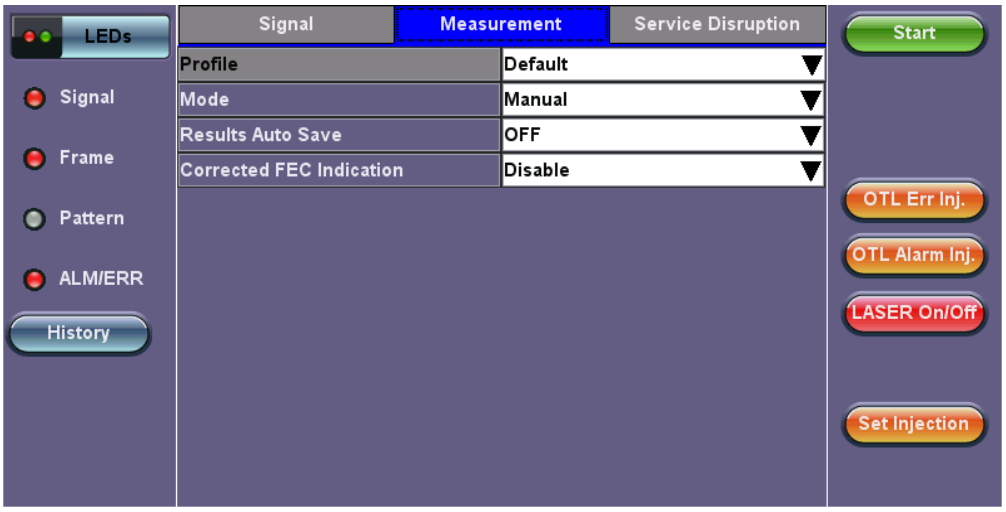
- **Test Data Mode:** In Services (Live), Out of Service
- **PRBS Pattern (TX and RX):** Pseudo Random Bit Sequences (PRBS) defined by ITU-T 0.150 and 0.151 standards, fixed words and 24-bit or 32 bit user defined patterns are available.
- **Invert** (Logic pattern inversion)**:** On / Off



OTU4 Setup - Test Data Settings

Go back to top Go back to TOC

6.1.2 Measurement

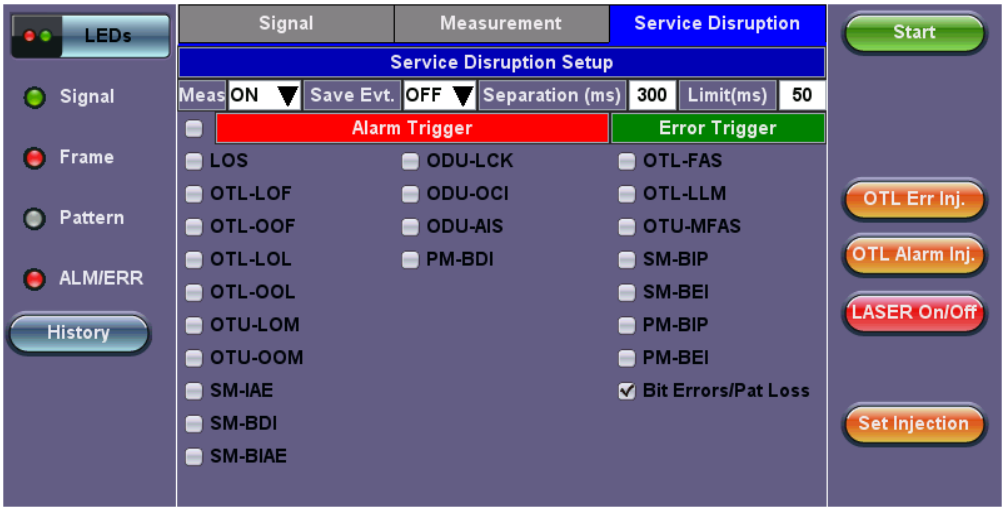


Measurement Setup

- **Mode**: Manual and Timed selections are available.
  - **Manual:** This is directly linked to the Start/Stop function on the drop-down menu. The test starts as soon as the **Start** button is pressed.
  - **Timed:** The test duration can be set by the user in seconds, minutes, hours or days. The test is activated by the Start/Stop function on the drop-down menu and stops automatically when the defined time has elapsed.
- **Results Auto Save:** Tap Auto Save and set it to ON to automatically save the results file.
- **Corrected FEC Indication**

Go back to top Go back to TOC

6.1.3 Service Disruption Test (SDT)



Service Disruption Setup

A service disruption is triggered by any qualifying error or alarm determined by the user and continues to count until the error-free condition (Gate Time) is met. If SDT is enabled and alarm/error triggers are selected, the results will appear in the Results section under the SDT tab.

Testing Process

The test set measures how long the event remains present after it is first recognized and will continue to measure the total service disruption time in the event of multiple disruptions.

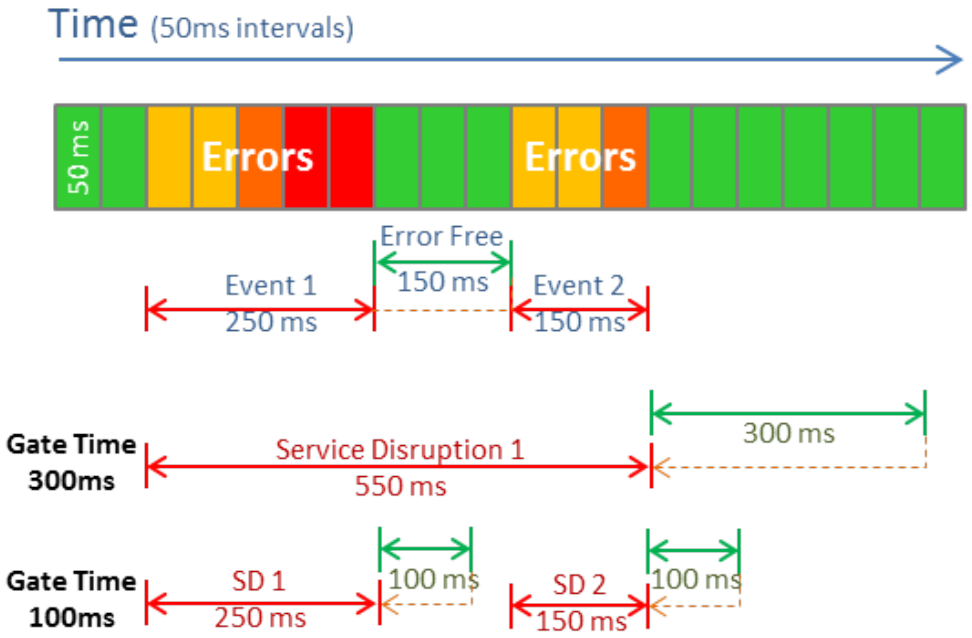
Before starting, ensure that no errors or alarms are present on the transmission system because this will impact the measurement.

In the past, Automatic Protection Switching (APS) was used to measure physical service cuts, especially in optical links. Service disruption measurements are meant to measure the total time the service is not available to customers, which isnot limited by the optical path cut. Therefore, it configures to include the time the whole system takes to recover.

Service Disruption can still be used to measure APS time, if the trigger selected is LOS only. This will just measure the physical protection switch time.

Setup

1. Set Measurement to ON to activate SDT testing during BER tests.
2. Set a limit time and separation time. Limit and Gate Time counters begin at the onset of the first valid event.
    - **Limit Time:** Specifies pass/fail criteria for SDT events. This represents the acceptable amount of time for the customer to experience a service disruption. Events greater than the limit time are considered a fail. Configurable from 20 to 1000 ms.
    - **Gate Time:** Specifies the length of error free signal time used to determine the number of service disruptions. Configurable from 20 to 10000 ms. The Gate Time is not included in the service disruption time calculation.
3. (Optional) Turn **Save Event** to ON when SDT Measurement is enabled to include the Events Table details in the test report (including individual events within each of the disruptions recorded). When Save Event is turned OFF, the saved test results will only display general results (Current, Last, longest event, shortest events, total number of events detected and a PASS/FAIL verdict).
4. Select the type of errors/alarms from the SONET, PDH, BERT, OTN tabs that will trigger the SDT test.
5. Press the **Start** button to begin testing.



Service Disruption Time diagram

In the simplified example above, two events occur with 150ms of error free time in between. A gate time of 300ms counts them as one service disruption because the error-free section is less that the gate time. Using a gate time of 100ms to evaluate the same situation would count two service disruptions, because the Gate Time condition is met within the error-free section.

Go back to top Go back to TOC

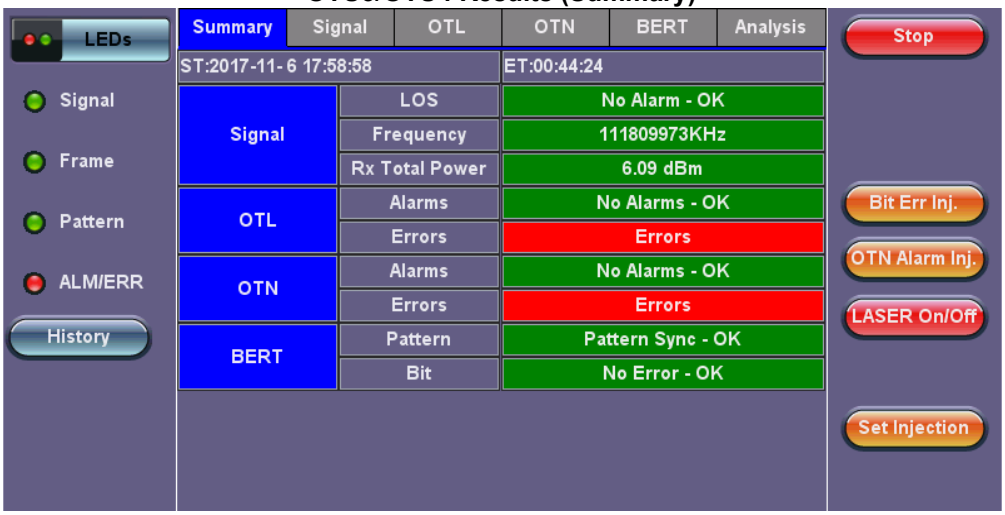
6.2 Results

Test measurements can be accessed from the **Results** icon in the main menu.

6.2.1 Results Summary

The Results Summary screen displays a summary of all the test results with start time (ST) and elapsed time (ET), alarms, errors, or signal failure pertaining to OTL, OTN, or BERT signal and its payload.

OTU3/OTU4 Results (Summary)



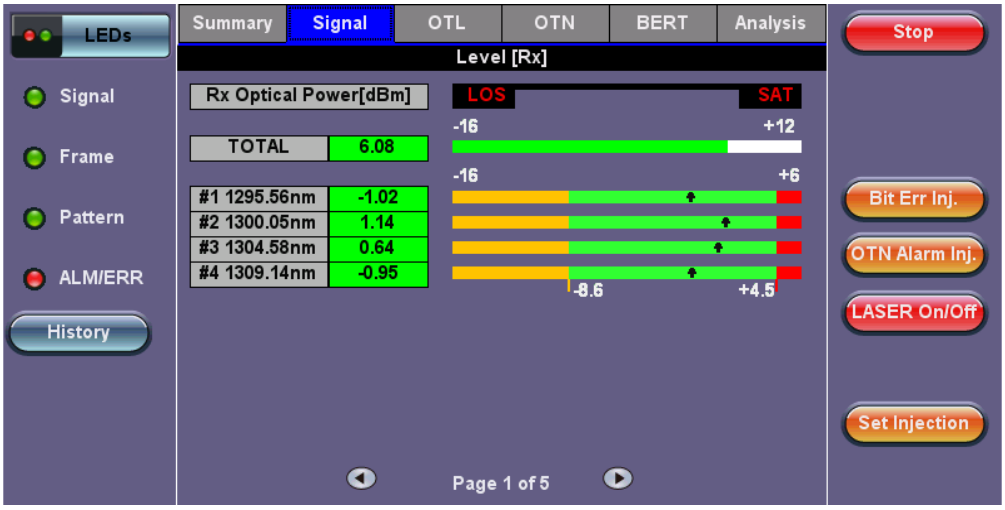
Go back to top Go back to TOC

6.2.2 Signal

The signal tab displays the Signal Level, Frequency and related measurements.

RX/TX Optical Level (Page 1-2)

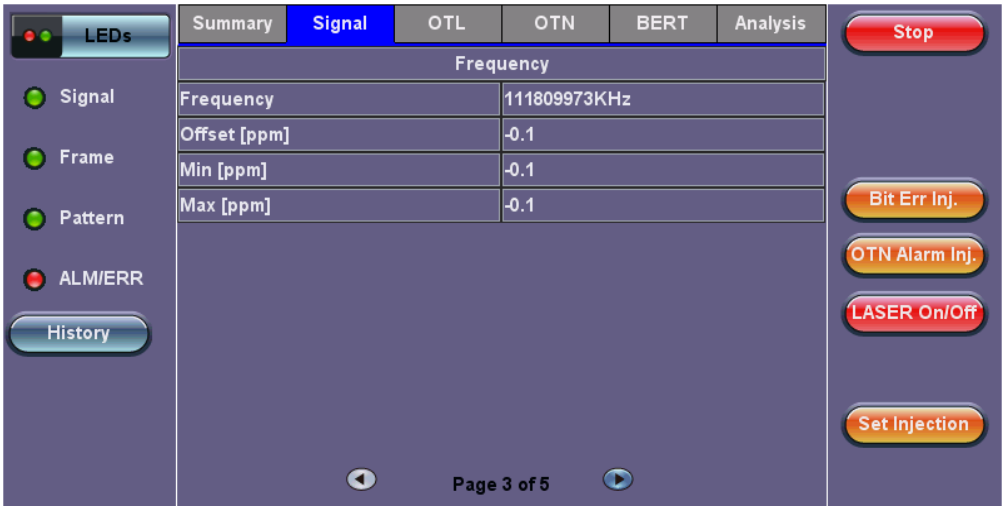
- The optical level measurement for each available wavelength (channel) is displayed in dBm.
- Loss of Signal (LOS) and the Saturation levels is shown both graphically and in dBm.



Signal - RX Optical Power Level

Frequency (Page 3)

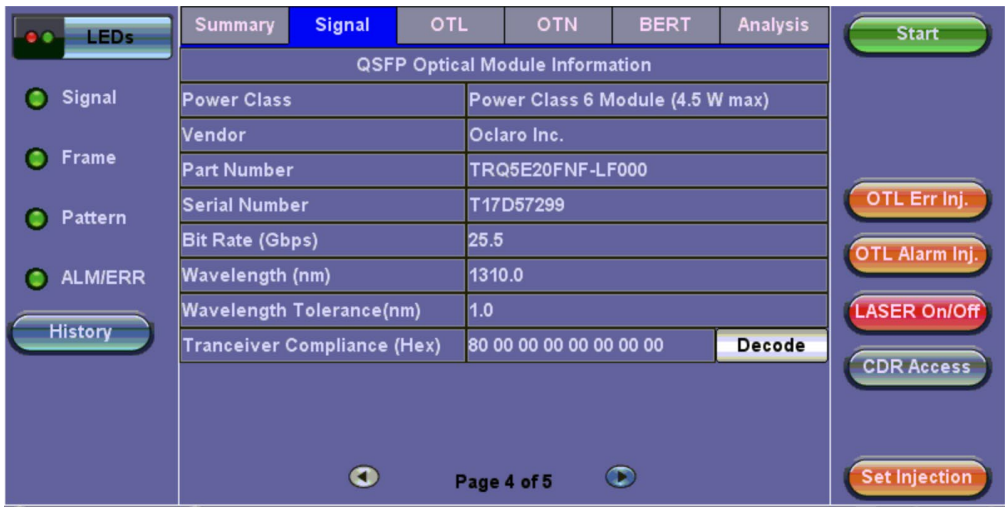
- The received signal frequency and offset is measured and displayed. The Signal page may display frequency measurements per lane for newer 40G/100G modules, depending on the test set and software version.
- For OTN signals, the measurement is performed on the optical interfaces QSFP28, and QSFP+.
- **Frequency:** Indicates the frequency of the input signal
- **Offset (ppm):** Indicates the difference between the standard rate and the bit rate of the input signal
- **Min (ppm):** Indicates the difference between the standard rate and the minimum deviation detected in the input signal
- **Max (ppm):** Indicates the difference between the standard rate and the maximum deviation detected in the input signal



Signal - Frequency (All Lanes)

QSFP Optical Module Information (Page 4)

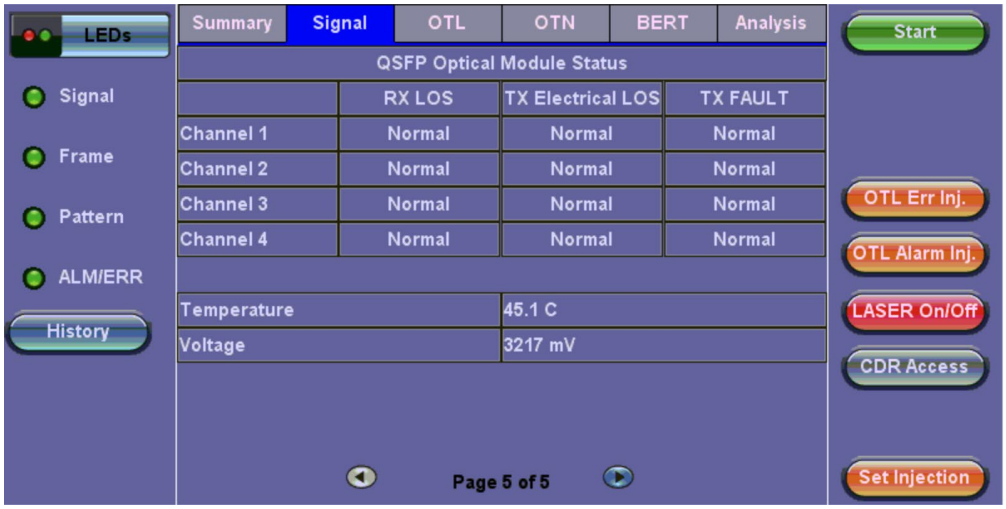
The information and capabilities of the QSFP in use are listed.



Signal (Page 4) - QSFP Optical Module Information

QSFP Optical Module Status (Page 5)

QSFP Optical Module Status displays the internal diagnostics status of the pluggable QSFP optics. Color-coded LEDs indicate status of alarms and errors.



Signal (Page 5) - QSFP Optical Module Status

Go back to top Go back to TOC

6.2.3 OTL and STL Results

Depending on the test configuration, OTL measurements are displayed for OTU3/OTU4.

Go back to top Go back to TOC

6.2.3.1 Summary

Color-coded LEDs indicating alarm and error status for each individual lane are listed.

Green: No error or alarm is present.

Red: An error or alarm condition is detected and is currently present.

Yellow: Indicates a history condition. An error or alarm was detected during the measurement interval but it is no longer present or active.

OTL Summary

OTL Alarm/Error Definitions per ITU-T G.709 and G.798	
LLM	Logical Lane Marker Error
FAS	Logical Lane Frame Alignment Error
MFAS	LL Multi-Frame Alignment Error
LOL	Loss of logical Lane alignment • Two or more logical lanes with the same marker • Consecutive LLM errors for ≥ 5 frames
OOL	Out of logical Lane alignment
OOF	LL Out of Frame (FAS error for ≥ 5 frames)
LOF	LL Loss of Frame (consecutive OOF for ≥ 3ms)
OOR	Out of Recovery (wrong LLM value for ≥ 5 cycles)
LOR	Loss of Recovery (consecutive OOR for ≥ 3ms)
OOLLM	Out of Logical Lane Marker (LLM errors for ≥ 5 frames)
OOMFAS	Out of LL MFAS (MFAS errors for ≥ 5 frames)
High Skew	Skew for any of the lanes is greater than a threshold (limit) value set for the application

Go back to top Go back to TOC

6.2.3.2 Rx Lane Skew

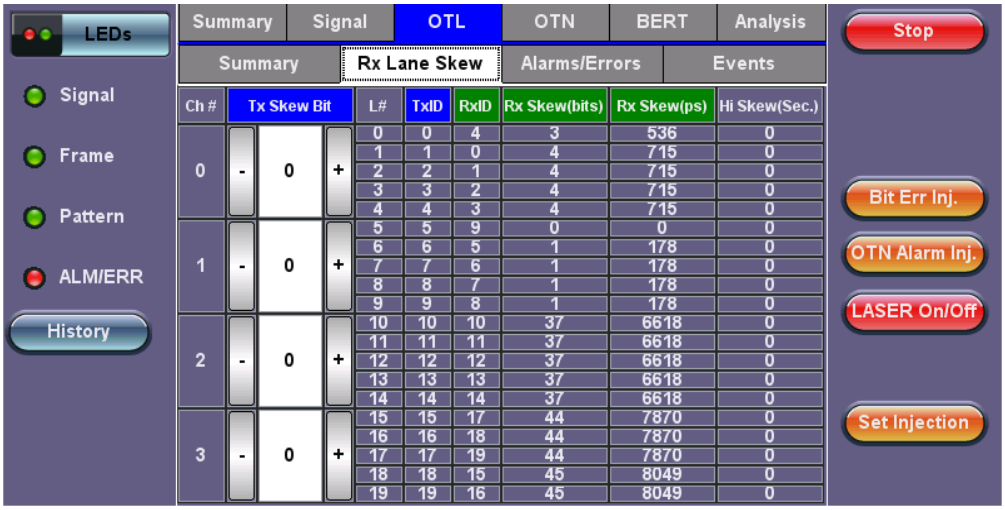
Lane skew is only available on 100G test modules.

Lane Skew

In OTU4 and 100GE implementations, the transmit data stream is split into 10 electrical lanes and 20 logical lanes, which are scrambled to ensure sufficient transition density (pulses) for clock recovery. The OTL/PCS layer is responsible for inserting Lane Alignment Markers into each of the logical lanes in the transmit direction, so the original 100G data stream can be reconstructed at the far end. The receiver's OTL/PCS layer is responsible for detecting the lane alignment markers and aligning recovered data in the receive direction. The alignment process ensures properly formatted data. Skew accumulation occurs downstream from the OTL/PCS and it is the responsibility of the receiver's OTL/PCS layer to remove skew and re-align the receive data.

Fixed Skew
Fixed or static skew represents the constant difference in arrival time for two signals generated from the same source. It is generated by physical lane-to-lane differences in the time a signal reaches a destination relative to the data on any other lane. This usually related to implementation factors, such as differences in electrical trace lengths (0.5 UI/cm), fiber optics dispersion, and lane-dependent clock recovery circuits (CDR).

Dynamic (Variable) Skew
Lane-to-lane skew can change or wander over time due to many physical and environmental factors, including uneven temperature, data rate, and supply voltage fluctuations.

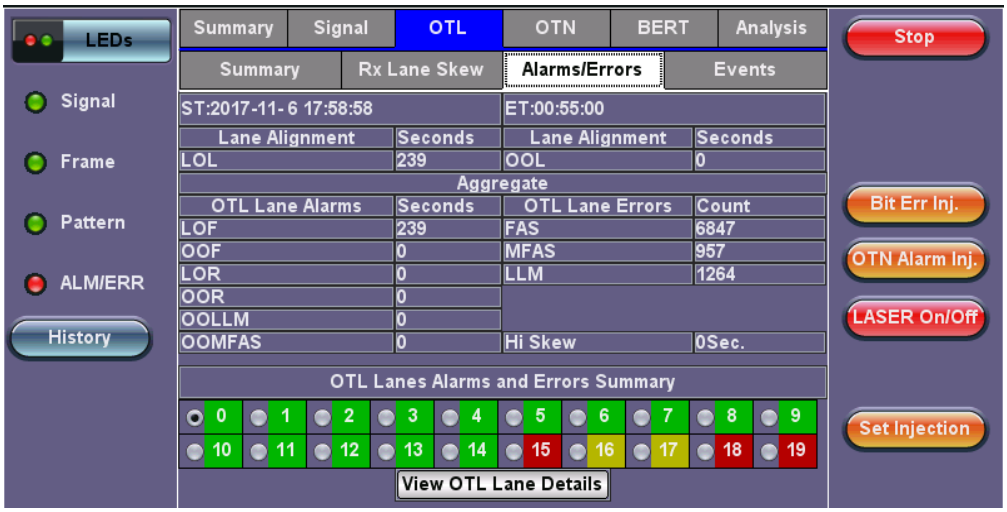


OTL Rx Lane Skew

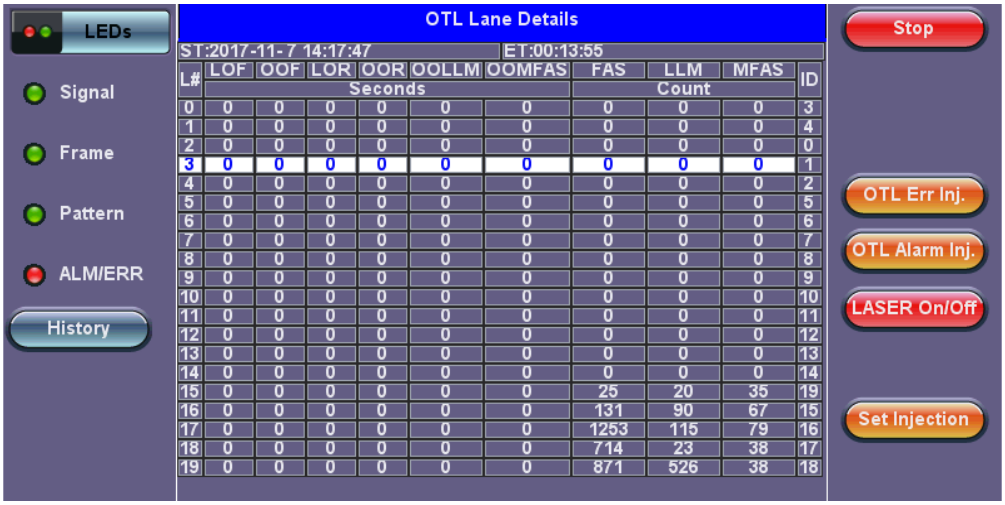
Go back to top Go back to TOC

6.2.3.3 Alarms/Errors

Detailed aggregate Alarm and Error count, as well as per-lane counters. Select the desired lane to be highlighted and press the **View OTL** button. Lanes are color-coded to indicate alarms and errors status. Refer to **Summary** for a description of LED color statuses.



OTL Alarms/Errors

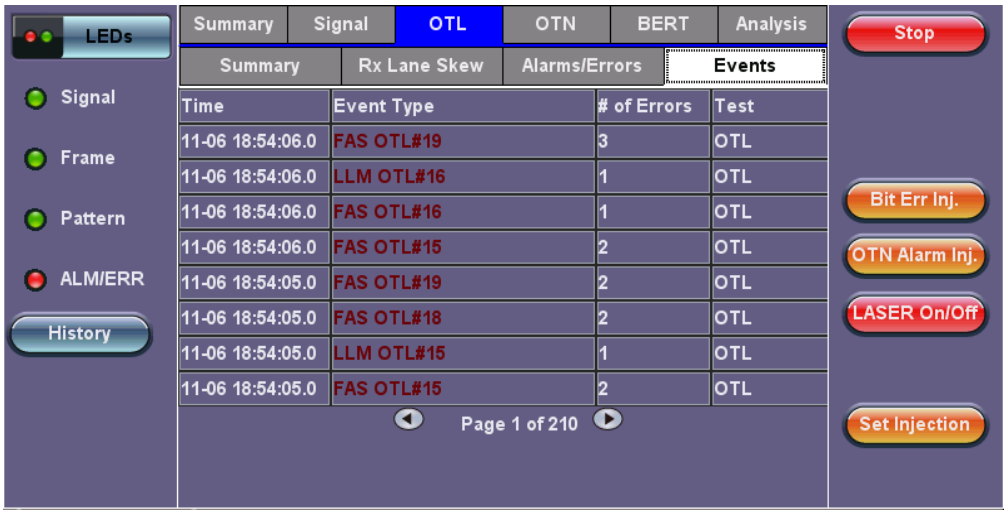


OTL Lane Details

Go back to top Go back to TOC

6.2.3.4 Events

The Events log tab lists Error and Alarm events recorded during the test. The events are presented in chronological sequence with start time and duration (alarms), event type, sequence number, ratio/count (errors), and test type.



