The Verification Experts

USER MANUAL

- Ethernet
- Fibre Channel

MTX150x

Multi-service Installation & Maintenance Test Set

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

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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.

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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

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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.

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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.

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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.

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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, or CFPs from the platform.
    - Connecting or disconnecting cables from modules or platform.

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3.0 Introduction

Refer to the MTX150X specification sheet for information on platform highlights and key features.

3.1 Utilities

Refer to the **V150 Common Functions** manual for information about all Utilities and Tools available.

3.2 Common Functions

Please refer to the **V150 platform manual** for the following functions:

- IP Tools: Ping, Trace Route
- Net Wiz
- WiFi Wiz
- Advanced Tools
- Utilities
- Files
- Backlight

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4.0 Basic Operations

For information on Basic Operations, Home menu, Test Applications, physical interfaces and other features specific to the V150 platform chassis, refer to the **V150 Common Functions** manual.

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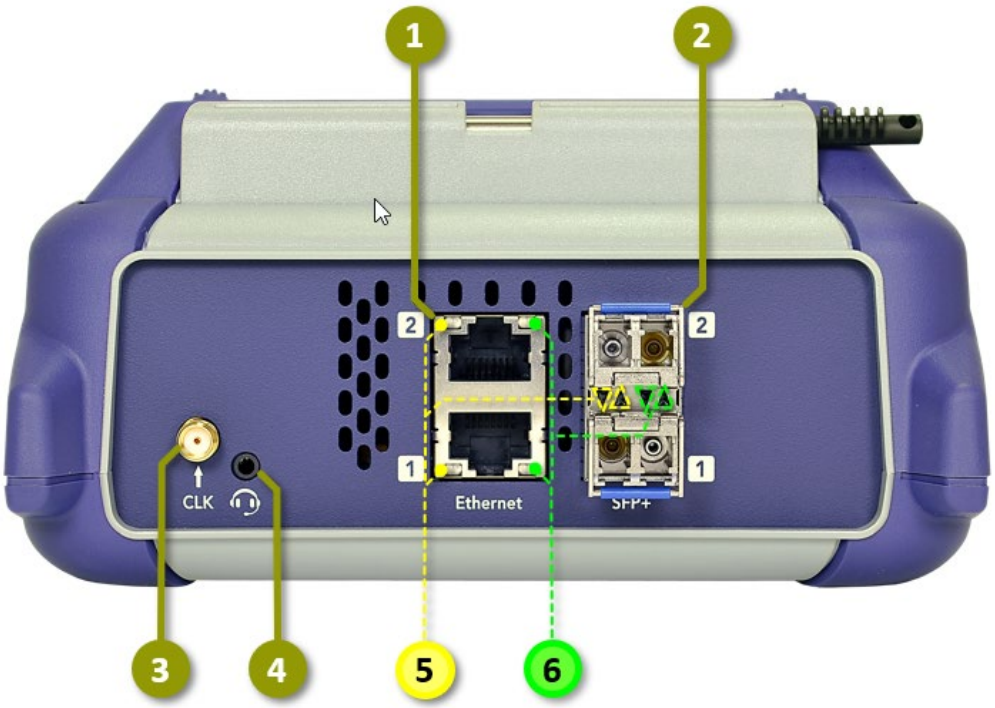
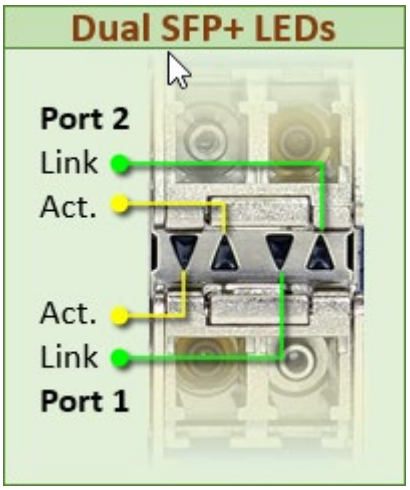
4.1 Connector Panel



MTX150 Connector Panel



Dual SFP+ LEDs

1. **Dual RJ45:** 10/100/1000BASE-T
2. **Dual SFP+:** 10GBASE-X, 1000BASE-X, 100BASE-FX 4/2/1GFC
3. **SMA:** External Reference Clock Input
4. **TRS:** 2.5mm: Headset jack (VoIP)
5. **LEDs:** Activity (P1, P2)
6. **LEDs:** Link (P1, P2)

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4.2. Hard Buttons and Interfaces

The Save, Power, and Home buttons on the V150 chassis control platform settings ranging from turning on the unit to saving test results and updating software. The chart below details the button combinations for various platform control functions.

Buttons					Quick Guide	Indicators
	SAVE	⏻	HOME			Alarm & Error Generation indicator A E Test is Running R Laser ON indicator
		(●)			Turns test set ON / OFF (hold 2 seconds)	
	●				Save current Test Results	
			●		Go Back to Main Menu	
	●		●		Initiate Touch Screen Calibration process	
	●	●			Clean Firmware Update (clears data & settings)	
		●	●		Firmware Update (keeps user data & settings)	
		((●))			Force Power OFF (hold 6 seconds)	
			((●))		Standby/Sleep Mode (hold 3 seconds)	
	●			←	Screen Capture (saves current screenshot)	
System configuring, please wait...						

Platform Settings Button Combinations

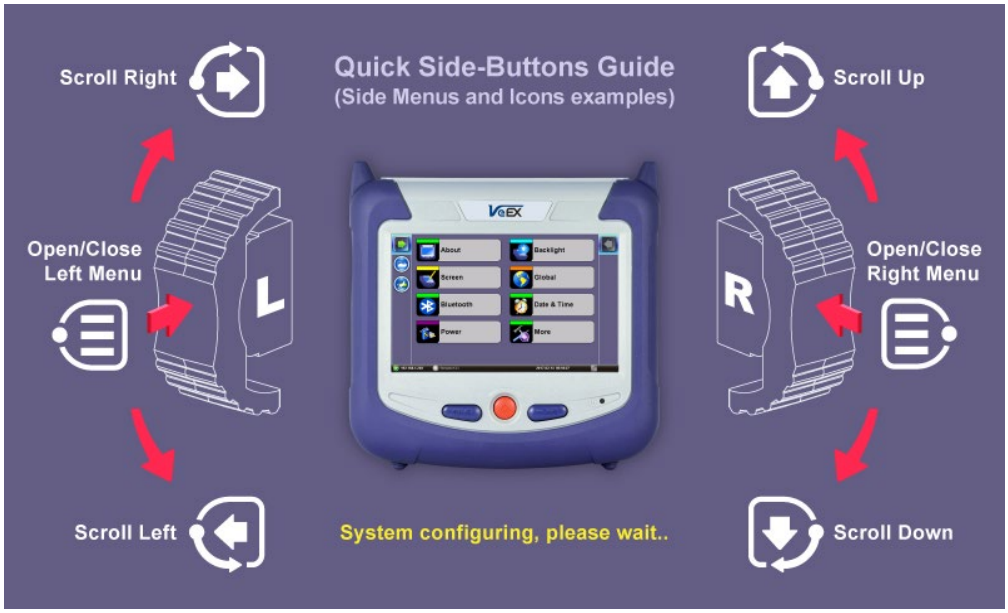
*Refer to the **V150 Common Functions** manual for software update instructions.*

4.2.1 Physical Buttons

Physical side buttons on the left and right side of the MTX150 are used to reveal menus and the scroll through table results.

Button functions vary depending on the product.

- **Push in:** Reveal function keys such as starting/stopping tests
- **Left key:** Scrolls up and down through table results
- **Right key:** Scroll left and right through table results



Side buttons on the left and right of the unit can be used for menu access or scrolling through table results

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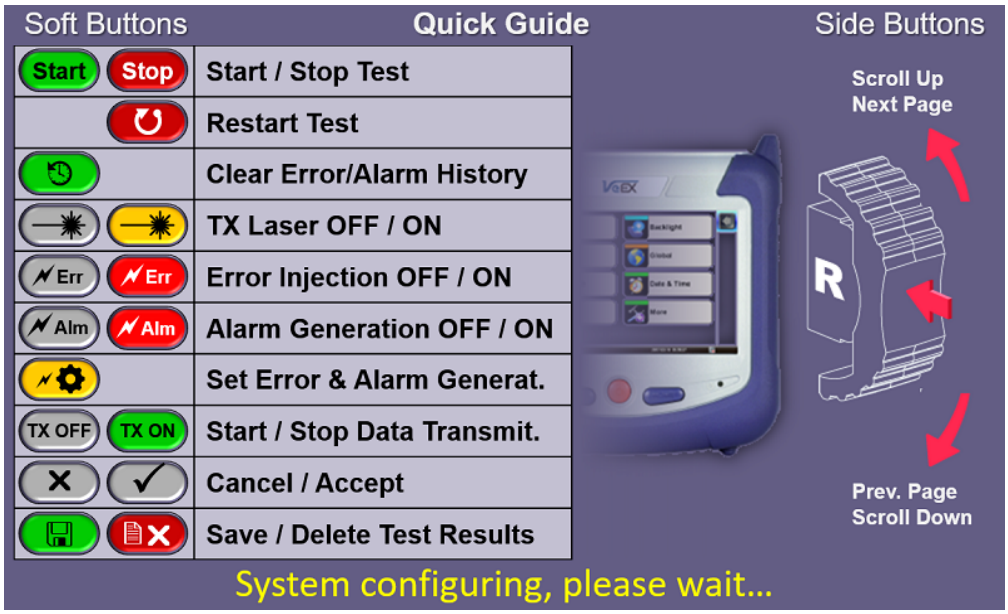
4.3 Home Menu and Screen Icons

For information on navigating the Home menu, launching Test Applications, and Platform screen icons refer to the **V150 Common Functions** manual. On screen soft buttons are used to control tests, alarms and error settings. Refer to the chart below for a description of each soft button.



Testing, Alarm and Error Soft Buttons

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4.4 LEDs

Soft LEDS are supported on several test modes:

Single Port LED Status Lights	
	• **Signal:** A valid input signal is detected • **Frame:** Valid framing on the input signal is detected • **Pattern:** Indicates test pattern synchronization in BERT, RFC, and Throughput modes • **Alarm/Error:** Alarms or errors are detected
Dual Port LED Status Lights	
	• **Signal:** A valid input signal is detected • **Frame:** Valid framing on the input signal is detected • **Pattern:** Indicates test pattern synchronization in BERT, RFC, and Throughput modes • **Alarm/Error:** Alarms or errors are detected • **Port:** P1 and P2 can be selected in dual port mode

The color indicates the alarm status:

- **Green:** No error or alarm is present
- **Red:** An error or alarm condition is currently detected
- **Red flashing:** Any error or alarm has occurred
- **Yellow:** An error or alarm was detected during the measurement interval but is no longer present or active
- **Grey:** Status not applicable or the test has not begun yet

For test modes that support dual ports, P1 and P2 indicates the port in operation.

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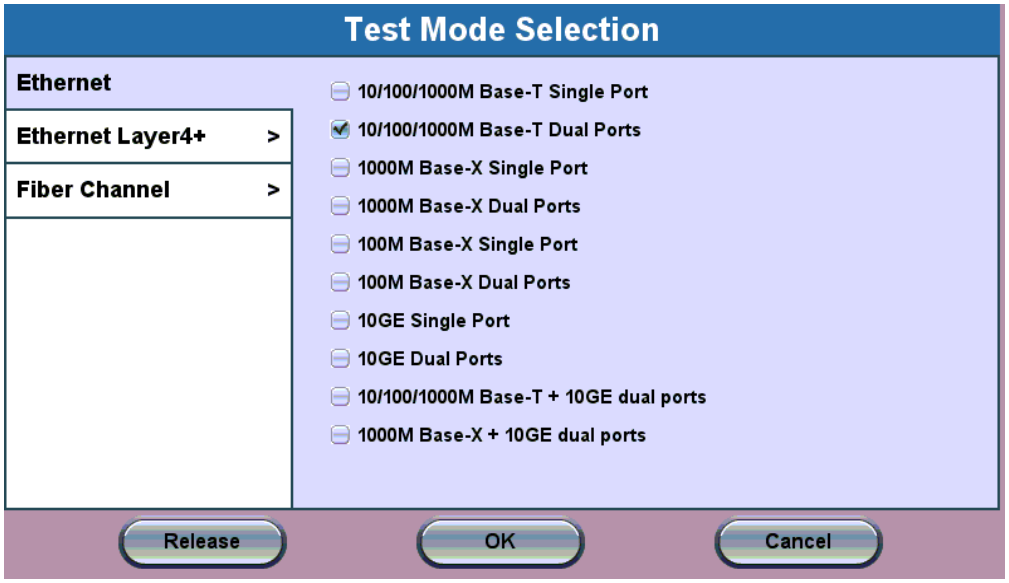
4.5 Test Port Selection

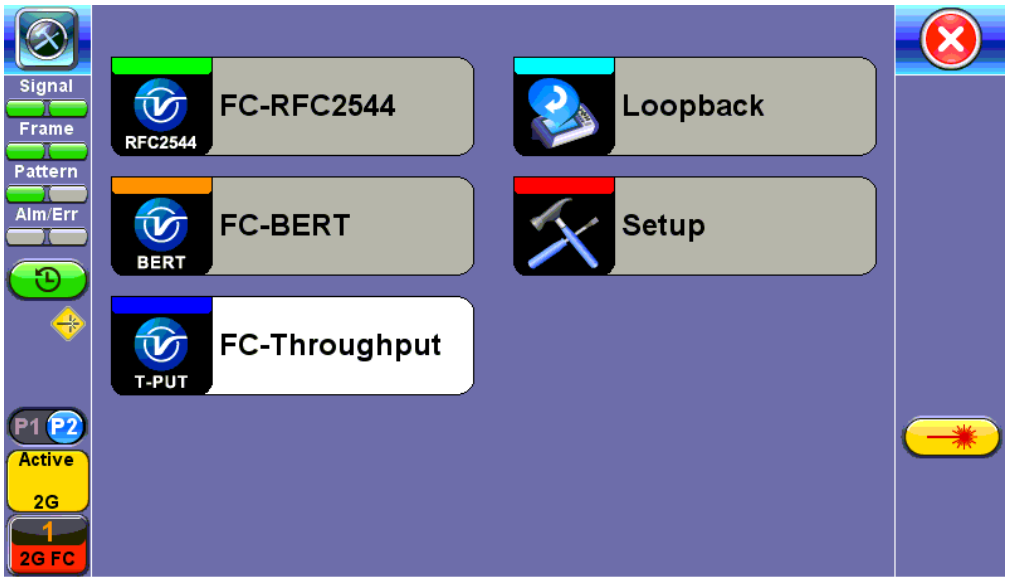
Test mode, test port(s), and network settings are required prior to performing any measurements or applications.

Ethernet test modes are accessed by selecting the Test Application button . Tap on a technology group then select a test interface. Depending on interface options purchased, the following selections are possible:



Test Mode Selection

Test interfaces requiring laser activation will indicate the active test port when the laser is turned on. In the example below, the **Active 2G** fiber channel port is active.



Turning the Laser On Activates the 2G Test Port for Fiber Channel

Toggle between Port 1 and Port 2 by taping on the slider button

Toggle between Port 1 and Port 2

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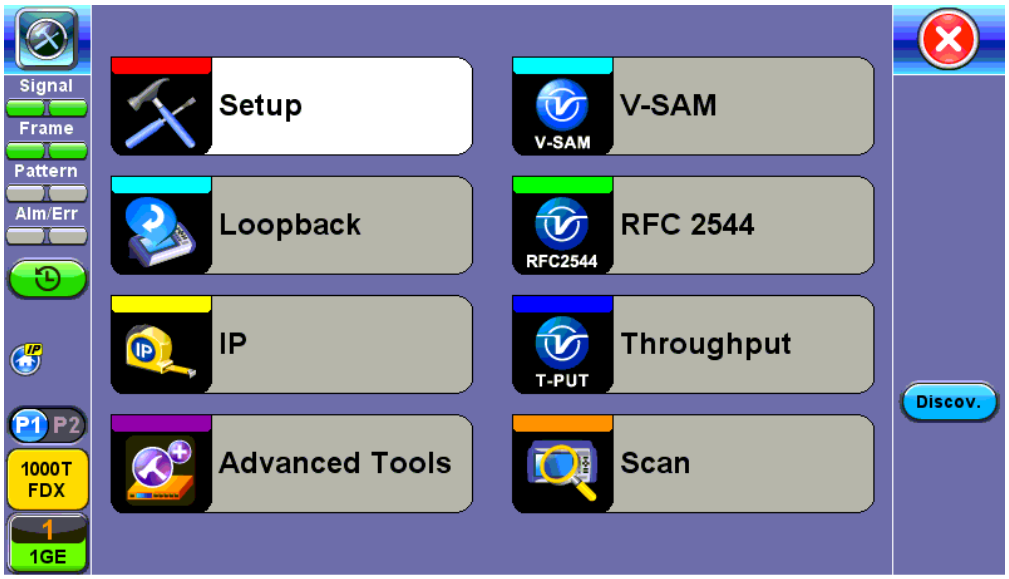
5.0 Ethernet

5.1 Ethernet Setup



Ethernet Home Menu

When the soft LEDs are steady green, this indicates 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).

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5.1.1 Port Setup

Port setup or test interface configurations are accessed via the **Setup** menu located on the Home page. 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.

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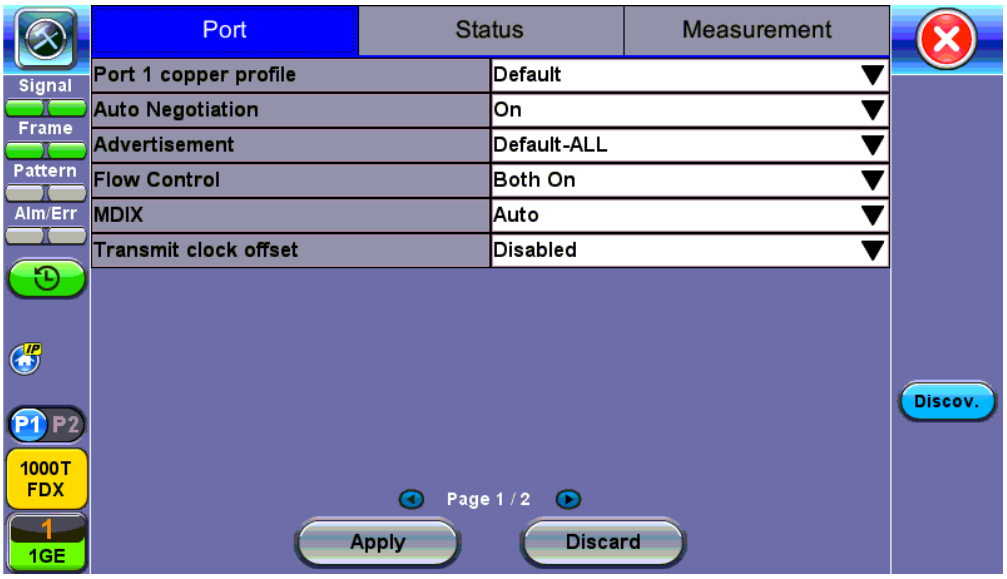

100/1000Base-X Port Setup

100/1000Base-X and 100/1000Base-T Port

- **Auto Negotiation:** On or Off. Matches the test set's negotiation settings to those of the link partner
- **Speed** *(only when Auto Negotiation is Off for 100/1000T)*: 10 Mbps, 100 Mbps, or 1000 Mbps
- **Duplex** *(only when Auto Negotiation is Off):* Half or Full
- **Advertisement** *(only when Auto Negotiation is On for 100/1000 Base-T)*: Default-All or Custom. Custom options include 10/100/1000M/Half or 10/100/1000M/Full.
- **Flow Control:** TX On, RX On, Both On, or Off
  - When flow control is On, the test set will respond to pause frames received by the link partner by adjusting the transmit rate
  - When flow control is Off, the test set ignores all incoming pause frames from the link partner and continues transmitting at the configured transmit rate
- **Clock Offset** *(1000 Mbps only)*: The frequency may be offset in parts per million
- **MDIX** *(100/1000Base-T only):* **Off, On, or Auto.** When MDIX is set to Auto, the test set detects the required cable connection type and configures the port connection properly for interfacing the partner device, eliminating the need for crossover cables.
- **Transmit clock offset** *(100/1000Base-T only)*: Disabled or Enabled. Due to hardware limitation, transmit clock offset is only valid when PHY is working on Master mode. Clock offset measurement is only valid when PHY is working on Slave mode.
  - **PHY working mode**: Master or Slave.
- **Transmit Ignore Link Status**: On/Off
- **Synchronous Ethernet (SyncE)**: Disabled or Enabled. When Enabled, makes the signal traceable to an internal or external reference clock.
  Note*: For information on configuring SyncE operation, see Port Page 2 - Mode Selection in the Synchronous Ethernet section*.

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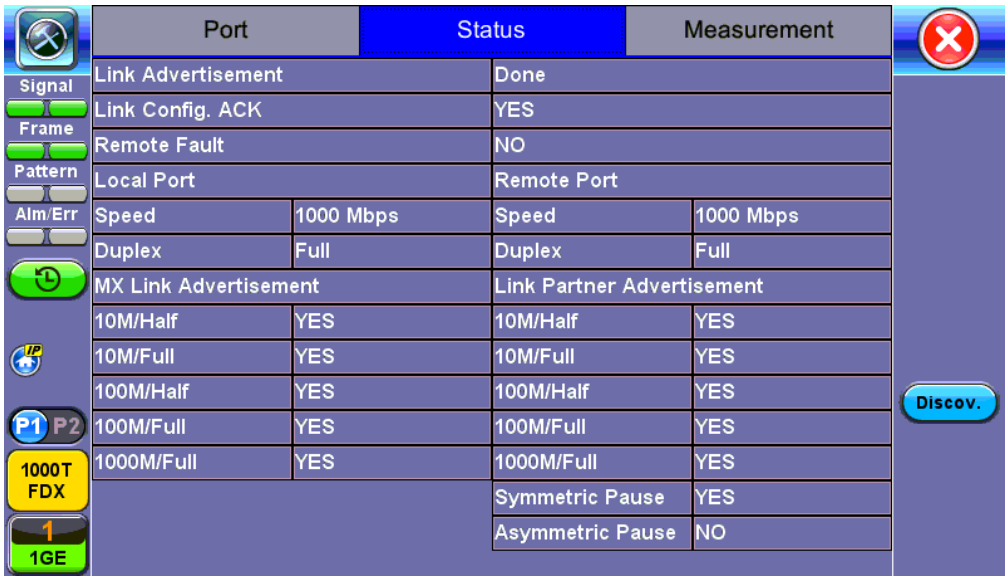
Status



Status tab for 10/100/1000Base-T

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.

10 GE Port

- **10GE Mode:** LAN or WAN
- **WIS Mode** (only available in WAN mode): SDH or SONET

- **Flow Control:** Enable chosen as default option
- **Clock Offset (ppm):** The frequency may be offset in parts per million
- **Link Fault Response:** Disable or Enable (also enables Local link and failure, remote, failure)
- **Transmit Ignore Link Status:** On/Off
- **Synchronous Ethernet**: (SyncE) Disabled or Enabled. When Enabled, makes the signal traceable to an internal or external reference clock.

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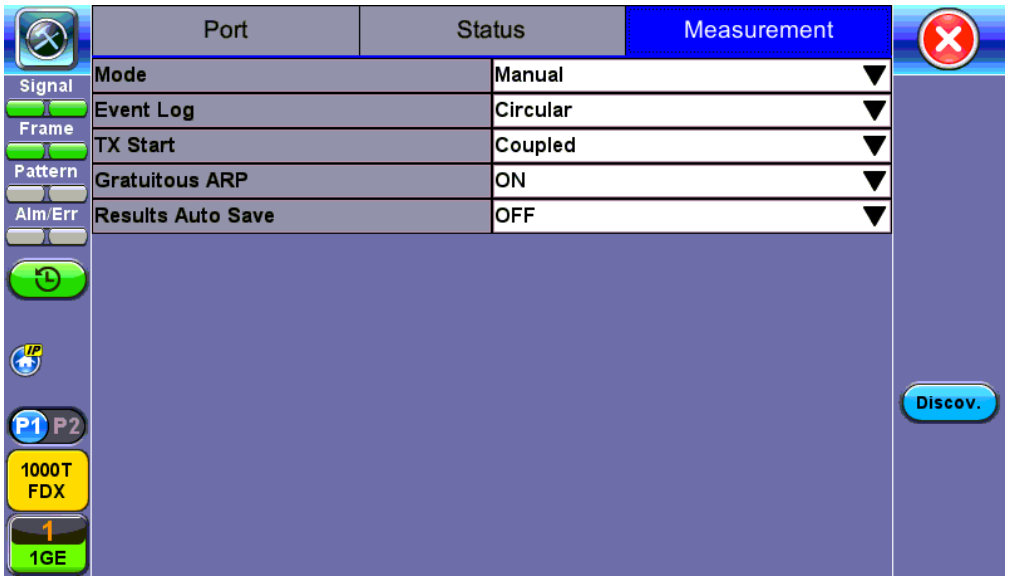
5.1.2 Measurement Settings



Measurement Setup

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

- **Mode:** Manual, timed, or auto mode are available.
  - **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.

- **Event Log**: Logs up to 1000 event entries. If there are more than 1000 events,
  - **Circular** keeps the latest entries. The oldest entry will be deleted so that the new event can be added.
  - **Blocked** stops recording new events after 1000 entries. The latest entries will not be logged.

- **TX Start:** Separated or Coupled. Configures 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, 1PPS, Local, Atomic 1PPS. 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.

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5.1.3 MX Discover and Control

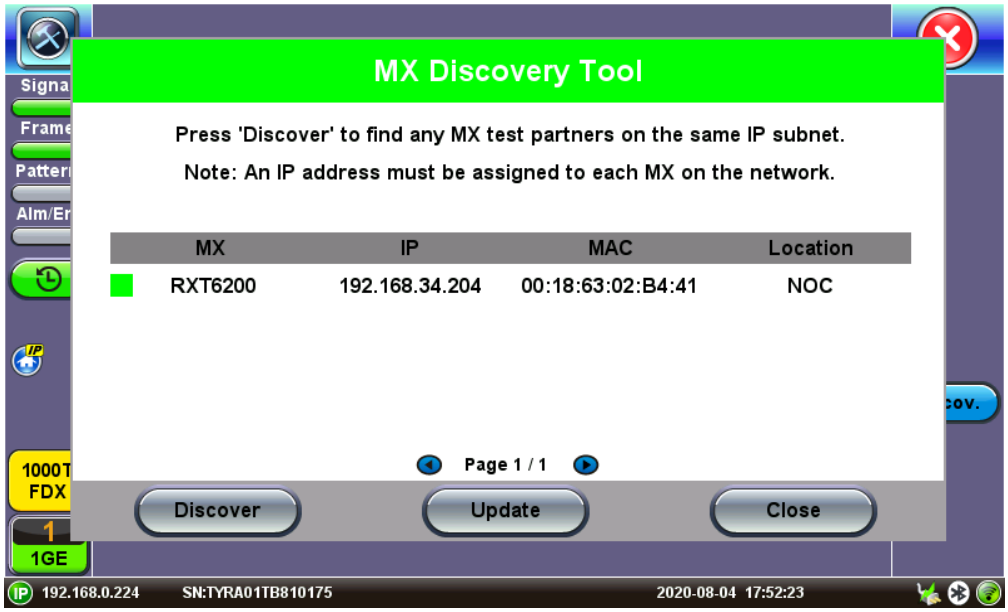
Before proceeding with MX Discover or Control, be sure to assign an IP address to each test port. To assign an IP address, proceed to the home menu and select the IP icon. Refer to IP Connection for additional instructions.

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

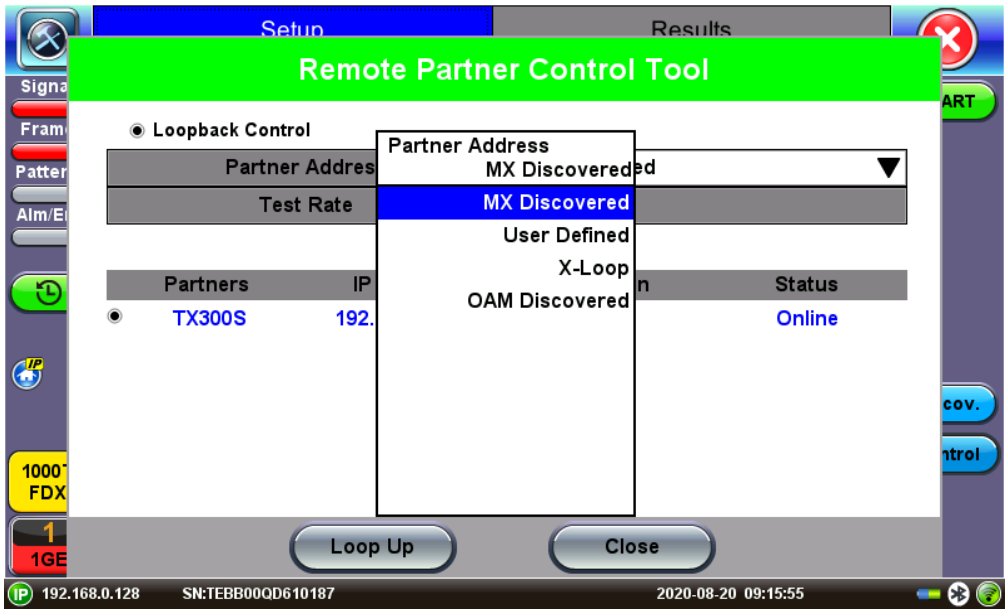
Using MX Discover

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



MX Discovery Remote Partner

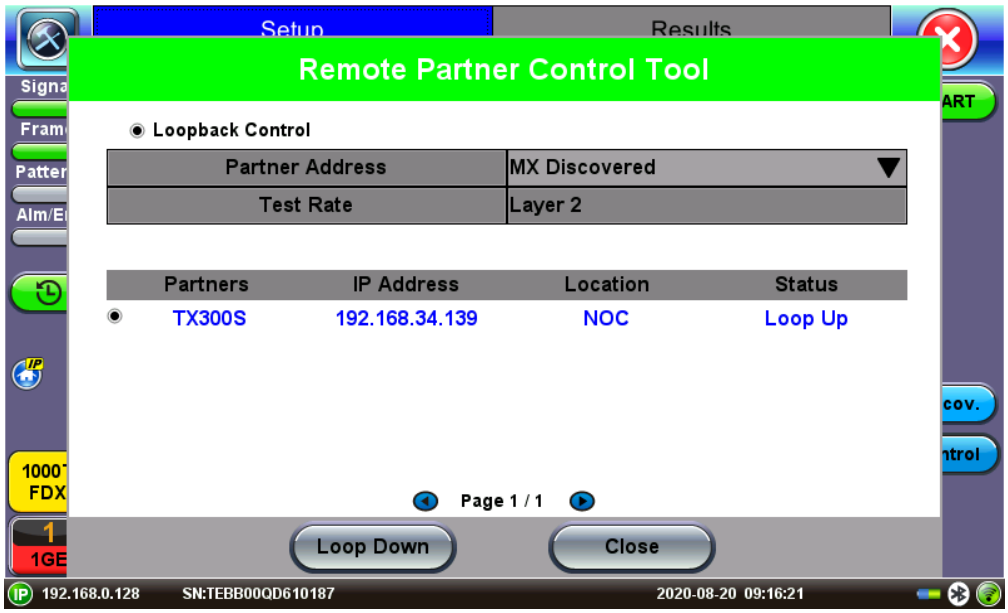
Loop Control

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
- **X-Loop:** Loops non-VeEX networking equipment.



Remote Partner Control

The **Peer-to-Peer** option is available only for RFC 2544 testing. For more information on **Peer-to-Peer** mode, please see [Peer-to-Peer and Asymmetric Testing].

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 1388v2 (except Layer 2).

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

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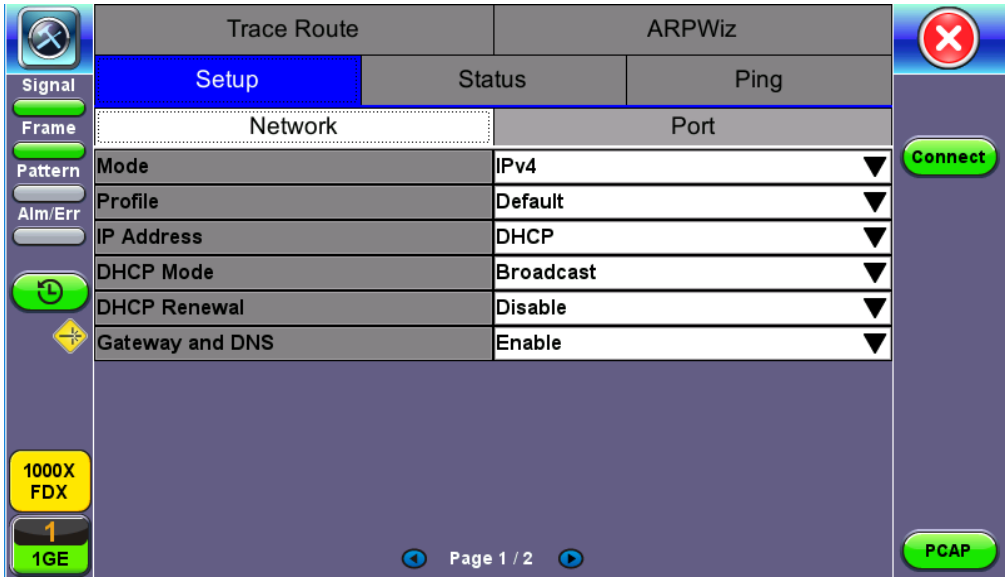
5.2.1.1 Setup

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
    - **DNS:** Input a primary and secondary DNS
    - **CIDR** (IPv6 only)**:** The user can enter a Classless Inter -domain Routing Network
    - **Subnet** (IPv4 only)**:** The user can enter a subnet mask
- **Gateway and DNS:** Enable/Disable. Enables entering the Gateway and DNS.
- **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.

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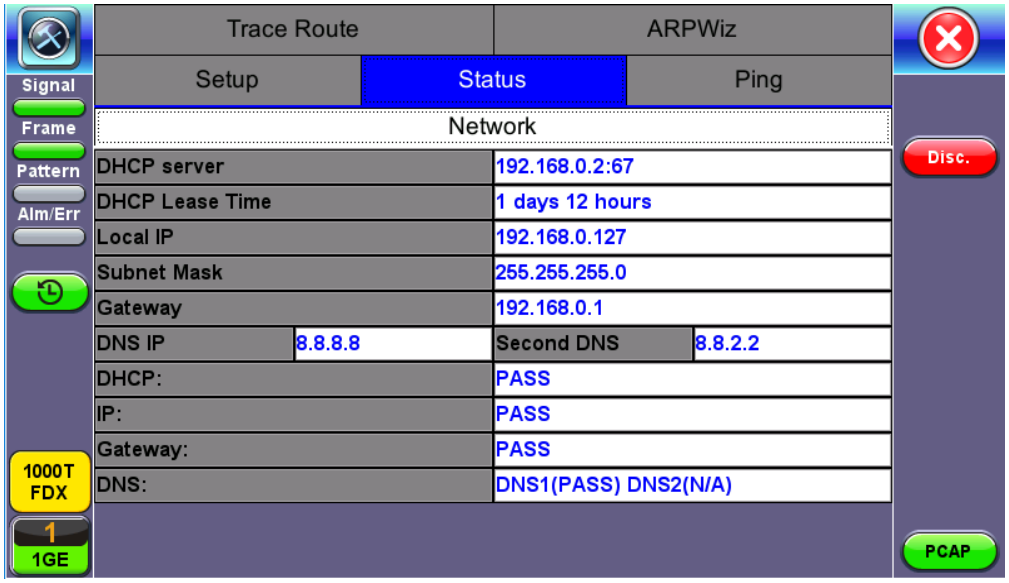
5.2.1.2 Status

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.

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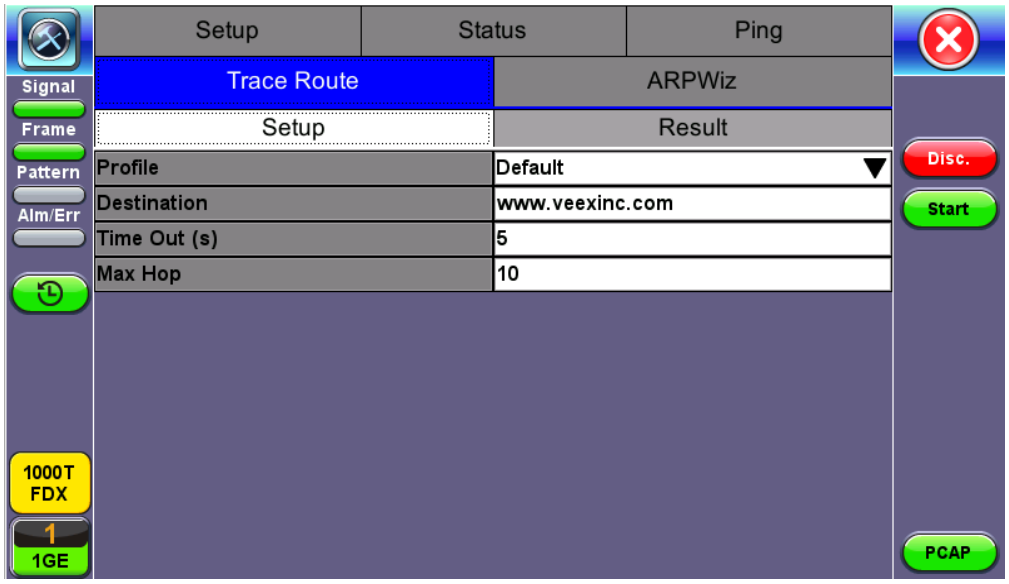
5.2.2 Trace Route

Trace Route is a common method used to find the route to the destination IP address or URL. It is often used to identify routing problems and unreachable destinations. All the remote IP addresses and their response times are displayed indicating possible network congestion points.



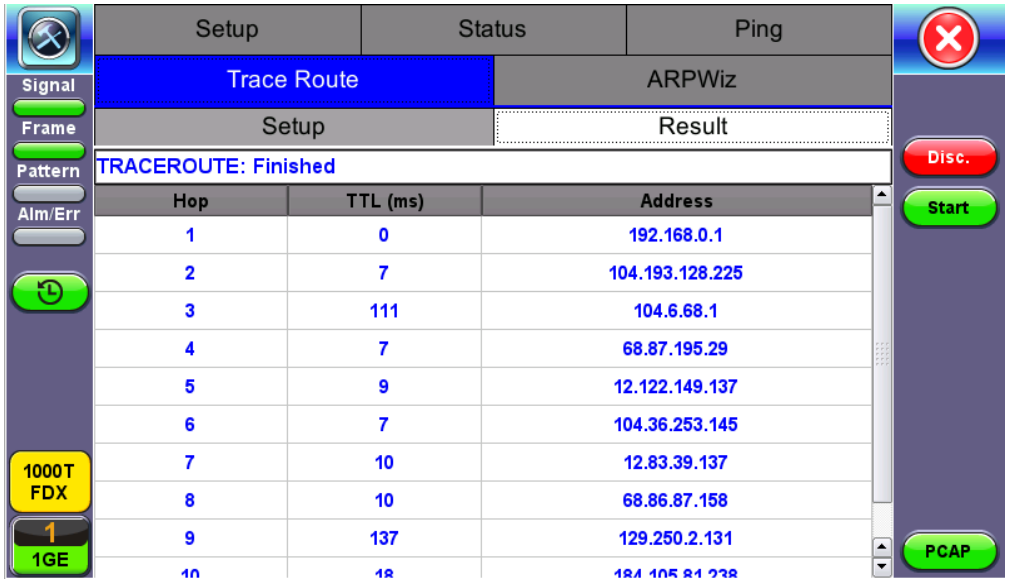
Trace Route - Setup

Trace Route Setup

The following setup selections are available:

- **Profile:** Delete, Save, Save as..., Default. Select Default to recall a trace route file or create a new test
- **Destination:** Enter the IP address or URL of the network device to be detected
- **Time Out:** Enter the maximum time allowed between an ICMP echo and response at each hop
- **Max Hop:** Enter the maximum number of network devices the packet is allowed to transit

Once the parameters are configured, press **Start** to begin the test.



Trace Route - Results

Results

- **Hop:** Order of the routers on the route
- **TTL:** Time to reach each router on the route
- **Address:** Address of each router on the route

If there is no response from a particular hop, an asterisk will be displayed.

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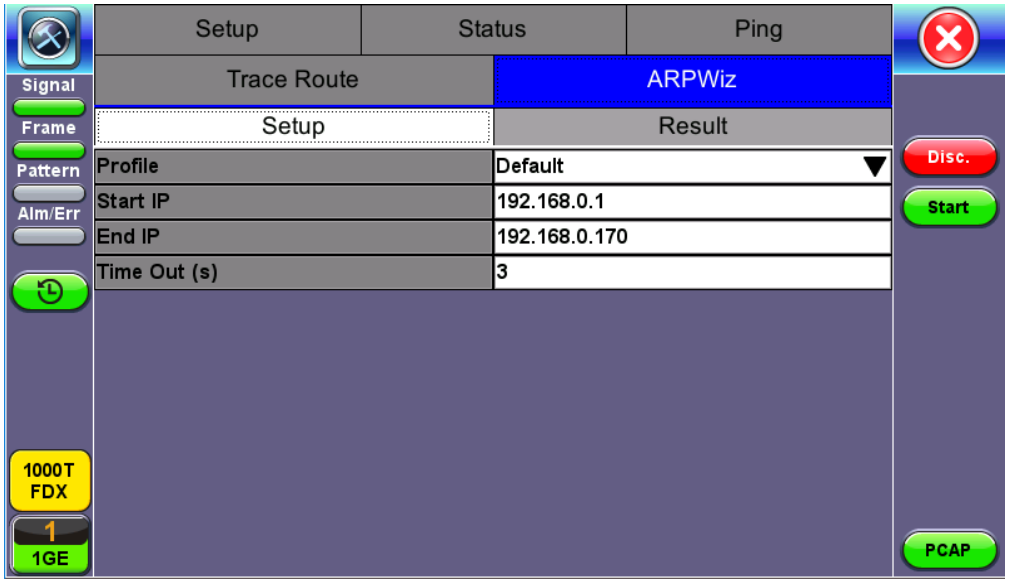
5.2.3 ARP Wiz

ARP Wiz uses the Address Resolution Protocol (ARP) to verify the status of each IP address in a user-selectable IP range. ARP is the standard method for finding a host's hardware address when only its network layer address is known. In other words, ARP is used primarily to translate IP addresses to Ethernet MAC addresses. ARP is defined in RFC826.

Setup

Configure the following parameters:

- **Profile:** Drop-down selections are Default, Delete, Save, or Save As...
- **Start IP:** Starting IP Address.
- **End IP:** Ending IP Address.
- **Time Out(s):** Range from 1-99 seconds. Input using the numeric keypad.
- Press **Start**.
- The test will continue to run until the user presses **Stop**. A finished status indication will display when the test finishes.

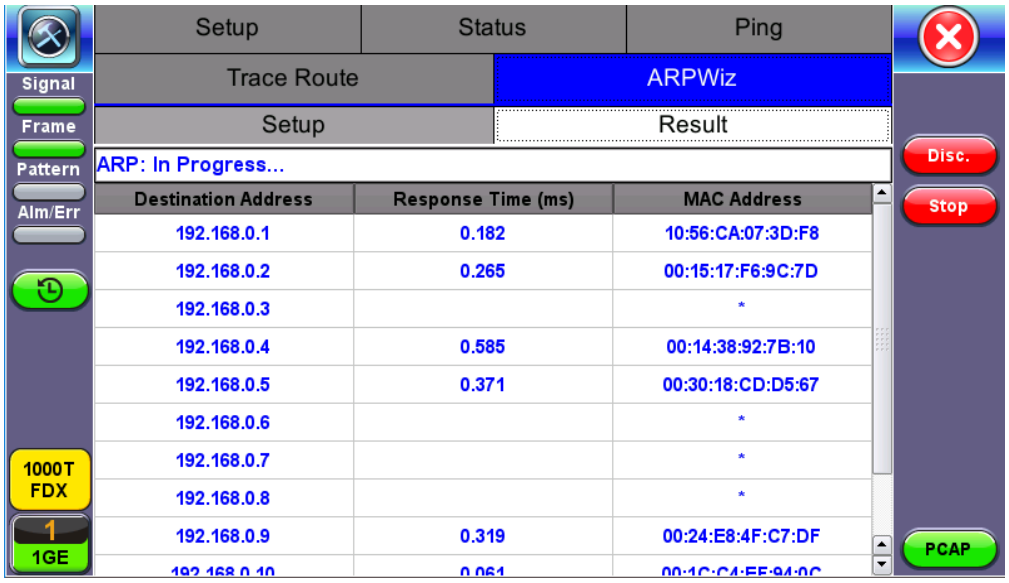


ARP Wiz Setup

Result

The MAC addresses associated with active IP addresses in the range are displayed. If no MAC address is associated with the IP address, a **FAILED** status is displayed.

ARP Wiz uses the ARP protocol and can only work within the same subnet as the IP address provided to the test set in IP Status



ARP Wiz Result

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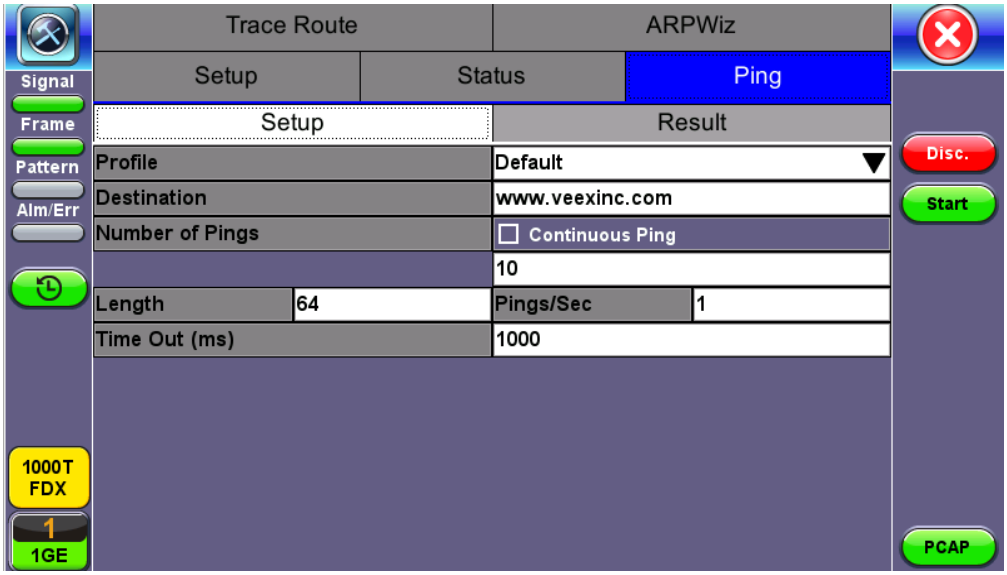
5.2.4 Ping

The Ping Result provides the number of Sent, Received, Unreach, Missing, and the Round Trip delay.

Ping Testing

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.



Ping Setup

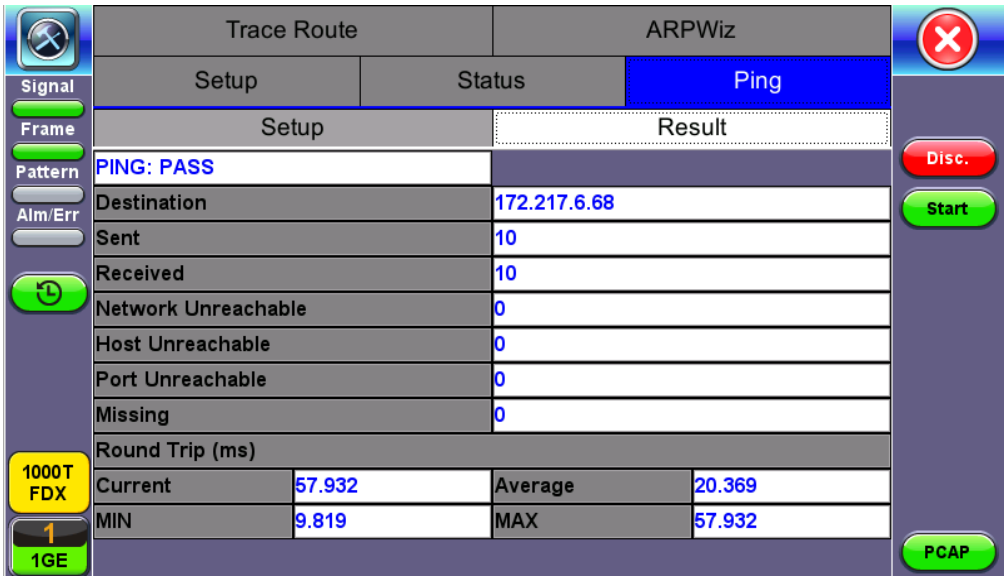
Ping Setup

- **Profile:** Delete, Save, Save as..., or Default.
- **Destination:** Press the drop -down menu and enter the destination IP address or URL to ping.
- **Number of Pings:** Enter the number of ping attempts (up to 10000) that will be performed to reach the network device.
  - ***Note****: If Continuous Ping is selected, the user is not required to enter the number of pings. The test set will continuously ping the target host until the user presses* ***Stop****.*
- **Length:** Enter the length of the ICMP echo request packet transmitted.
- **Ping/Sec:** Enter the Ping repetition rate (Ping/second).
- **Time Out:** Time-to-Live (TTL) in milliseconds. Enter the maximum time allowed (in ms, up to 99999 ms) between an ICMP ping and echo response.

Once the parameters are configured, press **Start** to begin the test.

Ping Results

Pressing Ping will take you to the Result tab and start the Ping test.



Ping Result

- **Destination:** Indicates the destination IP address.
- **Ping status:** In Progress, PASS, or FAIL.
- **Sent, Received, Unreach, Missing:** Number of pings sent, received, unreached or missing. A Ping is counted missing if no

response is received before timeout. A Ping is counted unreached if an echo response is received with host unreachable set.

- PING also estimates the **Round-Trip** time in milliseconds
  - **Current:** The current time for a Ping request to be answered.
  - **Average:** The average time recorded for a Ping request to be answered.
  - **Max:** The maximum time recorded for a Ping request to be answered.
  - **Min:** The minimum time recorded for a Ping request to be answered.

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5.3 BERT

5.3.1 BERT Setup

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

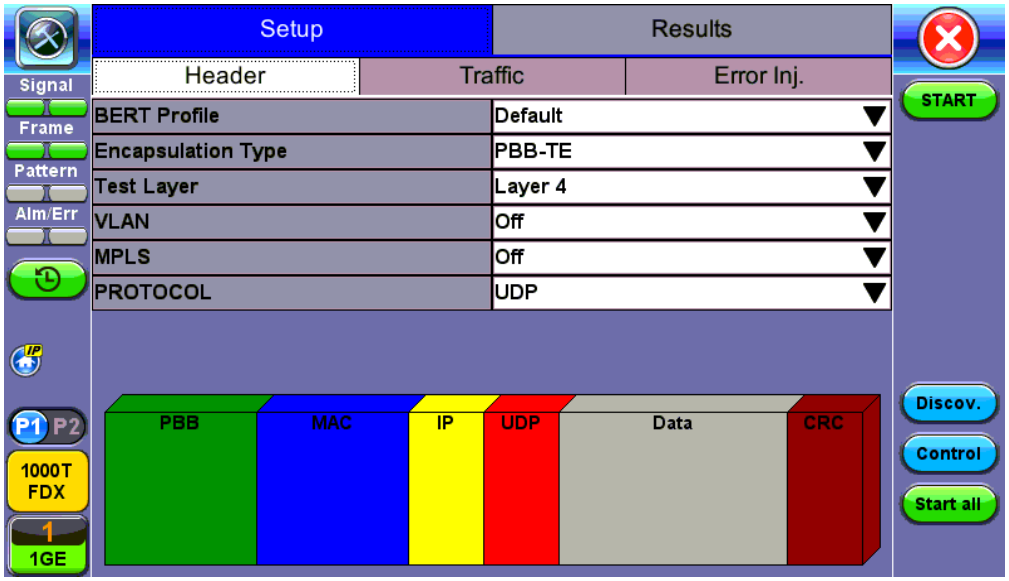
Overview:
BER testing at Layer 1, 2, 3, and 4 is supported. The BERT can be configured to use either regular PRBS test patterns, stress patterns (specifically for 10Gigabit Ethernet) or user defined test patterns to simulate various conditions. The test layer, frame header, traffic profile, error injection, and control settings of the far-end device (if applicable) must be configured prior to testing.

- **Layer 1:** Unframed mode (fiber ports only) or Framed mode
  - **Unframed mode:** Test traffic consists of a bit stream of the selected test pattern
  - **Framed mode:** Test pattern is encapsulated into a valid Ethernet frame with SOF, Preamble, and CRC field

- **Layer 2:** Framed BERT (same as Layer 1 Framed)
  - **MAC Address:** A default or user configured Media Access Control (MAC) address is added to the frame

- **Layer 3:** Framed BERT (same as Layer 1 & 2 Framed)
  - **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

- **Layer 4:** Framed BERT (same as Layer 1, 2, & 3 Framed)
  - **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
  - **UDP** or **TCP Address:** A user defined source and destination port address is added to the frame



BERT Setup - Header (Layer 4)

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5.3.1.1 Header Settings

- **BERT Profile:** Load a previously configured test profile or create a new profile from existing settings.
  Refer to the **Profiles** section in the **ReVeal MTX300 manual** for more details on how to create new profiles using ReVeal software.

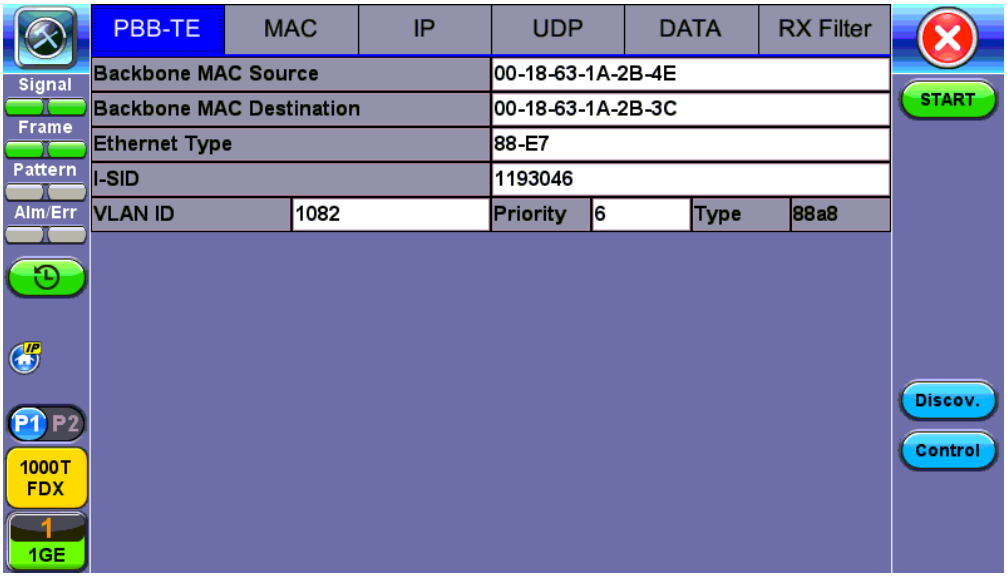
- **Encapsulation Type:** None, Provider Backbone Bridge (PBB-TE), or Multiprotocol Label Switching (MPLS-TP). MPLS-TP is a simplified version of MPLS. Provider Backbone Bridge MAC-in-MAC (IEEE 802.1ah) encapsulation are configured trunks that add resiliency and configurable performance levels in the 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.

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

MPLS-TP:

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



PBB

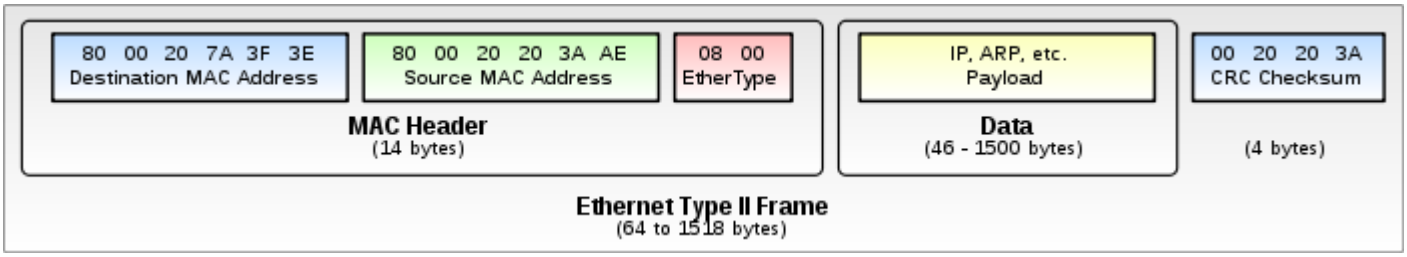
- **Test:** Select the test layer to perform the BERT
  - Options are Layer 1 Unframed, Layer 1 Framed, Layer 2, Layer 3, and Layer 4

- **Frame Type:** Select the Ethernet frame type for Layer 2 or Layer 3
  - 802.3 Raw (IEEE 802.3 frame without LLC) - Not available when Layer 3 is selected
  - 802.3 LLC (IEEE 802.3 frame with LLC header)
  - 802.3 SNAP (IEEE 802.3 frame with SNAP header)
  - Ethernet II (DIX) (named after DEC, Intel, and Xerox, this is the most common frame type today)

- **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 and Layer 4

- **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:** Off, 1 tag, 2 tags, 3 tags
  - The user is able to configure up to 3 MPLS tags
    Note: *MPLS tag configuration is only available when the MPLS option is purchased*



The most common Ethernet Frame format, Type II

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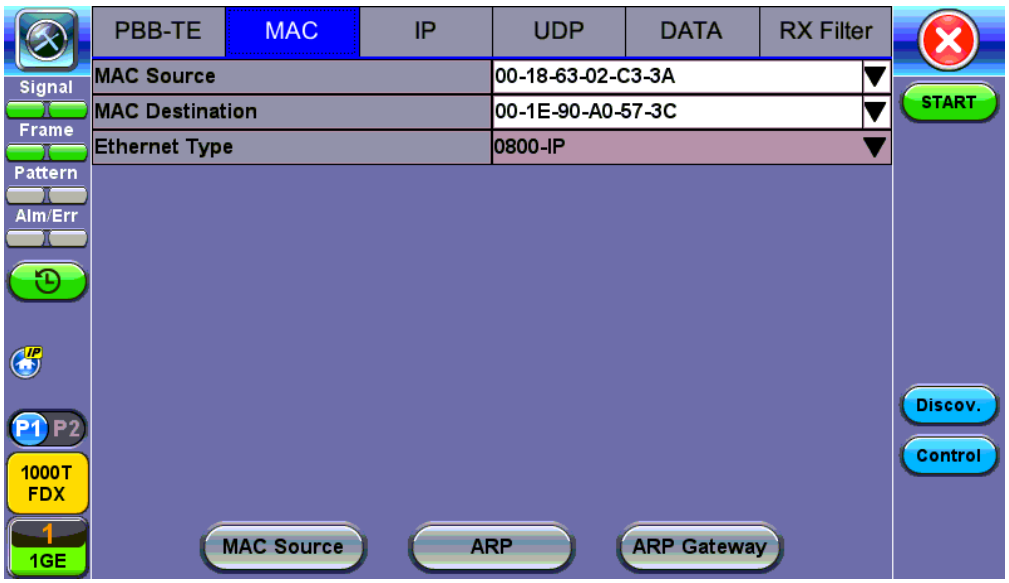
MAC, VLAN, MPLS, IP, and Test Pattern Configurations:

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**: A valid IP connection needs to be up to use these functions.* Refer to IP Connection for further instructions.
  - **Ethernet Type:** For Layer 2 testing, the user can also configure the Ethertype:
    - 0800-IP (Internet Protocol Version 4, IPv4)
    - 0600-Xerox
    - 0801-X.75 (X.75 Internet)
    - 0805-X.25 (X.25 Level 3)
    - 0806-ARP (Address Resolution Protocol [ARP])
    - 8035-RARP (Reverse Address Resolution Protocol [RARP])
    - 8137-IPX (Novell IPX)
    - 814C-SNMP
    - 8847-MPLS unicast
    - 8848-MPLS multicast
    - 86DD (Internet Protocol, Version 6 [IPv6]) - Future Release

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



BERT Setup - MAC address settings (Layer 3)

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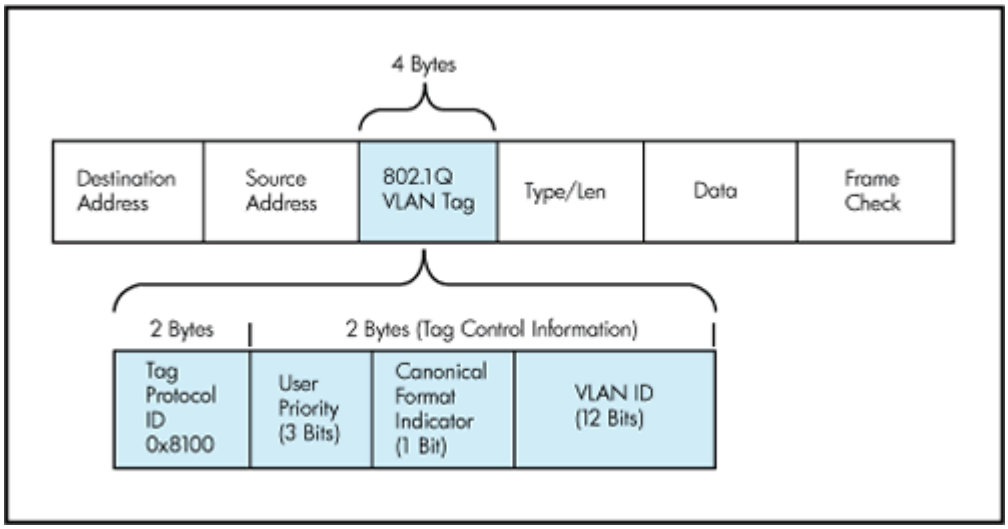
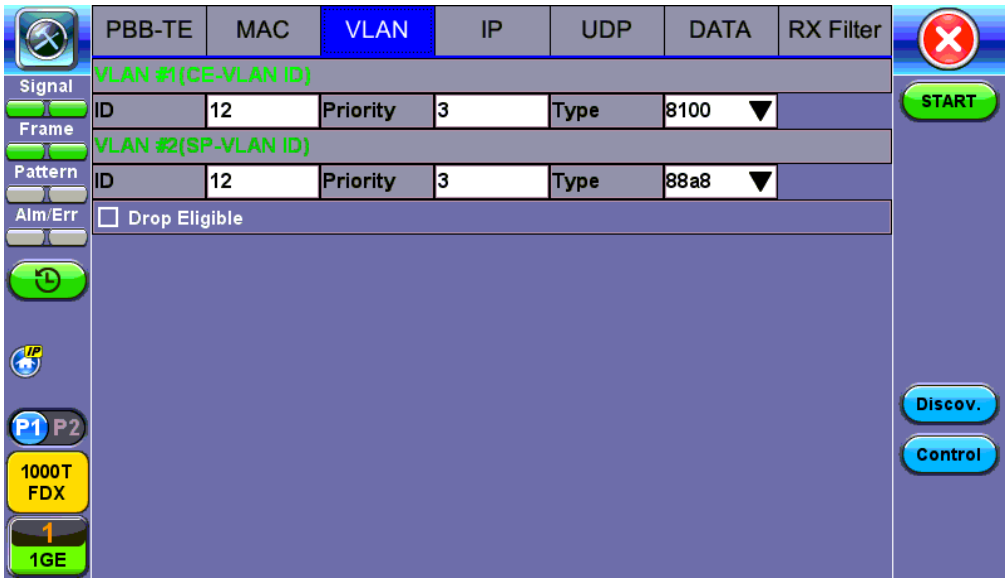
- **VLAN Tab:** In the VLAN tab the following parameters are configured:

- **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)
- **Drop Eligible:** If enabled, drop eligibility flag will be set.
- **VLAN Flooding:** Enable/Disable.
- **VLAN Flooding Range:** Specifies the number of VLAN IDs. Enter a number from 0-4096. The VLAN IDs will be incremented by 1 until it reaches the number of times entered in the flood range.



