The Verification Experts

USER MANUAL

Ethernet
Fiber Channel
OTN
SDH/SONET
PDH/DSn
Datacom

MTX150

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.

 D07-00-127P RevB00

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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 Introduction

Refer to the MTX150 specification sheet for information on platform highlights and key features.

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3.0 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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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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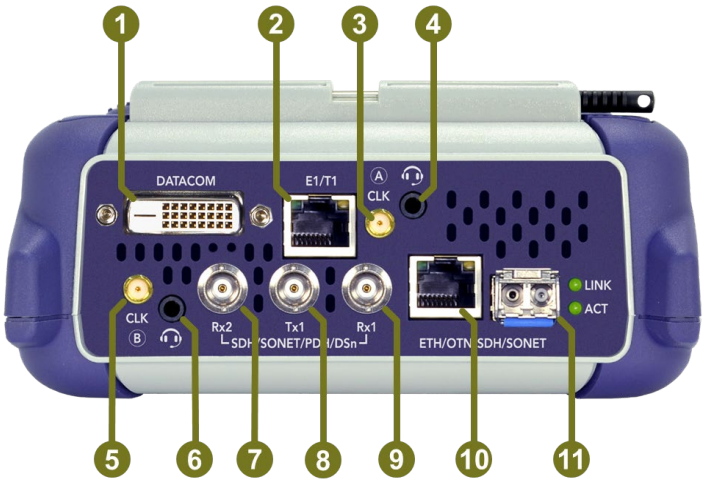
4.1 Connector Panel



MTX150 Connector Panel

1. **Datacom**: RS232A, RS232/V.24, V.35, RS449/V.36, X.21 (Uses VeEX's standard DTE and DCE interface cables)
2. **RJ48**: E1, T1, G.703 Codirectional (Balanced)
3. **SMA**: External Reference Clock Input (PDH/DSn)
4. **TRS 2.5mm**: Headset jack (PDH/DSn VF)
5. **SMA**: External Reference Clock Input (SDH/SONET, SyncE)
6. **TRS 2.5mm**: Headset jack (Auxiliary)
7. **BNC**: STM1e/0e, STS-3/1, E4, E3, E2, E1, T3 (Auxiliary RX)
8. **BNC**: STM1e/0e, STS-3/1, E4, E3, E2, E1 T3 (TX)
9. **BNC**: STM1e/0e, STS-3/1, E4, E3, E2, E1, T3 (RX)
10. **RJ45**: 10/100/1000Base-T
11. **SFP**: 100/1000Base-X, 10G, 4/2/1G FC, OTU1, STM64/16/4/1/0, OC192/48/12/3/1

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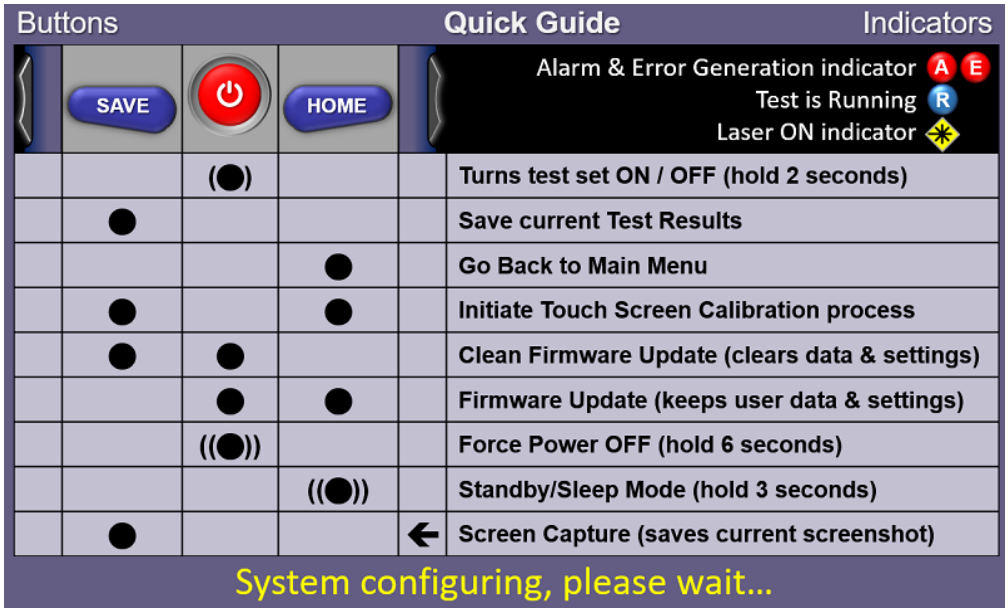
4.2. Hard Buttons and Interfaces

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.



Platform Settings Button Combinations

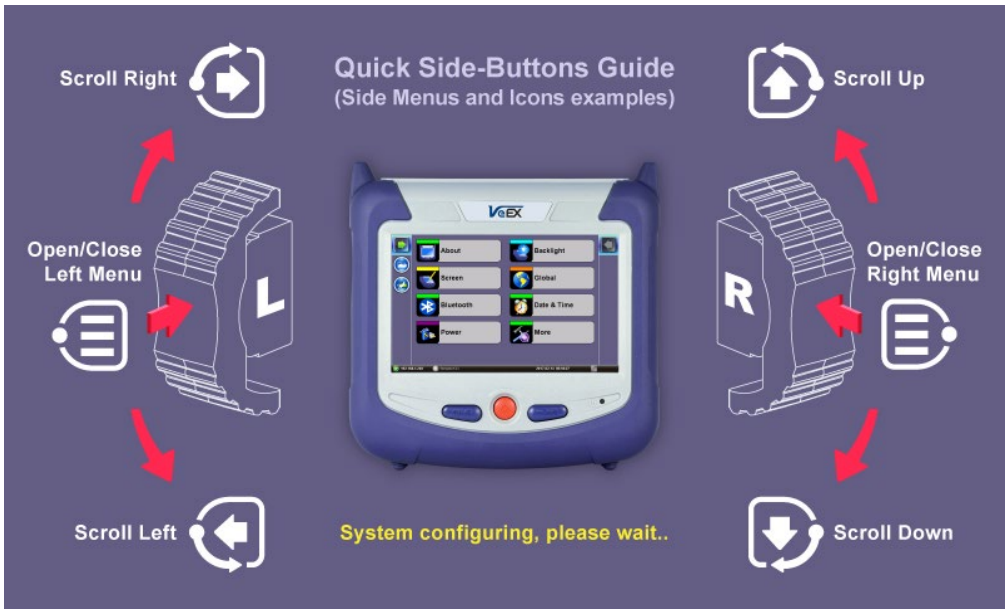
*Refer to the **V150 Common Functions** manual for software update instructions.*

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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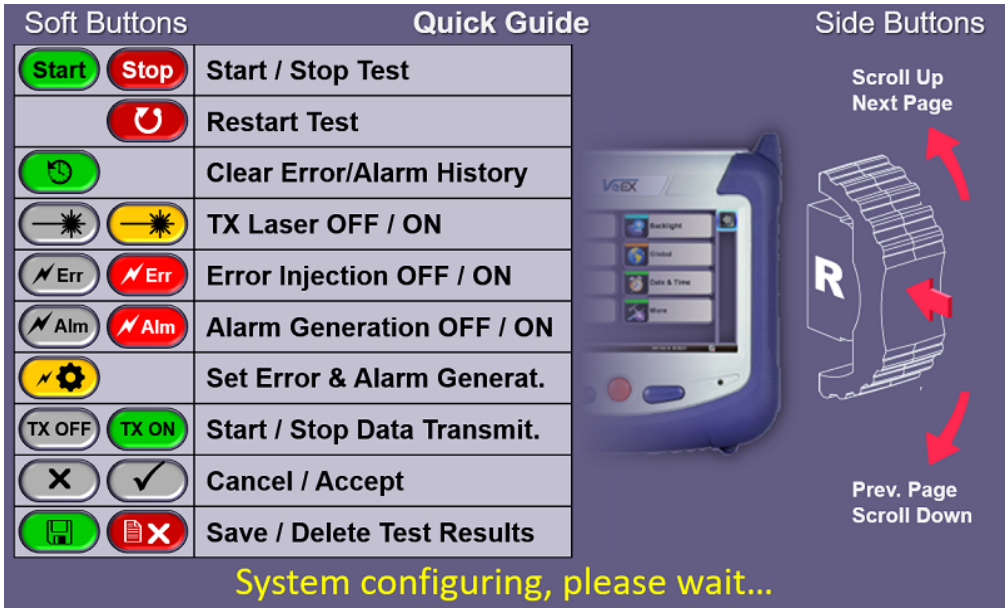
4.3 Home Menu and Screen Icons

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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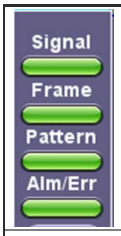
4.4 LEDs

Soft LEDS are supported on several test modes:



- **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

LED Status Lights

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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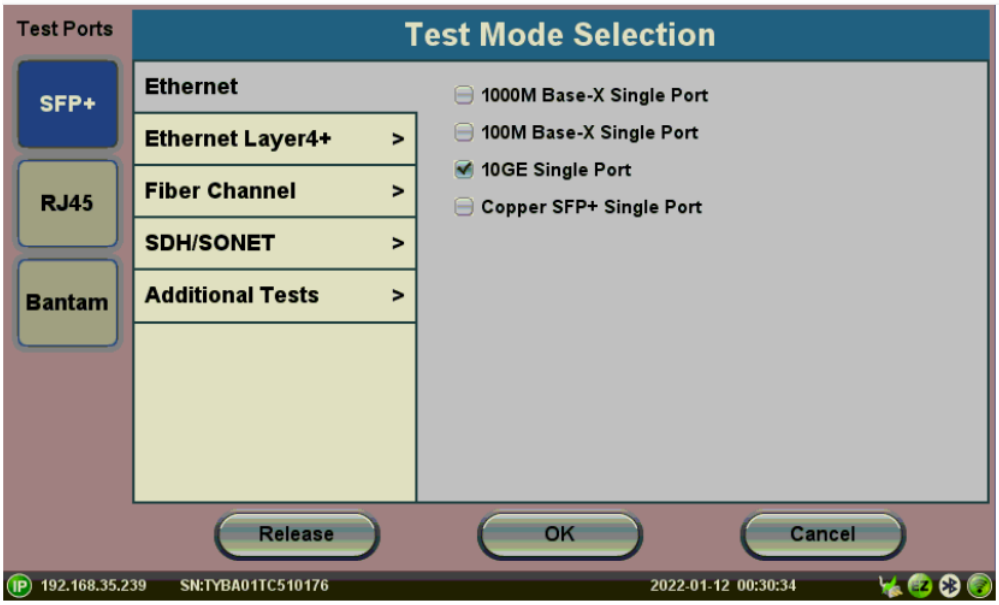
4.5 Test Port Selection

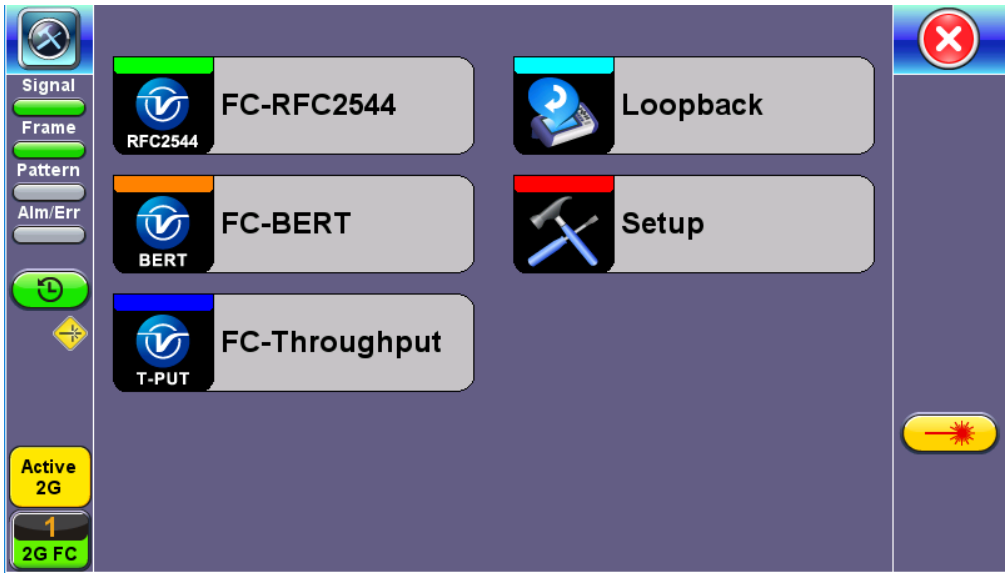
Test mode, test port(s), and network settings are required prior to performing any measurements or applications.

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

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5.0 Utilities

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

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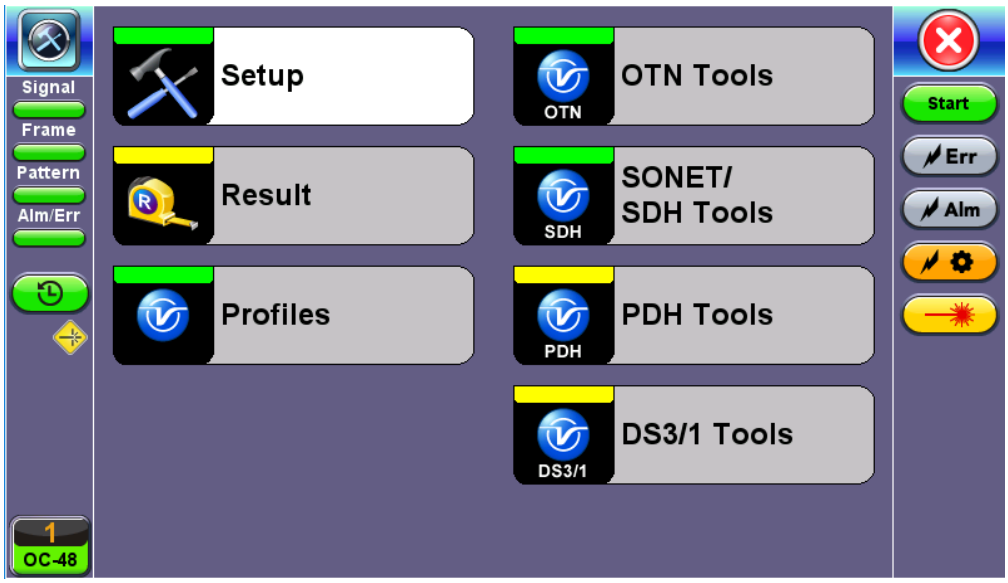
6.0 OTN, SDH/SONET, PDH/DSn Test Modes

Accessing Setup: Please see the Getting Started section in the **V150 platform manuals** for information on launching Test Applications.



OTN/SDH/SONET Home Menu

The Setup page has four tabs for setting the OTN, SDH/SONET, and PDH parameters: Signal, Measurements, General, and SDT tabs.