OTL Events

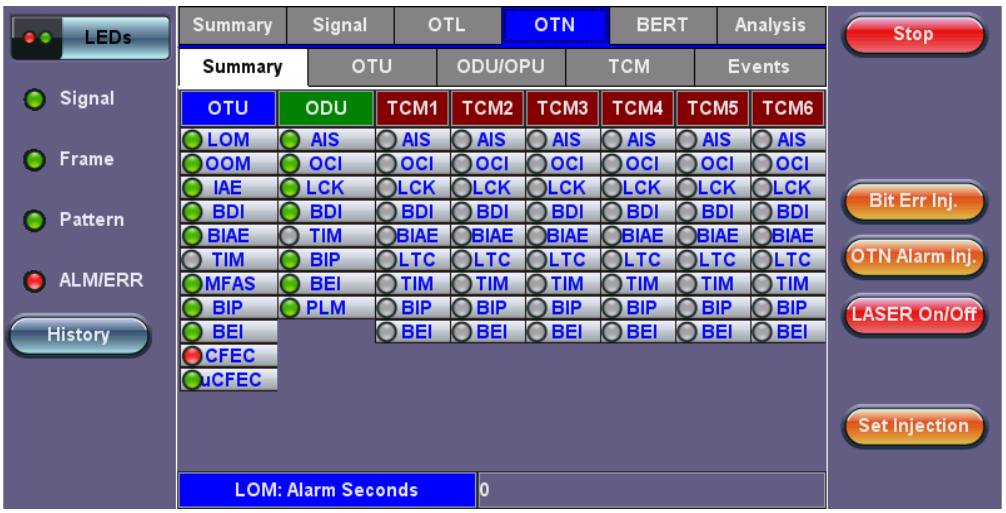
Go back to top Go back to TOC

Depending on the test configuration, OTN measurements are displayed for OTU3/OTU4 and SDH measurements displayed for SDH/SONET STL256.4.

Go back to top Go back to TOC

6.2.4 Summary

The OTN Results Summary screen displays a summary of alarms/errors pertaining to OTU, ODU, and TCM. Tap on the alarm/error for count and duration details.



OTN Summary Results

OTU Error Definitions per ITU-T G.709 and G.798	
FAS	Frame Alignment Signal Error (mismatch) • One or more framing bits in error
MFAS	Multi-Frame Alignment Signal error (mismatch) • MFAS indicator (0 to 255) is in error (out of sequence)
TIM	Trail Trace Identifier Mismatch • Received and expected TTI are different
BIP-8	Bit Interleaved Parity - level 8 code error (mismatch) • Received and calculated BIP are different
BEI	Backward Error Indication (BEI/BIAE bits) • 0 .. 8 Number of BIP-8 violations detected • 9 .. A No BIP-8 error detected • B Refer to BIAE • C .. F No BIP-8 error detected
BIAE	Backward Incoming Alignment Error (BEI/BIAE bits) • B (1011) ≥ 3 consecutive frames
cFEC	Corrected FEC errors (don't affect ODUk)
uFEC	Uncorrectable FEC errors (ODUk is affected)

OTU Alarm Definitions per ITU-T G.709 and G.798	
OOF	Out of Frame • FAS errors ≥ 5 consecutive frames
LOF	Loss of Frame • OOF condition for ≥ 3 ms
OOM	Out of Multiframe • MFAS errors for ≥ 5 consecutive frames
LOM	Loss of Multiframe • OOM condition for ≥ 3 ms
BDI	Backward Defect Indication • Defect: Set to 1 for ≥ 5 consecutive frames • Normal: Set to 0 for ≥ 5 consecutive frames
IAE	Incoming (Frame) Alignment Error • Defect: Set to 1 for ≥ 5 consecutive frames • Normal: Set to 0 for ≥ 5 consecutive frames
AIS	Alarm Indication Signal • Repetitive PN-11 sequence (2^{11}-1) completely filling OTUk frames

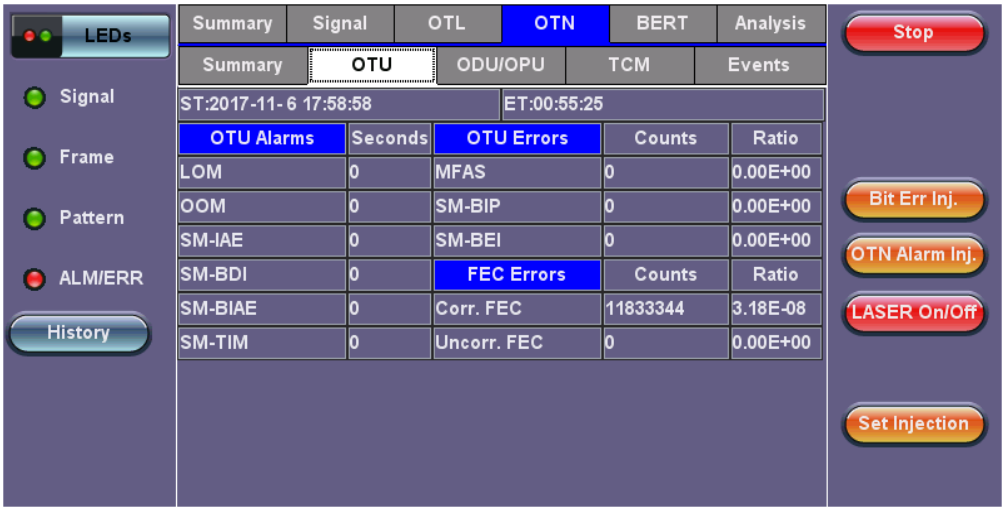
ODU Alarm/Error Definitions per ITU-T G.709 and G.798	
BIP-8	Bit Interleaved Parity - level 8 code error (mismatch) • Received and calculated BIP are different
BEI	Backward Error Indication (BEI/BIAE bits) • 0 .. 8 Number of BIP-8 violations detected • 9 .. F No BIP-8 error detected
BDI	Backward Defect Indication • Defect: Set to 1 for ≥ 5 consecutive frames • Normal: Set to 0 for ≥ 5 consecutive frames
LCK	Locked • Defect: STAT = 101 for ≥ 3 consecutive frames • Normal: STAT = 001
OCI	Open Connection Indication • Defect: STAT = 110 for ≥ 3 consecutive frames • Normal: STAT = 001
AIS	Alarm Indication Signal • Defect: STAT = 111 for ≥ 3 consecutive frames • Normal: STAT = 001
PLM	Payload Mismatch • Declared if the accepted payload type is not equal to the expected payload type(s) as defined by the specific adaptation function
TIM	Trail Trace Identifier Mismatch • Received and expected TTI are different

Go back to top Go back to TOC

6.2.4.1 OTU

OTU alarms/errors are displayed for OTU3/OTU4 test configuration.

Results are displayed in logical order that are associated with the signal under test. All errors are evaluated and stored. The Elapsed Time [ET] is shown in the right hand corner of the header.

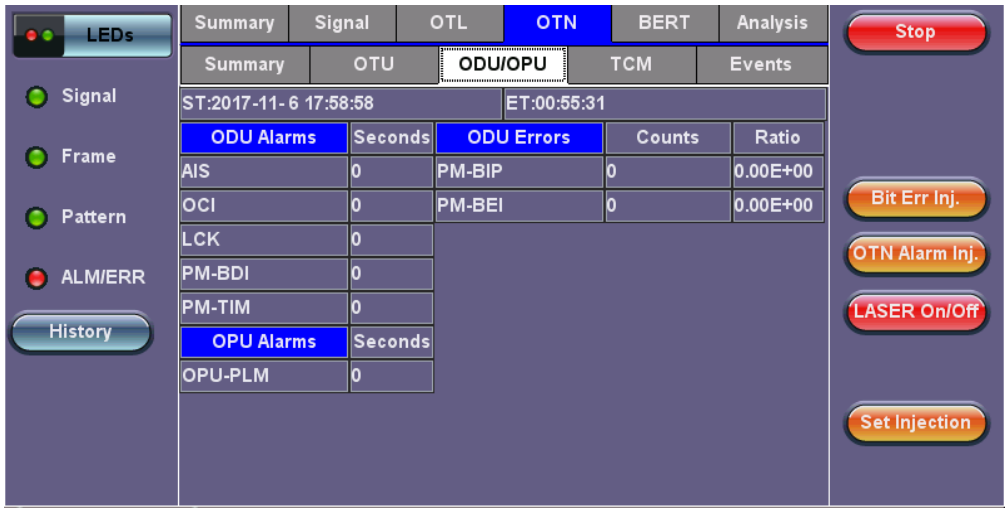


OTN Results - OTU

Go back to top Go back to TOC

6.2.4.2 ODU/OPU

ODU/OPU for OTU3/OTU4 test configuration displays errors and alarms in a logical order that are associated with the signal under test. All alarms are evaluated and stored.



OTN Results - ODU / OPU

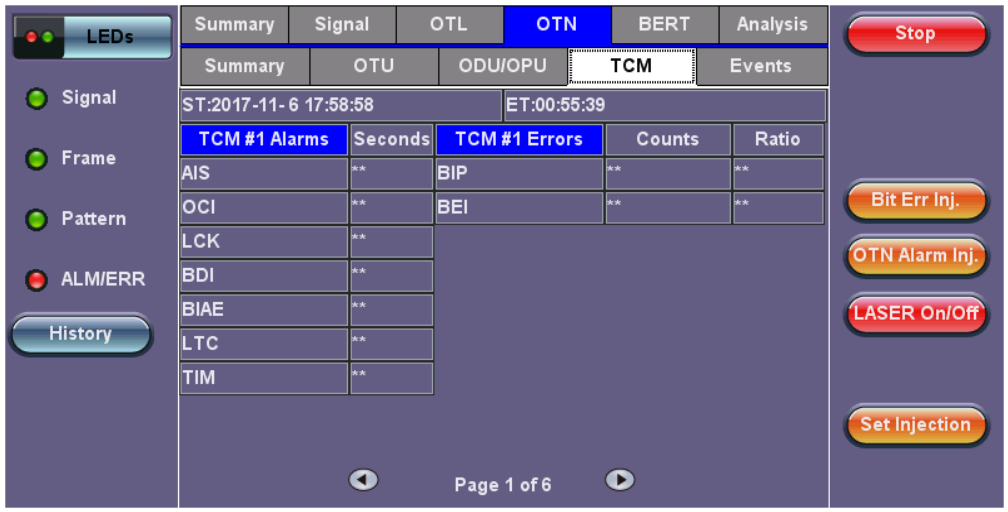
Go back to top Go back to TOC

6.2.4.3 Tandem Connection Monitoring (TCM)

Results are available for up to six tandem connections. Use the page buttons to navigate through TCM1 to TCM6 results. Tandem connections and corresponding source and sink functions are defined in ITU-T G.707, G.709, and G.783.

TCM enables the user and its signal carriers to monitor the quality of the traffic that is transported between segments or connections in the network. ITU G.709 allows six levels of tandem connection monitoring to be configured. The assignment of monitored connections is currently a manual process that involves an understanding between the different parties. There are various types of monitored connection topologies: cascaded, nested, and overlapping.

Counts are measured in number of errored bits. Ratio measures the bit error ratio.



OTN Results - TCM

Tandem Connection Monitoring (TCM) Definitions per ITU-T G.707, G.709, and G.783	
BIP-8	Bit Interleaved Parity - level 8 code error (mismatch) • Received and calculated BIP are different
BEI	Backward Error Indication (BEI/BIAE bits) • 0 .. 8 Number of BIP-8 violations detected • 9 .. F No BIP-8 error detected
BDI	Backward Defect Indication • Defect: Set to 1 for ≥ 5 consecutive frames • Normal: Set to 0 for ≥ 5 consecutive frames
LCK	Locked • Defect: STAT = 101 for ≥ 3 consecutive frames • Normal: STAT = 001
OCI	Open Connection Indication • Defect: STAT = 110 for ≥ 3 consecutive frames • Normal: STAT = 001
AIS	Alarm Indication Signal • Defect: STAT = 111 for ≥ 3 consecutive frames • Normal: STAT = 001
PLM	Payload Mismatch • Declared if the accepted payload type is not equal to the expected payload type(s) as defined by the specific adaptation function
TIM	Trail Trace Identifier Mismatch • Received and expected TTI are different

Go back to top Go back to TOC

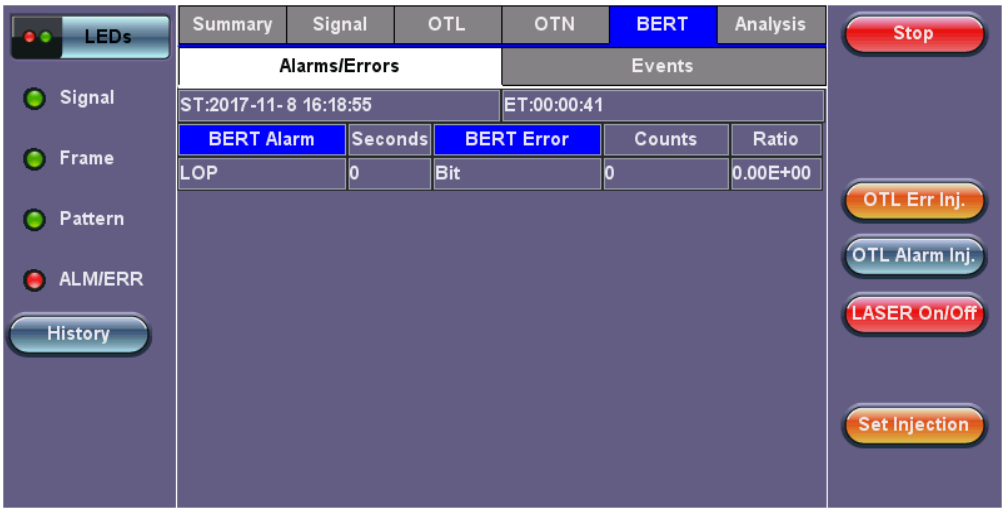
6.2.4.4 Events

The Events log tab lists Error and Alarm events recorded during the test. The events are presented in chronological sequence with start time and duration (alarms), event type, sequence number, ratio/count (errors), and test type.

Go back to top Go back to TOC

6.2.5 BERT

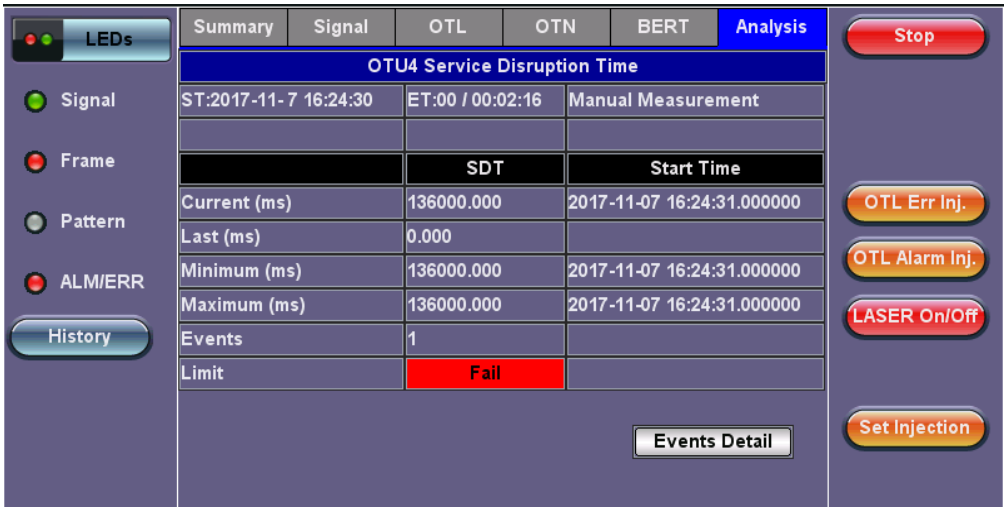
BERT alarms/errors results and Events are displayed in their respective tabs. Refer to BERT > Errors for a description of BERT alarms/errors.



BERT Results - Alarms/Errors

Go back to top Go back to TOC

6.2.6 Analysis

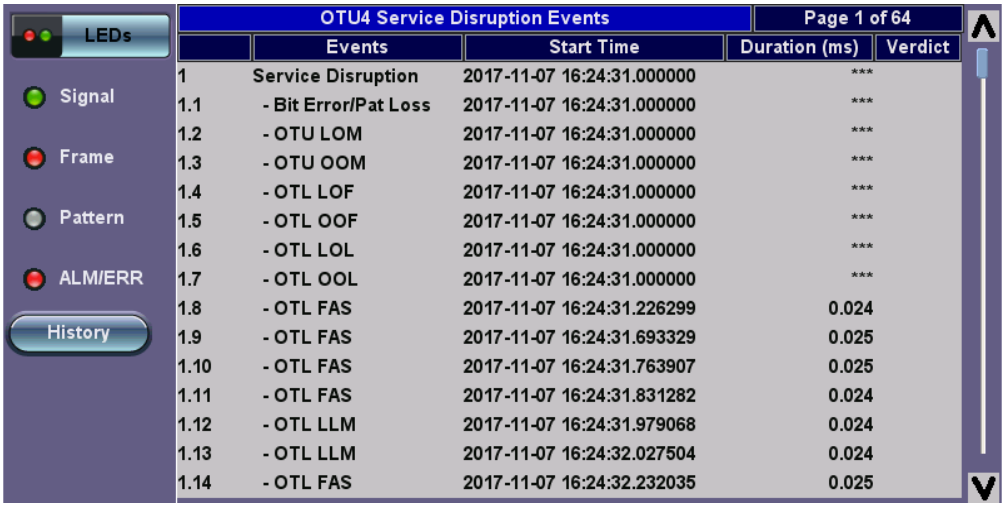


Analysis

Displays Service Disruption Time (SDT) results and start time and duration for each:

- **Current:** Current SDT measurement
- **Last:** Last SDT measured during the test
- **Min/Max:** Minimum and maximum SDT measured during the test
- **Events:** Number of service disruption events (SDTs)
- **Limit:** Displays Pass/fail results based on established threshold criteria

Tap on **Events Detail** for additional details on measured SDT events.
The event type for each service disruption and start and duration information is listed.



Analysis Details

Go back to top Go back to TOC

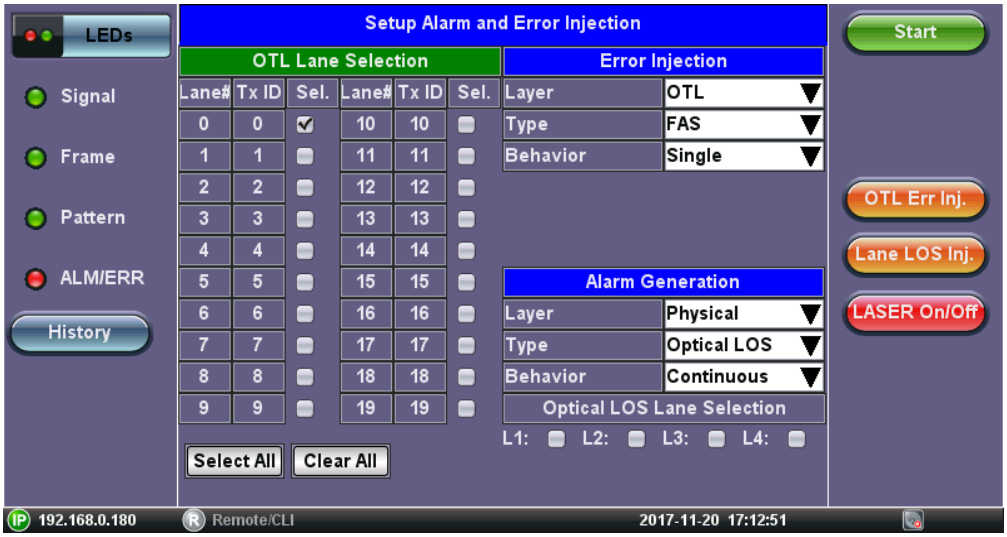
6.3 Alarm / Error Injection

Alarms and Errors can be injected into different signals. At any time during the test process, tap the **Error Injection** or **Alarm Injection** buttons to inject errors or generate alarms.

To access the setup for the alarms and errors, tap the **Set Injection** button on the right side of the screen.

Alarm and Error Injection Setup

OTL Alarm and Error Injection Setup



OTL/STL Lane Selection: For OTL and STL layers only

Error Injection:

- **Layer:** OTL, OTN, SDH, STL, BERT
- **Type:**
  - **OTL:** FAS, MFAS, LLM
  - **OTN:** MFAS, SM-BIP, SM-BEI, Corr. FEC, Uncorr. FEC, PM-BIP, PM-BEI, TCM1 to 6-BIP/BEI
  - **BERT:** Bit
  - **STL:** FAS, LLM
  - **SDH:** B1, B2, MS-REI, B3, HP-REI
- **Behavior:** Single, Single Burst, Cont. Burst, Rate

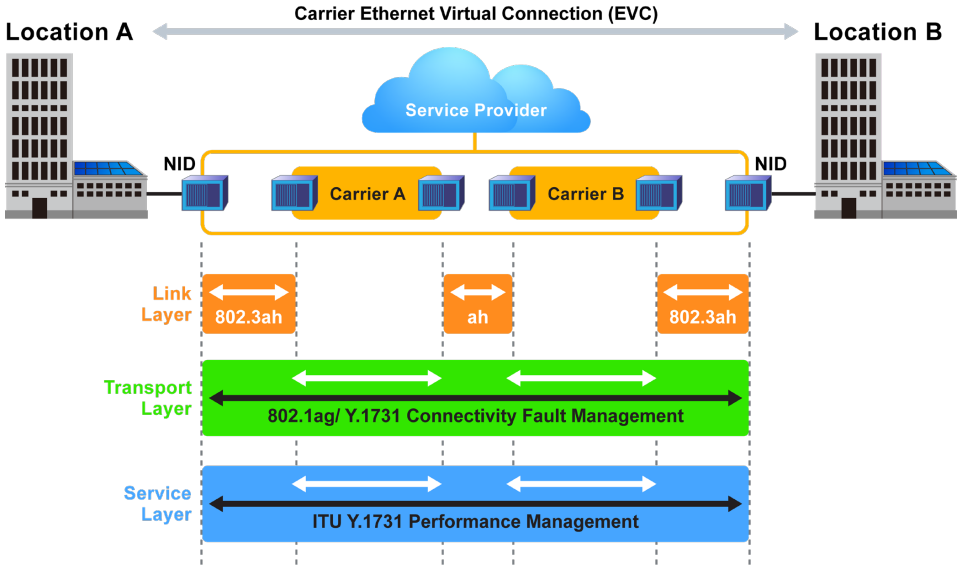
Alarm Injection:

- **Layer:** Physical, OTN, OTL, STL, SDH. Selecting the physical layer will display four optical lanes, L1-L4 or L1 to L10. Use these check boxes to select which lanes would be affected by the error generation. Note that, if no optical lane is selected, then no errors would be injected.
- **Type:**
  - **Physical:** LOS
    - LOS Lane Selection
  - **OTL:** OTL-LOF, OTL-OOF, OOLLM, OOMFAS
    - Continuous, Single Burst, Cont. Burst.
  - **OTN:** OTU-LOM, OTU-OOM, SM-IAE, SM-BDI, SM-BIAE, SM-TIM, ODU-AIS, ODU-OCI, ODU-LCK, PM-BDI, PM-TIM, OPU-PLM, and TCM1 to 6 ACI / OCI / LCK / BDI / TIM / BIAE / LTC
  - **STL:** LOF, OOF, STL-AIS
  - **SDH**: MS-AIS, MS-RDI, RS-TIM, AU-AIS, AU-LOP, HP-UNEQ, HP-PLM, HP-RDI, HP-TIM
- **Behavior:** Continuous, Single Burst, Continuous Burst

Click here to refer to OTU Alarm and Error Definitions.

Go back to top Go back to TOC

7.0 Ethernet OAM Testing



Ethernet OAM provides automatic defect detection, fault management and performance monitoring tools for network links and end-to-end Ethernet Virtual Circuits (EVC). The OAM service supports IEEE 802.3ah, IEEE 802.1ag, ITU-T Y.1731, and G.8113.1.

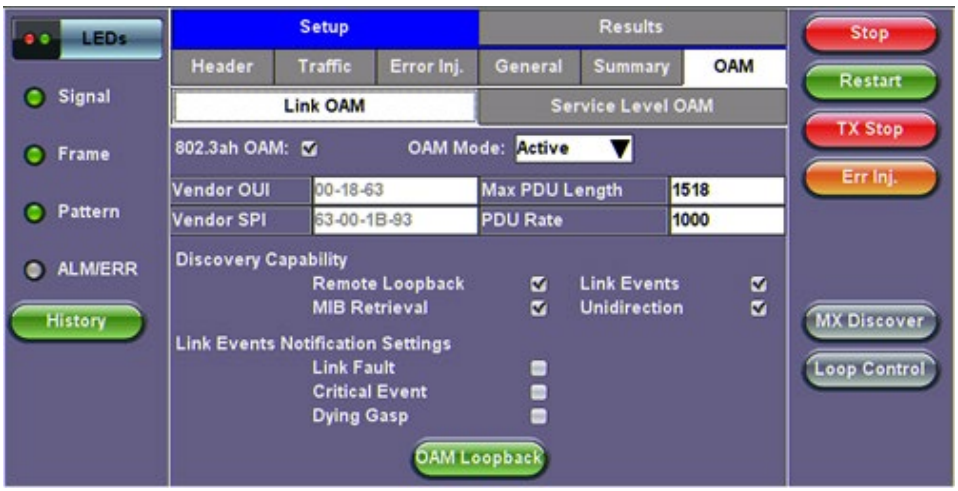
Go back to top Go back to TOC

7.1 OAM Setup

7.1.1 Link Level 802.3ah OAM Setup

802.3ah functions include:

- Discovery
- Link Performance Monitoring
- Remote loopback
- Fault detection



Link OAM Setup

- **802.3ah OAM**
  Tap on the check box to start 802.3ah protocol testing. Transmission of OAM PDUs starts as soon as the box is checked.

- **OAM Mode**
  Select Active or Passive mode from the drop-down menu. Active and passive mode determines the type of actions the test set will take. For more on acceptable Active/Passive mode combinations and actions, see section 802.3ah OAM Discovery.

Vendor OUI and SPI
Organization Unique identifier and Vendor specific information (similar to MAC address fields).

- **Max PDU Length**
  Advertised Max OAM PDU size (64 to 1518). After Discovery, the lowest of the local and remote will be used.

- **PDU Rate**
  100 to 10000 ms between consecutive OAM PDUs.

- **Discovery Capability**
  Enables OAM enabled devices to exchange their OAM capabilities, configuration, and identity to link partners. Check on the boxes to advertise selected capabilities during Discovery.

- **Link Events Notification Settings**
  Enable Event Notifications for Link Fault, Critical Event, and Dying Gasp.

Go back to top Go back to TOC

802.3ah OAM Discovery

Discovery is the first phase of the 802.3ah protocol. During Discovery, local and remote units exchange Information OAM PDUs indicating capabilities and configuration information (mode, PDU size, loopback support, etc.). After successful negotiation the OAM protocol is enabled on the link. If no OAM PDU is received after 5 seconds, Discovery is restarted. The device can be configured in Active or Passive mode combinations.

Action	Mode Passive	Mode Active
Initiates OAM discovery	No	Yes
Responds to OAM discovery	Yes	Yes
Peer must be in active mode	Yes	Yes
Sends Information OAM PDU	Yes	Yes
Sends Event Notification OAM PDU	Yes	Yes
Sends Variable Request OAM PDU	No	Yes
Sends Loopback Control	No	Yes
Reacts to Loopback Control	Yes	Yes

OAM Mode Active/Passive Actions

	Local Active	Local Passive
Remote Active	Yes	Yes
Remote Passive	Yes	No

OAM Mode - Acceptable Active/Passive Combinations

Notice that each device can be placed in any mode as long as the remote and local device are not both in passive mode.

Discovery Capabilities: Capabilities advertised during discovery process

- Remote Loopback
- Link Events: Supported, but no stateful
- MIB Retrieval: Can be advertised but is not supported in current release
- Unidirection

Remote Loopback: The user can transmit a loopback command to place the remote unit into loopback mode. Every frame received is transmitted back on the same port to ensure the quality of links during installation or troubleshooting and for fault isolation testing.