IEEE 802.1Q VLAN Tag in an Ethernet Frame



BERT Setup - VLAN Tag configuration (Layer 3)

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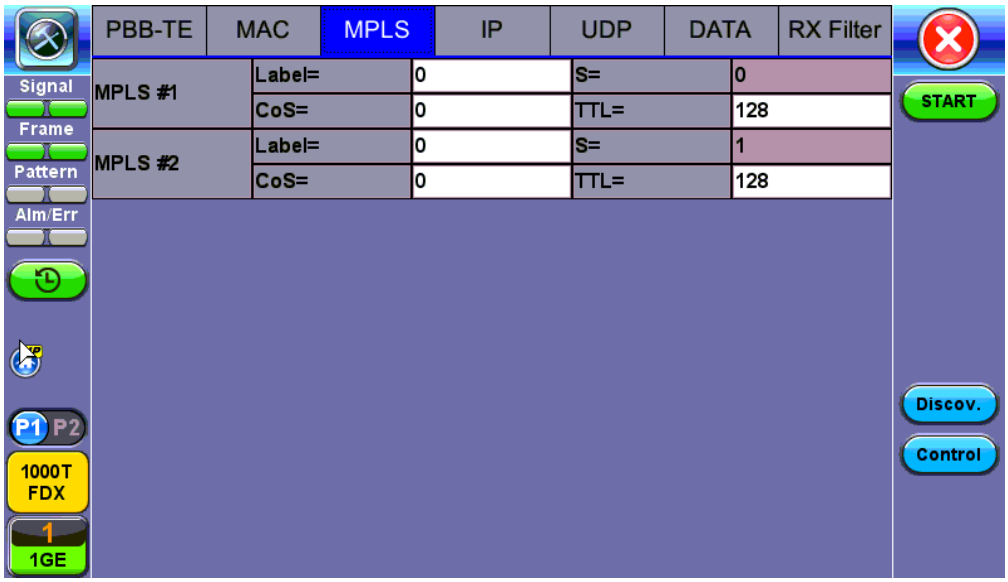
- **MPLS Tab:** In the MPLS tab the following parameters are configured:
  - **MPLS label:** Configurable in the range 16 through 1,048,575 (labels 0 to 13 are reserved).
    Note: *Composed of 20 bits which allows for the creation of over one million labels.*
  - **CoS:** Configurable in the range 0 to 6.

Note: *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.
  Note: *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.
  Note: *Used to decrement the time-to-live counter.*



BERT Setup - MPLS label configuration

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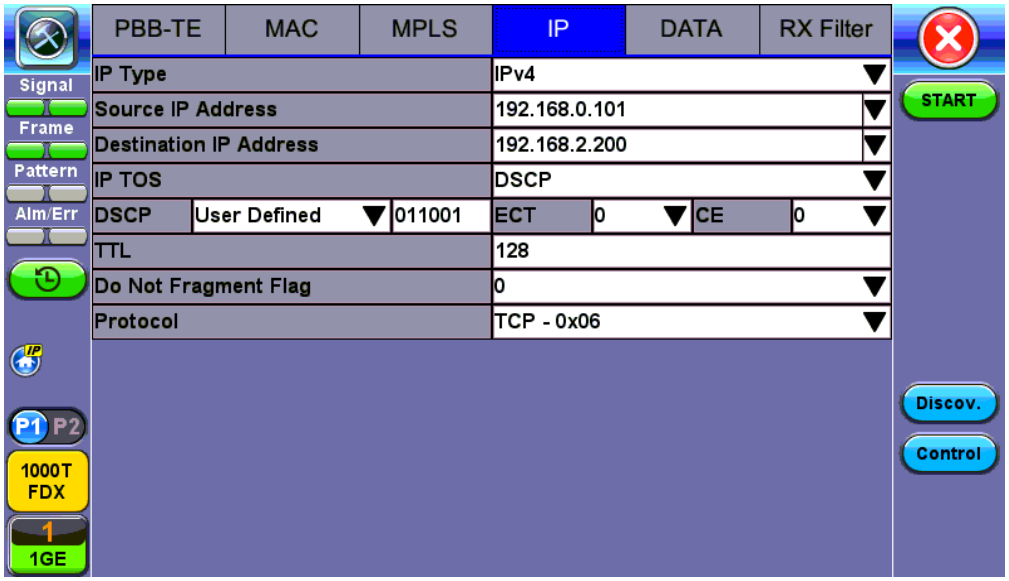
- **IP Tab:** In the IP tab the user must configure the destination IP address and source address. The user may also configure the following IP header fields:
  - **IP Type:** IPv4
  - **IP Src and IP Dest:** For IP Src, if the IP connection is up, refer to IP Connection. The source address is fixed to the IP address from the IP setup menu.
  - **IP TOS (for Quality of Service testing):**
    - **Legacy TOS (Precedence):** The first three bits of the IP TOS field can be edited:
      000 - Best Effort
      001 - Bulk Data
      010 - Transactional
      011 - Call Signaling
      100 - Streaming Video
      101 - Voice
      110 - Routing
      111 - Reserve
    - **DSCP (Differentiated Services Code Point):** The first six bits of the IP TOS can be edited to provide more granular service classification.
      For more information on the definition of DSCP field in IPv4 and IPv6 headers, refer to RFC2474.
    - **Time To Live (TTL):** Configurable in the range 0 to 255.
    - **Fragment offset byte:** Configurable in the range 0 to 65.528.
      Note: *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 settings (Layer 3)

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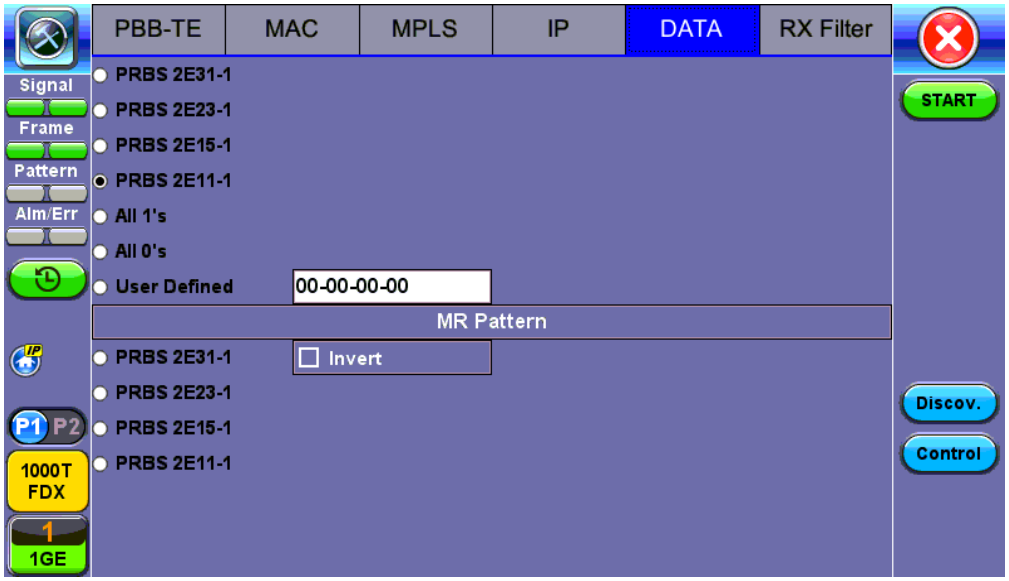
- **Data Tab:** User selects a test pattern that will be encapsulated in the Ethernet frame payload (for framed mode). Depending on the test layer, different test pattern options are available.
  - **Layer 2, 3, & 4 test patterns**
    - **PRBS:**
      - 2^31 -1 (147 483 647-bit pattern used for special measurement tasks, [e.g., delay measurements at higher bit rates])
      - 2^23 -1 (8 388 607 bit pattern primarily intended for error and jitter measurements at bit rates of 34 368 and 139 264 kbps)
      - 2^13 -1 (32 767 bit pattern primarily intended for error and jitter measurements at bit rates of 1344, 2048, 6312, 8448, 32 064 and 44 736 kbps)
      - 2^11 -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)
    - **Fixed:** All 0s or All 1s
    - **User Defined pattern:** Length depends on size of frame
    - **Inversion:** Normal or inverted



BERT Setup - Data selection - PRBS Patterns

    - **Auto (Special Patterns):** For special patterns, the most significant bit of the test pattern is populated first into the payload frame, as opposed to non-special patterns, in which the least significant bit is populated first.

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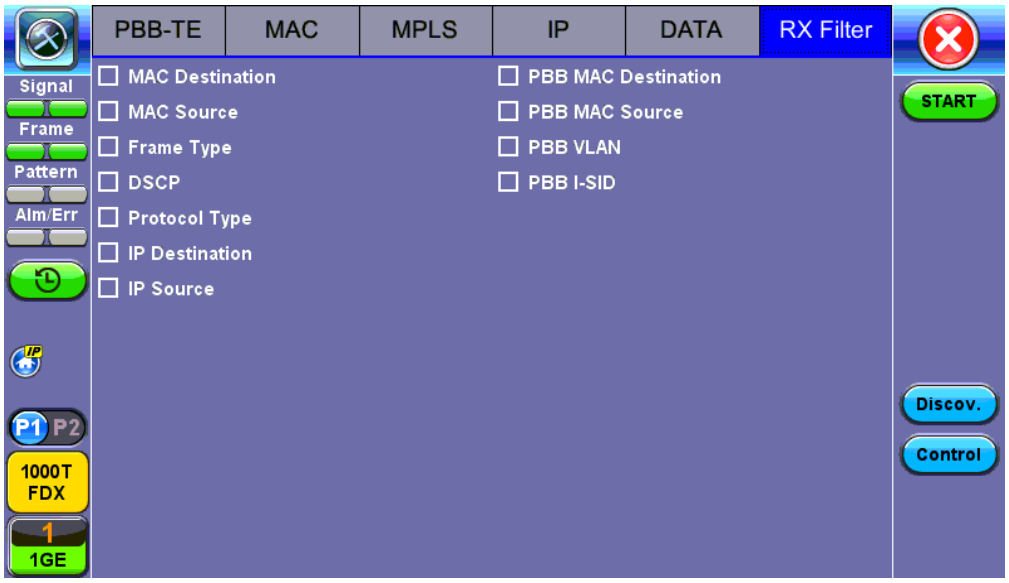
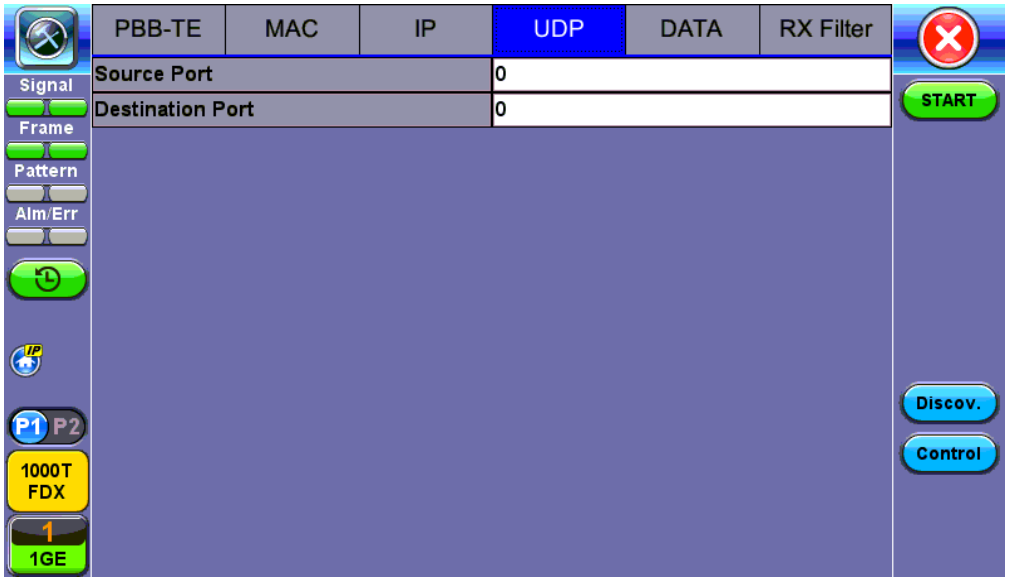
- **RX Filter Tab:** Allows the user to filter incoming streams. When checked, the incoming traffic flows not matching these criteria will not be considered for these results.
    - MAC Destination address
    - MAC Source address
    - VLAN
    - VLAN Priority
    - VLAN Eligible
    - Frame Type
    - Type of Service
    - Protocol Type
    - IP Destination address
    - IP Source address



BERT Setup - RX Filter selection

- **UDP/TCP:** Input Source Port and Destination Port.



BERT Setup - RX Filter selection

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5.3.1.2 Traffic Settings

Traffic tab:

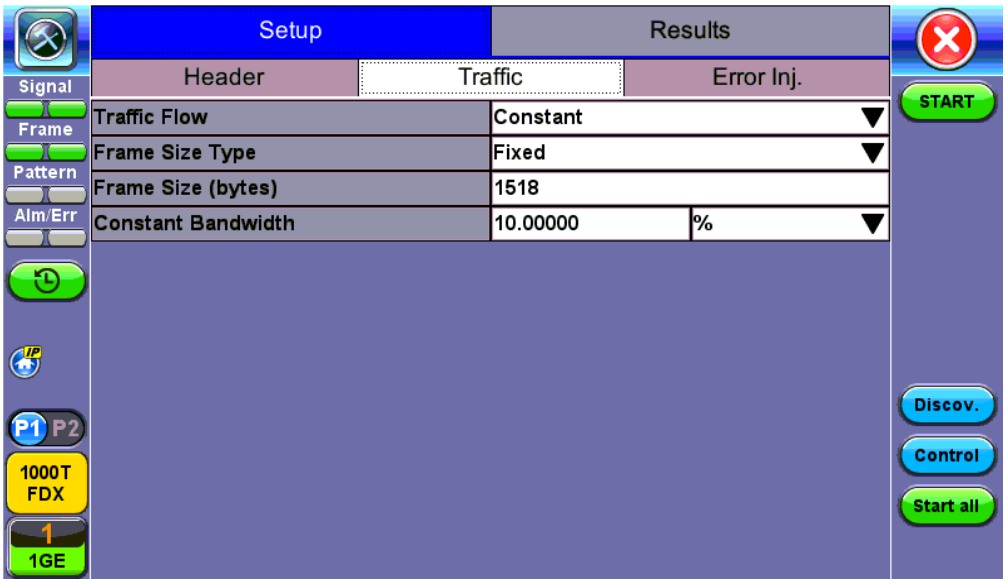
The user configures the traffic profile for the stream, including traffic flow, frame size, frame type, and transmit rate.

- **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):** Enter the frame size when a Layer 2, 3, or 4 BERT is selected
  - Frame size configuration is not available for Layer 1 BERT
  - Frame sizes can be from 64 bytes to 1318 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 - Constant Traffic

Note: Frame Size Limitations

Layer 1 framed mode - Frame size configuration is not available.
Layer 1 unframed mode - Traffic profile is constant at 100% bandwidth.

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5.3.1.3 Error Injection

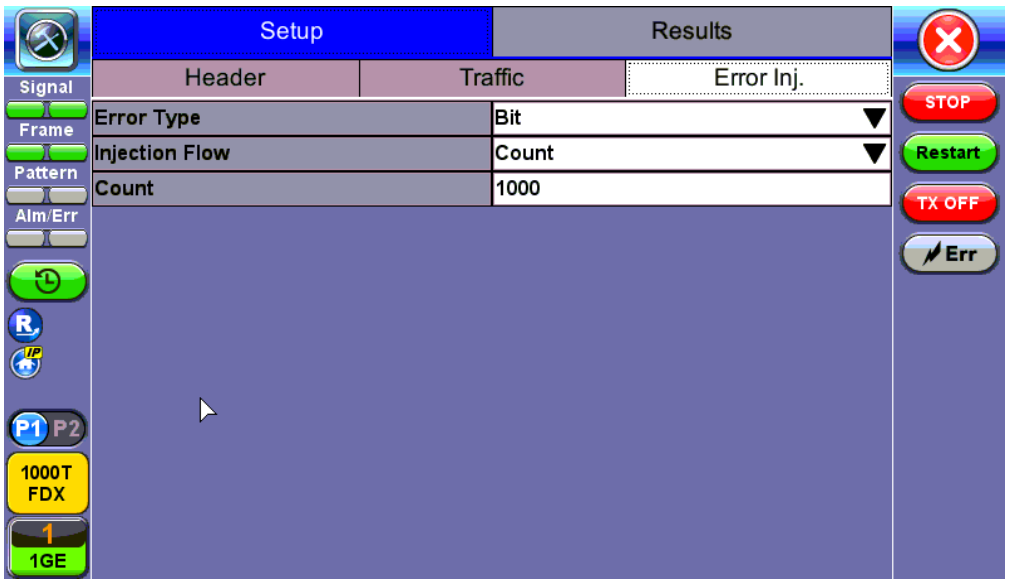
Error injection can be performed during testing. The error type and injection rate are configured in the Error Injection tab.

- **Error type:** Select from Bit, CRC, IP Checksum (Layer 3, 4 only), Pause, TCP/UDP Checksum (Layer 4 only). 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.

- **Injection Flow:** The error injection flow determines how the selected errors will be injected.
  - Select a single error injection or specific count.

- **Count:** Configures the error count via a numeric keypad.



BERT Setup - Error Injection

Error Injection

After pressing **Start**, error injection can be enabled by pressing the **Error Inj.** button on the right side of the screen.

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5.3.1.4 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 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 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 the 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.

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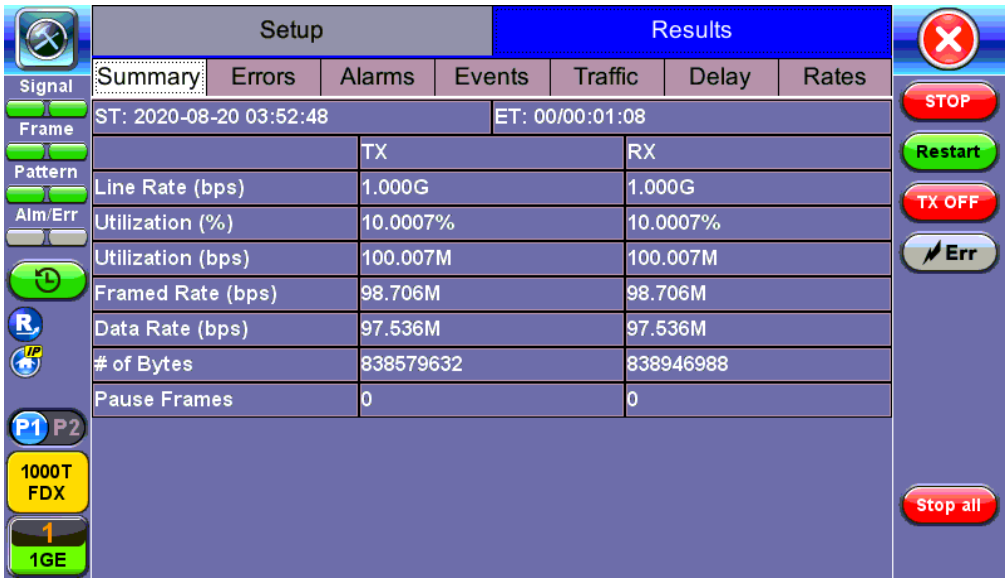
5.3.2 BERT Results

5.3.2.1 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.
- **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 %.
- **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).
- **Number of bytes**
- **Pause Frames:** Total number of transmitted and received ethernet pause flow-control frames.



BERT Results - Summary

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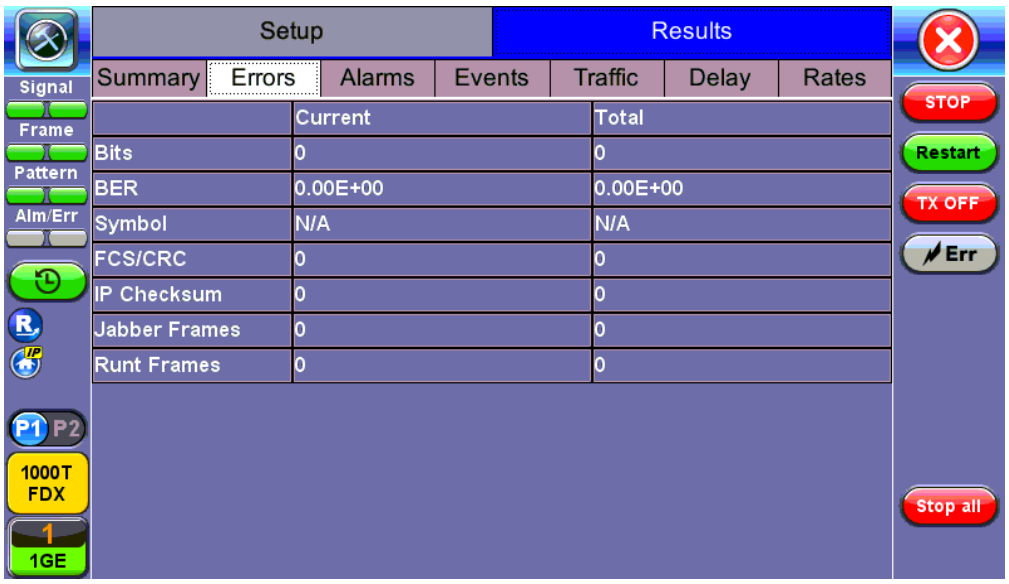
5.3.2.2 Errors

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 1318 bytes containing an invalid FCS
- **Runt frames:** Number of received frames smaller than 64 bytes containing an invalid FCS



BERT Results - Errors

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5.3.2.3 Events

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

BERT Results - Events

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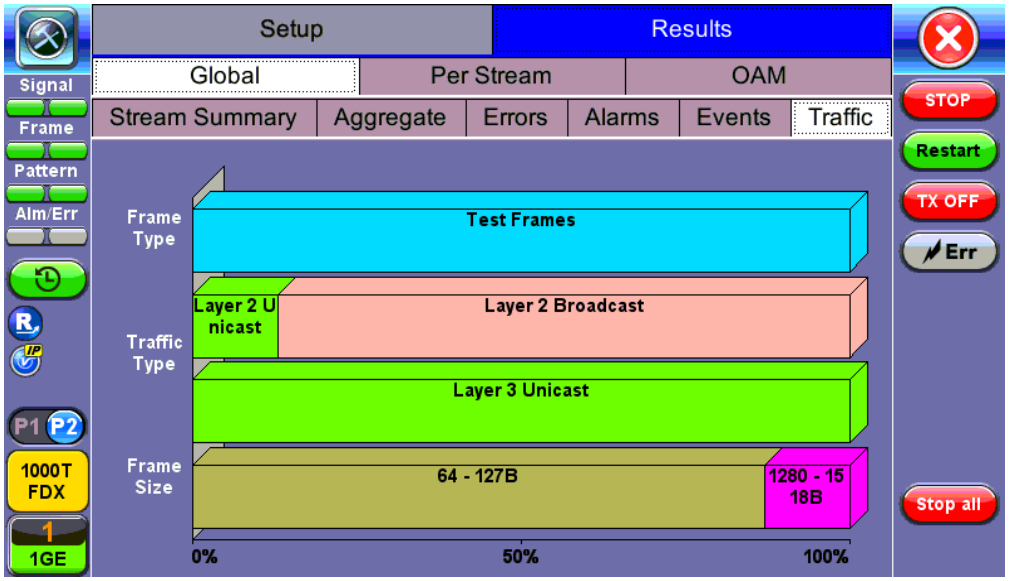
5.3.2.4 Traffic

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**
- **Pause frames**

Tap on the graph for detailed screens.



BERT Results - Traffic Distribution

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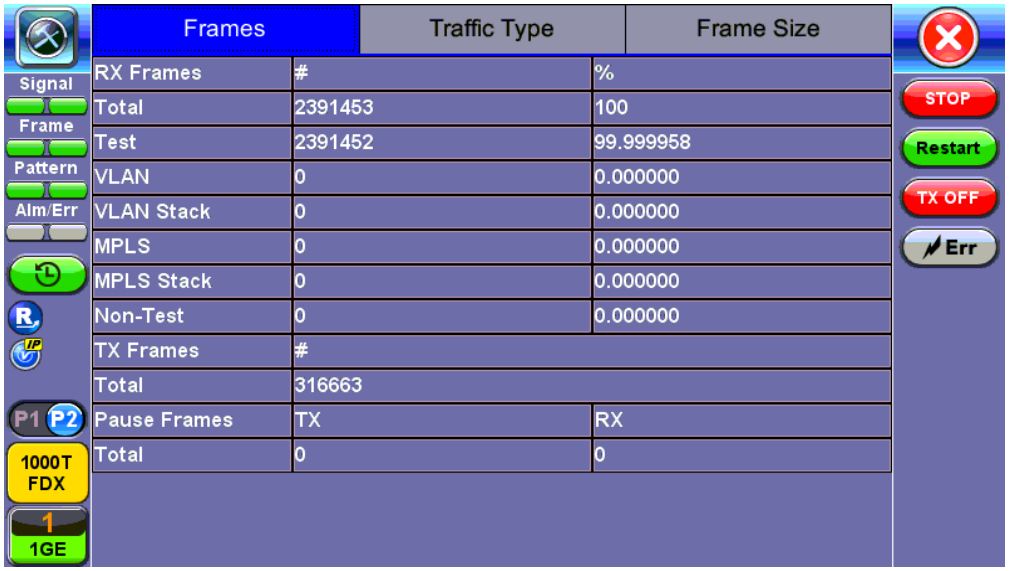
Frames tab: The following Frame distribution statistics are displayed in Count (#) and Percentage (%):

- **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



RX Frames	#	%
Total	2391453	100
Test	2391452	99.999958
VLAN	0	0.000000
VLAN Stack	0	0.000000
MPLS	0	0.000000
MPLS Stack	0	0.000000
Non-Test	0	0.000000
TX Frames	#	
Total	316663	
Pause Frames	TX	RX
Total	0	0

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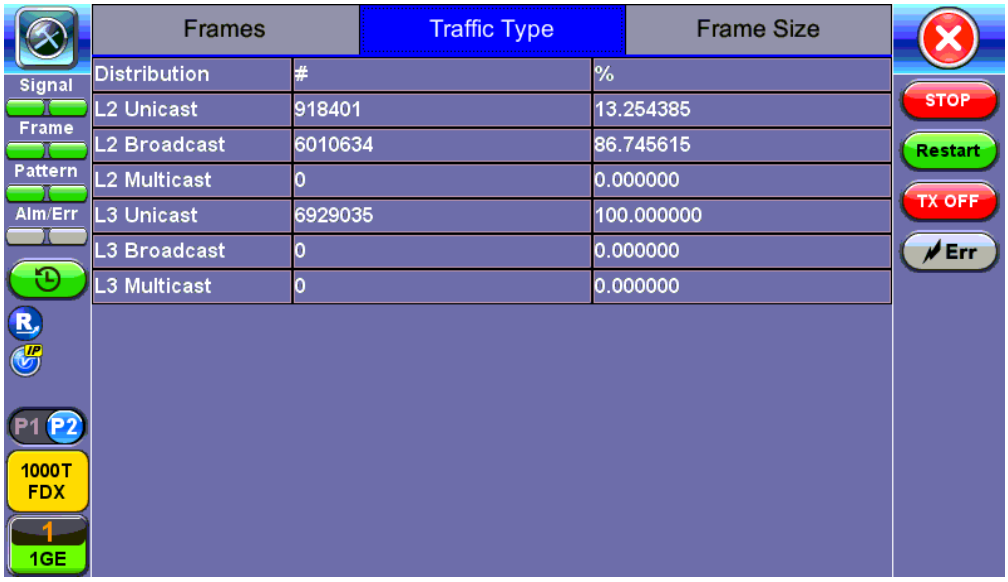
Traffic Type tab: The following Traffic distribution statistics are displayed in Count (#) and Percentage (%):

- **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

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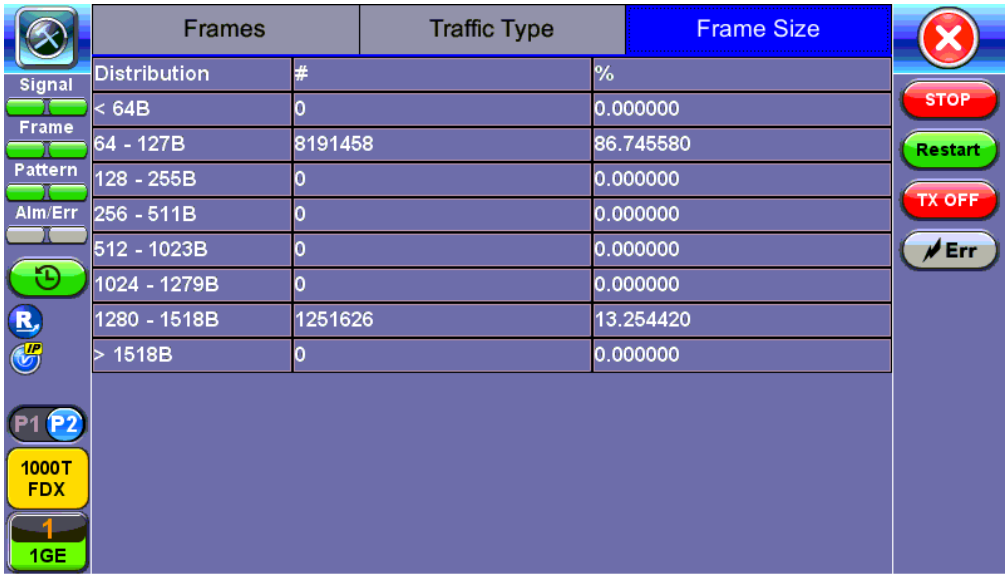
Frame Size tab: The following Frame distribution statistics are displayed in Count (#) and Percentage (%):

- < 64 bytes frames
- 64-127 byte frames
- 128-255 byte frames
- 256-511 byte frames
- 512-1023 byte frames
- 1024-1279 byte frames
- 1280-1318 byte frames
- > 1318 byte frames - Jumbo frames



BERT Results - Frame Size

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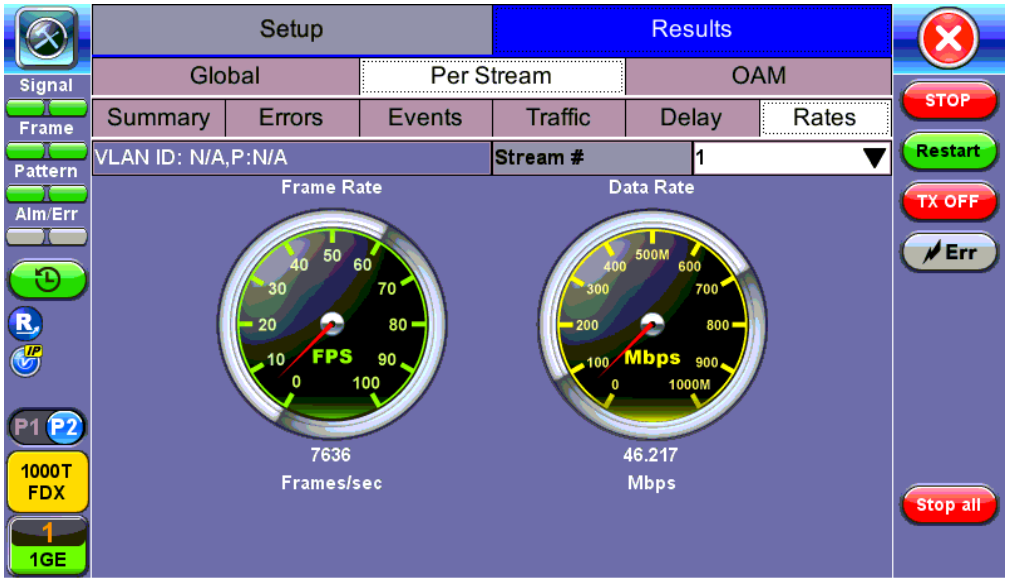
5.3.2.5 Rates

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

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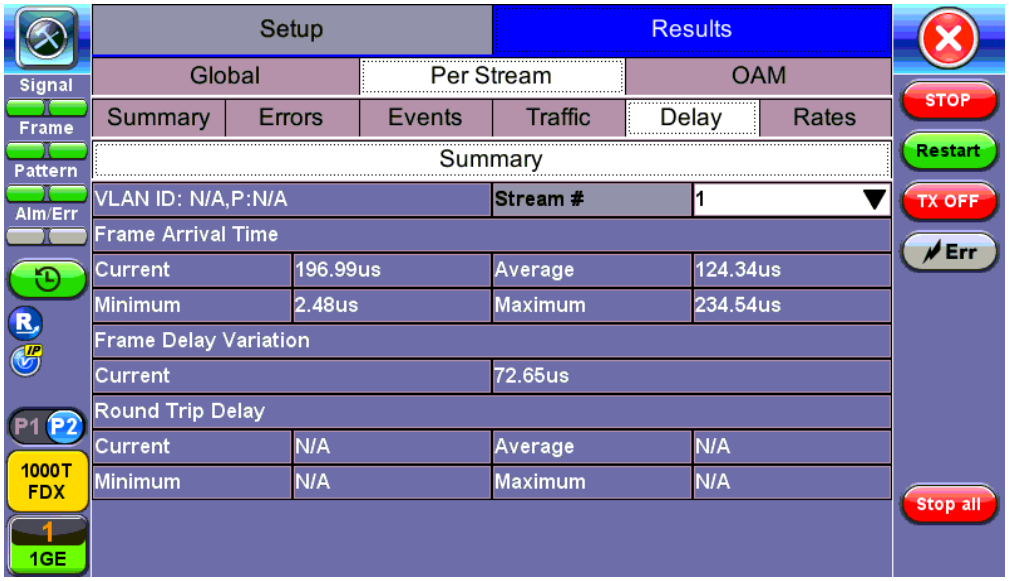
5.3.2.6 Delay

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

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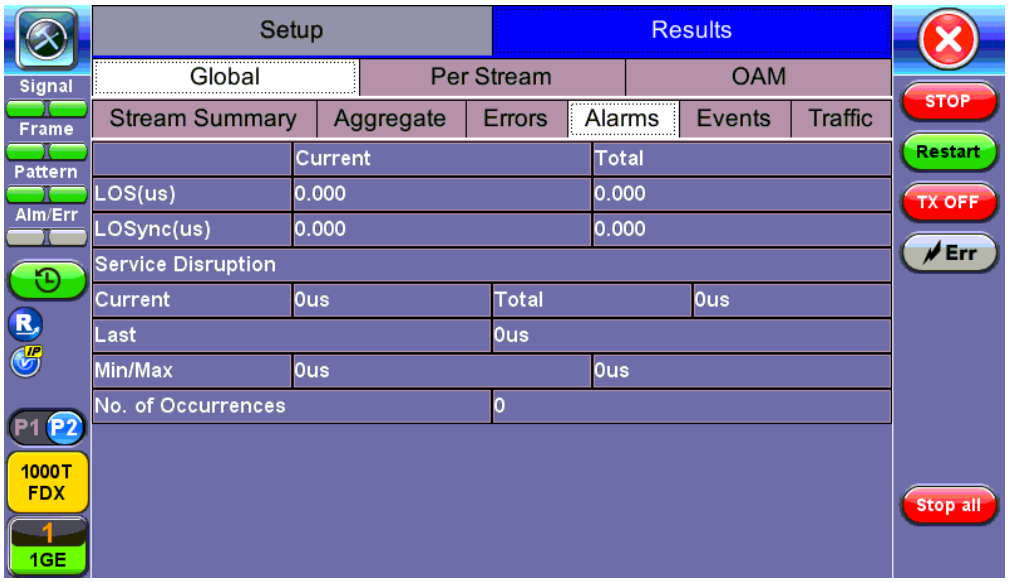
5.3.2.7 Alarms

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
    - **Min/Max:** Minimum and maximum duration of the service disruption events
    - **No. of Occurrences:** Counter of service disruption events



BERT Results - Alarms

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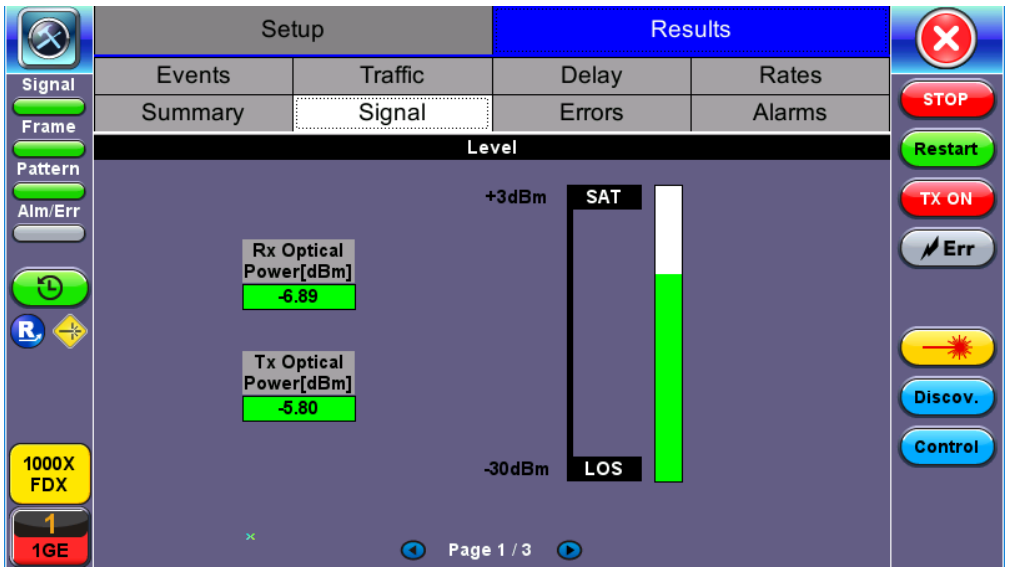
5.3.8 Signal

The Signal tab (fiber ports only) displays the optical level measured by the SFP or XFP transceiver. Page 1 displays the level measurement in dBm for the optical signal.

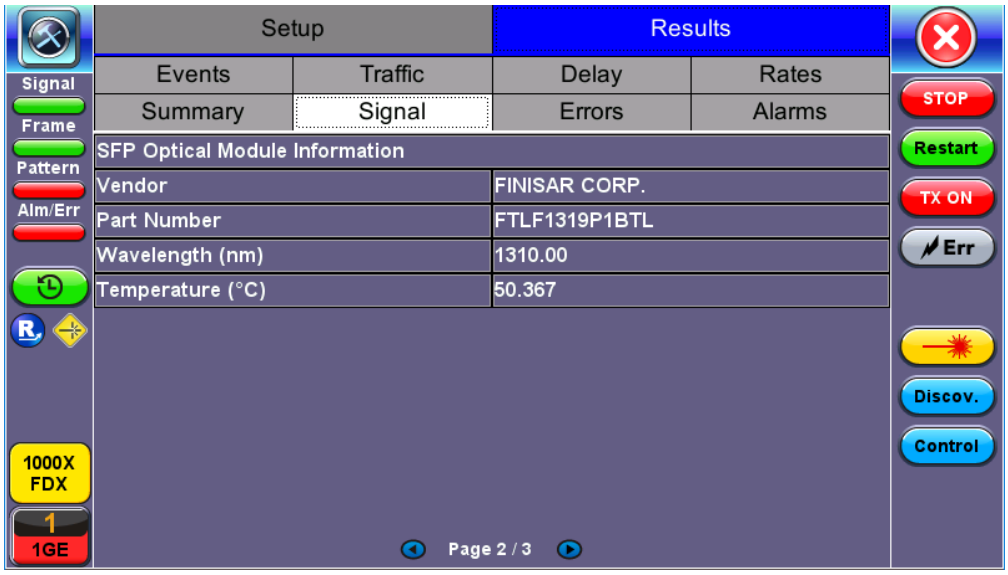
Loss of Signal (LOS) and the Saturation level for optical signals are shown graphically including the level measurement in dBm.



BERT Results - Signal

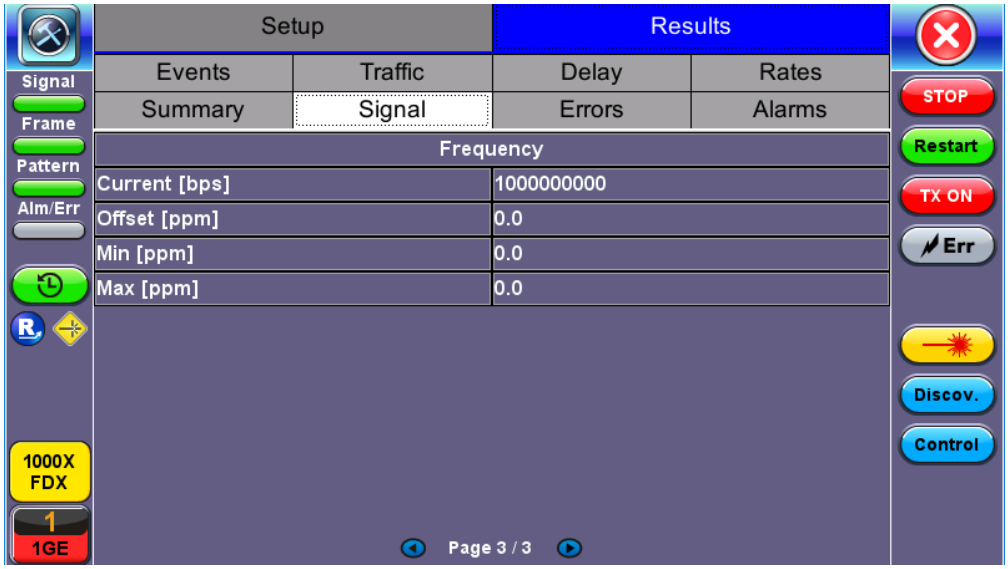
Signal (Page 2)

Page 2 displays the Optical module (SFP) information which includes Vendor name, Part Number and Optical Wavelength. Tap on the **Decode** button to view additional information on SFP optics.



BERT Results - Signal (Page 2)

Signal (Page 3)



BERT Results - Signal (Page 3)

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

- **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.

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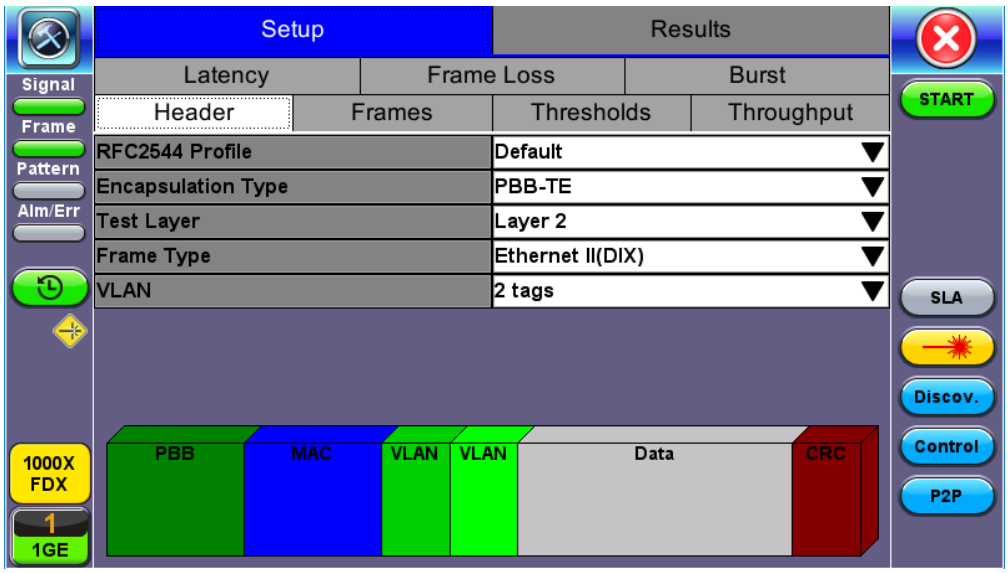
5.4 RFC 2544 Conformance Testing

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, & 4)
- Frame header (PBB, MAC, VLAN, IP, UDP, and Data)
- Test frames selection
- Pass/fail thresholds (optional)
- Far-end unit loop control
- Throughput
- Latency
- Frame loss
- Burst (back-to-back)



RFC 2544 Setup - Layer 2 parameters

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5.4.1 Setup - Standard Mode

Unless otherwise noted, the Frame Header and related setups are identical to the setups described in BERT Setup.

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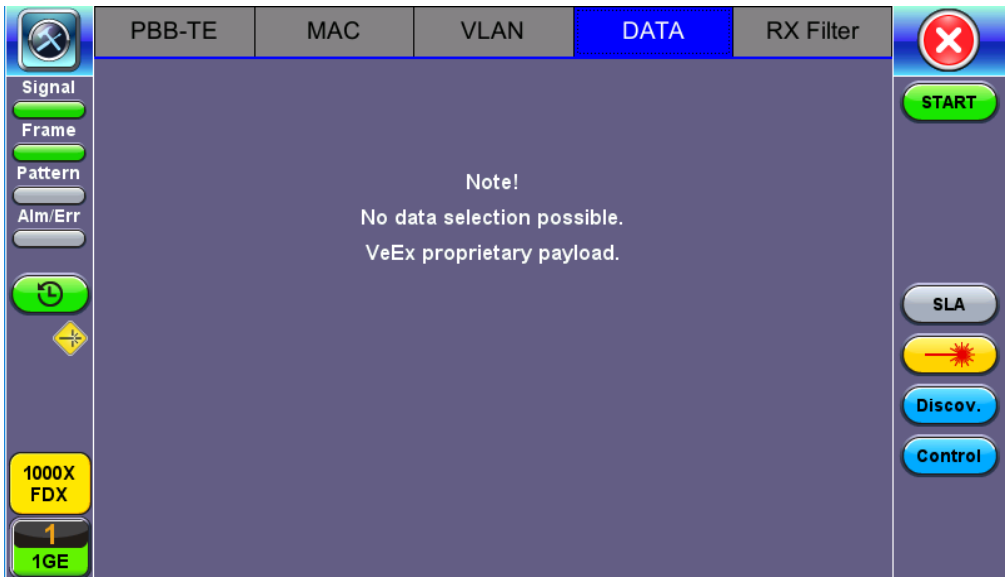
5.4.1.1 Header Settings

With the exception of the Data tab, RFC 2544 Header setup options are identical to the setups described in the BERT application. Refer to the Header Settings section of the BERT application for more information.

RFC 2544 setup options are listed below:

- Profile
- Encapsulation Type
- Test
- Frame Type
- MAC/IP
- VLAN

- MPLS:
- MAC, VLAN, MPLS, IP, and Test Pattern Configurations:
- MAC Header Tab
- Data Tab: No payload selection is possible.
  The payload area is populated with a VeEX signature field and other proprietary data.
- RX Filter Tab
- VLAN Tab
- MPLS Tab
- IP Tab



RFC 2544 Data tab

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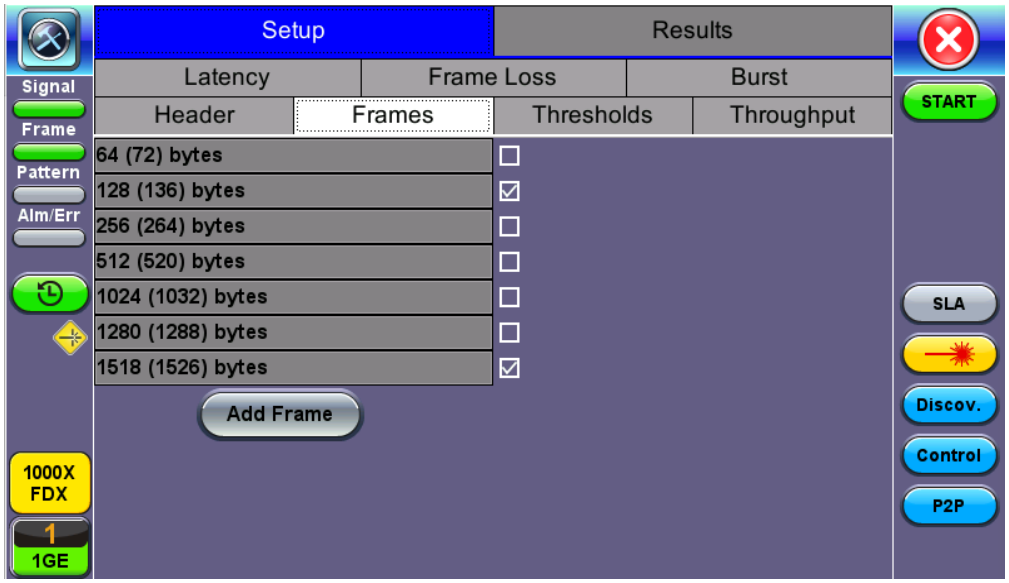
5.4.1.2 Frame Settings

Frames tab: User configures the following:

- **Preset Frames:** User selects 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 frames are 64 and 1518 bytes.
  - To select/deselect any of the recommended test frames, check the box to the right of the desired frame.
  - ***Note:*** *When VLAN tagging or MPLS tagging is enabled, the value in parentheses reflects the actual frame size transmitted.* For example one VLAN tag adds 4 bytes to the frame size, therefore a 64B frame becomes a 68 byte frame.

- **Add frame:** The user can add two additional user configurable test frames of any size ranging from 64 bytes to 10000 bytes.
  - 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).



RFC 2544 Setup - Frame Settings

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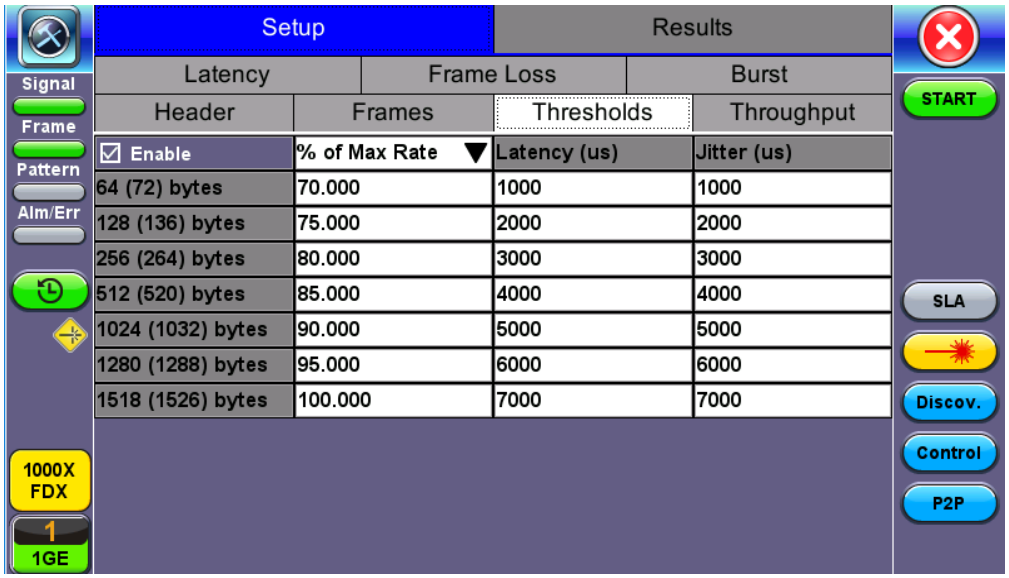
5.4.1.3 Threshold Settings

Threshold tab:

- User enables or disables threshold settings 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. Select a **rate type** from the drop-down menu that will be used to determine pass/fail criteria. Options are % of Max Rate, % of Line Rate, Utlized Line Rate (Mbps).
  - 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.



RFC 2544 Setup - Threshold Settings

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5.4.1.4 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 the **Enable/Disable box** in each test tab. By default all four tests are enabled.

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

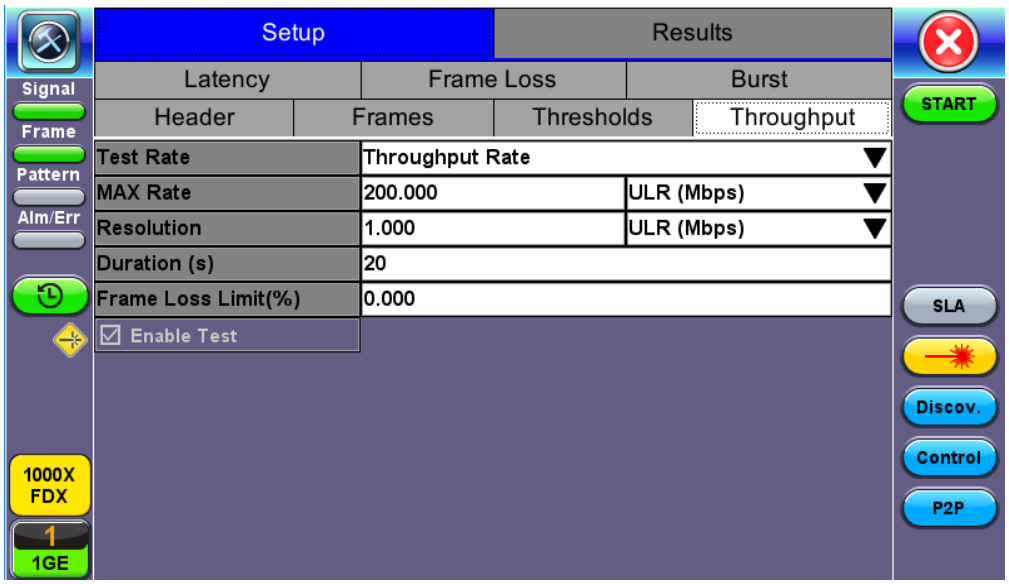
Throughput tab:

- **Test Rate:** Throughput Rate or Custom Rate per frame size.
  - **Throughput rate**: Throughput test will be performed at the specified maximum rate.
  - **Maximum 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.
    - 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.
  - **Custom Rate per frame size:** Configure a custom rate in % or Mbps for each test frame. Tap on **Rate Table Config**. to configure rates for each frame. After making edits tap **Apply** to confirm edits or **Apply to All** to apply rates to all tests.

- **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.

- **Frame Loss Limit (%):** Configures the frame loss tolerance used in the throughput rate search algorithm. If the frame loss count stays below the configured Frame Loss limit, the throughput rate search will stop, otherwise the throughput rate search will continue to the next step.



RFC 2544 Setup - Throughput Settings

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Latency tab:

- **Test:** 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:** User configures a custom rate in % or Mbps.
  - **Custom Rate per frame size:** The user can configure a custom rate in % or Mbps for each test frame. Tap on **Rate Table Config**. to configure rates for each frame. After making edits tap **Apply** to confirm edits or **Apply to All** to apply rates to all tests.

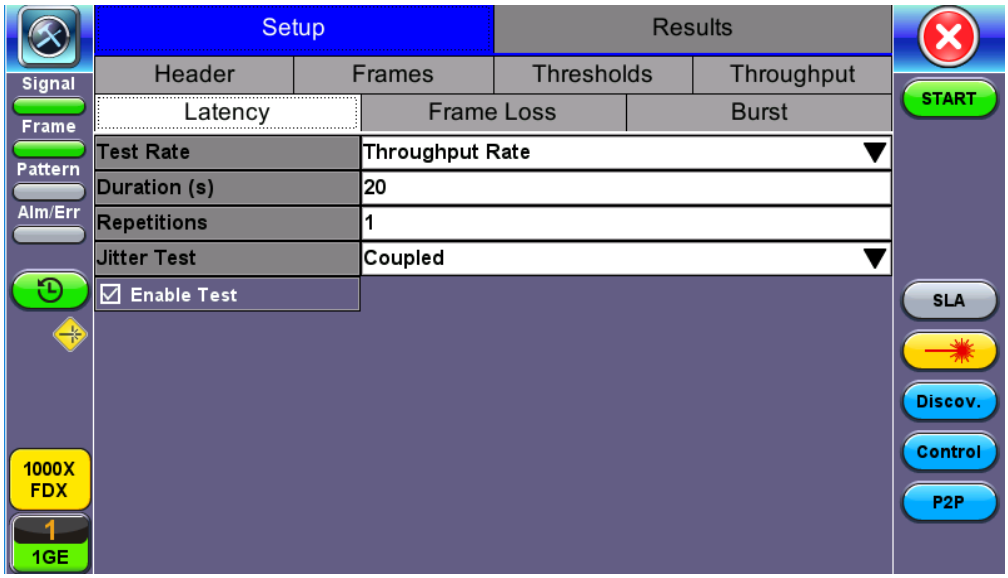
- **Rate:** Only available if Custom Rate is selected. Enter up to 100% of the negotiated line rate or enter the rate in Mbps.