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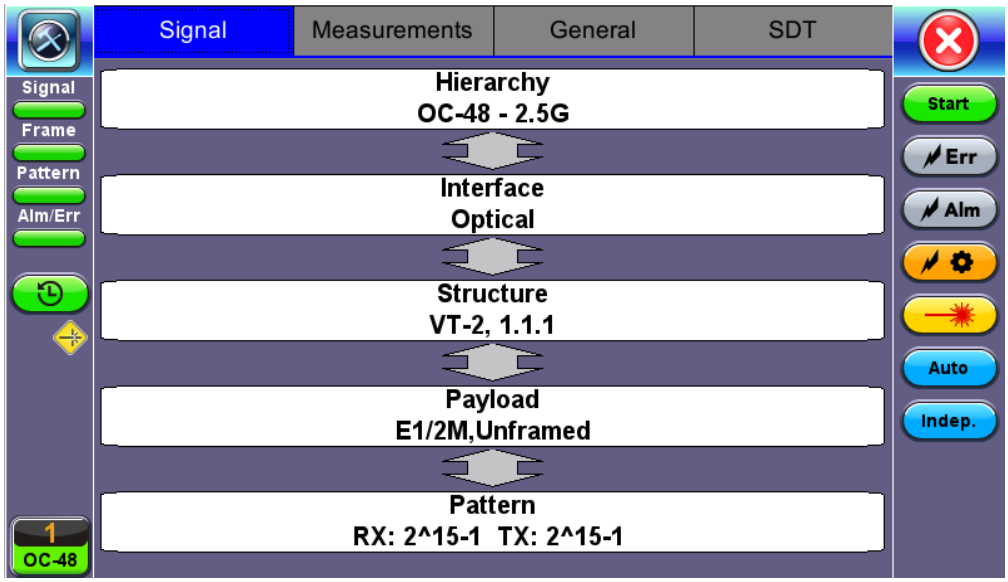
6.1 Signal Overview

Tap on the Signal tab to set up the Transmitter and Receiver interfaces and associated test parameters prior to running a test.



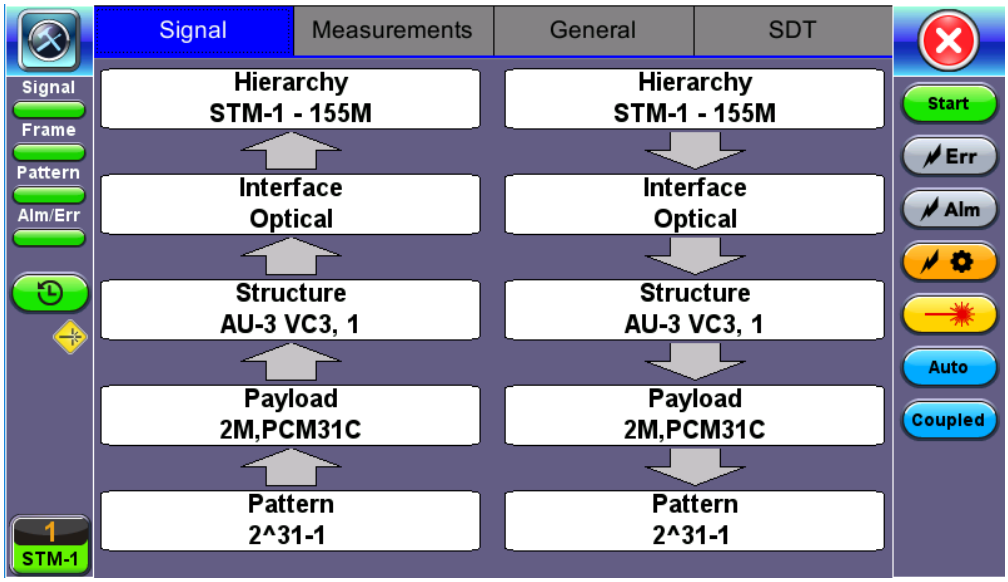
Signal tab

TX and RX Configurations

The Transmitter (TX) and Receiver (RX) configurations are grouped into a simple yet intuitive block diagram. The TX and RX signal parameters can be modified by tapping the applicable block which brings up a new dialog window displaying additional input and specific selection settings. The Transmitter transmits as soon as a valid configuration is entered. The Receiver will check for a valid signal on its input so the measurement function is synchronized. When a test is not running, the LEDs will still indicate errors and alarms, but any other results displayed will be the results of a previous test.

Coupled and Independent TX and RX

By default, TX and RX signal structures are coupled, making TX and RX configurations identical. To independently configure TX and RX signal parameters, tap **TX≠RX**. Tap **TX=RX** to turn on coupled configuration.



Independent TX and RX Signal Structures

Changes to the Setup are applied immediately unless an invalid parameter has been selected.

When the TX and RX signal structures need to be independent or asymmetrical, uncoupling the transmitter and receiver is possible. For example, the TX could be sending a PRBS of 2^23-1 in a VC12 carried within an optical STM-64, while the RX could be expecting to receive a PRBS of 2^23-1 in a 2Mbps E1 signal.

Hierarchy: Allows the user to configure OTN/SDH, OTN/SONET, PDH signal and network types, including the bit rate and higher order mapping, if applicable.

Interface: Allows the user to select optical or electrical test ports. Optical test ports apply to OTN/SDH signal types only, while electrical ports can apply to STTM-1E or PDH signals. Clock source and offset options are also configured in this screen.

Structure: Applies to SDH/SONET signals only and allows the user to configure lower order mapping and the channel number.

Payload: Applies to both SDH/SONET and PDH signals and allows the user to configure low rate signal (if applicable) and associated framing.

Pattern: Applies to both SDH/SONET and PDH signals and allows the user to configure the test pattern to be used. Use the pattern drop-down box to select the test pattern which will be inserted into the transmitted signal. Pseudo Random Bit Sequences (PRBS) defined by ITU-T 0.150 and 0.151 standards, fixed words and 24-bit or 32 bit user defined patterns are available. ***Note**: If the 32 bit user pattern entered is incorrect, the default pattern will be 0xFFFFFFFF.*

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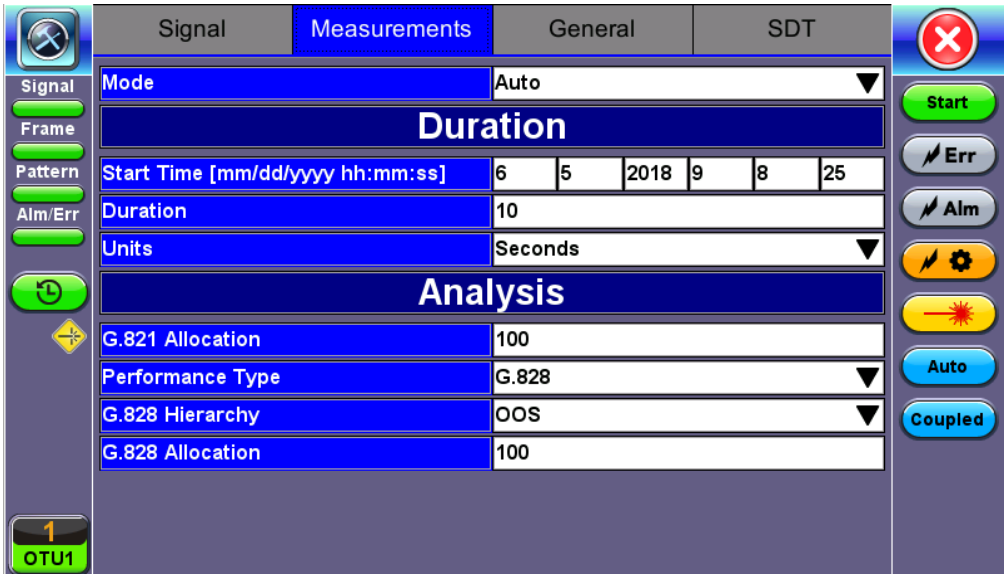
6.2 Measurement Configuration

Tapping the **Measurements** tab opens the setup screen for the Timer, Performance Analysis, and General configurations.



Measurements tab

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6.2.1 Timer Setup

Configure a test to run for a fixed duration and/or a delayed start.

Mode: Manual, Timed, and Auto selections are available.

- **Manual:** This is directly linked to the Start/Stop function on the drop-down menu. The test starts as soon as the **Start** button is pressed.
- **Timed:** The test duration can be set by the user in seconds, minutes, hours or days. The test is activated by the Start/Stop function on the drop-down menu and stops automatically when the defined time has elapsed.
- **Auto:** A predetermined start time can be set by the user. The test duration can be set in seconds, minutes, hours or days. After programming the start time and duration, press the **Start** button and the test will be activated automatically when the programmed start time is reached.

M.2100 and M.2101 performance objectives are only available in Timed and Auto Mode.

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6.2.2 Performance Analysis

The Analysis setup page selects the type of ITU-T performance evaluation that will be performed by the unit. Depending on Test mode, the selections include None, G.821, G.826, G.828, G.829, G.8201, M.2100, and M.2101. The available options may vary depending on configuration.

The recommendations are briefly defined as follows:

- **G.821:** Error performance of an international digital connection operating at a bit rate below the primary rate and forming part of an Integrated Service Digital Network (ISDN)
  - Long term error performance conducted Out of Service (OOS)
  - Based on measuring bit errors
  - Evaluation period of 30 days
  - Since there is no overhead structure at these bit rates, in-service measurements are not recommended
- **G.826:** End-to-end error performance parameters and objectives for international, constant bit rate digital paths and connections

    - Long term error performance for Out of Service (OOS) and In-Service Monitoring (ISM)
    - Based on measuring bit errors for connections and block errors for paths
    - Evaluation period of 30 days
- **G.828 Analysis**: Error performance parameters and objectives for international constant bit rate synchronous digital paths
    - Deals exclusively with SDH paths
    - Long term error performance for Out of Service (OOS) and In-Service
    - Based on measuring block errors
    - Evaluation period of 30 days
- **G.829 Analysis:** Error performance events for SDH Regenerator and Multiplexer sections
    - Deals exclusively with SDH sections
    - Error event definition
    - Based on measuring block errors
- **G.8201:** Error performance parameters and objectives for multi-operator international paths within optical transport networks (OTN) addressing the objectives for international (and national) ODUk paths. This is a block-based measurement concept using error detection code (EDC) and EDC usage inherent to the path under test. This simplifies in-service measurements.
    - Error performance for Out of Service (OOS) and In-Service Monitoring (ISM)
- **M.2100:** Performance limits for bringing into service and maintenance of international multi-operator PDH paths and connections
    - Deals exclusively with PDH paths, sections and systems
    - Based on measuring bit errors and block errors
    - Bring-into-Service (BIS) limits for OOS/ISM
    - Evaluation periods of 15 minutes, 2 hours and 24 hours
    - First step is a continuity test for 15 minutes
    - PDH paths are composed of sub-elements of different lengths each with its own set Reference Performance Objectives (RPO)
- **M.2101 Analysis:** Performance limits and objectives for maintenance and bringing into service SDH paths and multiplex sections.
    - Deals exclusively with SDH paths and sections
    - Based on measuring block errors
    - BIS limits for OOS/ISM
    - Evaluation periods of 15 minutes, 2 hours, 24 hours and 7 days
    - First step is a continuity test for 15 minutes

Only one performance analysis can be performed at a time. To view or enable the M.2100 and M.2101 analyses, the measurement timer has to be set to a determined period. The table below describes the anomalies evaluated for the performance analysis selected.

ITU-T Performance Analysis for PDH and SDH systems			
Analysis	**PDH**	**SDH**	**Anomalies**
G.821	●	●	TSE based on bit errors
G.826 (Out of service)	●	●	TSE based on block errors
G.826 (In service)		●	B1, B2, B3, LP-BIP, E1/E3/E4 FAS, E1, CRC
G.828 (In service)		●	B1, B2, TSE
G.829 (In service)		●	B1, B2, B3, LP-BIP, TSE
M.2100	●		E1/E3/E4 FAS, E1, CRC, TSE
M.2101		●	B1, B2, B3, HP, LP-BIP, TSE

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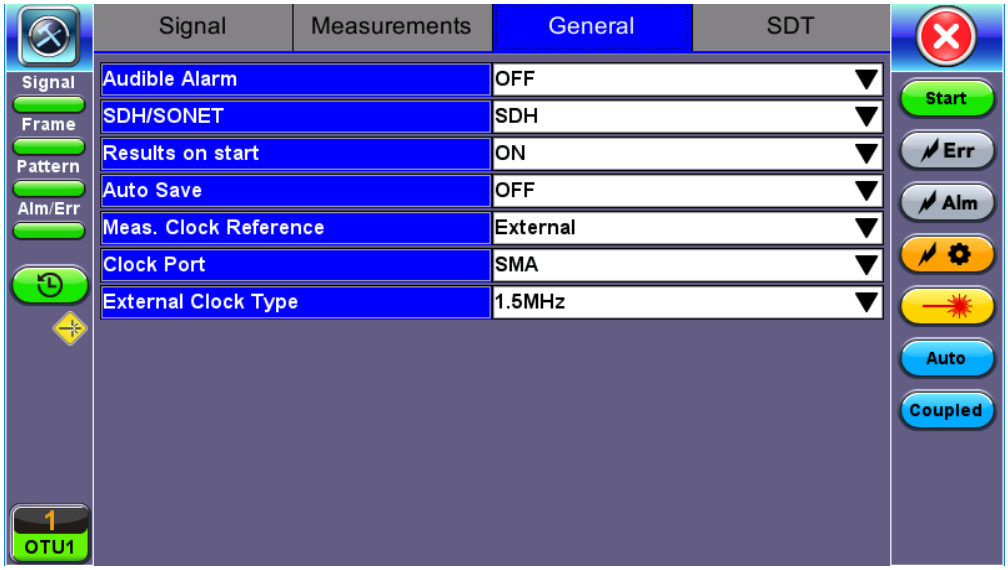
6.2.3 General

The General setup page configures the audible alarm and APS protocol settings. Audible alarms may not be supported by all test sets, technologies and applications.



General tab

- **APS Protocol:** Linear or Ring architectures are selectable. This determines how the APS bytes (K1/K2) are decoded in the SDH Overhead Analyzer or how they are generated in the SDH Overhead Generator. It also determines how the APS measurement will be made.
- **SDH/SONET:** SDH or SONET modes are available options. Defines the reference standard to be used for GUI terminology and functionality. Select SDH for SDH and PDH applications. Select SONET for North American SONET and DSn (T1 and T3). This may also change the behavior of certain menus and function.
- **STS-1 Bulk data** (SONET only): The STS-1 bulk mode fills the entire payload, except for the POH.
- **Result on start:** On or Off. Provides an automatic move to Result screen when it starts.
- **Auto Save:** Tap Auto Save and set it to **ON** to automatically save the results file.
- **Measurement Clock Source:** Internal Clock or Tx Clock Source; the measurement is synchronized to the Transmitted (Tx) Clock.

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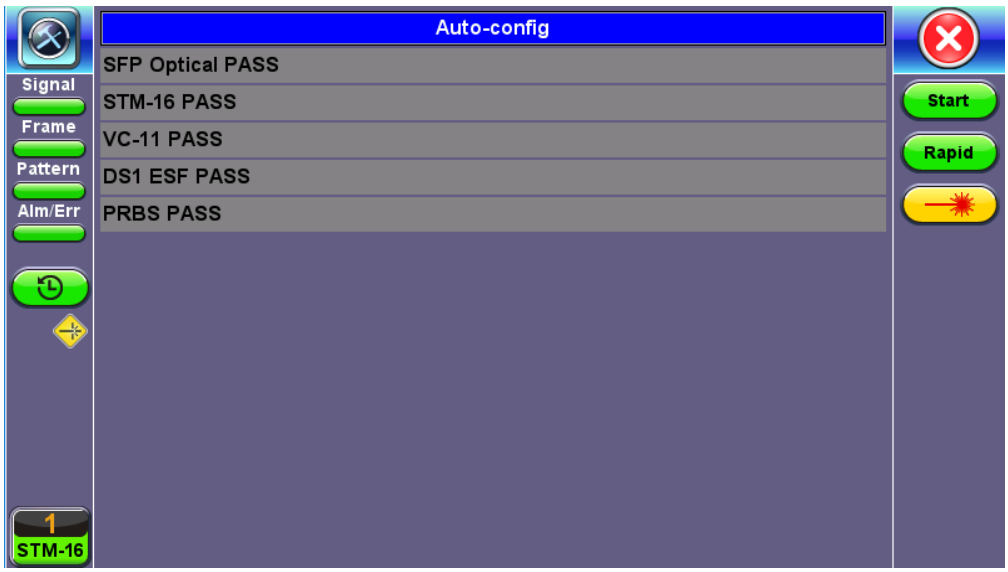
6.2.4 Auto-Config



Auto-config tab

The **Auto-Config** function automatically configures the test set's interface to match the received signal. A search for SDH and PDH signals at both the electrical or optical inputs is performed to determine the signal structure. For electrical signals, both Terminated and PMP voltage ranges are searched and supported.