Link Events: Event OAMPDU is transmitted when the link error exceeds the threshold. Events may be sent once or multiple times. In the current software release, link events are only transmitted upon user request, not based on threshold crossing.

MIB Retrieval: Retrieves information on network devices and interfaces.

Unidirection: Checks for unidirectional transmission.

Go back to top Go back to TOC

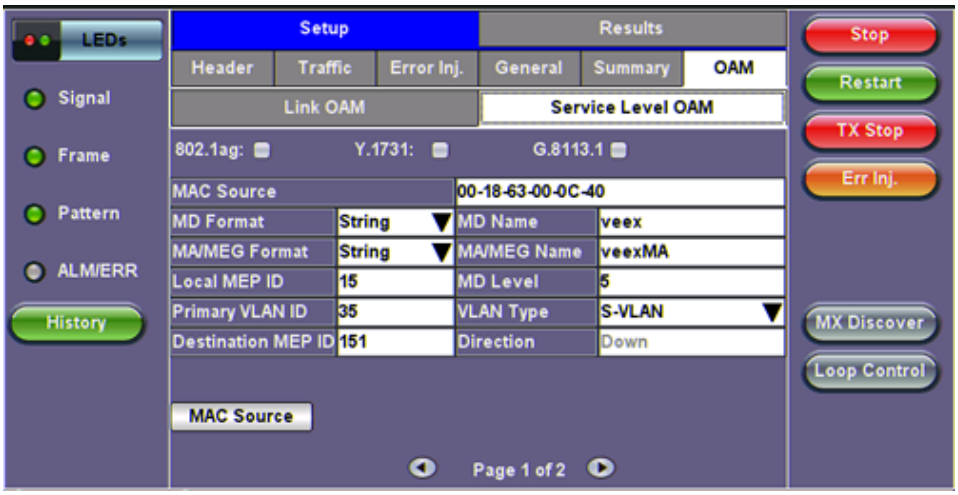
7.1.2 Service Level OAM: 802.1ag/Y.1731/G.8113.1 Setup

Under the **Service Level OAM** tab, the user has the option of starting the 802.1ag, Y.1731, or G.8113.1 test.

- Fill out the given parameters.

  MD Name, **MA Name**, **VLAN**, and **MD Level** input values must match for both connected OAM devices in order for the test to work. The **Destination MEPID** and **Local MEP ID** must also be inverted for the tests to work.

- Tap the box next to 802.1ag, Y.1731, or G.8113.1 to start the selected test. The transmission of OAM PDUs become active as soon as the checkmark is added to the test.



OAM - Service Level OAM (Page 1)

Service Level OAM Configuration Parameters

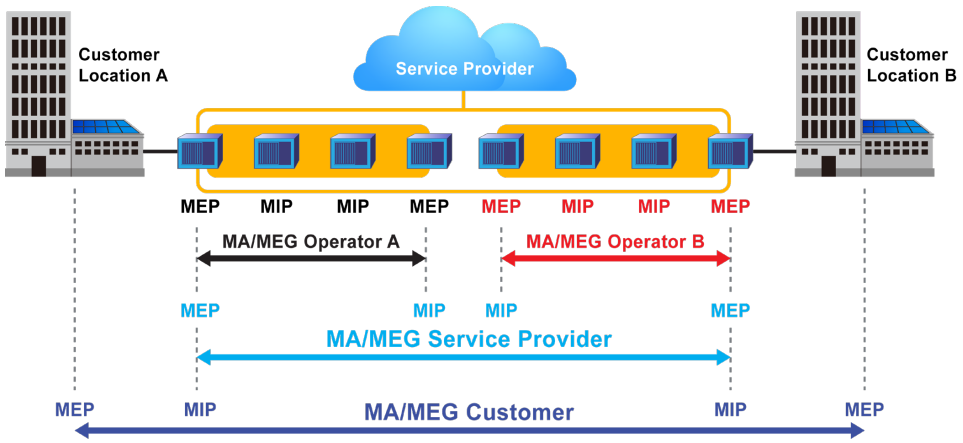
- **MAC Source:** Enter the source address of the test set or tap the **MAC Source** button to assign a default MAC address.
- **MD Format:** Configure the format of the Maintenance Domain Name:
  - **None**: No Maintenance Domain name
  - **MAC+2octet**: User configurable MAC address + 2 octets
  - **String**: User configurable ASCII character string
- **MD Name:** Name of the Maintenance Domain (only for 802.1ag)
- **MA/MEG Format:** Configure the format of the Maintenance Association name:
  - **VID**: User configurable ASCII character string
  - **String**: User configurable ASCII character string
  - **2 octet**: 2 octet integer
  - **ICC-Based**: User configurable ITU-T Y.1731 ITU Carrier Code (ICC) based
- **MA/MEG Name:** Enter the name of the 802.1ag MA or Y.1731 MG
- **Local MEP ID:** Local end point identifier along the path (1 to 8191)
- **MD Level:** Maintenance domain level (0 to 7)
- **MEP ID:** End point identifier (1 to 8191)
- **Primary VLAN ID:** VLAN ID associated with the MA or MEG
- **VLAN Type:** C-VLAN, S-VLAN, or None
- **Destination MEP ID:** MEP ID of the MEP end point
- **Direction**
  - **Up:** Inward facing MEP used for MA/MEG with a wider reach (i.e., end-to-end, beyond a single link)
  - **Down:** Outward facing MEP used for MA/MEG spanning a single link

Differences between 802.1ag, Y.1731, and G.8113.1

Selecting **802.1ag** enables Continuity Check Messages (CCM), Loopback Message (LBM) and Link Trace Message (LTM). **ITU-T Y.1731** provides all of the 802.1ag functionality with additional performance monitoring capabilities including Frame Loss (LM), and Delay (DM). **ITU-T G.8113.1** provides further monitoring of MPLS-TP traffic.

IEEE 802.1ag Definitions

- **Maintenance Domain (MD) :** Management space on a network that is owned and operated by a single network provider. There is a maintenance level (from 0 to 7) to define the hierarchical relationship between domains. Maintenance domains can be nested but never intersect. MD is defined by Operational or Contractual Boundaries (e.g., Customer/Service Provider/Operator).
- **Maintenance Association (MA):** Association of Maintenance. Elements that comprise the Maintenance domain.
- Maintenance Elements can either be MEPs (End points) or MIPs (Intermediate Points)
  - MEPs are at the edge of the network. They can generate and respond to OAM messages. A point-to-point EVC has only 2 MEPs, a multi-point EVC has multiple MEPs.
  - MIPs are located between the MEPs and can be used to isolate network problems. MIPs cannot generate OAM messages but can respond.
- **Maintenance Level:** Identifies the network hierarchy. Higher Level = Largest network. Level information present in all OAM PDU frames.
  - Level 0,1,2 = Operator domain
  - Level 3,4 = Service Provider domain
  - Level 5,6,7 = Customer domain



Some terms differ between IEEE 802.1ag and ITU Y.1731 protocols.The chart below describes the differences.

IEEE 802.1ag	ITU Y.1731 / G.8113.1
Maintenance Domain (MD)	No equivalent
Maintenance Association (MA)	Maintenance Entity Group (MEG)
Maintenance End Point (MEP)	Maintenance entity Group End Point (MEP)
Maintenance Intermediate Point (MIP)	Maintenance entity Group Intermediate Point (MIP)

Definition Equivalencies

Function	MEP	MIP
Initiates CCM messages	Yes	No
Initiates Loopback and Linktrace messages	Yes	No
Responds to Loopback and Linktrace messages	Yes	Yes
Y.1731 Performance Management messages (AIS,LCK, TST,LM, etc) initiates and responds	Yes	No
Forwards messages	Yes (upper maintenance layer) No (lower maintenance layer)	Yes (upper maintenance layer) No (lower maintenance layer)

Maintenance Point Roles

Go back to top Go back to TOC

OAM Services Setup

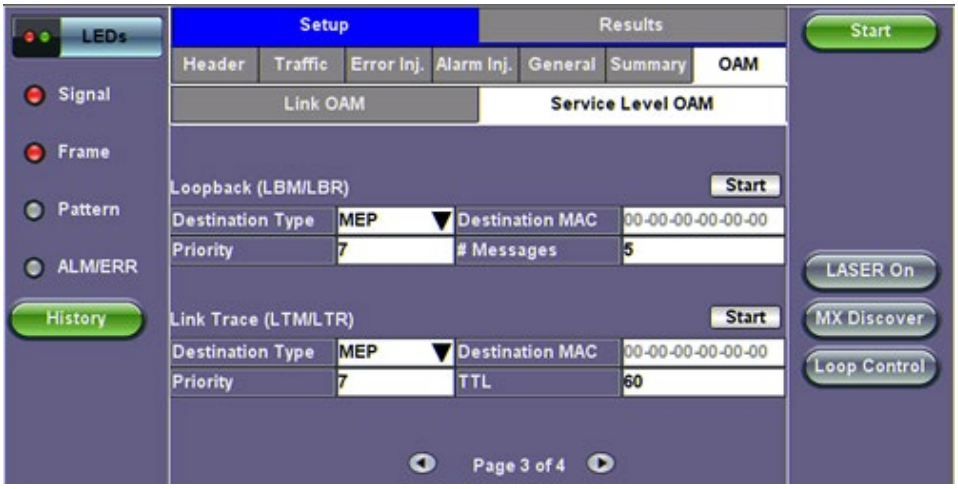
Under the same tab, OAM Services pertaining to 802.1ag, Y.1731, and/or G.8113.1 can be enabled. The tests listed include:

- Continuity Check (CCM)
- Loopback (LBM/LBR)
- Link Trace (LTM/LTR)
- Loss Measurement (LMM/LMR) (Y.1731 and G.8113.1)
- Delay Measurement (DMM/DMR) (Y.1731 and G.8113.1)
- Multi Protocol Label Switching Transport Profile (MPLS-TP) (G.8113.1 only)

General Setup

- To run any 802.1ag/Y.1731/G.8113.1 test, tap on the checkbox next to the corresponding test.
- To initiate testing for individual OAM services, press **Start** next to the desired service (NOT the green start button which initiates Throughput testing).
- **CCM** testing is initiated by selecting Enable from a drop-down menu.

Details on individual test parameters will be listed in the specified section.



Pressing Start next to Loopback (LBM/LBR) initiates testing for that OAM service

802.1ag/Y.1731/G.8113.1 Connectivity Fault Management Functions

Connectivity Fault Management Functions supported by the test set are as listed:

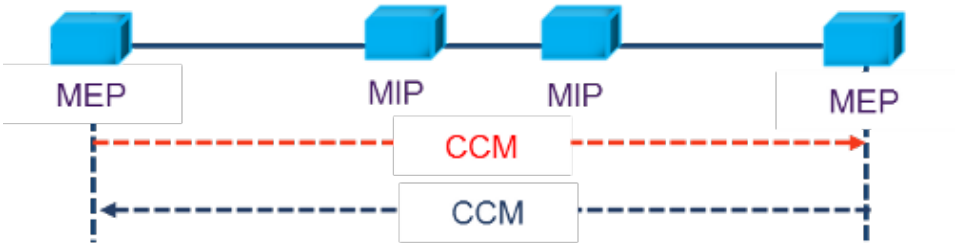
- Fault Detection – Continuity Check:
  - CCM "heartbeat" messages are transmitted at a configurable periodic interval by MEPs.
- Network/Path Discovery – Link trace message:
  - Equivalent to a traceroute test. MIPs and MEPs along the path send a response.
- Fault verification and isolation – Loopback:

- Verify connectivity to a specific point in the message. Equivalent to ping test.

Continuity Check Messages (CCM)

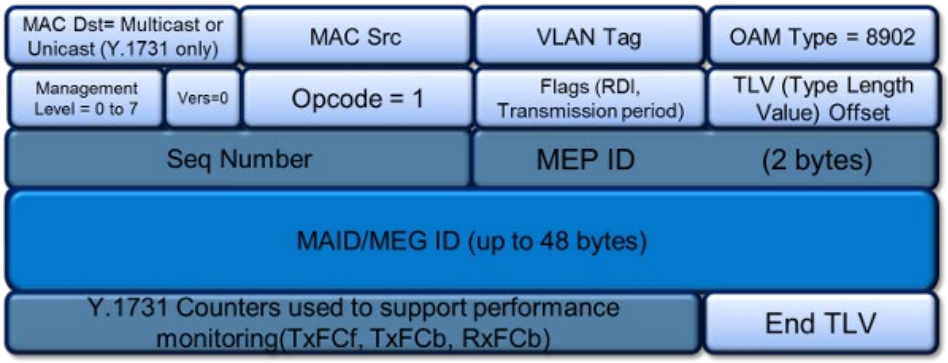
CCM Messages are multicast messages sent from MEP to MEP at configurable intervals. Loss of continuity is detected after no CCM is received for 3.5 times the CCM interval.

There can be 4,094 VLANs per port and up to eight maintenance levels. This yields a worst case CCM transmission rate of 9.8 million CCMs per second if 3.3ms interval is used.



Continuity Check Message (CCM)

RDI Flags added in CCM Messages indicates loss of continuity in the remote direction.

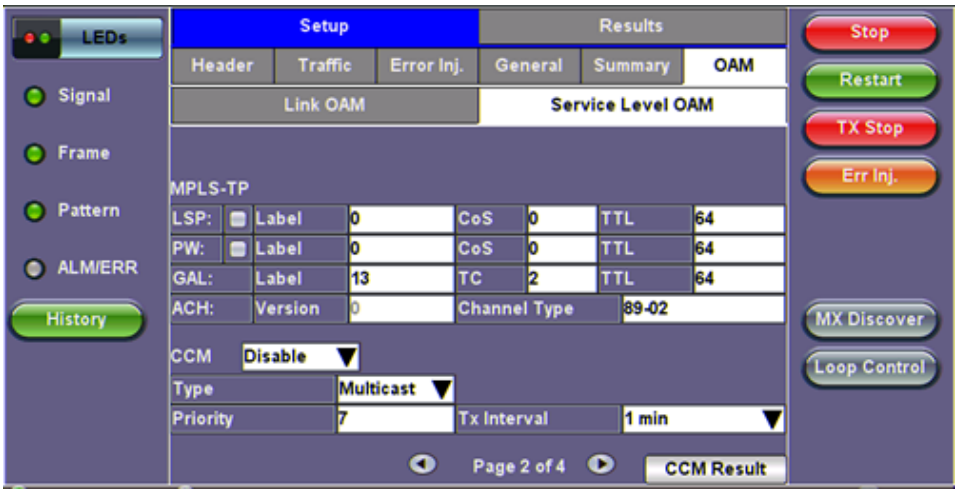


CCM Message Format

CCM Configuration Parameters

- **CCM:** Enable/Disable sending Continuity Check messages.
- **Type:** Unicast/Multicast. If CCM is set to Enable, this field is ignored. In unicast mode you must enter the MAC address of the destination unit.
- **Priority:** 802.1p priority in the CCM VLAN Tag.
- **Tx Interval:** Choose from the supported CCM intervals: 1 s, 10 s, 1 min, 10 min.

The **CCM Result** button is a shortcut that brings the user directly to the CCM Results tab.

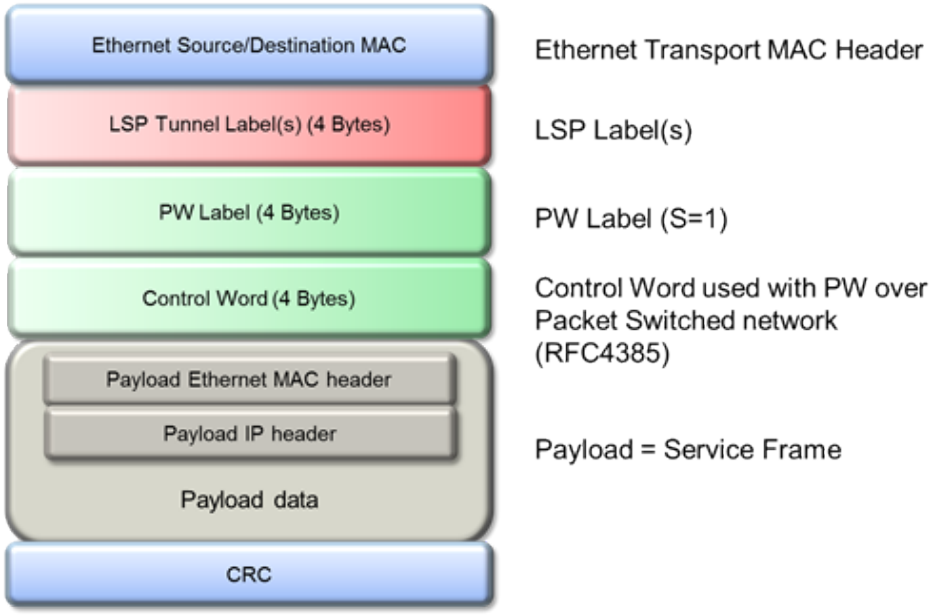


MPLS-TP, CCM Settings - Service Level OAM (Page 2)

Go back to top Go back to TOC

G.8113.1 Performance Management Functions

MPLS-TP



MPLS-TP over Ethernet with PW Label

MPLS-TP is a Layer 2 technology that combines the benefits of MPLS and removes the complexity of IP networking. It uses the MPLS Label switching mechanism, but with static route provisioning (no Label Distribution Protocol LDP or RSVP-TE). MPLS-TP supports an advanced set of OAM functions and path protection mechanisms. In-band OAM traffic is on the same path as data traffic.

Multi Protocol Label Switching Transport Profile (MPLS-TP) Configuration Parameters

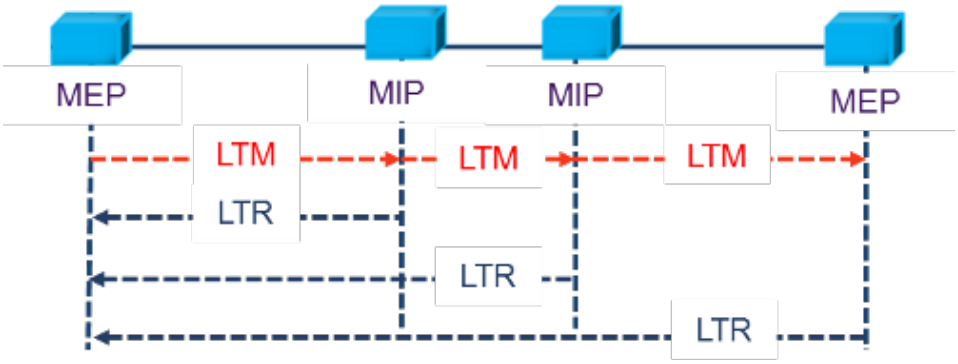
- For the path and tunnel, select **LSP** (Label Switched Path) and **PW** (Pseudowire).
  - **Label**: Configure in the range of 16-1,048,575 (labels 0-15 are reserved).
    ***Note**: Composed of 20 bits which allows for the creation of over one million labels.*
  - **CoS**: Enter the Classes of Service.
  - **TTL**: Enter the Time to Live. It will be decremented by 1 each time it crosses a hop. Frame is not forwarded after TTL reaches 0.
- **ACH** : Enter the Generic Associate Label
  ***Note:** For Pseudowires, the ACH used the first four bits of the PW control word.*
- **Version**: Enter the G-Ach version. The default is set to 0.
- **Channel Type**: Enter the channel type (16-bit field).

Go back to top Go back to TOC

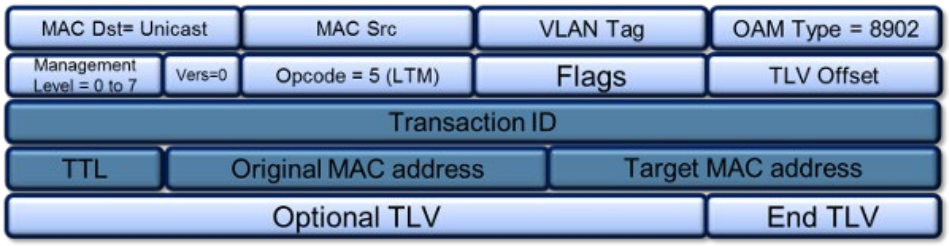
Link Trace and Loopback Messages

Link Trace Messages (LTM/LTR)

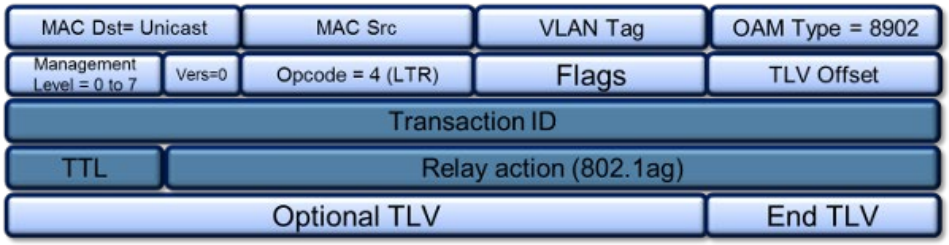
LTM (Link Trace Message) Multicast messages are transmitted on demand to a destination MAC address. All MIPs and destination MEPs respond with LTR (Link Trace Reply) and forward the LTM on to its destination.



LTM Diagram (LTM/LTR)



Link Trace Message Format

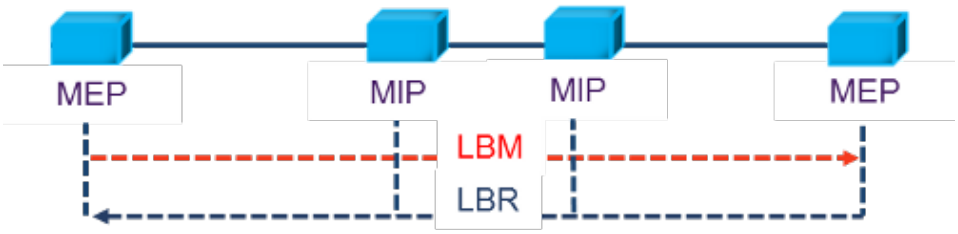


Link Trace Response Format

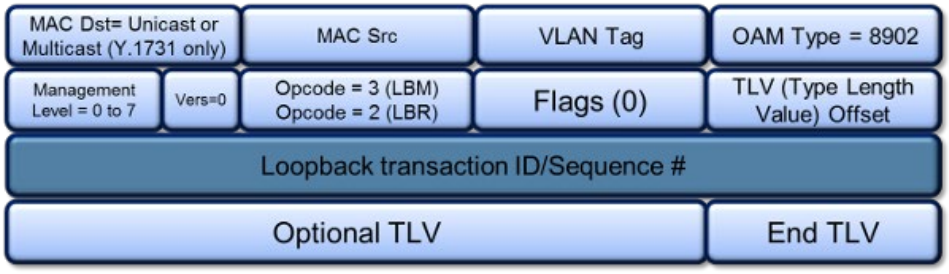
Go back to top Go back to TOC

Loopback Message (LBM/LBR)

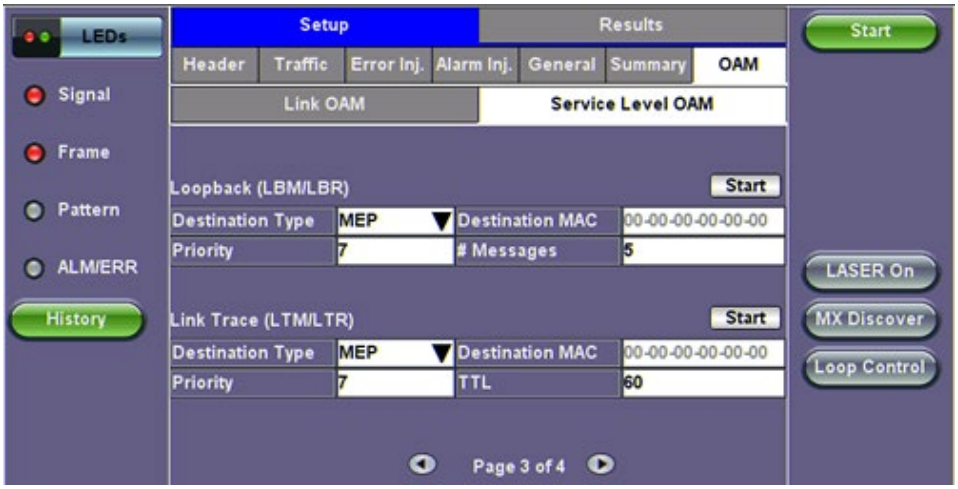
LBM (Loopback Message) are unicast messages transmitted on demand to a destination MAC address. A destination address responds with an LBR (Loopback Reply Message).



LBM Diagram (LBM/LBR)



Loopback Message Format



LBM/LBR, LTM/LTR Settings - Service Level OAM (Page 3)

Go back to top Go back to TOC

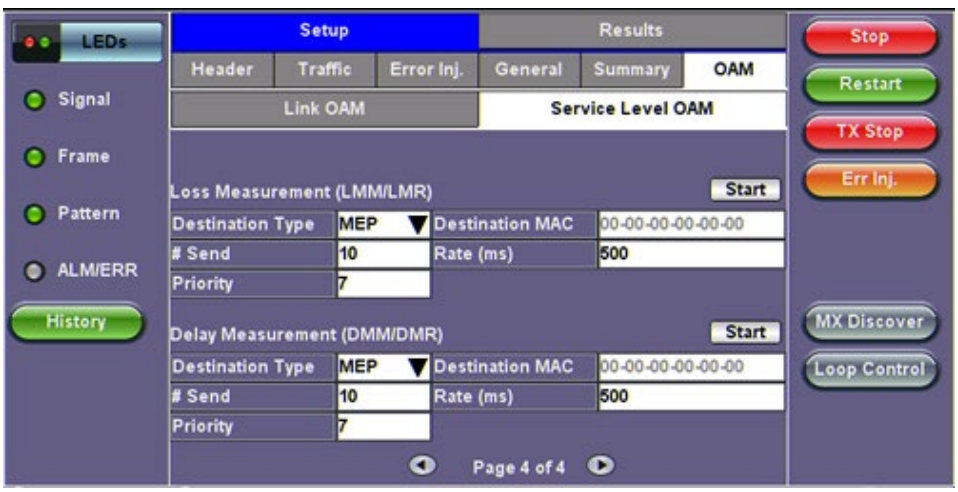
Link Trace (LTM/LTR) and Loopback Message (LBM/LBR) Config. Parameters

- **Destination**
  - **MEP**: Sends LTM/LBM to the destination MEP as configured on Page 1.
  - **MAC**: Sends LTM/LBM to a destination MAC address.
- **Priority:** 802.1p priority in the LTM/LBM VLAN Tag.
- **Destination MAC:** Configure the destination MAC address used for the LTM/LBM. This field is only used if Destination is set to MAC. If destination is set to MEP, this field is ignored.
- **# Messages:** Enter the number of Loopback messages to be sent (LBM test only).
- **TTL:** Enter the Time to Live field in the LTM message. TTL will be decremented each time it crosses a hop (MIP) (LTM test only).

Press **Start** to initiate testing.

Go back to top Go back to TOC

Y.1731/G.8113.1 Performance Management Functions



Loss (LMM/LMR) and Delay Measurement (DMM/DMR) Configuration Parameters

- **Destination**
  - **MEP**: Sends LMM/DMM to the destination MEP as configured on Page 1
  - **MAC**: Sends LMM/DMM to a destination MAC address
- **Priority**: 802.1p priority in the LMM/DMM VLAN Tag
- **Destination MAC:** Configure the destination MAC address used for the LMM/DMM. This field is only used if Destination is set to MAC. If destination is set to MEP, this field is ignored.
- **# Send** - Configure the number of LMM/DMM frames to send up to 50
- **Rate :** Configure the LMM/DMM frame interface rate (min: 100 ms; max: 10 seconds)

Press **Start** to initiate testing.