- **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.

- **Jitter Test:** Coupled or Uncoupled. Coupled will run the jitter test at the same time as the latency test.



RFC 2544 Setup - Latency Settings

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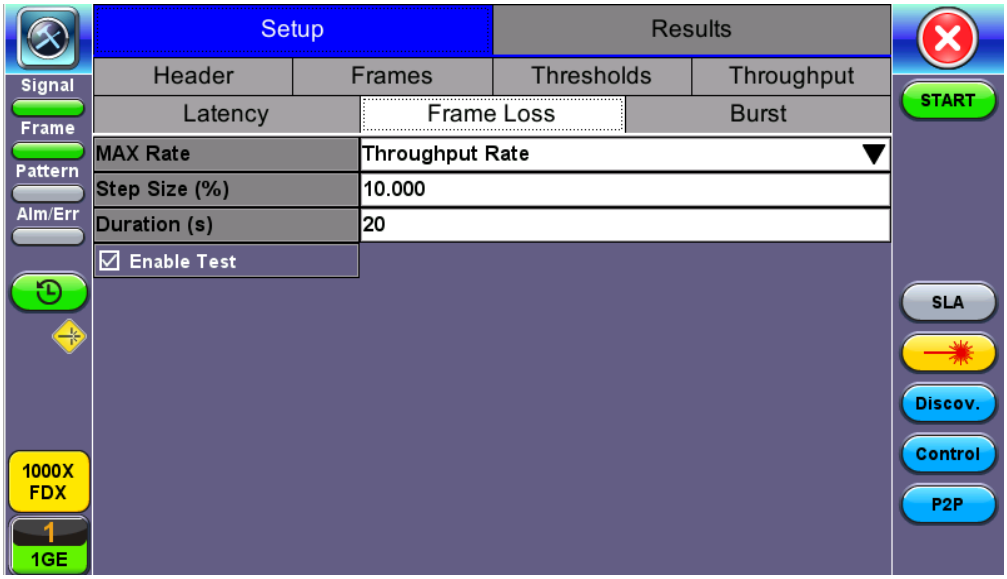
Frame Loss tab:

- **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.
  - **Throughput rate**: Latency test will be performed at the throughput rate found for each of the tested frame sizes.
  - **Custom rate:** User configures a custom rate in % or Mbps.
  - **Custom Rate per frame size:** The user can configure a custom rate in % or Mbps for each test frame. Tap on **Rate Table Config**. to configure rates for each frame. After making edits tap **Apply** to confirm edits or **Apply to All** to apply rates to all tests.

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

- **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.



RFC 2544 Setup - Frame Loss Settings

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Burst (Back-to-Back) tab:

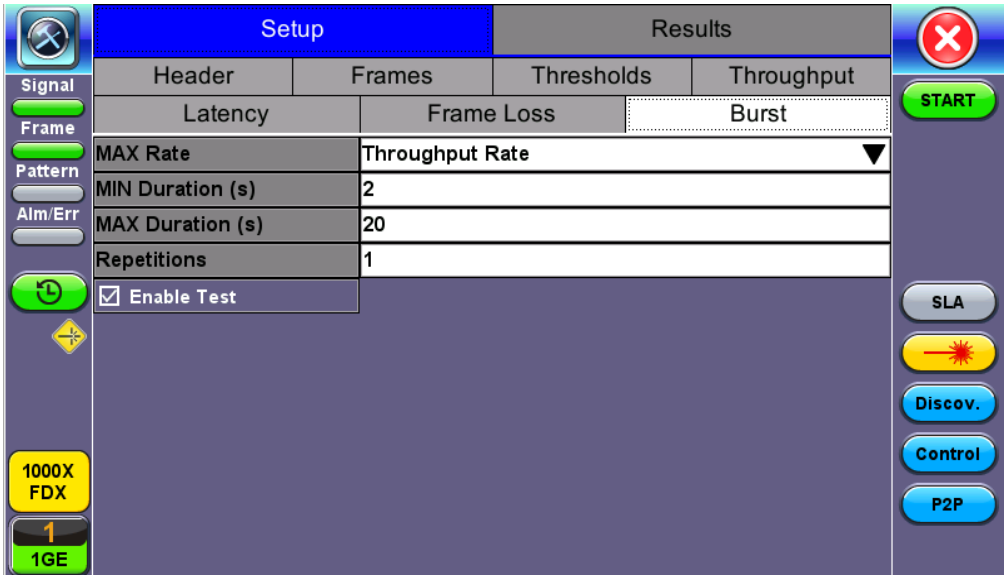
- **Max Rate:** Up to 100% of the negotiated line rate. The default value is 1000 ULR (Mbps).
  In the burst test, frames are always transmitted at the maximum rate for a given minimum and maximum burst duration. The user may configure this rate as a % of the total line rate or in Mbps. For example if 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.
  - **Throughput rate**: Latency test will be performed at the throughput rate found for each of the tested frame sizes.
  - **Custom rate:** User configures a custom rate in % or Mbps.
  - **Custom Rate per frame size:** The user can configure a custom rate in % or Mbps for each test frame. Tap on **Rate Table Config**. to configure rates for each frame. After making edits tap **Apply** to confirm edits or **Apply to All** to apply rates to all tests.

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

- **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.



RFC 2544 Setup - Burst Settings

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5.4.1.5 Starting/Stopping a RFC 2544 Measurement

Once all configurations have been made, the user can start the RFC 2544 test (press the **Start** icon on the top right section of the screen). The following are two scenarios of how to prepare and start the unit for RFC 2544 testing.
Note: *If testing on the fiber ports, make sure the LASER is turned On before starting the test.*

- **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 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 RFC 2544 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 RFC 2544 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 the all of the selected test are completed, the RFC 2544 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.

If the unit is in Advanced SLA mode, the RFC 2544 test runs simultaneously with the background.

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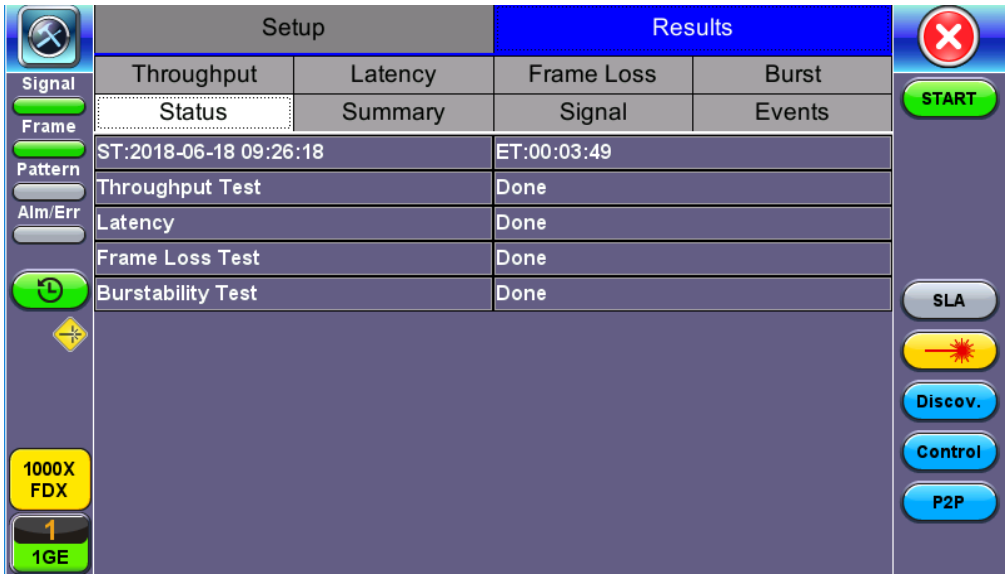
5.4.2 Results - Standard Mode

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

Results tab:

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.

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



RFC 2544 Results - Status

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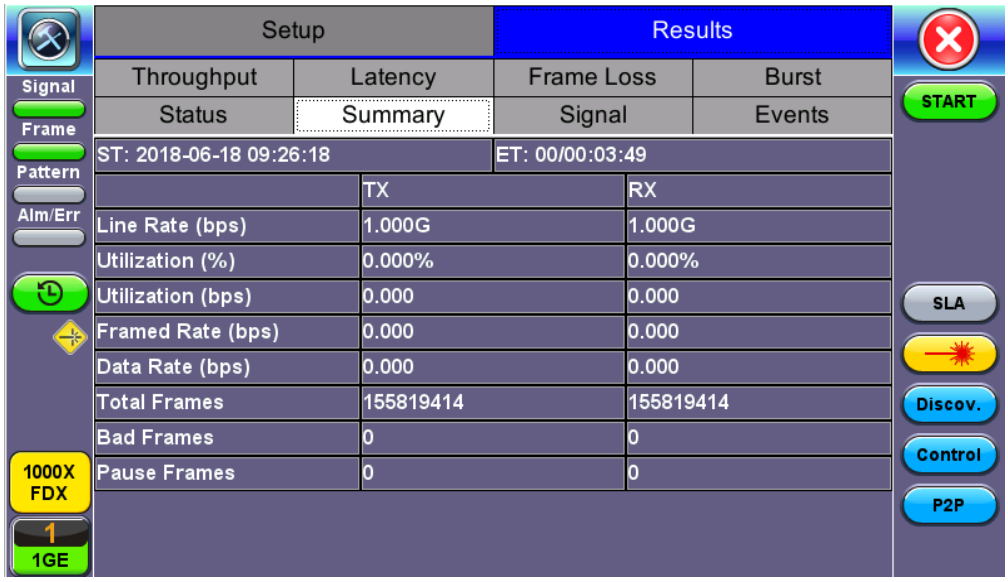
Summary tab: The following results including the Start (ST) and Elapsed (ET) times are displayed:

- **Line Rate** (Mbps)**:** Negotiated rate of the interface (10M, 100M, 1000M or 10GE). This value is always fixed since it depends on the maximum capacity of the link under test, hence the test interface that is configured.
- **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 %.
- **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).
- **Total Frames**
- **Bad Frames**
- **Pause Frames:** Total number of transmitted and received ethernet pause flow-control frames.



RFC 2544 Results - Summary

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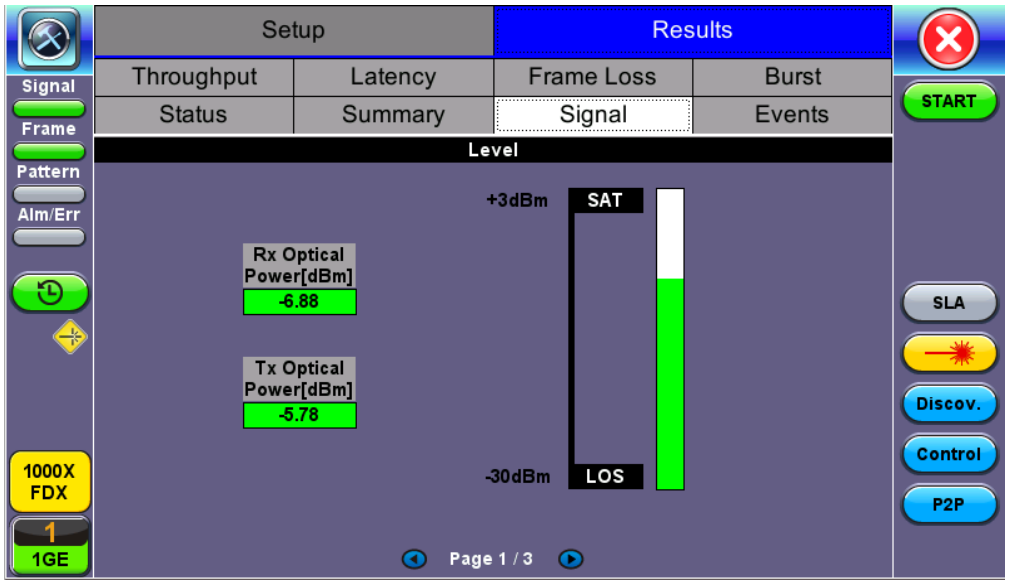
Signal tab: The Signal tab (fiber ports only) displays the optical level measured by the SFP transceiver. The RFC 2544 Signal tab is identical to the Signal tab for the BERT application. Refer to Signal from the BERT section for more information.



RFC 2544 Results - Signal (Page 1)

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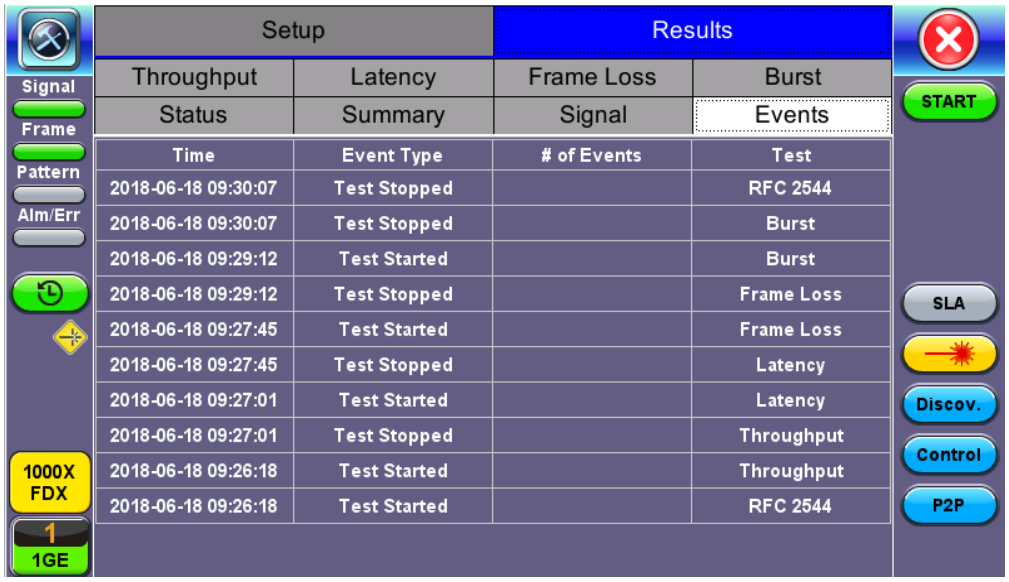
Events tab: A time stamped log of each test is displayed.



Time	Event Type	# of Events	Test
2018-06-18 09:30:07	Test Stopped		RFC 2544
2018-06-18 09:30:07	Test Stopped		Burst
2018-06-18 09:29:12	Test Started		Burst
2018-06-18 09:29:12	Test Stopped		Frame Loss
2018-06-18 09:27:45	Test Started		Frame Loss
2018-06-18 09:27:45	Test Stopped		Latency
2018-06-18 09:27:01	Test Started		Latency
2018-06-18 09:27:01	Test Stopped		Throughput
2018-06-18 09:26:18	Test Started		Throughput
2018-06-18 09:26:18	Test Started		RFC 2544

RFC 2544 Results - Events

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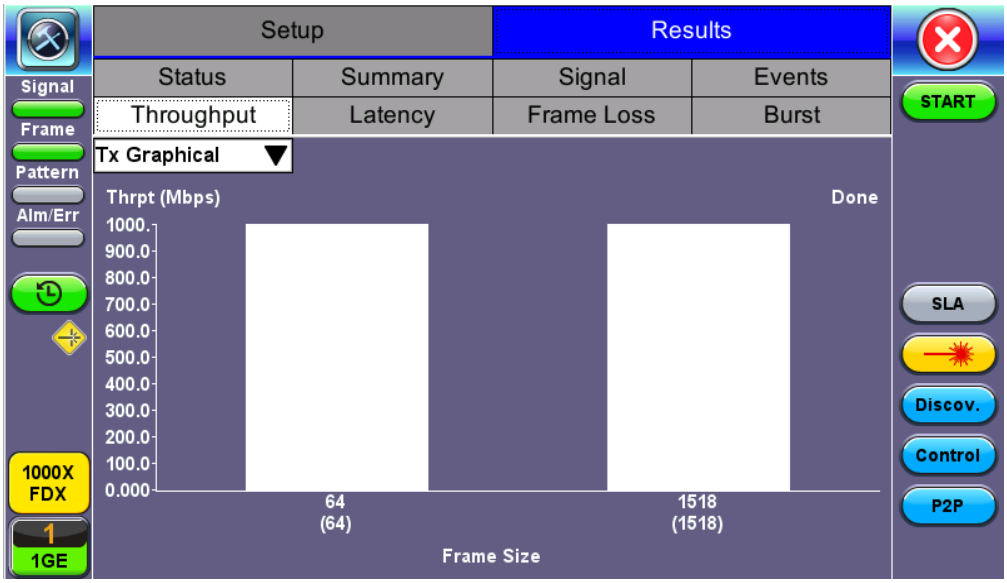
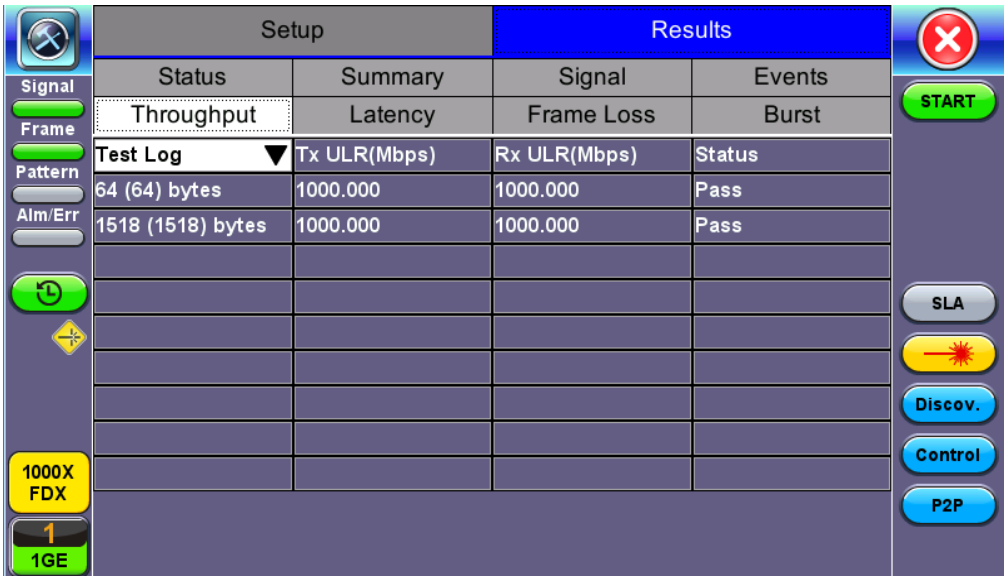
Throughput tab

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
  - **Thresholds:** Pass/Fail test status determined by test criteria set in the Threshold tab



RFC 2544 Results - Throughput (Tx Graphical)



RFC 2544 Results - Throughput (Test Log)

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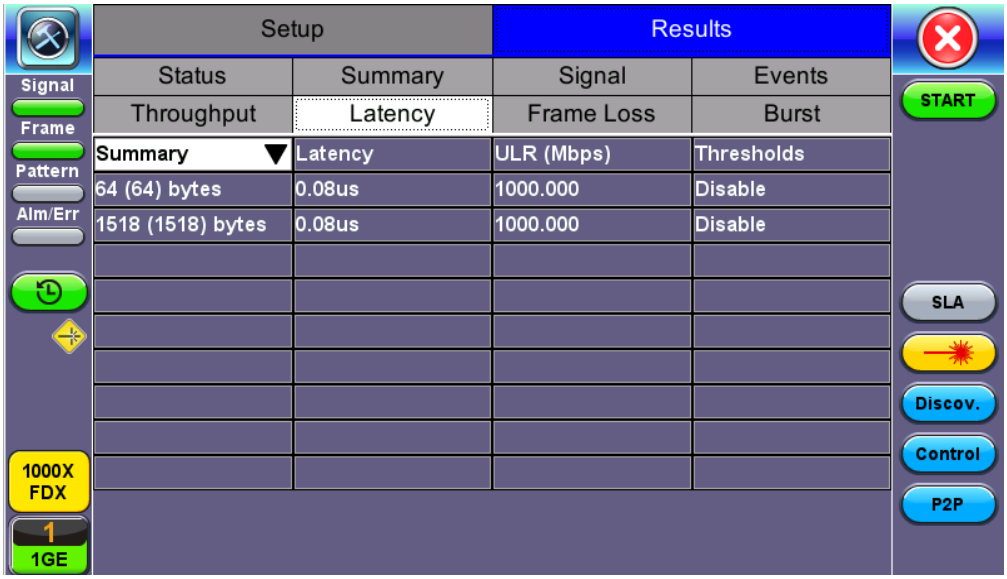
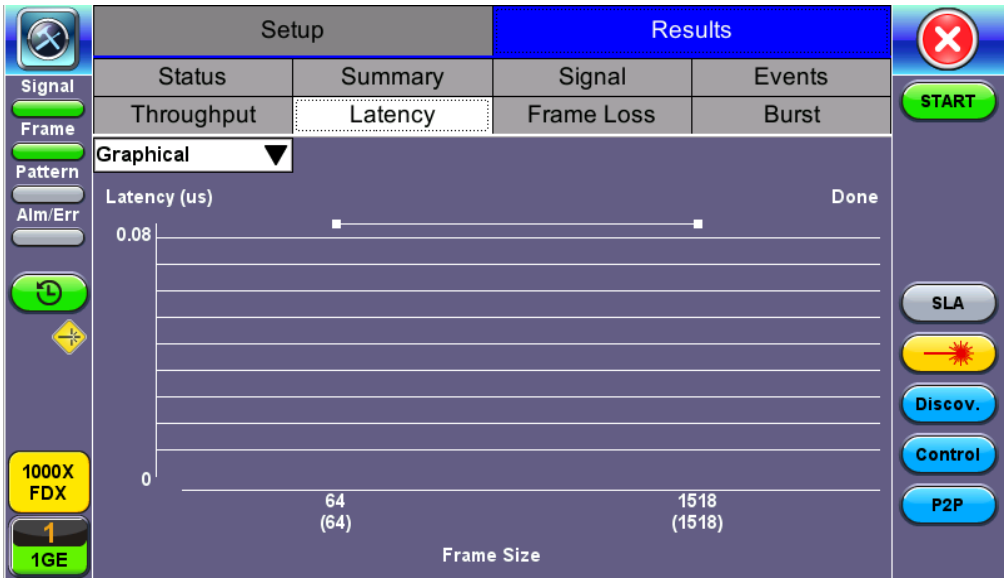
Latency and frame jitter measurements results are displayed in the following formats. Use the drop-down menu to select the Latency format:

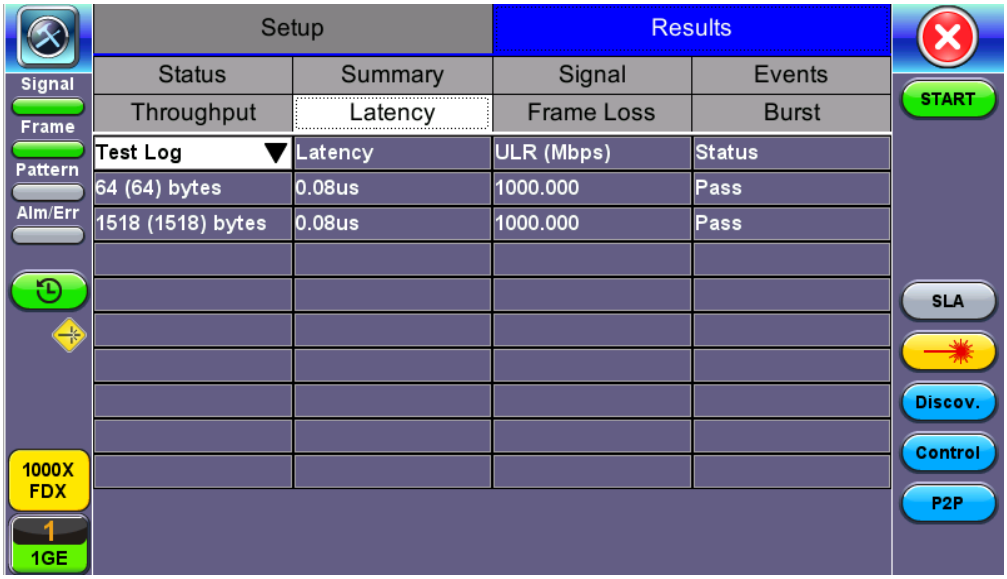
- **Graphical:** Latency results displayed in line graph form (Latency [us] vs Frame size [bytes]).
- Summary and Test log tables display:
  - byte size
  - **Latency (us):** Round trip delay latency.
  - **Rate (%):** Percentage of frames transmitted. Data rate used for latency test.
  - **Pass/Fail**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



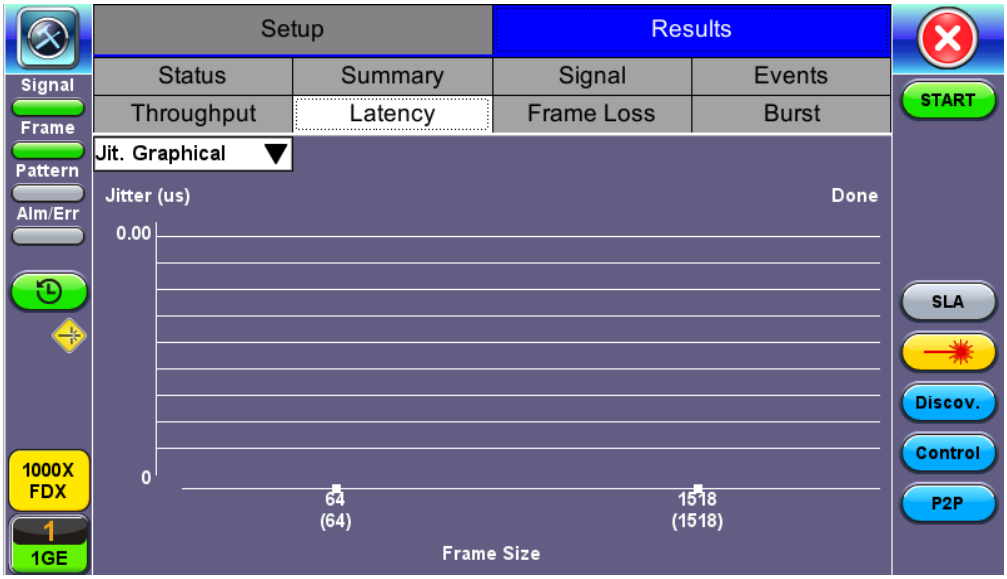
RFC 2544 Results - Latency (Summary)



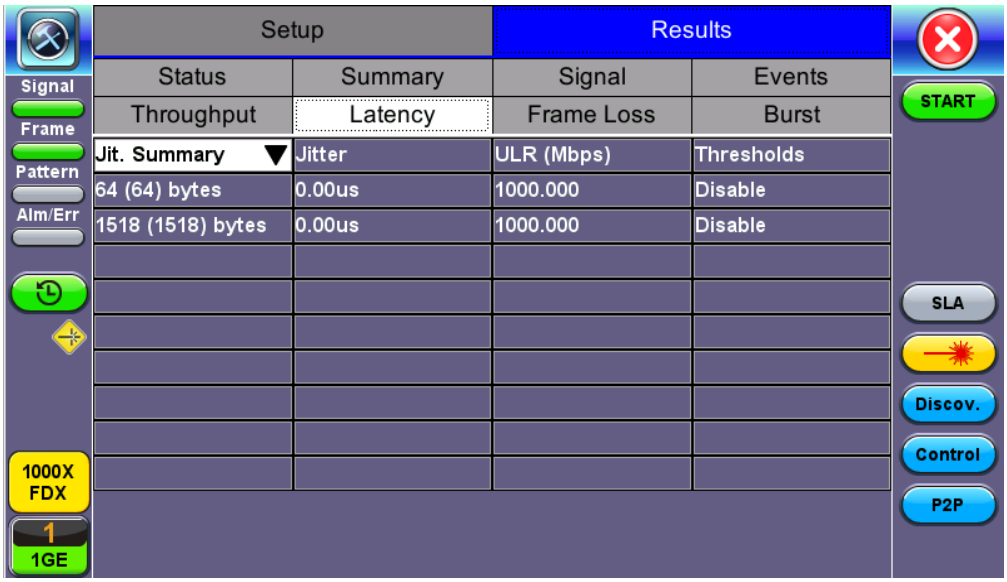
RFC 2544 Results - Latency (Graphical)



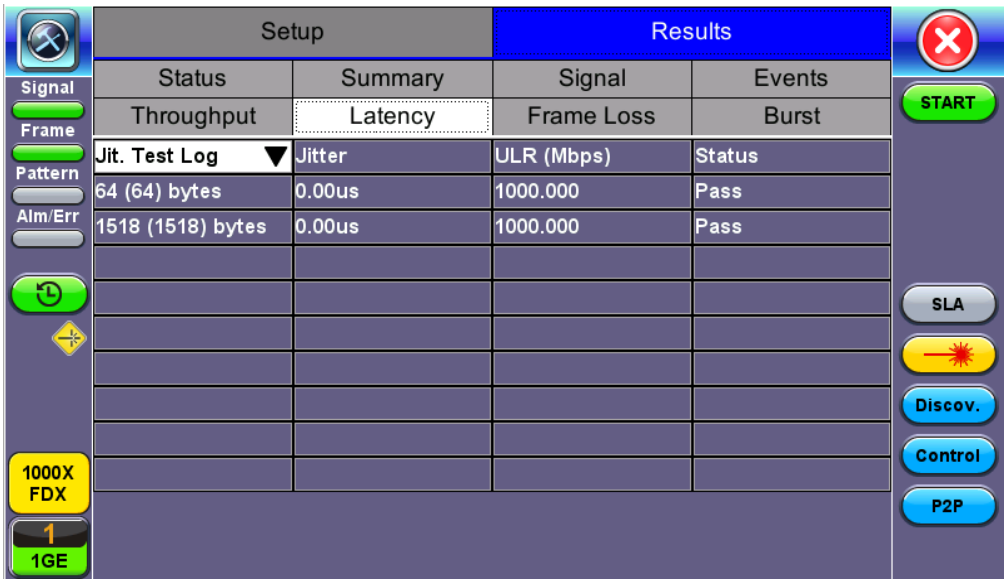
RFC 2544 Results - Latency (Test Log)



RFC 2544 Results - Latency (Jitter Graphical)



RFC 2544 Results - Latency (Jitter Summary)



RFC 2544 Results - Latency (Jitter Test log)

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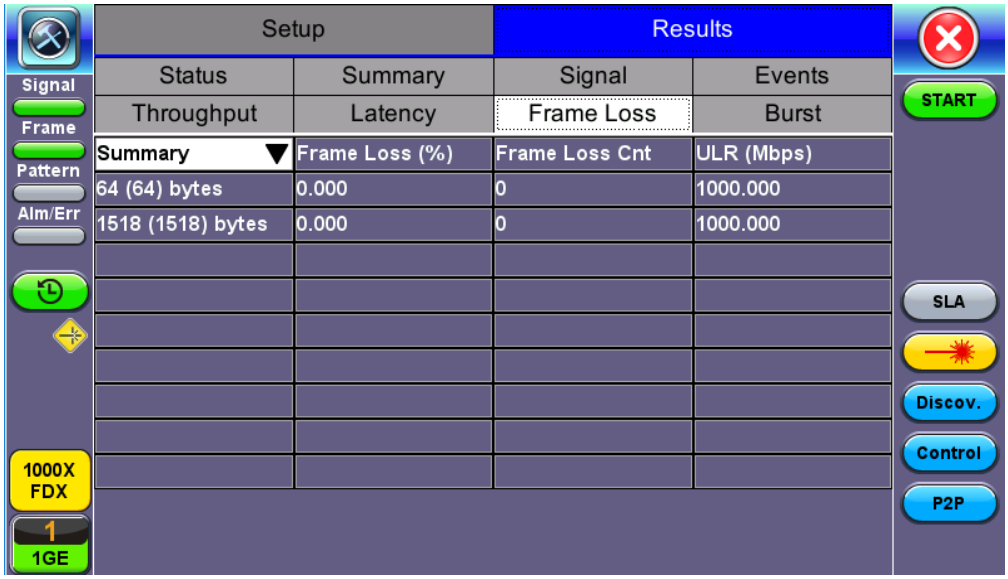
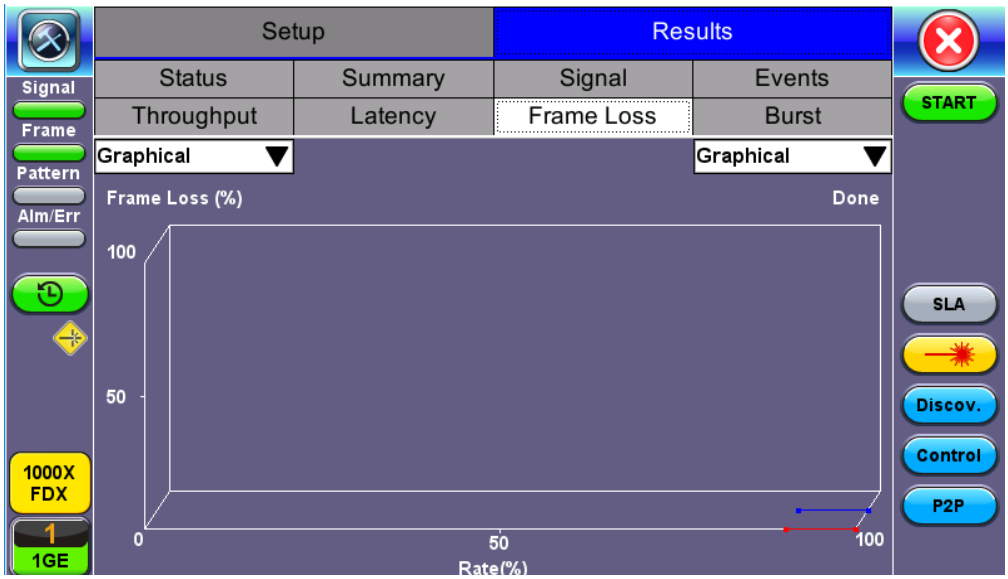
Frame Loss tab: Frame loss displays the percentage of frames not received. Use the drop-down menu to select the Frame Loss format:

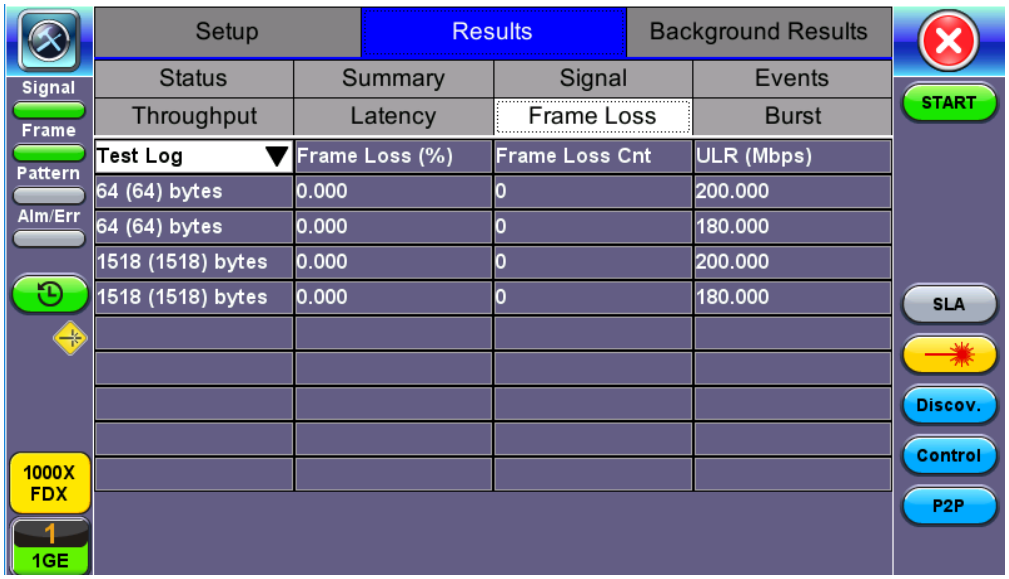
- Summary and Test log tables display test frame length, byte size, **frame loss (%)** from received traffic, and **rate (%)** transmitted.
- **Graphical:** Frame Loss displayed in line graph form (Frame size [bytes] vs Rate [%]). Tap on the **Graphical Type** drop-down menu on the right to view the graph legend.



RFC 2544 Results - Frame Loss (Summary)



RFC 2544 Results - Frame Loss (Graphical)



RFC 2544 Results - Frame Loss (Test log)

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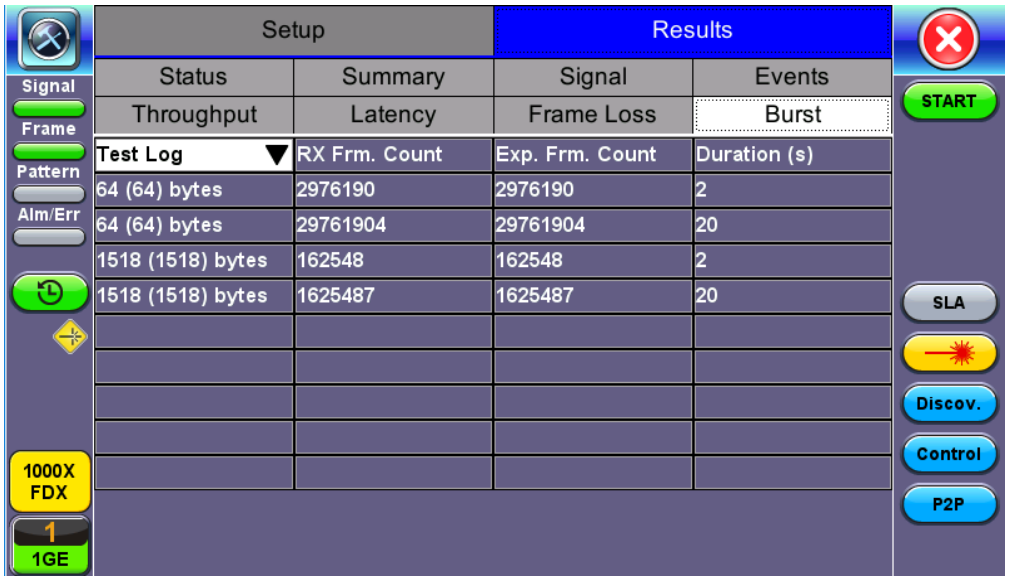
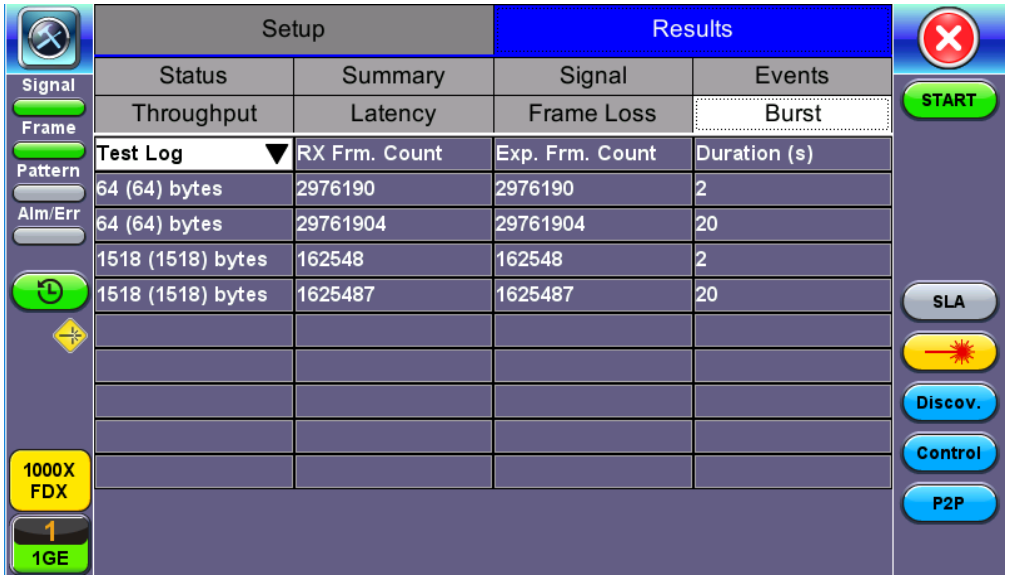
Burst tab: Burstability (back-back) results are the number of frames successfully transmitted/received at the line rate. It is displayed in the following formats:

- **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

RFC 2544 Results - Burstability (Summary)



RFC 2544 Results - Burstability (Summary)



RFC 2544 Results - Burstability (Test Log)

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5.4.3 Saving RFC 2544 Results

Once the test has been stopped the results can be saved by pressing the **Save** key on the VePAL's keypad. The results will be saved and named automatically. Once the results are saved, the user may view or rename the results file by going to **Utilities** > **Files** > **Saved**. For more information on retrieving saved test results, refer to *File Manager: Working with Saved Results, Profiles, Images* in the **V150 platform manual** for more information.

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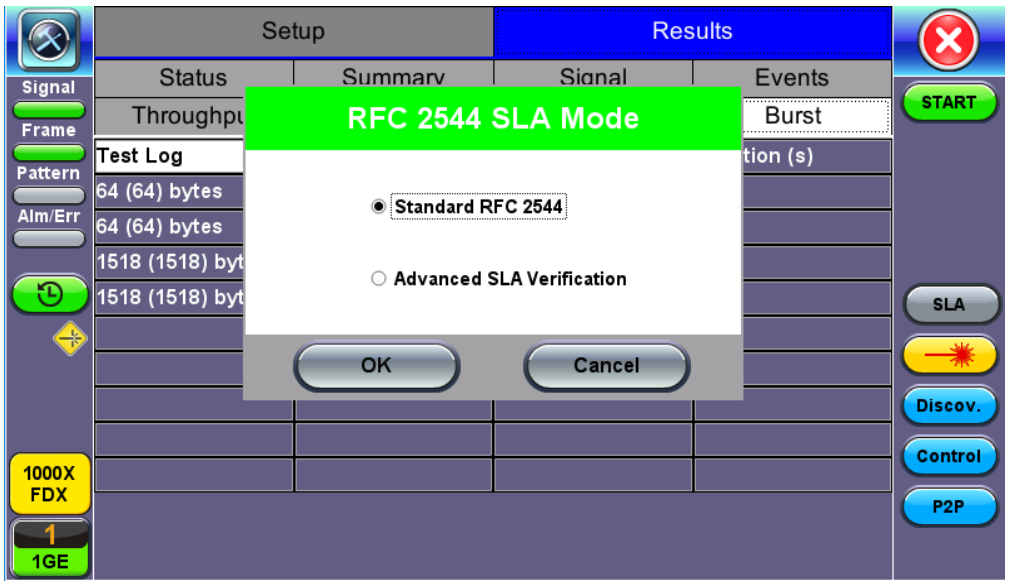
5.4.4 Advanced SLA Mode

Using this test function, users are able to verify SLAs while end-to-end QoS is assessed properly. By configuring one primary test stream and up to seven background streams each with independent frame size, bandwidth, and more importantly QoS levels, simulating different service applications is now realized. The Advanced RFC 2544 SLA mode provides detailed visibility of the test parameters for each of the traffic streams being measured, providing an efficient in-depth qualification in a fast and automated way.

To change SLA modes, tap on the **SLA** button on the right side of the screen and tap **OK** after selecting an SLA mode.



RFC 2544 SLA Mode

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Setup

For **Header**, **Frames**, **Thresholds**, **Throughput**, **Latency**, **Frame Loss**, and **Burst**, refer to Setup - Standard Mode.

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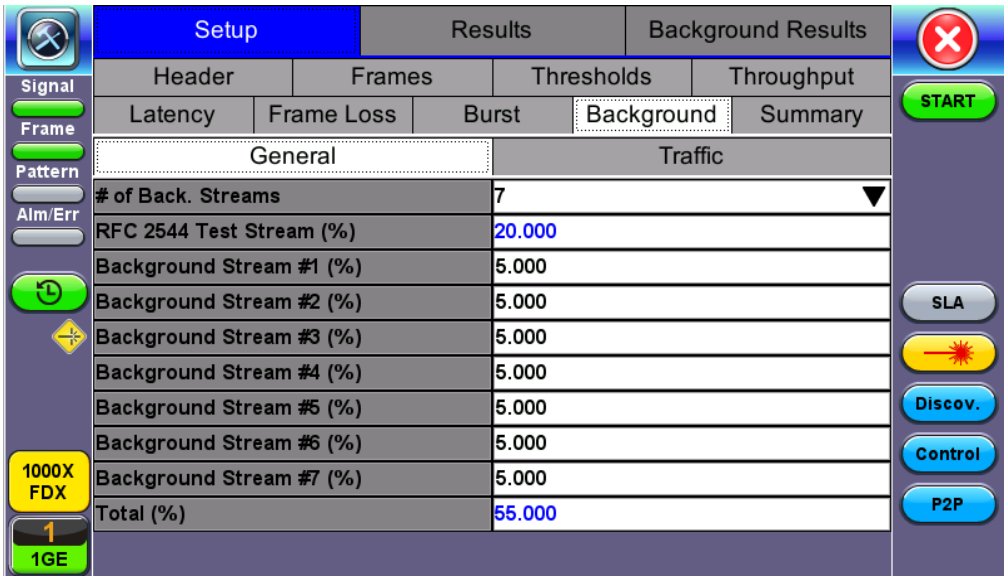
Background - General

- **# of Back. Streams:** From 1 to 7 streams.
- **RFC 2544 Test Stream (%):** This is the max rate set in frame loss.
- **Background Stream # (%):** Allocated Bandwidth per Stream. The total bandwidth for all streams cannot exceed 100%.
- **Total (%):** Sum of all stream rates in %.



Setup - Background - General Traffic

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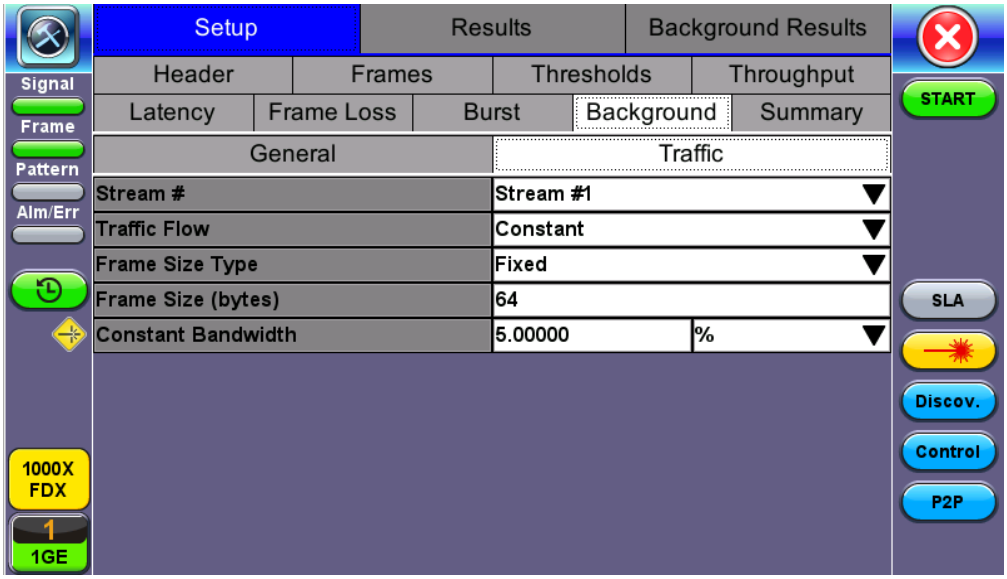
Background - Traffic

- **Background Stream #:** Select a stream number to configure.
- **Traffic Flow:** Select from Constant, Ramp, Burst, or Single Burst traffic flow.
- **Frame Size (Type):** Fixed or Uniform. If uniform is chosen, the user will have to input a minimum and maximum frame size.
- **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 10k bytes.
- **BW (Transmit Bandwidth):** Configure the transmit rate for the stream.
  Note: *The bandwidth allocation per stream is already configured in the* ***General Settings*** *tab, but can be modified in this screen as well.*



Setup - Background - Background Traffic

Starting/Stopping an Advanced SLA Mode

Please see Starting/Stopping a RFC 2544 Test for information on starting/stopping the test.

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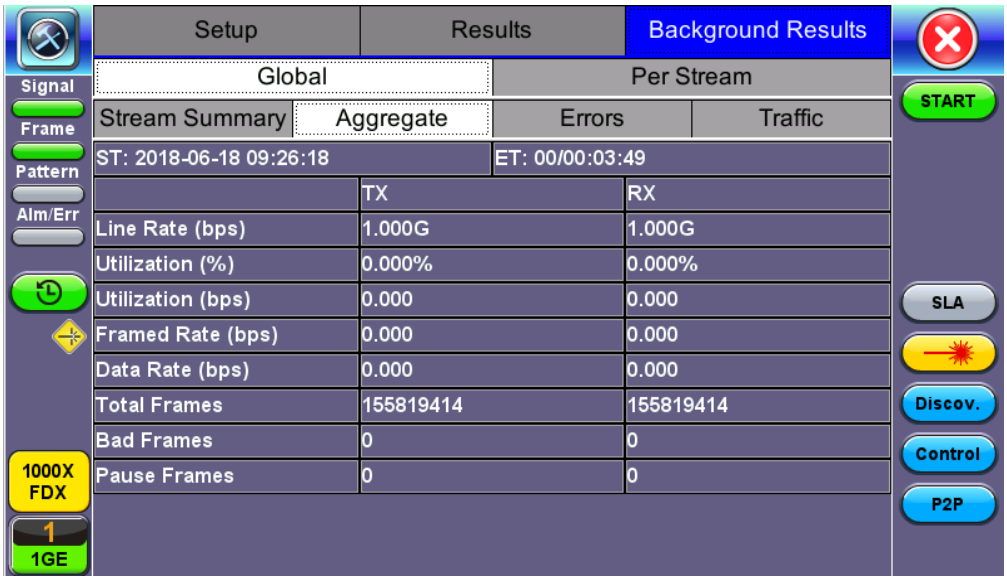
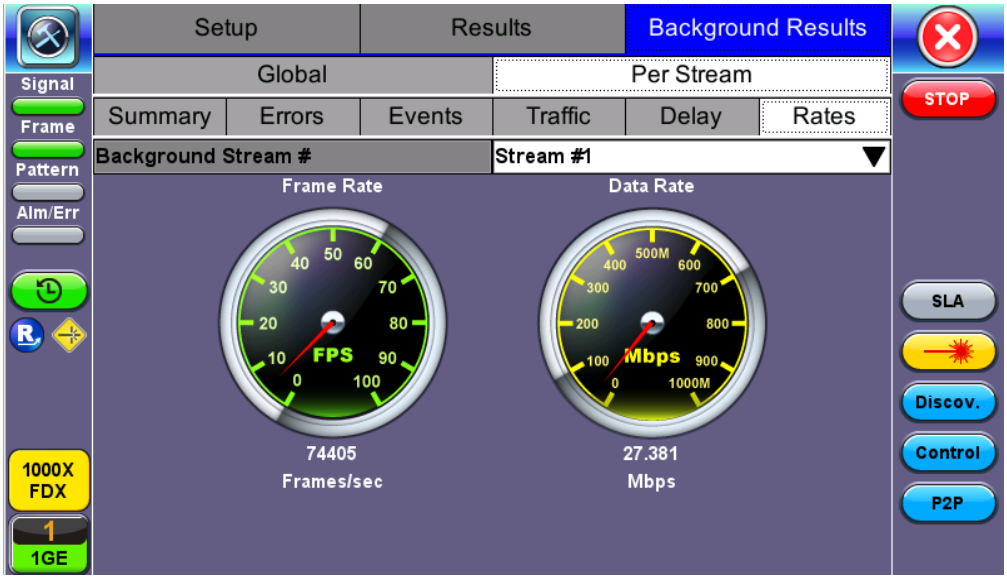
5.4.5 Background Results - Advanced SLA Mode

For information on Global and Per Stream Results in Advanced SLA Mode, please refer to Throughput Results.



Background Results - Global



Background Results - Per Stream

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5.4.6 Peer-to-Peer and Asymmetric Testing

Remote Partner Control

When the local unit connects to the remote (peer) partner, it loads the same configuration profile (header, traffic, and frame size) to the remote partner, with the MAC and IP addresses inverted. From the peer-to-peer menu, asymmetric testing becomes available.

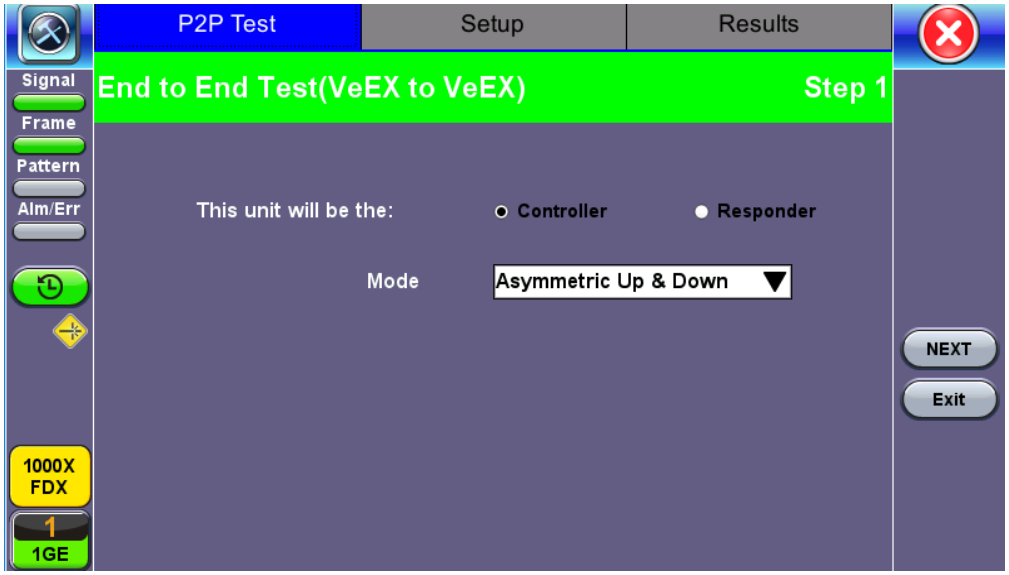
Asymmetrical links provide different line rates in the two directions. To verify the information for both the low and the high rates of the link, the user needs to send a test signal from one instrument located at one end of the link to an instrument at the other end of the link and vice versa to test traffic capacity. The two test instruments have to be synchronized because the tests defined in RFC 2544 require the receiver to know the contents of the test signal to be transmitted in detail.

The test set offers an automated RFC 2544 test application to perform throughput, frame loss, and burstability tests in a local-remote unit setup. The user first configures the test setup in the local unit. Once initiated, the local unit transfers the setup information to the remote unit via the line under test. Upon completion, the remote unit transfers the test results back to the local unit, enabling the user to read the results for both directions of the link on the local unit.

Asymmetric Testing Setup

1. Tap on the **P2P Setup** button on the right side of the screen to start the step-by-step setup process.
2. Set the Local unit as a **Controller** or **Responder**.

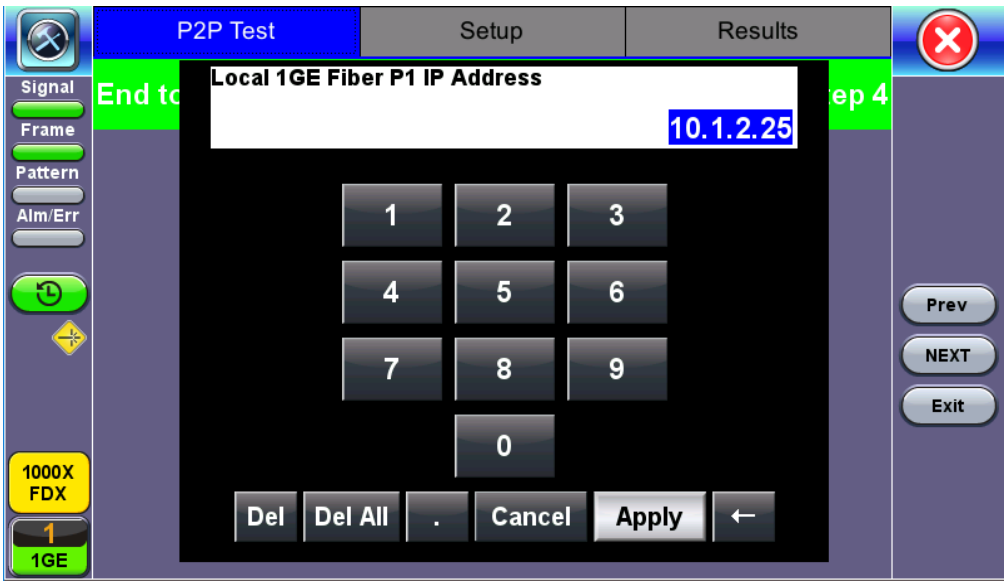
At any time during the process, tap on the right side navigation buttons to move to the **NEXT** screen, return to the **Previous** screen, or **Exit** the setup guide**.**



Set the Local unit as Controller or Responder

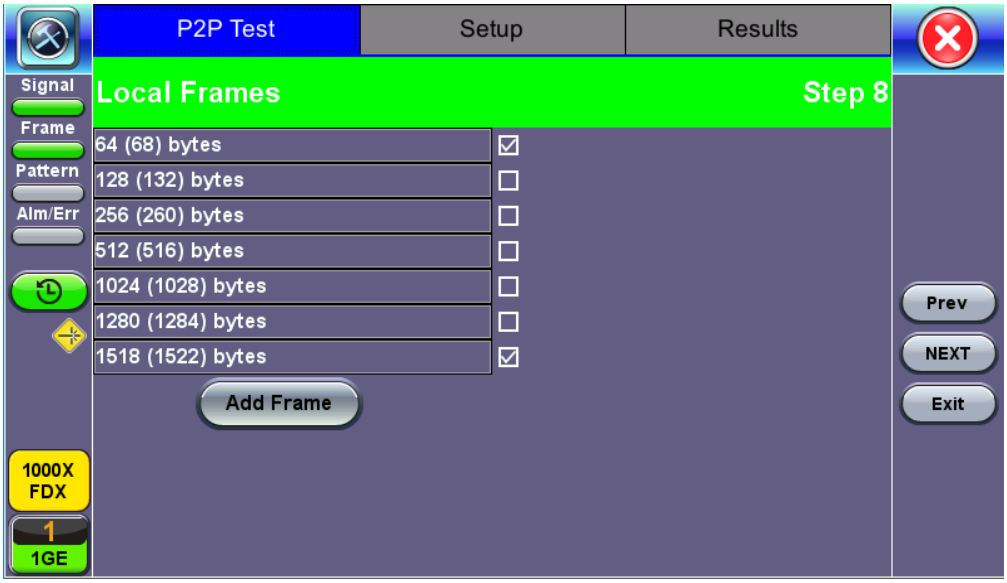
Unit as Controller Setup Process

- **Step 1:** Select Controller.
  - **Mode:** Select an asymmetric test configuration.
    - **Asymmetric Up:** Tests traffic in the upstream direction (local to remote direction).
    - **Asymmetric Down:** Tests traffic the downstream direction (remote to local direction).
    - **Asymmetric Up & Down:** Test traffic in both upstream and downstream direction.
- **Step 2-7:** Make the following selections for the Controller and Remote units: Layer, IP Address, Subnet, Gateway, and VLAN tags. Tap on the white fields to edit options. Use the alphanumeric keyboard to input parameters and press **Apply** to save edits.



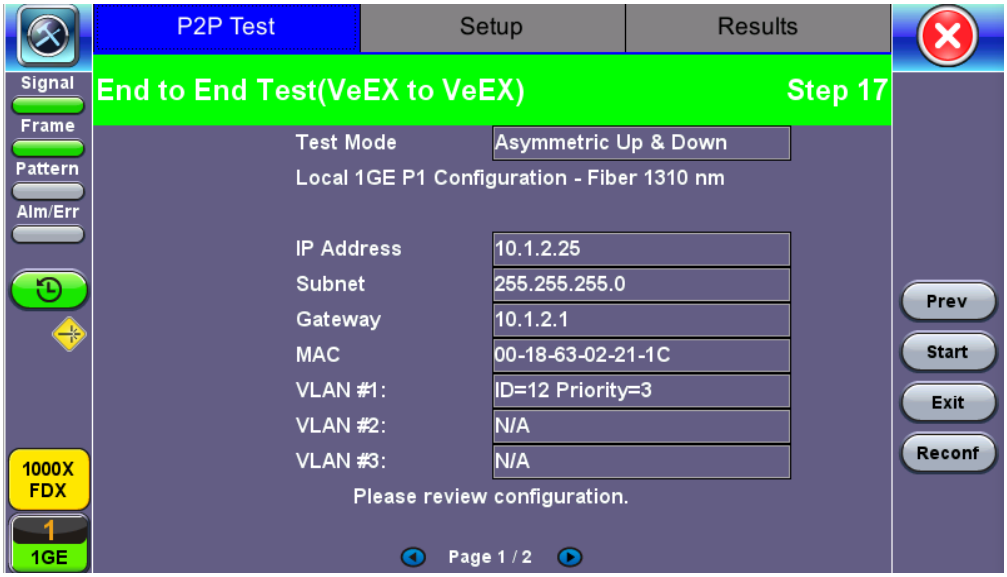
Input screen

- **Step 8:** Tap on the check boxes to add local frames. Tap on the **Add Frame** button to add a customized frame size.