Procedure

From the Signal tab, tap **Auto-config** > **Start** to begin the search. The received signal is checked for network type, hierarchy and bit rate, payload structure, payload framing, test pattern and signal level. If the search is successful, a “PASS” result is displayed.

Search parameters and criteria

- **Interface:** Checks physical parameters (bit rate line code).
- **Mapping:** Checks mapping structure using the signal label and pointer bytes.
- **Payload:** Only test patterns defined in ITU-T or ANSI standards will be recognized. If no test pattern is detected, the unit assumes live traffic.

PDH Signals: Unframed or framed payloads at all hierarchies. For 1.5M signals containing 64kbps timeslots, the test set will assume live traffic and will not search for a test pattern.

If minor changes are made to an existing or similar test interface, select **Rapid** to load the test faster. Rapid starts searching from the selected interface rather than searching from the highest test rate and moving down (e.g. searching from STM-64 to STM-16).

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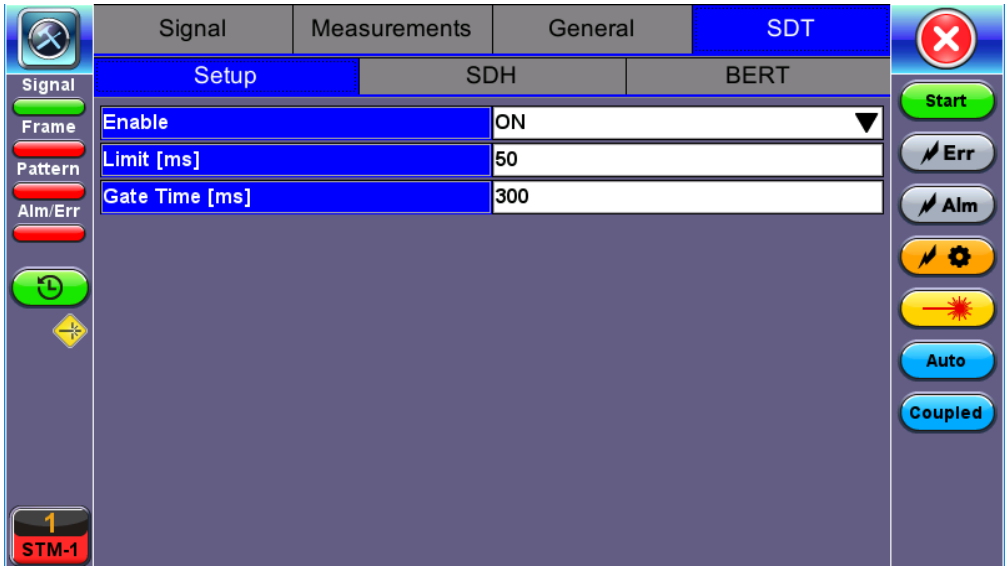
6.2.5 Service Disruption Test (SDT)



SDT Setup

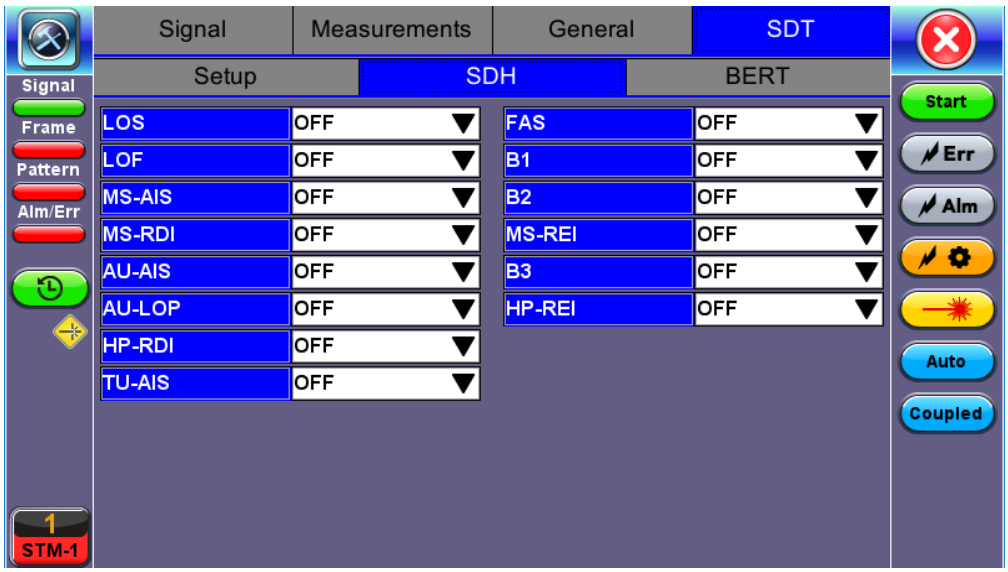
A service disruption is triggered by any qualifying error or alarm determined by the user and continues to count until the error-free condition (Gate Time) is met. If SDT is enabled and alarm/error triggers are selected, the results will appear in the Results section under the SDT tab.

Testing Process

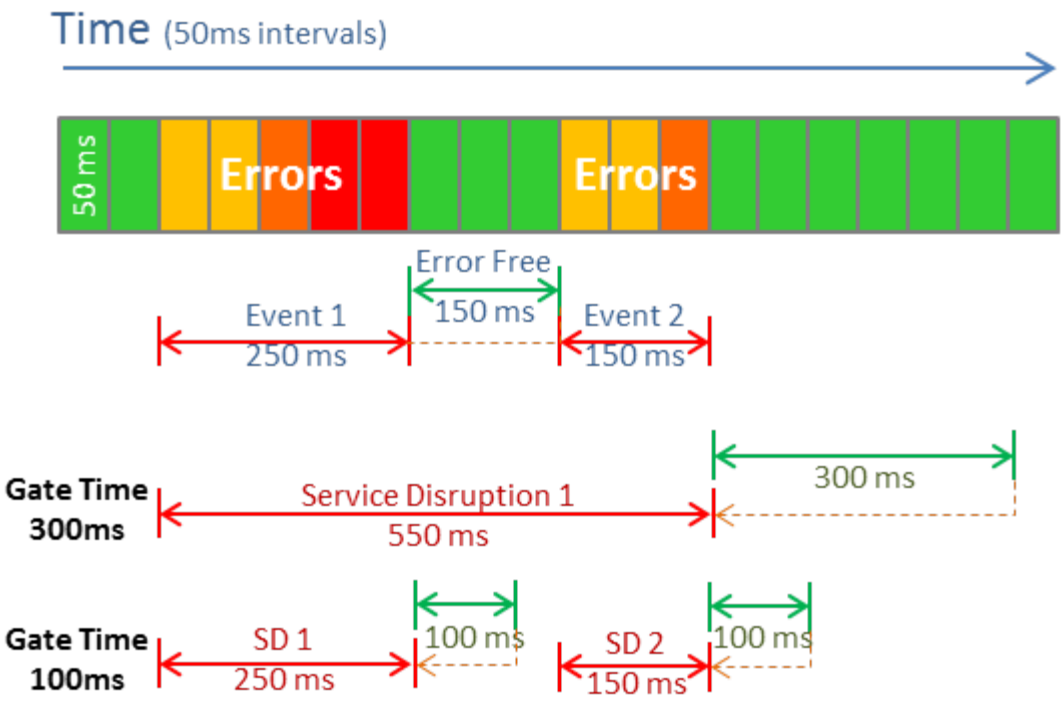
- The test set measures how long the event remains present after it is first recognized and will continue to measure the total service disruption time in the event of multiple disruptions.
- Before starting, ensure that no errors or alarms are present on the transmission system because this will impact the measurement.
- In the past, Automatic Protection Switching (APS) was used to measure physical service cuts, especially in optical links. Service disruption measurements are meant to measure the total time the service is not available to customers, which is not limited by the optical path cut. Therefore, it configures to include the time the whole system takes to recover.
- Service Disruption can still be used to measure APS time, if the trigger selected is LOS only. This will just measure the physical protection switch time.

Setup

1. Set **Enable** to ON to activate SDT testing.
2. Set a limit time and gate time. Limit and Gate Time counters begin at the onset of the first valid event.
    - **Limit Time:** Specifies pass/fail criteria for SDT events. This represents the acceptable amount of time for the customer to experience a service disruption. Events greater than the limit time are considered a fail. Configurable from 20 to 1000 ms.
    - **Gate Time:** Specifies the length of error free signal time used to determine the number of service disruptions. Configurable from 20 to 10000 ms. The Gate Time is not included in the service disruption time calculation.
3. Select the type of errors/alarms from the **SONET**, **PDH**, **BERT**, **OTN** tabs that will trigger the SDT test.
4. Press the **Start** button to begin testing.



SDT SDH



Multiple Service Disruptions

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

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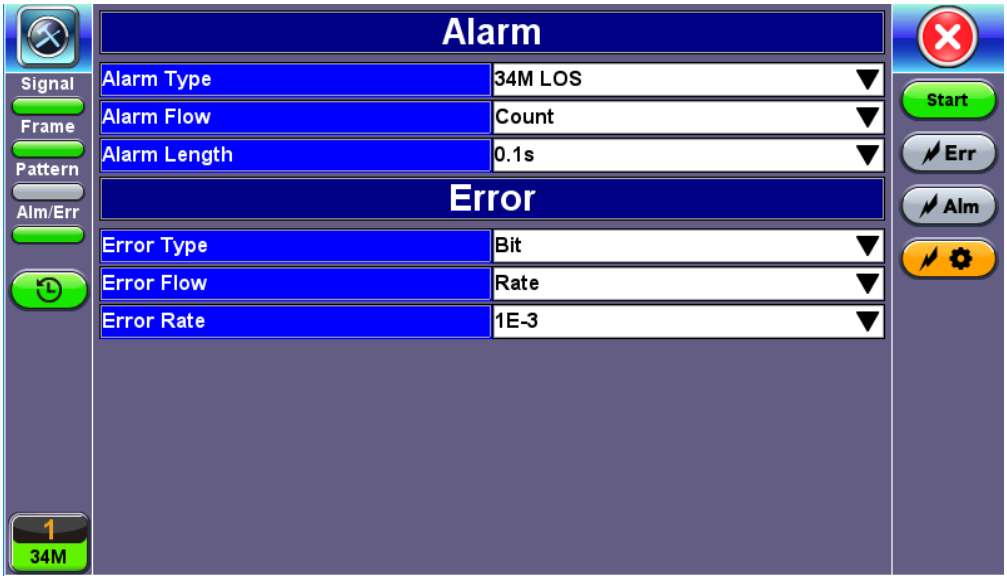
6.2.6 Alarm Generation and Error Insertion

Accessing Alarm and Error Generation Setup Menu

Tap on the **Alarm/Error Generation** Setup icon to open the Alarm and Error setup menu.

Alarms and errors selected in the drop-down menu are assigned to the Alarm and Error injection buttons.



PDH Alarm/Error Insertion Setup

The list of available alarm/error types depend on the type of framing being used and the SDH or PDH hierarchies and line interfaces that have been selected.

Alarm/Error Injection Buttons

Tap Alm to insert alarms or Err to insert errors any time during testing. Available alarm and error types depend on PDH, SDH, or OTN signal types.

Alarm/Error Generation Flow Types

Alarm and error flow determines how alarms and errors will be inserted into the transmit signal. Alarm flow types include:

- **Continuous:** Generates a continuous alarm when button is tapped
- **Count:** Specific count for 0.1s, 1s, 10s, 100s when button is tapped

Error insertion flow types include:

- **Single:** Inserts a single error every time the insertion button is tapped
- **Count:** Specific count or number of errors when the insertion button is tapped
- **Fixed Rate:** Specific rate between $1x10^{-3}$ and $5x10^{-6}$

Available alarms and errors may depend on signal or payload structure.

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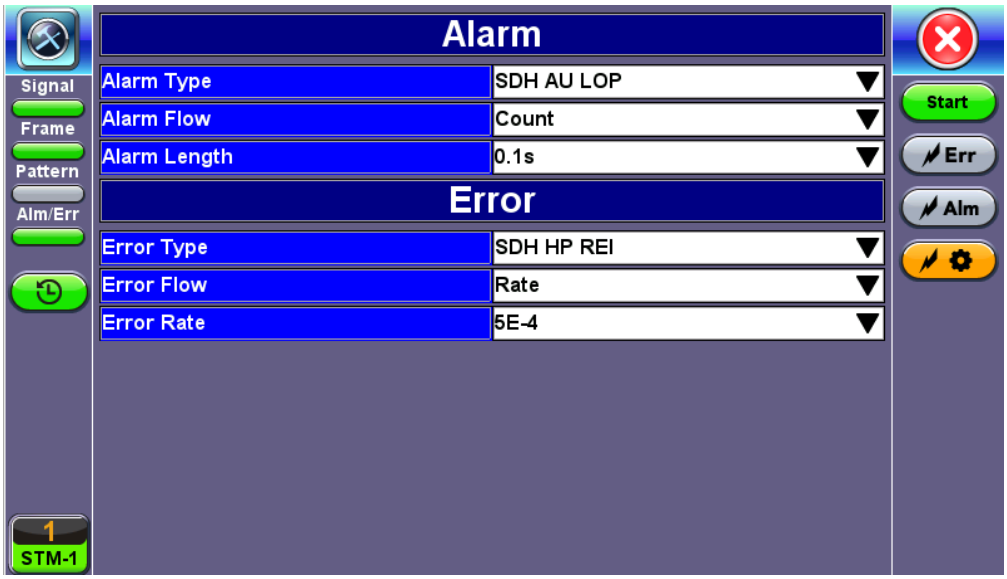
6.2.6.1 SDH

The following **SDH Alarms** can be generated:

- **STM-0/1/4/16:** LOS, LOF, MS-AIS, MS-RDI, RS-TIM, AU-LOP, AU-AIS, HP-UNEQ, HP-PLM, HP-RDI, HP-TIM, TU-LOM, TU-LOP, TU-AIS, LP-UNEQ, LP-PLM, LP-RDI, LP-RFI, LP-TIM

Payload alarms: DS1-AIS, DS1-LOF, 2M-AIS, 2M-RDI, 2M-LOF, 34M-AIS, 34M-LOF, 34M-RDI, 45M-AIS



SDH Alarm/Error Menu

The following **SDH errors** can be generated:

- **STM-1/4/16 signals:** FAS, B1, B2, MS-REI, B3, HP-REI, LP-BIP, LP-REI,
- **Depends on payload:** 2M-FAS, 2M-CRC, 2M-REI, 34M-FAS, 45M-FAS, 1.5M-FAS