Frame Loss Measurement

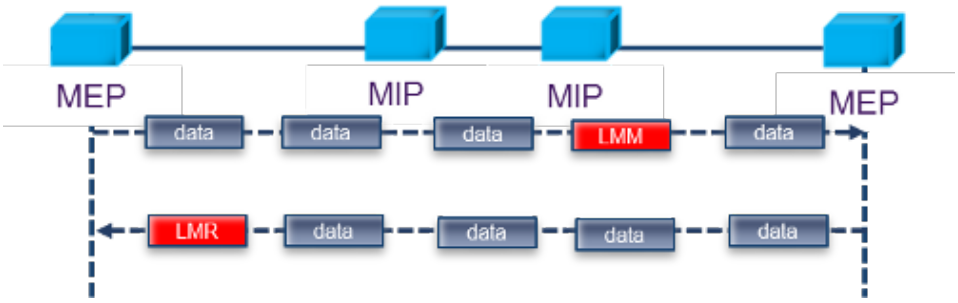
Two local counters for each peer MEP:

- TxFCf: Counter for in-profile data frames transmitted towards peer MEP
- RxFCf: Counter for in-profile data frames received from peer MEP

Single-ended ETH-LM:

- On demand OAM
- MEP sends LMM frame (Unicast DA or Multicast Class 1 DA) and receives LMR frame (Unicast DA) with counters

CCM frames contain frame counters.



Single Ended Frame Delay Measurement

LMM frames contain frame counters.

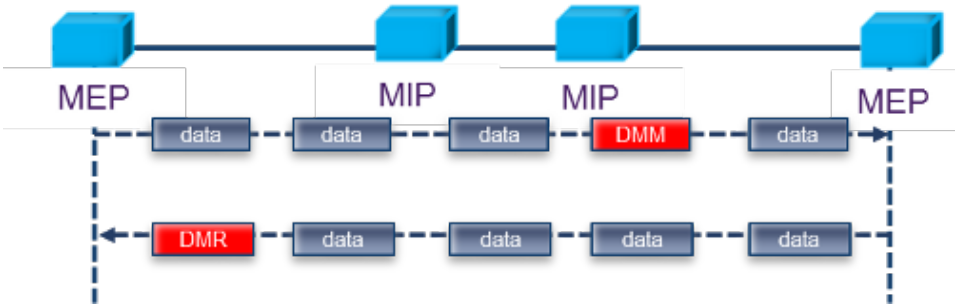
Delay Measurement

On demand OAM for measuring Frame Delay (FD) and Frame Delay Variation (FDV):

- TxTimeStampf = Timestamp transmission of DMM frame
- RxTimef = Reception time of the DMM frame
- RxTimeb = Reception of DMR frame

Two-way ETH-DM:

- DMM frame (Unicast DA or Multicast Class 1 DA for multipoint measurement) & DMR frame (Unicast DA)
- FD = RxTimeb – TxTimeStampf



Dual Ended Frame Delay Measurement

DMM and DMR frames contain timestamp info.

Go back to top Go back to TOC

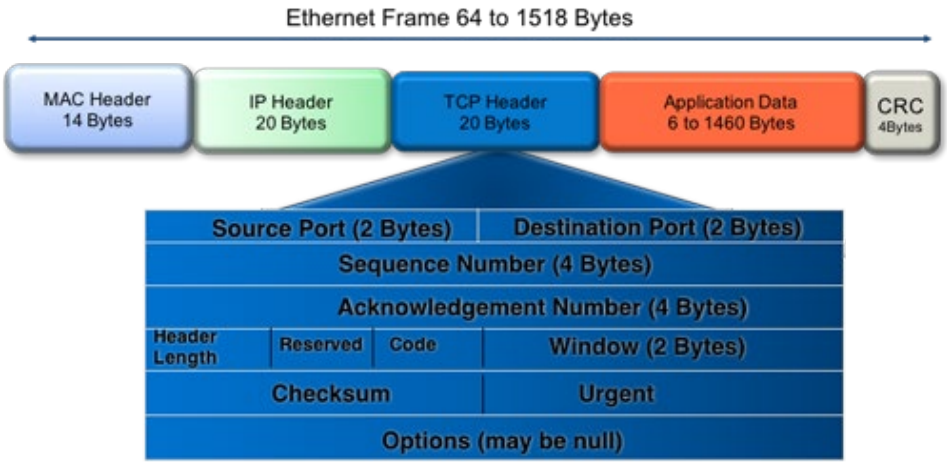
7.1.3 Layer 4+ Applications

Stateful TCP testing refers to the validation of TCP connections used for the TCP/IP Protocol Stack. A V-PERF test will validate that the TCP parameters in the network were set up correctly. The optional V-PROBE is used as remote server to establish TCP connections and validate that the network is configured correctly for seamless passing of TCP traffic. It will also verify the maximum throughput for TCP traffic. Typically in the field, after running layer 2 & layer 3 tests successfully, a customer may still complain that their connection is slow to deliver their applications. Running a stateful TCP test will help verify maximum throughput rates in the download and upload direction. If throughput performance is poor, the test can help identify what the issue could be.

TCP Protocol and Overview

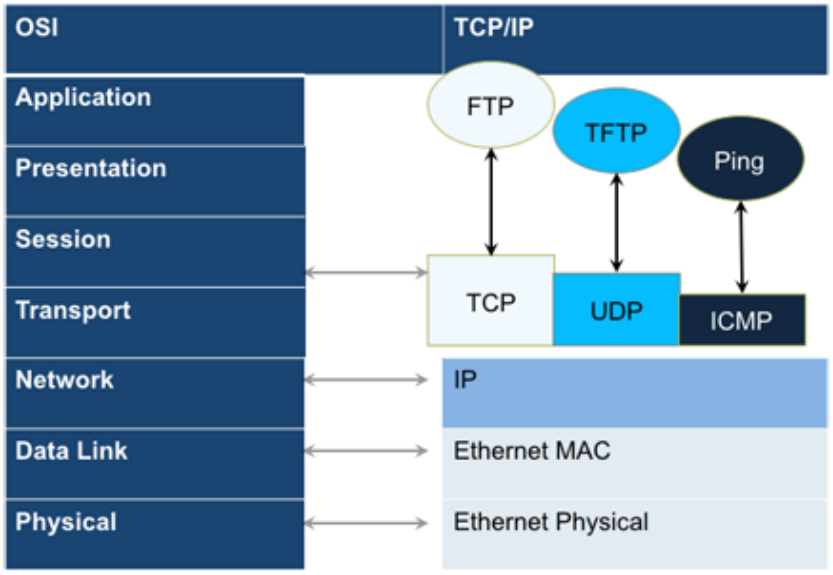
Fundamental TCP parameters are the ideal TCP Window Size and Throughput. The complete list of relevant measurements include

- TCP Window Size
- TCP Throughput
- Number of Connections Established
- Download Time
- File Transfer Size
- Retransmits



Transmission Control protocol is the most widely used transport layer protocol. TCP is used by most application protocols: HTTP, FTP, Telnet. It provides the following services:

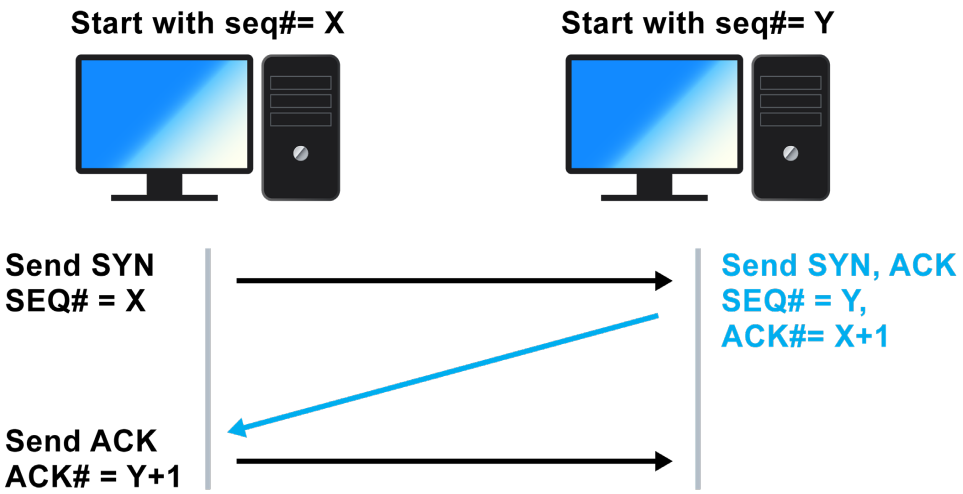
- End-to-end connection
- Multiplexing/Demultiplexing of separate sessions
- Flow control



TCP is a connection oriented protocol. A Connection is established prior to data transmission between the two end devices (client and server). A 3-way handshake procedure is used to establish connection.
When a connection is established, the data transfer can start. TCP uses sequence numbers to reassemble data and verify that no data has been lost.

TCP uses Window mechanism for Flow Control:

1. The Sender indicates in the Window size the data it is prepared to receive
2. The **Window size** is the amount of outstanding data that can be sent before acknowledgement is received
3. If data is lost, the window size is decreased and less data is sent prior to acknowledgement



- **Step 1:** Client sends a SYN message with SYN flag set in the TCP header. The Sequence number specifies the number assigned to the first segment.
- **Step 2:** Server receives SYN packet and sends SYN + ACK packet SYN flag set, ACK flag set Sequence number specifies the server's starting sequence number. Acknowledgment number means that the server has received X and expects X+1.
- **Step 3:** Client receives SYN + ACK and send ACK back. ACK number means that server has received Y and expects Y+1.

Go back to top Go back to TOC

RFC 6349 Testing Methodology

RFC 6349 is a practical testing methodology consisting of 4 different steps for measuring end to end TCP Throughput and Performance in a managed IP network.

- Step 1 **Max MTU Search**:
  Search for the maximum packet length that can be sent through the network without segmentation. The Path MTU search follows RFC4821 (Packetization Layer Path MTU Discovery).

- Step 2 **Round Trip Time (RTT) Search**:
  Measure of the roundtrip time between the TCP segment sent and the acknowledgement received, the test has to be done in a network that is not congested to obtain the real round trip delay (not accounting for network buffer delay).

- Step 3 **Bottleneck Bandwidth (BB) Search**:
  For this step, a Layer2/3 test can be done (RFC2544 or Y.1564) to determine the maximum throughput rate supported by the network.

- Step 4 **Bandwidth Delay Product Calculation**:
  Based on RTT and BB results, the BDP is computed to estimate the optimal window size that should be used for testing (Auto mode). User can also specify fixed window size.

Key Metrics:

- TCP Bandwidth Delay Product
- Transfer Time Ratio
- TCP Efficiency
- Buffer Delay

TCP Bandwidth Delay Product is the theoretical maximum of data that can be transmitted based on network delay and throughput rate.

BDP (Bytes) =
Link Bandwidth (bps) x RTT (s)/ 8

To completely occupy the available bandwidth the Window size must be set to the BDP value.

The ideal TCP transfer time is based on the Maximum achievable TCP transfer rate, calculated based on the Bottleneck Bandwidth (BB) and the layer 1-2-3-4 overheads associated with the network path. The actual TCP transfer time measures the time it takes to transfer data.

Transfer Time Ratio =
Actual TCP Transfer Time / Ideal TCP Transfer Time

Link Speed	MAX Achievable TCP Throughput	Ideal TCP Transfer Time (rounded)
100Mbps Ethernet	94.9 Mbps	9 s
1G Ethernet	949.2 Mbps	1 s
10G Ethernet	9492.2 Mbps	0.1 s

Example of an ideal TCP transfer time based on a 1500 Bytes size MTU and 100MB file download:

TCP retransmission is done when TCP segments are lost during transmission or an acknowledgement is missing. Segments can be retransmitted more than once.

There is no direct correlation between the number of Ethernet frames lost at the physical layer and the number of TCP retransmission, since a single lost acknowledgement could trigger many retransmission.

TCP Efficiency =
Transmitted Bytes + Retransmitted Bytes/ Transmitted Bytes x 100

The Buffer Delay represents the increase (or decrease) in Round Trip Time (RTT) during a TCP throughput test compared to the baseline RTT.

A large RTT Buffer delay indicates that the network is experiencing congestion and that segments are being delayed.

Buffer Delay =
Average RTT – Baseline RTT/ Average RTT x 100

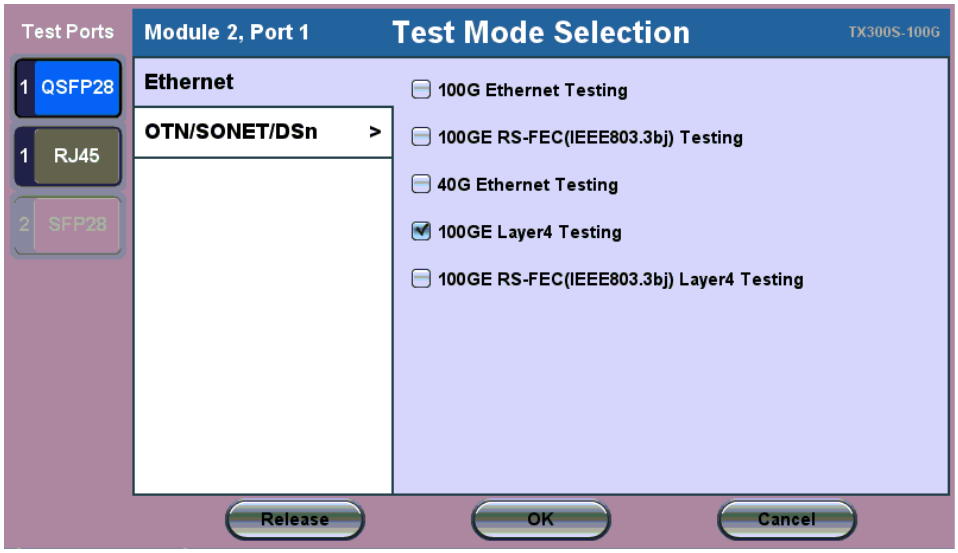
Go back to top Go back to TOC

Layer 4+ Applications Configuration

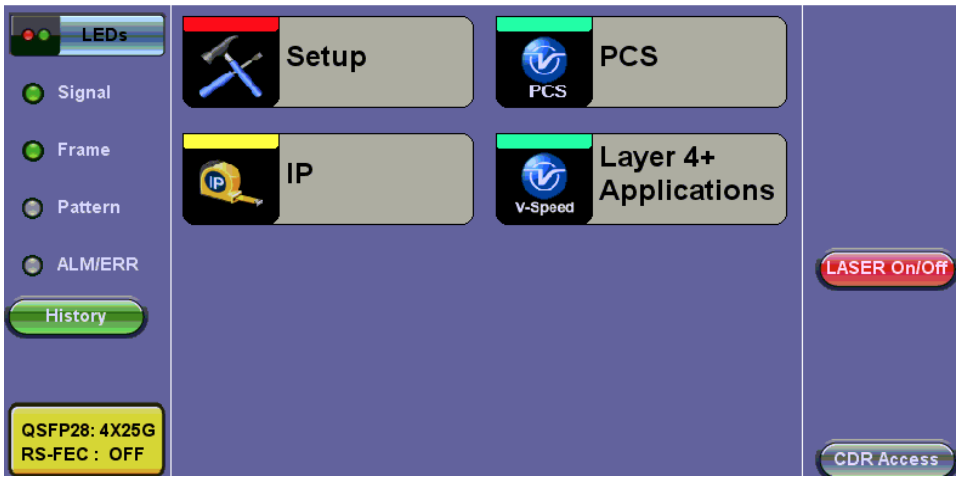
Before launching V-PERF, it's necessary establish an IP connection. For V-PERF testing, repeat these steps for both the far end and near

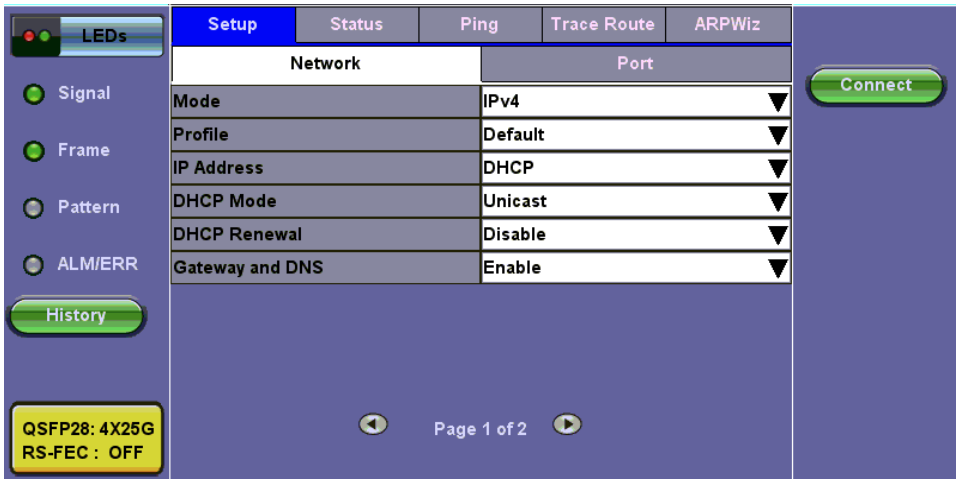
end test sets.

1. Launch the desired Ethernet Test Application from the Main Menu.



2. For testing on SFP/XFP ports, turn the **Laser On**. Tap the **IP** button. Configure a static IP address for testing. If you are in an environment that supports DHCP, select DHCP from the IP Address menu, then tap **Connect**.





3. Once the proper IP information is entered, press **Connect**. An **IP: PASS** status indicates proper connection.

4. Go to **Layer 4+ Applications**. The test application will load.

Saving Test Results

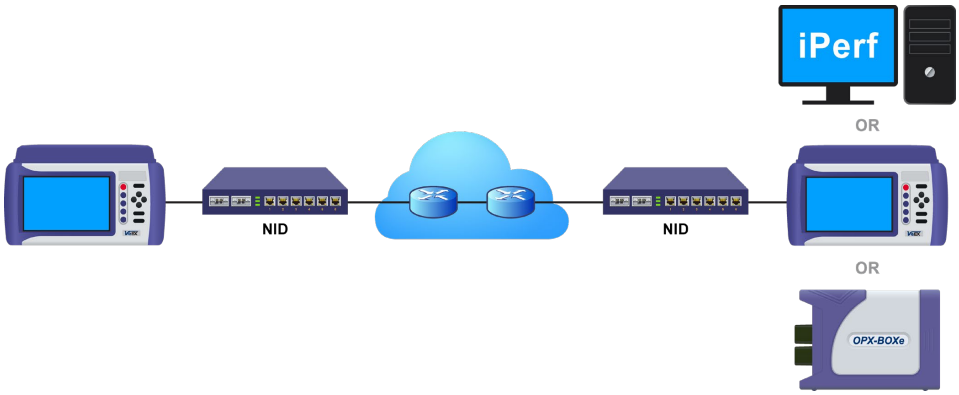
Test results can be saved to the File Server using the Folder hardkey  . Results can be retrieved via USB drive or remotely using the Web UI. Refer to **File Management** in the **TX300s, MTTplus, RXT-1200, or UX400 platform manuals** for more information on saving files.

Go back to top Go back to TOC

7.1.3.1 V-PERF

The V-PERF test suite consists of the full TCP Throughput test Compliant with RFC6349 (Test Set to Test Set only) and also the original stateful TCP testing to iPerf/iPerf3 server or to our V-Probe.

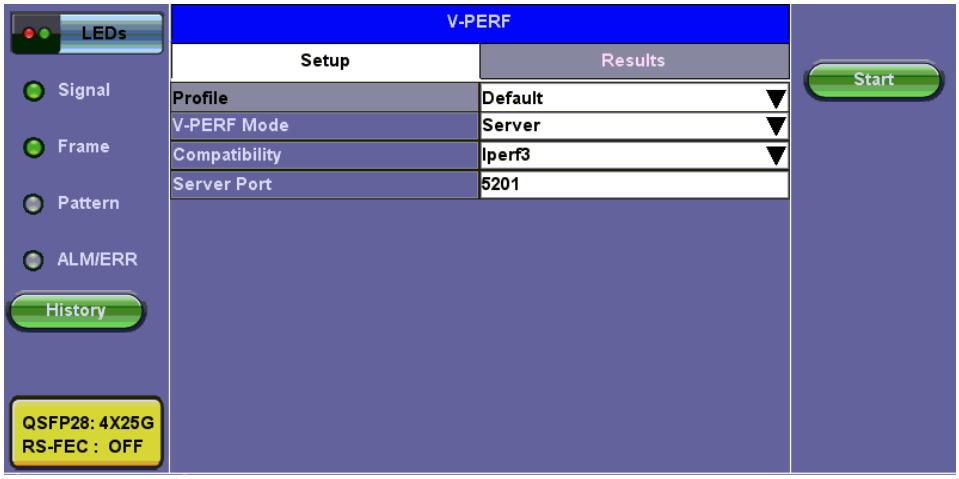
- Stateful TCP Test up to 1GE/10GE/100GE line rate
- TCP Client/Server and Bi-Directional modes
- Compatible with iPerf Client/Server
- MTU search per RFC4821
- Round Trip Time Measurement
- Configurable TCP Window
- Multi-Window size tests
- Measurements: TCP Throughput rate (min, max, average), Transfer file size and duration, Transfer time ratio, TCP Efficiency %, Buffer Delay %.



TCP Throughput Test Diagram

Server/Client - Unidirectional Configuration and Results

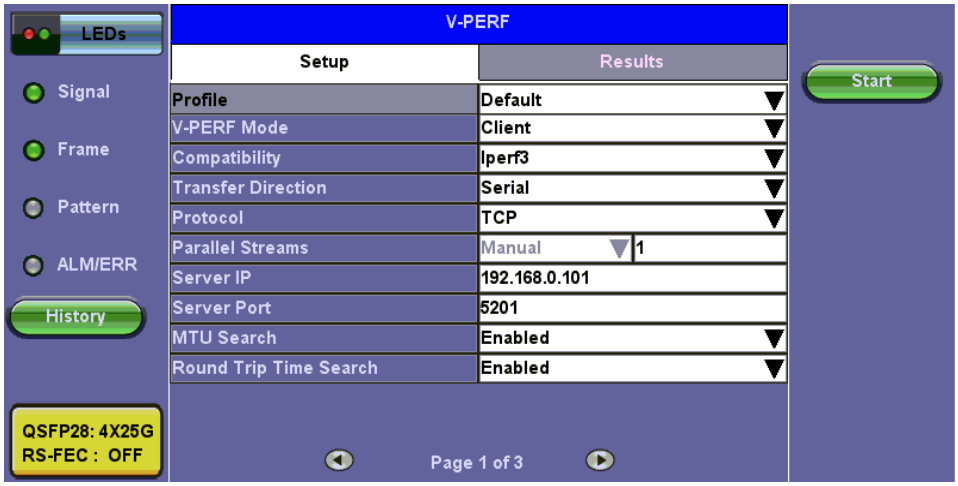
1. After loading the Layer 4+ Application, set one test set as a Server from **TCP Mode**. Press **Start**.



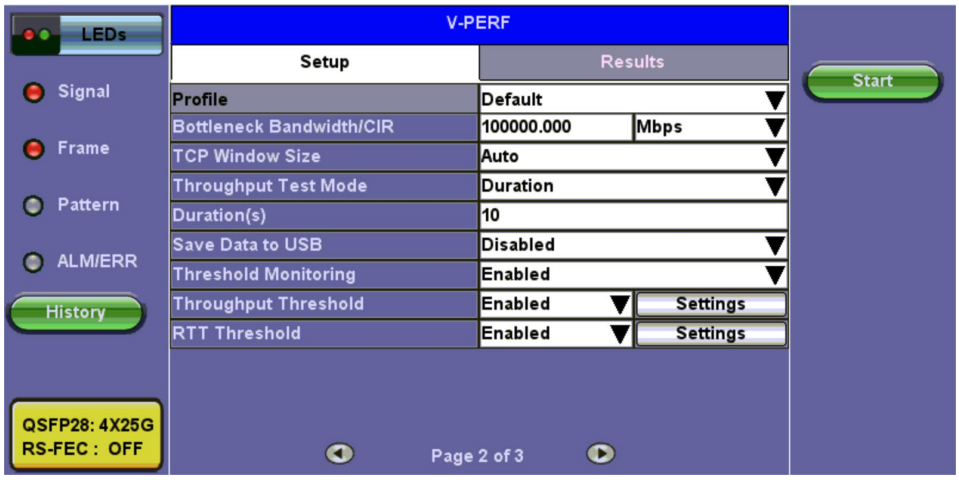
Test Set #1 - V-PERF Setup - Server

Test Set #1 After Pressing Start

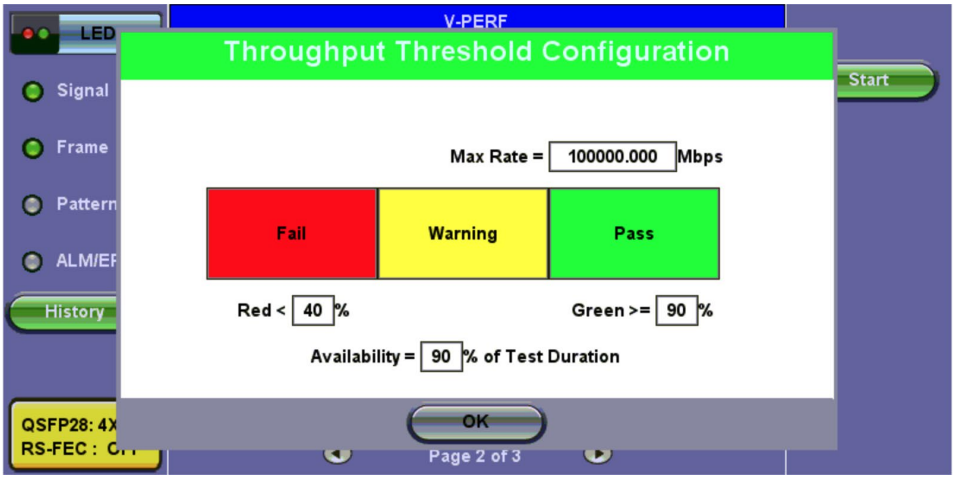
2. Set the other test set as a Client. Tap on Page 2 to configure the Throughput Test Mode type. MTU Search, Round Trip Time Search, Bottleneck Bandwidth, and Window Size and Threshold Monitoring options are also on Page 2.