Controller - Step 7

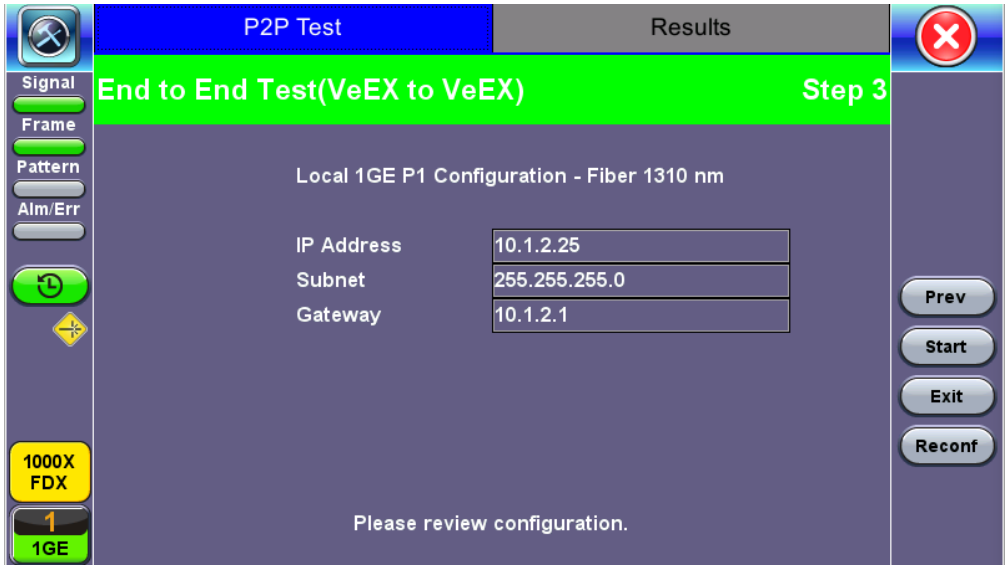
- **Steps 9-12:** Set up and enable/disable tests for the Local unit.
  - **Step 9:** Local Throughput testing setup. See the Throughput section for a description of menu options
  - **Step 10:** Local Frame Loss testing setup. See the Frame Loss section for a description of menu options.
  - **Step 11:** Local Burst testing setup. See the Burst (Back-to-Back) section for a description of menu options.
  - **Step 12:** Local RX Thresholds setup. See the Thresholds section for a description of menu options.
- **Steps 13-16:** Set up and enable/disable tests for the Remote unit. See Steps 8-11 for information on setting up individual tests.
- **Step 17:** Review configuration selections on the summary screen. The option to **Start** testing or **Reconfigure** test settings becomes available.



Controller Summary Screen

Unit as Responder Setup Process

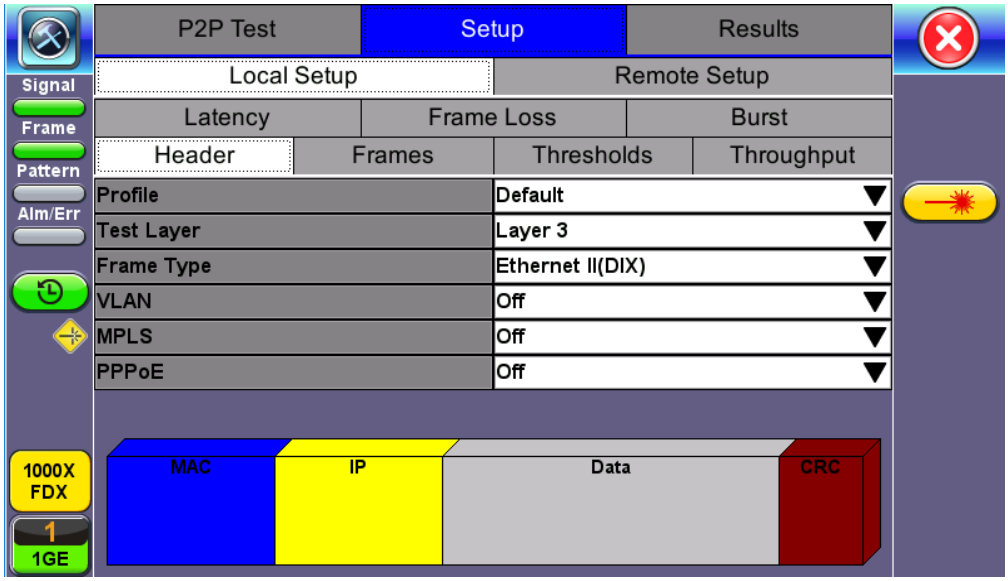
- **Step 0-2:** Tap on the white fields to setup the Local unit's IP Address, Subnet, and Gateway. Tap on **Next** to setup VLAN tags using the drop-down menu.
- **Step 3:** Review configuration selections. The option to **Start** testing or **Reconfigure** test settings becomes available.



Responder Summary Screen

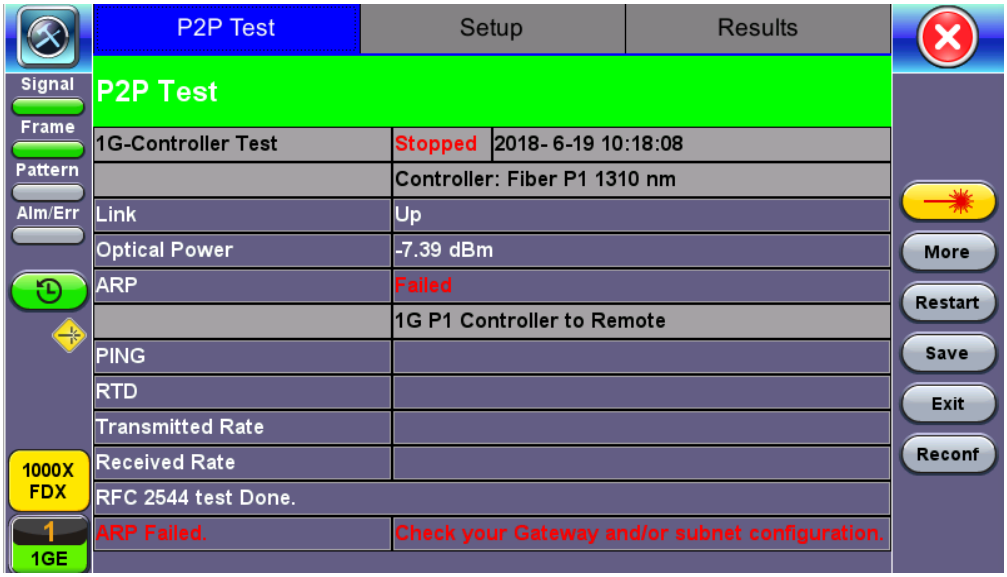
RFC 2544 Local and Remote Test Setup

RFC 2544 Test setup for the local and remote unit is available in the **Setup** tab. Refer to Setup - Standard Mode for more information.



Local Setup

Test Results



P2P Test Results

While the test is running the options to **Stop** the test, **Stop and Save** results, and view result **Details** appear. After testing finishes, the option to test **More** IPs**, Restart**, or **Save** test results become available as right side buttons. For more information on retrieving saved test results, refer to *File Management* in the **V150 platform manual** for more information.

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5.5 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.

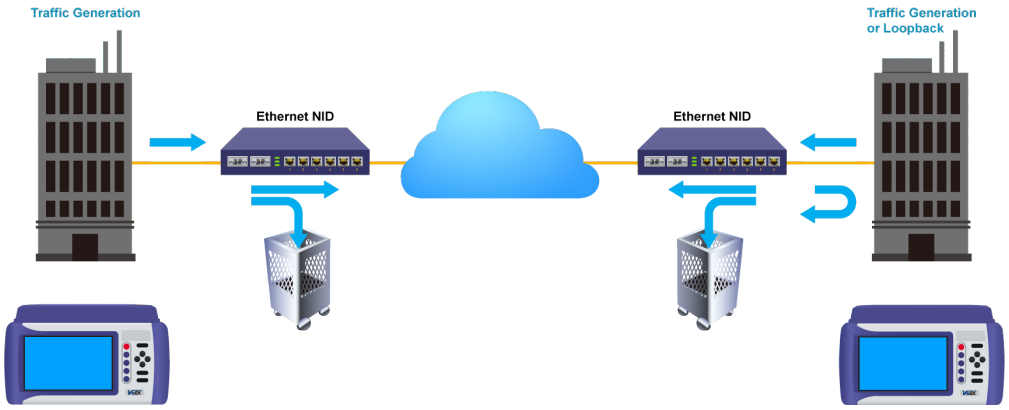
	RFC2544	Y.1564
Key Test Objective	Device performance	Network Service verification/activation
Service validation	One service at a time	Multiple services simultaneously
Throughput	Yes	Yes
Latency	Yes	Yes
Frame Loss	Yes	Yes
Burstability	Yes	Yes
Packet Jitter	No	Yes
Multiple Streams	No	Yes
Test Duration	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.



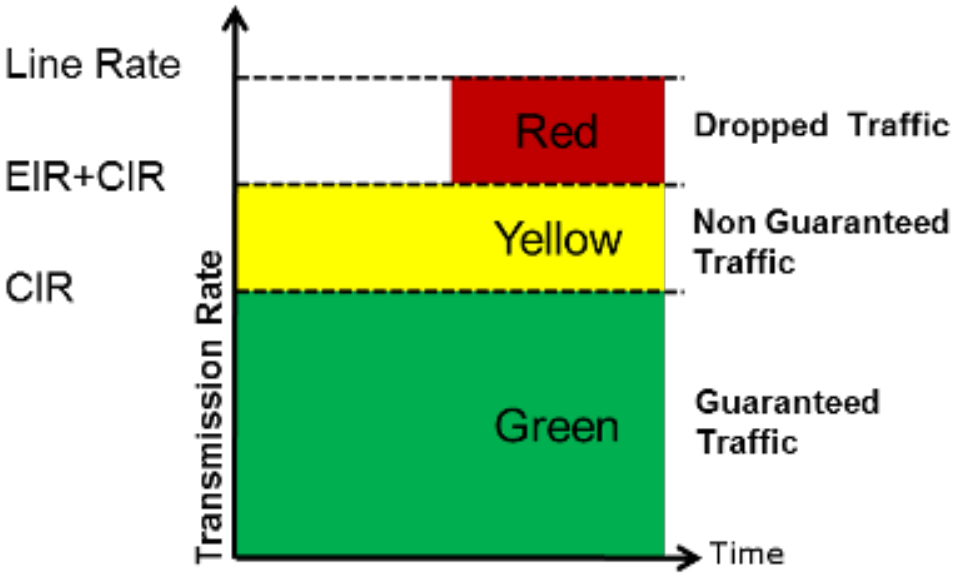
Test Application

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.

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5.5.1 V-SAM Setup

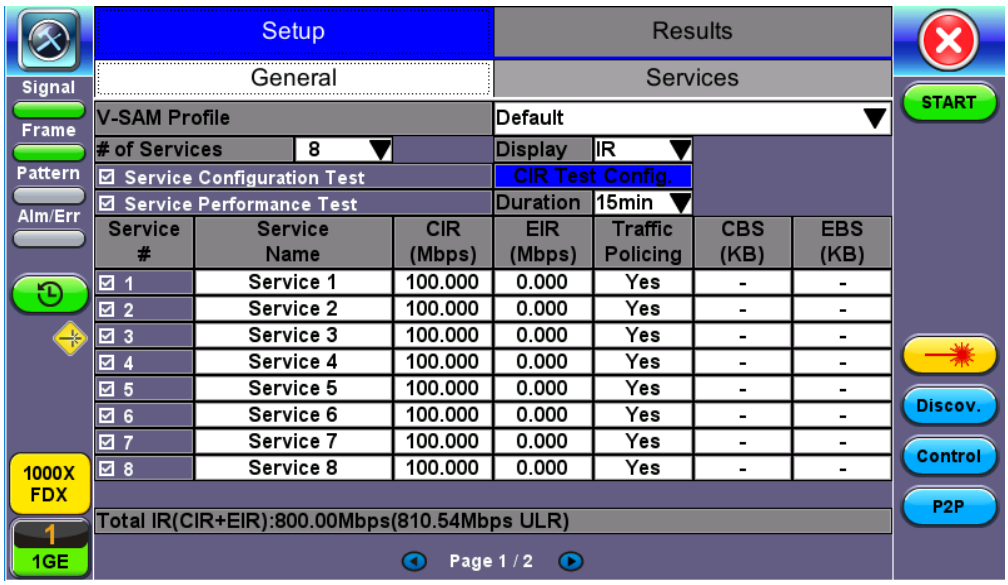
General (Page 1 and 2)

- **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-

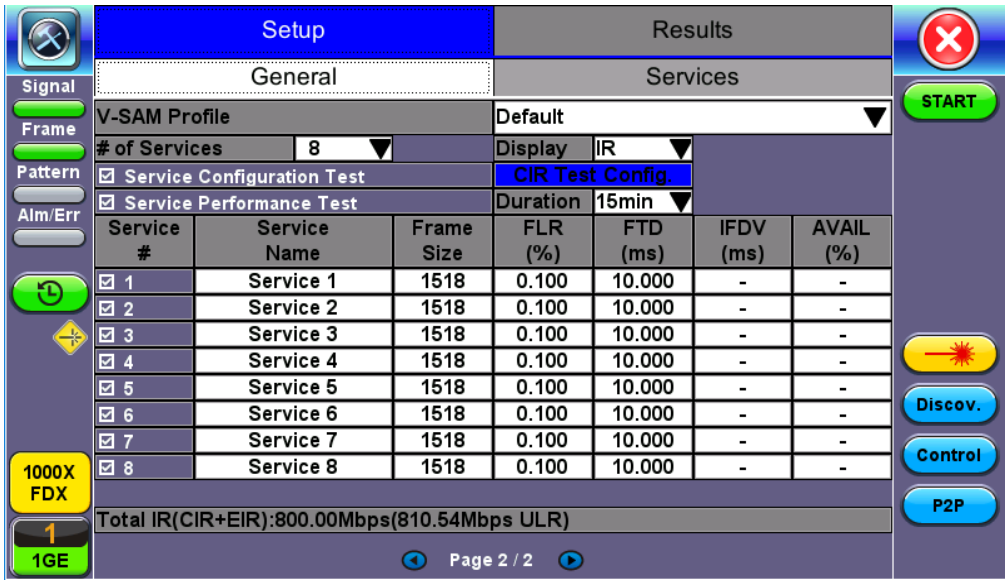
defined is selected, input a duration between 1-10000 min.

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)



V-SAM - Setup - General (Page 2)

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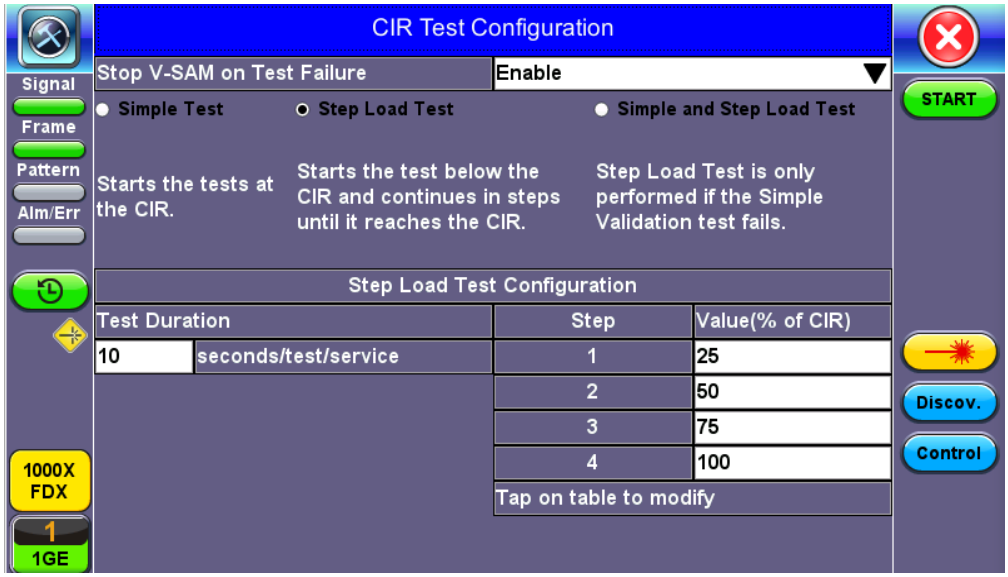
CIR Test Configuration

- **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

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5.5.1.1 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.
    Note: *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.

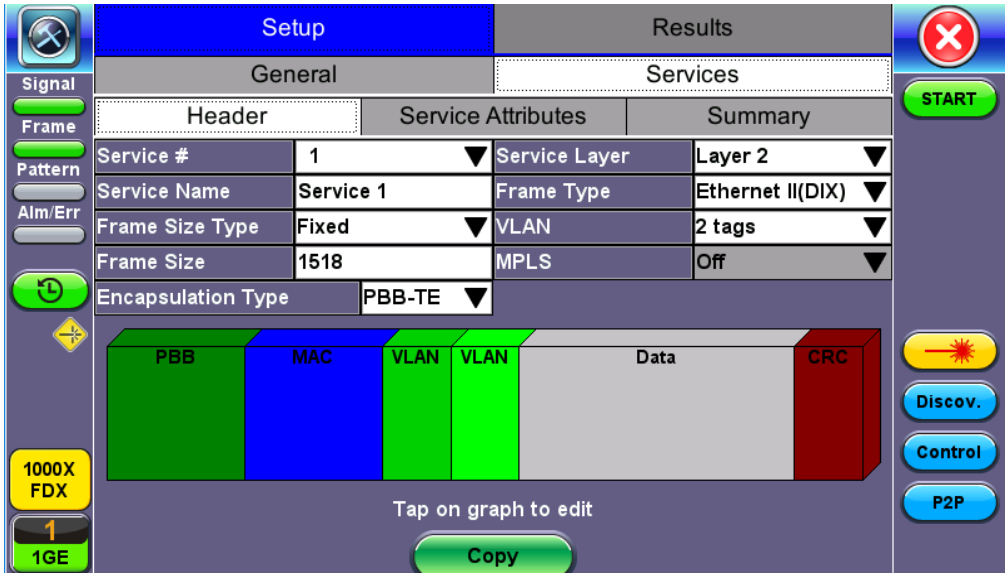
  PBB:

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

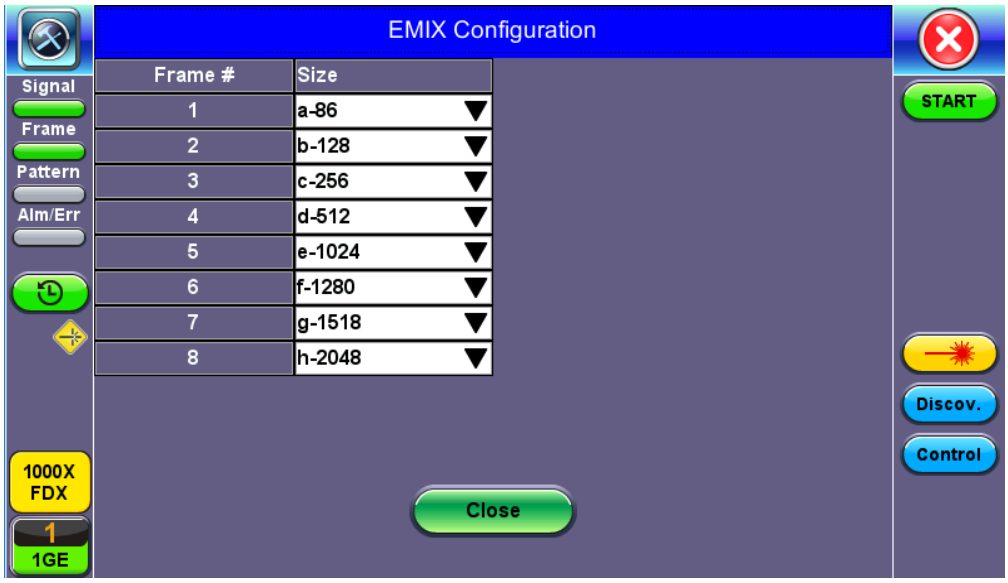
  MPLS-TP:

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

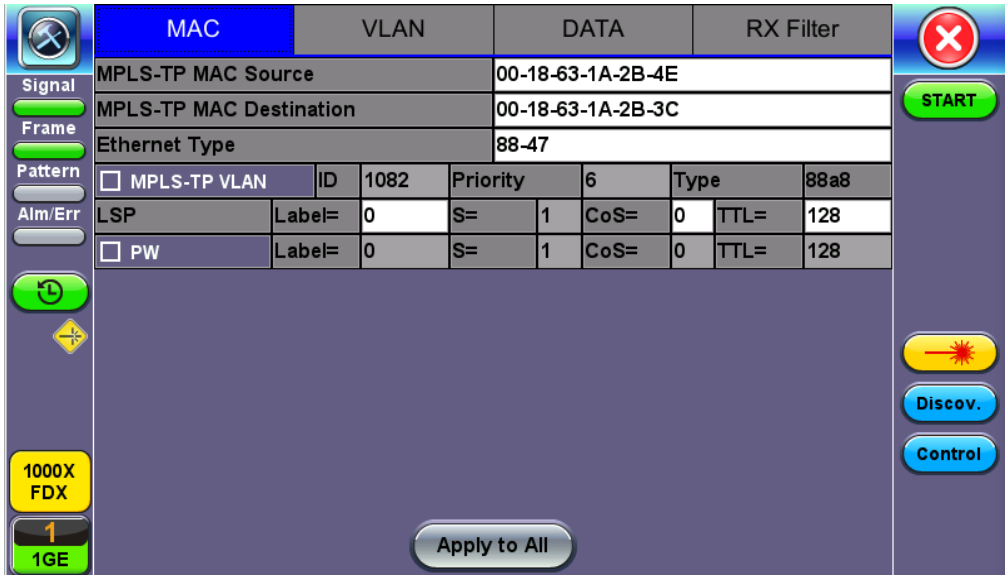
After making changes, tap **Apply to All**, for MPLS-TP configuration.
Please see RFC 2544 Setup and follow the setup procedure to configure the remaining Header Settings for V-SAM.



V-SAM Setup - Services - Header Settings



V-SAM Setup - Services - EMIX Frame Size Settings



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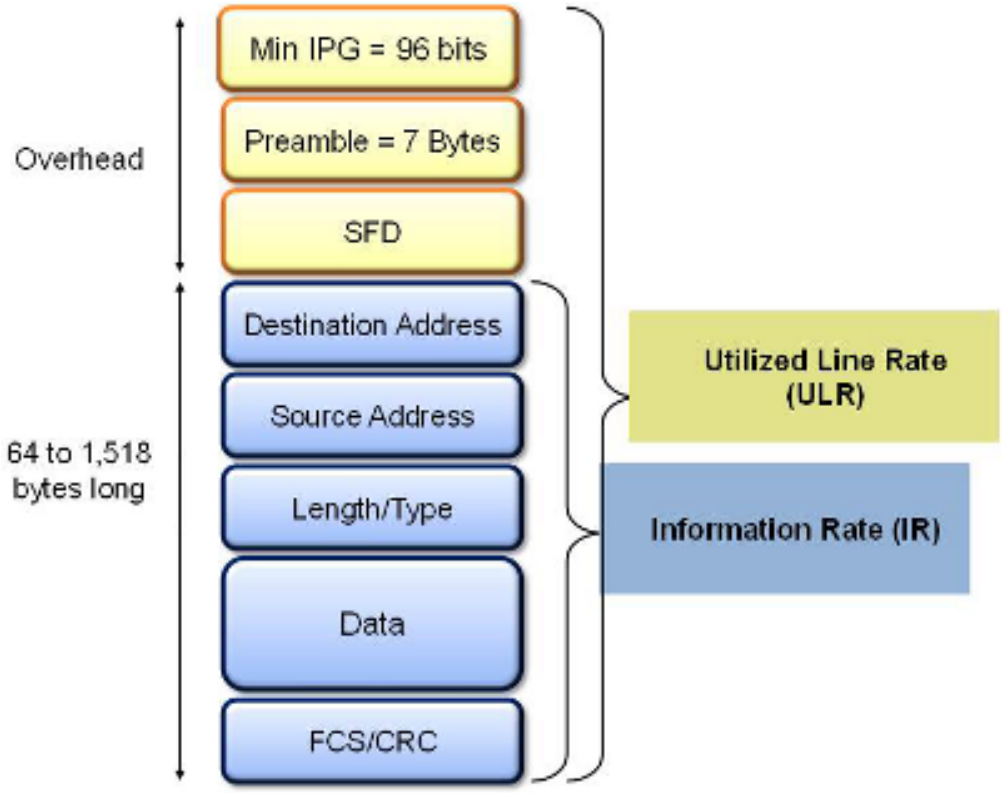
5.5.1.2 Service Attributes

Bandwidth Profile Parameters

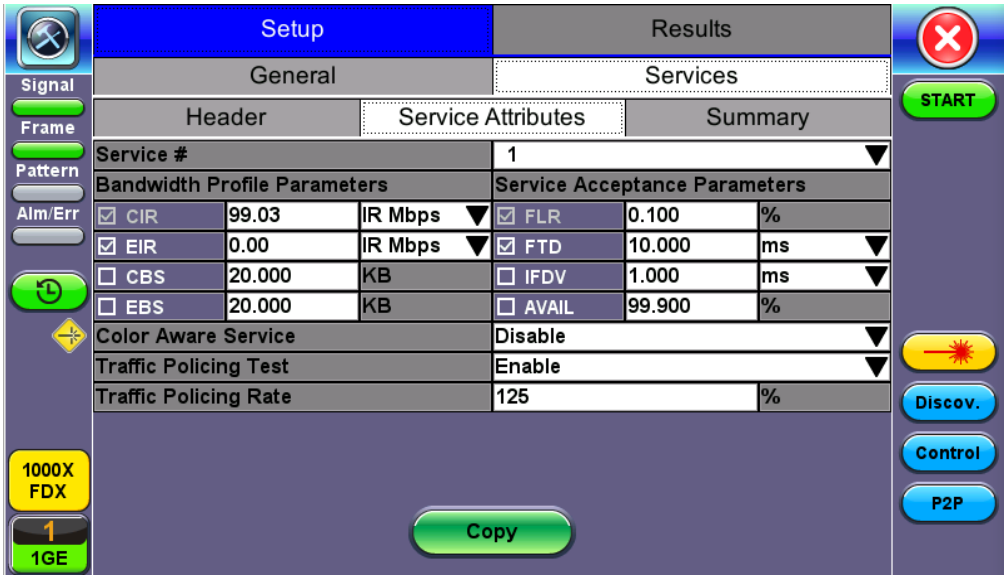
The Bandwidth Profile specifies how much traffic the customer is authorized to transmit and how the frames are prioritized within the network. In the Bandwidth table, the user specifies the following bandwidth criteria:

- **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.

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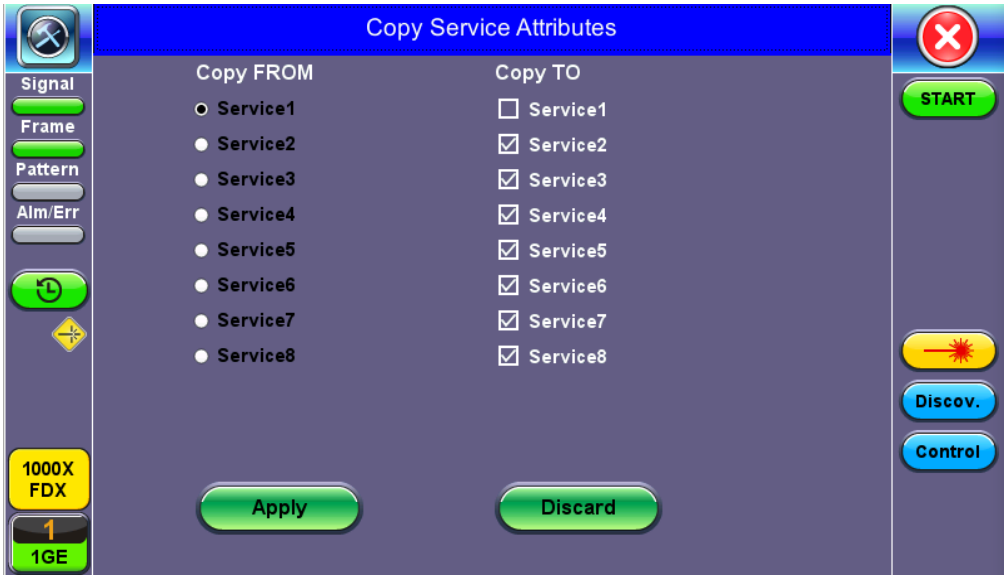
Service Acceptance Parameters

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.

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MX Discover and Control Settings

The **Control** button offers additional loopback control settings including User Defined and OAM Discover. For instructions on how to loop up/down the test set with another test set or device, please refer to 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 **PCAP**. Tapping **PCAP** again will stop packet capture and automatically name and save 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 *File Management* in the **V150 Common Functions** manual for more information.

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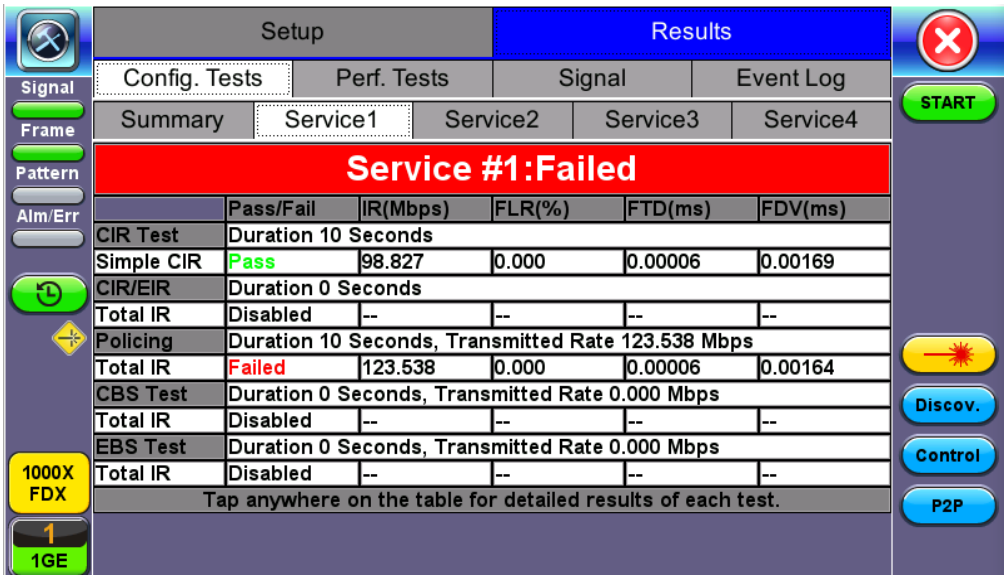
5.5.2 Results



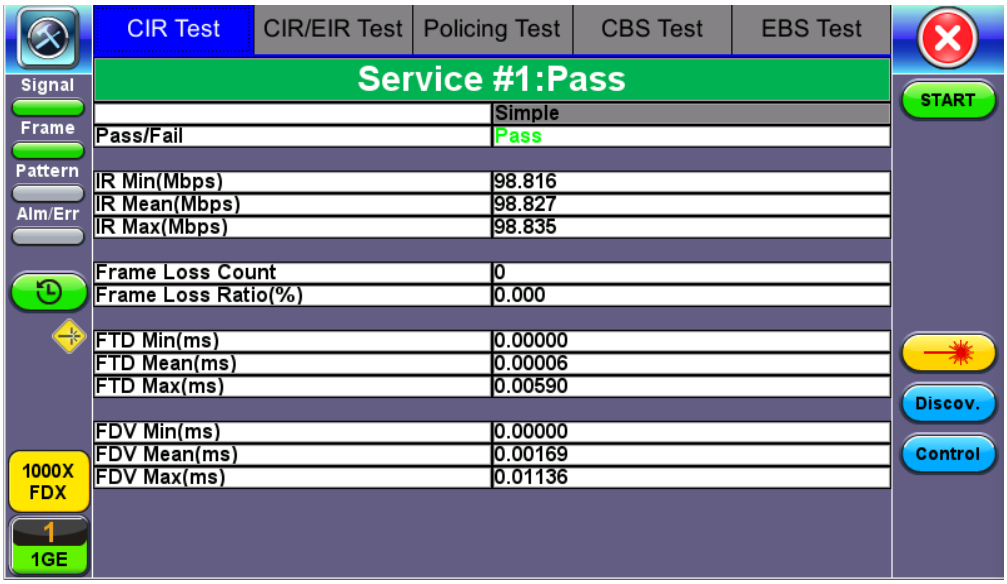
Results - Config. Tests - Service 1

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** and enabled tests including **CIR/EIR, CBS, EBS,** and **Policing Test** results for the chosen Service**.** The test 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.

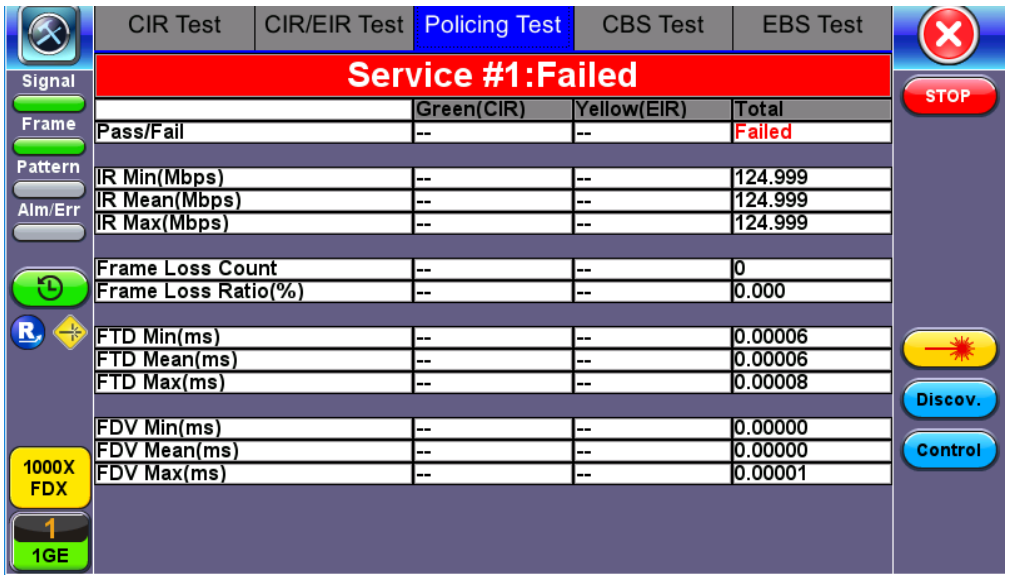
- **IR Mbps:** Information Rate. Measures the average Ethernet frame rate starting at the MAC address field and ending at the CRC.
- **FTD:** Measures the time that the frames can take to travel from source to destination.
- **FDV:** Measures the frame jitter.
- **Frame Loss Count:** Counts the number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



Tap the Table to View Test Details such as CIR Test

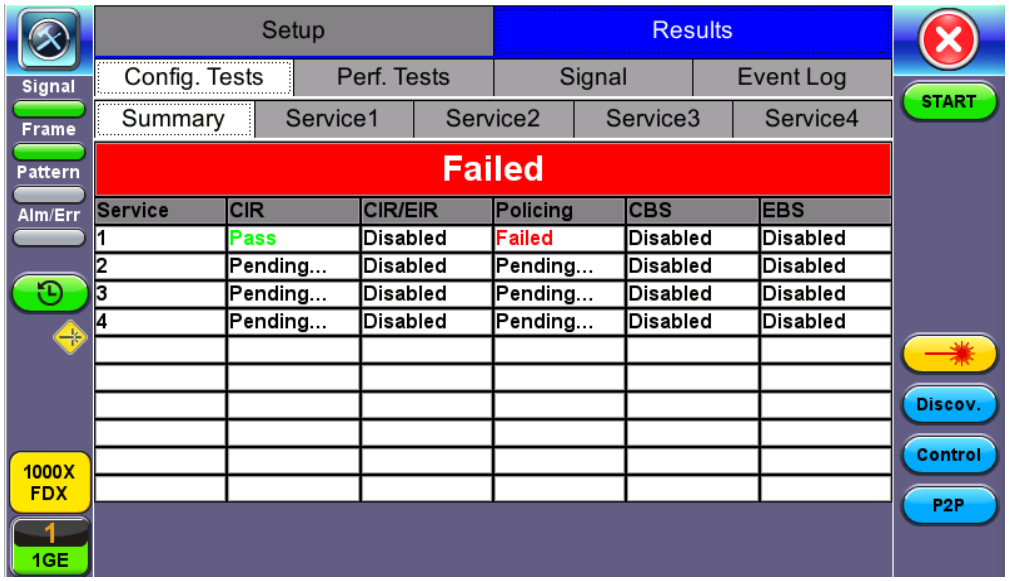
CIR test: The test passes if all measured values are below the thresholds configured. If a threshold is disabled, it will not be evaluated towards pass/fail criteria.

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



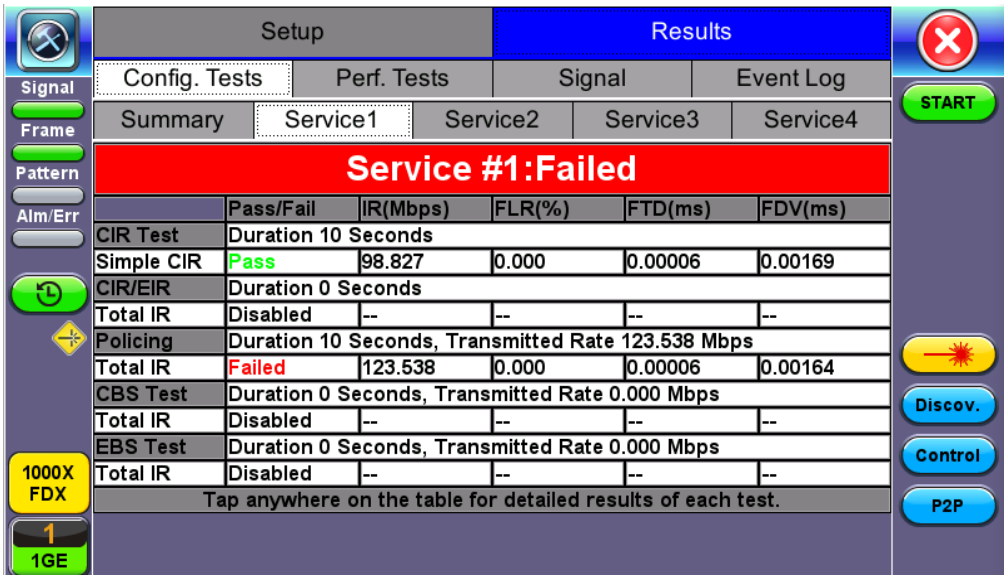
Policing Test - Service 1

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

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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.

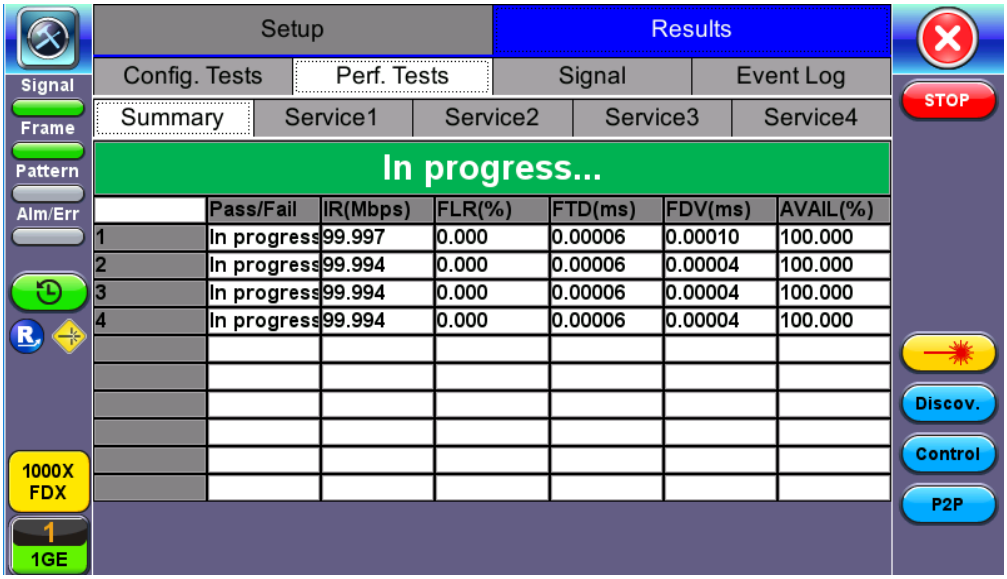
- **IR Mbps**, **FTD**, **FDV**, **Frame Loss Count**, **Frame Loss Ratio (%)** definitions are listed in the **Configuration Test** section.
- **Availability:** Minimum percentage of service availability allowed to still be compliant with the SLA. The service becomes unavailable if more than 50% of 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

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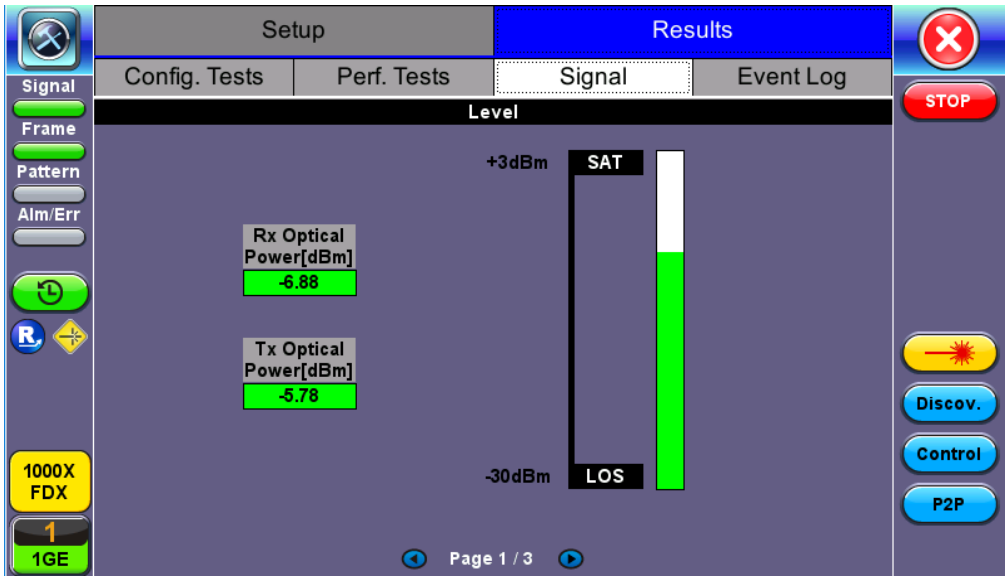
Signal tab: The Signal tab (fiber ports only) displays the optical level measured by the SFP transceiver. The RFC 2544 Signal tab is

identical to the Signal tab for the BERT application. Refer to Signal from the BERT section for more information.



Perf. Tests - Summary

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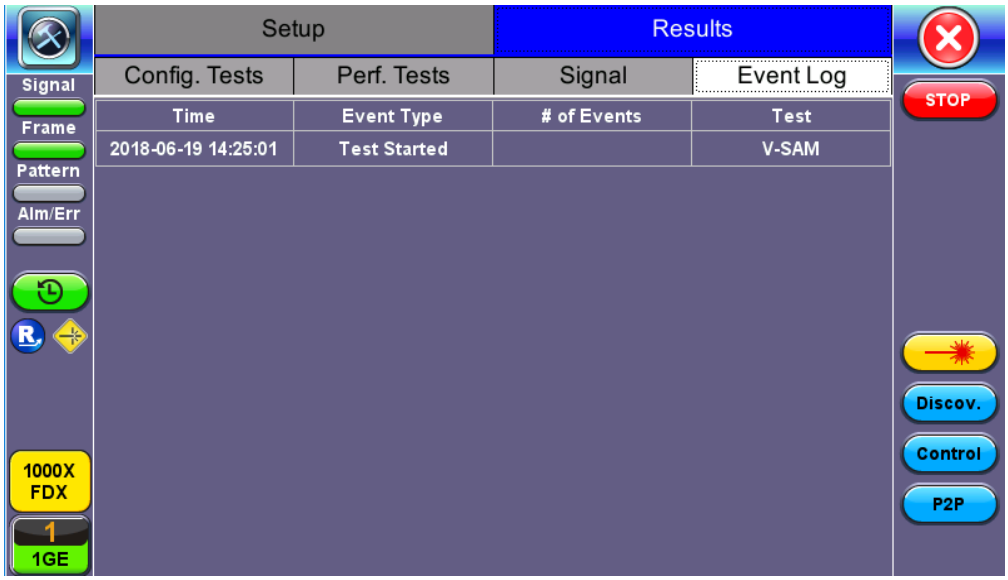
Event Log

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



Event Log

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5.6 Throughput Testing (Multiple Streams)

Overview:

The throughput application (or the multiple streams 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 allows for the configuration of up to 8 traffic streams with their own MAC and IP addresses, VLAN tags (up to 3 per stream), 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 (up to 8 streams) 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.

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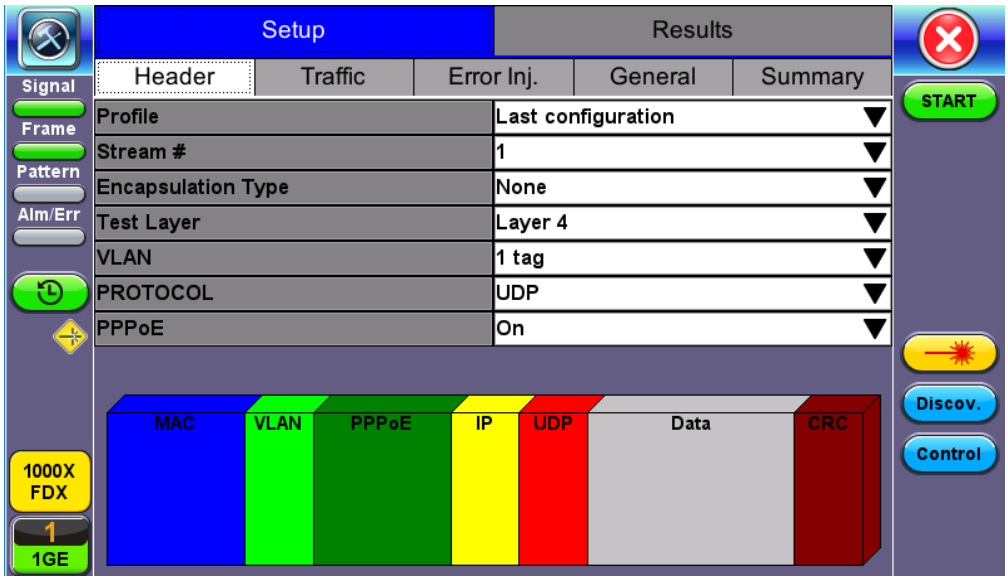
5.6.1 Setup

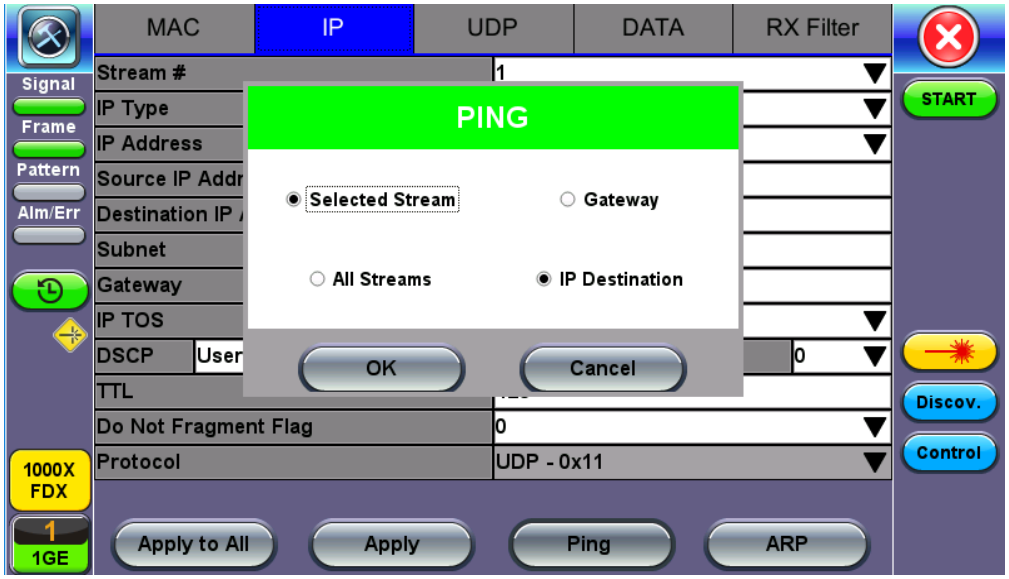
Unless otherwise noted, Frame Header, Traffic, and Error Injection setups are identical to the ones described in the BERT section. The following parameters must be configured prior to performing a Throughput test:

- 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)



Setup Header

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 ping and ARP sections in the **IP** chapter for information on setup and results for these test applications.



Throughput Header - IP - Ping 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.

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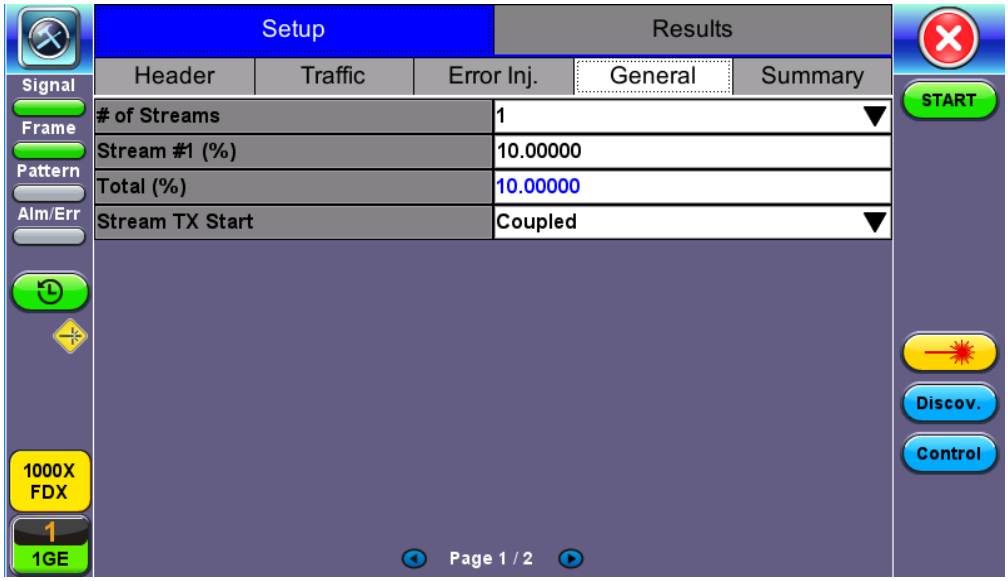
5.6.1.1 General Throughput Settings (Global Configuration)

Page 1:

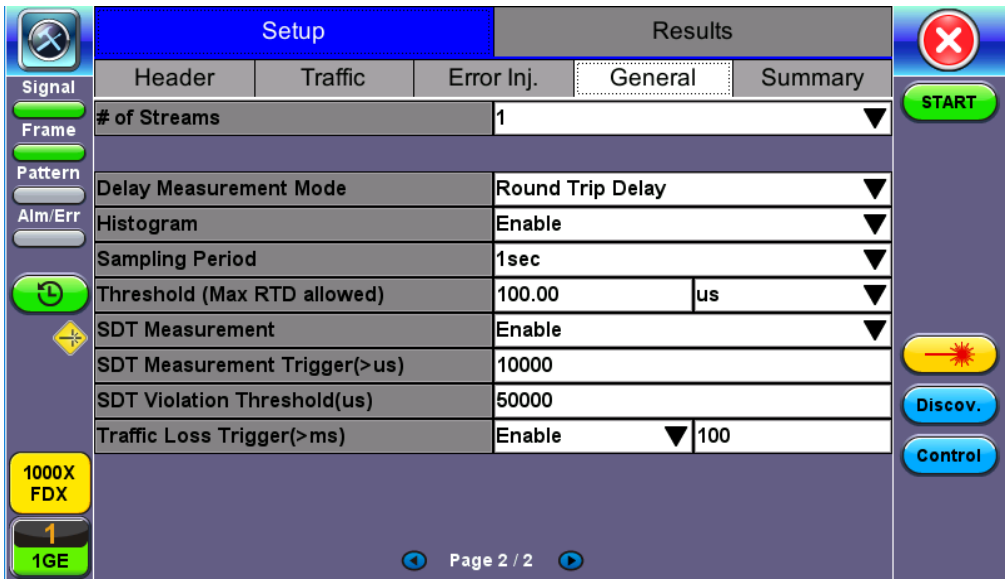
- **# of Streams:** From 1 to 10 streams.
- **Stream #:** Allocated Bandwidth per Stream: The total bandwidth for all streams cannot exceed 100%.
- **Total (%):** Sum of all stream rates in %.
- Stream TX Start: Coupled or Separated. Configures how the measurements are started for multiple streams.
    - **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.



Throughput Setup - General Settings

Page 2:

- **#of Streams:** From 1 to 8 streams. ***Note:*** *# of Streams can be specified either on Page 1 or Page 2. It will be reflected on both pages.*
- **Delay Measurement Mode:** Disable, Round Trip Delay. Local One way delay measurement, Atomic one way delay, or GPS one way delay are also available depending on the Glock Synchronization device selected in the Setup (home menu) > Measurement menu. Refer to Measurement Settings for more information. Round Trip Delay should only be enabled when running the test to a remote loopback.
- **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.
- **SDT Measurement**: Enable/Disable. The Service Disruption Test is triggered based on user established thresholds.
    - ***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.
    - ***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.
- **Traffic Loss Trigger:** If the receiver does not detect incoming traffic within the configured threshold time, a traffic loss trigger is recorded in the event log.



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

5.6.1.2 MX Discover and Control Settings

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

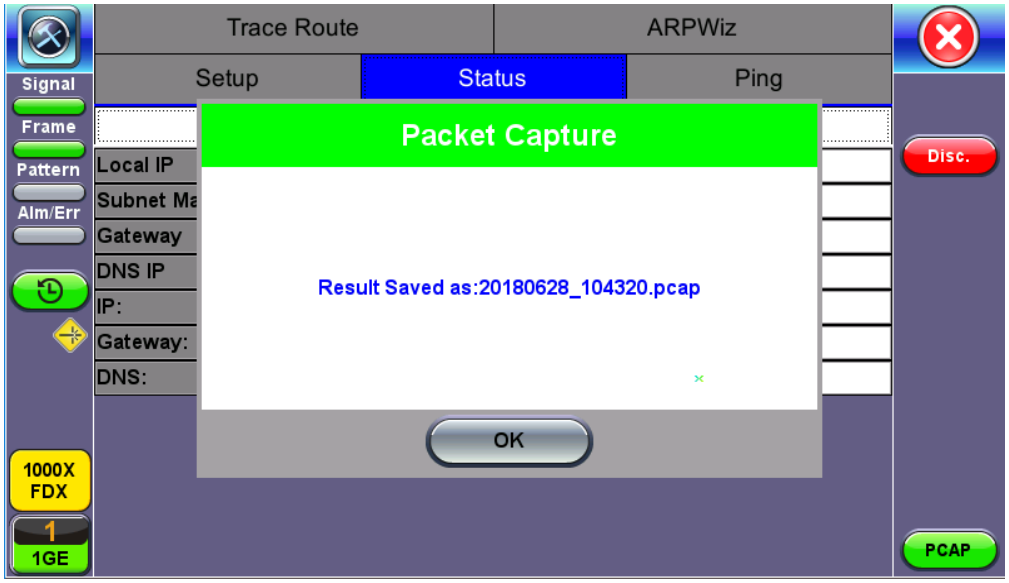
The **Control** button offers additional loopback control settings including User Defined. These features are described in MX Discover and Control.

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. X-loop is for looping non-VeEX networking equipment.

Packet Capture

To start and stop packet capture, tap on **PCAP**. 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 filecan be exported to a PC and analyzed using Wireshark. Refer to *File Management* in the **V150 Common Functions** manual for more information on retrieving and managing saved files.



PCAP Saved Results

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5.6.1.3 Per Stream Configurations

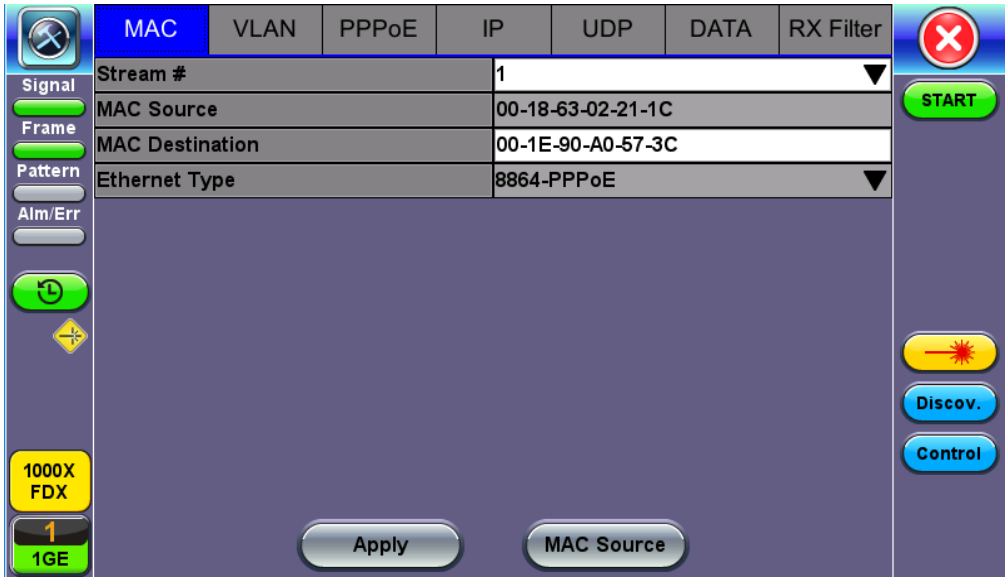
Frame Header, Traffic, and Error Injection setup is identical to the configuration for BERT testing. Refer to the corresponding BERT section for setup information on the following:

- Frame Header Settings
- MAC, VLAN, MPLS, IP, and test pattern configurations
- Traffic Settings

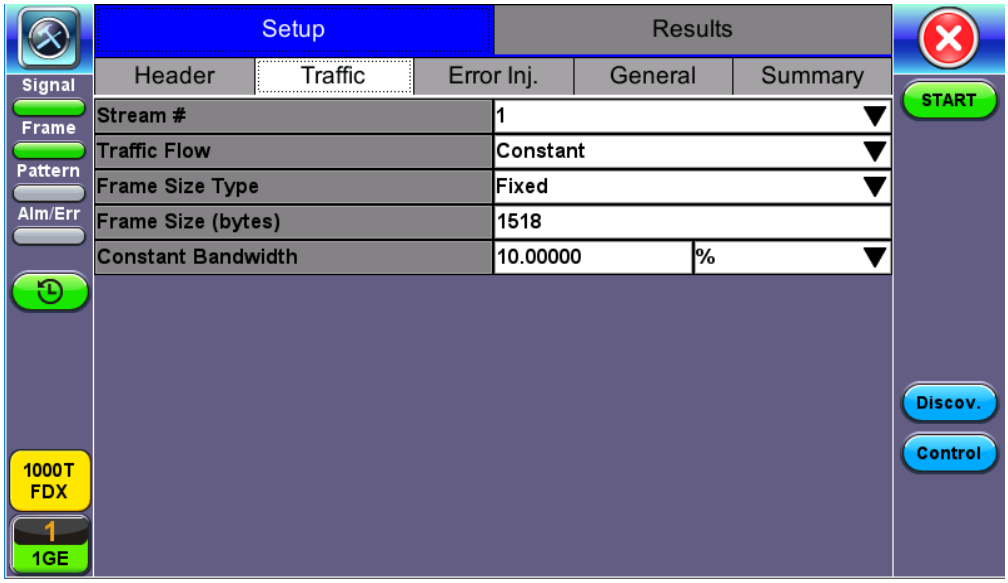
- Error Injection

*Settings for each stream can be setup by selecting the **Stream #** from the drop-down menu.*

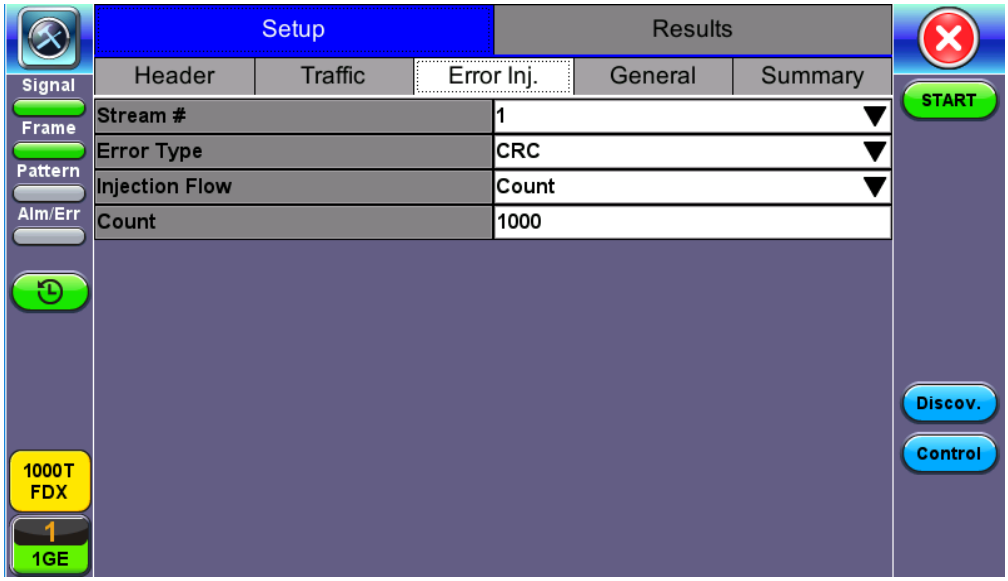
For information on header configuration refer to BERT Header Settings.