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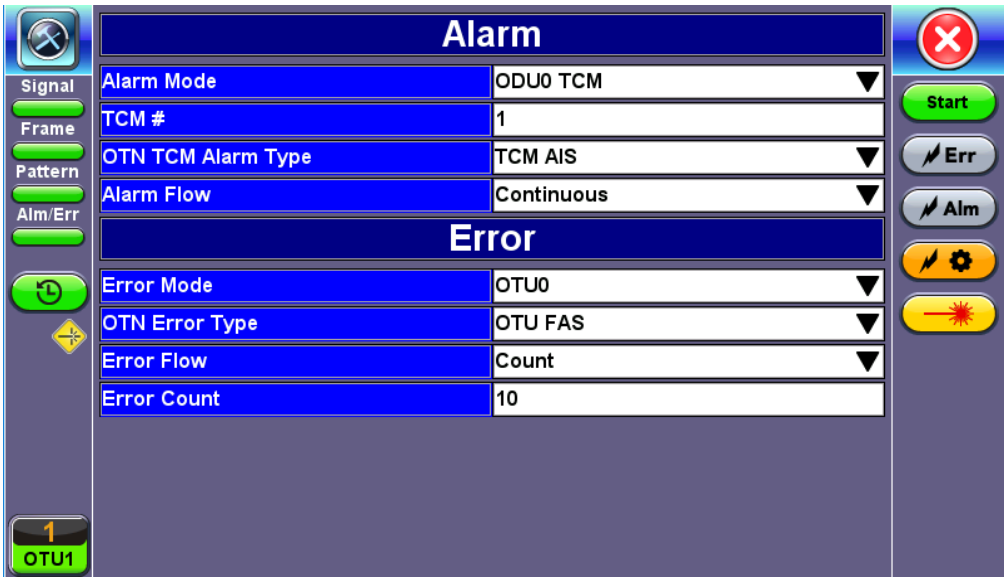
6.2.6.2 OTN

The following **OTN alarms** can be generated:

- **OTU-1:** LOS, LOF, OOF, OOM, LOM, AIS, IAE, BIAE, BDI, TIM
- **ODU-1:** AIS, OCI, LCK, BDI, TIM
- **OPU-1/OTU-2:** PLM
- **SDH Payload alarms:** LOF, MS-AIS, MS-RDI, RS-TIM, AU-LOP, AU-AIS, HP-UNEQ, HP-PLM, HP-RDI, HP-TIM, TU-LOM, TU-LOP, TU-AIS, LP-UNEQ, LP-PLM, LP-RDI, LP-RFI, LP-TIM
- **PDH Payload alarms**: DS1-AIS, DS1-LOF, 2M-AIS, 2M-RDI, 2M-LOF, 34M-AIS, 34M-LOF, 34M-RDI, 45M-AIS



OTN Alarm/Error Menu

The following **OTN errors** can be generated:

- **OTU-1 signals**: FAS, MFAS, BIP, BEI, Corrected FEC errors, Uncorrectable FEC
- **ODU-1 signals**: BIP, BEI
- **STM-16/64 signals:** FAS, B1, B2, MS-REI, B3, HP-REI, LP-BIP, LP-REI
- **Depends on payload:** 2M-FAS, 2M-CRC, 2M-REI, 34M-FAS, 45M-FAS, 1.5M-FAS

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6.2.6.3 PDH

The following **PDH alarms** can be generated: 2M-AIS/LOF/RDI, 8M-AIS/LOF/RDI, 34M-AIS/LOF/RDI/LOS

The following **PDH errors** can be generated: 2M-REI/CRC/FAS, 8M-FAS, 34M-FAS/CODE, Bit

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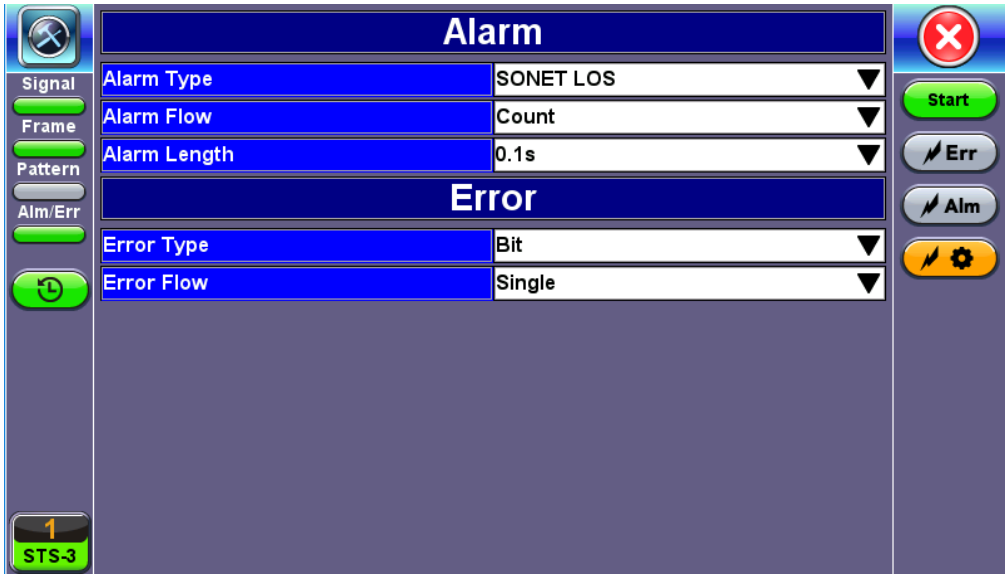
6.2.6.4 SONET



SONET Alarm/Error Menu

The following **SONET alarms** can be generated:

- SONET LOS/LOF
- Line AIS/RDI
- Section TIM
- Path LOP/AIS/UNEQ/PLM/RDI/TIM
- 34M AIS/LOF/RDI

The following **SONET errors** can be generated:

- SONET FAS
- Section BIP
- Line BIP/REI
- Path BIP/REI
- 34M FAS
- Bit

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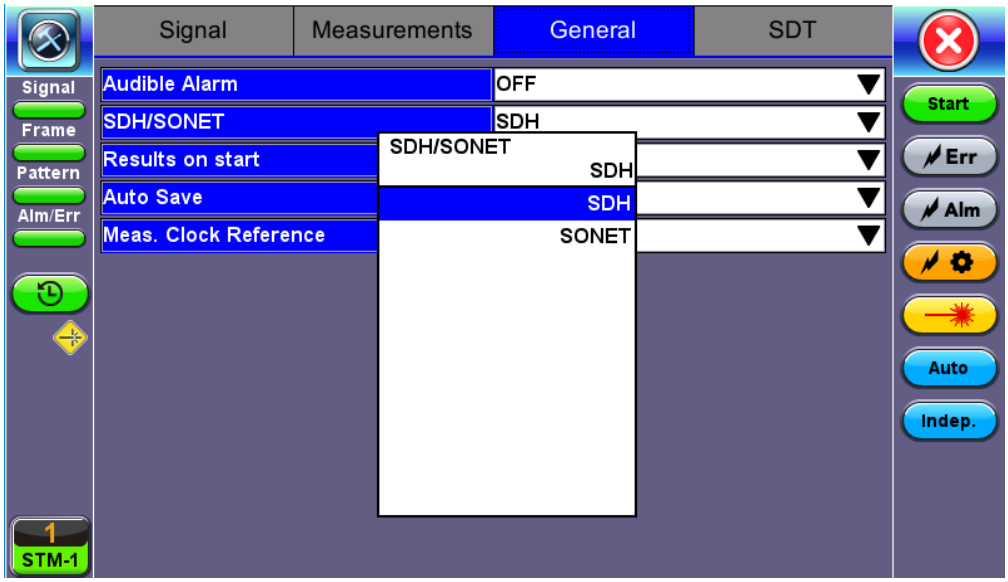
6.2.6.5 Datacom

DATA LOS alarms and Bit errors can be generated during Datacom transmission signals.

7.0 SDH



SDH/SONET selection from the General tab

Accessing SDH Testing

To display SDH options for the TX and RX block configuration,

1. Tap on the **General** tab from the Setup screen and select SDH from the **SDH/SONET** drop-down menu.
2. Tap on **Signal** tab > **Hierarchy** > **Network Type** and select *SDH* from the drop-down menu.

*Depending on whether SDH or SONET is selected from the **SDH/SONET** option under the **General** tab, TX and RX configuration screens will look slightly different.*

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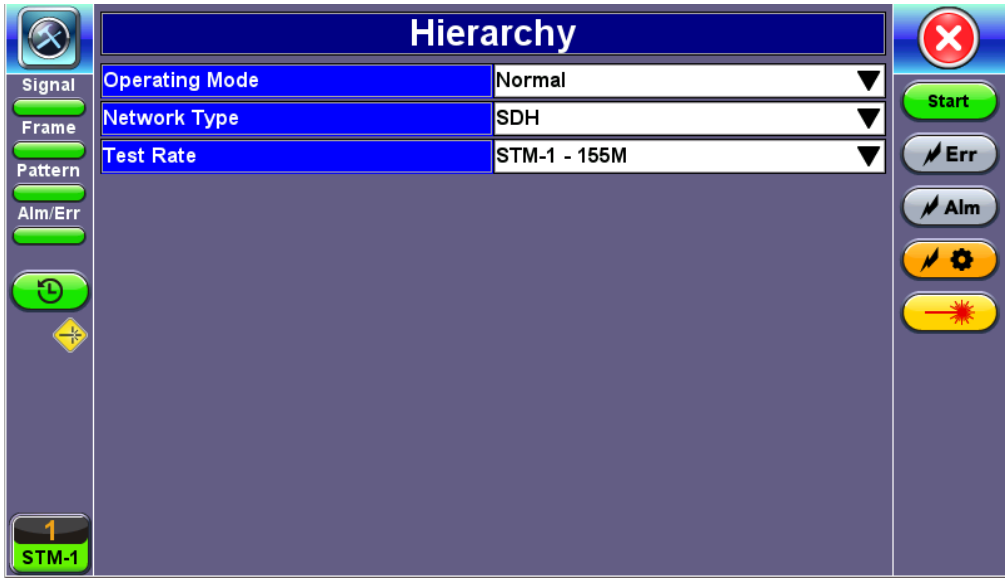
7.1 Signal (Transmitter/Receiver) Setup

This section of the manual describes the SDH configuration capabilities. The block diagram of the Tx and Rx structure is described in Signal Overview. Tap on a block diagram to open the setup menu for the selected parameter.

7.1.1 Hierarchy



Coupled Hierarchy - Normal Operating Mode

- **Operating Mode:** Normal, Payload, or Transparent.
  - **Normal Mode:** Unit working as normal SDH mode.
  - **Payload Through Mode:** Overhead overwrite Editing Thru mode allows for some intrusive error and alarm injection through overhead manipulation.
  - **Transparent Through Mode:** All the traffic goes through the unit untouched and the unit can monitor it. It is comparable to Monitor mode with a 10/90 splitter. In Transparent mode, the unit regenerates the signal in amplitude. The clock is recovered from the received signal.

Through modes are used to test network behavior under certain conditions, such as alarms. To select Payload Through, the payload has to be the same for the relevant ports.

- **Network Type:** Select SDH as the network type.
- **Test Rate:** Select a test rate.

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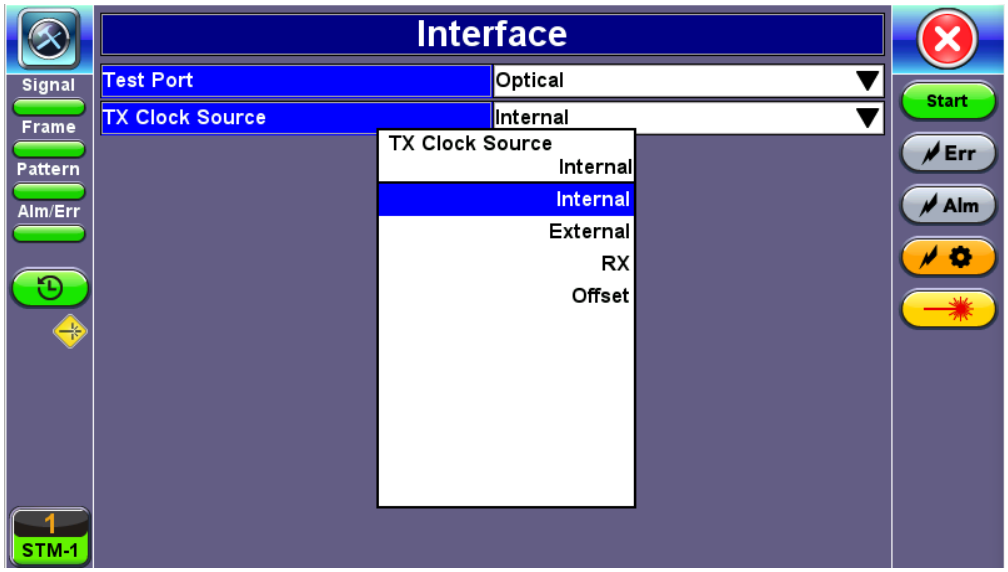
7.1.2 Interface



Tx Interface Setup

- **Test Port:** Optical or Electrical.
  - Optical interface is available for STM-0, STM-1, STM-4, STM-16 and STM-64 signals.

- Electrical interface is available for STM-0E, STM-1E signals.

- **Clock Source:** Can be configured as follows:
  - ***Internal clock:*** The clock for the transmitter is derived from the internal clock. The internal clock has an accuracy of +/- 3.5ppm conforming to G.812 recommendations.
  - ***External clock:*** The clock for the transmitter is derived from a 1.5MHz, 2MHz, 1.5Mbps, or 2Mbps signal on the SMA.
  - ***Rx:*** The clock for the transmitter is derived from the received signal, and the jitter of the incoming signal is suppressed.
  - ***Offset:*** The clock for the transmitter is derived from the internal clock generator. It can change the offset while measurements are running. Use the numeric key to increase and decrease the frequency shift, up to 0.01ppm. Frequency offset: ± 50ppm with 1, 0.1, 0.01ppm resolution.
  - ***Atomic 10 MHz:*** Built-in Atomic Clock option provides 10 MHz reference and can be disciplined to the built-in GPS receiver option.

Remember to use an optical attenuator to prevent receiver overload or damage – refer to the SFP chart below to determine safe levels. Avoid looping back the Tx and Rx on a 1550nm XFP or SFP using a patchcord only – this will damage the SFP.