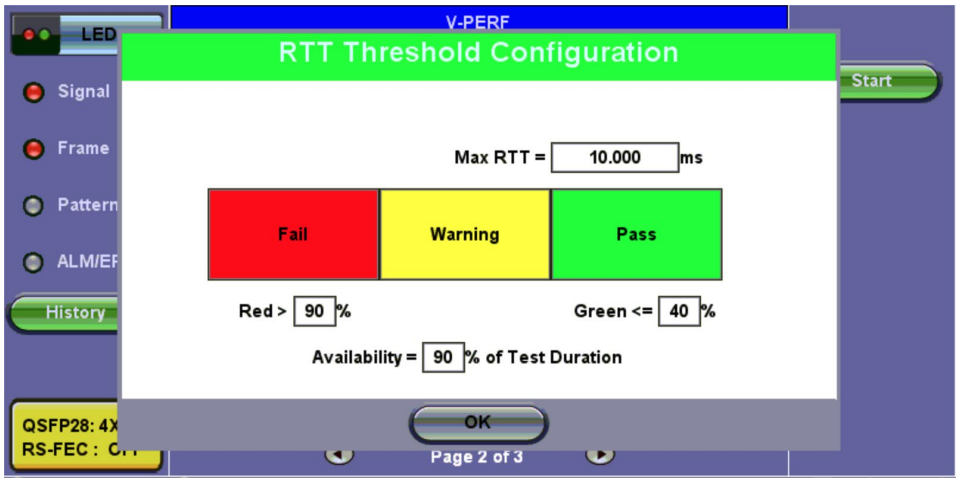
Test Set #2 - V-PERF Setup - Client



Test Set #2 - V-PERF Setup - Client - Page 2

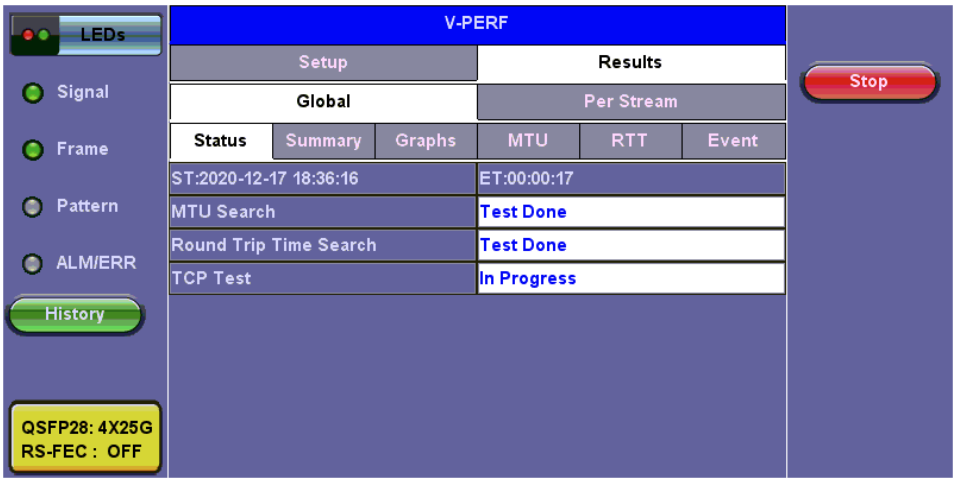


Throughput Threshold Configuration



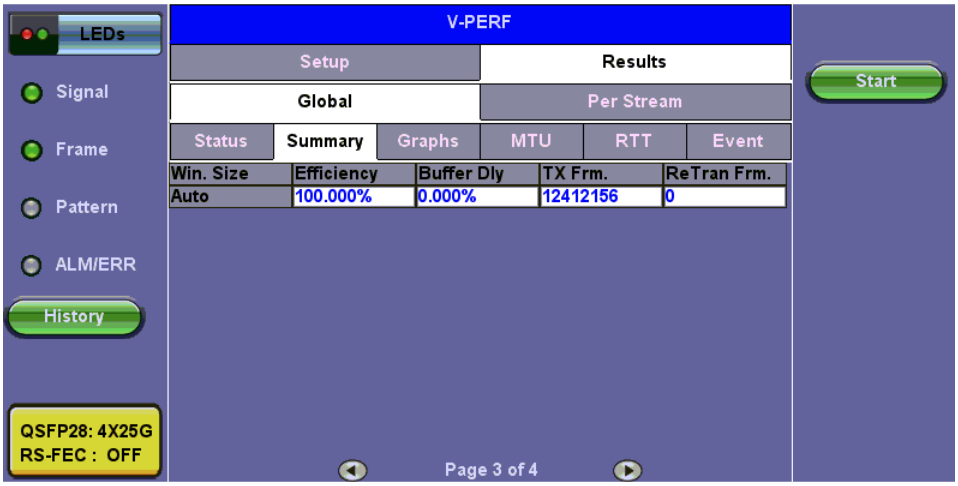
RTT Threshold Configuration

3. Connect the two test sets to the Near End (NE). Press **Start** on the Client unit.

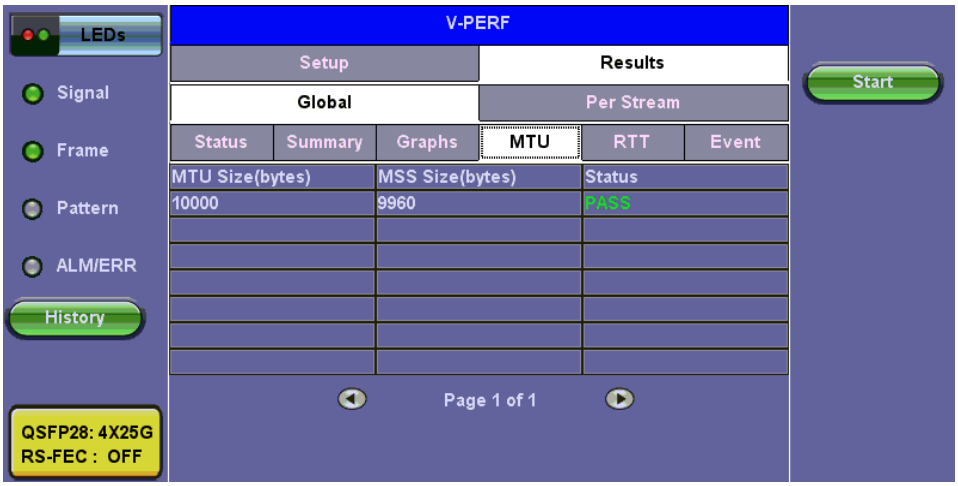


Test Set #2 - Client - Results - Status

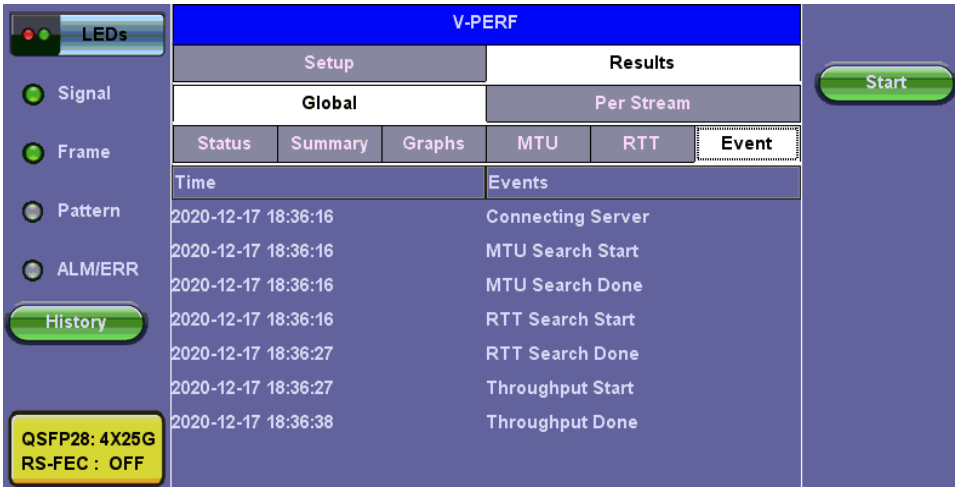
The **Summary** tab displays the following RFC 6349 metrics: TCP Efficiency, Buffer Delay & Retransmits.



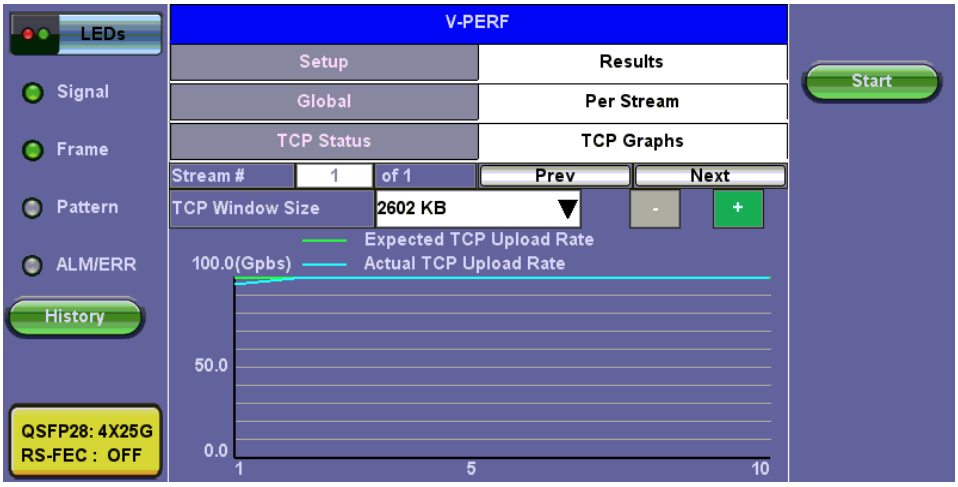
Test Set #2 - Client - Results - Summary



Test Set #2 - Client - Results - MTU



Test Set #2 - Client - Results - Event



Test Set #2 - Client - Results - Per Stream TCP Graphs

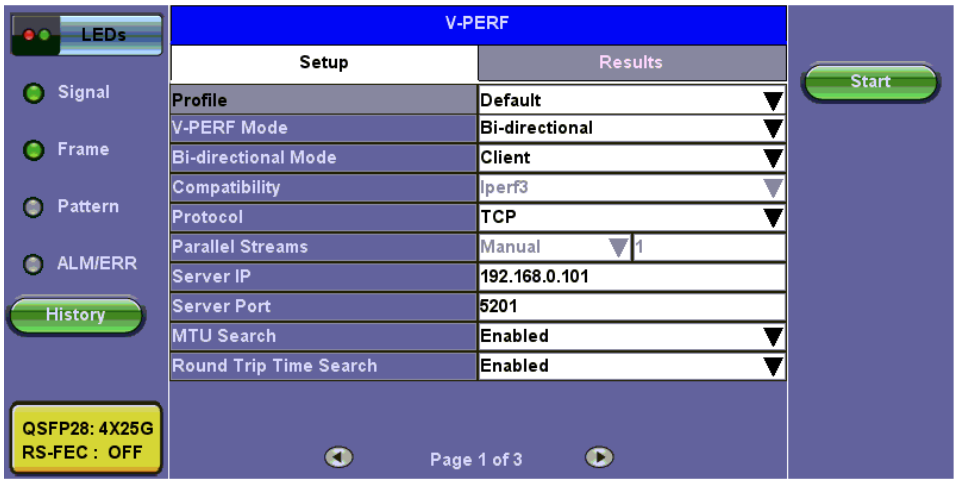
Go back to top Go back to TOC

Bi-Directional Configuration and Results (VeEX Enhanced Testing Methodology Implementation)

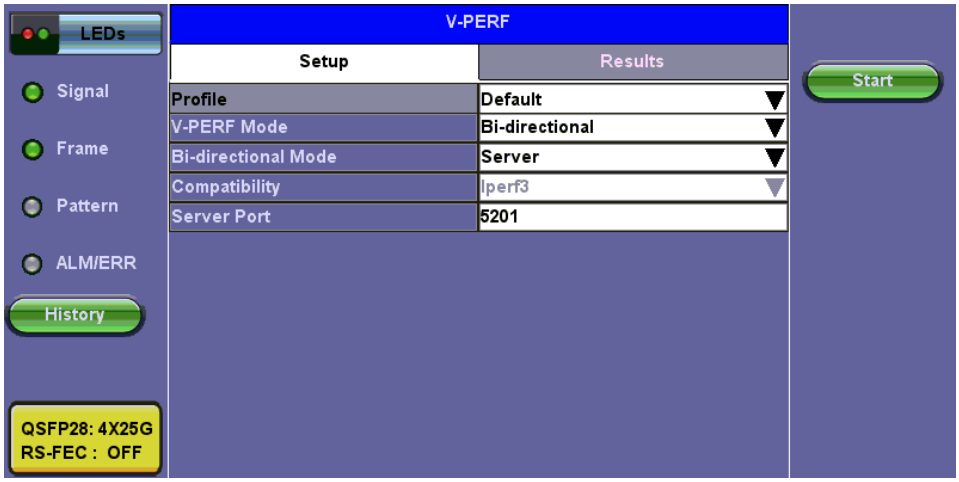
The Bi-Directional TCP testing methodology is unique as it allows two separate tests to run simultaneously on the same link in different directions. Both Test Sets are actually configured as Client & Server at the same time, saving the time of having to run each direction separately.

To simplify the configuration for this example, one test set is configured as a Client and the other as a Server. In reality however, as mentioned previously, both tests will be running simultaneously.

1. Select Bi-Directional from the V-PERF Mode drop-down menu on both test sets. Select the Bi-Directional Mode as Client on the Local End and Server on the Remote end.



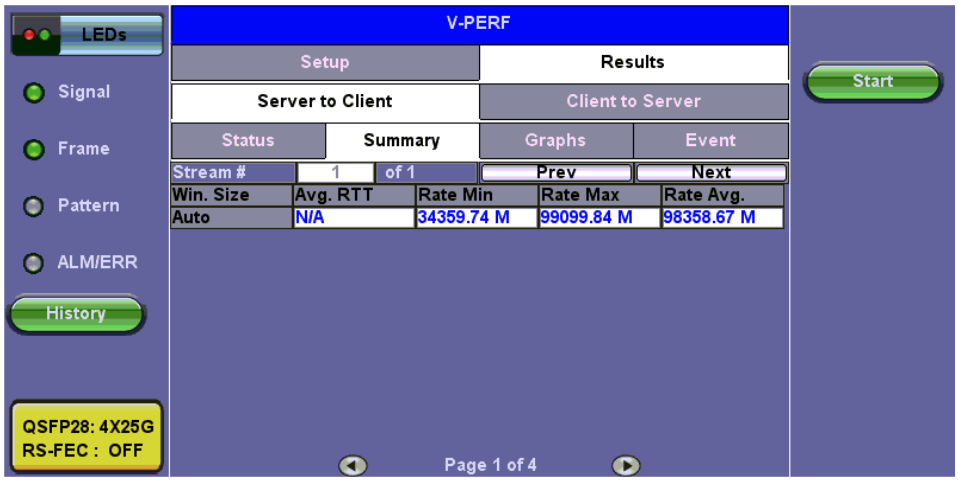
Local End Tester - Client - Bi-Directional Setup



Remote End Tester - Server - Bi-Directional Setup

Press **Start** test at the Near End. The entire test flow is automated. Results will show up as the tests run – a total of 4 sessions.

- Current test progress is shown in **Event**.
- **Summary (Page 1)** provides information on the current session running and the RFC-6349 key performance indicators. Tap on **Client Results** to verify the metrics.
- Final results of the completed test will show under **Status**.



Bi-Directional - Server Results - Summary

Go back to top Go back to TOC

8.0 Fibre Channel

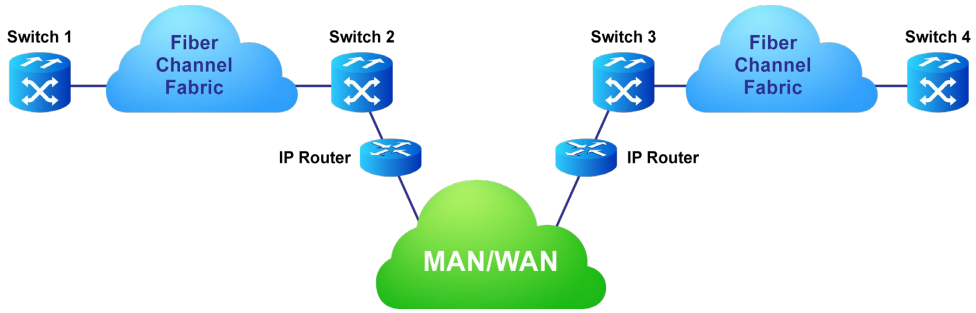
Fibre Channel Applications

Introduction

Enterprises worldwide rely on complex IT infrastructures to store and maintain critical data and applications. Storage Area Networks (SANs) have evolved to improve availability, resiliency, performance, modularity and geographical distribution of data storage systems and Fiber Channel is an important technology for linking SANs together.

Fiber Channel over IP

Often, IP-centric networks are used to connect SAN islands over Local Area Networks (LAN), Metropolitan Area Networks (MAN), or Wide Area Networks (WAN). An operational IP backbone (Layer 2 or Layer 3 topology) capable of delivering the required bandwidth for Fiber Channel applications is an absolute prerequisite. The test set equipped with Ethernet and Fiber Channel features is able to verify FCIP connections in a variety of network configurations.



Fiber Channel over SDH/SONET

Service providers have made huge investments in SDH/SONET infrastructure over many decades, hence storage over SONET/SDH networks are considered an essential part of any operator's SAN extension solution. DWDM networks are perfect for transporting high-density, high-bandwidth SAN applications over short distances while SDH/SONET/OTN networks are often used for longer distance applications. The test set is equipped with a strong set of features needed to verify the strategic components and network interconnects.

Key Test Applications

Transport layer - Most customers or providers transporting Fibre Channel are not necessarily trained or concerned with testing the higher protocol layers -- instead the transport groups tasked with transporting this data across a point-to-point or ring type DWDM network are more likely to ask: Did data arrive error free or were any bit errors encountered? Was the CRC corrupted or were any code violations experienced? Testing the transport layer is crucial and normally includes the FC-0 Layer, FC-1 Layer, and parts of the FC-2 Layer where:

- FC-0 addresses the physical layer: the optical fiber, connectors, and associated optical signal parameters.
- FC-1 addresses the transmission protocol encoding/decoding, and special characters used for protocol management.
- FC-2 addresses the signaling protocol layer, which comprises the framing protocol and the flow control process.

The Fibre Channel option addresses all the transport layers by measuring the optical power level and supporting the generation/analysis of bit errors, order sets, frame delimiters, frame transmission, and the generation of primitive sequences. User defined bytes, fixed test patterns or industry-standard PRBS patterns can be selected and inserted into the payload field depending on the test layer. Bit error, CRC error and Code violation insertion are useful features to verify Mux/Demux equipment for error monitoring and detection.

Internal SD Card Format

Buffer-to-Buffer Credit Estimation - To avoid loss of frames during transmission, the Fibre Channel protocol uses a buffer-to-buffer flow control mechanism between link partners. During the login process, the remote node informs the local nodes as to the number of receive buffers it has available. For each frame received, the remote port returns a R_RDY frame to indicate that one of the receive buffers is now free - the local port in turn increments its available credit counter by one for each R_RDY acknowledgement frame it receives. However, as the distance between nodes or link partners increases, so does the time it takes for the transmitting node to receive the R_RDY frame because of signal propagation delay. The standard practice for a 1Gbps Fibre Channel link is to allow 1 buffer credit for each 2km of distance.

Go back to top Go back to TOC

8.1 Setup

“Fibre Channel ” versus “Fiber Channel”

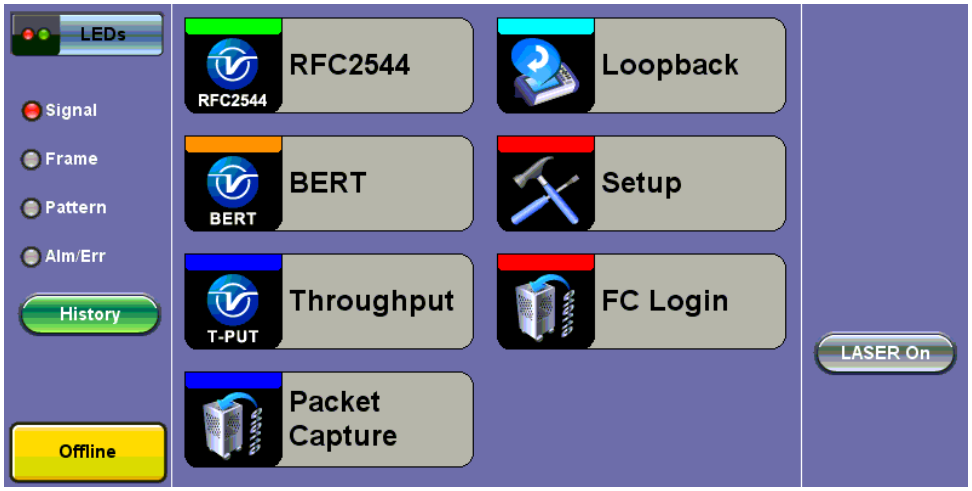
Confusing naming and spelling conventions have stuck with Fibre Channel during its development.
The word “channel” in no way indicates a preference for channel protocols or environments.
Even though “fibre” and “fiber” are semantically equivalent (“fibre” is the international English spelling), “Fibre Channel” is the official spelling for the technology.
“Fiber” has come to mean more specifically the optical (glass) media used for long-distance (up to 10 km) connections.

Go back to top Go back to TOC

8.1.1 Test Applications

After selecting the Fiber Channel test mode, the **Fiber Channel** main menu appears.

If using the UX400-Combo module, refer to the UX400 Platform manual for more details on how to assign a test module. Depending on the test platform and installed module, availability of test applications and features may vary.



Fiber Channel Main Menu

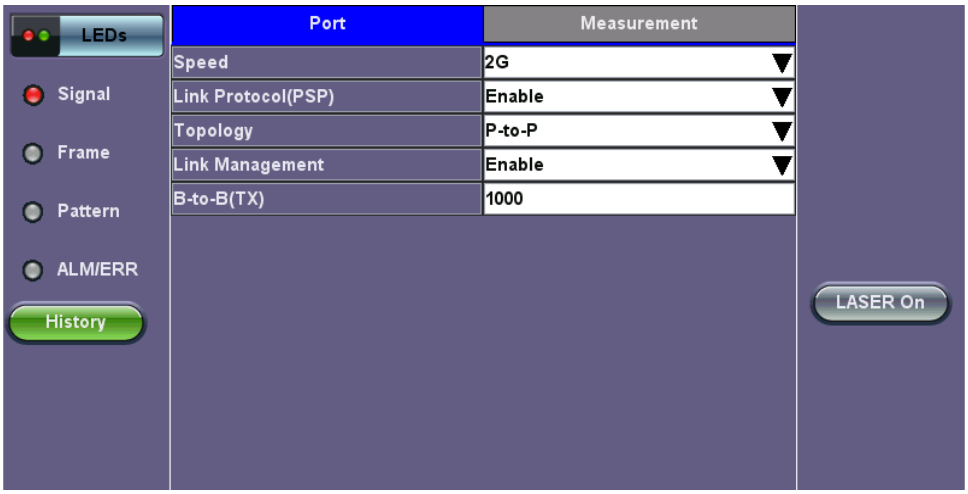
The Fiber Channel Main Menu provides shortcut application buttons for FC BERT, FC RFC 2544, FC Throughput, FC Loopback, and IP testing.

Some test capabilities or test rates may be specific to the product configuration or may require the purchase of a software option in order to be displayed or be enabled.

To configure ports and measurements, press **Setup** on the main menu.

Go back to top Go back to TOC

8.1.2 Port Configuration



Fiber Channel - Port Setup

On the **Port** tab, select from the following options to configure your FC port:

- **Speed:** Selectable test rates via drop-down menu:
  - 1G (1.0625 Gbps)
  - 2G (2.125 Gbps)
  - 4G (4.25 Gbps)
  - 8G (8.50 Gbps)
  - 10G (10.52 Gbps)
  - 16G (14.025 Gbps)
  - 32G (28.05 Gbps)

- **Link Protocol:** Enables or Disables the PSP
  - Enabling the Primitive Sequence Protocol (PSP) allows link management
  - Disabling the Primitive Sequence Protocol (PSP) forces the port into an Active state with no link management
    - PSP is an Ordered Set transmitted repeatedly which is used to establish and maintain a link.
    - PSP also when this setting is enabled
    - When a Primitive Sequence is received and recognized, a corresponding Primitive Sequence or Idle is transmitted in response. Recognition of a Primitive Sequence requires consecutive detection of 3 instances of the same Ordered

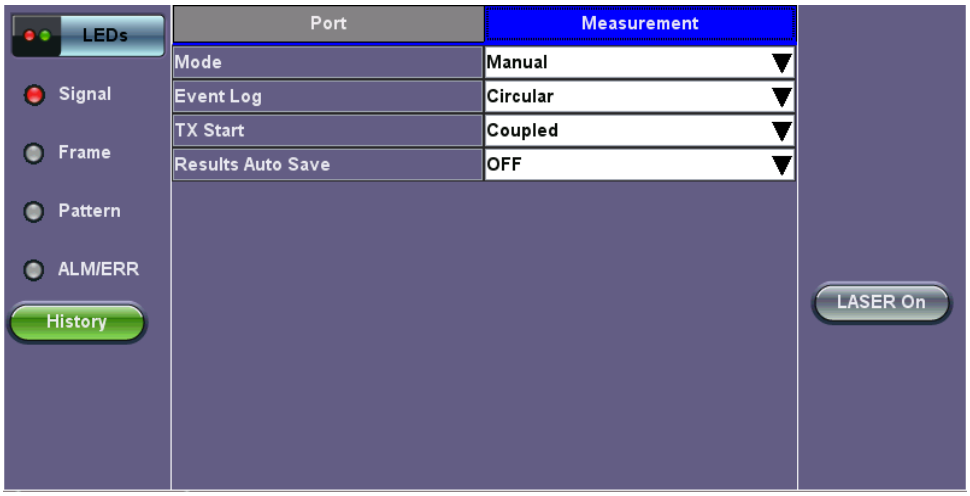
Set.
    - The Primitive Sequences supported by the standard are:
        - Offline (OLS)
        - Not Operational (NOS)
        - Link Reset (LR)
        - Link Reset Response (LRR)

- **Topology:** Point-to-Point (P-to-P) mode is supported.
    - In Point-to-Point mode, only two ports are used, connected by a fiber optic link. The transmitter of each port is connected directly to the receiver of the opposite port. There is no ambiguity in addressing, and there is no question of availability.
    - ***Note**: Fibre Channel defines three topologies: 1) Point-to-Point, 2) Arbitrated Loop, and 3) Fabric; however, Point-to-Point topology is the least complex.*

- **Link Management:** Enable or Disable
    - Only available when PSP is enabled
    - Initializes the Fibre Channel link and manages various states, including link failure, loss of synchronization, loss of signal, or protocol violations

- **B-to-B (Tx): Buffer to Buffer:** Valid settings are in the range from 1 to 65535.
    - Number of local port frame buffers are available to receive frames from another port
    - Determines how many frames can be sent before receiving R_RDY acknowledgements.
    - “Credits”, or the number of frames, are negotiated between the n_ports and f_ports at the time of login
    - Both ports on the link exchange values of how many frames they are willing to receive at a time from the other port. This value becomes the other port's BB_Credit value and remains constant as long as the ports are logged in.
    - Each port also keeps track of BB_Credit_CNT.
        - **Transmitter**: For each frame transmitted, BB_Credit_CNT is incremented by 1.
        - **Receiver**: The value is decremented by 1 for each R_RDY Primitive Signal received from the other port.

Go back to top Go back to TOC



Fiber Channel - Measurement Setup

On the **Measurement** tab, select from the following options to setup your FC measurements:

- **Mode**: Manual or Timed
    - **Manual:** Measurement is started (by the User) by pressing the **Start** button and ended when pressing the **Stop** button.
    - **Timed:** Measurement duration can be programmed in seconds, minutes, hours or days.
- **Event Log**: Circular or Blocked. When set to Circular, log events may be overwritten with the latest events if the circular buffer fills up. The oldest event will be deleted so that the new event can be added. When set to Blocked, the log will not be overwritten when buffer is full and the latest events will not be logged.
- **TX Start:** Separated or Coupled. Configures how the measurements are started when in BERT and Multiple Streams test modes.
    - **Separate:** Independent control (Start/Stop) of the transmitter is enabled. At the start of the test only the receiver is turned on -- the user must start the transmitter manually.
    - **Coupled:** Transmitter and receiver are turned on at the same time, and the Tx and Rx measurements start at the same time at the start of the test.

Go back to top Go back to TOC

8.2 BERT/Throughput

8.2.1 Overview

The test set complies with ANSI NCITS FC-FS recommendations and has the ability to test 1,2,4,8,10,16 and 32 Gigabit Fibre Channel.

- 1/2/4/8G Fiber Channel: The unit verifies the 8B/10B PCS Layer with a basic primitive set at FC-1 or FC-2 lower layers.
- 10/16/32G Fiber Channel: The unit verifies the 64B/66B PCS Layer with a basic primitive set at FC-1 or FC-2 lower layers.
    - FC-1 Layer addresses the transmission protocol encoding, decoding, and special characters used for protocol management
    - FC-2 is the signaling protocol layer, which is made up of a framing protocol and a flow control process

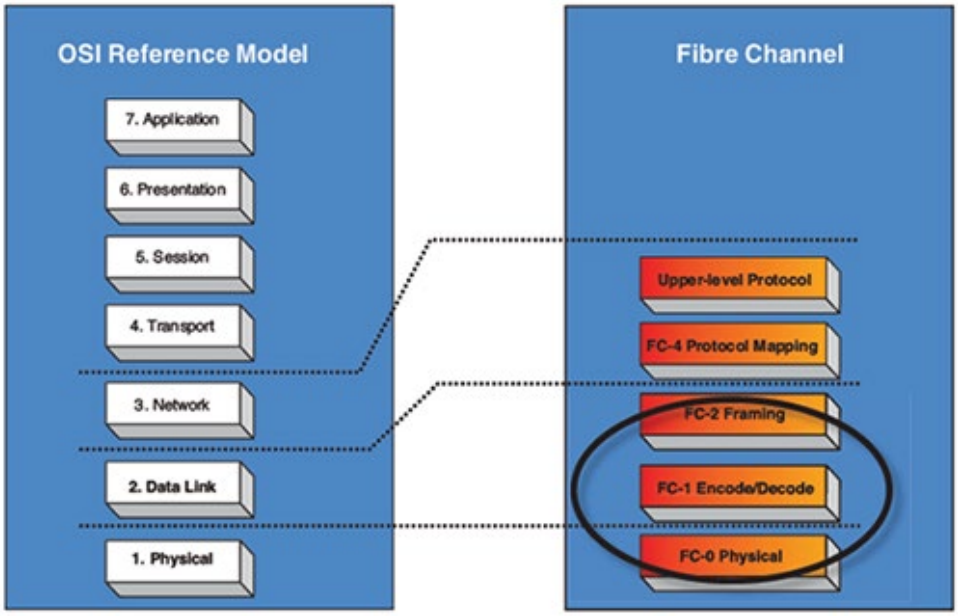
The unit supports the generation and monitoring of: bit errors, order sets, frame delimiters, frame transmission, and generation of primitive sequences. BERT diagnostics perform a bit-by-bit comparison to find bit errors in the received data pattern. Error Count and Error Rate for the latest sample are displayed and maintained, as well as totals for all samples from the test start.