MAC Setup



Throughput Setup - Traffic Setup - Constant Traffic Flow



Throughput Test - Error Injection Settings per Stream

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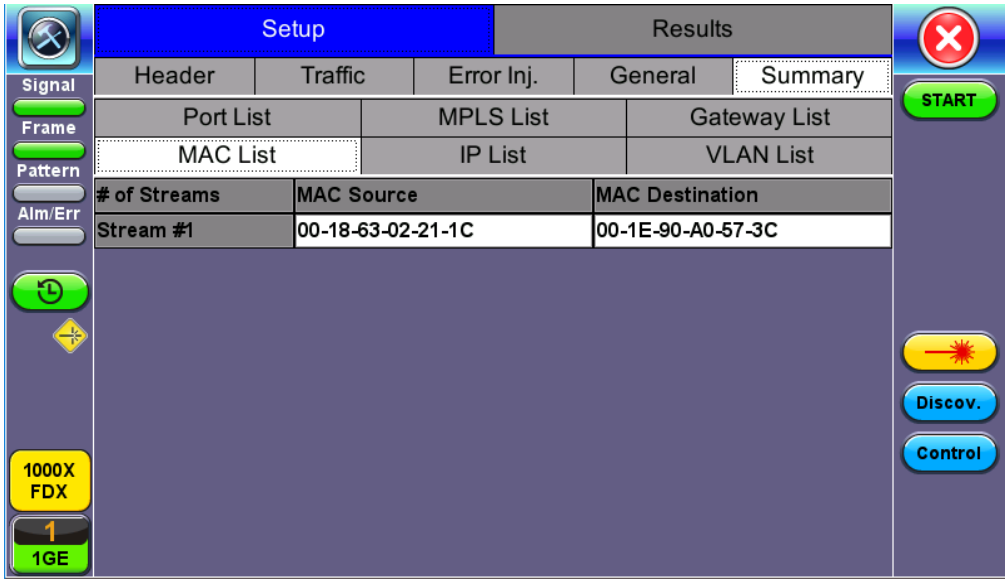
5.6.1.4 Summary

The summary screen lists the source, 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 Test - Summary (MAC List)

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5.6.1.5 Starting/Stopping a Throughput (Multiple Streams) Test

Once all configurations have been made, the user can start the Throughput 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 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 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 Throughput 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 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.

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5.6.2 Throughput Results

5.6.2.1 Viewing Throughput (Multiple Streams) Test Results

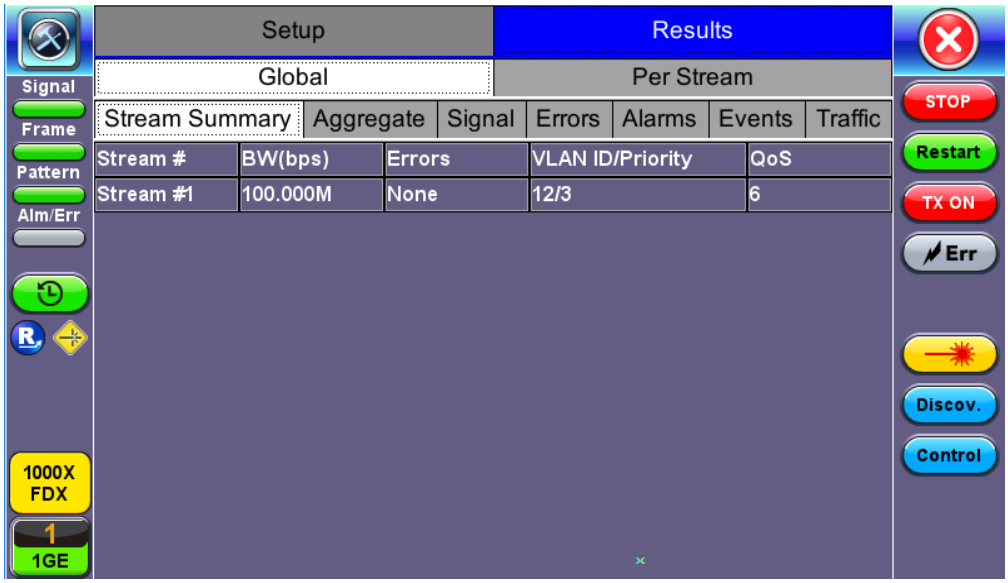
When the test is first started, the screen automatically changes to the Global/Aggregate results screen.

5.6.2.2 Global/Aggregate Results

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

The **Global Stream Summary** screen displays:

- Stream number (#)
- Total received 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

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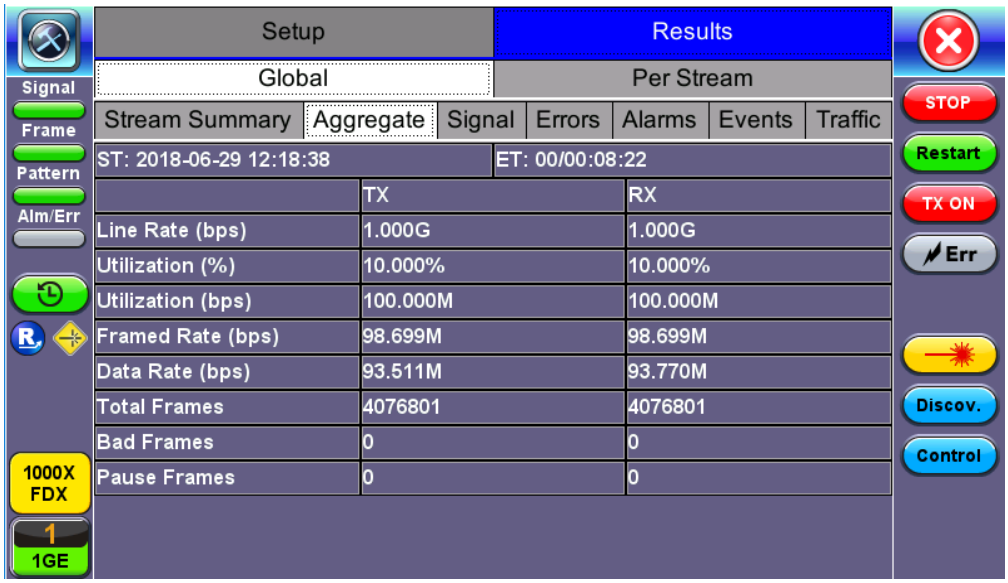
The Aggregate screen displays these parameters:

- **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).
- **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



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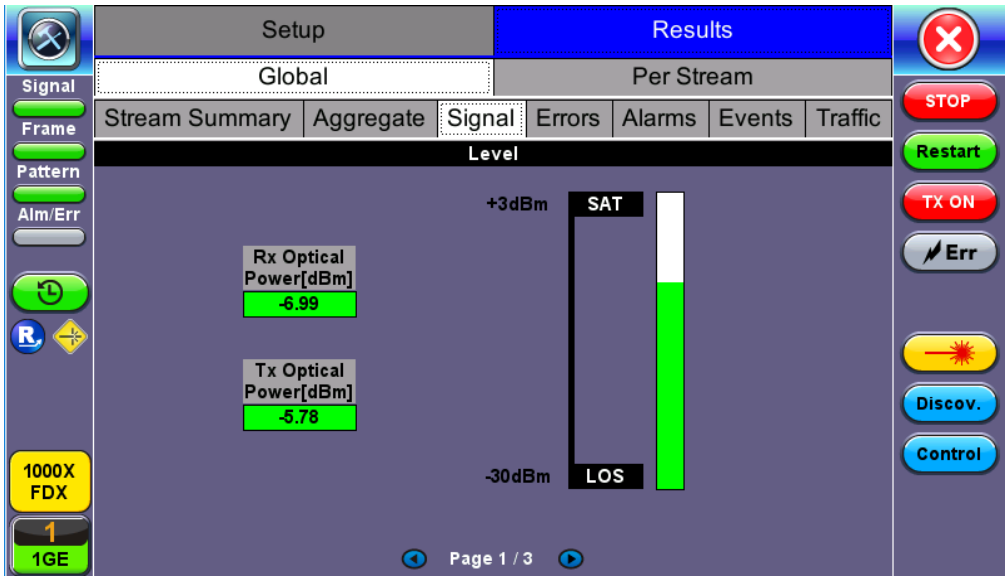
The **Global Signal** screen (fiber ports only) displays the optical level measured by the SFP transceiver. Page 1 displays the level measurement in dBm for the optical signal.

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



Throughput Results - Global Signal (Page 1)

Signal (Page 2)

Page 2 displays the Optical module (SFP) information which includes Vendor name, Part Number and Optical Wavelength. Tap on the **Decode** button to view additional information on SFP optics.

Signal (Page 3)

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

- **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.

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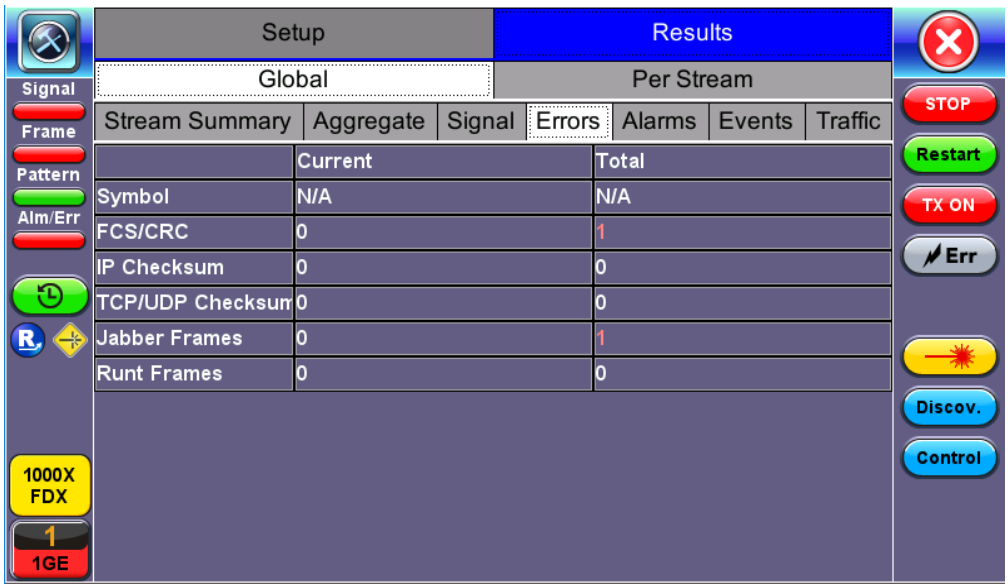
The **Global Errors** screen displays the Current and Total error count of all streams:

- 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



Throughput Results - Global Errors

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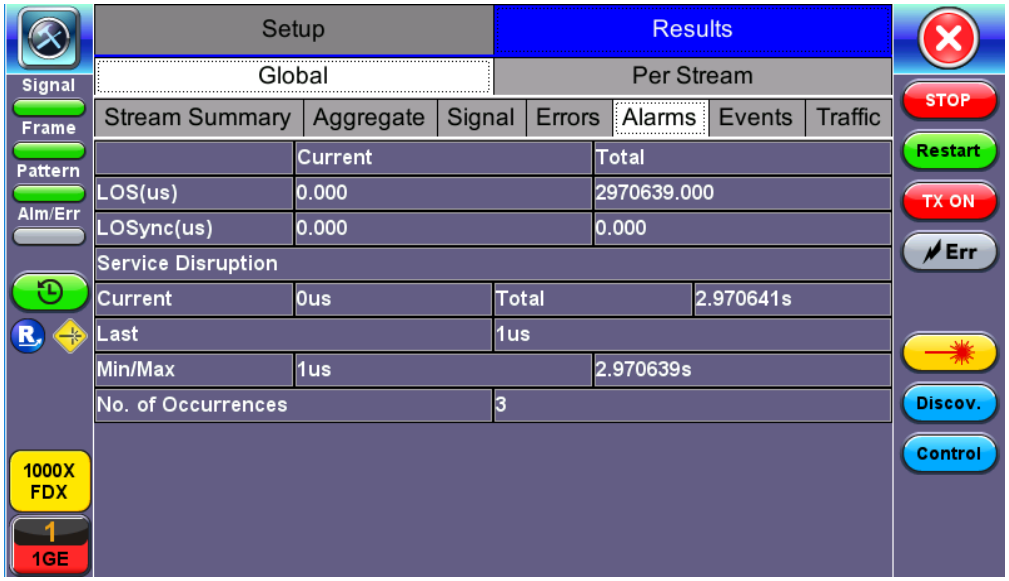
The **Global Alarms** screen displays the Current and Total alarm count of all streams:

- **LOS:** Loss of Signal
- **LOSync:** Loss synchronization
- 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**
- **PCS-HI-BER:** PCS High BER
- **PCS-LOBL**: PCS Loss of Block Lock



Throughput Results - Global Alarms

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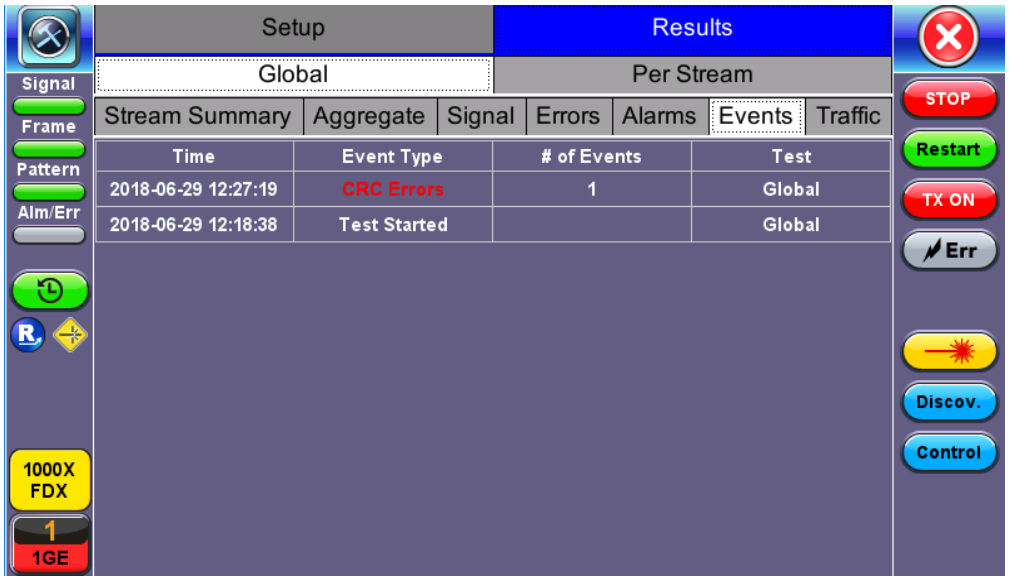
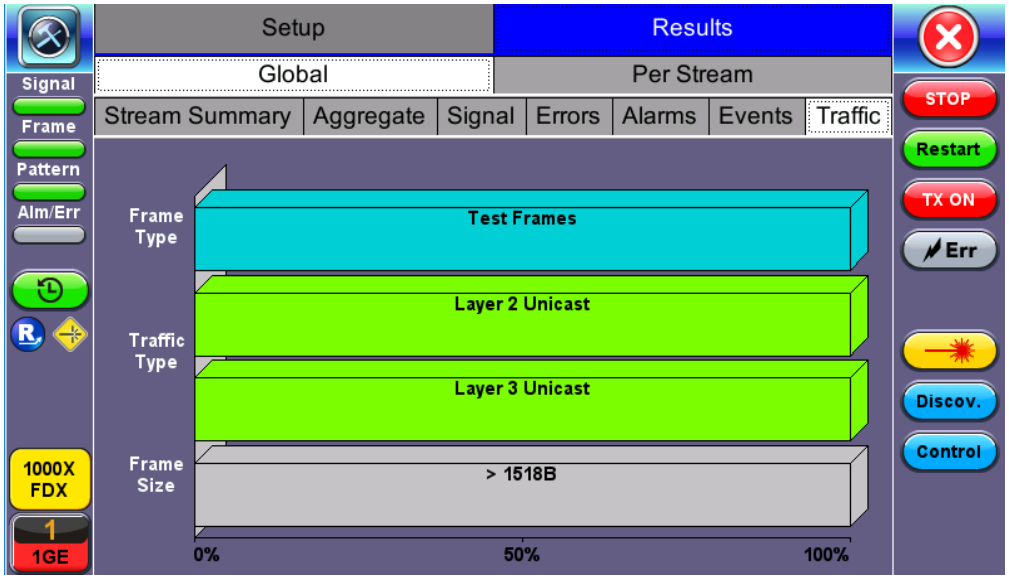
The **Global Events** screen displays the **Time**, **Event Type**, **Number of Events**, and **Test Type**.



Throughput Results - Global Events

The **Global Traffic** screen displays:

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

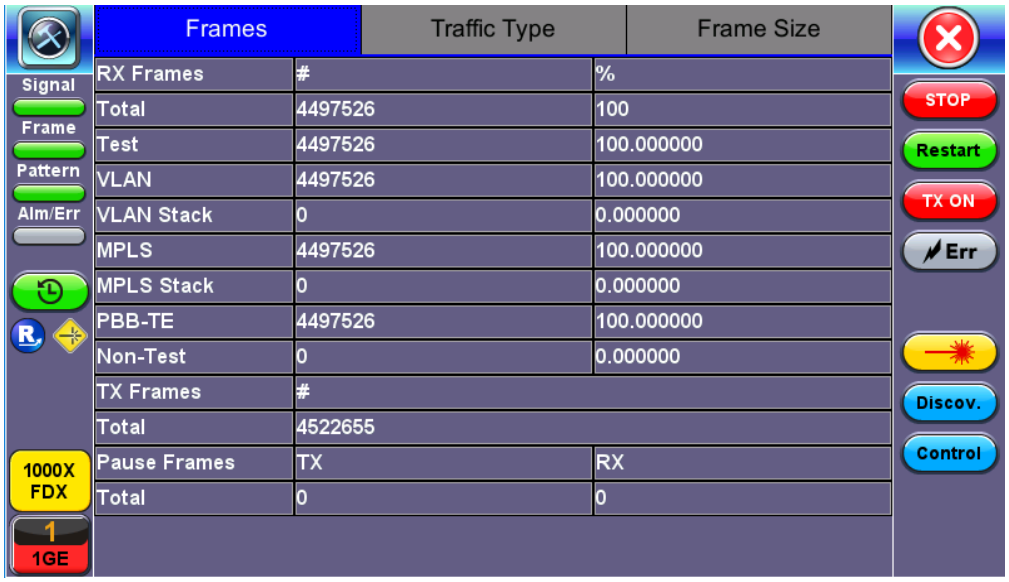


Throughput Results - Global Traffic Summary

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 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



Throughput Results - Frames Type

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

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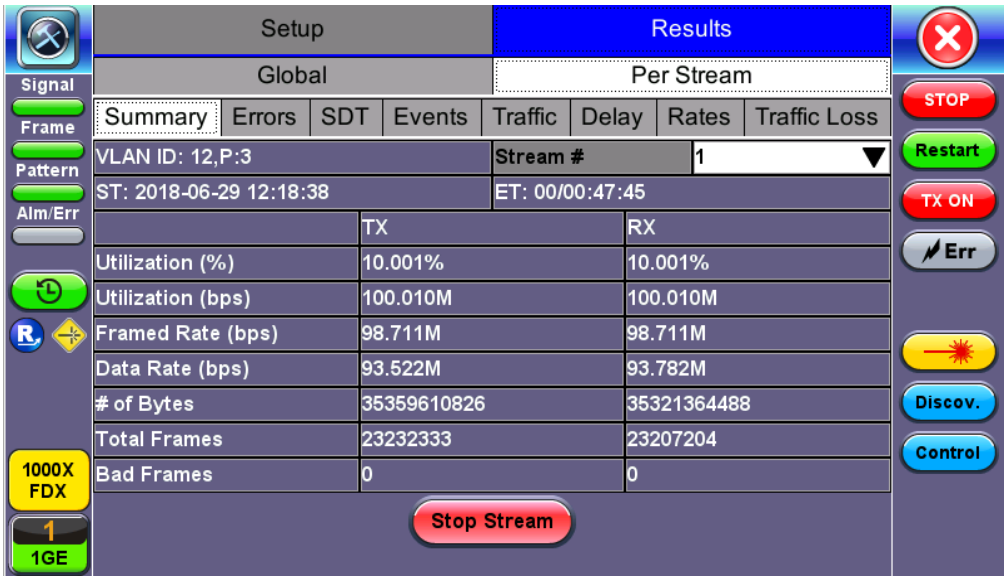
5.6.2.3 Per Stream Results

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 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.



Throughput Results - Summary per Stream

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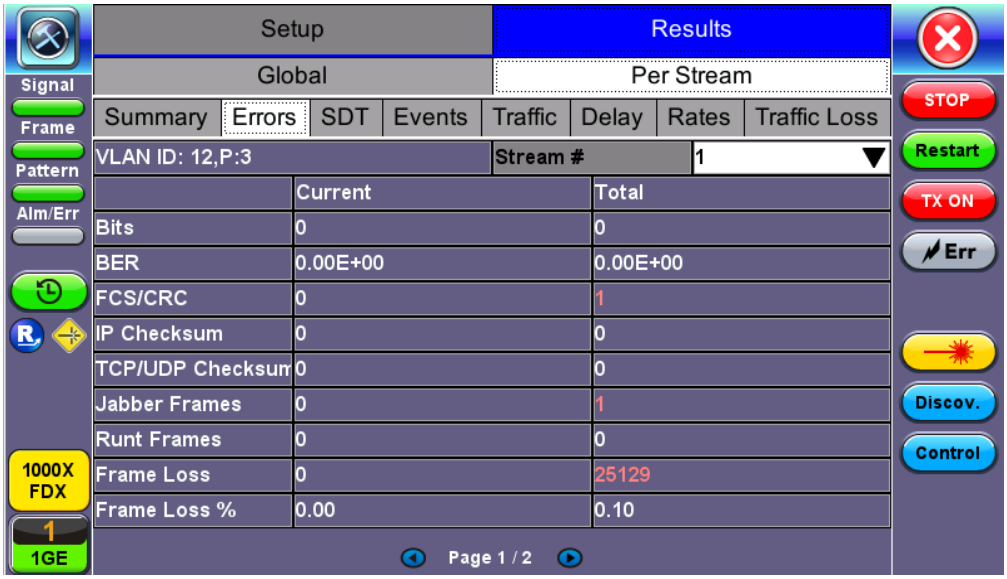
The **Per Stream Errors** screen displays the Current and Total error count of each stream.

- **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**



Throughput Results - Errors per Stream

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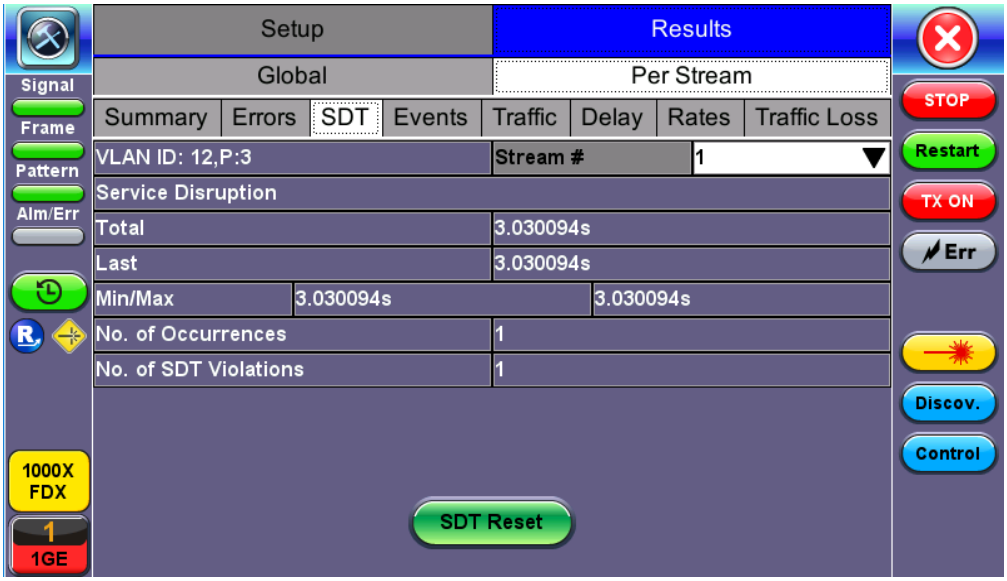
Service Disruption Test (SDT)

- **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.



SDT Per Stream Results

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

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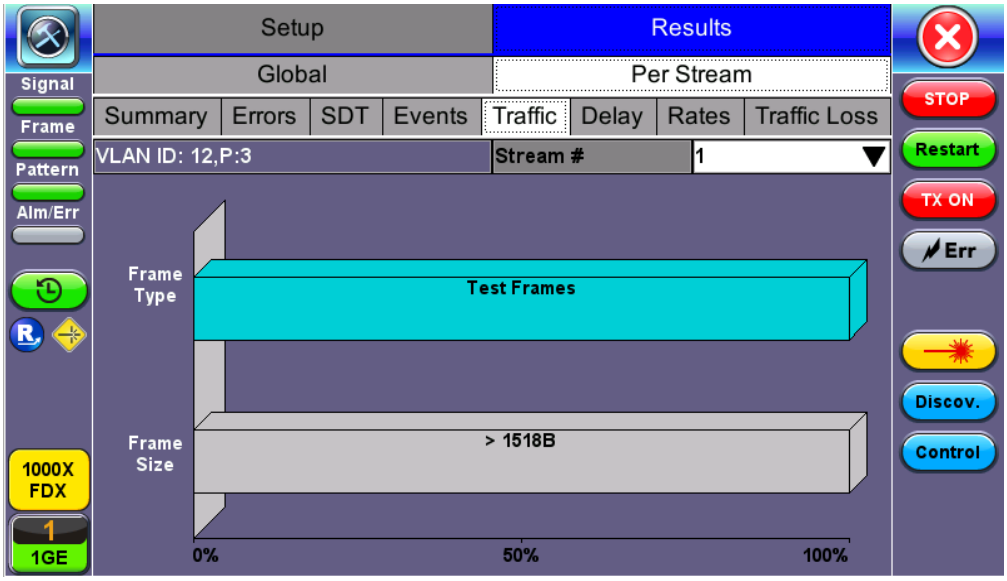
The **Per Stream Traffic** screen displays the frame type and frame size distribution pertaining to each stream.



Throughput Results - Traffic per Stream

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The **Per Stream Delay** screen displays the frame delay information pertaining to each stream. The Histogram shows the sampling points for the delay.

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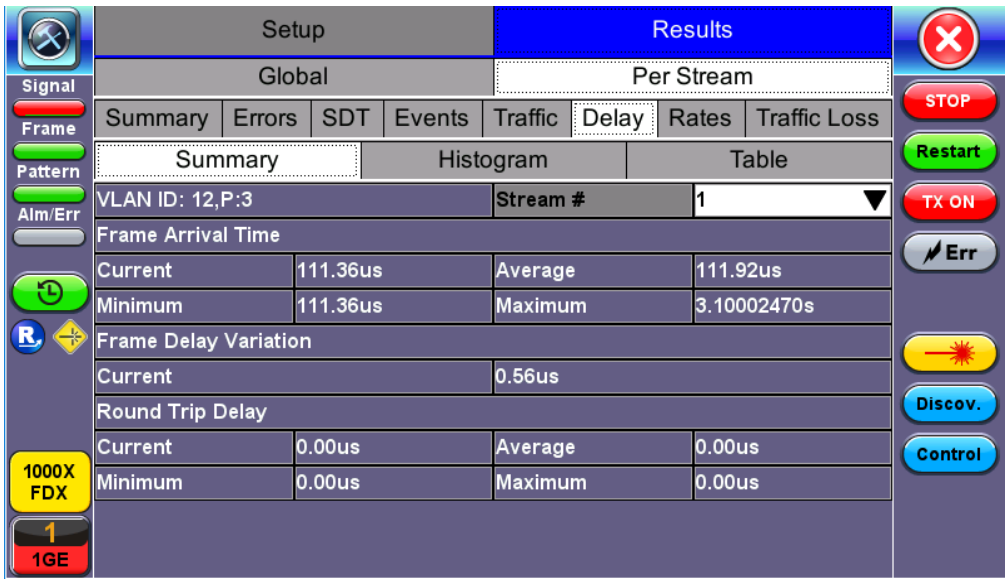
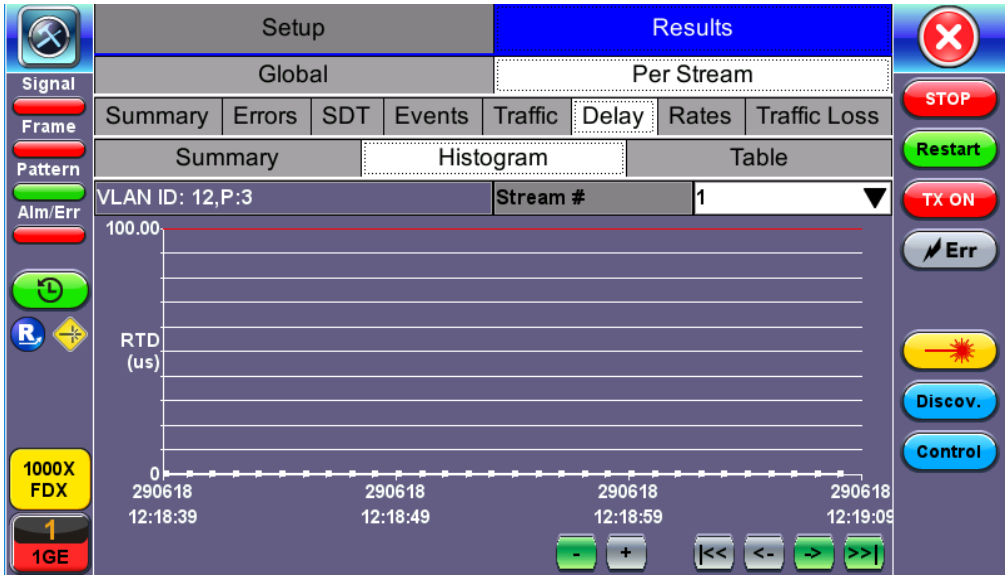
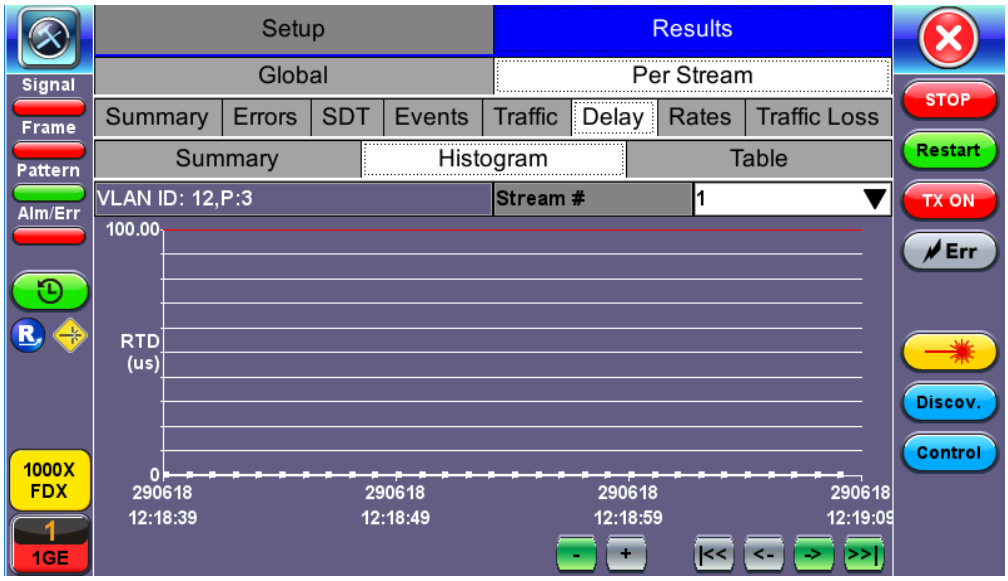
Round Trip Delay Results and Histogram



Delay per Stream - Summary



Round Trip Delay Histogram



Per Stream Delay Table

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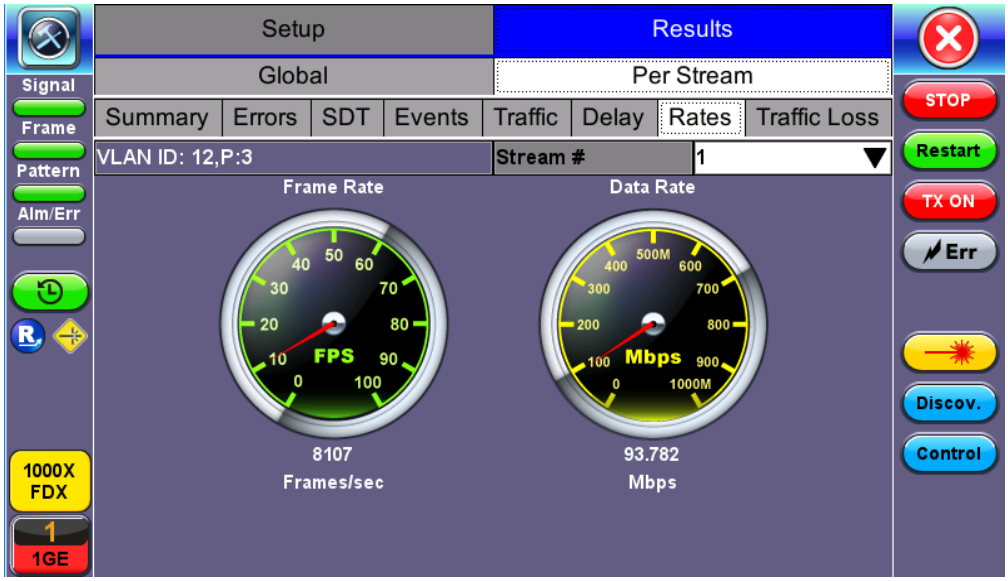
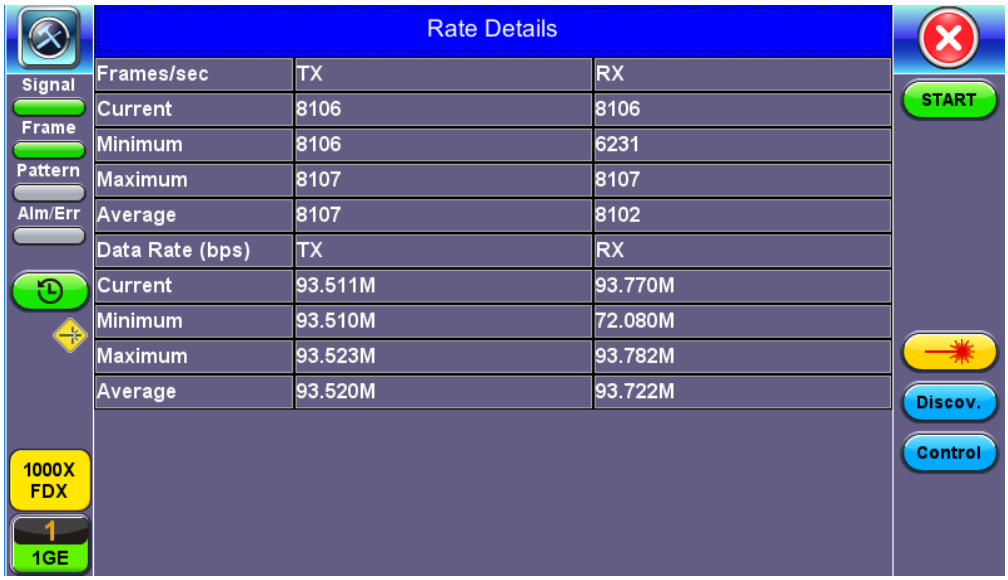
The **Per Stream Rate** screen displays the frame rate and data rate pertaining to each stream. Tap on either dial to see rate details.



Throughput Results - Rates per Stream



Frames/sec	TX	RX
Current	8106	8106
Minimum	8106	6231
Maximum	8107	8107
Average	8107	8102
Data Rate (bps)	TX	RX
Current	93.511M	93.770M
Minimum	93.510M	72.080M
Maximum	93.523M	93.782M
Average	93.520M	93.722M

Throughput Results - Rates per Stream (Rate Details)

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5.6.2.4 Saving Throughput (Multiple Streams) Results

Once the test has been stopped the results can be saved by pressing the **Save** key on the VePAL's keypad. The results will be saved and named automatically. Once the results are saved, the user may view or rename the results file by going to **Utilities** > **Files** > **Saved**. For more information on retrieving saved test results, refer to *File Management* in the **V150 Common Functions** manual for more information.

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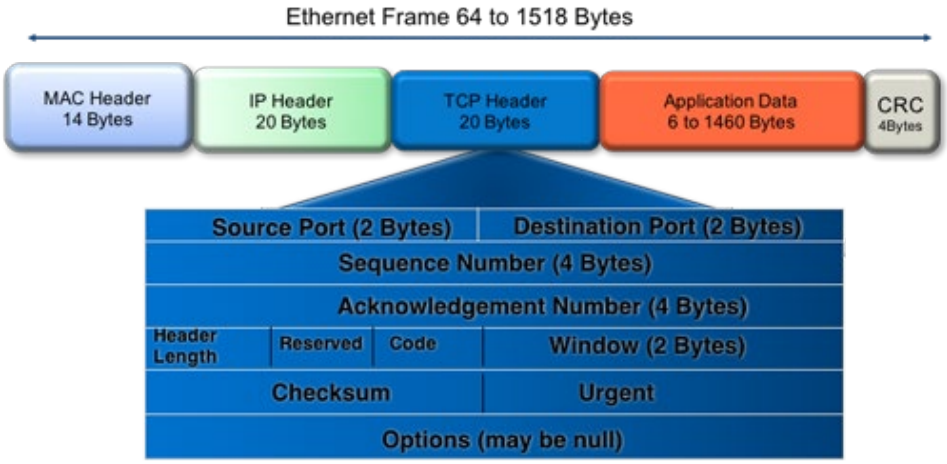
5.7 Layer 4+ Applications

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

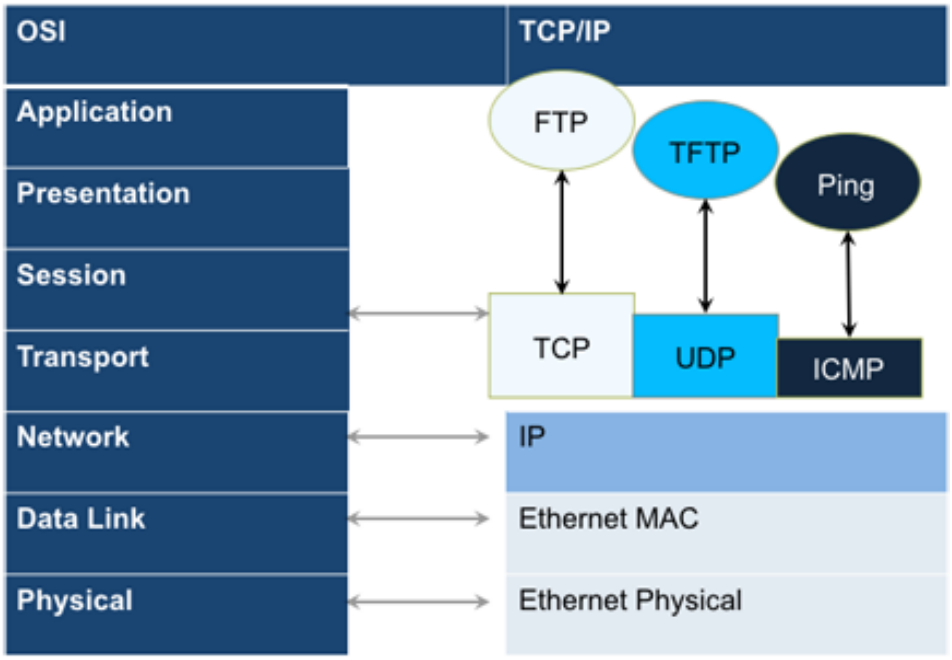
Fundamental TCP parameters are the ideal TCP Window Size and Throughput. The complete list of relevant measurements include:

- 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:

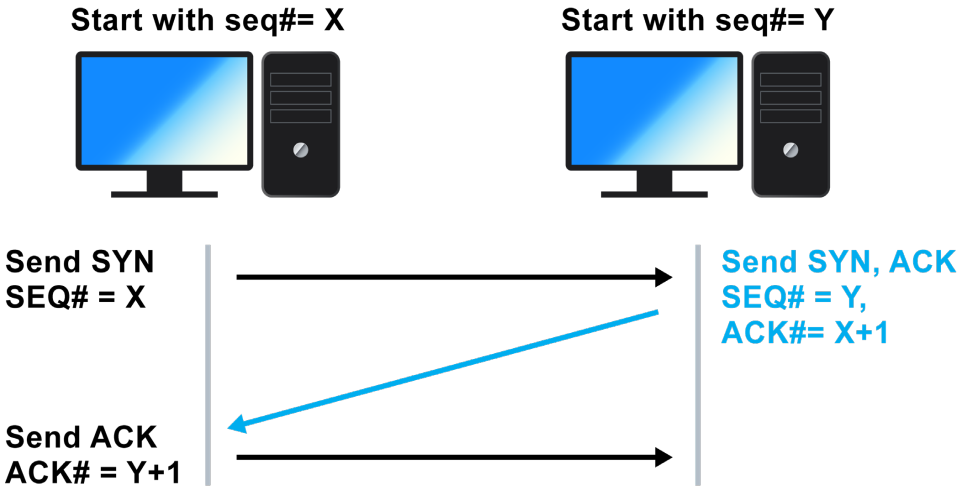
- End-to-end connection
- Multiplexing/Demultiplexing of separate sessions
- Flow control



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 the 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 acknowledgment



- **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.

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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 acknowledgment 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

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

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

TCP retransmission is done when TCP segments are lost during transmission or an acknowledgment 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 acknowledgment 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.
Note: *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

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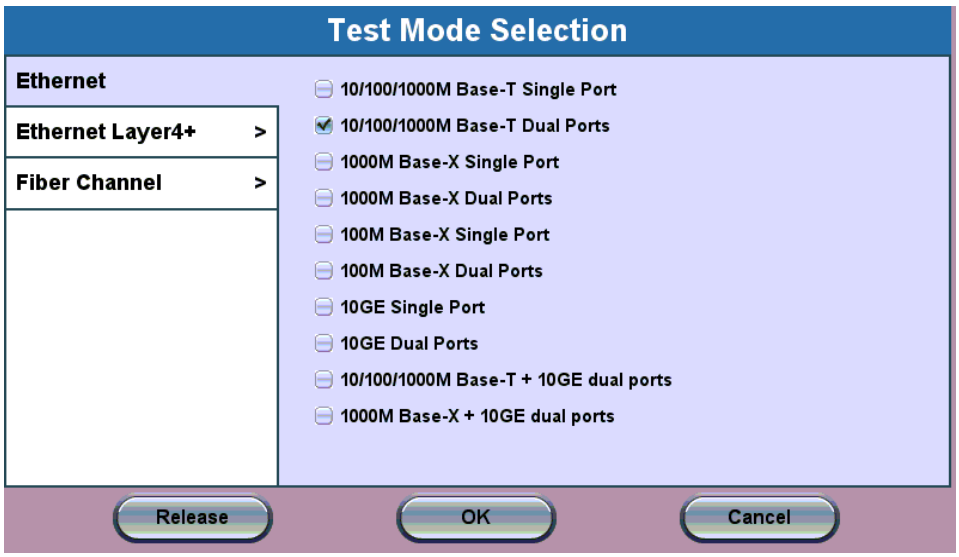
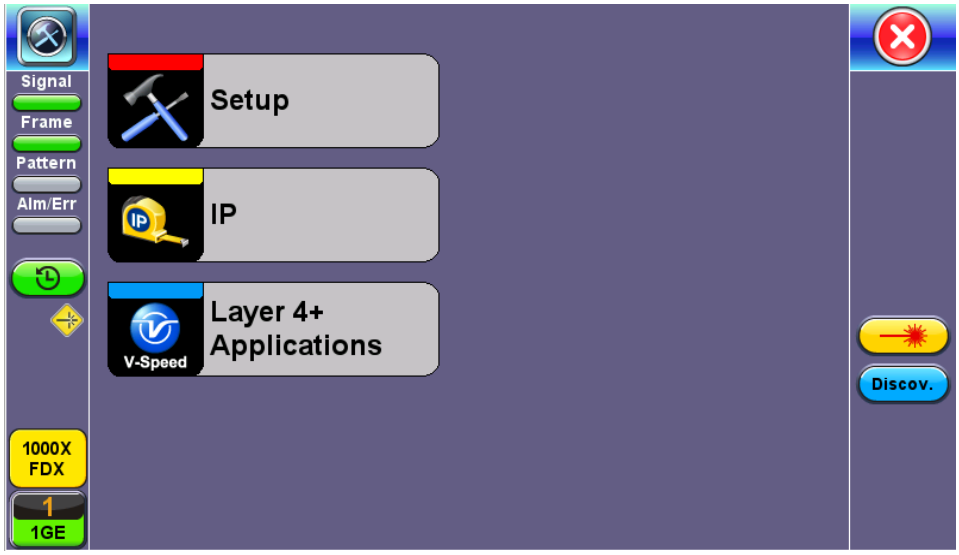
Layer 4+ Applications Configuration

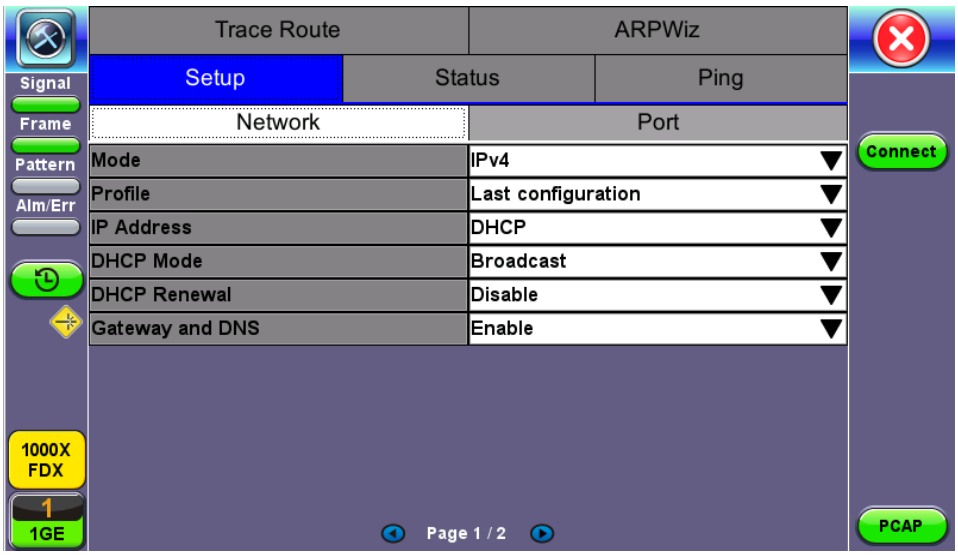
Before launching V-Perf, V-Test, or V-FTP tests, it's necessary establish an IP connection. For V-Perf testing, repeat these steps for both the far end and near end test sets.

1. Select a Layer 4 test application to launch from the Test Mode menu.



2. For testing on SFP ports, turn the **laser on**.
3. Tap the **IP** icon. 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**.





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

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

Saving Test Results

Test results can be saved to the File Server using the **Save** hardkey. Results can be retrieved via USB drive or remotely using the Web UI. Refer to *File Management* in the **V150 Common Functions** manual for more information on managing saved files.

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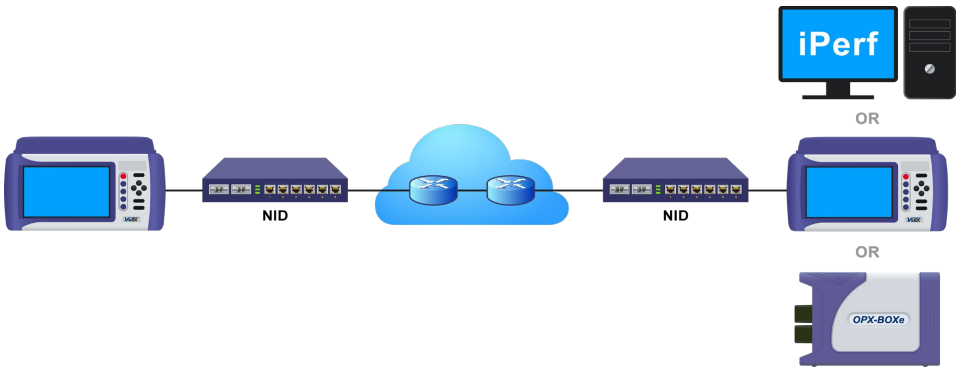
5.7.1 V-Perf

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.

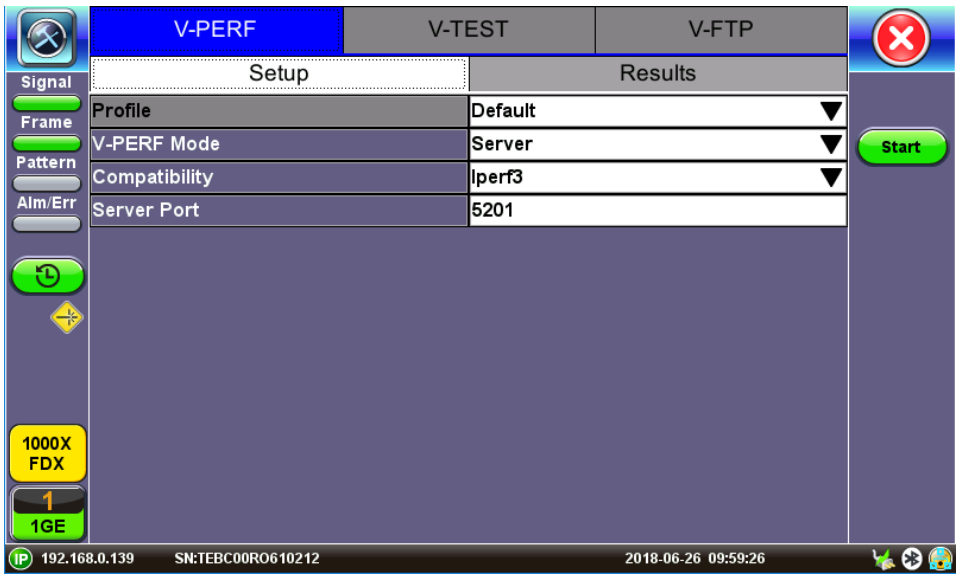
- Stateful TCP Test up to 1GE line rate
- TCP Client/Server and Bi-Directional modes
- Compatible with iPerf Client/Server
- MTU search per RFC4821
- Round Trip Time Measurement
- Configurable TCP Window
- Multi-Window size tests
- Measurements: TCP Throughput rate (min, max, average), Transfer file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



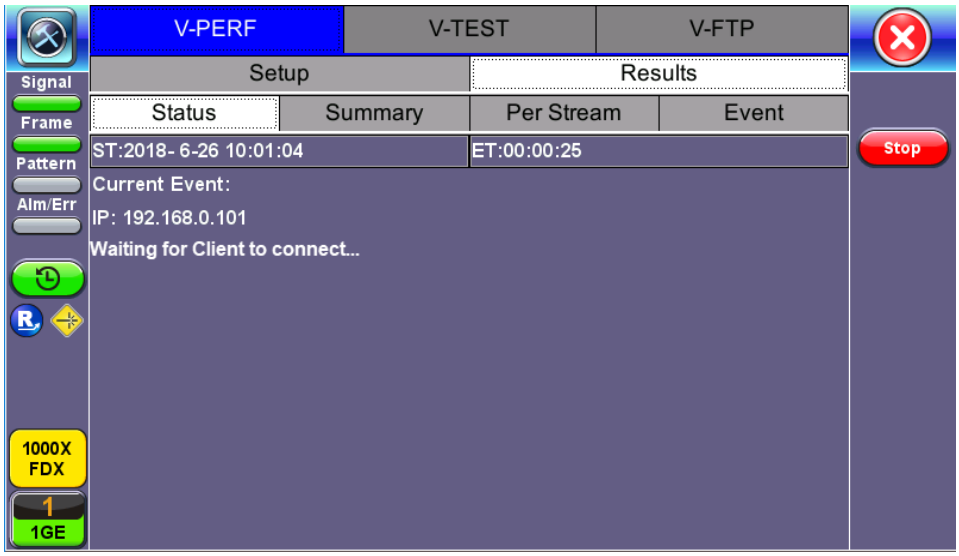
TCP Throughput Test Diagram

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**.

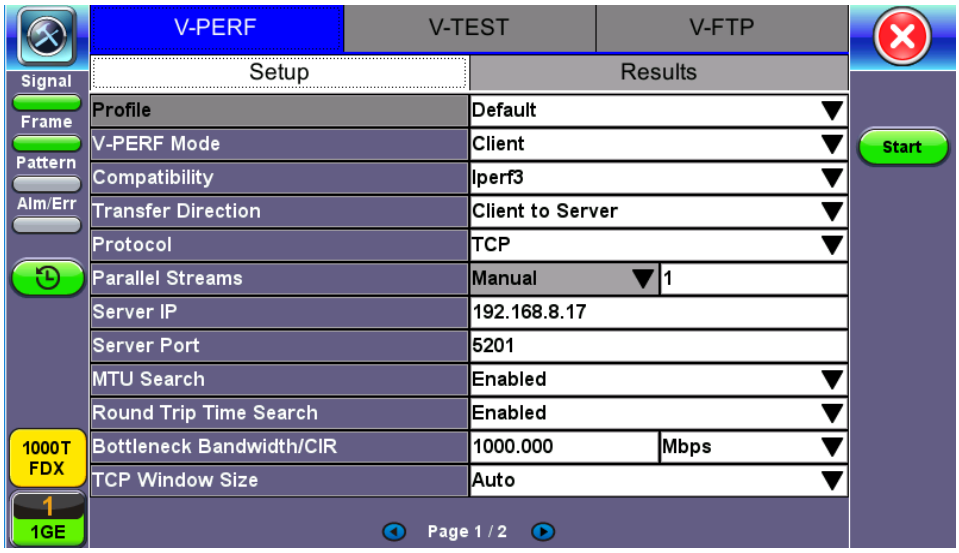


Test Set #1 - V-Perf Setup - Server



Test Set #1 After Pressing Start - Server Mode

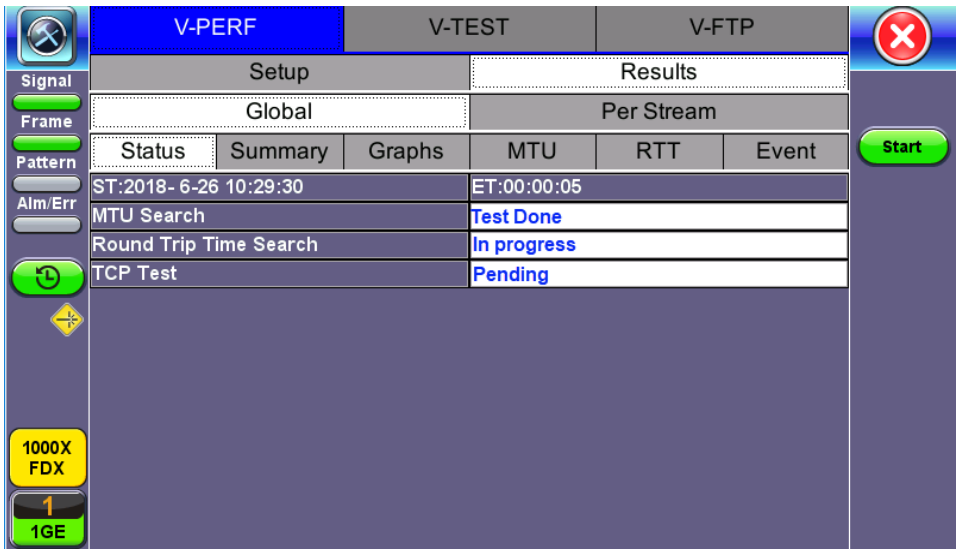
2. Set the other test set as a Client. Tap on Page 2 to configure the Throughput Test Mode type. MTU Search, Round Trip Time Search, Bottleneck Bandwidth, and Window Size options are also on Page 2.



Test Set #2 - V-Perf Setup - Client

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

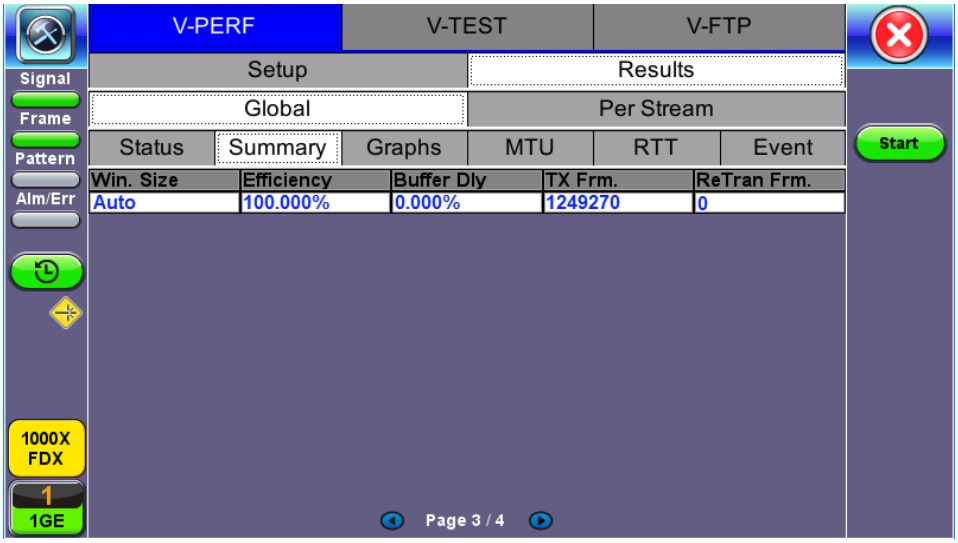
Status



Client - Results - Status

The Status tab displays test progress and pass/fail results for MTU Search, RTT Search, and TCP Test.