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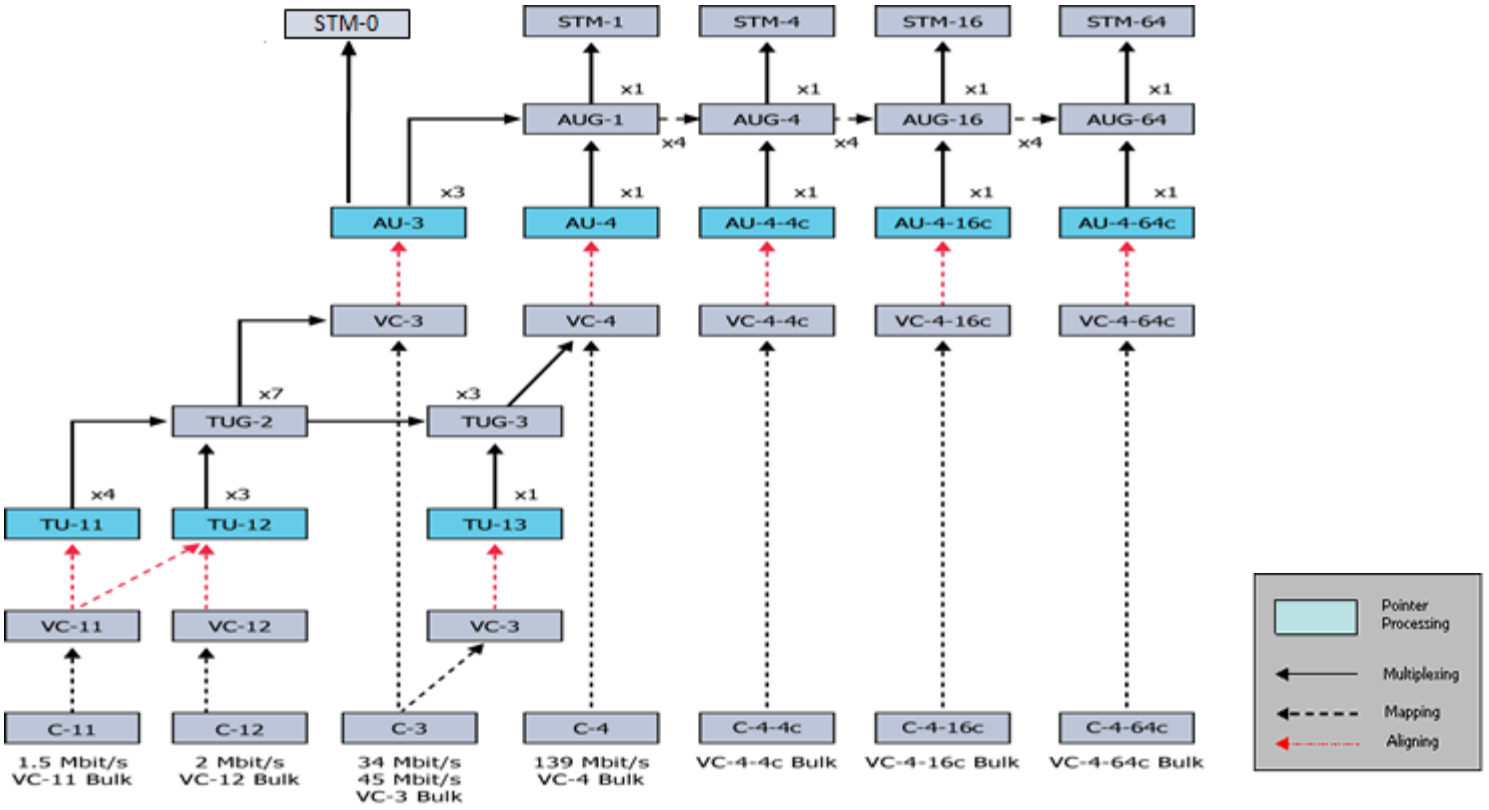
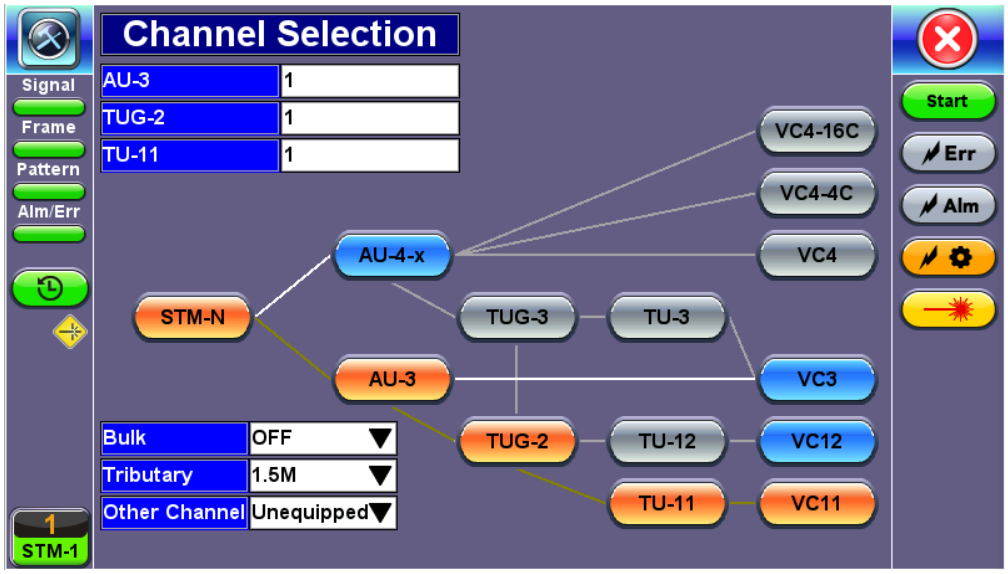
7.1.3 Structure

Tapping the Tx Structure box opens the Tx Structure Setup screen, displaying the SDH multiplexing structure.

SDH Mapping: Both AU-4 and AU-3 signal mappings per G.707 recommendations are supported. The multiplexing structure is shown below.





Structure Setup

- **AU4 Mapping:** VC4-64C, VC4-16C, VC4-4C, VC4, VC3, and VC12 are available.
- **AU3 Mapping:** VC3,VC12, and TU11/VC11 are available.
- **Bulk:** Tap the check box to enable the setting. In bulk mode, the entire VT container is filled with a test pattern per ITU-T 0.181 recommendations.
- **Tributary:** Preset to DS1, E1, DS3, and E3 rates depending upon the options and mapping.

Channel Selection: The Tx channel is selected by entering the STM-N, TUG-3, TUG-2, and TU-12 numbers for the channel.

- **TUG:** A Tributary Unit Group is the structure generated by combining several lower level tributaries into the next higher level tributary
- **TU-12**: Each TU-12 frame consists of 36 bytes, structured as 4 columns of 9 bytes
  - At a frame rate of 8000Hz, these bytes provide a transport capacity of 2.304Mbps and accommodate the mapping of a 2.048Mbps signal
  - 63 x TU-12s may be multiplexed into a STM-1 VC-4

The tributary numbering used above is per ITU-T G.707 standard.

The high order paths are named using a C, B, A convention as follows:

- C: The AUG-4 are numbered 1 to 4
- B: The AUG-1 are numbered 1 to 4
- A: The AU-3 are numbered 1 to 3

Thus the naming convention per SDH rate is as follows:

- For STM-16: [C, B, A] convention is used
- For STM-4: [B, A] convention is used
- For STM-1 using AU-3 mapping: [A] convention is used
- For STM-1 using AU-4 mapping: [0] convention is used

The low order paths are named using a K, L, M convention as follows:

- K: TUG-3 are numbered 1 to 3
- L: TUG-2 are numbered 1 to 7
- M: TU-11, TU12, within the TUG-2 are numbered 1 to 4

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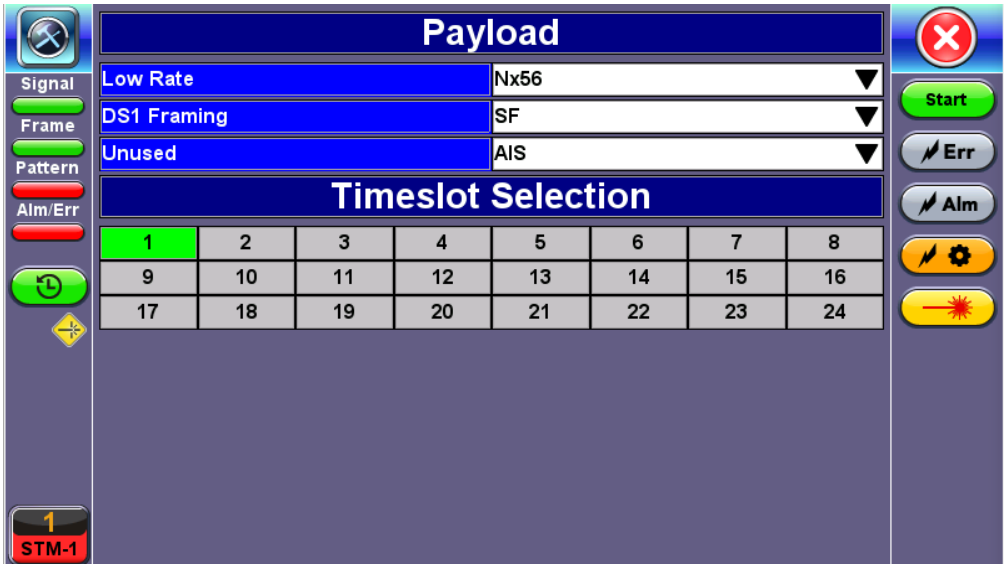
7.1.4 Payload



Payload Setup

Depends on mapping selected.

In TU11/VC11 mapping mode, the Low Rate options are 1.544M or Fractional DS1 (Nx64 or Nx56) where:

- 1.544M: Configures the transmitter for full rate testing at 1.544Mbps
- Fractional DS1 (Nx64 or Nx56): Configures the transmitter for fractional testing using N or M 64kbps timeslots (contiguous or non-contiguous timeslots)

In VC3 mapping mode/Tributary set to DS3, the Low Rate options are 45M, 1.544M Mux (DS3/DS1 Mux), or Fractional DS1 (Nx64 or Nx56) Mux where:

- 45M: Configures the transmitter for full rate testing at 45Mbps
- 1.544M Mux mode: Configures the transmitter for full rate testing at 45Mbps signal with DS1 payloads (1 to 28 channels)
- Fractional DS1 Mux mode: Configures the transmitter for full rate testing at 45Mbps signal with DS1 payloads (1 to 28 channels) for fractional testing using N or M 64kbps or 56kbps timeslots (contiguous or non-contiguous timeslots)

In VC12 mapping mode, the Low Rate options are 2M or Fractional E1 (N x64) where:

- 2M: Configures the transmitter for full rate testing at 2.048Mbps
- Fractional E1: Configures the transmitter for fractional testing using N or M 64kbps timeslots (contiguous or non-contiguous timeslots)

In VC3 mapping mode/Tributary set to E3, the Low Rate option are 34M or 2M Mux (E3//E1 Mux) or Fractional E1 Mux (E3//E1 Mux w/Nx64) where:

- 34M: Configures the transmitter for full rate testing at 34Mbps
- 2M Mux mode: Configures the transmitter for full rate testing at 34Mbps signal with E1 payloads (1 to 16 channels)
- Fractional E1 Mux mode: Configures the transmitter for full rate testing at 34Mbps signal with E1 payloads (1 to 16 channels) for fractional testing using N or M 64kbps timeslots (contiguous or non-contiguous timeslots)

Depends on low rate selected:

- In DS1 mode, the options are unframed, D4 (SF), and ANSI T1.107 (ESF).
- In DS3 mode, the options are unframed, M13, and C-Parity.
- In E1 mode, the options are unframed, PCM31, PCM31C, PCM30, and PCM30C. Framing conforms to G.704 and G.706 recommendations and are briefly described below.
- In E3 mode, the options are unframed, framed G.751.

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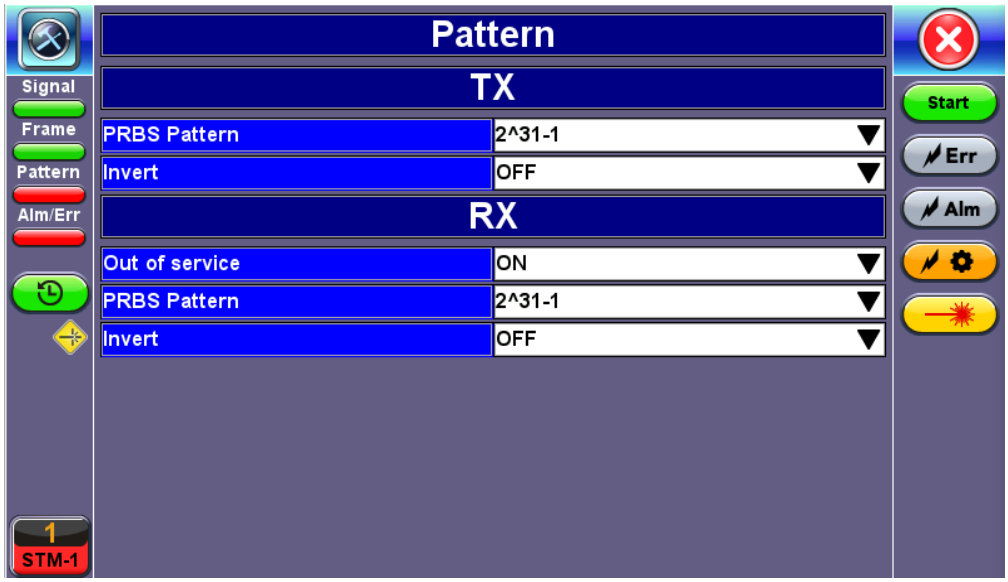
7.1.5 Pattern

Tapping the Pattern box opens the Pattern Setup screen.



Pattern Setup

- **PRBS Pattern:** Use the pattern drop-down box to select the test pattern which will be inserted into the transmitted signal. Pseudo Random Bit Sequences (PRBS) defined by ITU-T 0.150 and 0.151 standards, fixed words and 24-bit or 32 bit user defined patterns are available. ***Note****: If the 32 bit user pattern entered is incorrect, the default pattern will be 0xFFFFFFFF.*
- **Invert:** Inversion of polarity is also available.
- **Out of Service** *(RX only)***:** Should be turned *ON* if the incoming signal is expected to contain a known test pattern. Deselect this option if signal is expected to contain live traffic.

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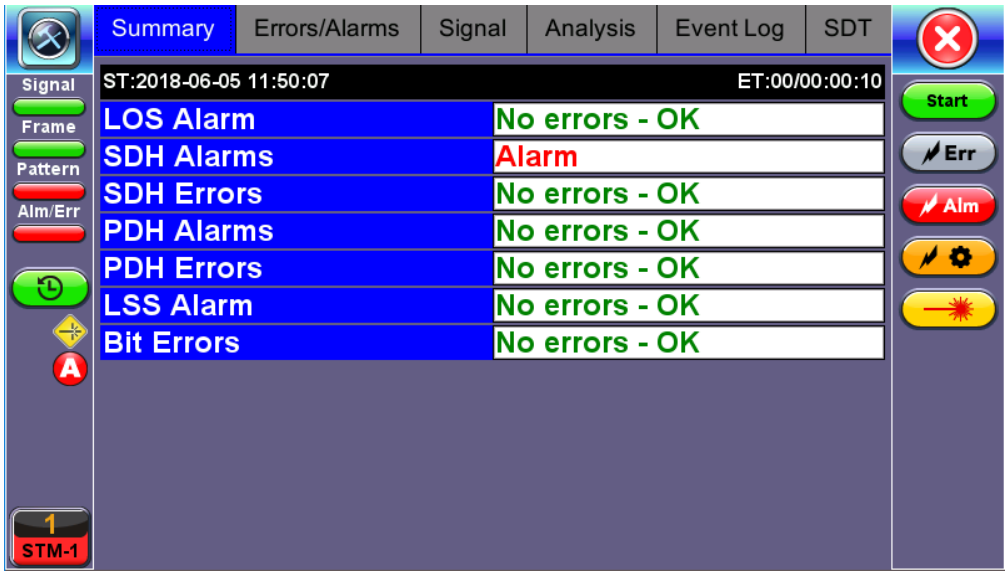
7.2 SDH/SONET Results

SDH/SONET test results feature the same measurements and are displayed in an identical format. Test measurements can be accessed from the **Result** icon in the main menu.

7.2.1 Summary

The Summary tab displays a summary of test results and parameters. At a glance, the user is able to see if there are any alarms, errors, or signal failure pertaining to the SDH/SONET signal and its payload.