The user can use a default frame header or define a custom frame header - the unit takes care of the frame/header setup, creates the user defined SOF and EOF delimiters and calculates the CRC error checking bytes, which are placed within the frame. User defined bytes, fixed patterns or industry standard PRBS patterns can be selected from drop-down menus and radio buttons and inserted into the payload field.

Testing is supplemented with the capability to perform Bit and CRC error insertion. These tests allow users to test their own Mux demux equipment for error monitoring and detection. The test set displays the BERT test results continuously and any anomaly is recorded in an event log which is date and time stamped. All results can be saved and exported into ReVeal MX for analysis or customer test report generation.

Fiber Channel Layers

The Open Systems Interconnect (OSI) model breaks communications into seven layers namely, Physical, Data Link, Network, Transport, Session, Presentation, and Application. Fibre Channel does not follow the ISO model - instead, the protocol has been broken into five layers: FC-0, FC-1, FC-2, FC-3, and FC-4.



OSI layers versus FC layers

- **FC-0** defines the physical portions of Fibre Channel, including the media types, connectors, and the electrical and optical characteristics needed to connect ports. This level is in the FC-PH standard.
    - Signaling
    - Media specifications
    - Receiver/Transmitter specifications

- **FC-1** defines the transmission protocol, encoding, order of word transmission, and error detection. This level is in the FC-PH standard.
    - 8B/10B character encoding (1/2/4/8G FC) or 64/66B character encoding (10/16/32G)
    - Link maintenance

- **FC-2** defines the signaling and framing protocol, including frame layout, frame header content, and rules for use. It also contains

independent protocols such as login. This is the bulk of the FC-PH standard.

- Frame format
- Sequence management
- Exchange management
- Flow Control
- Classes of Service
- Login/Logout
- Topologies
- Segmentation and Reassembly

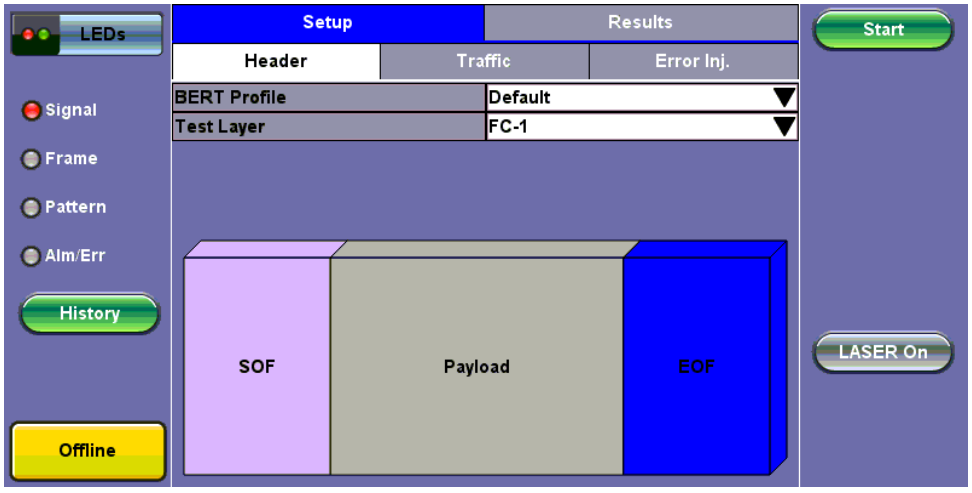
OSI Model	Fiber Channel	Description
Layer 2: Data link	FC-2	Similar to the MAC functionality – Fiber Channel frames are defined, addressed and CRC are added
Layer 1: Physical	FC-1	Similar to the physical layer of the OSI model – Fiber Channel adds basic flow control functionality and ordered sets
	FC-0	

Fiber Channel layers and functionality

- **FC-3** defines common services that may be available across multiple ports in a node. This level has no standard now.
  - Services for multiple ports on one node
- **FC-4** defines the mapping between the lower levels of Fibre Channel, and the command sets that use Fibre Channel.
  - Upper Layer Protocol (ULP) mapping
    - Small Computer System Interface (SCSI)
    - Internet Protocol (IP)
    - High Performance Parallel Interface (HIPPI)
    - Asynchronous Transfer Mode - Adaption Layer 5 (ATM-AAL5)
    - Intelligent Peripheral Interface - 3 (IPI-3) (disk and tape)
    - Single Byte Command Code Sets (SBCCS)

Go back to top Go back to TOC

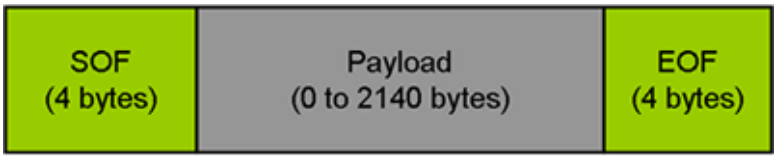
8.2.2 Setup



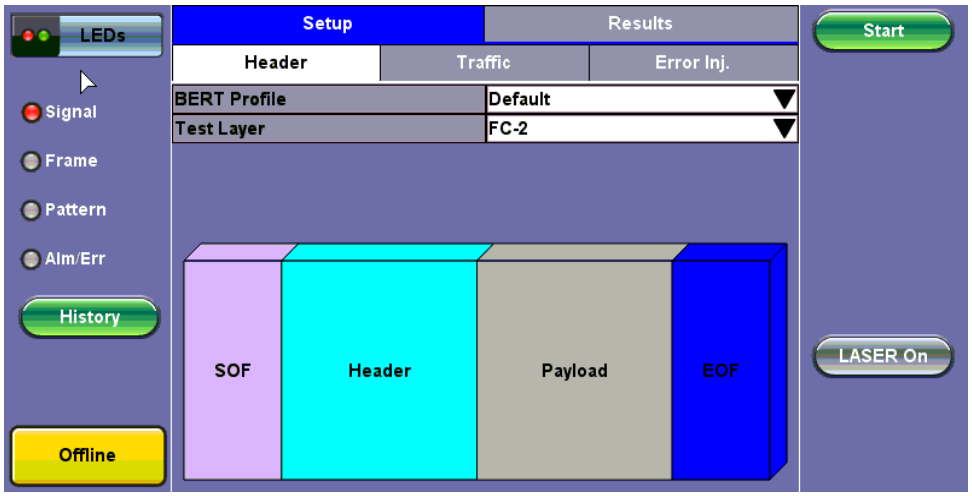
FC-1 BERT - Test Frame Setup

Profile: User Defined Profile or Default setting can be used for testing.
Test layer: FC-1 or FC-2 only. Testing at other layers is not supported.

- **FC-1:** Information is transmitted using an adaptive code (8B/10B or 64/66B) depending on test rate and the encoding process results in the generation of transmission characters.
  - The two types of Transmission Characters defined are data and special. Certain combinations of Transmission Characters, referred to as Ordered Sets, are designated by this standard to have special meaning.
  - Ordered Sets are used to identify frame boundaries, transmit primitive function requests, and maintain proper link transmission characteristics during periods of inactivity.

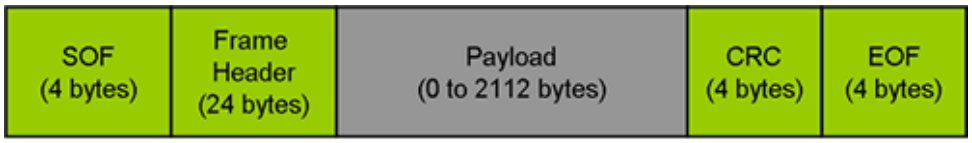


FC-1 Frame Structure

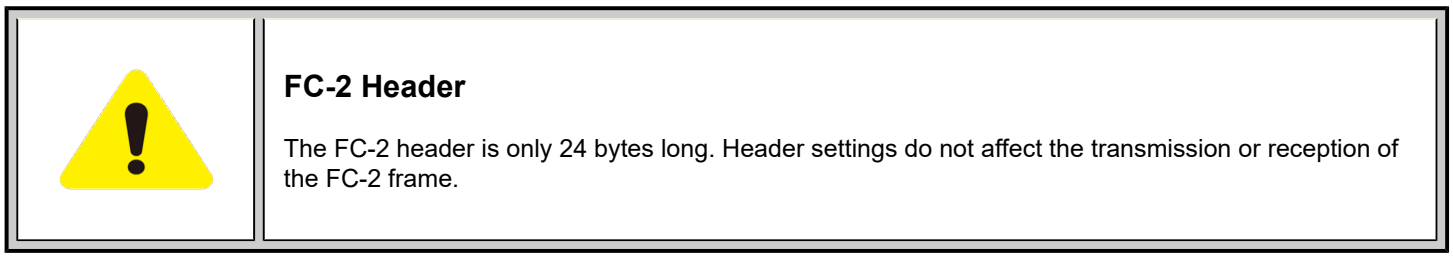


FC-2 BERT - Header Setup

- **FC-2:** Only FC-2 frames have a header, so these fields are not available for FC-1 frames.
  - Defines the framing rules and mechanisms for controlling the different service classes. The following building blocks are defined by the standard:
    - Ordered Set
    - Frame
    - Sequence
    - Exchange
    - Protocol



FC-2 Frame Structure



FC-2 Header

The FC-2 header is only 24 bytes long. Header settings do not affect the transmission or reception of the FC-2 frame.

Go back to top Go back to TOC

Understanding the Basic Test Channel Frame Structure

The Fibre Channel standard defines a variable frame length consisting of 36 bytes of overhead and up to 2112 bytes of payload for a total maximum size of 2148 bytes.

- **SOF and EOF**
  - A Start of Frame (SOF) delimiter and End of Frame (EOF) delimiter mark the beginning and end of each Fibre Channel frame
  - Available for both FC-1 and FC-2 frame formats
- **Frame Header**
  - Is the first field of the frame content and immediately follows the SOF delimiter and is transmitted on a word boundary

Is used to control link operations and device protocol transfers as well as detect missing or out of order frames
    - Available in FC-2 frame format only
- **CRC** - The Cyclic Redundancy Check (CRC)
    - Is a four byte field that follows the Data Field and is used to verify the data integrity of the Frame Header and Data Field.
    - SOF and EOF delimiters are not included in the CRC verification
    - The CRC field is calculated on the Frame Header and Data Field prior to encoding for transmission and after decoding upon reception

Frame Delimiters

A frame delimiter is an **Ordered Set** that immediately precedes or follows the contents of a frame. Separate and distinct delimiters shall identify the start of a frame and the end of a frame and shall be recognized when a single Ordered Set is detected. An Ordered set is described below.

Ordered Set

An Ordered Set is a four-character combination of data and special Transmission Characters. Ordered Sets provide the ability to obtain bit and word synchronization that also establishes word boundary alignment. The three types of Ordered Sets are:

- **Frame Delimiters**
    - **(SOF)** Start-of-Frame
    - **(EOF)** End-of-Frame

- **Primitive Signals**
  A Primitive Signal is an Ordered Set designated to have special meaning. All FC_Ports shall at a minimum recognize R_RDY and IDLE Primitive Signals. All Primitive Signals not recognized by the FC_Port shall be treated as an IDLE.
    - **Idle:** Idle is a Primitive Signal transmitted on the link to indicate that link initialization is complete and to maintain link synchronization
    - **(R_RDY)** Receiver Ready

- **Primitive Sequence**
    - **(OLS)** Off-line
    - **(NOS)** Not Operational
    - **(LR)** Link Reset
    - **(LRR)** Link Reset Response

Start of Frame (SOF) and End of Frame (EOF) Delimiter setup

The Start-of-Frame (SOF) delimiter is an Ordered Set that immediately precedes the frame content. There are multiple SOF delimiters defined for Sequence control. SOF indicates that a Frame will immediately follow and indicates which class of service the Frame will use.

The value of the SOF field determines the class of service associated with the FC frame. Several Classes of service are specified in Fiber Channel but only Classes 1,2,3 & 4 are described below. Classes 1, 2, and 3 are topology independent, however, Classes 4 and 6 require a Fabric. If the Fabric is not present, the service is provided as a special case of point-to-point. FC_Ports are not required to support all classes of service.

- **Class 1:** Dedicated physical connection with delivery confirmation. This class of service has three phases:
    - Setting up the connection
    - Transferring the information
    - Closing down the connection
- **Class 2:** Frame multiplexed service with delivery confirmation. No dedicated connection between the two communication parties is established. This class of service allows a stream of frames to be sent to different destinations quickly. Class 2 also requires frame confirmations by the recipient.
- **Class 3:** Is sometimes called "datagram". It is "connectionless" service with the Fabric multiplexing frames at frame boundaries, if a Fabric is present. If a Fabric is not present, this service becomes a special case of point-to point.
- **Class 4:** Is a service that uses a virtual circuit established within a Fabric and between two communicating Nx_Ports to transmit frames to each other using a fabric-managed fractional bandwidth allocation protocol. This service requires a Fabric.

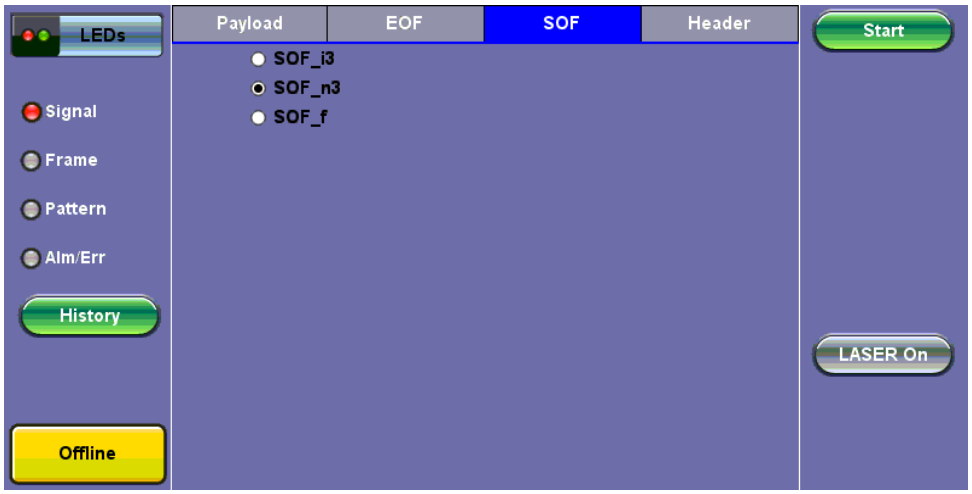
The following SOF Service Class selections are available:

- **SOF Initiate** (SOFix)
  A Sequence shall be initiated and identified by using SOFi1, SOFi2, SOFi3, or SOFi4 in the first frame. SOFix is used to represent these four SOF delimiters.
    - **SOF_i3:** Contains a code value of 0x2E indicating SOF Initiate Class 3. A SOFi3 should be used on the first frame of a Sequence for Class 3 Service.

SOF Normal (SOFnx)
The following delimiters identify the start of all frames other than the first frame of a Sequence based on class of service. SOFnx is used to indicate SOFn1, SOFn2, SOFn3 and SOFn4.

- **SOF_n3:** Contains a code value of 0x36 indicating SOF Normal Class 3. The SOFn3 shall be used for all frames except the first frame of a Sequence for Class 3 Service.

- **SOF Fabric (SOFf)**
  - **SOF_f:** Contains a code value of 0x28 indicating SOF Fabric. If an Nx_Port or Fx_Port receives a Class F frame, indicated by an SOFf delimiter, it shall be discarded by the Nx_Port or Fx_Port. The receiving Nx_Port or Fx_Port may send an R_RDY



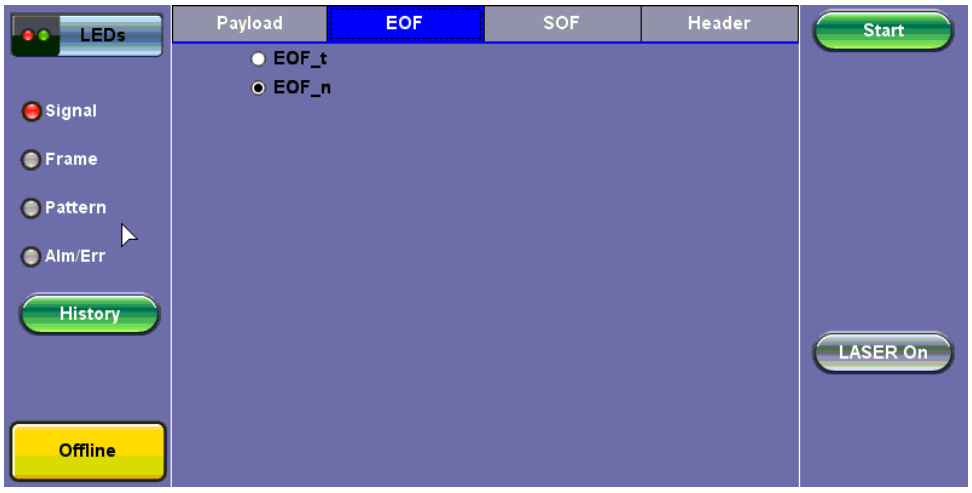
FC-2 BERT - SOF Setup

End of Frame (EOF)

The End-of-Frame (EOF) delimiter is an Ordered Set that immediately follows the CRC and is transmitted on a word boundary. The EOF delimiter designates the end of the frame content and is followed by Idles. There are three categories of EOF delimiters found in the Fiber Channel standard, however the test set only supports the first category that indicates that the frame is valid from the sender's perspective and potentially valid from the receiver's perspective.

The following selections are available:

- **EOF_t:** Contains a code value of 0x42 indicating EOF Terminate. The EOFt indicates that the Sequence associated with this SEQ_ID is complete. EOFt is used to properly close a Sequence without error.
- **EOF_n:** Contains a code value of 0x41 indicating EOF Normal. The EOFn identifies the end of frame when one of the other EOF delimiters indicating valid frame content is not required.



FC-2 BERT - EOF Setup

Go back to top Go back to TOC

Payload

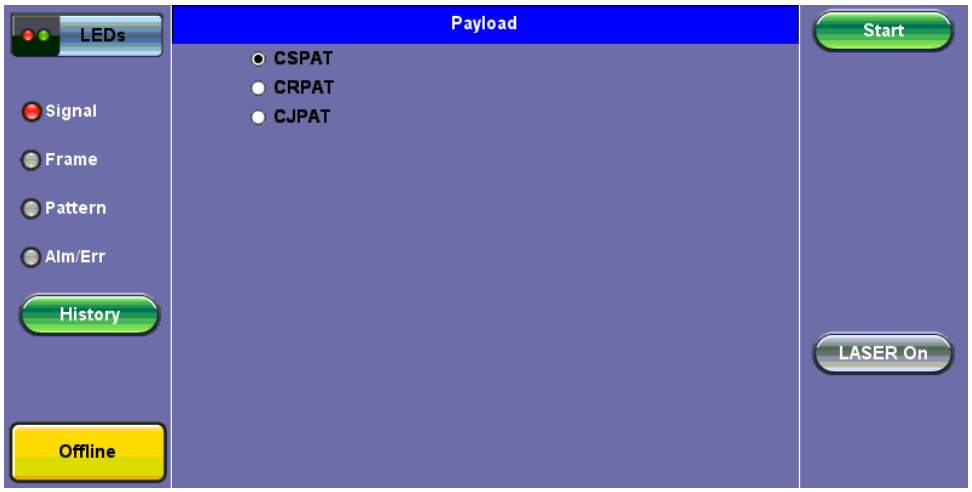
The test set implements and observes "Methodologies for Jitter and Signal Quality Specification (MJSQ)". A major goal of MJSQ is to

improve the relationship between measurements on signals and receiver performance in terms of bit errors. The unit transmits a "compliant pattern" which consists of a valid Fiber Channel protocol frame (SOF, payload, CRC, EOF) containing a test pattern as the payload. Different payload selections are available depending on the Fiber Channel layer to be tested. The payload consists of 0 to 2112 bytes, and is sent in 4 byte increments, otherwise it is considered to be a misaligned frame.

FC-1 Payload (test pattern)
Layer 1 test patterns are formatted using the 8B/10B symbol format and include the PCS layer as part of the BER pattern.

CRPAT, CSPAT, and CJTPAT test patterns according to NCITS-TR-25-1999 and MJSQ, are designed to evaluate frequency fluctuations, transceiver noise and phase jumps caused by jitter and other anomalies. These test patterns are described briefly as follows:

- **CSPAT:** Compliant Supply Noise Pattern
  - Represents worst case power supply noise
- **CRPAT:** Compliant Random Pattern
  - Provides broad spectral content and minimal peaking for the measurement of jitter at component or system level
- **CJTPAT:** Compliant Jitter Test Pattern
  - Jitter Tolerance Pattern that stresses a receiver by exposing it to extreme phase jumps thereby stressing the clock data recovery (CDR) circuitry
  - The pattern alternates between repeating low transition density patterns and repeating high transition density patterns



FC-1 BERT - Payload Setup

FC-1 Test Patterns

CRPAT sequence is offered for TX jitter measurements.

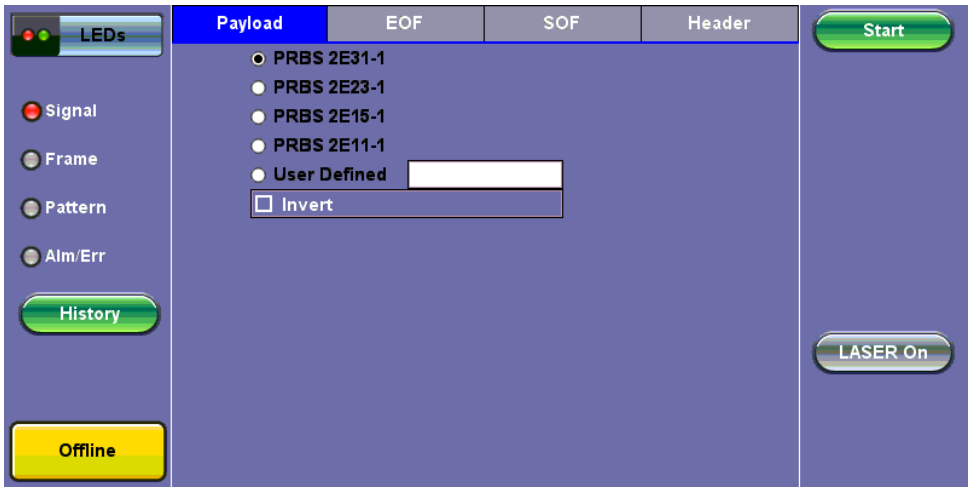
CRPAT and CJTPAT are available for RX jitter tolerance measurements - use these test patterns to test the resilience of the receiver (Clock Data Recovery - CDR) and its tolerance to signals with jitter.

Go back to top Go back to TOC

FC-2 Payload (test patterns)
Layer 2 "Compliant" test patterns are modified to resemble a true Fiber Channel frame - the pattern's format is similar to a basic frame which includes a Start of Frame Delimiter (SFD), End of Frame Delimiter (EFD), and Cyclic Redundancy Check (CRC).

Pseudo Random Bit Sequences (PRBS) are commonly used to test the signal integrity of high-speed links and are defined in ITU-T 0.150 & 0.151 Recommendations – These legacy SONET/SDH/PDH test sequences may appear random but they have specific properties that can be used to measure the quality of a link. PRBS patterns can be normal or can be inverted.

- **2E31-1:** 147 483 647-bit pattern used for special measurement tasks, (e.g., delay measurements at higher bit rates)
- **2E23-1:** 8 388 607 bit pattern primarily intended for error and jitter measurements at bit rates of 34 368 and 139 264 kbps
- **2E15-1:** 32 767 bit pattern primarily intended for error and jitter measurements at bit rates of 1544, 2048, 6312, 8448, 32 064 and 44 736 kbps
- **2E11-1:** 2047 bit pattern primarily intended for error and jitter measurements on circuits operating at bit rates of 64 kbps and N x 64 kbps



FC-2 BERT - Payload Setup

BERT Testing Tips

A BERT samples every incoming bit and looks for something that doesn't occur often. This traditional method typically used in SONET/SDH measurements, can however take a very long time. For example, in a 1Gbps Fiber Channel system, errors occur on average once every 1000 s (about 17 Min) for $1x10^{-12}$ BER, so you would need to detect at least 10 to 100 errors before you can have confidence in your measurement. Bear in mind that for a quick measurement, you need a test pattern that repeats frequently. A PRBS-11 sequence (2047 bits) repeats many times a second at a 1-Gbps rate, however a PRBS-31 pattern, with 2 billion bits, repeats only every 2 s at 1 Gbps.

A general rule of thumb is to choose a PRBS that is closest to the nature of the data you will be passing through your network. Patterns between $2^{11}–1$ and $2^{31}–1$ (such as $2^{15}–1$ and $2^{23}–1$) offer good gradual steps in difficulty that allow you to see where networks fail, or how much margin you have beyond pass/fail thresholds.

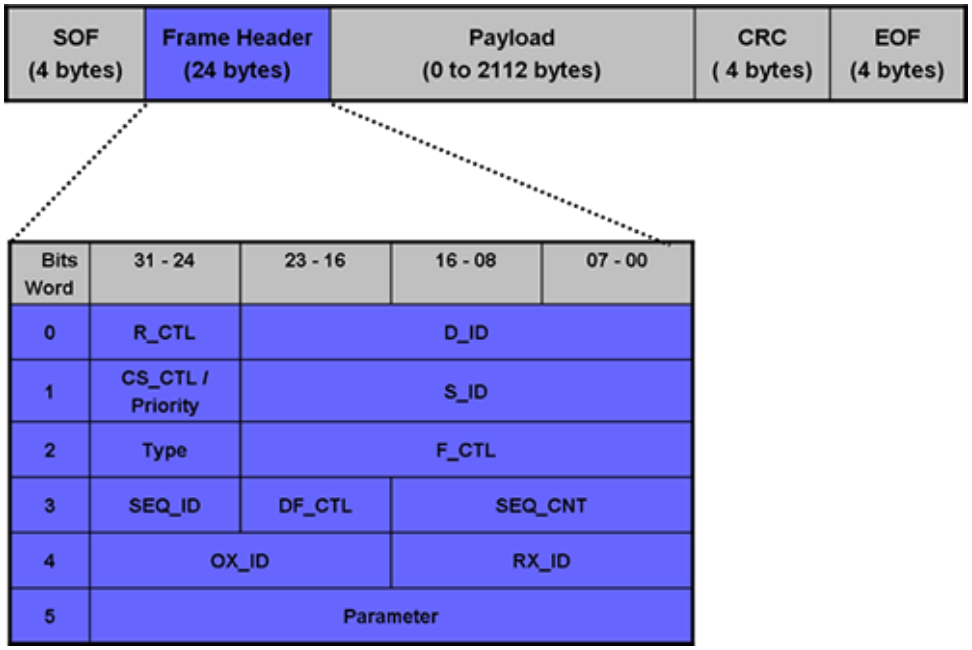
Bit errors can affect the data frames - these frames will be re-transmitted at the request of the upper-layer protocols. If the FC link suffers a lot of bit errors, you may experience a slight performance loss. These bit errors can also affect the Receiver Ready (R_RDY) messages. A R_RDY is never repeated, so the buffer credit is one BB_Credit short until the link is reset.

The Fiber Channel standard allows a 1 x 10E-12 maximum error rate.