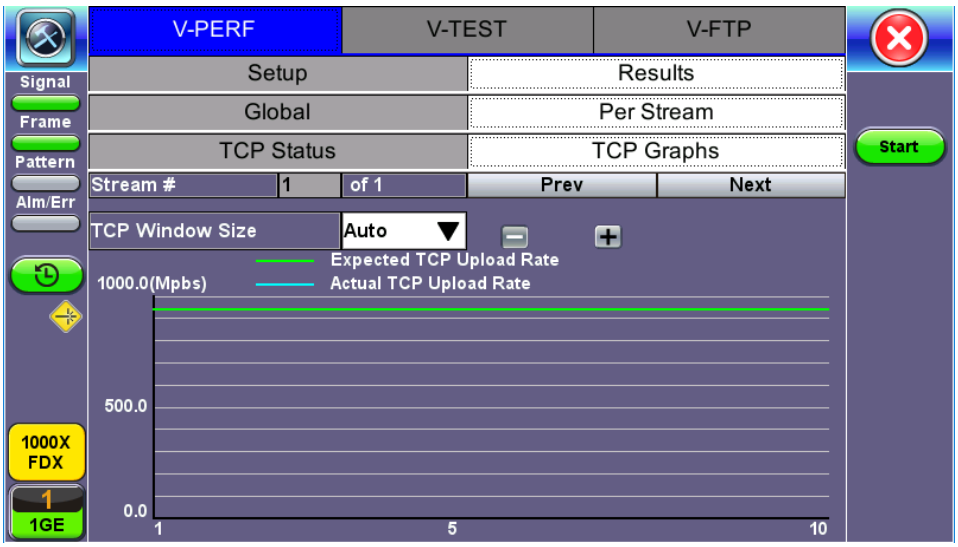
Summary



Client - Results - Summary

The Summary tab displays test progress and pass/fail results for RFC 6349 measurements.

Graphs



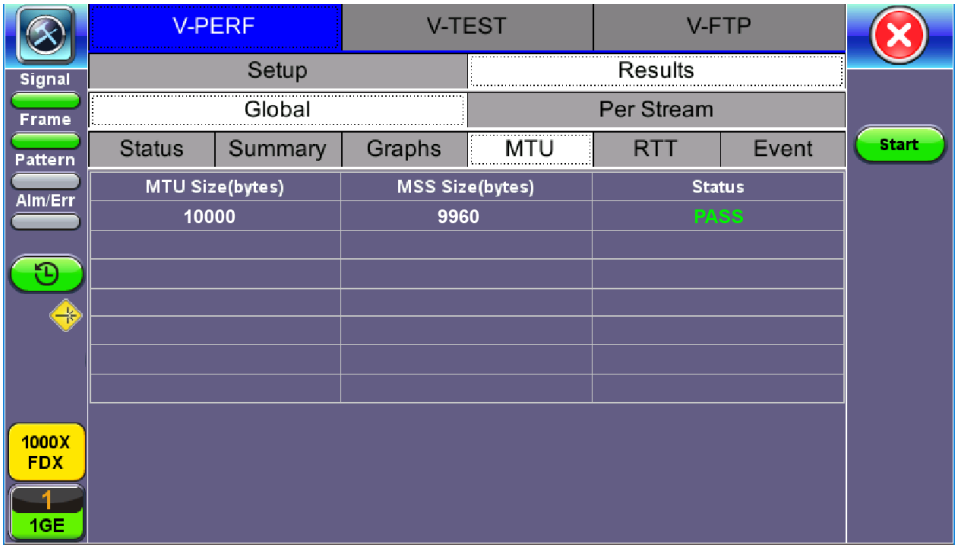
Client - Results - Per Stream TCP Graphs

Graphs compare the Expected TCP Upload Rate with the measured TCP rate for all tested window sizes.

Graph display options can be modified in the following ways:

- Change the Mbps range with the - and **+** buttons.
- Display all window sizes on one graph or individual window sizes using the drop-down menu.
- View the legend for each color-code line measurement with **Lines Color**.

MTU and **RTT** measurements are displayed in their respective tabs.



Client - Results - MTU

Event

The Event tab displays the time and date for each event that occurs during testing.

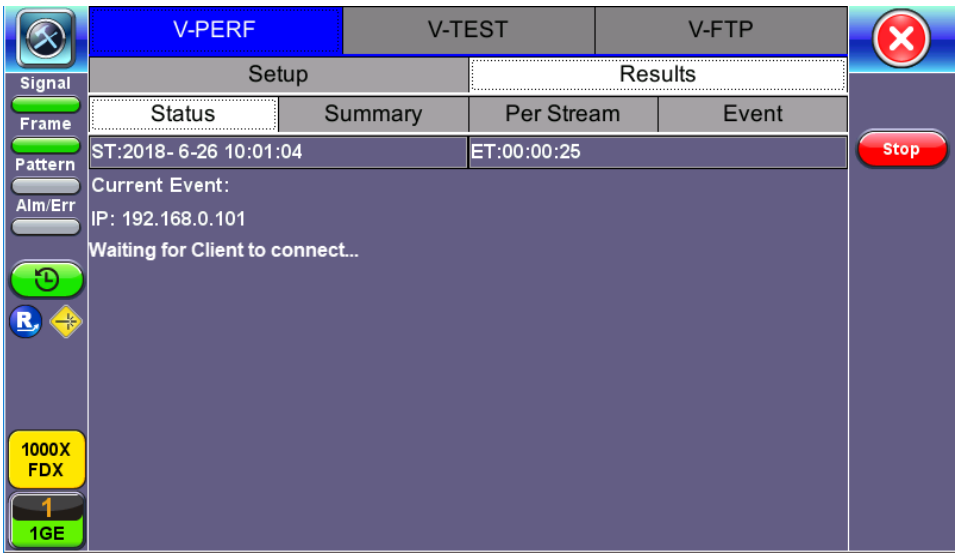
Per Stream results displays the TCP results for each stream.

TCP Status displays test progress and pass/fail results for RFC 6349 measurements identical to the Summary (Global Results) tab.

TCP Graphs displays per stream graphs identical to the Graphs (Global Results) tab.

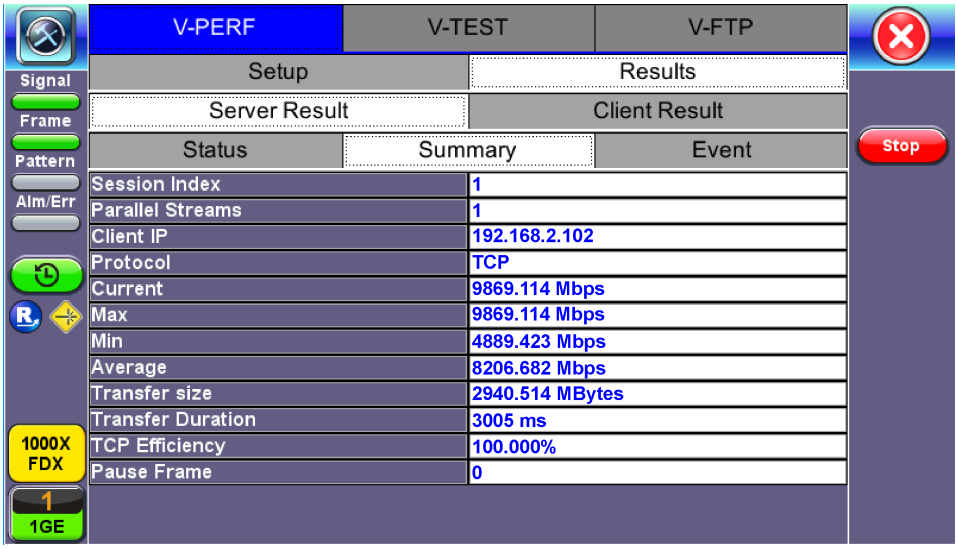
Server Results

The Status tab displays the Client IP and current test event.



Server - Results - Status

Summary displays information on the current session and the RFC-6349 key performance indicators. Summary results per stream are viewable in the **Per Stream** tab.



Server Results - Summary

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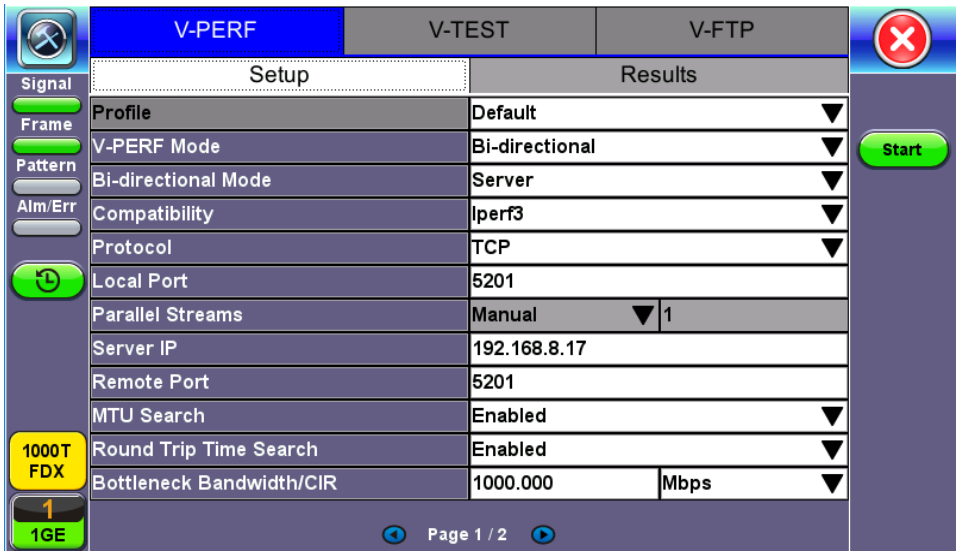
Bi-Directional Configuration and Results (VeEX Enhanced Testing Methodology Implementation)

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 - Bi-Directional Server 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**.

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5.7.2 V-Test

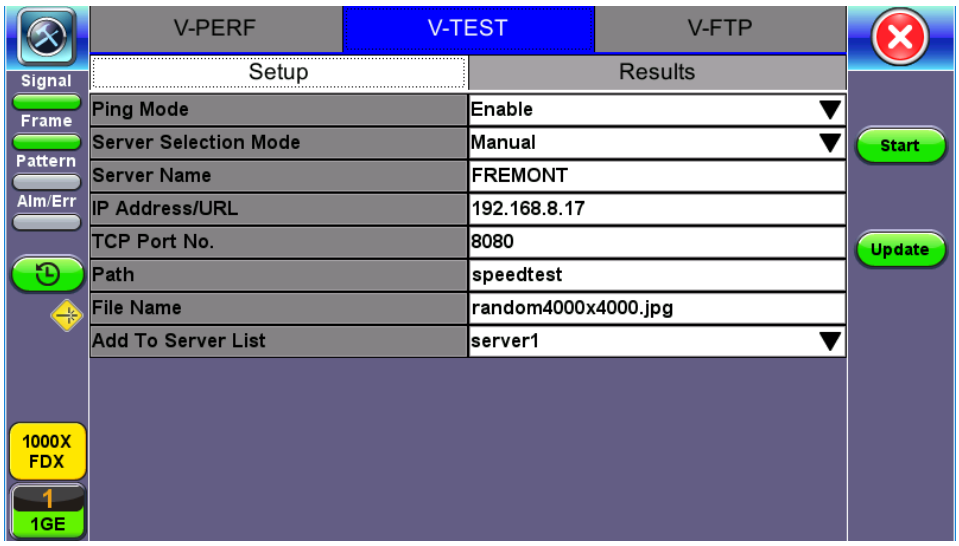
V-Test is a VeEX speed test. There are a few different server types that can be used to run the speed test. The following server types are available from **Server Selection Mode:**

- **VeEX Managed** (Server List): A list of servers maintained by VeEX initially provided by the user. Specific server names for each location are listed. This list can be automatically updated when connected to our server by tapping **Update List**.

- **Ookla Speedtest**
  - **Auto Mode**: Automatically Pings nearby Ookla servers. The download/upload tests are carried out to the server that has the fastest ping response.
  - **Manual Mode**: A list of all nearby servers is automatically displayed. The corresponding server ID and server information (URL/IP, location, and ISP) are also provided. Users can manually select any server from the list to carry out tests.

- **User Managed** *(Server List)*: Lists servers and server lists created via Manual mode. Options to modify or delete server lists are available under **Server List Manage**.

- **Manual** *(Server Configuration)*: Create a new server profile or server list. Enter the IP/URL of the server to test. If TCP port number 8080 is used, there is no need to enter a Path and File name. Port 8080 is used by Ookla netgauge servers, therefore the proper Speedtest handshaking will take place between the test set (client) and Ookla server. If TCP port number 80 is used, the correct Path and Filename need to be entered by the user.



Server Named *FREMONT* Can Be Added to *server1*

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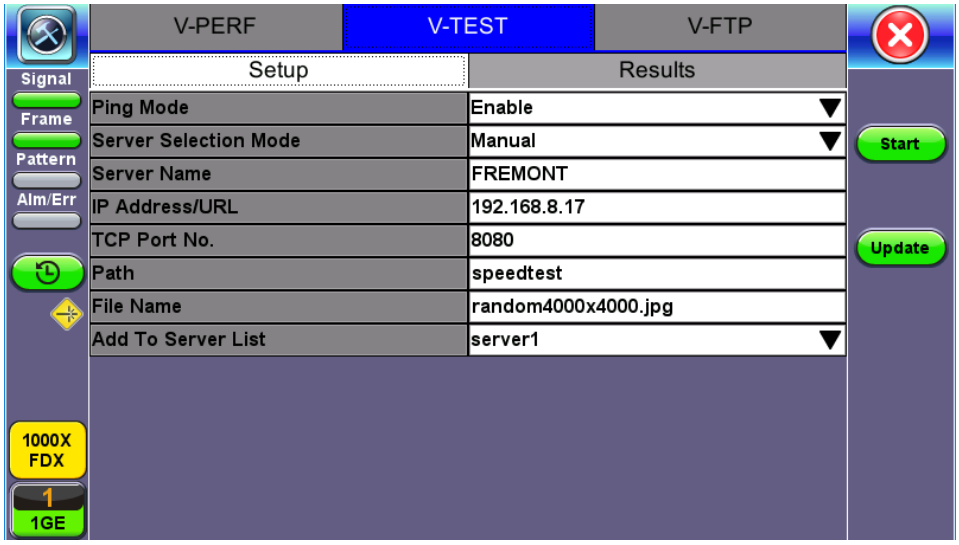
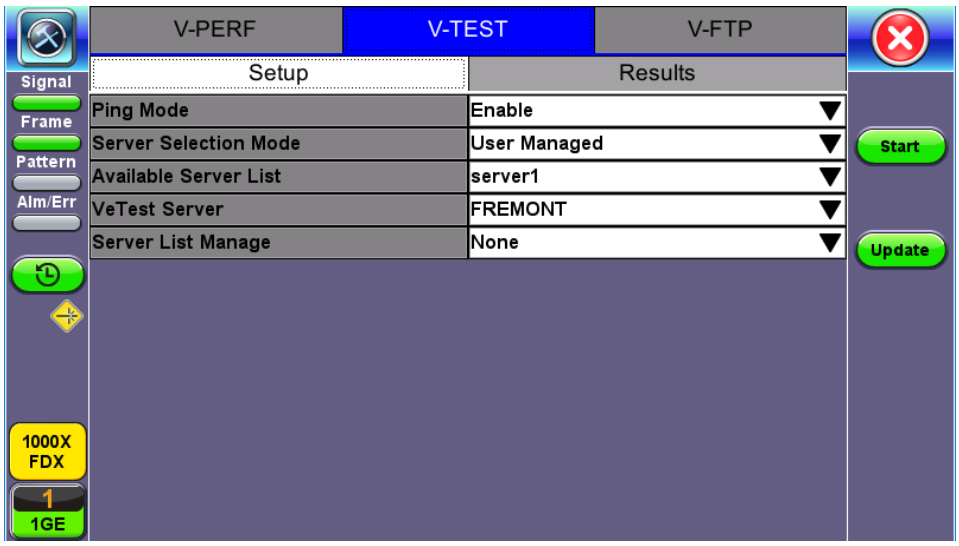
Creating New Server Profiles and Server Lists

1. From the Setup tab, select **Manual** from **Server Selection Mode**.
2. Tap **Update** and select a file to transfer. The **File Name** and **Path** will populate into the field. After setting up the new server profile, tap the **Add To Server List** drop-down menu. **Save as new** creates a new server list and adds the current server profile to that list. The option to add the profile to an existing server list is also available.



Server Named *FREMONT* Can Be Added to *server1*

3. Server profiles and server lists created from here are available in Server Selection Mode > User Managed.



***FREMONT* and *server1* appearing in User Managed**

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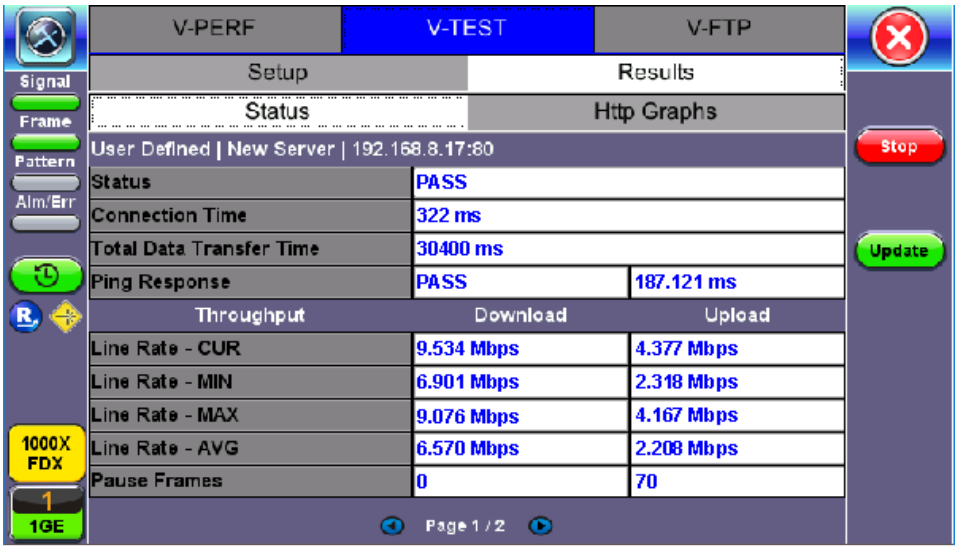
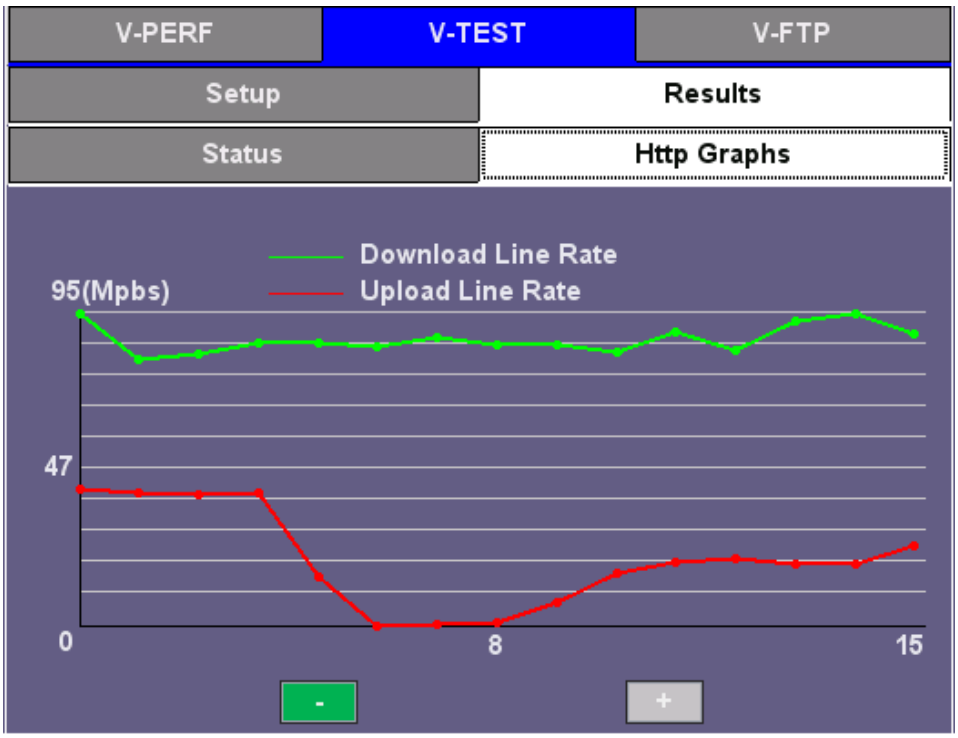
Starting a V-Test

Select a server from User Managed or VeEX Managed. Enabling Ping mode simultaneously runs a Ping test. Ping Response results will appear under the Results tab. Tap **Start** to initiate testing. The download test starts first, followed by the upload test.



V-Test - Results - Status



V-Test - Results - Http Graphs

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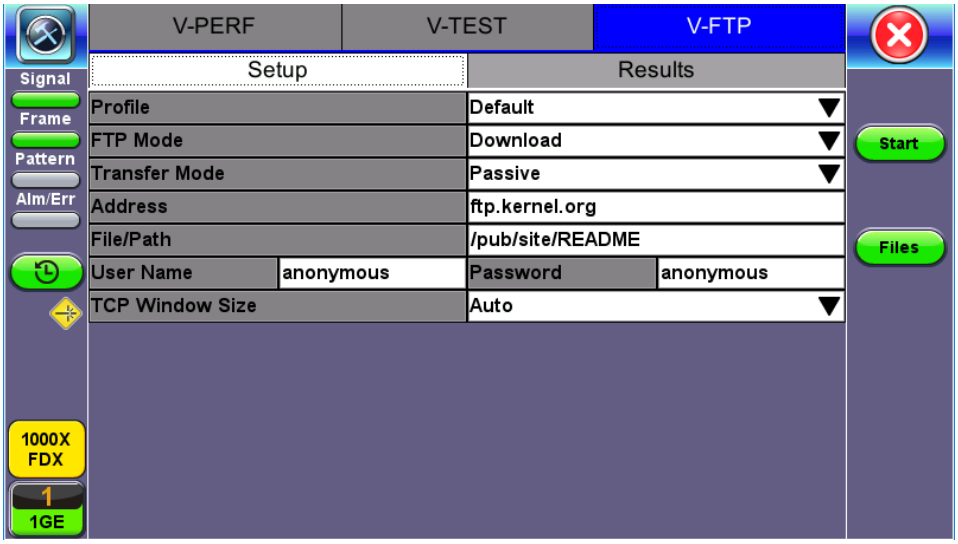
5.7.3 V-FTP

V-FTP is an FTP Connectivity/Download/Upload test all in one (wirespeed).

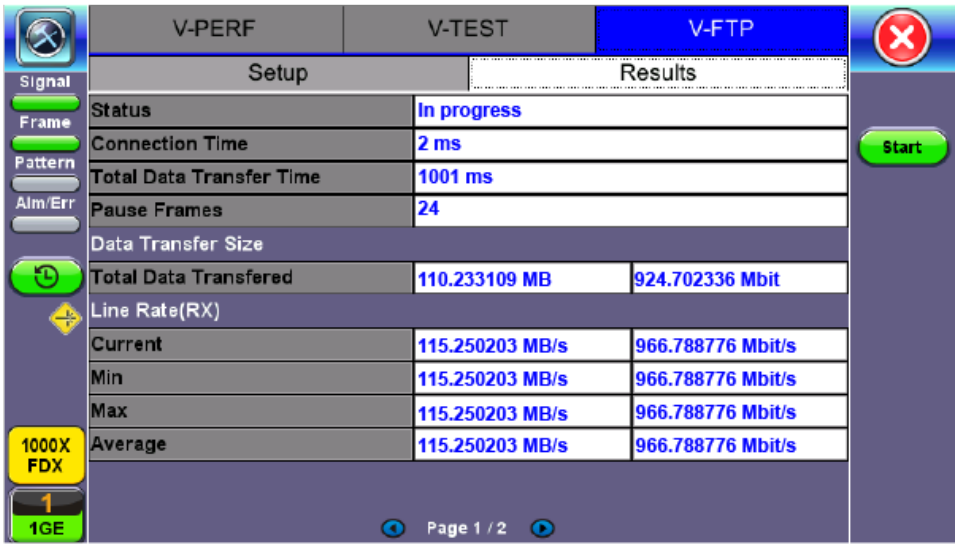
Running Download/Upload Tests

1. From Setup, select Download or Upload from **FTP Mode**. Enter the FTP server IP **Address, File/Path, User Name,** and **Password** information if setting up Download FTP Mode.
2. To open up the FTP file selection window and view all the files on the server, tap on the **List Files** button. Select a file to transfer and tap **Start** to run the test.

When finished with setup, press **Start**.



V-FTP - Setup - Download



V-FTP - Download - Results

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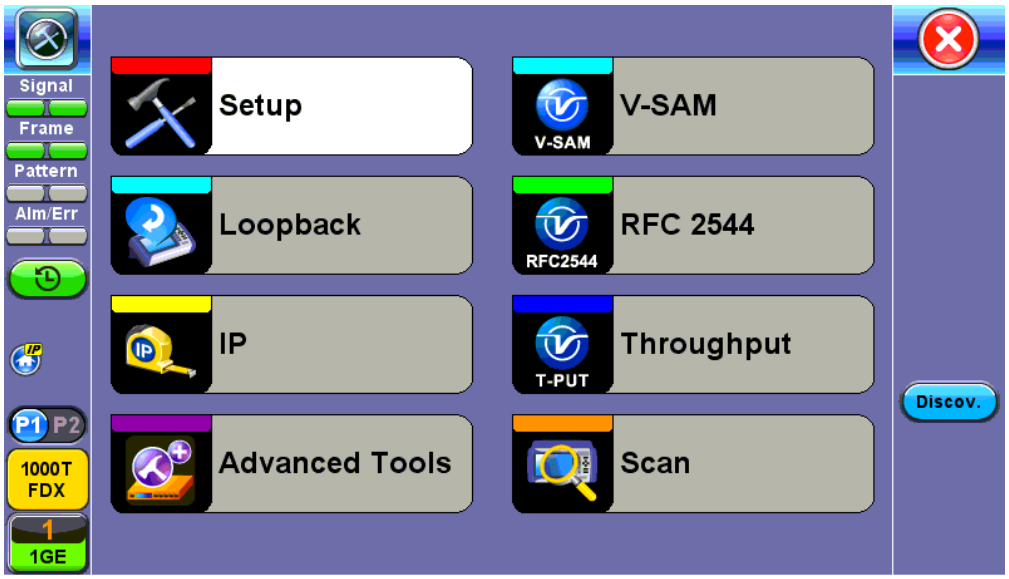
5.8 SyncE



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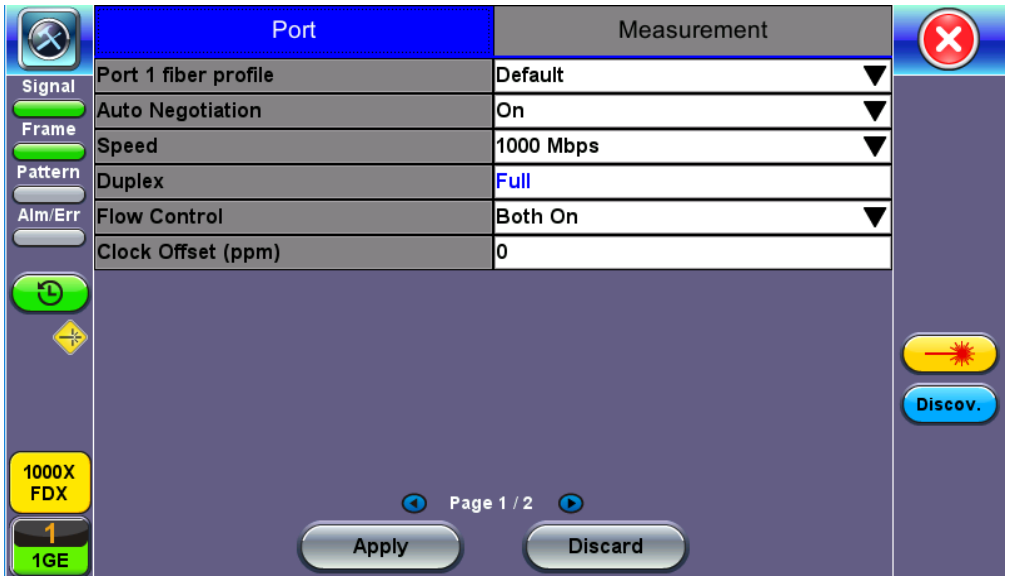
5.8.1 SyncE Setup

Port (Test Port selection)

Prior to starting the SyncE operation, the selected test port must be connected to a network that supports SyncE timing synchronization. Port selections include 100/1000T and 100/1000BaseX. After setting up the port, IP connection is not required for SyncE tests. Please see section Port Setup for port configuration instructions.



Port Status

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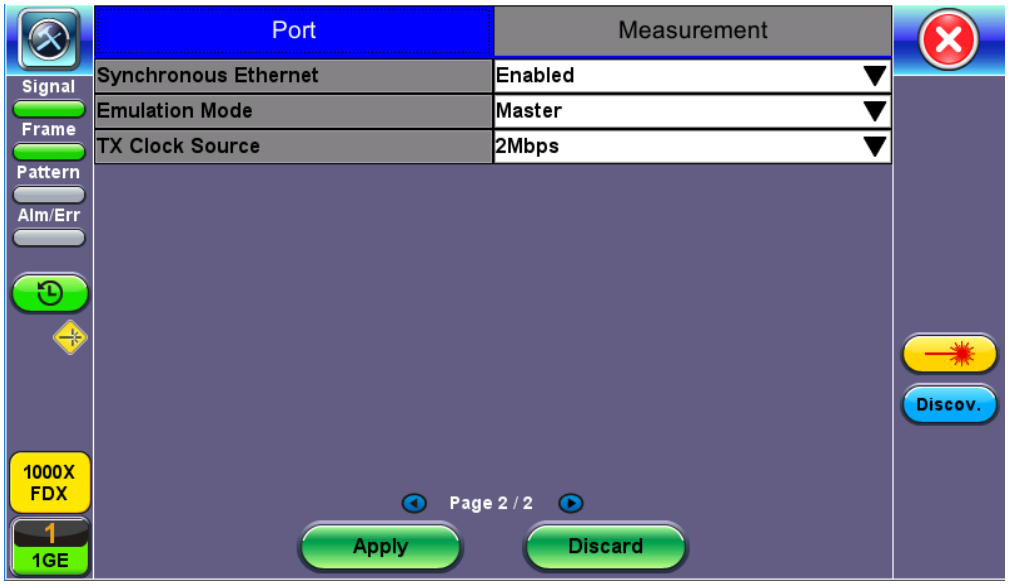
Port Page 2 - Mode Selection

Master and Slave Mode

Master Mode emulates a SyncE Master clock device and slave mode emulates a SyncE Slave clock device. Both modes operate out of the Ethernet test port (100/1000BaseT, 100/1000BaseX, or 10GE) and can use an internal or external reference clock.



SyncE Master-Emulation Mode

- **Synchronous Ethernet:** Enabled or Disabled.
- **Emulation Mode**: Select Master or Slave emulation mode. In Master mode, the unit uses the TX Clock Source reference clock to provide SyncE clock on the Ethernet interface (10/100/1000T and 100/1000BaseX or 10GE port). In Slave mode, the unit recovers SyncE clock from the Ethernet interface (10/100/1000T and 100/1000BaseX or 10GE port).
- **TX Clock Source** (Master Mode): Select between an internal or external clock source. This clock is used as a reference clock for SyncE Master operation.
- **Measurement Clock Reference** (Slave Mode): Select between an internal or external clock source. This clock is used as a reference clock for SyncE Master and for SyncE Slave Wander Measurement.
  Possible Internal Clock sources: Internal Clock (+/-3.5ppm accuracy), Internal GPS 1 PPS (Requires GPS option and Antenna), Internal Atomic 1 PPS (Requires High Precision Atomic Clock option).
- Possible external clock sources: 1.5444MHz,1.544Mbps, 2 MHz, 2Mbps (E1 signal), 10MHz, 25MHz, 125MHz or External1 pps. The external clock source is connected to the SMA port on each Test Module. This port is marked CLK on the connector panel.
  Note: *Avoid using rigid BNC-to-SMA adapters to prevent any stress on the test set's connector. Flexible adapters or cables are recommended.*
- **Recovered Clock Output**: The reference clock used by the SyncE master or slave can be regenerated out of the PDH TX port (marked Tx on the connector panel) with a different clock format in order to synchronize other network elements. In Slave mode the Reference Clock Output is the regenerated clock recovered by the SyncE slave.
  The clock can be formatted to: 2Mbps (E1 signal), 2MHz, 10MHz, 25MHz, 125MHz, 1PPS and None.
- If 2Mbps clock is selected from Recovered Clock Output, then the following parameters need to be set:
  - **Line Code:** HDB3 or AMI
  - **Framing:** Unframed, PCM31, PCM31C, PCM30, or PCM30C
  - **PRBS Pattern**
  - **Invert**
- **Offset(ns)** (only for 1 PPS Recovered Clock Output)

Press **Apply** once all the parameters are set.

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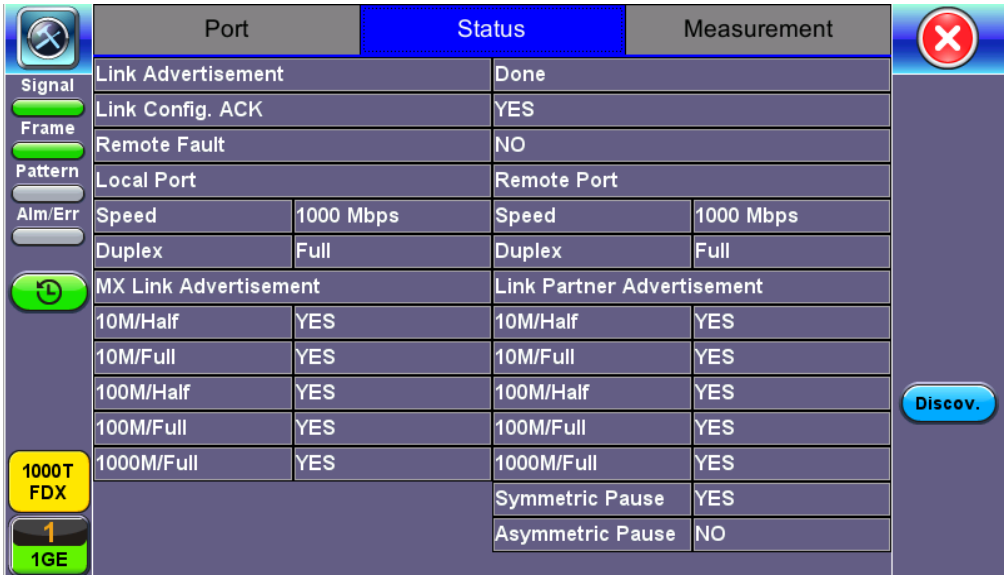
Status



Status

Indicator Symbols

An M or S indicates that the test set is in Master or Slave Mode. A green icon indicates a successful Slave to Master connection. If the icon is solid red, there may be an issue with setup and the test will not work.

Symbol	Description
	Test set is in Master mode.
	Test set is in Slave mode.

Master and Slave Clock IDs get populated once the test is started.

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5.8.2 SyncE Wander Measurements (Slave Mode only, Optional)

SyncE slave precision timing protocol may be available on the test set with purchase of an optional wander measurement license, adding verification of stability (wander) and accuracy.

Besides measuring time interval error (TIE) on datalink interfaces, other complementary wander measurement and analysis applications may also be offered by the test set (all optional), along with an off-line MTIE/TDEV analysis software for Windows® PC. The last three are required for post-analysis and standard masks fitting (Pass/Fail) evaluations.

- Clock Wander & Phase Measurements for physical clock interfaces (1.544, 2.048, 10 MHz and 1PPS)
- Wander TIE logging and real-time export to USB
- Built-in MTIE/TDEV Wander Analysis
- VeEX MTIE/TDEV Wander Analysis PC software

Recovered Clock Wander Measurements

In 1GE/10GE test mode, the Wander Measurement function may be found under the Advanced Tools menu, provided that SyncE slave mode is enabled.

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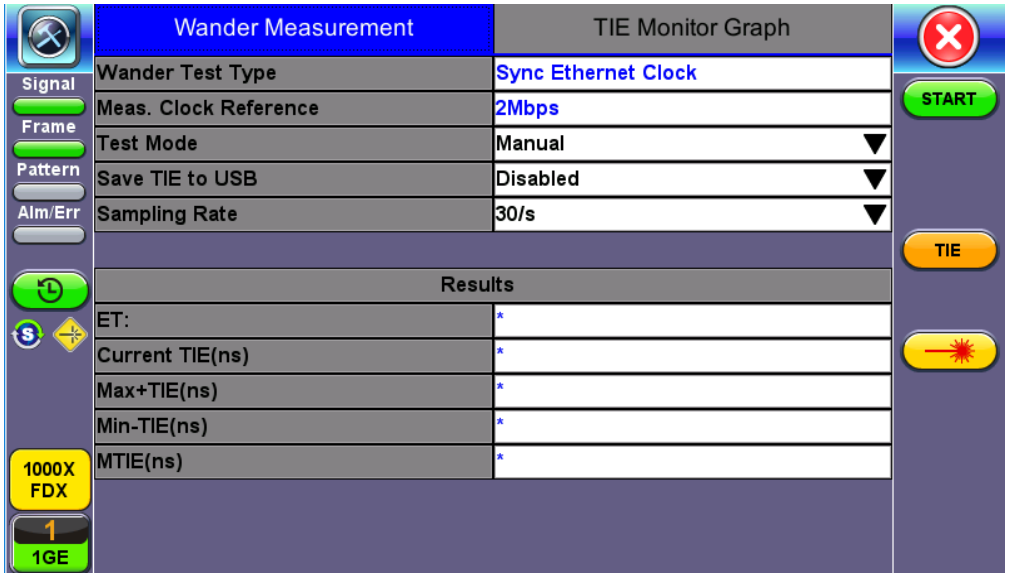
5.8.2.1 Setup



SyncE Wander Measurements Setup

- **Measurement Clock Reference** reflects the selection chosen from Port setup.
- **Test Mode:** Select between Manual start/stop and Timed measurements. If Timed is selected, users can set the length of the test in seconds, minutes, hours or days. Once the selected time has elapsed the test automatically stops.
- **Save TIE** can be turned ON to write all wander measurements to a FAT32 USB Memory stick in real time, to be analyzed later on.
- **Sampling Rate** (samples per second) can be set to 1/s, 5/s, 10/s or 30/s, depending on the application. 30/s is recommended.
- File Name identifies the new folder in which all configuration and measurement data will be stored. This folder will be created in the root of the memory stick.
- Tap **Start** to initiate the measurements and data logging.
- Tap on the Stop button to force the measurement and data logging to stop. This will also stop a Timed test, even if the total time has not finished yet.
- After stopping the test, and if the built-in MTIE/TDEV option is enabled, users can also tap on the Analysis button to view the TIE graph and perform the MTIE/TDE analysis on the recorded TIE data. Refer to the following sections for more details.
- Users may also be allowed to perform run-time MTIE/TDEV analysis with all the data collected up to that point, without having to stop an ongoing long-term wander test.

Note: *Do not remove the USB memory stick while the wander test is running.*

Note: *The wander tests will automatically stop if either of the signals used as reference clock or recovered clock (test signal) have significant levels of impairments, are lost, or disconnected.*

Press **Stop** to terminate the test. If Save TIE to USB is set to ON, then remove the USB memory stick from the test set, bring it to a computer, and open it with the VeEX Wander Analysis PC software. For further MTIE, TDEV, and masks analysis (refer to the MTIE and TDEV Analysis section).

Both, Wander Analysis and MTIE / TDEV Post Analysis are optional features.

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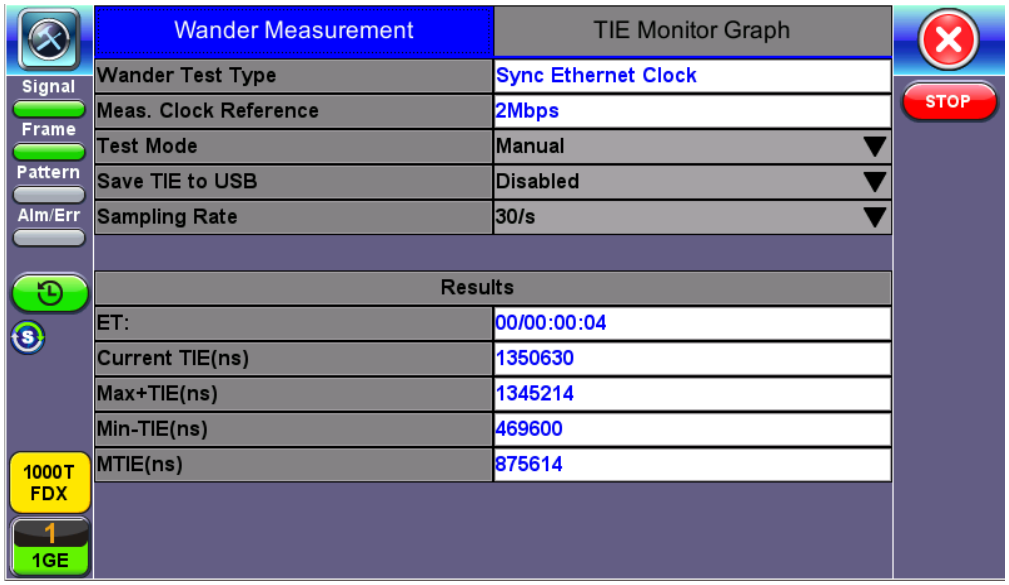
5.8.2.2 Results



SyncE Wander Measurement Results

Numerical counters are provided to let users know the status of the test, with a basic summary of the TIE information.

- **Current TIE:** Shows the current time interval error measurement.
- **Max TIE:** Maximum positive TIE value that has been recorded since the beginning of the test.
- **Min TIE:** lowest or negative TIE value that has been recorded since the beginning of the test. Since wander measurements always start with a TIE=0, then the minimum value can only be zero or negative.
- **MTIE:** Denotes the maximum span of TIE values recorded since the beginning of the test. In this summary, MTIE = MaxTIE – MinTIE. It gives users an idea of how much the signal under test is wandering.
- A real-time **TIE monitor graph** may also be included in the summary screen for users to see the TIE for the last 7 or 10 minutes of the ongoing test.

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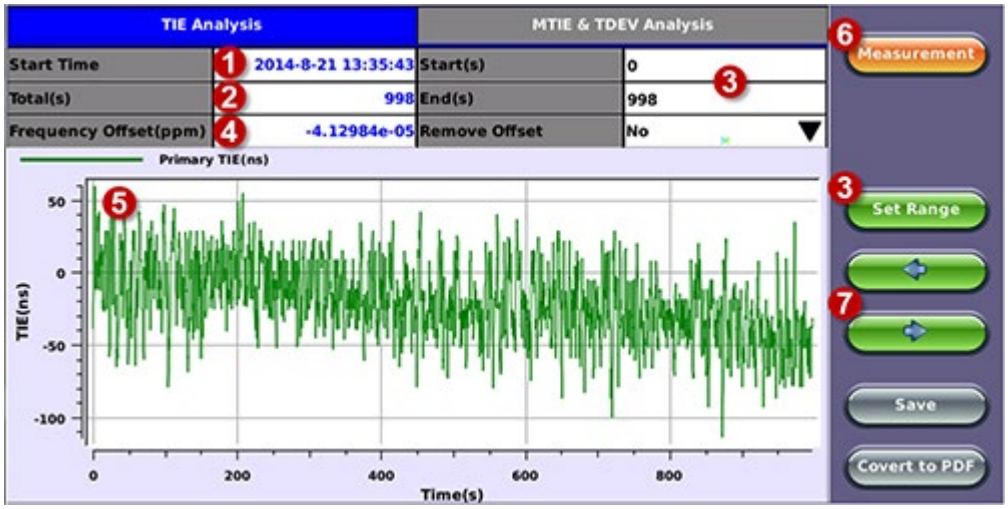
5.8.2.3 Built-in MTIE & TDEV Analysis (Optional)

This option enables the test set to analyze up to 72 hours' worth of wander measurement data and compare it against standard masks for a PASS/FAIL assessment, without the need for a PC. The test set may allow the analysis to be performed while the test is still running for run-time verification. Longer test take a lot longer to be analyzed, so the VeEX Wander Analysis PC Software is recommended for tests longer than 24 hours. Tap on **TIE** to view TIE, MTIE and TDEV Analysis.

Features:

- Provides further post-processing of clock stability data, such as MTIE and TDEV
- Frequency offset calculation and removal for relative TIE analysis
- Standard MTIE and TDEV masks can be selected
- MTIE and TDEV results and mask export to CSV for further report generation using spreadsheets
- Direct PDF report generation to USB

TIE Results

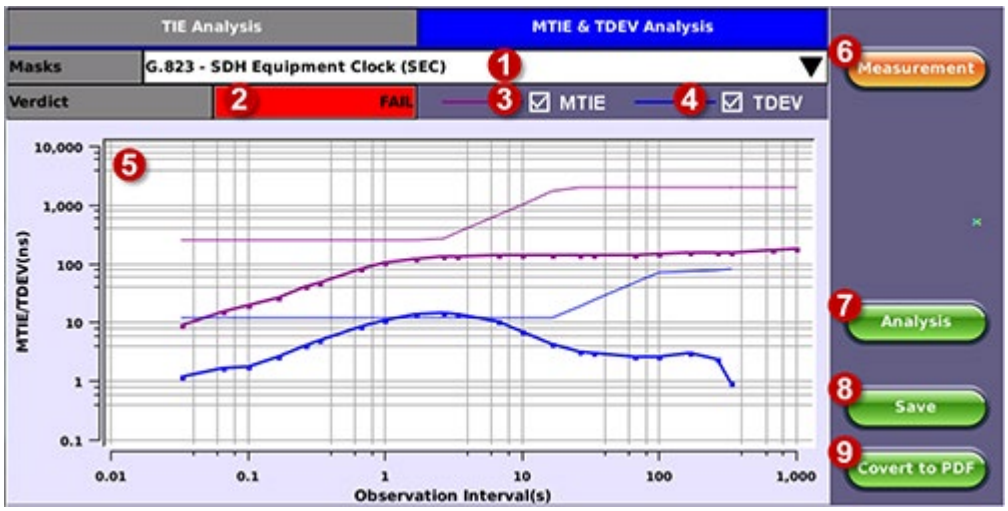


TIE Results

1. Date and Time stamp indicating when the test was started
2. Total of seconds recorded during the test
3. Beginning and end of the data set to be analyzed and displayed in the graph (5) below. Tap in the Start and/or End field and enter the desired time limits, then press the Set Range button to apply these changes.
4. Based on all the TIE measurements captured, the test set automatically calculates any small difference in frequency between the signal under test and the reference clock. Once the frequency difference is known, users can remove it to perform Relative TIE measurements. The offset removal tool is important for field tests when the local reference clock used is highly accurate and stable but not traceable to the PRC in the network core (e.g. a portable frequency reference). Even if the frequency of the local reference is a few ppb (parts per billion) different than the PRC, it can still be used for wander measurements, as long as it is highly stable, because the Offset Removal feature can mathematically remove the know difference and make it as if a traceable reference had been used. Once removed, user can perform relative MTIE (or MRTIE) and TDEV analysis.
5. Auto-scale TIE graph, based on the limits set.
6. Press the Measurement button to return to the current wander measurements
7. Fine cursor controls. User can use the stylus to tap on the screen to position the cursor and then use these arrow buttons to position the cursor and read specific TIE values. The rubber cursor keys can also be used to move the cursor.

***Save** and **Convert to PDF** options may not be available on all software versions.*

MTIE & TDEV Pass/Fail Analysis

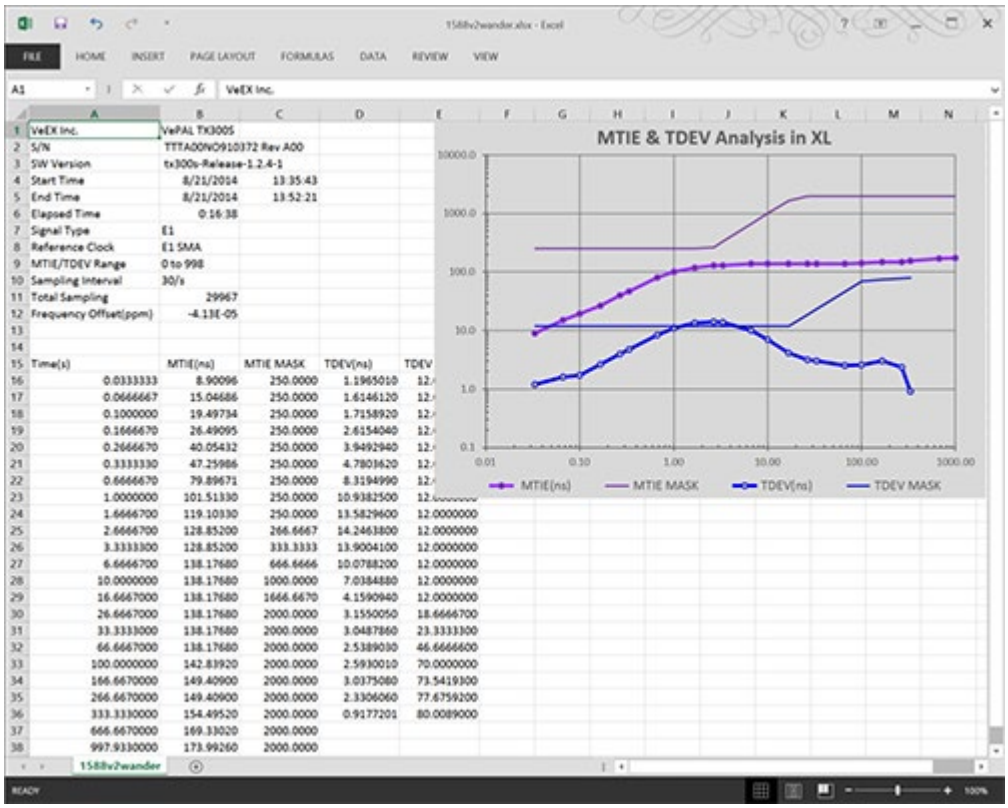


MTIE Results

1. Standard MTIE & TDEV masks selection
2. Pass or Fail indicator, evaluated depending on selected masks

3. MTIE line color indicator and Enable/Disable check box
4. TDEV line color indicator and Enable/Disable check box
5. MTIE & TDEV logarithmic graphs and standard masks
6. Press this button to return to the wander measurements screen
7. Once the mask has been selected, press Analysis to run the MTIE and/or TDEV calculations. Depending on the number of samples collected, this calculation could take a few minutes.
8. Save the MTIE, TDEV and mask calculations in CSV format to a USB Memory stick. The graph can be recreated using a spreadsheet program like Microsoft® Excel, printed as a report or shared via email or any other electronic media
9. Generates a MTIE and TDEV report in PDF format to a USB Memory stick.

MTIE & TDEV Results Exported to CSV



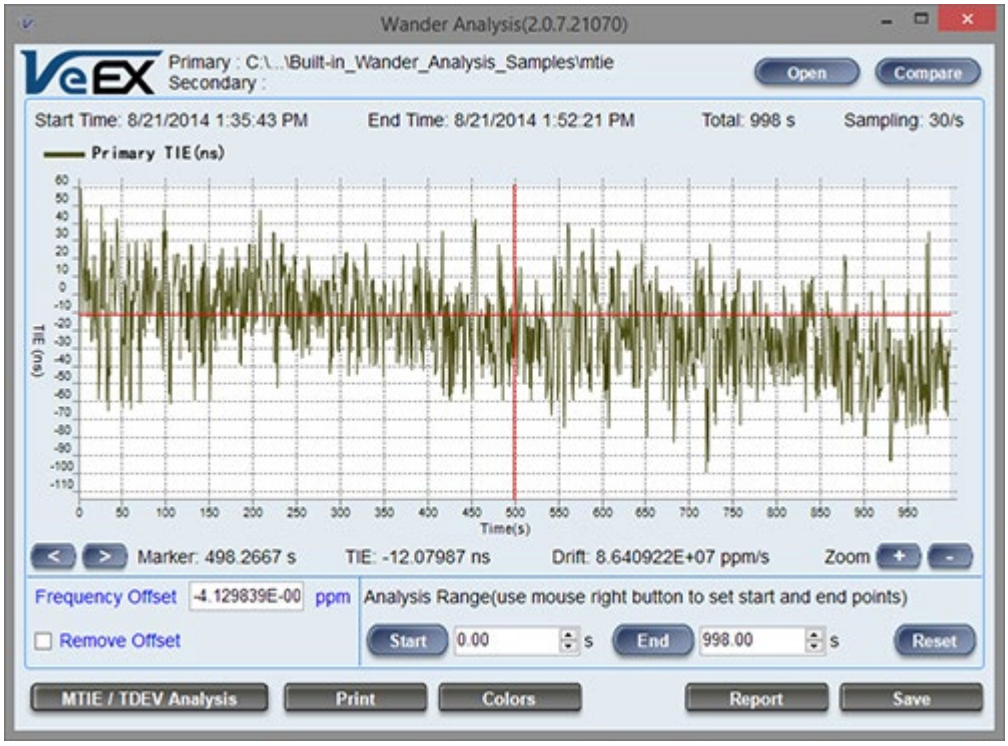
5.8.2.4 VeEX MTIE/TDEV Wander Analysis PC Software

- Provides further post-processing of clock stability data, such as MTIE and TDEV for long-term tests
- Frequency offset calculation and removal for relative TIE analysis
- Standard and user-programmable masks
- PDF report generation
- Conversion of TIE data file, fro VeEX's proprietary format to an open CSV format
- Fully resizable window, to accommodate any screen size and provide detailed zoom levels
- Compact stand-alone Windows® software. It can be carried in the same USB memory as the TIE data. No installation is necessary.

- For added convenience, the software doesn't need installation and can be stored on and run from the same USB stick where the wander log files are being stored.

5.8.2.5 TIE Measurement Results

Click on the Open button to load the desired MTIE of Phase file and see the TIE behavior on the screen. Use the Compare button to load a secondary trace for comparison purposes. Up to two traces can be displayed and analyzed simultaneously.



Click on the MTIE/TDEV Analysis button to go to the wander analysis function.

5.8.2.6 MTIE & TDEV Analysis

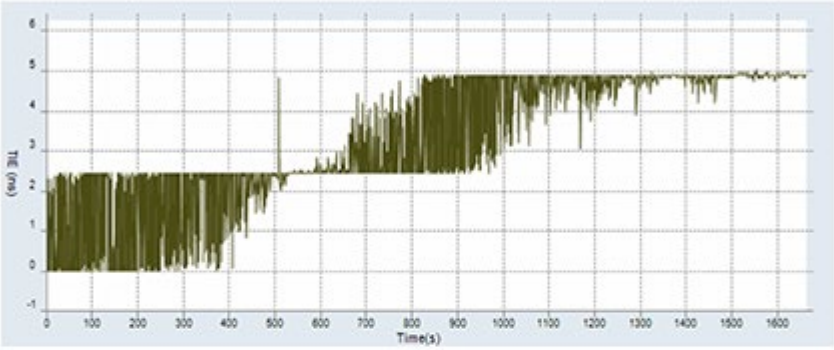
Select the desired tolerance masks from the pull-down list and click on the Analyze button to perform the MTIE and/or TDEV analysis.

5.8.2.7 MTIE & TDEV Analysis Report in PDF

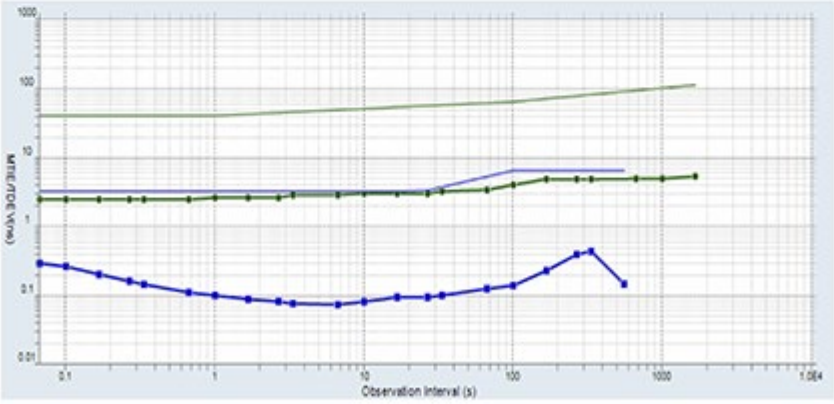
Click on the Report button to generate a copy of the measurement and analysis in PDF format.

Wander Expert Analysis v.1.00
Typical Standard Header information

File: C:\Users\ \Documents\TX Series\Wander Analysis\TIE log files\E1warmup 28min\mtie
Start Time: 1/17/2012 11:05:30 AM
End Time: 1/17/2012 11:33:13 AM
ET: 1663 s
MTIE/TDEV Range: 0 to 1663
Sampling Interval: 30/s
Total Sampling: 49916
Frequency Offset(ppm): -0.00000003628156 Not Removed
TIE (ns)



MTIE/TDEV Masks: G.813 - Option 1 SDH Equipment Slave Clock (SEC) at constant temperature √ Pass
MTIE
TDEV



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5.8.3 ESMC SSM

Overview

Ethernet Synchronization Message Channel (ESMC) Synchronization Status Messages (SSM) are supported by both SDH and Ethernet networks. SDH is supported by the transport overhead channel and is unidirectional; Ethernet is defined as Organization Specific Slow Protocol (OSSP).

SSM represents the quality level of the system clocks located in the network. Background (or heartbeat) is sent once per second as keep alive. ESMC information PDU- event message is sent immediately in case the clock quality level has changed. ESMC event PDU- failure condition is declared if no message is received in 5 seconds.

ESMC PDU Format		
Octet number	**Size**	**Field**
1-6	6 octets	Destination address = 01-80-C2-00-00-02
7-12	6 octets	Source address
13-14	2 octets	Slow protocol Ethertype = 88-09
15	1 octet	Slow protocol subtype =0x0A
16-18	3 octets	ITU-OUI = 00-19-A7
19-20	2 octets	ITU-T subtype
21	4 bits	Version
	1 bit	Event flag
	3 bits	Reserved
22-24	3 octets	Reserved
25-1514	36-1490 octets	Data and padding (see point j)
Last 4	4 octets	Frame check sequence

Event flag: This bit distinguishes the critical time-sensitive behavior of the ESMC event PDU from the ESMC information PDU. A value of 1 indicates an event PDU and a value of 0 indicates an information PDU.