SDH Summary

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7.2.2 Errors and Alarms

The Errors/Alarms tab brings up several pages showing the errors and alarms status.

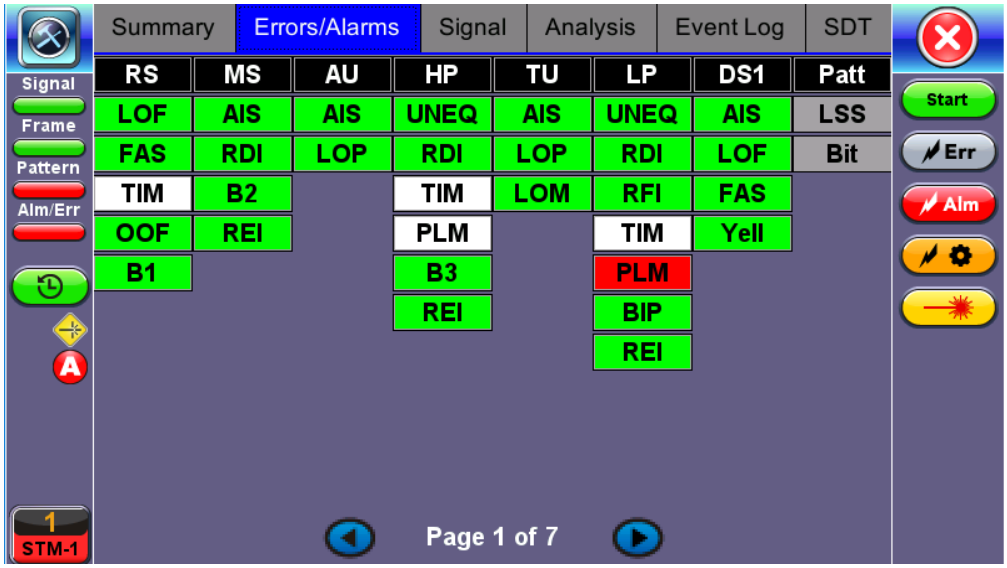
Page 1 provides an overview of all the Errors and Alarms applicable to the signal or network under test. The color of the page tab is normally blue; however, it will turn red when an alarm error condition has been detected or recorded.

The soft LEDs on screen are arranged logically and will depend on signal hierarchy, structure, payload, and framing selected. The soft LEDs have a tricolor function:

Green: No error or alarm is present.

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

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



Errors/Alarms (Page 1)

*Tapping the individual soft LED will automatically link directly to the applicable result screen which provides detailed information. Depending on the settings chosen in **Setup** > **Signal**, the Alarms/Errors displayed and page length will vary, but the order in which they are presented remain the same.*

SDH LED headers are described in the tables below:

SDH Alarm Definitions and Descriptions	
RS	Regenerator Section
MS	Multiplexer Section
AU	Administrative Unit
HP	High Order Path
TU	Tributary Unit
LP	Low Order Path
E1	2Mbit/s signal (depends on payload selected)
Pat	Pattern detection (PRBS, user, fixed words)

SDH Error and Alarm definitions per ITU-T G.707 and O.150 recommendations:

Signal and BER - Alarm Definitions	
LOS	Loss of Signal • LOS is raised when the synchronous signal (STM-N) level drops below the threshold at which a BER of 1^{-3} is predicted. It could be due to a cut cable, excessive attenuation of the signal, or equipment fault. The LOS state will clear when two consecutive framing patterns are received and no new LOS condition is detected.
TSE	Test Sequence Error
LSS	Loss of Sequence Synchronization • Out-of-service bit error measurements using pseudo-random sequences of PRBS can only be performed if the reference sequence produced on the receiving side of the test set-up is correctly synchronized to the sequence coming from the object under test. Sequence synchronization shall be considered lost and re-synchronization shall be started if: 1. The bit error ratio is ≥ 0.20 during an integration interval of 1 second; or 2. It can be unambiguously identified that the test sequence and the reference sequence are out of phase.

Regenerator Section - Alarm Definitions	
LOF	Loss of Frame • Declared when OOF state exists for up to 3 ms. If OOFS are intermittent, the timer is not reset to zero until an in-frame state persists continuously for 0.25ms.
OOF	Out of Frame • Declared when 4 consecutive SDH frames are received with invalid (errored) framing patterns. Maximum OOF detection time is 625µs.
B1	Regenerator section error monitoring • Parity errors evaluated by the B1 byte (BIP-8) of an STM-N. If any of the eight parity checks fail, the corresponding block is assumed to be in error.

Multiplexer Section - Alarm Definitions	
MS-AIS	Multiplexer Section Alarm Indication Signal • Declared when bits 6, 7, 8 of the K2 byte contain a "111" pattern for five consecutive frames
MS-RDI	Multiplexer Section Remote Defect Indication • Declared when bits 6, 7, 8 of the K2 byte contain a "110" pattern for five consecutive frames
MS-REI	Multiplexer Section Remote Error Indication • For STM-1 signals, declared when the M1 byte located in TS #3 is different • For STM-4/16 signals, declared when the M1 byte located in TS #7 is different
B2	Multiplexer Section Error Monitoring • Parity errors evaluated by the B2 byte (BIP-24 x N) of an STM-N. If any of the Nx24 parity checks fail, the corresponding block is assumed to be in error

Administrative Unit- Alarm Definitions	
AU-AIS	Administrative Unit Alarm Indication Signal • Alarm is declared when H1 and H2 pointer bytes contain an all ones pattern for three consecutive frames
AU-LOP	Administrative Unit Loss of Pointer • Indicates that a valid pointer is not found in N consecutive frames where N=8, 9, or 10 or a 1001 pattern is detected (NDF)
AU-NDF	Administrative Unit New Data Flag

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High Order Path - Alarm Definitions	
HP-UNEQ	HO path Unequipped • Declared when the C2 byte contains "00H" in five consecutive frames
HP-RDI	HO path Remote Defect Indication • Alarm is declared when bits 5, 6, 7, of the G1 byte contain 100 or 111 in five consecutive frames
HP-TIM	HO path Trace Identifier Mismatch • Indicates that the J1 path trace does not match the expected message value. The TIM function must be enabled for this alarm to be active
HP-PLM	HO path Payload Mismatch • Declared after receiving five consecutive frames with mismatched VC signal labels
B3	HO path Error Monitoring of VC-3, VC-4 • Parity errors evaluated by the B3 byte (BIP-8) of a VC-N (N=3, 4). If any of the eight parity checks fail, the corresponding block is assumed to be in error.
HP-REI	HO path Remote Error Indication • Alarm is declared when bits 5, 6, 7, of the G1 byte contain 100 or 111 in five consecutive frames

Tributary Unit - Alarm Definitions	
TU-AIS	Tributary Unit Alarm Indication Signal • Declared when the V1 and V2 bytes for the TU path contain an all ones pattern for five consecutive super-frames
TU-LOP	Tributary Unit Alarm Indication Signal • Declared when no valid pointer is detected in N consecutive superframes (N>8 and <10), or if N consecutive NDFs "1001" patterns are detected
TU-LOM	Tributary Unit Loss of Multiframe (H4)

Low Order Path - Alarm Definitions	
LP-UNEQ	LO path Unequipped • Declared when bits 5, 6, 7, of the V5 byte contain "000" for five consecutive frames
LP-RDI	LO path Remote Defect Indication • Declared when bit 5 of the V5 byte contains a "1" in five consecutive TU super-frames while bits 6, 7 of the K4 byte contain "00" or "11"
LP-RFI	LO path Remote Failure Indication • Declared when bit 4 of the V5 byte contains "1" in five consecutive frames
LP-TIM	LO path Trace Identifier Mismatch • Indicates that the J2 path trace does not match the expected message value. The TIM function must be enabled for this alarm to be active
LP-PLM	LO path Payload Mismatch • Declared when bits 5, 6, 7 of the V5 byte are set to "000", "001", or "111" which indicate a mismatch LP signal label
LP-REI	LO path Remote Error Indication • Declared when bit 3 of the V5 byte is set to "0"
LP-BIP	LO path Bit Interleaved Parity (VC-11, VC-12) • A BIP-2 parity error calculated over all the bytes of the previous VC frame

SONET LED headers are described in the table below:

SONET Alarm Definitions and Descriptions	
Section	Section Layer
Line	Line Layer
STS Path	STS Path Layer
VT Path	Virtual Tributary Path Layer
DS1	1.5 Mbit/s signal (depends on payload selected)
Pat	Pattern detection (PRBS, user, fixed words)

SONET Error and Alarm definitions per Bellcore GR.253 and ANSI T1.105 recommendations:

Signal and BER - Alarm Definitions	
LOS	Loss of Signal
TSE	Test Sequence Error
LSS	Loss of Sequence Synchronization
AIS	Alarm Indication Signal

Regenerator Section - Alarm Definitions	
LOF	Loss of Frame (A1, A2)
OOF	Out of Frame (A1, A2)
B1	Regenerator Section Error Monitoring (B1)
TIM-S	Trade Identifier Mismatch (J0)

Line - Alarm Definitions	
AIS-L	Line AIS (K2)
RDI-L	Line Remote Defect Indication (K2)
REI-L	Line Remote Error Indication (M1)
B2	Error Monitoring (B2)

STS Path - Alarm Definitions	
LOP-P	Loss of STS Pointer (H1, H2)
AIS-P	Administrative Unit AIS (STS-1 SPE include. H1, H2, H3)
RDI-P	STS path Remote Defect Indication (G1)
REI-P	STS path Remote Error Indication (G1)
TIM-P	STS path Trace Identifier Mismatch (J1)
PLM-P	STS path Payload Label Mismatch (C2)
B3	Error Monitoring (B3)
UNEQ-P	STS path Unequipped

Virtual Tributary Path (VT) - Alarm Definitions	
LOP-V	Loss of TU Pointer (V1, V2)
AIS-V	TU Alarm Indication Signal (VT incl. V1 to V4)
LOM	TU Loss of Multiframe (H4)
UNEQ-V	VT Path Unequipped (V5)
RDI-V	VT Path Remote Defect Indication (V5)
REI-V	VT Path Remote Error Indication (V5)
RFI-V	VT Path Remote Failure Indication (V5)
TIM-V	VT Path Trace Identifier Mismatch (J2)
PLM-V	VT Path Payload Label Mismatch (V5)
BIP-2	VT Path Error (V5)

SONET Error and Alarm detection criteria per Bellcore GR.253 and ANSI T1.105/231:

Section/Line Layer - Detection Criteria	
LOS	Loss of Signal • All-zero pattern for 2,3 µs ≤ T ≤ 100µs
LOF	Loss of Frame • A1, A2. No valid framing pattern for 3 ms (24 frames)
B1	Section BIP Error • Mismatch of the recovered and computed BIP-8 covers the whole STS-N frame
B2	Line BIP error • Mismatch of the recovered and computed NxBIP-8 covers the whole STS-N frame
AIS-L	Line-AIS • K2 (bits 6, 7, 8) = 111 for 5 frame
REI-L	Line Remote Error Indication • Number of detected B2 errors in the sink side encoded in the byte M0 or M1 of source side
RDI-L	Line Remote Defect Indication • K2 (bits 6, 7, 8) = 110 for z frame (z=5-10)

STS Path Layer - Detection Criteria	
AIS-P	STS Path AIS • All "1" in the STS pointer bytes H1, H2 for ≥ 3 frames
LOP-P	STS Path Loss of Pointer • 8-10 NDF enable, 8-10 invalid pointers
B3	STS Path BIP error • Mismatch of the recovered and computed BIP-8 covers the entire STS-SPE
UNEQ-P	STS Path Unequipped • C2 = "0" for ≥ 5 (≥ 3 as per T1.231) frames
TIM-P	STS Path Trace Identifier Mismatch • Mismatch of the accepted and expected Trace Identifier in byte J1 (64 bytes sequence)
REI-P	STS Path Remote Error Indication • Number of detected B3 errors in the sink side encoded in byte G1 (bits 1, 2, 3, 4) of the source side
RDI-P	STS Path Remote Defect Indication • G1 (bit 5) = 1 for 10 frames
PLM-P	STS Path Payload Label Mismatch • Mismatch of the accepted and expected Payload Label in byte C2 for ≥ 5 (≥3 as per T1.231) frames

VT Path Layer - Detection Criteria	
LOM	Loss of Multiframe • Loss of synchronization on H4 (bits 7, 8) superframe sequence
AIS-V	VT Path AIS • All "1" in the VT pointer bytes V1, V2 for ≥ 3 frames
LOP-V	VT Path Loss of Pointer • 8-10 NDF enable, 8-10 invalid pointers
BIP-2	VT Path BIP Error • Mismatch of the recovered and computed BIP-2 (V5 bits 1, 2) covers entire VT
UNEQ-V	VT Path Unequipped • V5 (bits 5, 6, 7) = 000 for ≥ 5 (≥ 3 as per T1.231) superframes
TIM-V	VT Path Trace Identifier Mismatch • Mismatch of the accepted and expected Trace Identifier in byte J2
REI-V	VT Path Remote Error Indication • If one or more BIP-2 errors detected in the sink side, byte V5 (bit 3) = 1 on the source side
RDI-V	VT Path Remote Defect Indication • V5 (bit 5) = 1 for 10 super frames
PLM-V	VT Path Payload Label Mismatch • Mismatch of the accepted and expected Payload Label in byte V5 (bits 5, 6, 7) for ≥ 5 (≥3 as per T1.231) superframes

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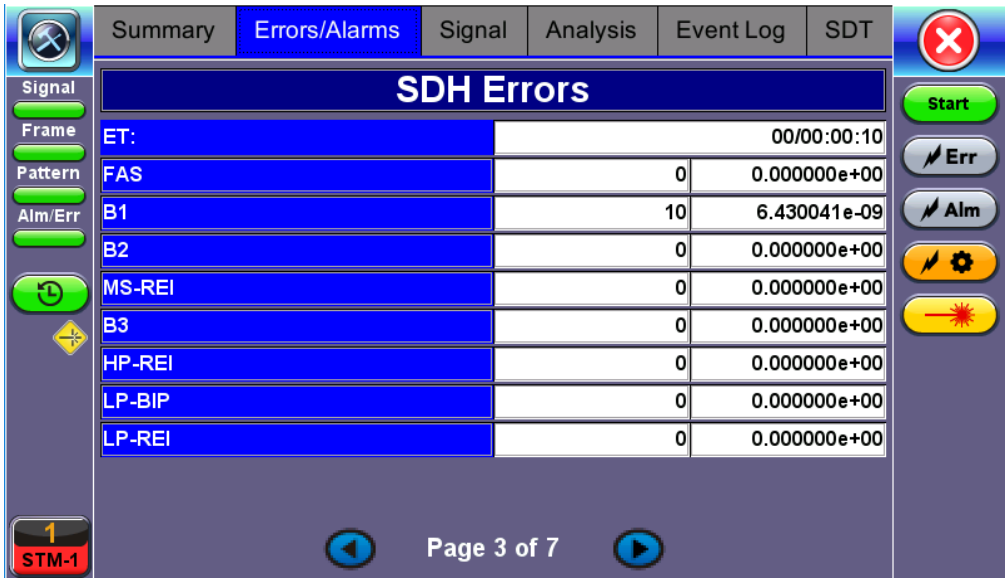

Event Log

Errors/alarms listed on each page are presented in a logical order associated with the signal under test. All errors are evaluated and stored. The Elapsed Time [ET] is shown in the right hand corner of the header. Error conditions are displayed in red including count and rate. The Errors/Alarms tab brings up several pages of the errors and alarms statuses. Errors/alarms displayed depend on selected test settings and may include the following:

- SDH/SONET Errors/Alarms
- PDH Alarms/Errors
- BERT Errors
- Section (SOH) and Line Overhead Alarms
- High Order Path and Low Order Path
- STS path and VT path

Refer to the SDH or SONET Error and Alarm definitions tables for error/alarm definitions.