Go back to top Go back to TOC

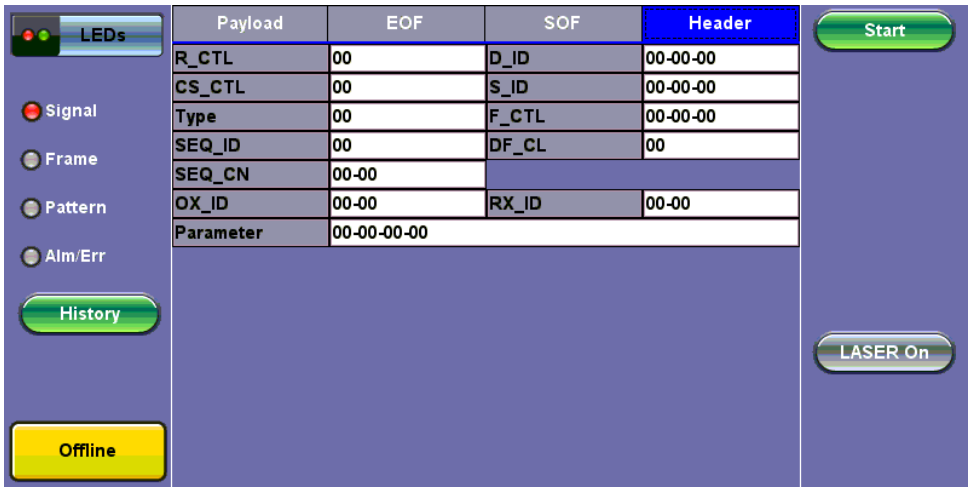
Header Setup (FC-2 only)

The FC-2 Frame Header is subdivided into the fields as shown in the diagram below.



FC-2 Header Format

The Frame Header is the first field of the frame content and immediately follows the SOF delimiter. The Frame Header is used to control link operations and device protocol transfers as well as detect missing or out of order frames. The values of each field can be edited depending on network setup and test scenario. A brief description of each parameters is provided below.



FC-2 Header Setup

- **Routing Control (R_CTL):**
  - The R_CTL field is a one-byte field in Word 0 Bits 31-24 that contains routing bits and information bits to categorize the frame function.
  - When used in combination with the TYPE field (Word 2, bits 31-24), it provides an FC_Port with assistance in frame routing, data routing, or addressing.
  - The R_CTL field is further subdivided into the ROUTING field (bits 31-28) and the INFORMATION field (bits 27-24).

- **D_ID Address Identifier:**
  - Destination Identifier is a three-byte field (Word 0, Bits 23-0) that contains the address identifier of the destination Nx_Port.
  - Each Nx_Port has a native N_Port_ID that is unique within the address domain of a Fabric. It may also represent hunt groups, domain controllers, and other servers.

- **Class Specific Control (CS_CTL)/Priority:**
  - When bit 17 of F_CTL is set to zero, Word 1, bits 31-24 of the Frame_Header is defined as the CS_CTL field.
  - Contains management information for the class of service identified by the SOF. The meaning of the CS_CTL field is dependent on the class of service.
  - When supported by FC_Ports, the Priority field shall be used to resolve resource contention or to determine the order to deliver frames. The definition and use of the Priority field is class dependent.

- **S_ID Address Identifier:**

- The S_ID is a three-byte field (Word 1, Bits 23-0) that contains the address identifier of the source Nx_Port.

- **Type (Data Structure Type):**
  - The data structure type (TYPE) is a one-byte field (Word 2, Bits 31-24) that identifies the protocol of the frame content for Data frames.

- **Frame Control (F_CTL):**
  - The Frame Control (F_CTL) field (Word 2, Bits 23-0) is a three-byte field that contains control information relating to the frame content such as exchange, retransmission, or sequence control. It is also used to identify the function of the CS_CTL/P field.

- **Sequence Identifier (SEQ_ID):**
  - The SEQ_ID is a one-byte field (Word 3, Bits 31-24) assigned by the Sequence Initiator that is unique for a specific D_ID and S_ID pair while the Sequence is open.
  - Both the Sequence Initiator and the Sequence Recipient track the status of frames within the Sequence using fields within the Sequence_Qualifier.

- **Data Field Control (DF_CTL):**
  - Data Field Control (DF_CTL) is a one-byte field (Word 3, Bits 23-16) that specifies the presence of optional headers at the beginning of the Data_Field for Device_Data or Video_Data frames.
  - DF_CTL bits are not meaningful on Link_Control or Basic Link Service frames.

- **Sequence count (SEQ_CNT):**
  - The sequence count (SEQ_CNT) is a two-byte field (Word 3, Bits 15-0) that indicates the sequential order of Data frame transmission within a single Sequence or multiple consecutive Sequences for the same Exchange.

- **Originator Exchange_ID (OX_ID):**
  - The Originator Exchange_ID is a two-byte field (Word 4, Bits 31-16) that identifies the Exchange_ID assigned by the Originator of the Exchange.
  - Each Exchange is assigned an identifier unique to the Originator or Originator - Responder pair.

- **Responder Exchange_ID (RX_ID):**
  - The Responder Exchange_ID is a two byte field (Word 4, Bits 15-0) assigned by the Responder that provides a unique, locally meaningful identifier at the Responder for an Exchange established by an Originator and identified by an OX_ID.

- **Parameter:**
  - The Parameter field (Word 5, Bits 31-0) has meanings based on frame type.
  - For Link_Control frames, the Parameter field is used to carry information specific to the individual Link_Control frame.
  - For Data frames with the relative offset present bit set to 1, the Parameter field specifies relative offset, a four-byte field that contains the relative displacement of the first byte of the Payload of the frame from the base address as specified by the ULP.

For detailed information, please visit http://www.incits.org/ and download the Fiber Channel FRAMING AND SIGNALING-2 (FC-FS-2) standard.

Go back to top Go back to TOC

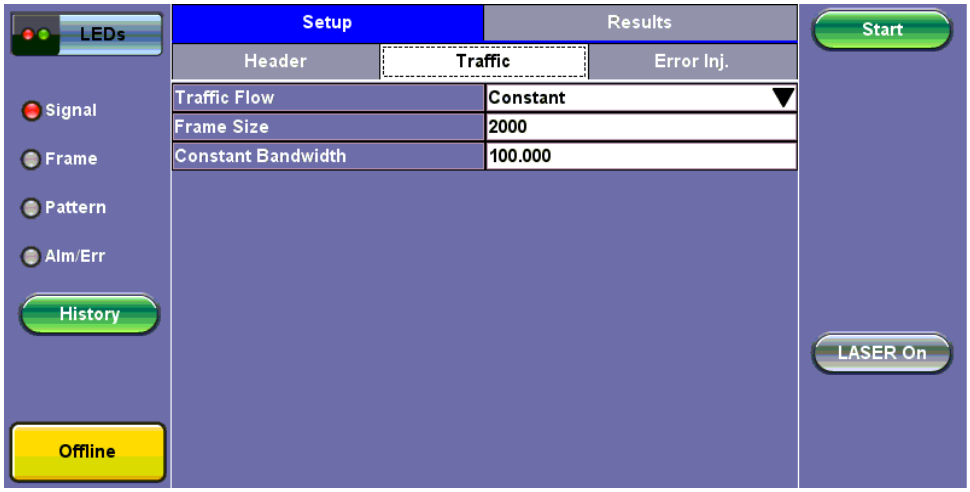
8.2.3 Traffic Generation and Error Injection

Traffic Setup

- **Traffic Flow:** Select from Constant, Ramp, or Burst traffic flow - available selections depend on FC-1 or FC-2
  - **Constant:** Continuous traffic (no traffic shaping)
  - **Burst:** Two burst bandwidths are configured with variable burst time in seconds
  - **Ramp:** Start and stop bandwidths are configured along with the bandwidth step size and duration

- **Frame Size:** Set the frame size in bytes.
  - Available in FC-2 mode only
  - Valid settings are 56 bytes to 2148 bytes.
  - The frame length includes the SOF and EOF overhead bytes.

- **Constant Bandwidth:** Configure the transmit rate or bandwidth in %
  - Valid settings are 1% to 100% in 0.01% increments



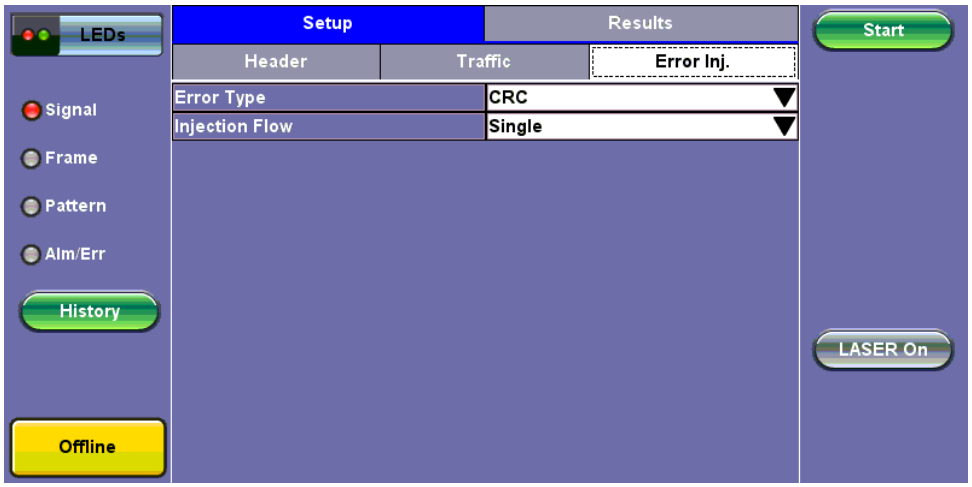
FC-BERT/FC-Throughput Traffic Setup

Go back to top Go back to TOC

Error Injection Setup

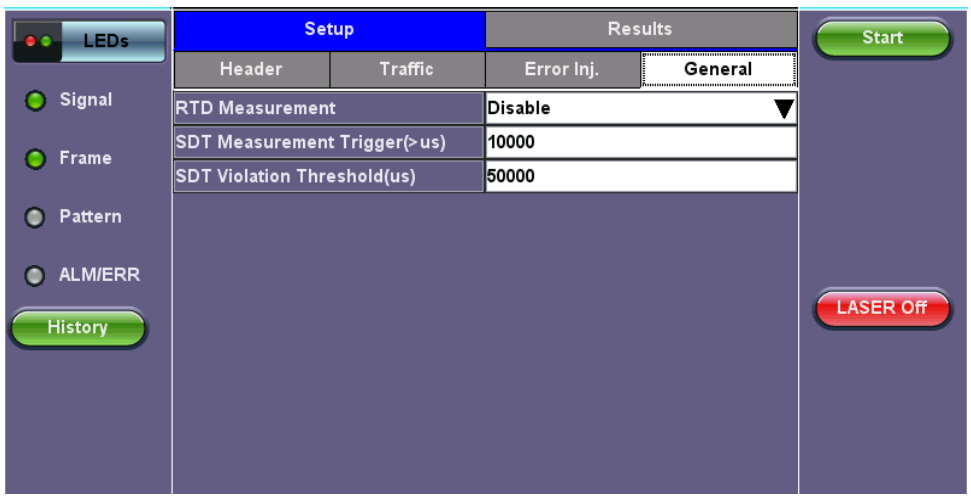
Error injection can be performed during a test. The type of errors and error injection rate or flow are configured in the Error Injection tab.

- **Error type:** Select from Bit and CRC.
- **Injection Flow:** Determines how the selected errors will be injected. The user can select a single error injection, a specific count, or error rate.
- **Count:**When Count is selected, configure the error count via the numeric pop-up keypad.



FC-BERT/FC-Throughput Error Injection Setup

Once the test is running, error injection can be enabled by selecting the **Error Injection** button from the action drop-down menu at the top of the screen. Press the **Error Inject** button to start injecting errors.



FC-1/2 Throughput - General

Go back to top Go back to TOC

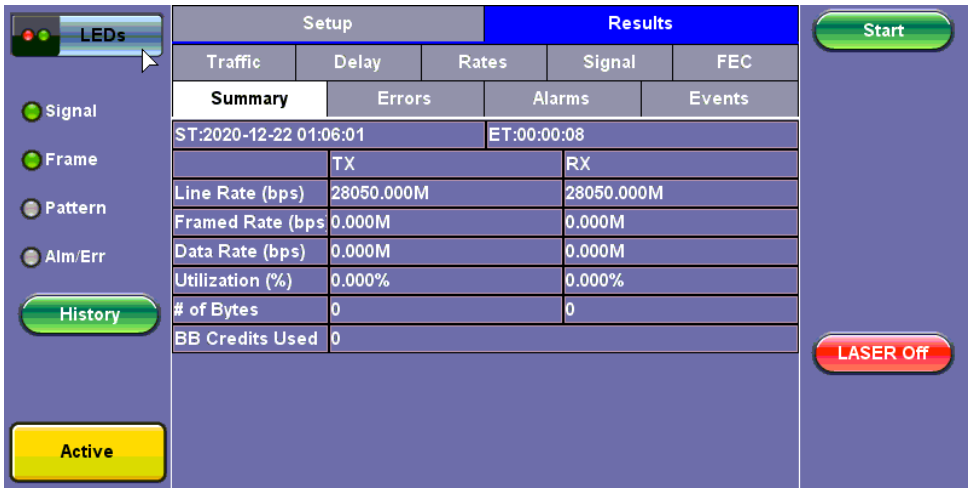
General tab (Throughput only)

- **RTD Measurement:** Enable or Disable Round Trip Delay Measurement
- **SDT Measurement Trigger (>µs)**: Any inter-frame gap that is equivalent or greater than the configured threshold will trigger the SDT measurement. This is useful if a known threshold is expected from a given network under test. For example, if the known switchover time is 50ms, the trigger can be set to a value slightly below 50ms to assure that the SDT is measured.
- **SDT Violation Threshold (µs)**: Triggers an SDT Violation event in the event log. This is helpful for historical purposes during any given test. If the measured SDT is equivalent or greater than the configured threshold an SDT Violation event is counted.

Go back to top Go back to TOC

8.2.4 Starting Measurements

- **Start** button: Click to start the measurement.
- **Laser** button: Can be turned On or Off to make adjustments to the fiber patch cord, etc.
- **TX Start** button: Activate the Transmitter to initiate the BER measurement.



FC-1/2 BERT - Prior to Starting

Go back to top Go back to TOC

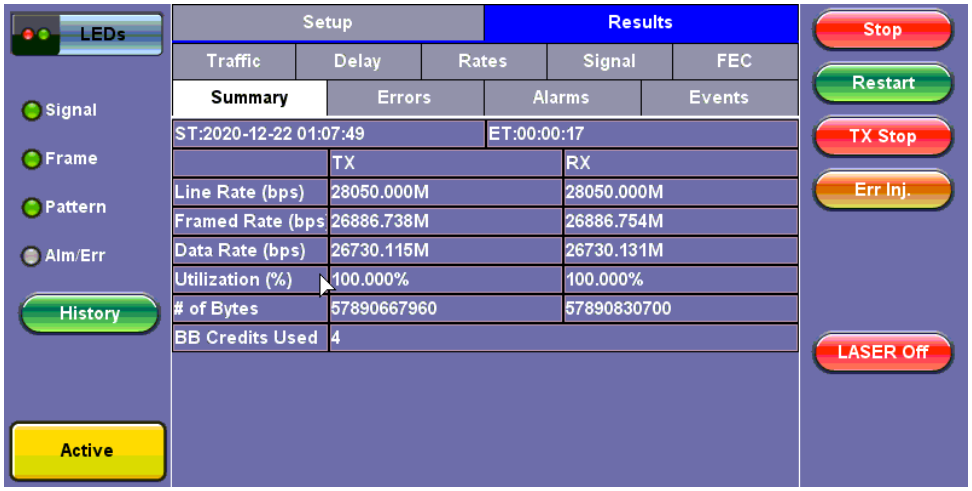
8.2.5 Results

Summary

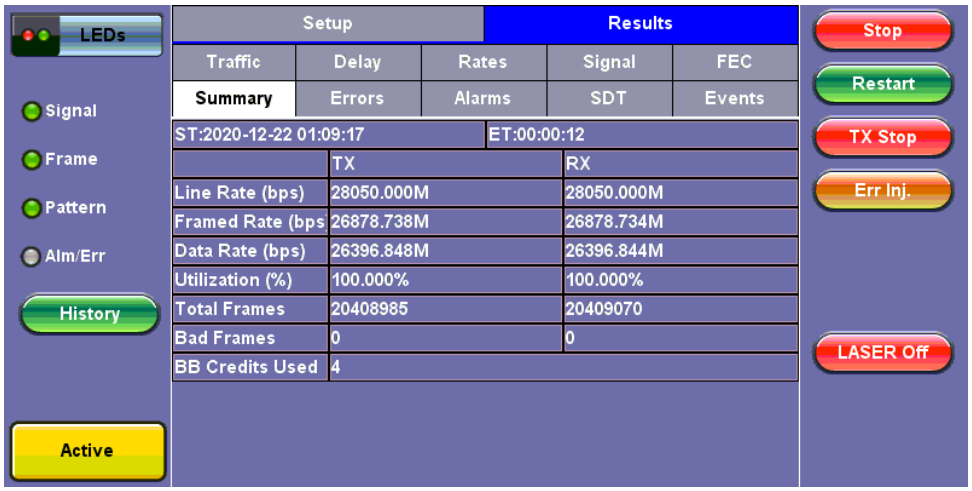
- **Line Rate:** Indicates the transmitted and received bit rate
  - 1.0625 Gbps, 2.125 Gbps, 4.25 Gbps, 8.50Gbps, 10.52Gbps, 14.025Gbps, 28.05Gbps
- **Framed Rate:** Total number of frames including overhead of any type per second (Mbytes)
- **Data rate:** Total count of frames with payload data per second (Mbytes)
- **Utilization:** Bandwidth utilization in %
- **# of Bytes:** Number of bytes transmitted versus bytes received.
- **BB Credits Used:** Number of Buffer Credits used.

Summary *(Throughput only)*

- **Total Frames**: Total number of frames transmitted versus frames received
- **Bad Frames:** Number of frames transmitted but not received.



FC - BERT - Summary



FC - Throughput - Summary

Go back to top Go back to TOC

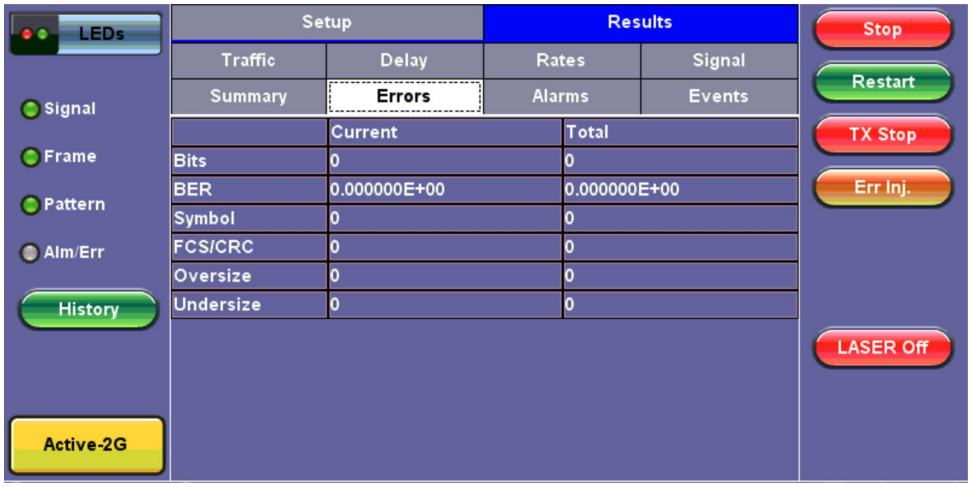
Errors

Current and Total values for:

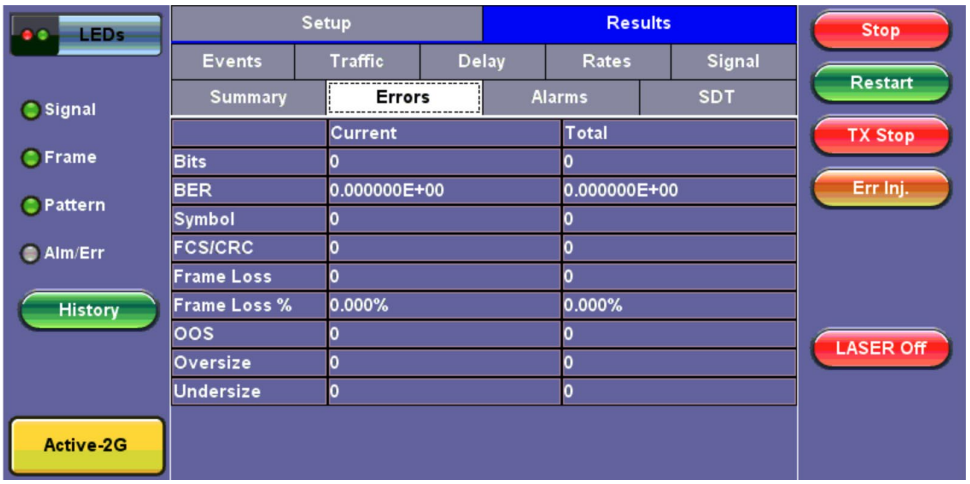
- **Bits:** Number of bits received
- **BER:** Bit error ratio based on PRBS received or ratio of payload bit errors to total received payload bits
- **Symbol:** Symbol error or Code Violation is a bit error or disparity error occurring in a primitive sequence or Ordered Set
- **FCS/CRC:** Number of frames with either a bad or missing CRC or Frame Check Sequence
- **Oversize:** Number of Oversize frames received (> 2112 bytes)
- **Undersize:** Number of Undersize frames received (< 28 bytes)

Errors *(Throughput only)*

- **Frame Loss:** Number of frames lost
- **Frame Loss (%):** Percentage of frames lost
- **OOS:** Number of out-of-sequence frames received



BERT - Errors



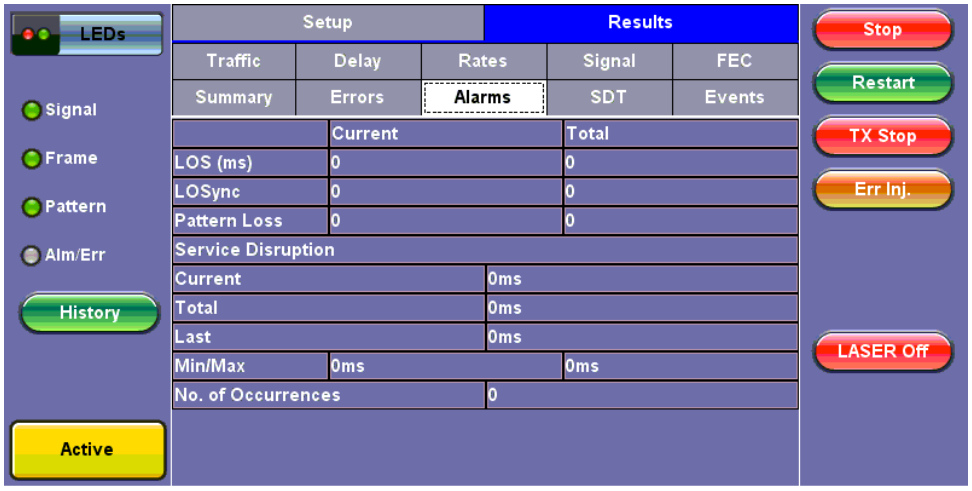
Throughput - Errors (Page 1)

Go back to top Go back to TOC

Alarms

Current and Total values for:

- **LOS:** Number of times the Link has transitioned to a Loss of Signal state in the measurement interval. Generally loss of optical signal.
- **LOSync:** Number of times the Link has transitioned to a Loss of Sync state in the measurement period
- **Pattern Loss:** Number of times test pattern or test sequence was lost
- **Service Disruption**
  - **Current:** Current disruption in ms
  - **Total:** Total measurement period
  - **Last:** Last disruption measurement time
  - **Min/Max:** Minimum and Maximum disruption time
  - **No. of Occurrences:** A count of the disruption events over the measurement period

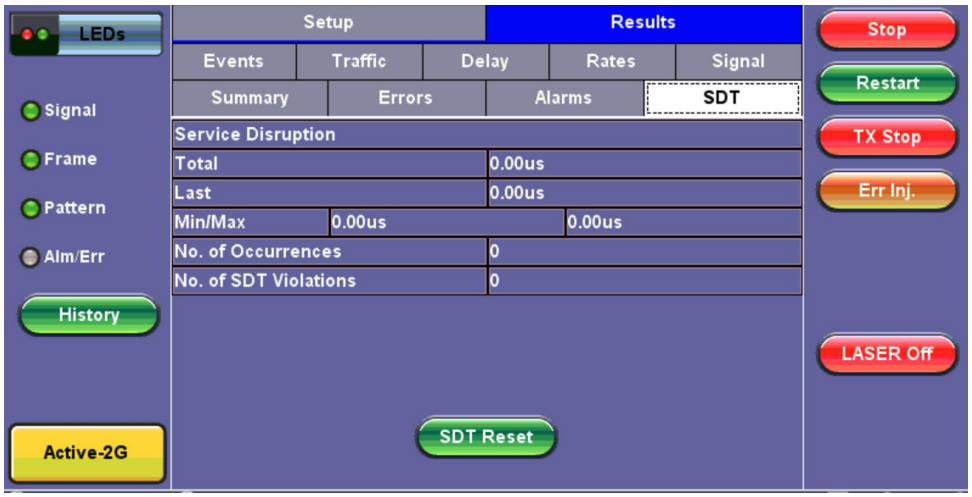


FC-BERT/FC-Throughput - Alarms

Go back to top Go back to TOC

Service Disruption Test (SDT) ***(Throughput only)***

- **Total:** Total cumulative service disruption for the duration of the test.
- **Last:** Last SDT measured during the test.
- **Min/Max:** Minimum and maximum SDT measured during the test.
- **No. of Occurrences:** Number of service disruption events (SDTs).
- **No. of SDT Violations:** Number of instances the SDT threshold was met or exceeded.