IEEE Assigned OUI and Slow Protocol Subtype	
8 bits	Type: 0x01
16 bits	Length: 00-04
4 bits	0x0 (unused)
4 bits	SSM code

QL TLV Format	
Quality Level	**Highest**
QL-PRC	Highest
QL-SSU-A	|
QL-SSU-B	|
QL-SEC	|
QL-DNU	|
QL-INVx, QL-FAILED, QL-UNC, QL-NSUPP	Lowest

TLV: Type Length Field

QL: Quality Level

Hierarchy of Quality Levels in Option I of Synchronization Networks	
Quality Level	**Order**
QL-PRC	Highest
QL-SSU-A	|
QL-SSU-B	|
QL-SEC	|
QL-DNU	|
QL-INVx, QL-FAILED, QL-UNC, QL-NSUPP	Lowest

Hierarchy of Quality Levels in Option II of Synchronization Networks	
Quality Level	**Order**
QL-PRS	Highest
QL-STU	|
QL-ST2	|
QL-TNC (Note)	|
QL-ST3E (Note)	|
QL-ST3	|
QL-SMC	|
QL-ST4	|
QL-PROV (default position)	|
QL-DUS	|
QL-INVx, QL-FAILED, QL-UNC, QL-NSUPP	Lowest
NOTE - QL-TNC and QL-ST3E are not defined for first generation synchronization networking (refer to clause 5.4.1.2) and QL-PROV was identified as QL-RES	

The SyncE ESMC SSM option has the following features:

- Generates “information” at a programmable interval, IPG, (default 1 sec)
- Generates “event” upon changing the QL-TLV followed by “information”
- Count message types
- Monitor and decode messages on screen
- Capture ESMC/SSM messages and output in pcap file for further off-line protocol analysis

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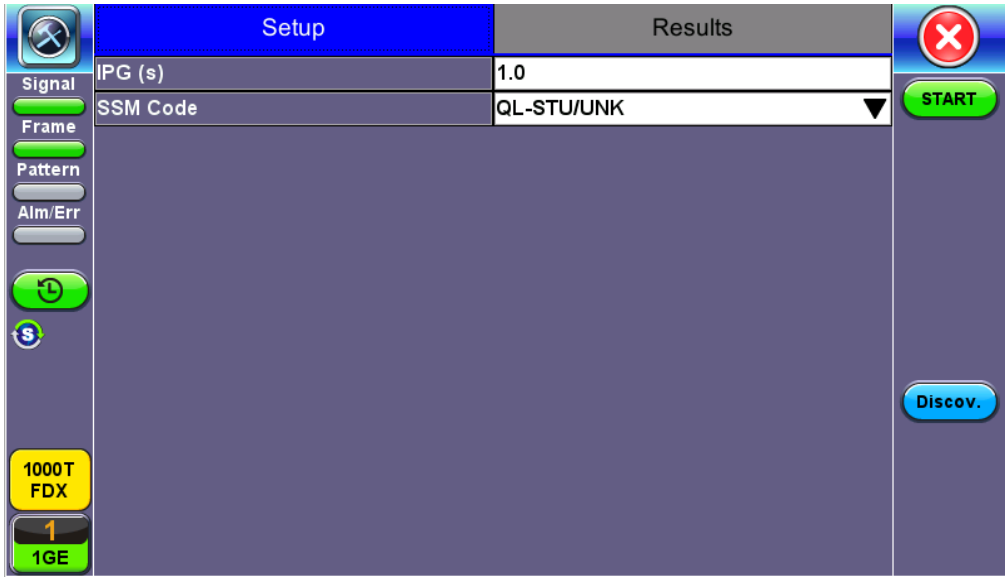
Setup

- **IPG(s):** Value can be entered by clicking in the box next to it.
- **SSM Code:** Quality Levels

Once the parameters are set, press **Start** to start the test.



ESMC SSM

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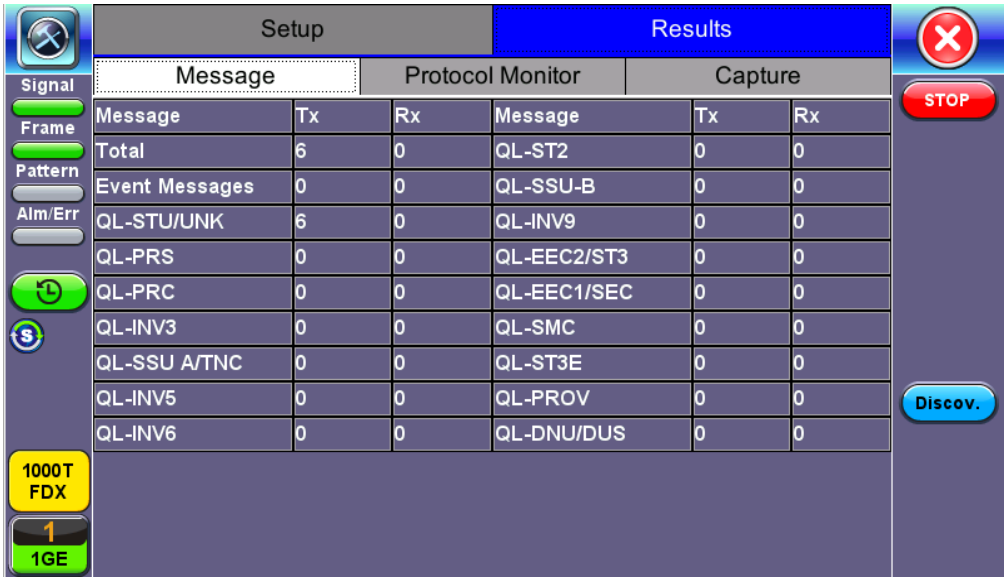
Results

The Results screen shows Messages, Protocol Monitor, and Capture.

Message: A list of all the SSM quality levels with the results of the QL selected in Setup next to it.



Message	Tx	Rx	Message	Tx	Rx
Total	6	0	QL-ST2	0	0
Event Messages	0	0	QL-SSU-B	0	0
QL-STU/UNK	6	0	QL-INV9	0	0
QL-PRS	0	0	QL-EEC2/ST3	0	0
QL-PRC	0	0	QL-EEC1/SEC	0	0
QL-INV3	0	0	QL-SMC	0	0
QL-SSU A/TNC	0	0	QL-ST3E	0	0
QL-INV5	0	0	QL-PROV	0	0
QL-INV6	0	0	QL-DNU/DUS	0	0

SyncE ESMC SSM Results- Message

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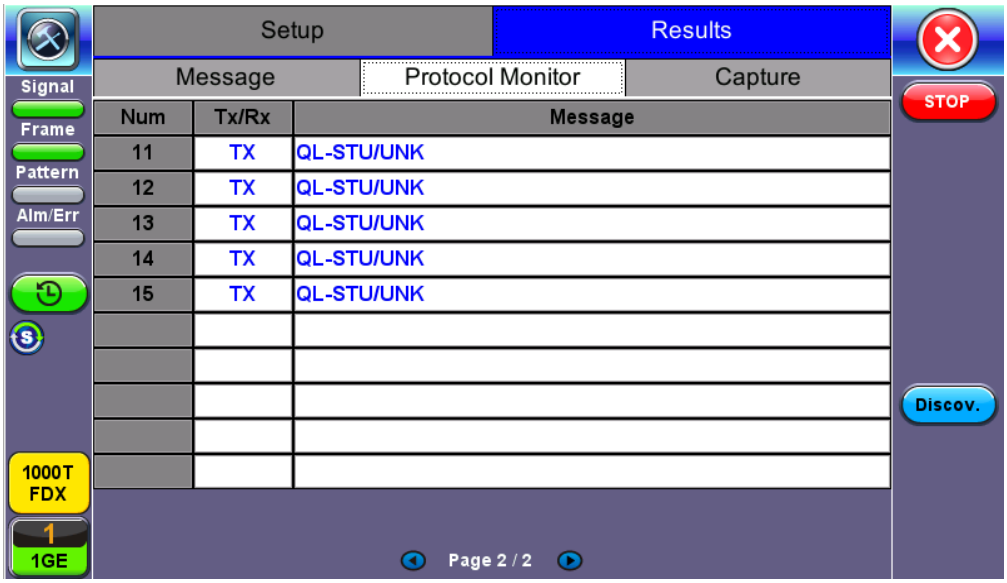
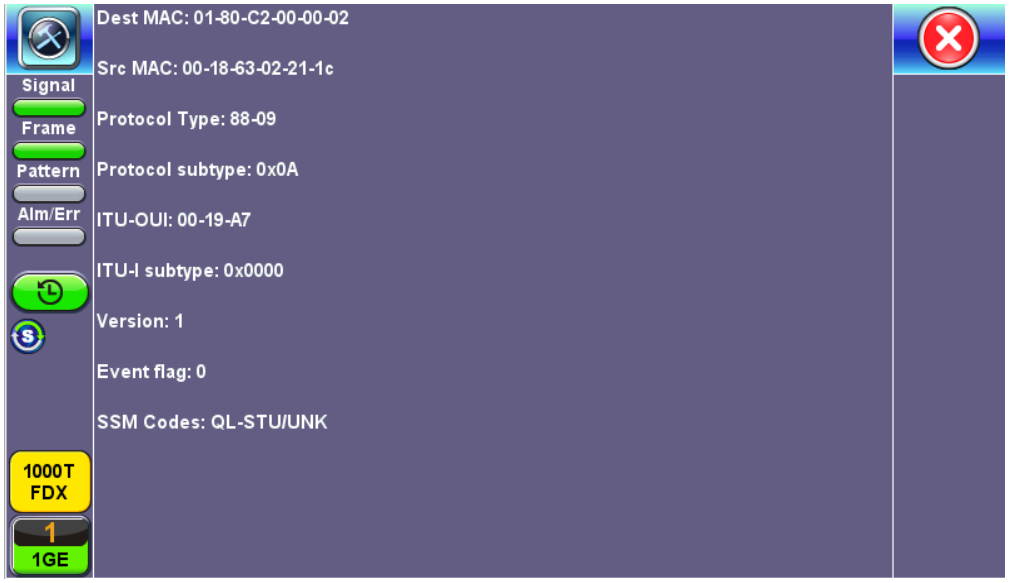
Monitor

The Tracer shows the messages as they are sent or received. The test set stores up to 2000 messages. Tap on the desired message to view decoded message details.



Num	Tx/Rx	Message
11	TX	QL-STU/UNK
12	TX	QL-STU/UNK
13	TX	QL-STU/UNK
14	TX	QL-STU/UNK
15	TX	QL-STU/UNK

SyncE ESMC SSM Results- Protocol Monitor



Message Details

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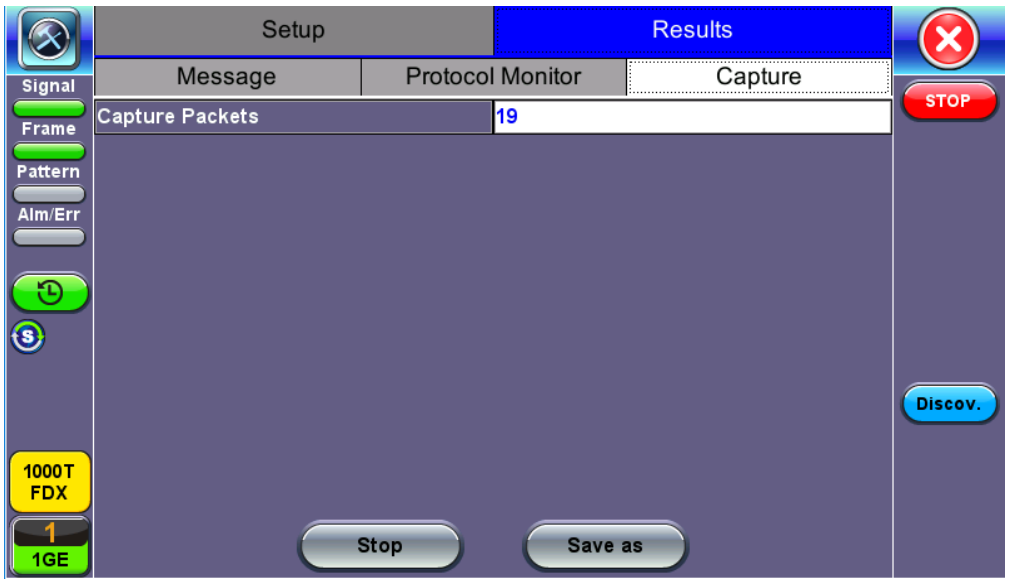
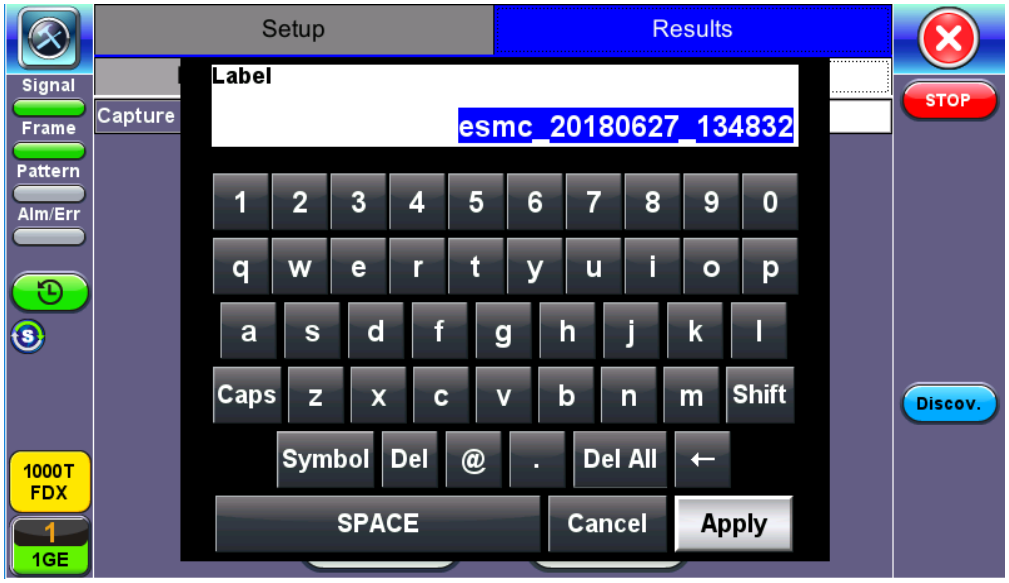
Capture

Press **Start** to Capture Packets. The number of captured packet results is displayed.

To store these results packets, press **Stop**, then press **Save as**. Enter a name for the results file. 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. Refer to *File Management* in the **V150 Common Functions** manual for more details on exporting saved results.



SyncE ESMC SSM Results- Capture



SyncE ESMC SSM Capture Save

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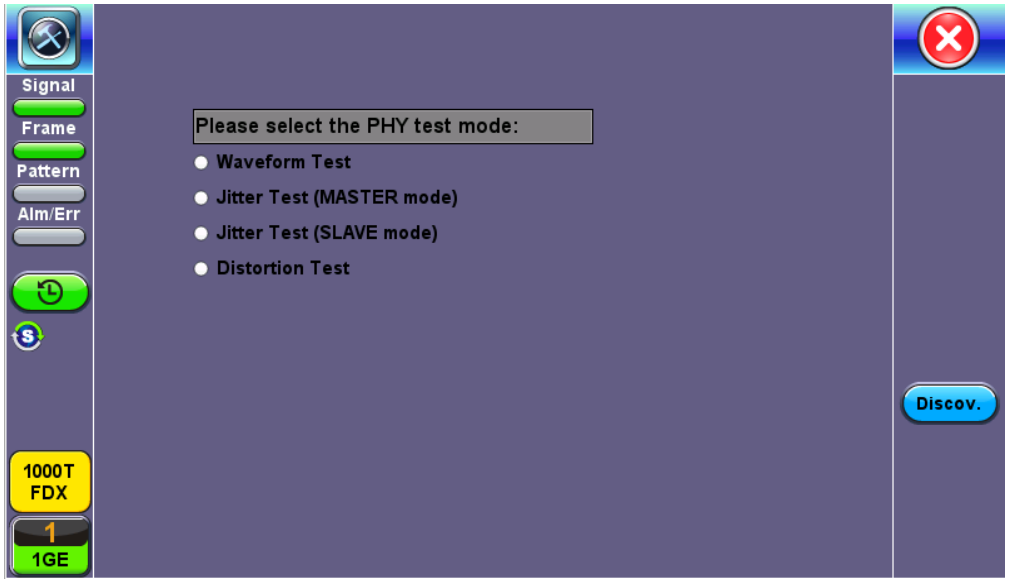
5.9 Phy Mode

Phy Mode puts the Phy chip in a special mode to transmit a specified wave form. Exiting the menu automatically returns the PHY chip to normal operation.



Phy Mode Menu

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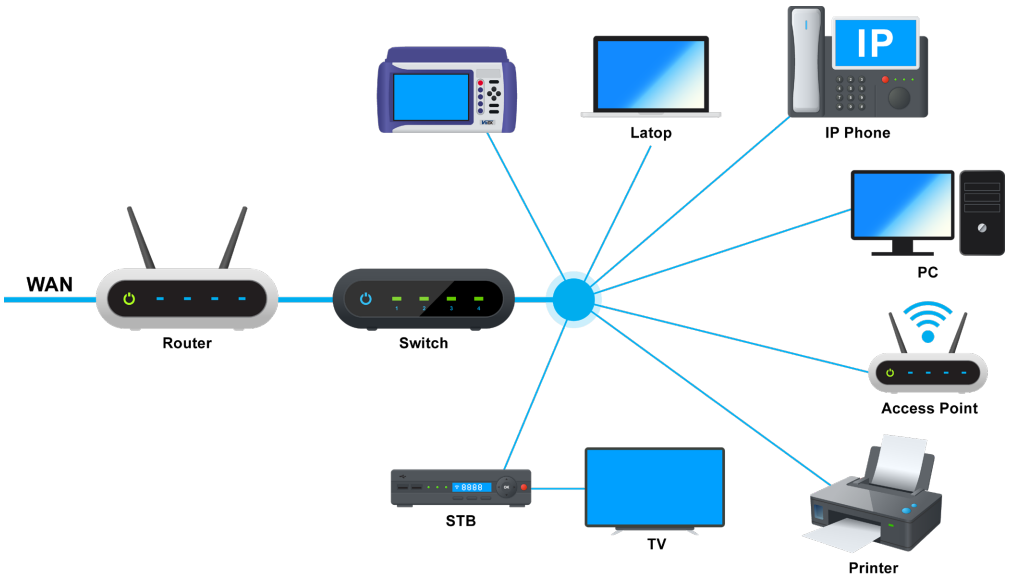
5.10 Net Wiz

The Net Wiz function tests the Ethernet cable and associated network environment. A typical application is shown below.



Typical Net Wiz Application

Net Wiz Test functionalities include:

- Cable Analysis with distance (Ethernet RJ45 Test port only, not available on Ethernet RJ45 Management port)
  - to switch with MDI mode (Straight or Crossover)
  - to fault, type of fault (Open, Short, Impedance Mismatch)
- Analyze the network and automatically report
  - Stations
  - Routers/Gateway
  - Printers
- Provide MAC and IP addresses of each device
- PING each device and verify the device is active
- Provide detected networks (NetBiOS, IPX, etc.)

Before proceeding with any Net Wiz tests, make sure that an IP connection has been established (see IP Connection).

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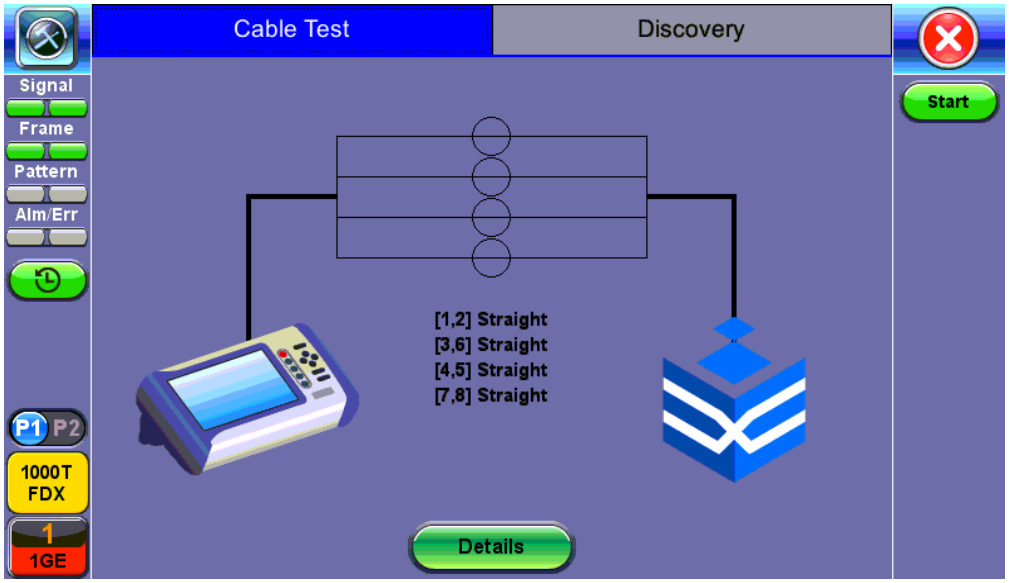
Cable Test



Cable Test Results

Press Start to begin the test. The test set will return the connection type (Straight or Cross Over) if connected to an end device. If fault is detected (Open or Short) the fault will be indicated as well as the distance to the fault.

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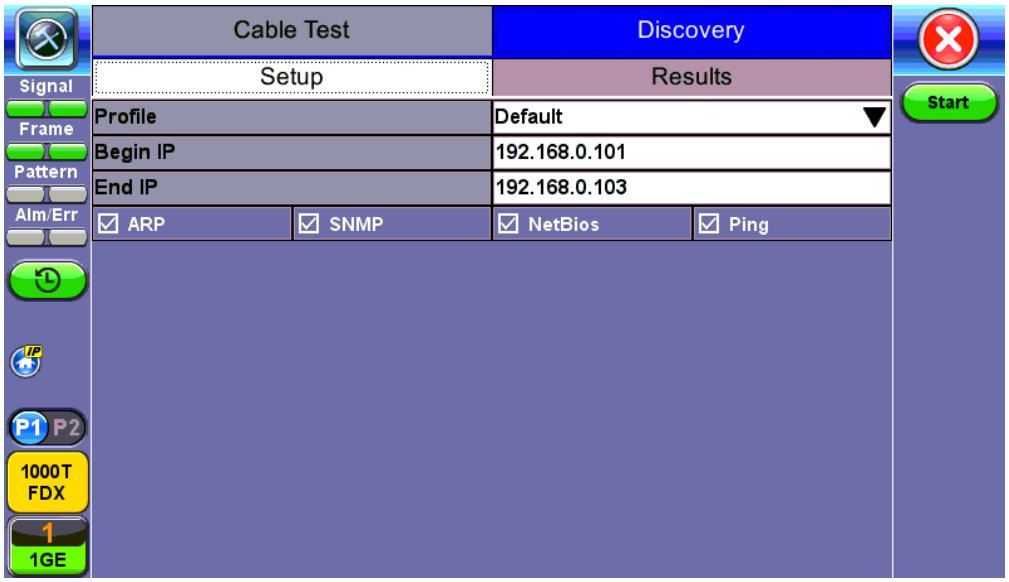
Discovery Setup



Discovery Setup

Profile: Drop-down selections are Default, Delete, Save, Save As...

- **Begin IP:** Set the start address for the desired IP range using the numeric keypad
- **End IP:** Set the end address for the desired IP range using the numeric keypad
- Select by placing a check mark in the corresponding box of any of the following: ARP, SNMP, NetBios, Ping, Net

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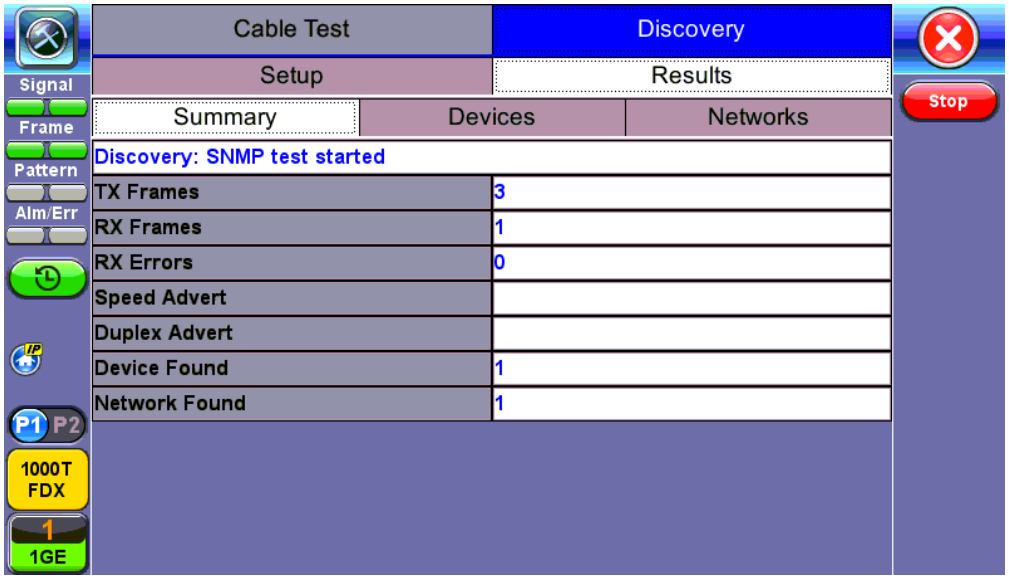
Discovery Results



Discovery Results - Summary

Summary indicates the test status and reports:

- **TX/RX Frames:** Total number of TX (transmitted) and RX (received) frames
- **RX Errors:** Received frames in error
- **Speed Advert:** Speed advertised
- **Duplex Advert:** Duplex mode advertised
- Total number of Devices and Networks found

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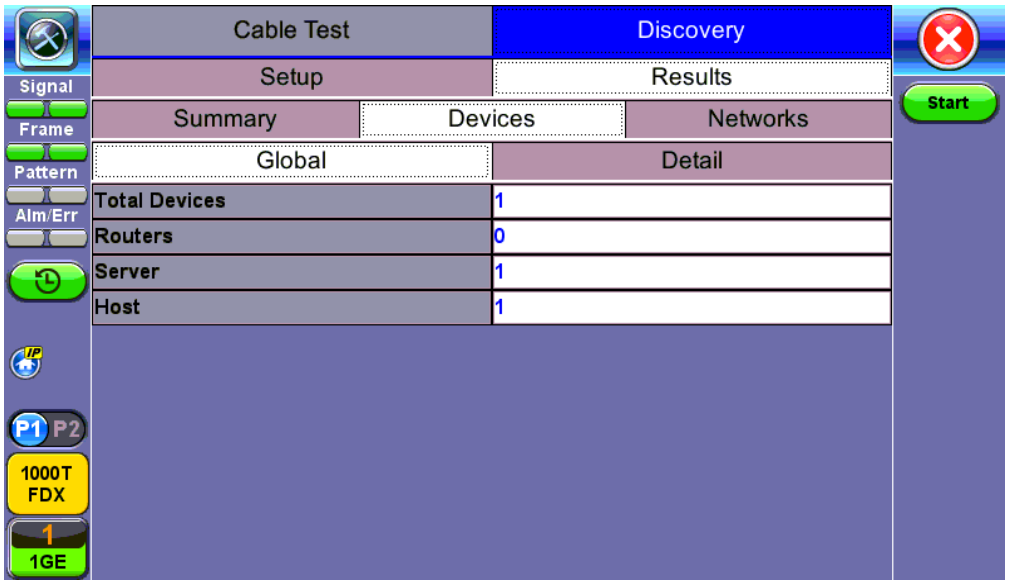
The **Devices** tab reports global and detailed device information.



Discovery Results - Devices - Global

Go back to top Go back to TOC

Global reports:

- Total number of devices found
- Number of devices (Routers, Servers, Hosts)

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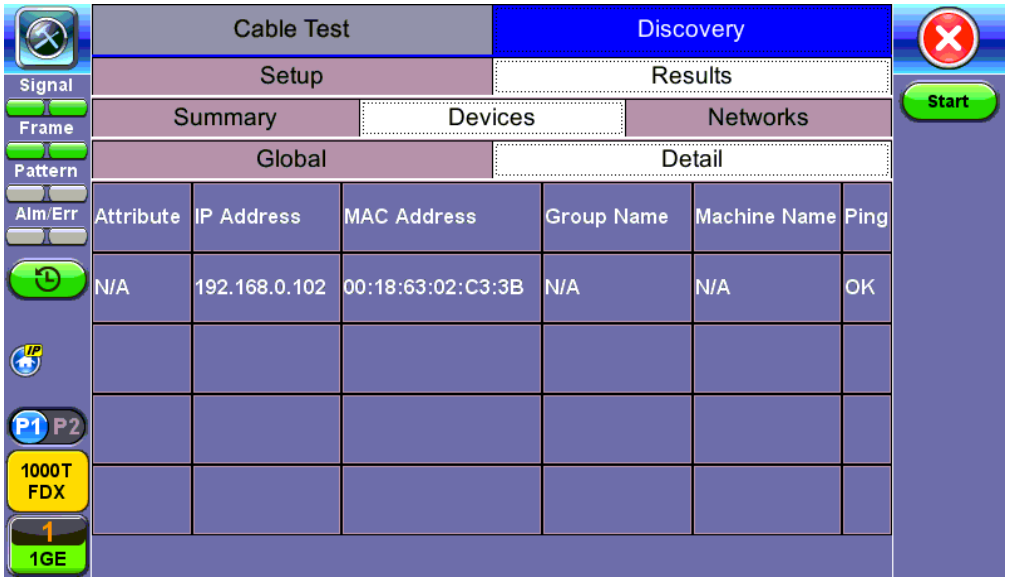

Discovery Results - Devices - Detail

Detail displays the Attribute, MAC and IP Addresses, Group and Machine Names and Ping test results of each device discovered.

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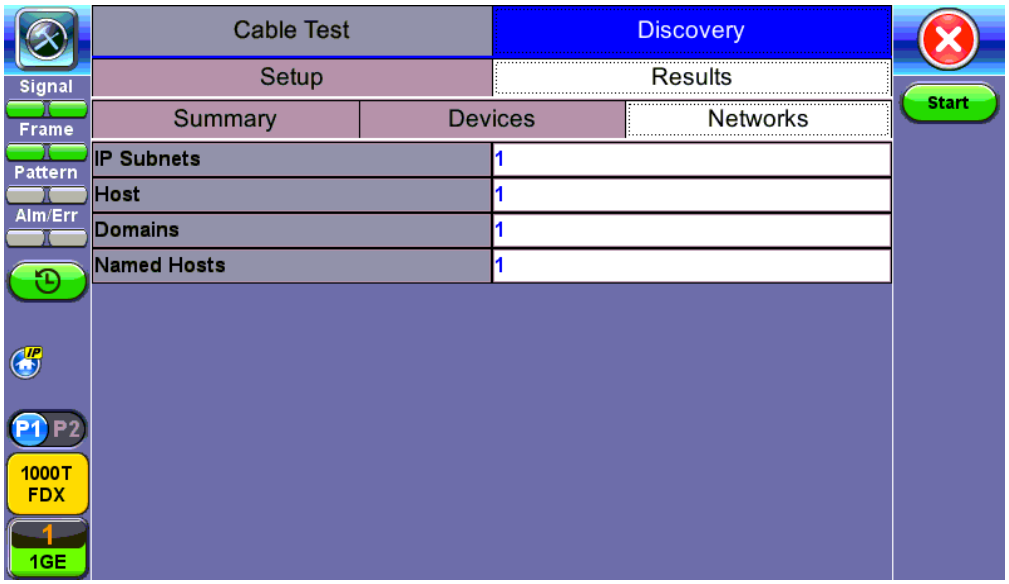

Discovery Results - Networks

Networks reports the number of IP Subnets, Hosts, Domain, and Named Hosts found.

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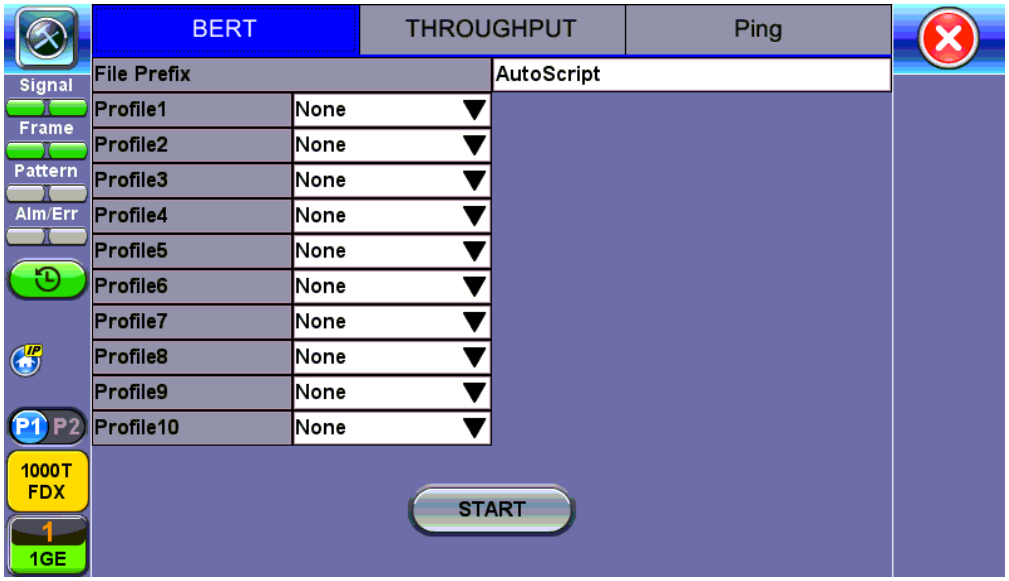
5.11 Autoscripting

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



Autoscripting - BERT Setup

Autoscripting Setup

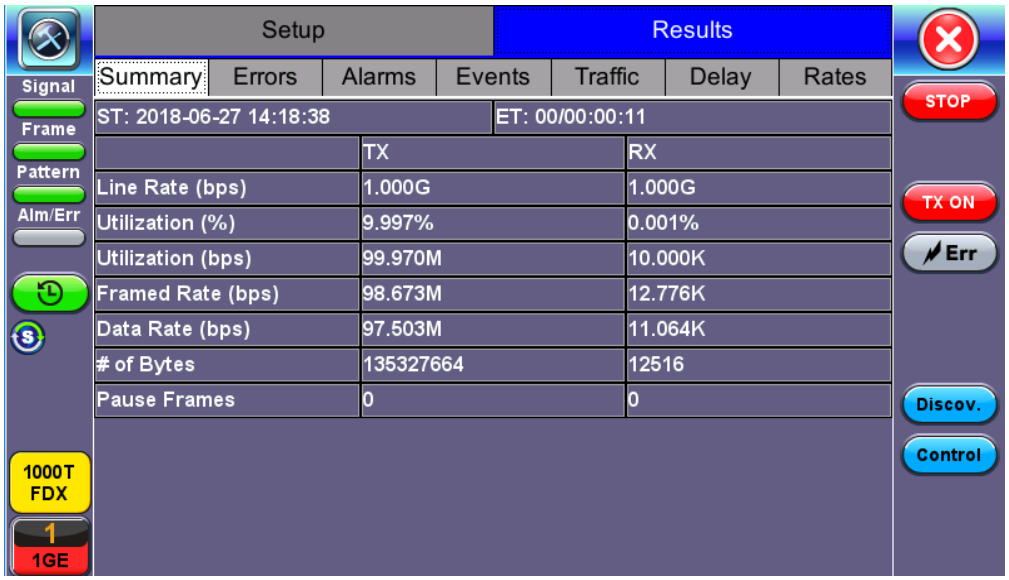
- **File Prefix:** Prefix added to name of test results. The default prefix is "Autoscript."
- **If Alarm/Error detected:** Choose to **Continue** or **Exit** testing if an alarm/error is detected.
- **Profile:** Select Default, Last Configuration, or None.
- Testing duration can be set for seconds, 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.

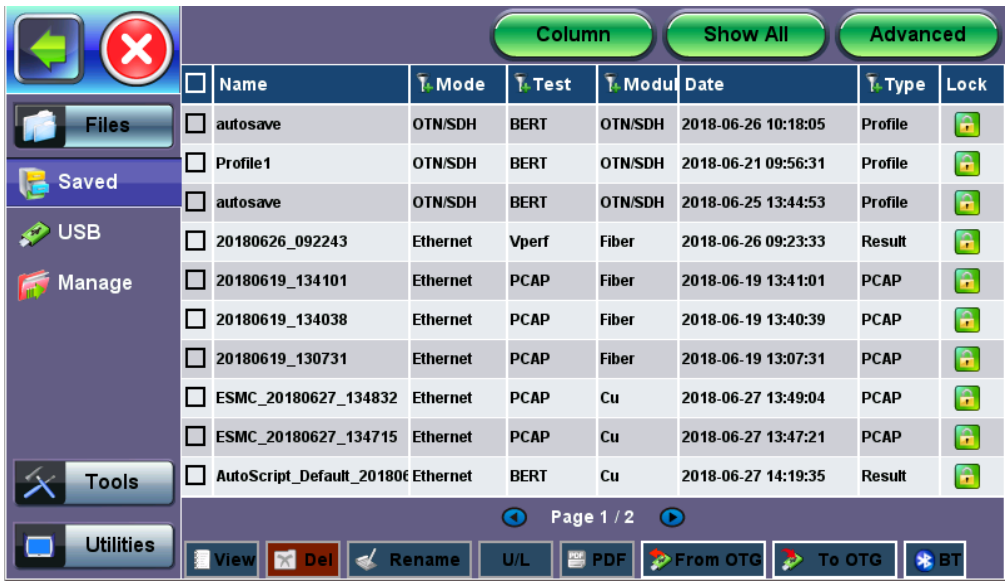
The soft LED light indicates the status of finished tests:

- **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 **V150 platform manual** for information on accessing saved results.



Autoscripting - BERT Results



File Manager - Saved Results

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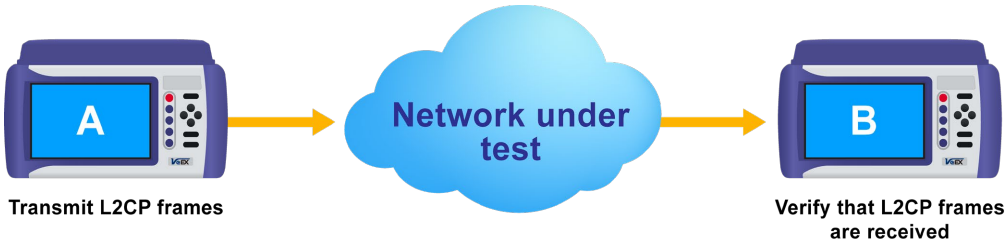
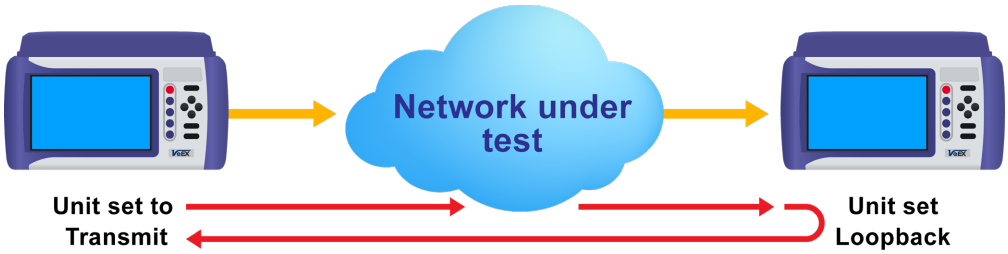
5.12 L2 Control Protocol Transparency Test (L2CP)

L2CP tests network transparency to Layer 2 Control Protocols by transmitting a number of preselected L2 control protocol frames from Test set A and making sure that they are received on Test set B through the network under test.



L2CP Transmit/Receive Mode



L2CP Loopback Mode

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Setup

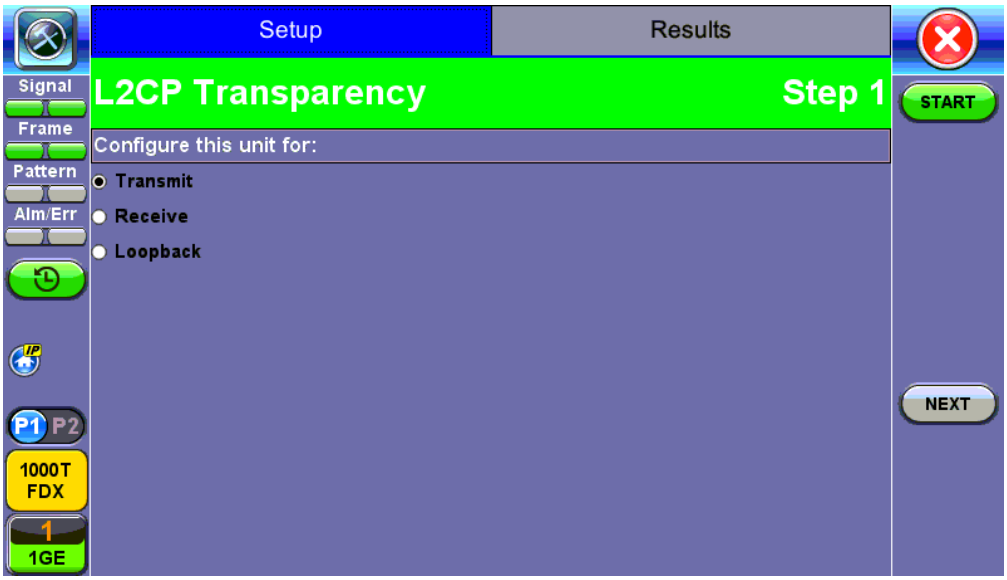
Press the green **Start** button to start the test with previous settings or **NEXT** to continue with the step-by-step setup process.

Procedure

Step 1

- **Transmit:** Unit is setup to transmit and Receive L2CP frames. If the unit is selected as a transmitter, the option to **Automatically Loop Up/Down** becomes available.
- **Receive:** Unit is setup to only Receive L2CP frames.

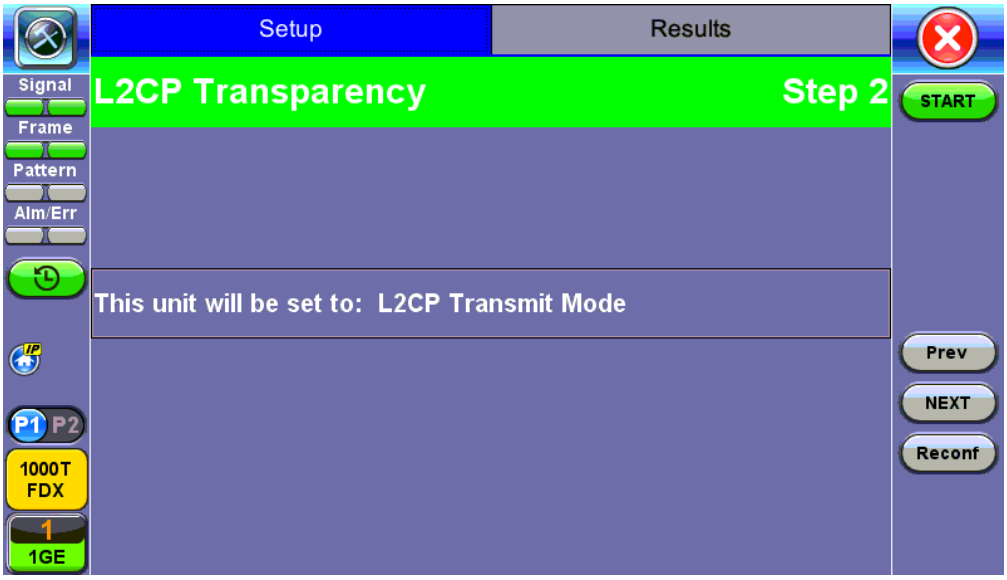
- **Loopback:** Unit loops incoming L2CP frames at Layer 1.



L2CP Transparency Test - Step 1

Step 2

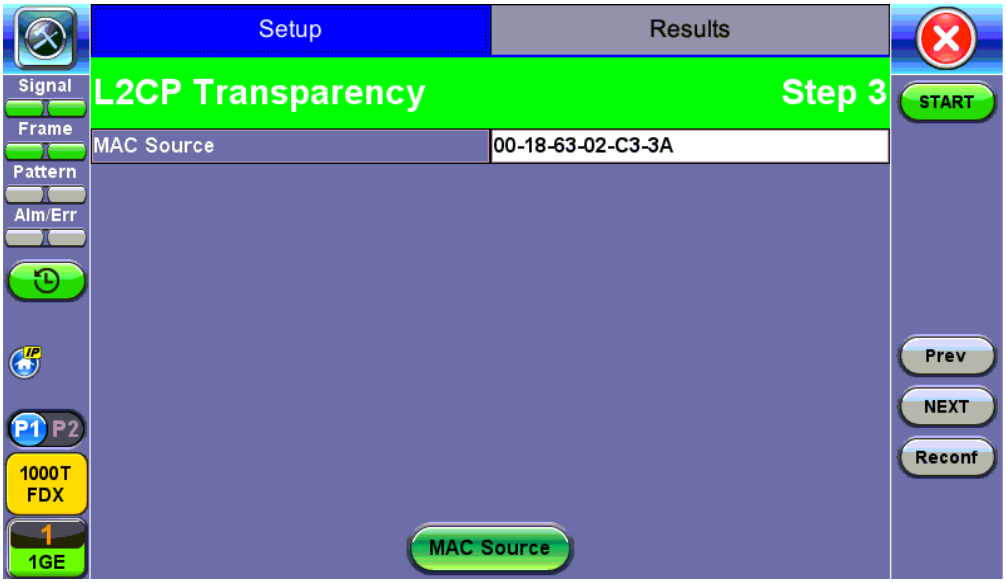
Step 2 confirms the test mode selection. If the unit is set to Receiver mode, setup is complete.



L2CP Transparency Test - Transmitter - Step 2

Step 3

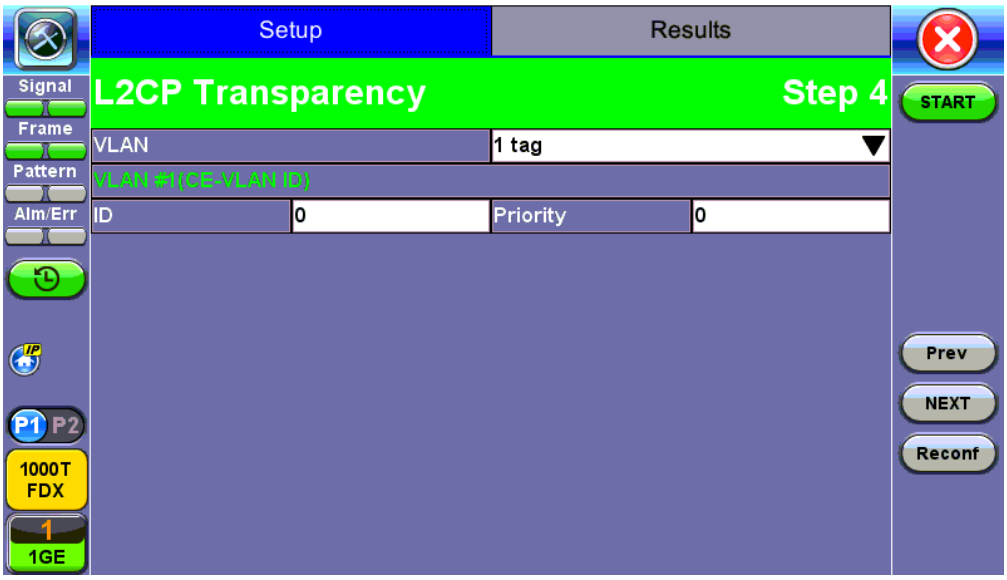
- If the unit is set to Receiver mode, setup for the receiver is complete.
- For Transmit mode, configure the MAC address that will be used as MAC Source for all the test frames or press the “MAC Source” function key to overwrite with the MAC address of the test set.



L2CP Transparency Test - Transmitter - Step 3

Step 4

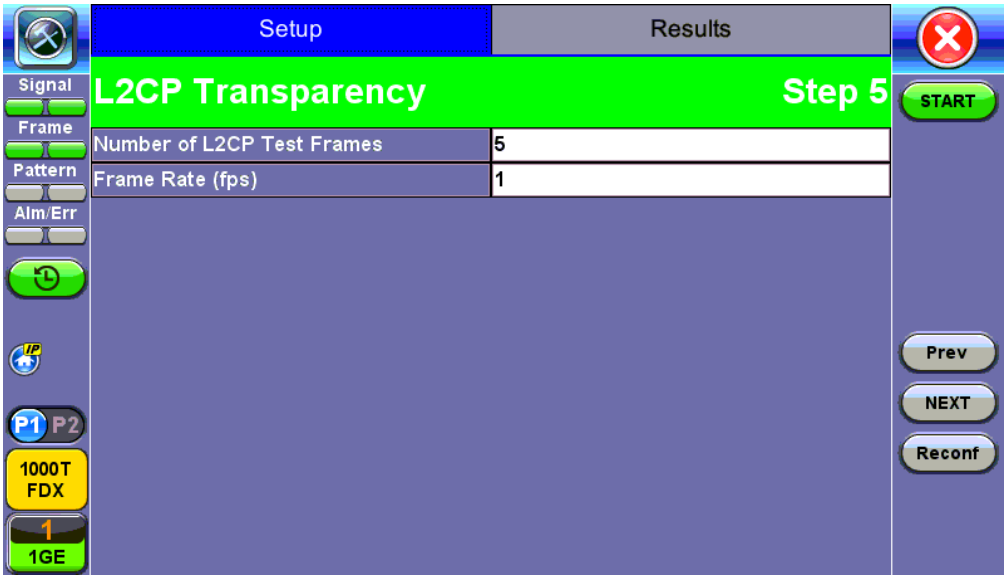
Configure the VLAN Tag(s) that will be used for the test frames. VLAN can be disabled or enabled with up to 3 tags.



L2CP Transparency Test - Transmitter - Step 4

Step 5

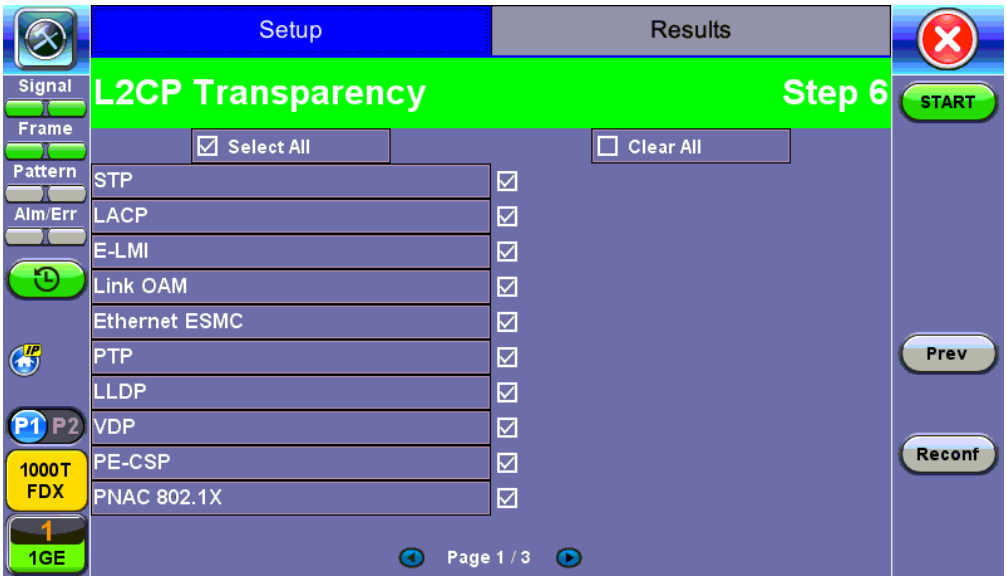
Select the number of test frames that will be transmitted for each L2CP. Configurable from 1 to 100. Configure Test Frame Rate: From 1 to 10 frames per second.



L2CP Transparency Test - Transmitter - Step 5

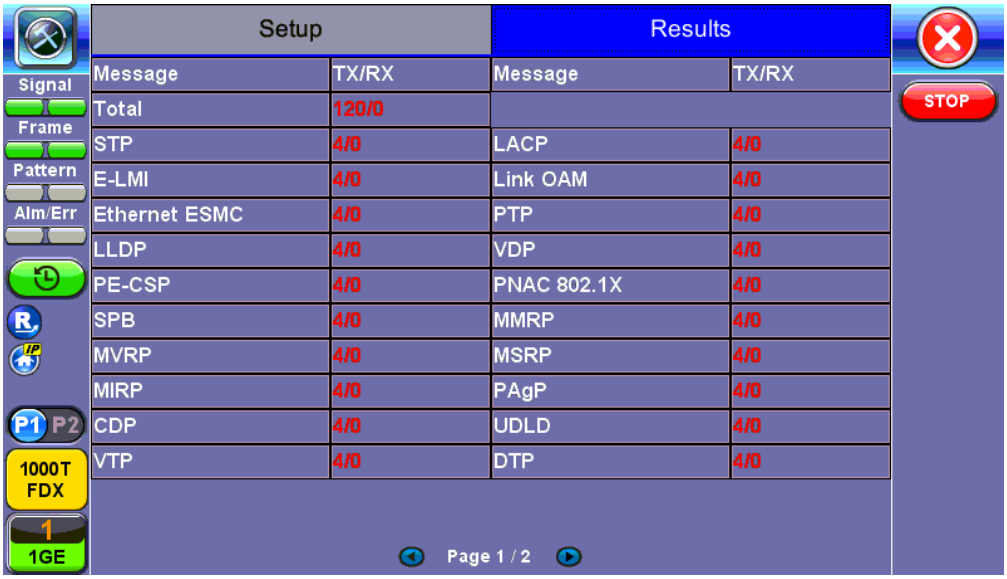
Step 6

Select the type of frames that will transmitted during the test. Please see the List of Protocols section for more information. Add a check mark to each L2CP to test or select all.



L2CP Transparency Test - Transmitter - Step 6

When the test starts, the screen displays L2CP frames transmitted and received for each protocol. The field displays N/A if a protocol type has not been selected for the test. Packet capture (green **PCAP Start** button) can run simultaneously with the test. Refer to Packet Capture for information on using packet capture and retrieving saved files.



L2CP Transparency Test Running

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List of Protocols		
Layer 2 Control Protocol	**Protocol Identifier**	**L2CP Destination Address**
Spanning Tree (STP, MSTP, RSTP)	LLC=0x82	01-80-C2-00-00-00
Link Aggregation (LACP)	Ethertype: 0x8809 Subtypes: 0x01	01-80-C2-00-00-02
E-LMI	Ethertype: 0x88EE	01-80-C2-00-00-07
Link OAM	Ethertype: 0x8809 Subtypes: 0x03	01-80-C2-00-00-02
Ethernet ESMC	Ethertype: 0x8809 Subtypes: 0x0A	01-80-C2-00-00-02
PTP	Ethertype: 0x88F7	01-80-C2-00-00-0E
Link Layer Discovery Protocol (LLDP)	Ethertype: 0x88CC	01-80-C2-00-00-0E
Virtual Station Interface Discovery and Configuration Protocol (VDP)	Ethertype: 0x8940 Subtypes: 0x0001	01-80-C2-00-00-00
Port Extender Control and Status Protocol (PE-CSP)	Ethertype: 0x8940 Subtypes: 0x0002	01-80-C2-00-00-03
Port Based Network Access Protocol (PNAC 802.1X)	Ethertype: 0x888E	01-80-C2-00-00-00
Shortest Path Bridging (SPB)	LLC address = 0xFE	01-80-C2-00-00-2E
Multiple MAC registration Protocol (MMRP)	Ethertype: 0x88F6	01-80-C2-00-00-20
Multiple VLAN registration Protocol (MVRP)	Ethertype: 0x88F5	01-80-C2-00-00-21
Multiple Stream Registration Protocol (MSRP)	Ethertype: 0x22EA	01-80-C2-00-00-0E
Multiple ISID Registration Protocol (MIRP)	Ethertype: 0x8929	01-80-C2-00-00-00

Port Aggregation Control Protocol (PAgP)	Protocol type code 0x0104	01-00-0C-CC-CC-CC
Cisco Discovery Protocol (CDP)	OUI of 0x00000C and a protocol ID of 0x2000	01-00-0C-CC-CC-CC
Cisco Unidirectional Link Detection (UDLD)	SNAP format: LLC value 0xAAAA03 Org Id 0x00000C protocol type 0x0111	01-00-0C-CC-CC-CC
Cisco VLAN Trunking Protocol (VTP)	SNAP format: LLC value 0xAAAA03 Org Id 0x00000C protocol type 0x2003	01-00-0C-CC-CC-CC
Cisco Dynamic Trunking Protocol (DTP)	SNAP format: LLC value 0xAAAA03 Org Id 0x00000C protocol type 0x2004	01-00-0C-CD-CD-CD
Cisco Inter Switch Link (ISL)	SNAP format: LLC value 0xAAAA03 Org Id 0x00000C	01-00-0C-00-00-00
Per VLAN Spanning Tree (PVST/PVST+/RPVST)	SNAP format: LLC value 0xAAAA03 Org Id 0x00000C protocol type 0x010	01-00-0C-CD-CD-CD
Custom Frame #1	Configurable	Configurable
Custom Frame #2	Configurable	Configurable

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6.0 Fiber Channel

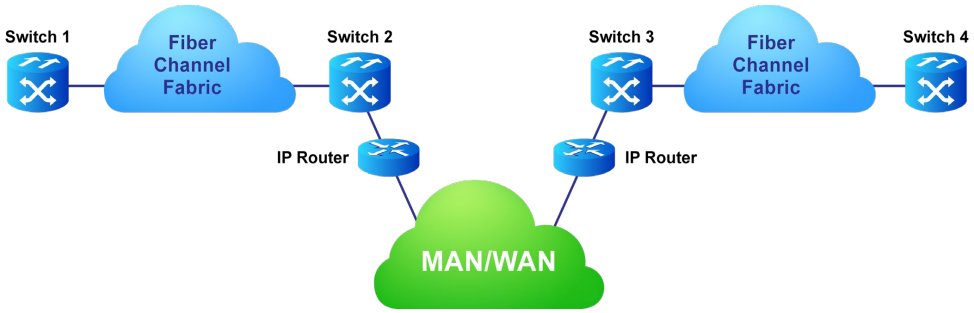
Fiber Channel Applications

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.

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 acknowledgment 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.

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6.1 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.

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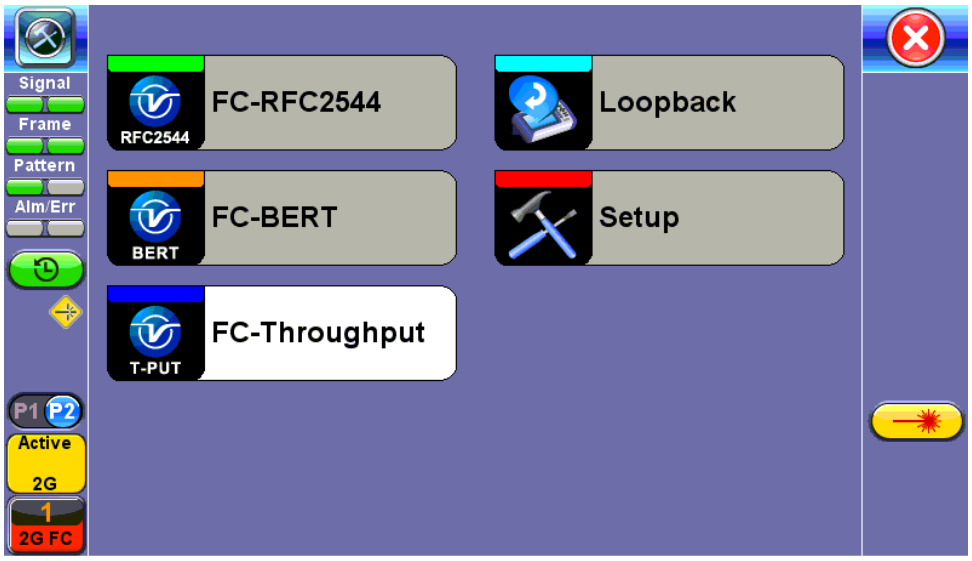
6.1.1 Test Applications

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



Fiber Channel Main Menu

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

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.

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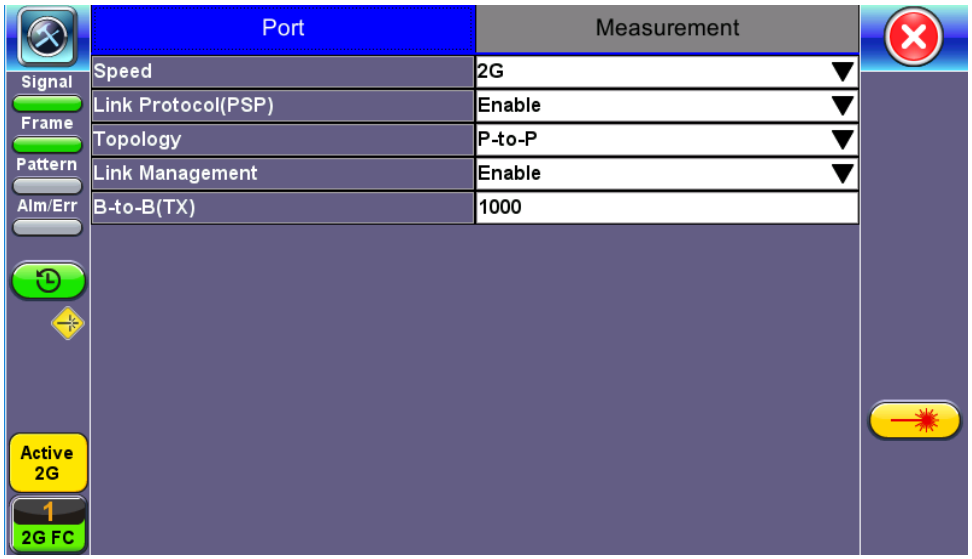
6.1.2 Port Configuration



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)

- **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 acknowledgments.
  - “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.