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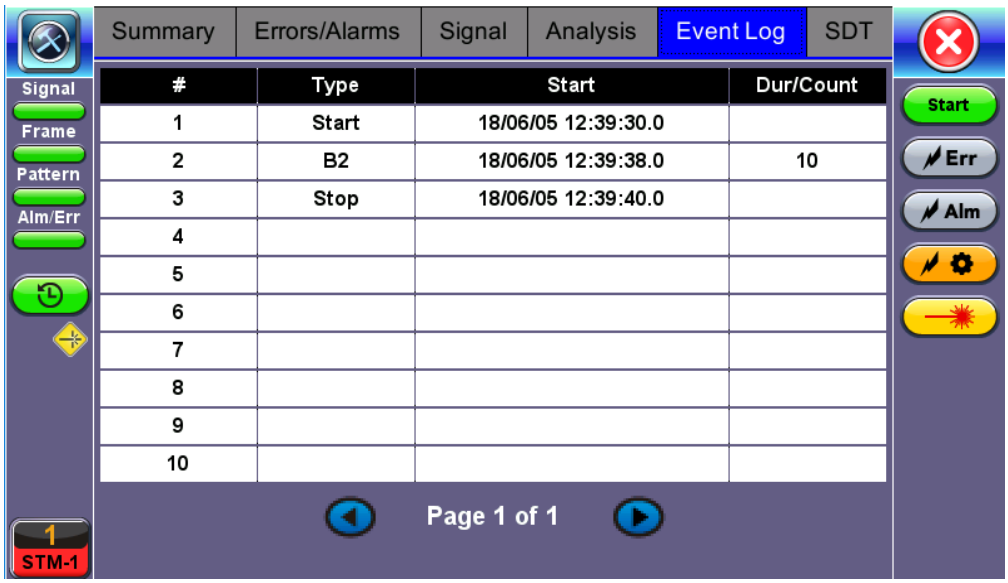
7.2.3 Event Log

The Event Log tab brings up the screen listing the Error and Alarm events recorded during a test. The events are presented in chronological sequence - number, type of event, start time, duration (alarms), and ratio/count (errors) are displayed.



Event Log

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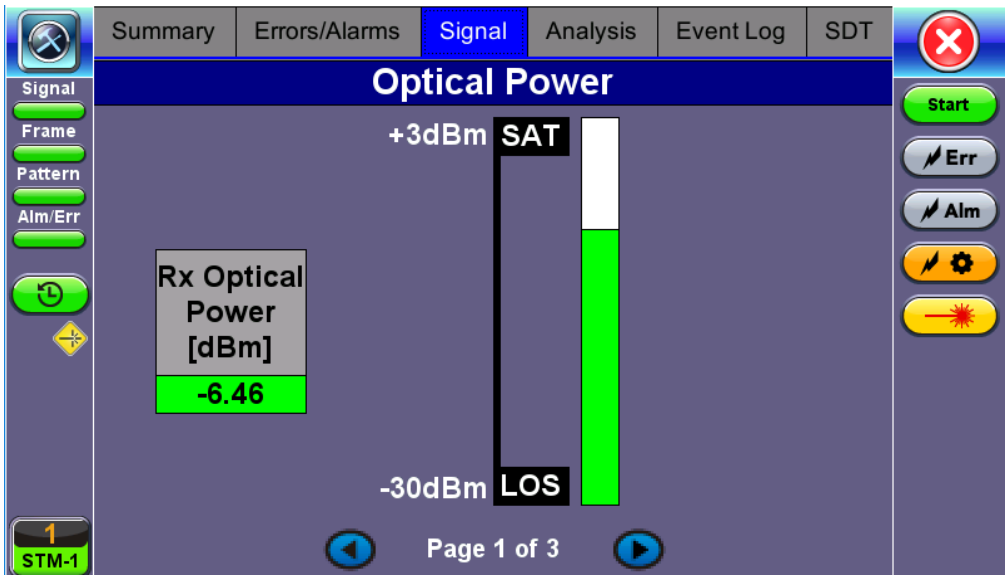
7.2.4 Signal

The signal tab displays the Level and Frequency screen. Page 1 and 2 display the level measurement in electrical units (volts) for STS1, STS3, STM1e and dBm for STM-1, STM-4, STM-16, STM64 and OC-1, OC-3, OC-12, OC-48, OC-192 signals received (RX) and transmitted (TX).

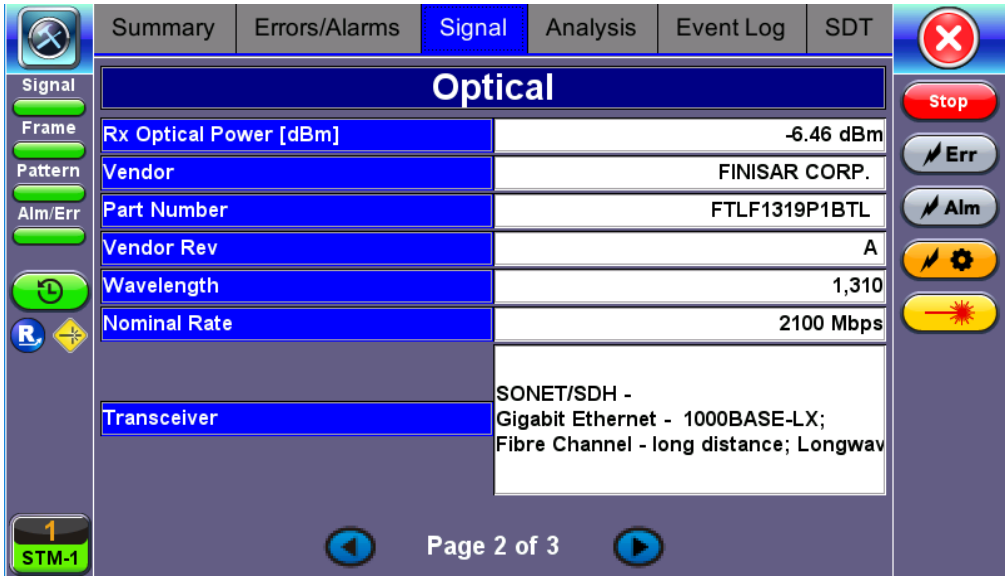
Loss of Signal (LOS) and the Saturation level for optical signals is shown graphically including the level measurement in dBm.



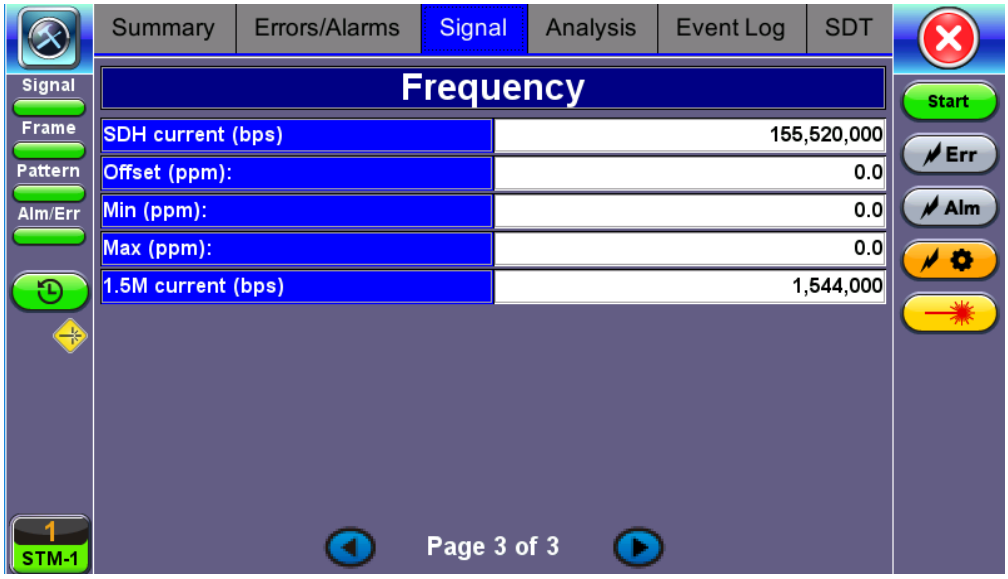
Signal - Optical Power (Page 1)

Optical Information (Page 2)

Page 2 displays the Optical module information.



Signal - Optical Information (Page 2)



Signal - Frequency (Page 3)

Frequency: The received signal frequency and offset is measured and displayed.

- **SDH/SONET 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.
- **Current:** Indicates the frequency of the payload data. Options 1.5M, 45M, 34M are displayed.

A Min (ppm) and Max (ppm) function can be used to ensure that the received signal is within a certain clock tolerance and that the network element is transmitting correctly. The frequency limits for the various signal types according to ITU-T recommendations are presented in the table below.

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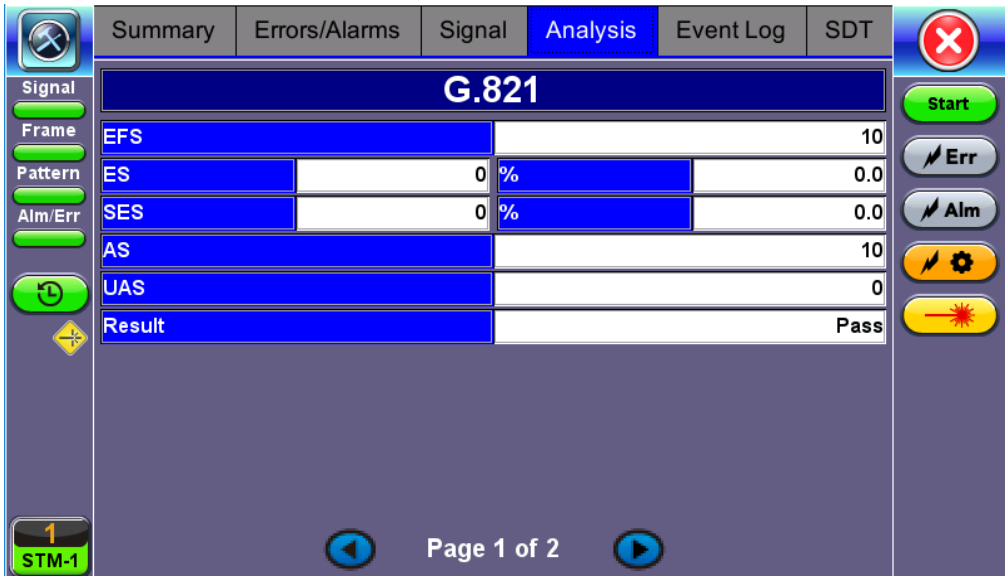
7.2.5 Performance Analysis



G.821 Analysis

*If the Analysis tab is blank, None was selected as a **Performance Type** from the Measurements tab or **Out of Service** (from Signal > Pattern) is OFF.*

The Analysis tab displays measured objectives from ITU-T performance tests selected from the Measurements tab (Setup >

Measurements). See Performance Analysis in the PDH section for information on the Analysis tab and test definitions. For a brief description of supported G-Series and M-Series performance tests as well as setup instructions, please see Performance Analysis in the Measurement Configuration section.

Evaluation According to ITU-T G.821

This recommendation was originally specified for international circuit-switched N x 64kbps connections and later expanded to include higher bit rates.

ES, SES, AS and UAS are evaluated and can be performed on the following events:

- FAS bit errors (FAS 2, FAS 34)
- CRC errors
- E bit errors
- Bit errors (TSE, Test Sequence Error)

The following signals can be measured when performing G.821 evaluation of bit errors (TSE):

- Unframed patterns
- N x 64kbps
- Framed patterns and bulk signals
- Pass/Fail result is in conjunction with path allocation between 0.1 and 100%

ITU-T G.821 evaluates bit errors, therefore, facilities for evaluating block errors are disabled. G.821 relies on the evaluation of bit errors, thus the test channel must be taken out of service to perform the measurement.

Definitions:

- **Errored Second (ES):** A one-second time interval in which one or more bit errors occur.
- **Severely Errored Second (SES):** A one-second interval in which the bit error ratio exceeds 10^{-3}.
- **Unavailable Second (UAS):** A circuit is considered to be unavailable from the first of at least ten consecutive SES. The circuit is available from the first of at least ten consecutive seconds which are not SES.
- **Available Second (AS):** A one-second time interval in which no bit errors occur.
- **Errored Free Second (EFS):** A one-second time interval in AS during which no errors and no pattern slips have been detected.

Evaluation According to ITU-T G.826

G.826 recommendation makes provision for higher bit rates and allows in-service measurement using the evaluation of block errors.

The following are evaluated: ES, SES, BE, BBE, and UAS.

Pass/Fail result depends on path allocation of 0.1 to 100%.

In-Service Measurement (ISM): Simultaneous in-service measurement of “near end” and “far-end” of a selected path.

Out-of-Service Measurement (OOS): Out-of-service measurement using bit errors in a test pattern.

Definitions:

- **Errored Second (ES):** A one-second time interval containing one or more errored blocks.
- **Severely Errored Second (SES):** A one-second time interval in which more than 30% of the blocks are errored.
- **Block Error (BE):** A block containing one or more errored bits.
- **Background Block Error (BBE):** An errored block that is not a SES.
- **Unavailable Second (UAS):** A circuit is considered to be unavailable from the first of at least ten consecutive SES. The circuit is available from the first of at least ten consecutive seconds which are not SES.

The recommended measurement time for G.821 and G.826 is 30 days.

Evaluation According to ITU-T G.828

G.828 provides a precise block length for each bit rate as opposed to G.826.

- ES, SES, BBE, UAS and SEP are evaluated.

Pass/Fail result is in conjunction with path allocation between 0.1 and 100%.

G.828 evaluation can be performed on the following events:

- B1
- B2
- MS-REI
- B3
- HP-REI
- LP-BIP
- LP-REI
- Bit errors (TSE)

Evaluation of the near end and far-end is possible, however far-end evaluations can only be made if REI is available.

Bit errors can be evaluated for:

- Unframed patterns
- Framed patterns and bulk signals
- Overhead bytes E1/E2 (order wire), F1/F2 (user), D1 - D3 and D4 - D12 (DCC) in the SDH overhead (SOH and POH)

Bit error evaluation is disabled because G.828 evaluates block errors.

Evaluation According to ITU-T G.829

G.829 is based on the principle of monitoring block errors in service.

ES, SES, BBE and UAS are evaluated.

G.829 evaluation can be performed on the following events:

- B1
- B2
- MS-REI
- Bit errors (TSE)

Evaluation of the near end and far-end is possible, however far-end measurement can only be made if REI is available.

Bit errors can be evaluated for:

- Unframed patterns
- Framed patterns and bulk signals
- Overhead bytes E1/E2 (order wire), F1/F2 (user), D1 - D3 and D4 - D12 (DCC) in the SDH Overhead (SOH and POH)

Evaluation According to ITU-T M.2100

M.2100 applies to commissioning and maintenance. Commissioning consists of a 15-minute line up phase followed by a 24-hour in-service measurement. Once the line up phase is completed successfully, errors may occur within certain limits.

ES, SES and UAS are evaluated.