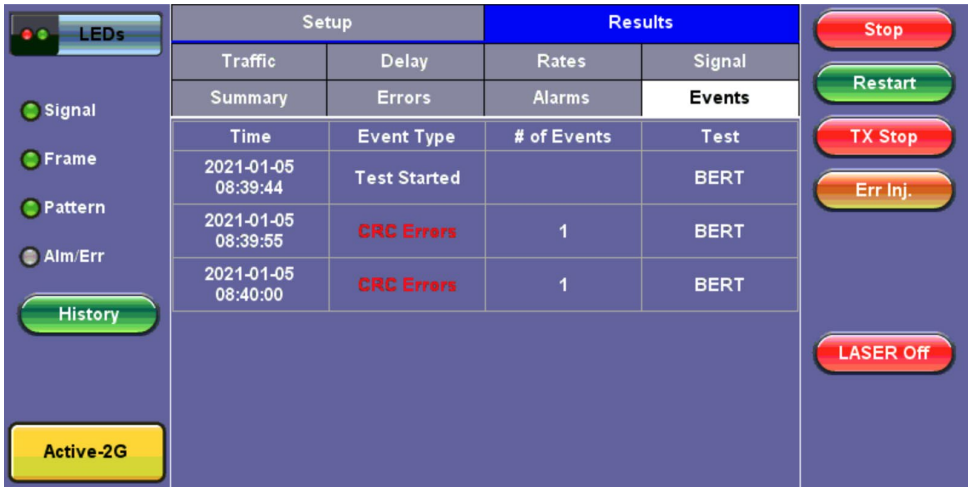
FC-Throughput Results - SDT

Go back to top Go back to TOC

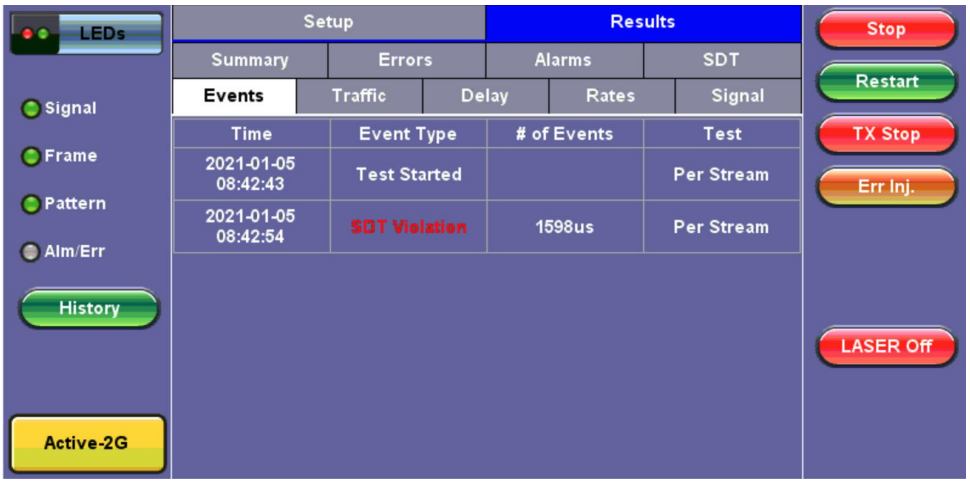
Events

Time stamped event table:

- **Time:** Indicates when the test was started, an anomaly occurred or a test was stopped
- **Event/Event Type:** Indicates type of anomaly
- **# of Events:** Indicates the number of times the event occurred
- **Test:** Indicates the test mode



BERT - Events



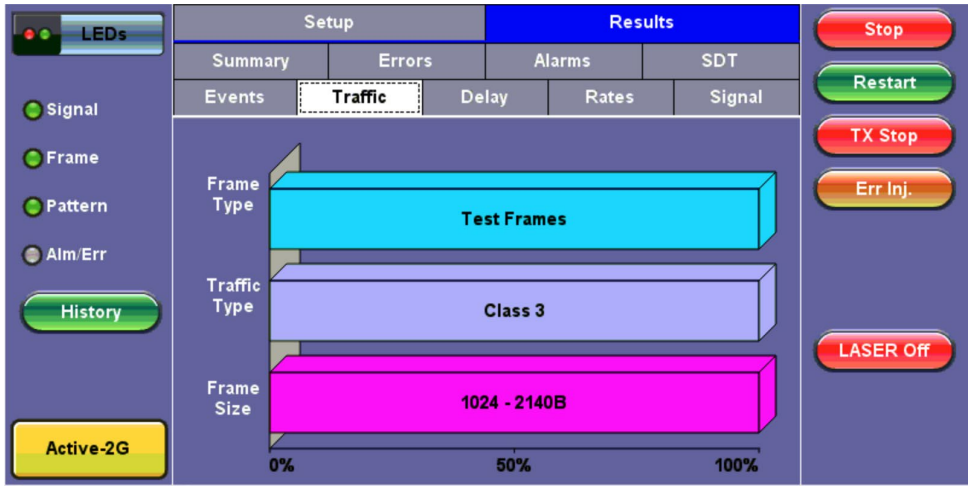
Throughput - Events

Go back to top Go back to TOC

Traffic Distribution Overview

Graphical representation of:

- **Frame type:** Test frames in BER mode
- **Traffic type:** Class of service set by the SOF delimiter
- **Frame size:**
  - FC-1 mode - the frame size is determined by the test sequence being used
  - FC-2 mode - the frame size corresponds to the frame size configured in the traffic menu



FC-BERT/FC-Throughput - Traffic Summary

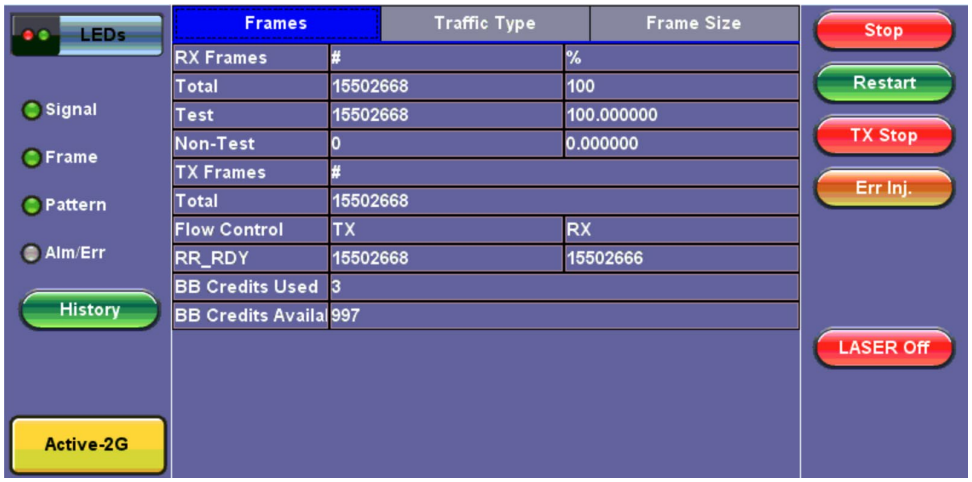
Go back to top Go back to TOC

Traffic Distribution Details - Frames

- **RX (Received) Frames**
  - **Total**: Total number of frames received
  - **Test**: Number of test frames received
  - **Non-Test:** Number of non-test frames received
- **TX (Transmitted) Frames**
  - Total: Number of test frames transmitted
- **Flow Control:** Flow control is the FC-2 control process to pace the flow of frames between Nx_Ports, an Nx_Port and the Fabric and within the Fabric to prevent overrun at the receiver.
  - Flow control is managed between Nx_Ports (end-to-end) and between FC_Ports (buffer-to-buffer). Flow control management has variations dependent upon the service class, however Class 3 uses only buffer-to-buffer flow control.
- **RR-RDY:** For Class 3 frames transmitted and received, a R_RDY is issued when a receive buffer is available.

  Memory or “buffers” to temporarily store frames as they arrive and until they are assembled in sequence, and delivered to the upper layer protocol. Buffer Credits are the number of frames a port can store. To track the number of frames transmitted for which R_RDY responses are outstanding, the transmitting FC_Port uses the BB_Credit_CNT.

- **BB Credits Used**: The number of unacknowledged or outstanding frames awaiting R_RDY responses from the directly attached FC_Port.
- **BB Credits Available**: The number of frames transmitted and received R_RDY responses from the directly attached FC_Port.



FC-BERT/FC-Throughput - Frame Distribution

Go back to top Go back to TOC

Traffic Distribution - Traffic Type

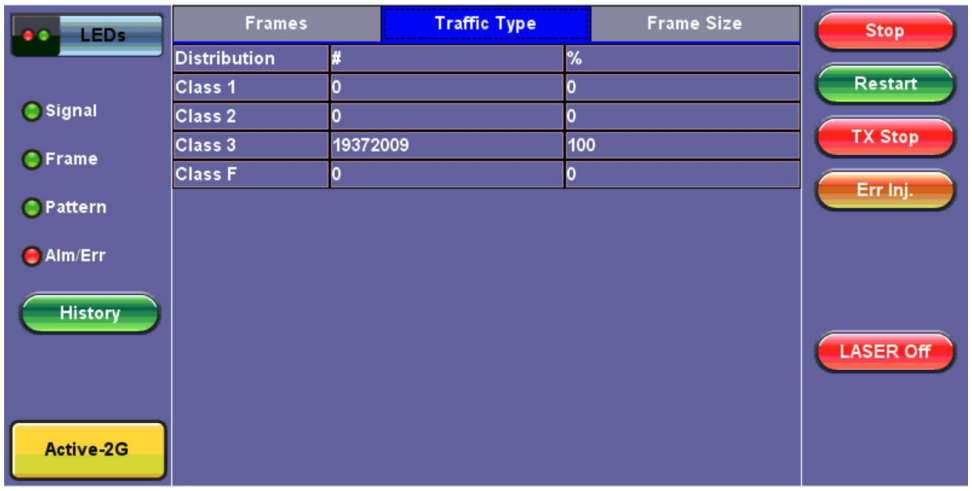
Fibre Channel supports three classes of services, and a fourth which is a combination of classes 1 and 2.

Similar to ATM, different classes allow Fibre Channel to support a variety of communication needs.

- **Class 1:** Provides a circuit-emulation service for time-sensitive applications such as video teleconferencing.
  - Designed for dedicated, non-bursty links between supercomputers. Class 1 traffic is circuit-switched.

- **Class 2**: Provides guaranteed delivery for connectionless traffic.
  - Class 2 traffic is switched on each frame rather than on a connection. An acknowledgment from the destination provides an end-to-end guarantee of delivery.

- **Class 3:** Offers a best-effort connectionless service.
  - Class 3 is similar to Class 2, except that no guarantee is given for delivery.

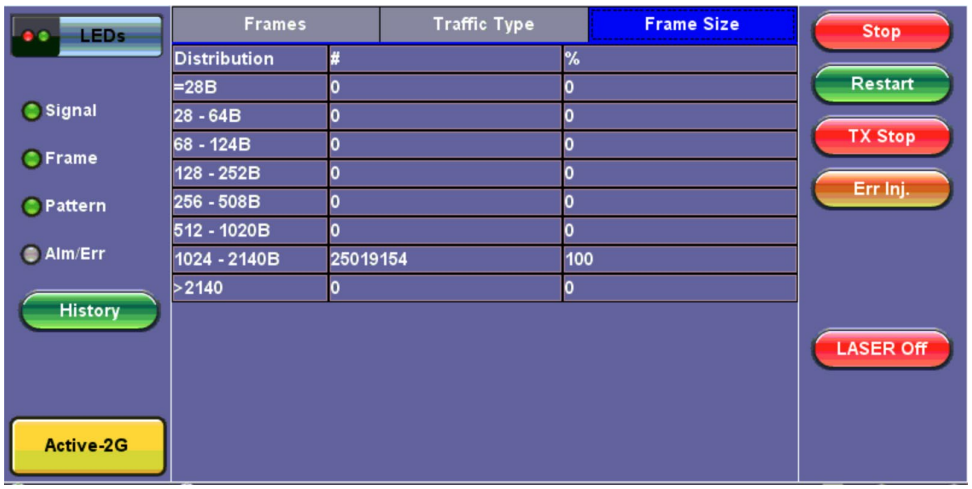


FC-BERT/FC-Throughput - Traffic Type Distribution

Go back to top Go back to TOC

Frame Size Distribution

Indicates the number and percentage of different frame sizes received during the test period.



FC-BERT/FC-Throughput - Frame Size Distribution

Go back to top Go back to TOC

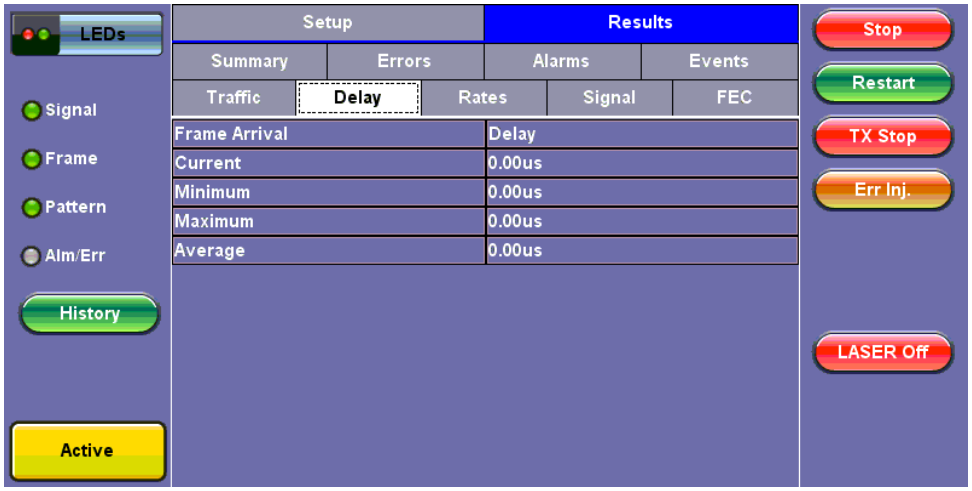
Delay

Frame Arrival Delay or Latency is the round-trip delay experienced by a frame as it traverses the fiber link or network. The difference between the transmitted time and received time is the measured delay.

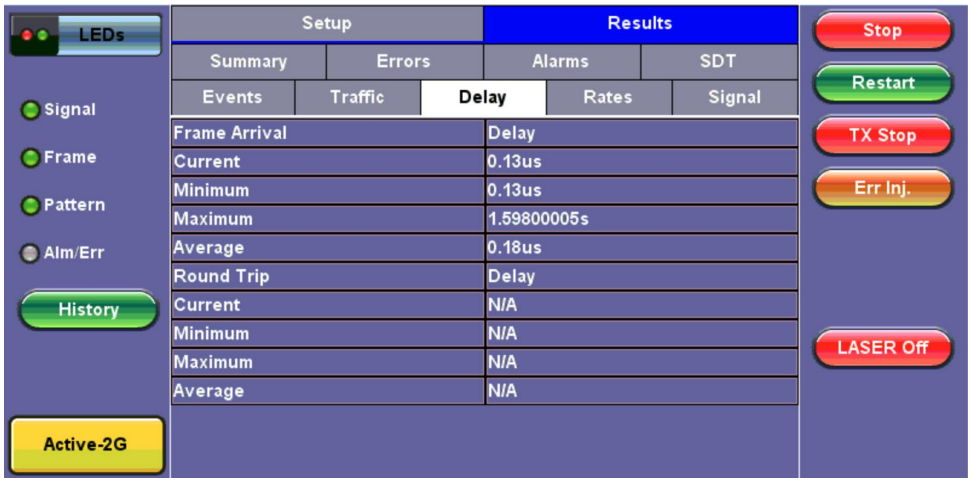
Indicates the **Current**, **Minimum**, **Maximum**, and **Average** frame arrival delay during the test period.

Delay *(Throughput only)*

Current, **Minimum**, **Maximum**, and **Average Round-Trip Delay** during the test period is also displayed.



FC - BERT - Delay

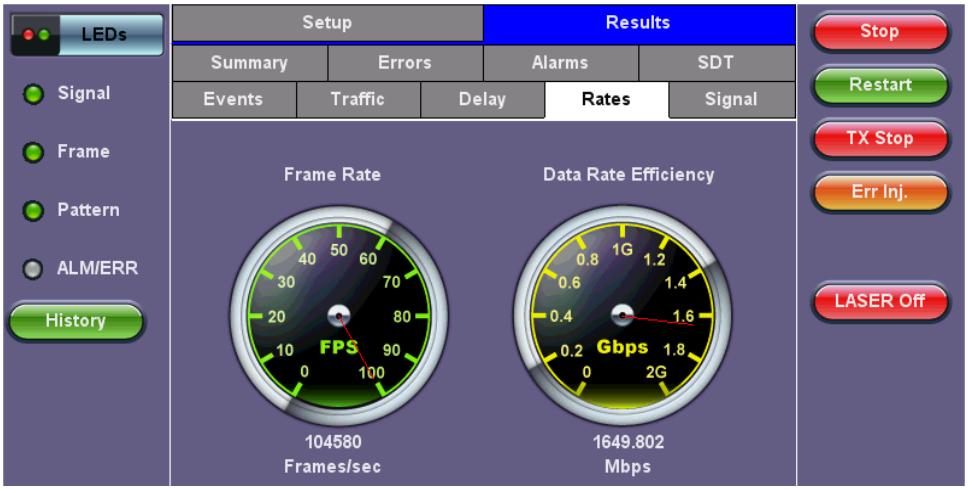


FC - Throughput - Delay

Go back to top Go back to TOC

Frame Rate Summary

Graphical representation of the Frame rates and Data rates.

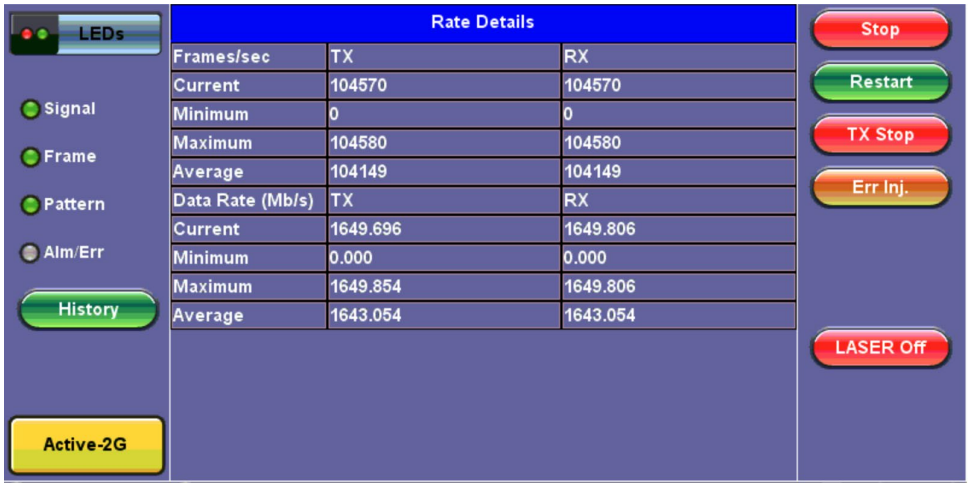


FC-BERT/FC-Throughput - Frame Rate Summary

Go back to top Go back to TOC

Frame Rate Details

Tabular representation of the Transmitted and Received frames and the corresponding Data Rates in Mbps.



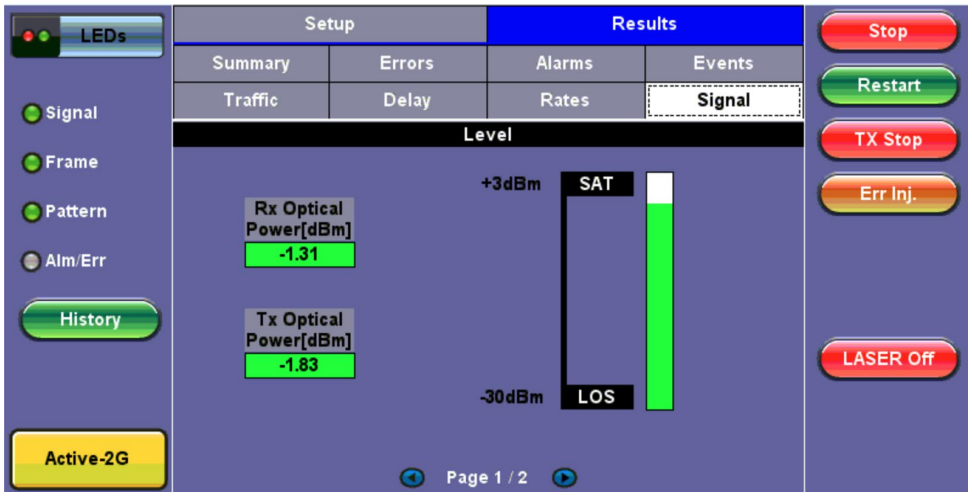
FC-BERT/FC-Throughput - Frame Rate Details

Go back to top Go back to TOC

Signal

Level (Page 1)

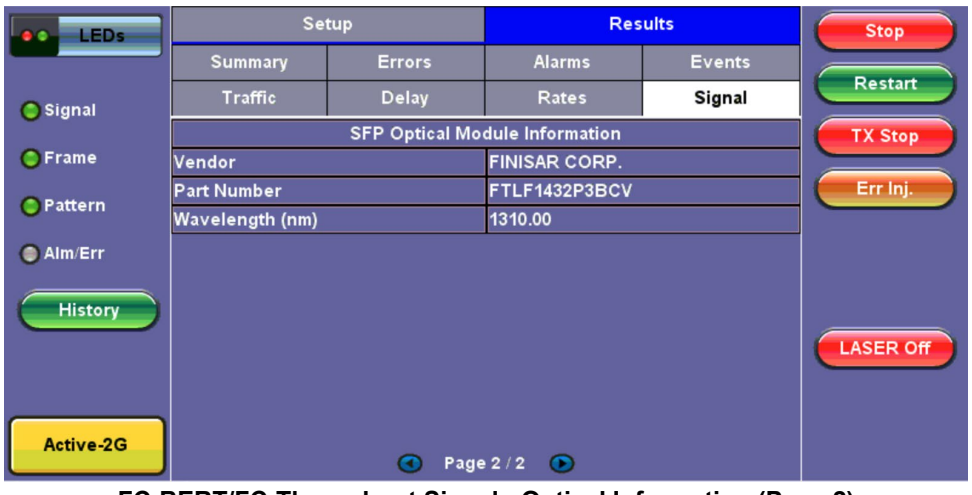
The Signal tab displays the Level and Frequency screen. Page 1 displays the level measurement Loss of Signal (LOS), and the Saturation level for optical signals is shown graphically, including the level measurement in dBm.



FC-BERT/FC-Throughput Signal - Level (Page 1)

Optical Information (Page 2)

Page 2 displays the Optical module XFP information which includes Vendor name, Part number, and Optical Wavelength.



FC-BERT/FC-Throughput Signal - Optical Information (Page 2)

8.3 RFC 2544

The RFC 2544 Ethernet test suite is adapted to Fiber Channel circuits to verify 1Gbps, 2Gbps, 4Gbps, 8Gbps, 10Gbps ,16Gbps and 32Gbps SAN networks. The automated RFC 2544 test routine/analysis ensures repeatable installations:

- Check buffer parameters needed to achieve desired Service Level Agreement (SLA)
- Determine optimum buffer size - Capacity versus link speed
- Determine minimum buffer credits for selected throughput for each frame length
- Measuring throughput at various buffer credit sizes to check link quality

Go back to top Go back to TOC

8.4 Loopback

The Loopback function can be found on the Fiber Channel Home menu.

FC-1/2 Manual Loopback Setup

Modes of operation: Manual and Responder (future)

Mode (FC layer): FC-1 or FC-2 Layer loopbacks are supported. In FC-2 mode, the destination and source IDs (D_ID and S_ID) are swapped including any other relevant Header fields (e.g., OX_ID, RX_ID, etc.).

FC-1/2 Manual Loopback Active

To enable the loopback, press **Start** from the drop-down menu. Once the loopback is enabled, a message appears indicating that the loopback is active.

Go back to top Go back to TOC

8.5 Packet Capture

The packet capture function can be used to capture packets to Fiber Channel test ports. The packet capture format is compatible with Wireshark and can be viewed on a PC.

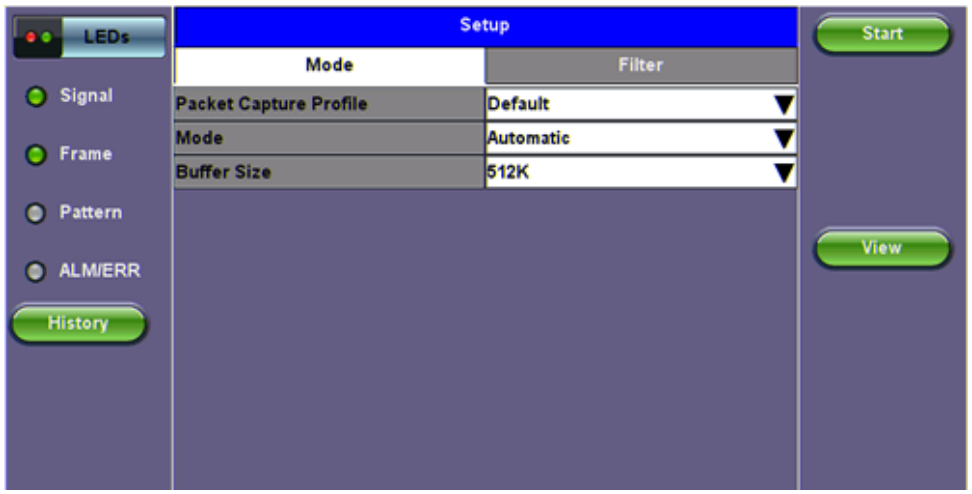
The following packet capture options are available in the **Capture Mode** tab:

- **Profile:** Drop-down selections are Default, Delete, Save, Save As...
- **Mode:** Automatic. Packet capture is automatically started when pressing the **CAP ON** function key.
- **Buffer Size:** Defines the size of the storage allocated to packet capture.
- **Truncate:** Captures the whole frame or first number of bytes of that frame.

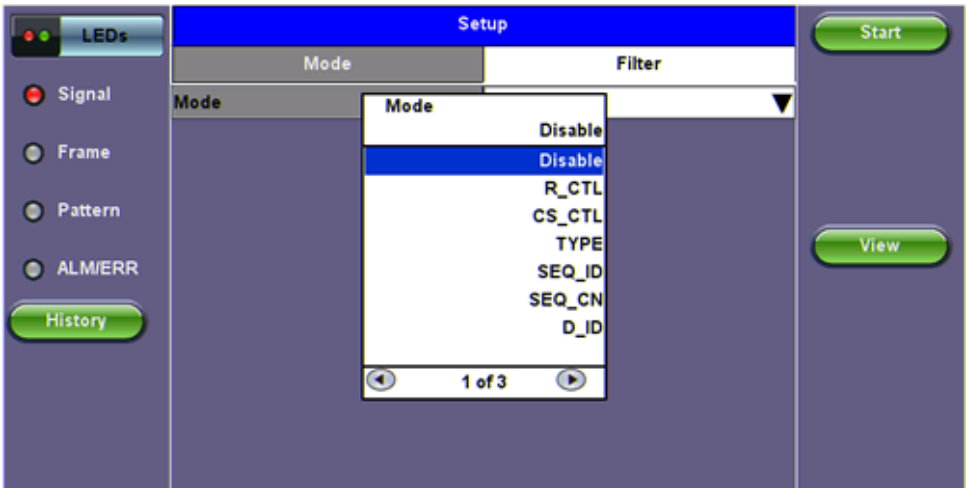
Tap on the **Filter** tab to select frame header parameters to filter for. Refer to Header Setup (FC-2 only) for a brief description of each parameter.

Press the green **Start** button to begin packet capture. To store these results packets:

1. Press **Stop**, then press **Save as**.
2. Enter a name for the results file, and then press **Apply** to save the file. The file is saved under the Files folder on the unit in pcap format. The file can be later exported to a PC and analyzed using Wireshark.



Capture Mode



Filter

Capture Save

Go back to top Go back to TOC

9.0 Certifications and Declarations

Declaration of Conformity

What is CE?

The CE marking is a mandatory European marking for certain product groups to indicate conformity with the essential health and safety requirements set out in European Directives. To permit the use of a CE mark on a product, proof that the item meets the relevant requirements must be documented.
Use of this logo implies that the unit conforms to requirements of European Union and European Free Trade Association (EFTA). EN61010-1

For a copy of the CE Declaration of Conformity relating to VeEX products, please contact VeEX customer service.

RoHS Compliance

VeEX QUALITY AND ENVIRONMENTAL POLICY

Our quality and environmental policy is to limit and progressively eliminate the use of hazardous substances and chemicals in the design and manufacture of our products.

ROHS Statement

VeEX products are classified as Monitoring and Control Instruments under Article 2, Section (1), Category 9 of the WEEE 2002/96/EC Directive.

RoHS and WEEE Position Statement

The Council of the European Union and the European Parliament adopted Directive 2002/95/EC (January 27, 2003), to Reduce the use of certain Hazardous Substances (RoHS) in Electrical and Electronic Equipment, and Directive 2002/96/EC on Waste Electrical and Electronics Equipment (WEEE), with the purpose of reducing the environmental impact of waste electrical and electronic equipment. Both were later recast by Directives 2011/65/EU and 2012/19/EU respectively. All VeEX products being placed on the EU market conform with these directives.

Additional RoHS substance restrictions for the Monitoring and Control Instruments were adopted by EU Directive 2015/863 (March 31, 2015). These new restrictions will take effect from July 22, 2021. VeEX has established a program to ensure that from July 22, 2021, all its products to be sold and shipped into the EU market will conform with (EU) 2015/863.

VeEX Inc. is committed to comply with RoHS and WEEE Directives to minimize the environmental impact of our products.

For more information about RoHS as it relates to VeEX Inc, go to the VeEX web site at www.veexinc.com/RoHS

10.0 About VeEX

VeEX Inc., a customer-oriented communications test and measurement company, develops innovative test and monitoring solutions for next generation telecommunication networks and services. With a blend of advanced technologies and vast technical expertise, VeEX products address all stages of network deployment, maintenance, field service turn-up, and integrate service verification features across copper, fiber optics, CATV/DOCSIS, mobile 4G/5G backhaul and fronthaul, next generation transport network, Fibre Channel, carrier & metro Ethernet technologies, WLAN and synchronization.

Visit us online at www.veexinc.com for the latest updates and additional documentation.

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Go back to top Go back to TOC