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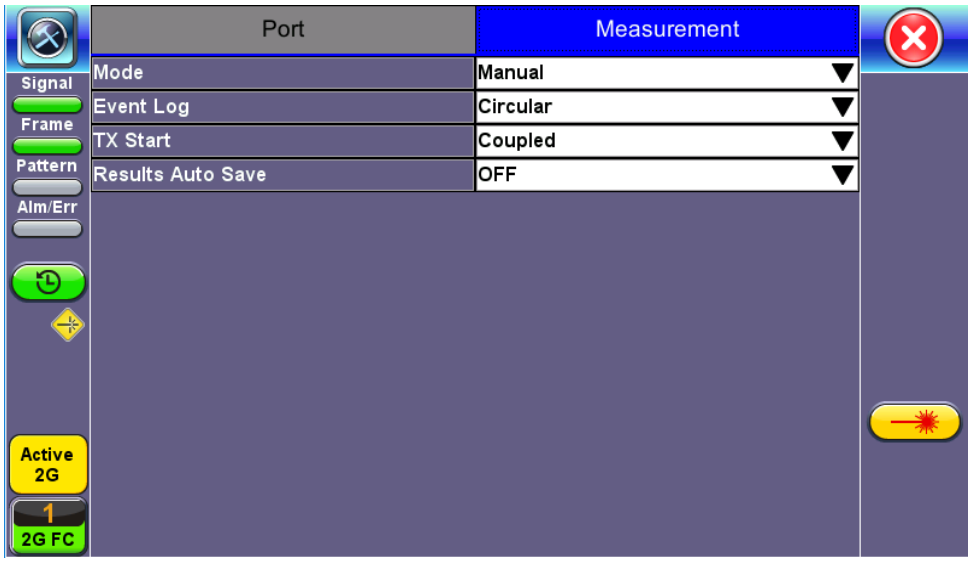

Fiber Channel - Measurement Setup

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.

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6.2 BERT/Throughput

6.2.1 Overview

The test set complies with ANSI NCITS FC-FS recommendations and has the ability to test 1, 2, 4, 8 and 10 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.
- 10G 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

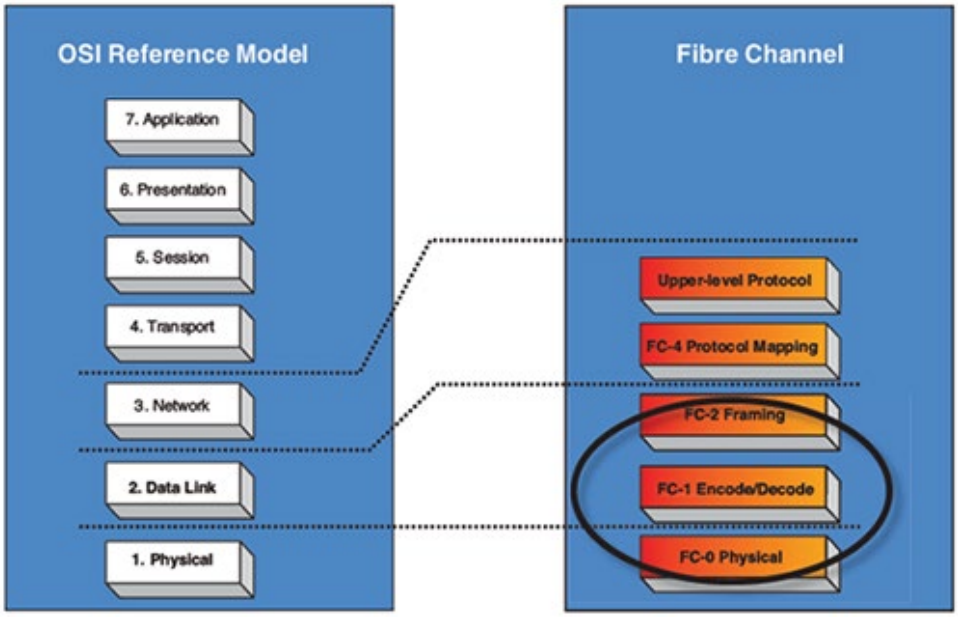
The unit supports the generation and monitoring of: bit errors, order sets, frame delimiters, frame transmission, and generation of primitive sequences. BERT diagnostics perform a bit-by-bit comparison to find bit errors in the received data pattern. Error Count and Error Rate for the latest sample are 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 (10G FC)
  - 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)

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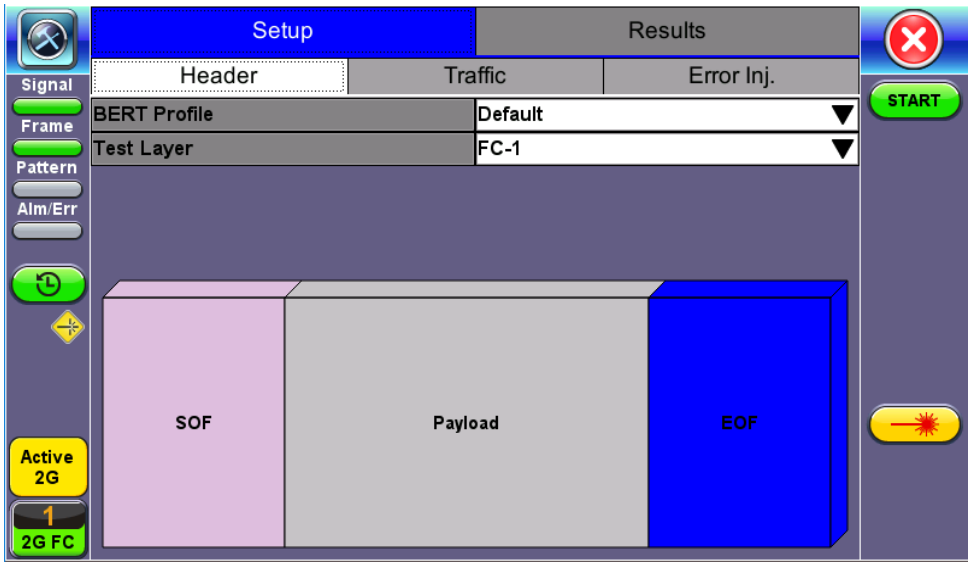
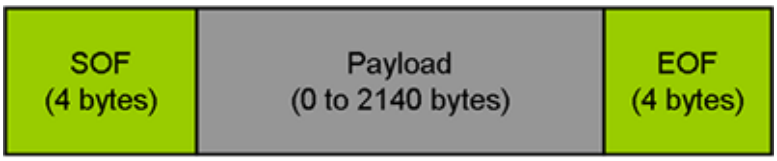
6.2.2 Setup



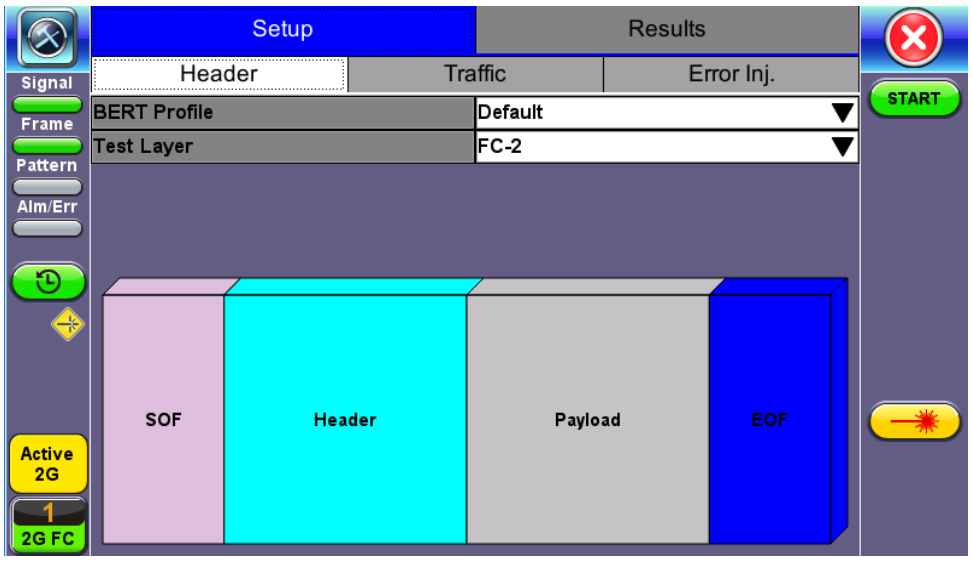
FC-1 BERT - Test Frame Setup

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.

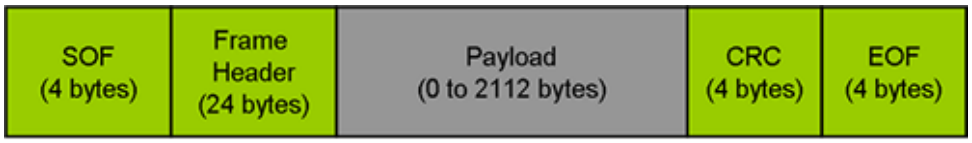


FC-1 Frame Structure



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.

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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.

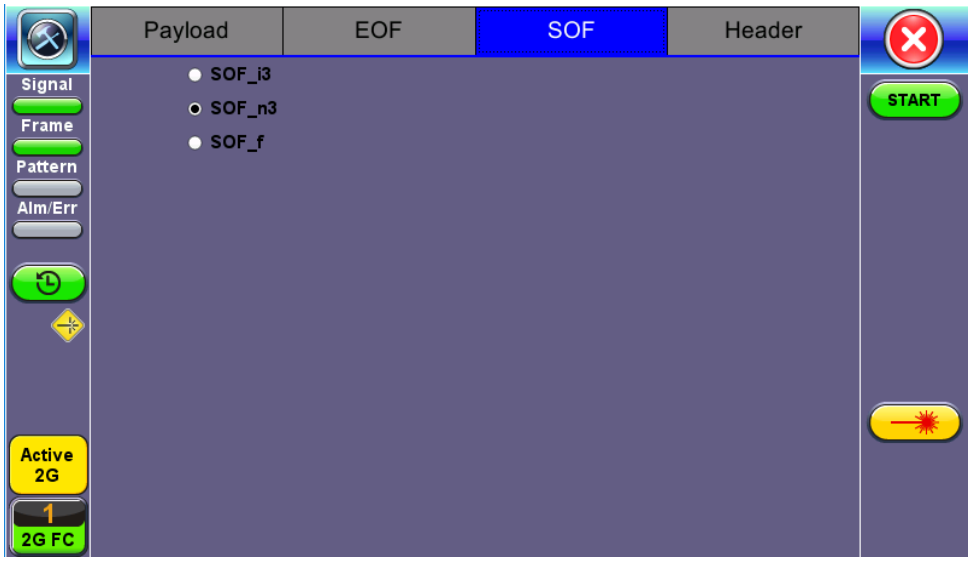
The following SOF Service Class selections are available:

- **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



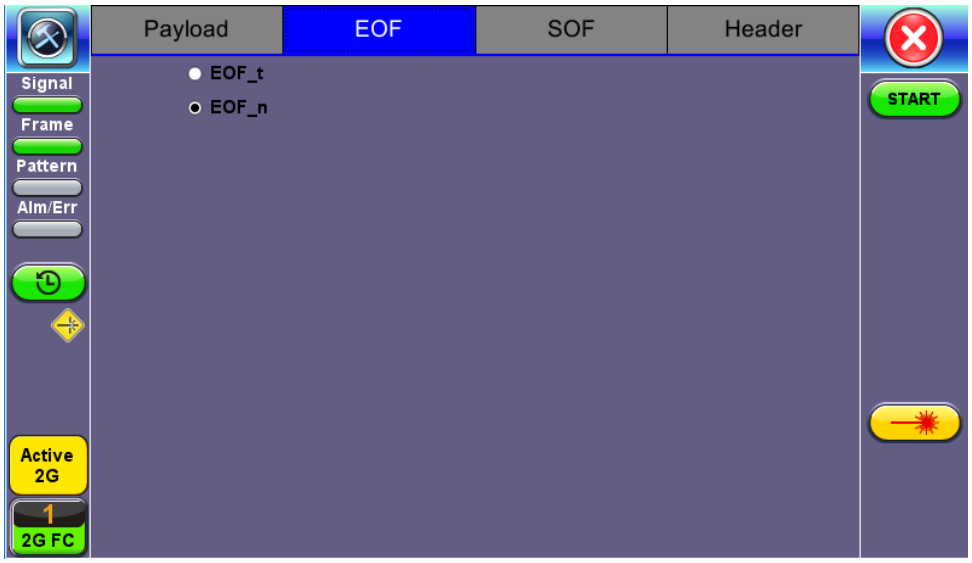
FC-2 BERT - SOF Setup

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

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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.

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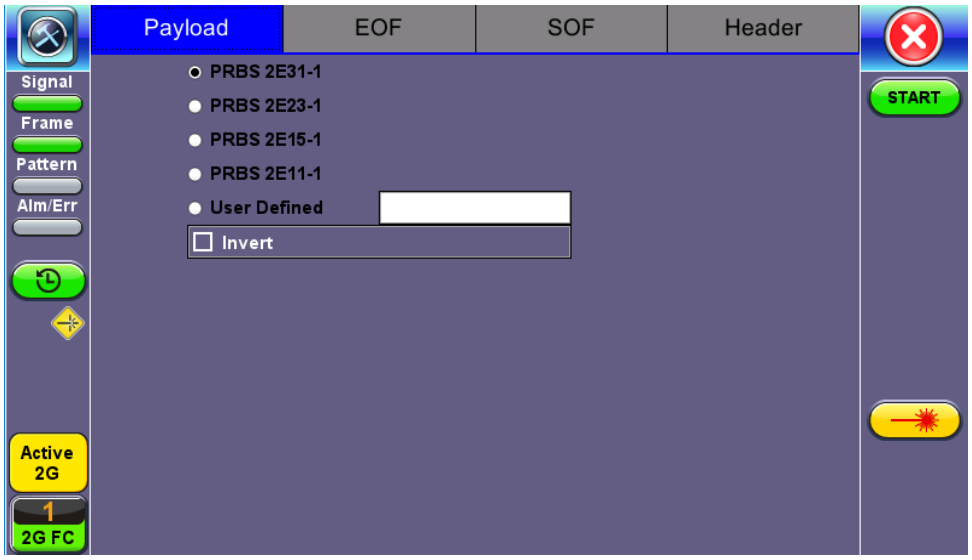
FC-2 Payload (test patterns)
Layer 2 "Compliant" test patterns are modified to resemble a true Fiber Channel frame - the pattern's format is similar to a basic frame which includes a Start of Frame Delimiter (SFD), End of Frame Delimiter (EFD), and Cyclic Redundancy Check (CRC).

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.

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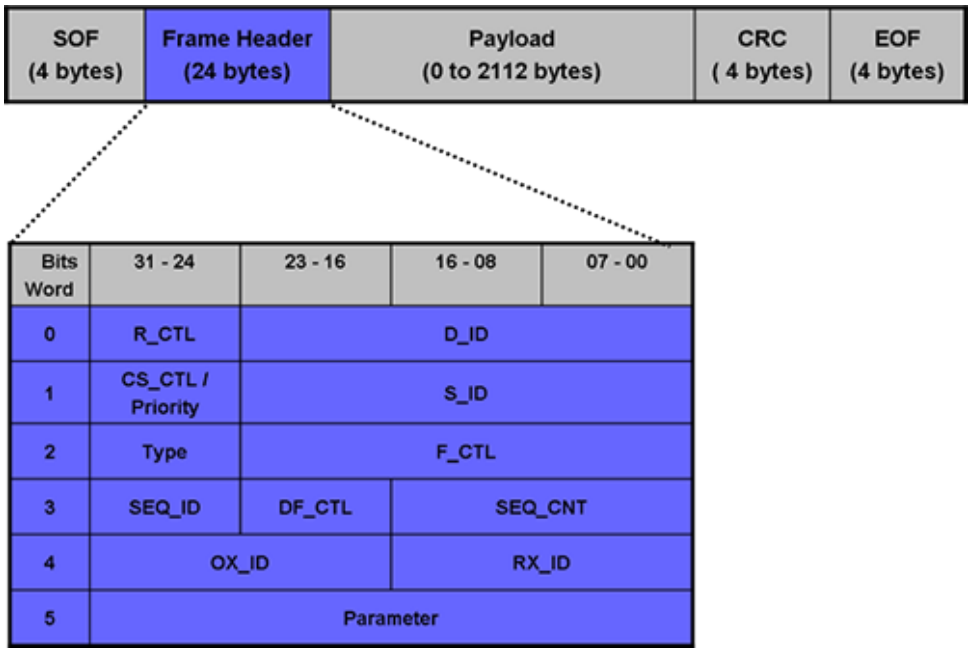
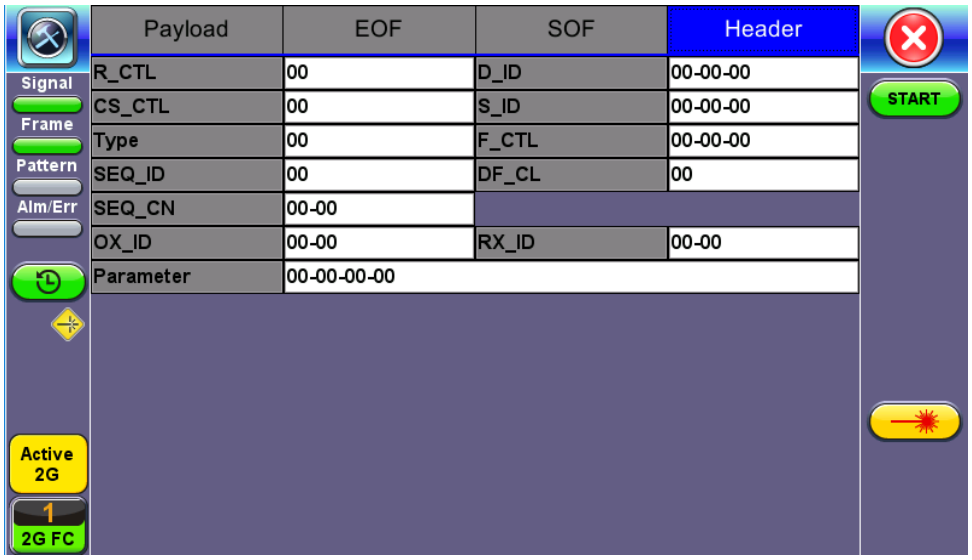
Header Setup (FC-2 only)

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.

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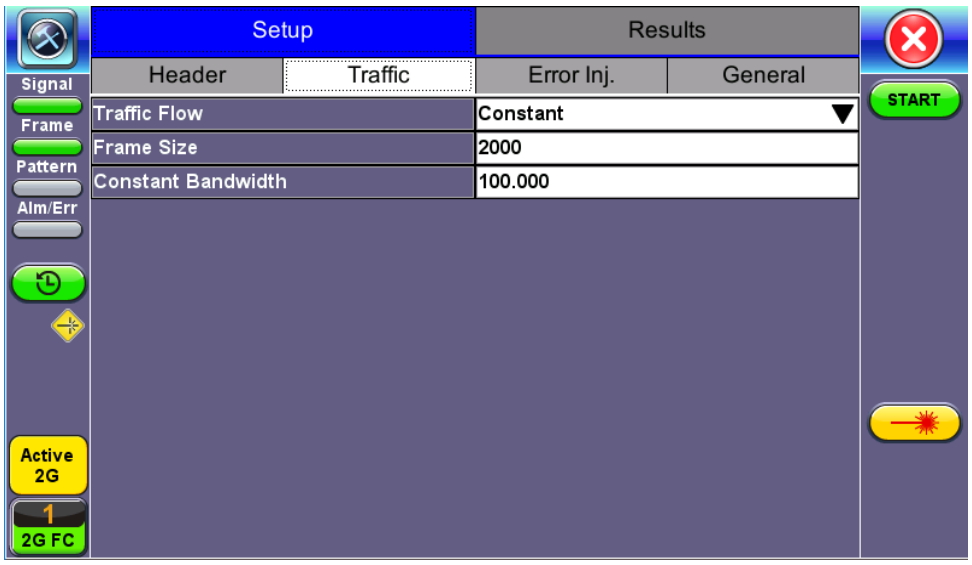
6.2.3 Traffic Generation and Error Injection

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

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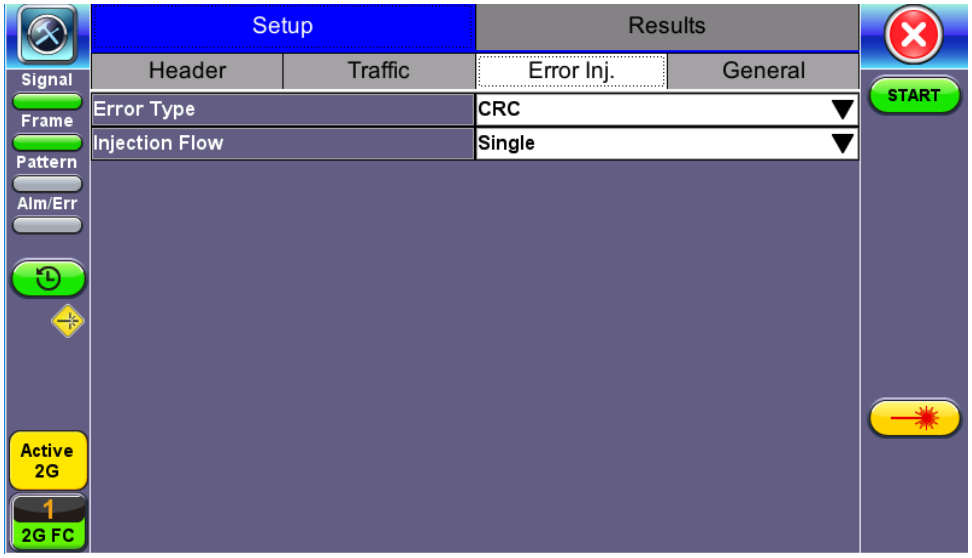
Error Injection Setup

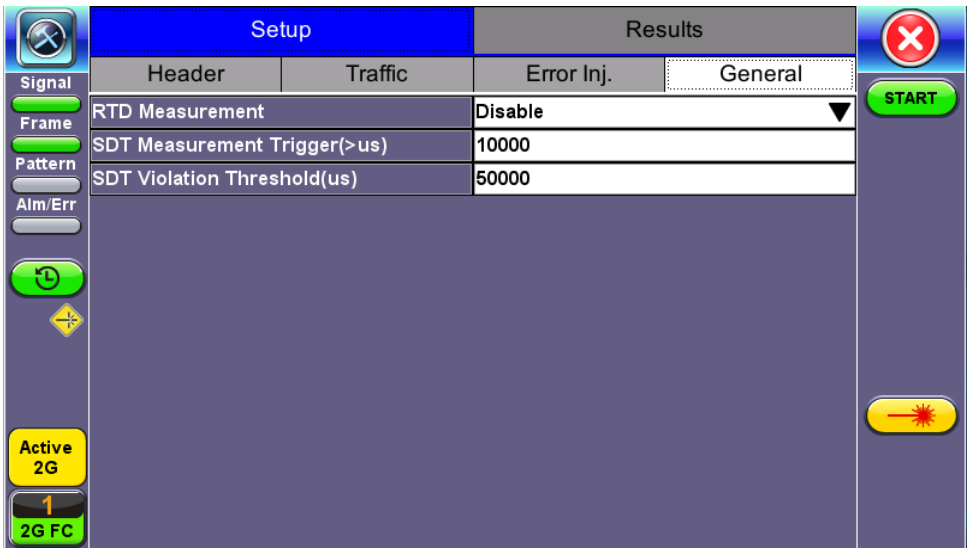
Error injection can be performed during a test. The type of errors and error injection rate or flow are configured in the Error Injection tab.

- **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** icon 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

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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.

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6.2.4 Starting Measurements

- **Start**: Starts the measurement.
- **Laser** : Can be turned On or Off to make adjustments to the fiber patch cord.
- **TX ON/OFF**: Activates the Transmitter to initiate the BER measurement.

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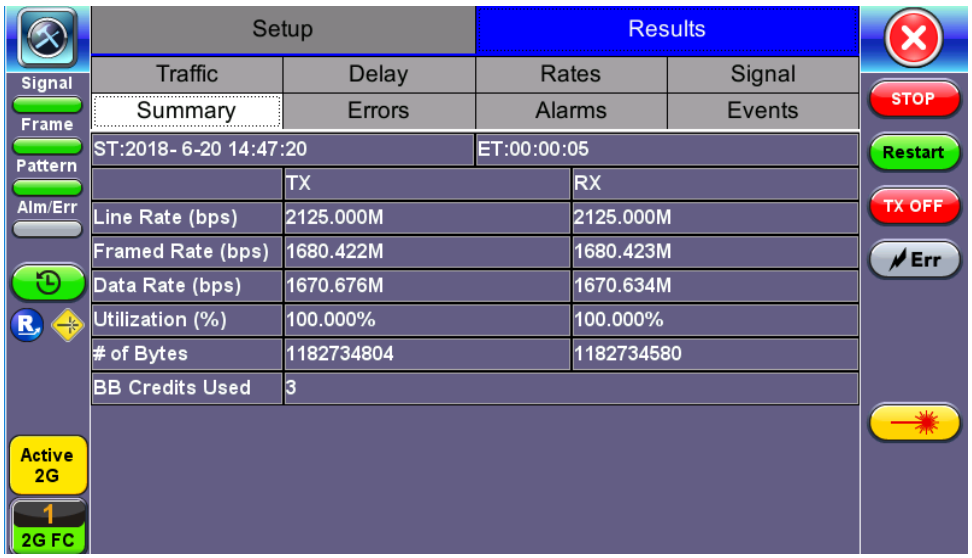
6.2.5 Results

Summary

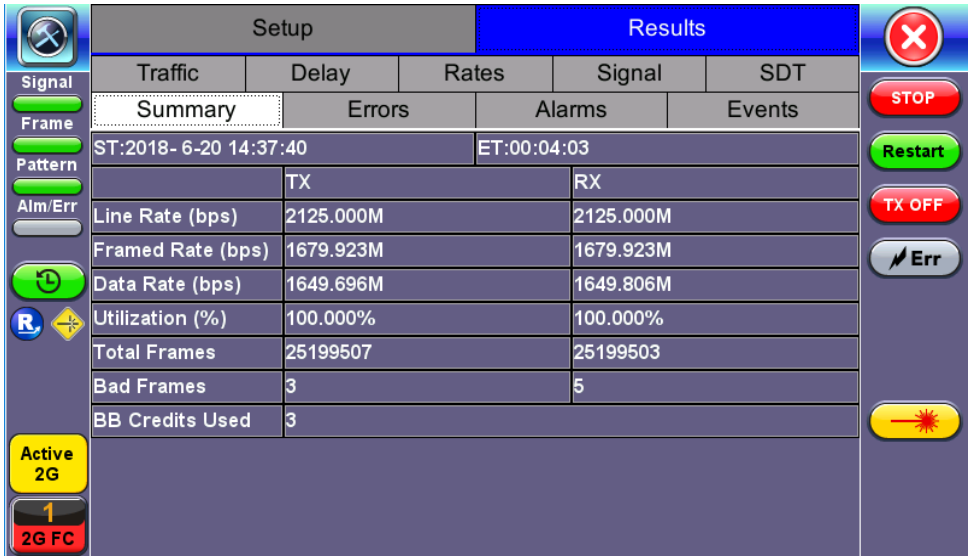
- **Line Rate:** Indicates the transmitted and received bit rate
  - 1.0625 Gbps, 2.125 Gbps, 4.25 Gbps, 8.50Gbps, or 10.52 Gbps, 14.025G, 16G displayed in Mbps
- **Framed Rate:** Total number of frames including overhead of any type per second (Mbytes)
- **Data rate:** Total count of frames with payload 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

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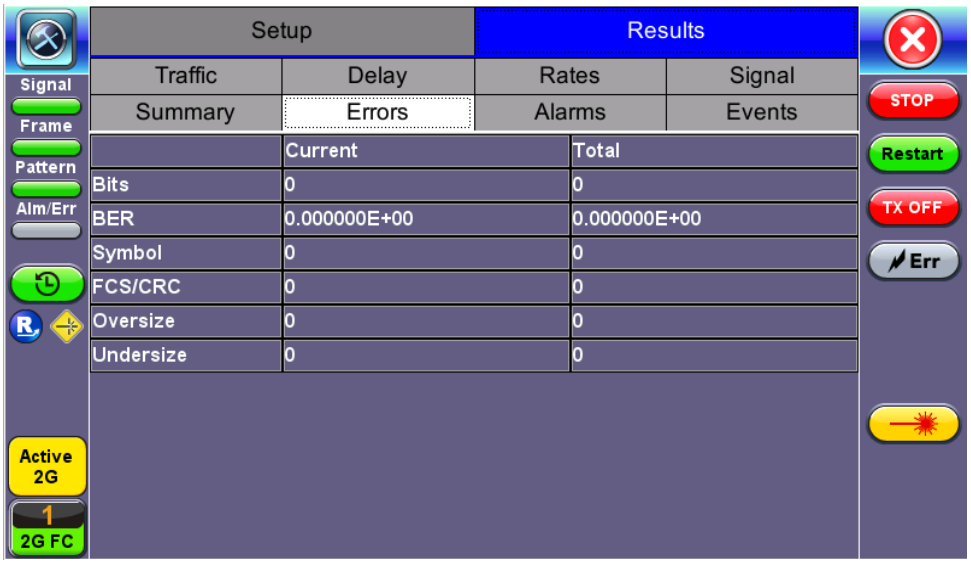
Errors

Current and Total values for:

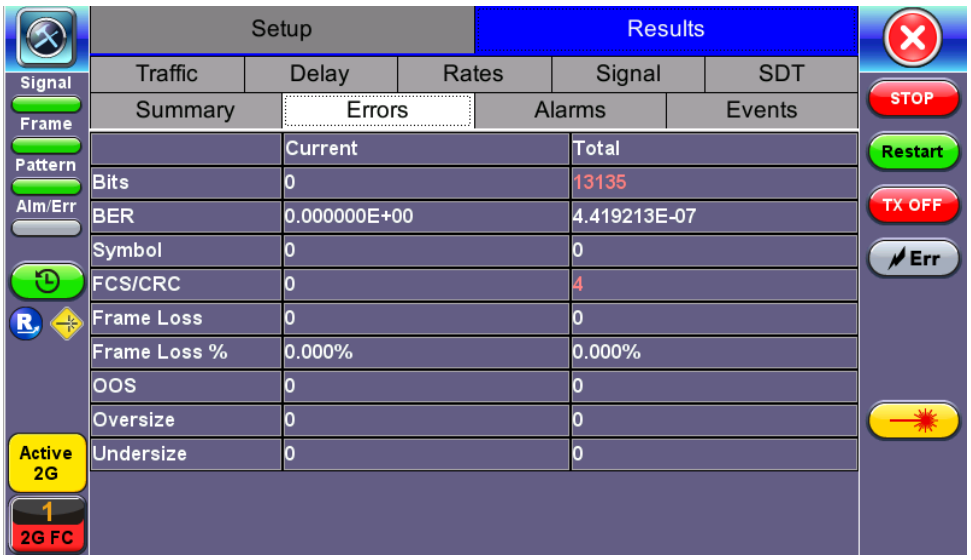
- **Bits:** Number of bits received
- **BER:** Bit error ratio based on PRBS received or ratio of payload bit errors to total received payload bits
- **Symbol:** Symbol error or Code Violation is a bit error or disparity error occurring in a primitive sequence or Ordered Set
- **FCS/CRC:** Number of 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)

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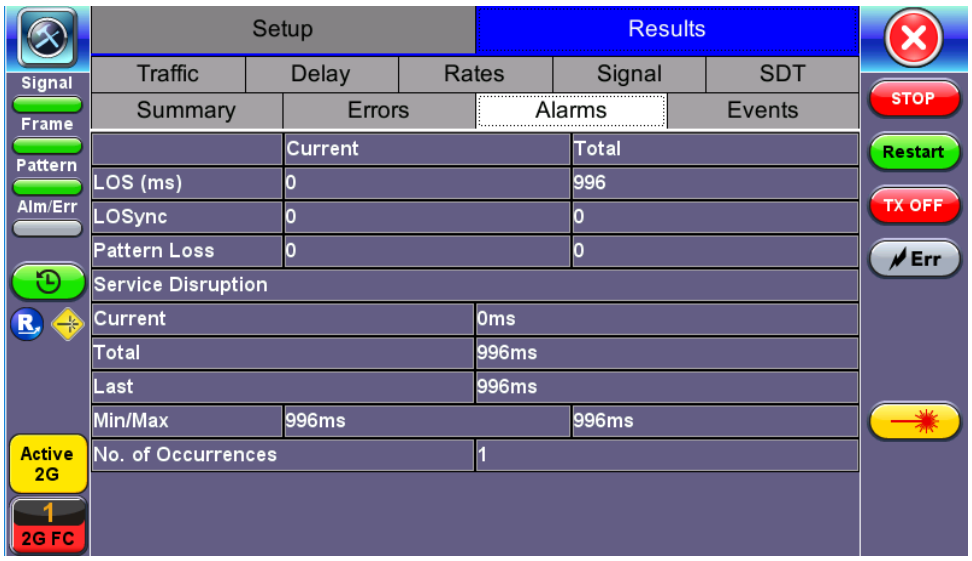
Alarms

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

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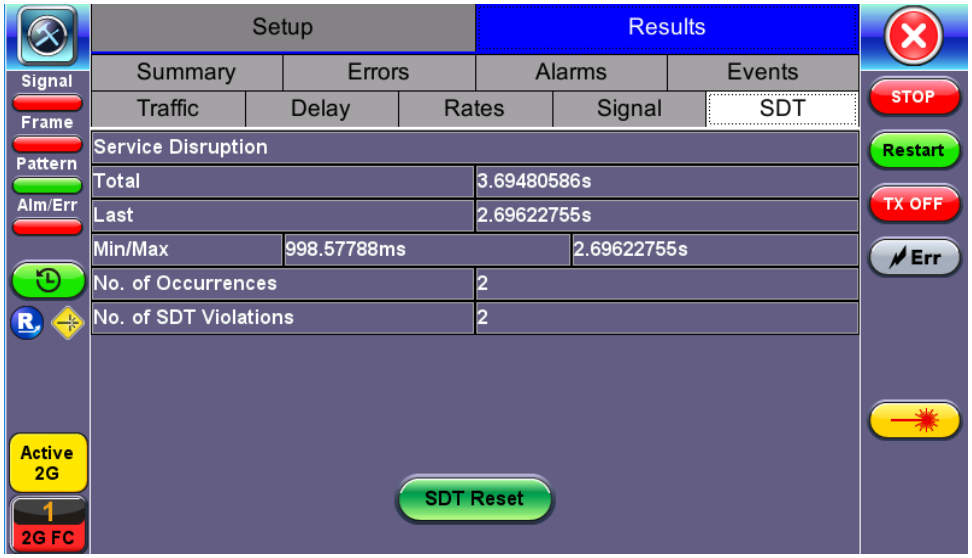
Service Disruption Test (SDT) ***(Throughput only)***

- **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

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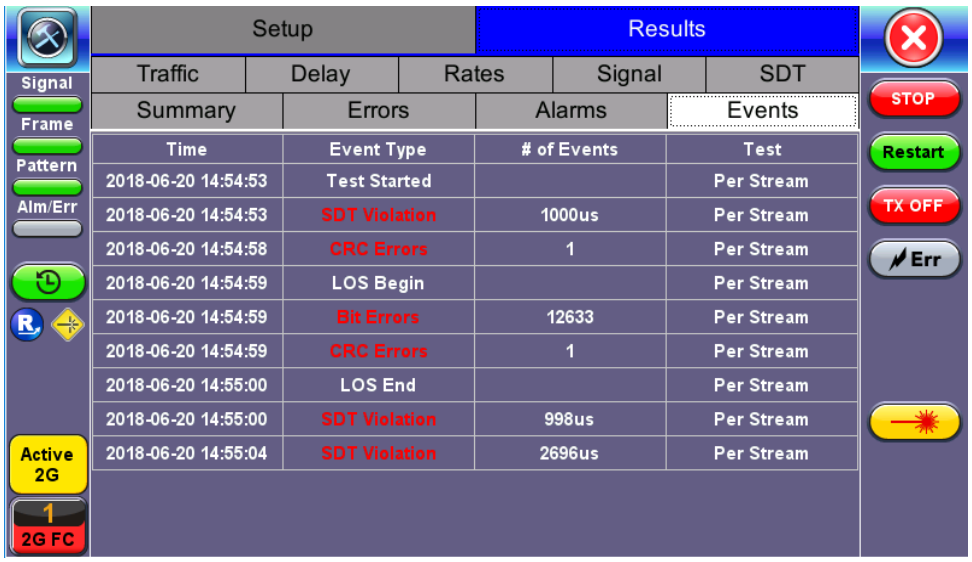
Events

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



Throughput - Events

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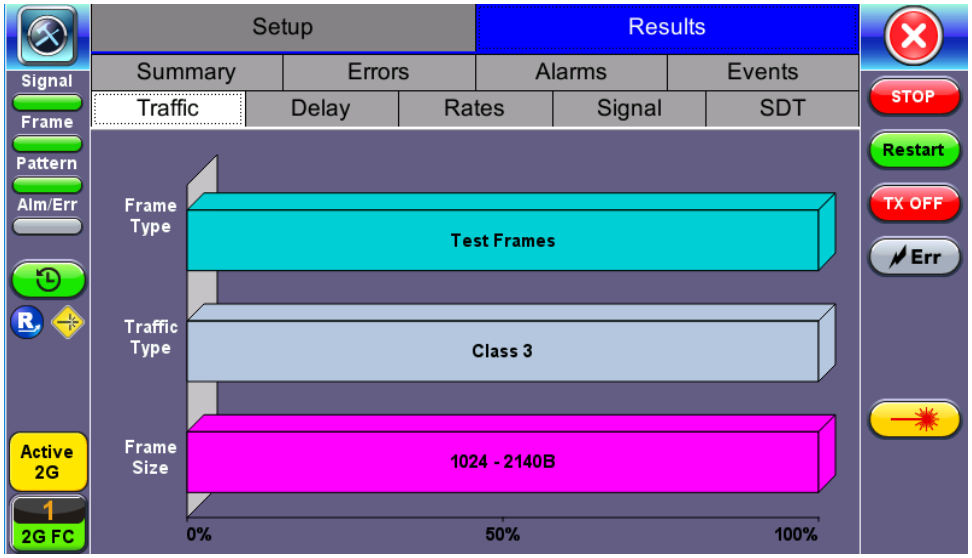
Traffic Distribution Overview

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

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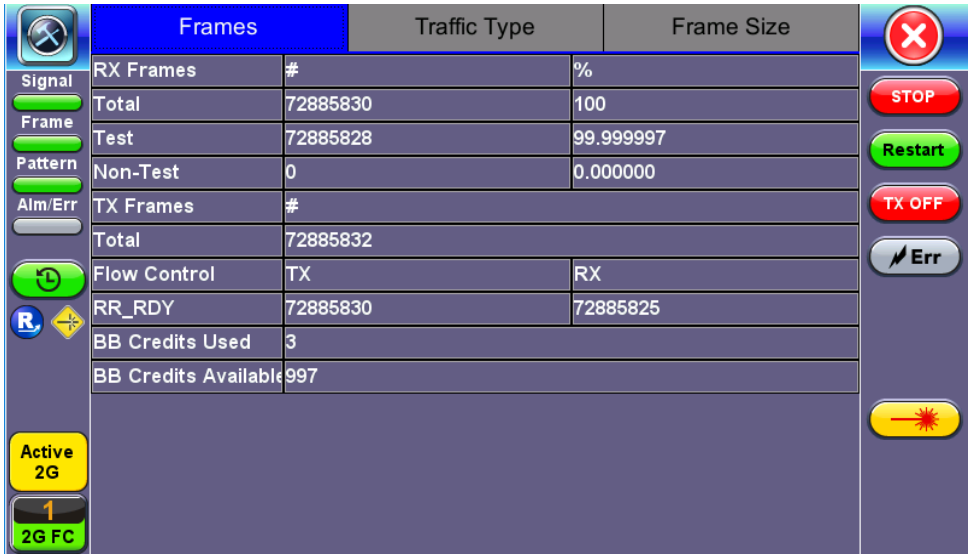
Traffic Distribution Details - Frames

- **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

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Traffic Distribution - Traffic Type

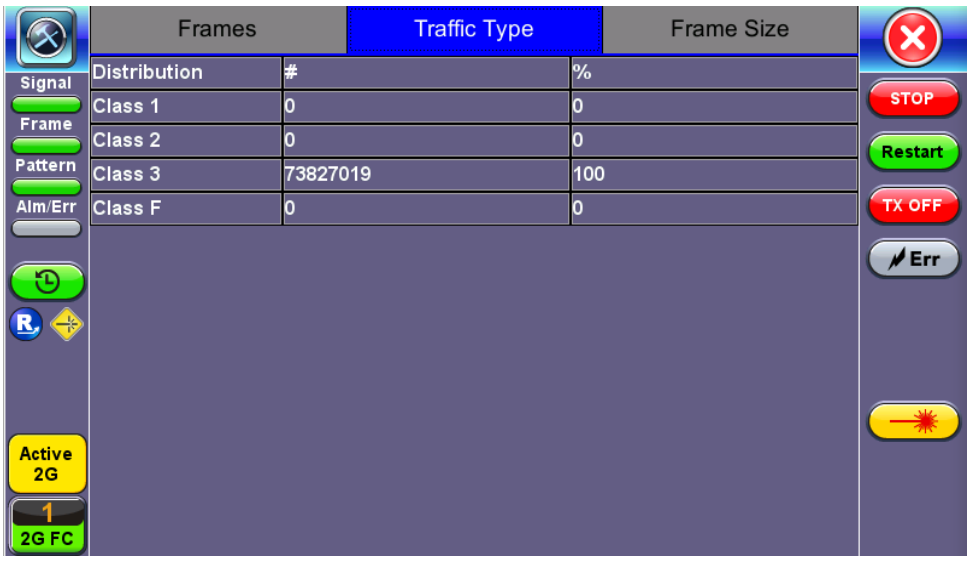
Fibre Channel supports three classes of services, and a fourth which is a combination of classes 1 and 2.

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

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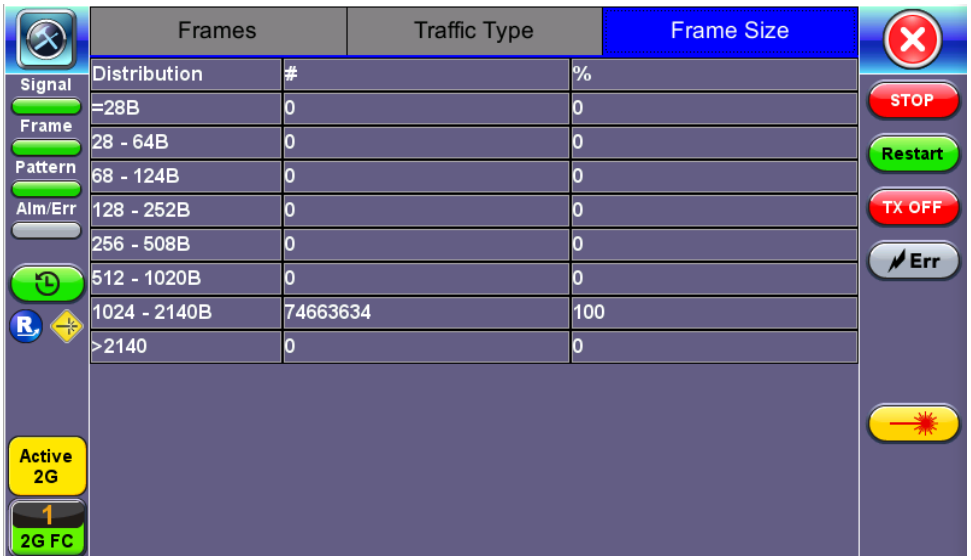
Frame Size Distribution

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



FC-BERT/FC-Throughput - Frame Size Distribution

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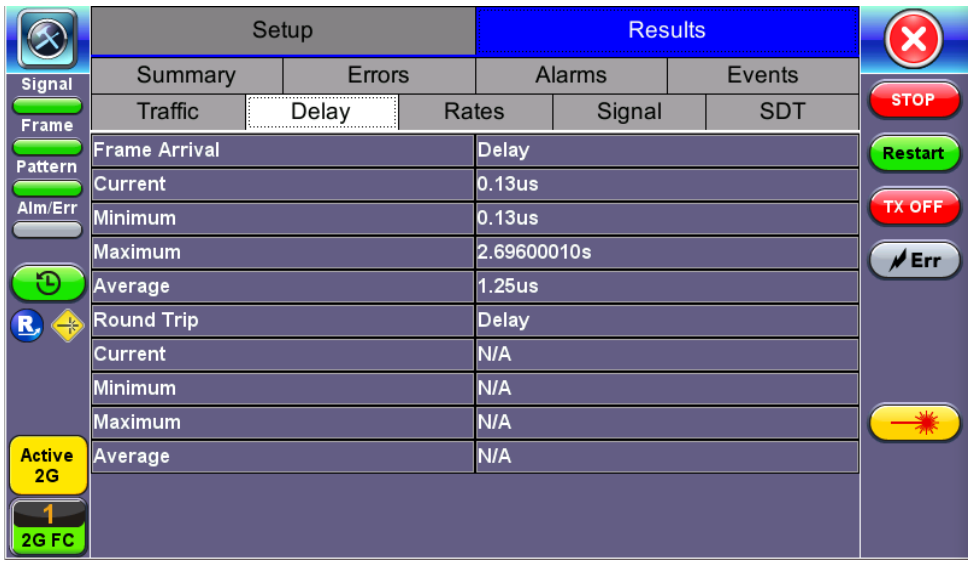
Delay

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 - Throughput - Delay

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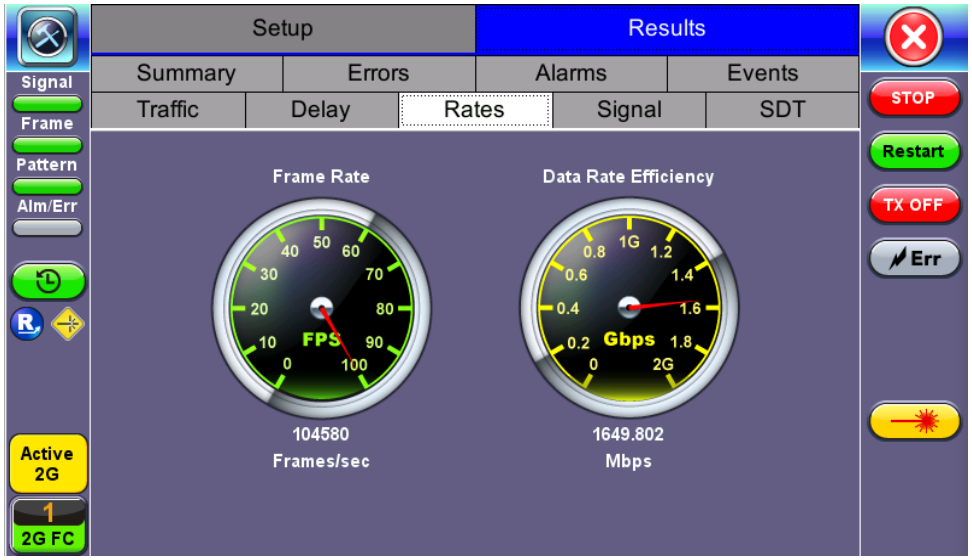
Frame Rate Summary

Graphical representation of the Frame rates and Data rates.



FC-BERT/FC-Throughput - Frame Rate Summary

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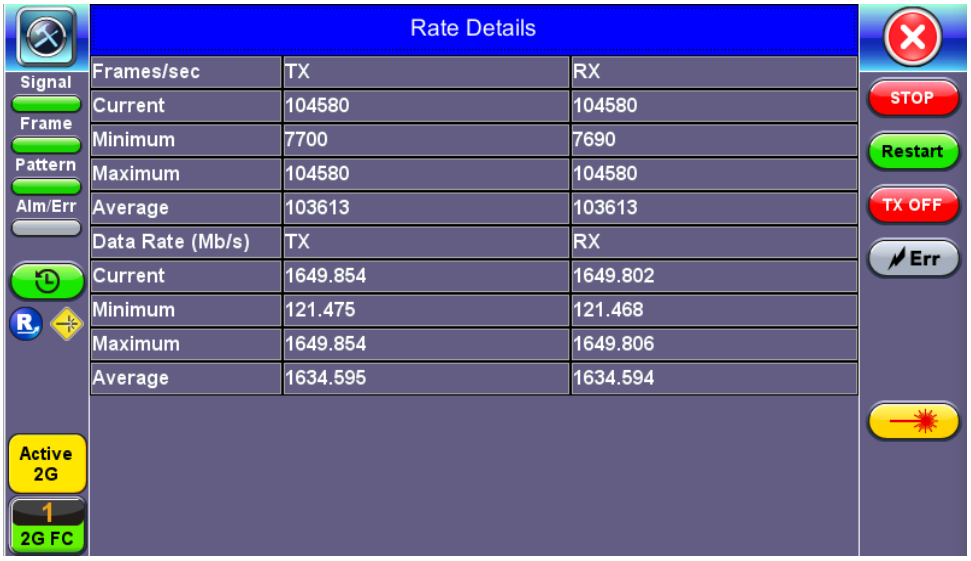
Frame Rate Details

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



Frames/sec	TX	RX
Current	104580	104580
Minimum	7700	7690
Maximum	104580	104580
Average	103613	103613
Data Rate (Mb/s)	TX	RX
Current	1649.854	1649.802
Minimum	121.475	121.468
Maximum	1649.854	1649.806
Average	1634.595	1634.594

FC-BERT/FC-Throughput - Frame Rate Details

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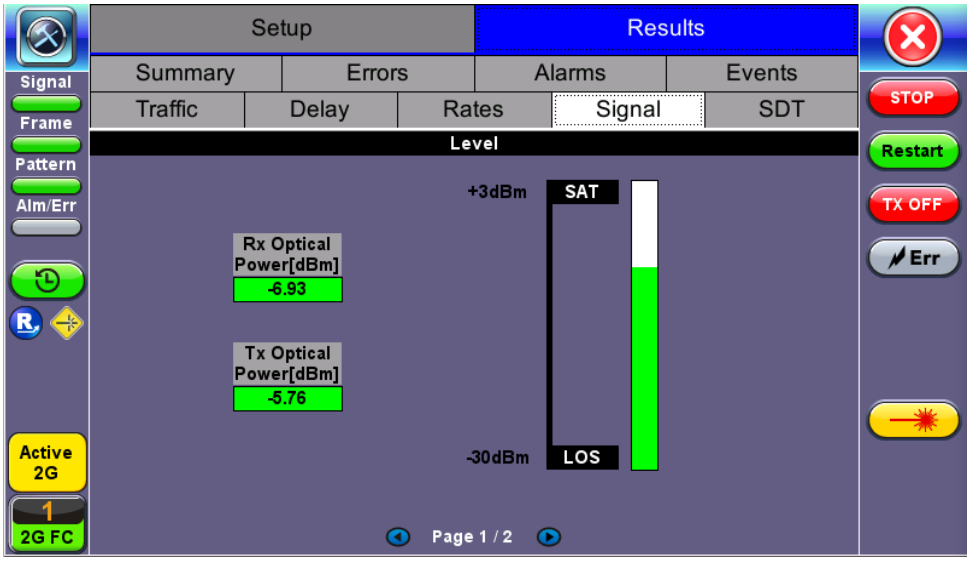
Signal

Level (Page 1)

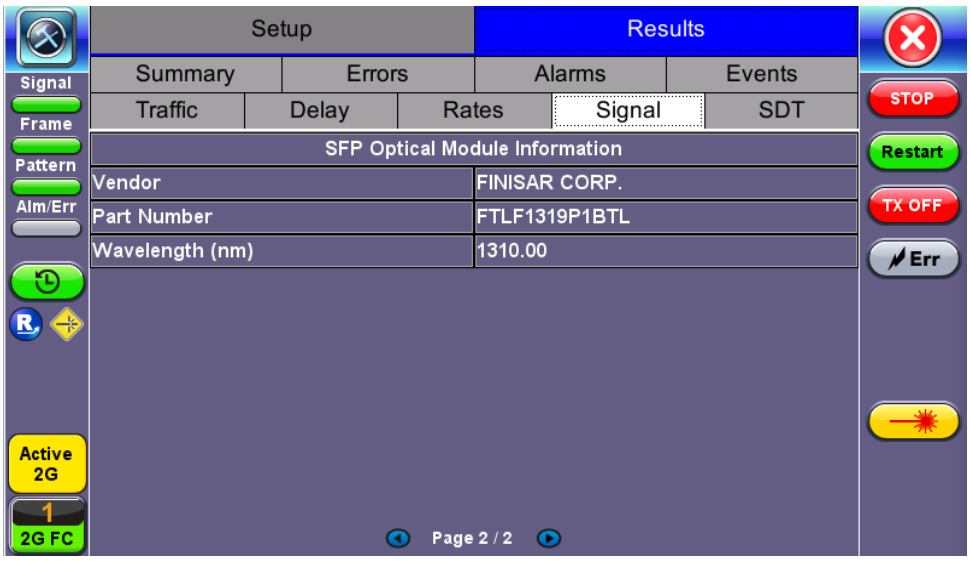
The Signal tab displays the Level and Frequency screen. Page 1 displays the level measurement Loss of Signal (LOS), and the Saturation level for optical signals is shown graphically, including the level measurement in dBm.



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)

Frequency (Page 3)

Page 3 displays the Frequency information which includes:

- **Current [bps]**: Indicates current frequency level.
- **Offset [ppm]**: Indicates the frequency offset.
- **Min [ppm]**: Indicates the minimum frequency detected.
- **Max [ppm]**: Indicates the maximum frequency detected.

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6.3 RFC 2544

The RFC 2544 Ethernet test suite is adapted to Fiber Channel circuits to verify 1Gbps, 2Gbps, 4Gbps, 8Gbps and 10Gbps 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

The test methodology is the same as for Ethernet testing. Please refer to the RFC 2544 section for details.

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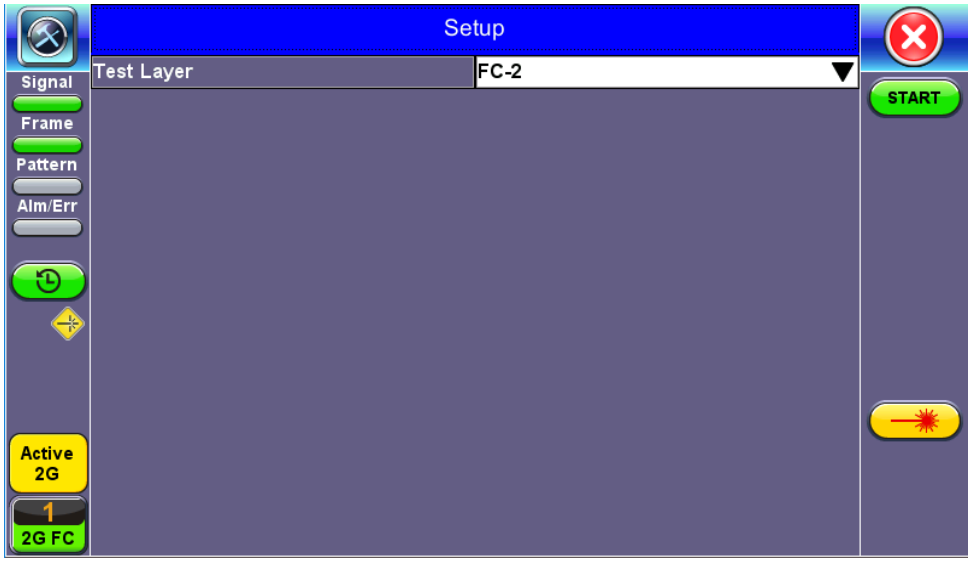
6.4 Loopback

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.).

To enable the loopback, press **Start**. Once the loopback is enabled, a message appears indicating that the loopback is active.

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7.0 Profiles

Profiles can be created in any application that has a "Profiles" drop-down menu available. The PDH, SDH, OTN, Ethernet and Fiber Channel applications, among others, all have the ability to save profiles.

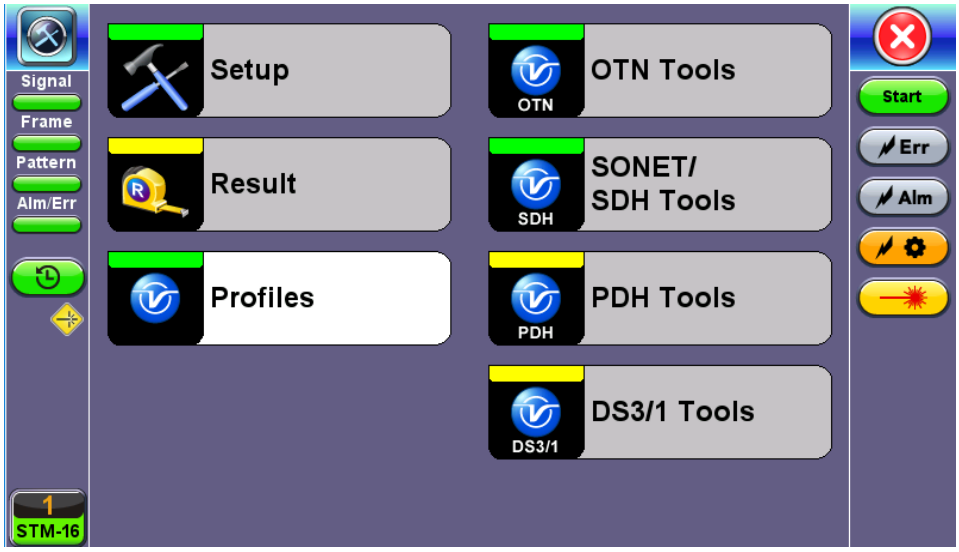
Profiles can also be managed from the Utilities icon > Files > Saved. Options include the ability to filter, rename, delete, export, and import files.

Accessing and Configuring Profiles

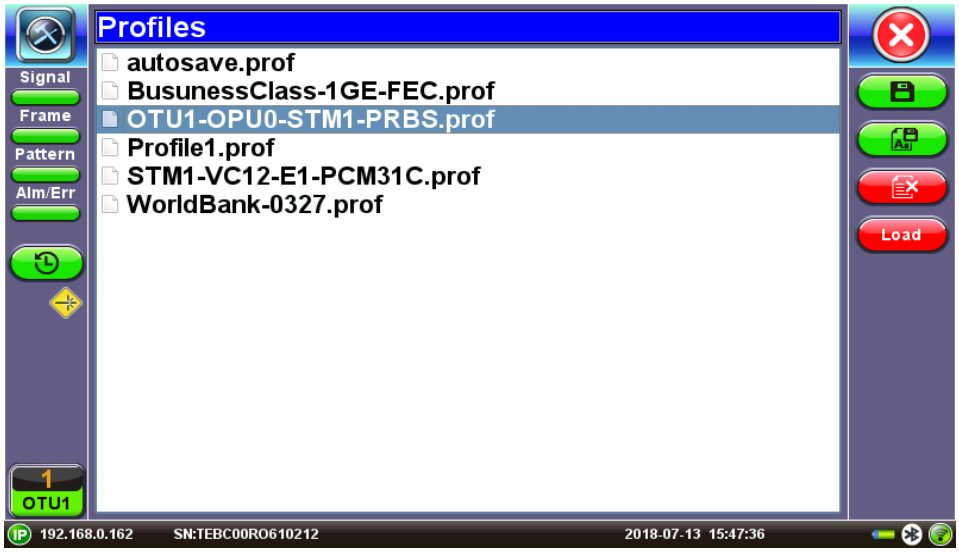
Tap on the **Profiles** icon to access the Profiles menu. Profiles can be managed from buttons on the right panel.

Profile Management Buttons

Profile Management Buttons	
	Save: Save current settings to the selected test profile.
	Save As: Save a new profile. This will bring up an alphanumeric keypad to name the profile. When the profile is saved, all of the test configurations that apply to the particular application are saved. This allows for fast access to preconfigured test configurations.
	Delete: Deletes the selected test profile.
Load	**Load:** Select a test profile to load onto the test application.



Home Menu with Profile Icon



Select a Profile to Manage

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8.0 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.

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

ROHS Statement

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.

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9.0 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.

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