Pass/Fail results are based on threshold values S1 and S2 for ES and SES.

Settings for S1 and S2:

- Path allocation: 0.1 to 100%
- BISO multiplication factor: 0.1 to 100

The M.2100 evaluation can be performed on the following events:

- FAS bit errors (FAS2, FAS34, and FAS140)
- CRC-4 errors
- EBIT errors
- Bit errors (TSE)

Evaluation is made at the “Near End” and at the “Far End” for PCM-30/31 signals with CRC.

Bit errors can be evaluated for:

- Unframed patterns
- Framed patterns and bulk signals
- N x 64kbps

Since M.2100 evaluates bit errors, facilities for evaluating block errors are disabled.

Evaluation According to ITU-T M.2101

M.2101 is very similar to M.2100 except it deals with SDH systems only.

ES, SES, BBE, SEP and UAS are evaluated.

Pass/Fail results are based on the threshold values S1 and S2 for ES, SES, BBE and SEP.

Settings for S1 and S2:

- Path allocation: 0.1 to 100%
- BISO Multiplier: 0.1 to 100%

The M.2101 evaluation can be performed on the following events:

- B1
- B2
- MS-REI
- B3
- HP-REI
- LP-BIP
- LP-REI
- Bit errors (TSE)

Evaluation of the near end and far-end is possible but far-end evaluations can only be made if REI is available.

Bit errors can be evaluated for:

- Unframed patterns
- Framed patterns and bulk signals
- Overhead bytes E1/E2 (order wire), F1/F2 (user), D1 - D3 and D4 - D12 (DCC) in the SDH Overhead (SOH and POH)

M.2101 measures block errors, therefore bit error evaluation is disabled.

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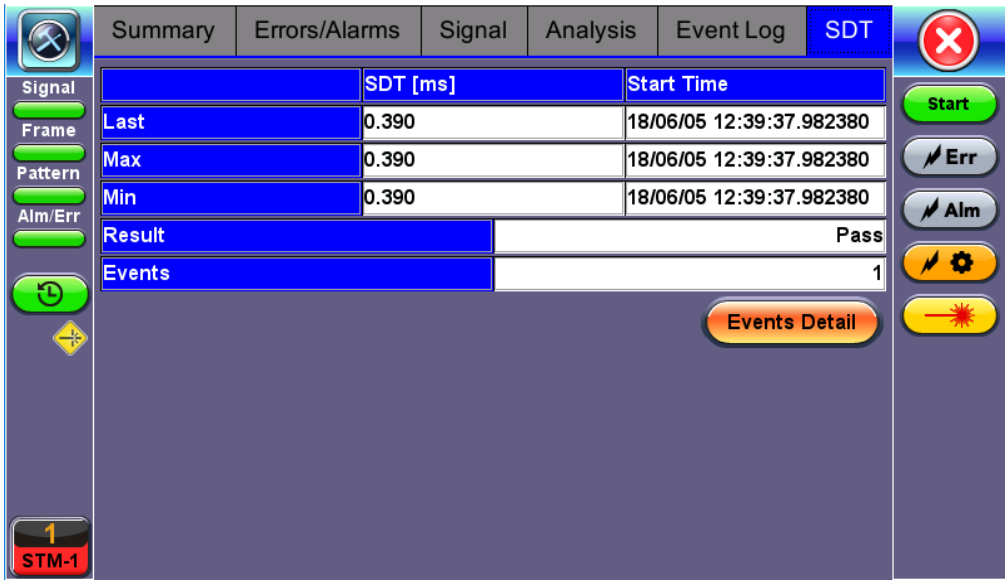
7.2.6 Service Disruption Test (SDT) Results

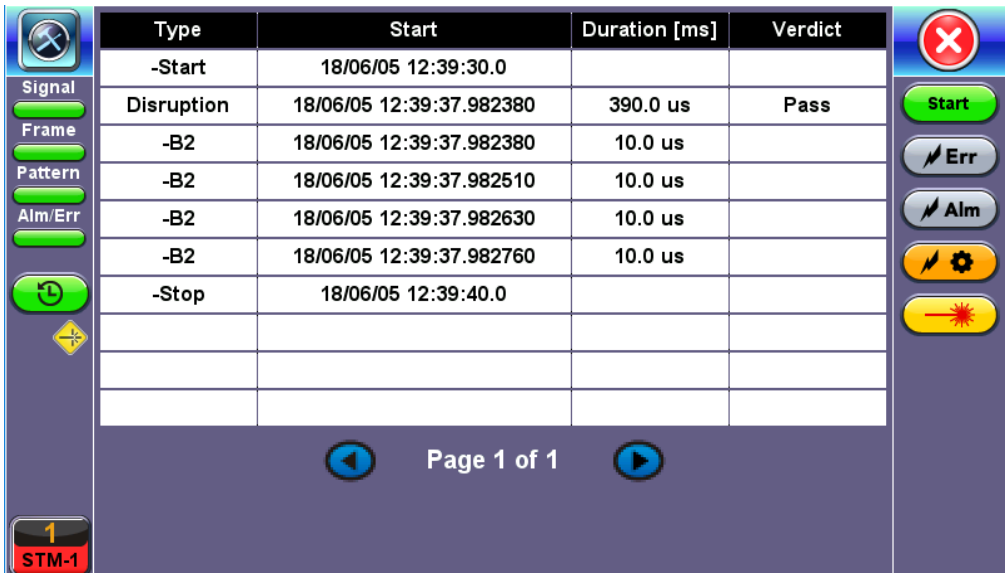


SDT Results

If SDT is enabled in Setup, the SDT tab will display time measurements of detected errors/alarms specified by the user in SDT setup.

- **Last SDT**: The duration of the last service disruption detected
- **Min/Max**: Shortest and longest service disruption duration
- **Result**: Waiting for trigger or Measure
  - Waiting for trigger: Testing is in progress and the unit is waiting to detect an error/alarm
  - Measure: Error/alarm is in progress
- **Events**: Number of errors/alarms detected

Events Detail displays additional details such as error/alarm type and Pass/Fail status.



SDT Events Detail

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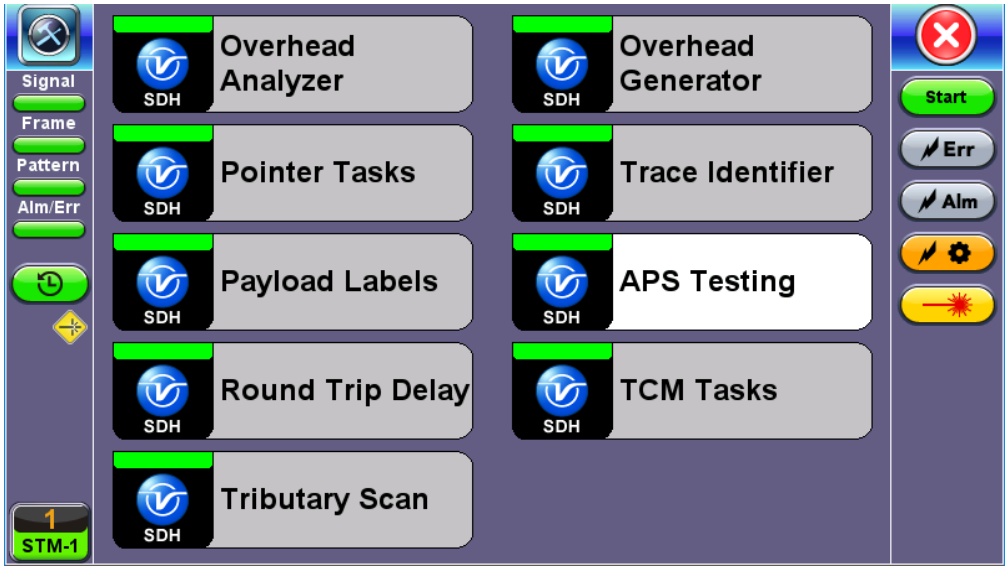
7.3 SDH/SONET Tools

Accessing SDH/SONET Tools

Tap on the main menu > **SONET/SDH Tools**.

Measuresments displayed may vary depending on whether SDH or SONET is configured in Setup.

7.3.1 Shortcuts



SDH/SONET Tools Menu

- **Overhead Analyzer:** Displays the Section/Line Overhead (SOH) and STS Path Overhead (POH) bytes of the received channel.
- **Overhead Generator:** Used to edit Section/Line Overhead (SOH) and STS Path Overhead (POH) bytes of the transmitted channel.
- **Pointer Tasks:** For SDH, displays both AU and TU pointer values and generates AU and TU pointer movements. Pointer sequences are according to ITU-T G.783 recommendations are also possible. For SONET, displays both STS and VT pointer values and generates STS and VT pointer movements. Pointer sequences are according to Bellcore GR.253 recommendations are also possible.
- **Trace Identifier:** Used to generate and edit J0, J1 and J2 path traces and set expected trace for received channel according to G.831 recommendations.
- **Payload Labels:** Used to set the C2 and V5 Path Signal Labels which indicate the content of the High order/STS path and Low order VCs/ VTs.
- **APS Testing:** Used to measure Automatic Protection Switching limits. Using selectable triggers, the drop out times of tributary connections are measured and compared with preset values.
- **Tributary Scan:** Used to scan individual or multiple tributaries to verify routing and error free operation. Only available in VC-12 or VC-11 mode for SDH, and VT-1.5 or VT-2 mode for SONET.
- **TCM Tasks:** Used to analyze or edit the sequence of TCM bytes by generating alarms and errors in the Tandem connection sub-layer. SDH uses N1 and TCM bytes and SONET uses Z5 and Z6 TCM bytes.
- **Round Trip Delay (Propagation Delay):** Measurement works by sending a test pattern. Bit errors are transmitted in the pattern. The time it takes for the error to reach the receiver is the propagation time through the network.

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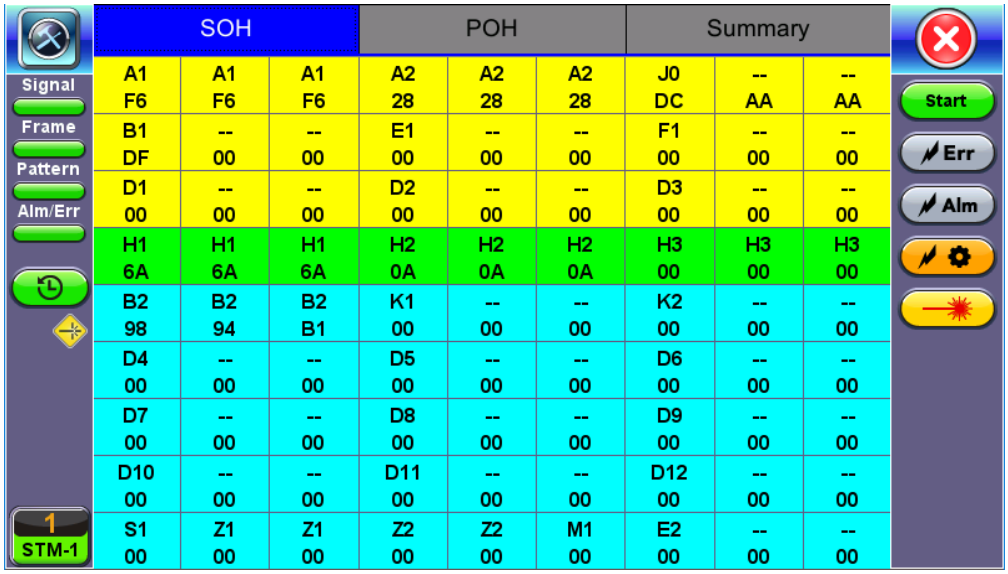
7.3.2 Overhead Analyzer

Tap the Overhead Analyzer icon to display the OH screens shown below. There are tabs for:

- SOH RX, which displays the bytes associated with the Section/LINE Overhead
- POH RX, which displays the bytes associated with the Path Overhead

- Summary, which displays the Path Traces (J0, J1, J2), APS (K1, K2), Synchronization status (S1), STS Path (C2), and VT Path (v5) Signal Label bytes



SOH

Tapping the applicable byte enables an automatic decode – a byte description including the Hexadecimal and Binary value is provided. For some bytes, an advanced decode of the various bits is also available.

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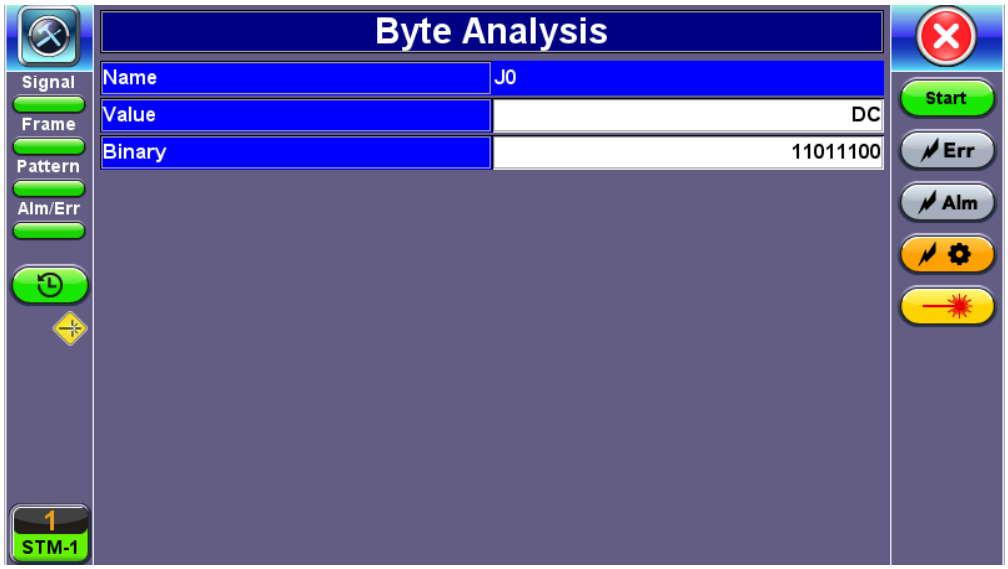
7.3.2.1 Section Overhead Layer

The following is a partial list of SOH bytes and their corresponding functions:

Section Layer

Framing Bytes (A1/A2)

- The A1/A2 bytes indicate the beginning of the STM-N frame and provide a frame alignment pattern
  - A1 is the 1st framing byte: 11110110 (Hex F6)
  - A2 is the 2nd framing byte: 00101000 (Hex 28)
- Both A1 and A2 bytes are unscrambled
- The Frame Alignment Word of a STM-N frame is composed of (3 x N) A1 bytes followed by (3 x N) A2 bytes



Path Trace Byte (J0)

Path Trace Byte (J0)

- Regenerator section trace
- Used to transmit a 16 or 64-byte identifier (trace) (including a CRC-7 byte) repeatedly so that all regenerators can verify their connection
- Used for continuity testing between regenerators

B1 Byte (RS-BIP)

- An 8-bit even parity code used to check for transmission errors over the regenerator section
- Its value is calculated over all the bits of the STM-1 frame before scrambling
- The checksum value is placed in the RS overhead of the following STM-1 before scrambling

Order Wire Byte (E1)

- Local order wire channel for voice communication between regenerators, cross connects, hubs and remote terminal locations

F1 Byte

- Section user channel
- Byte is allocated for user purpose to carry proprietary messages
- The channel is terminated at each regenerator location

Data Communications Channel Bytes (D1/D2/D3)

- Data Communications Channel (DCC)
- D1, D2 and D3 together form a 192kbps message channel for OAM purposes
- It can generate internal or external messages
- It can also be used as a BER function

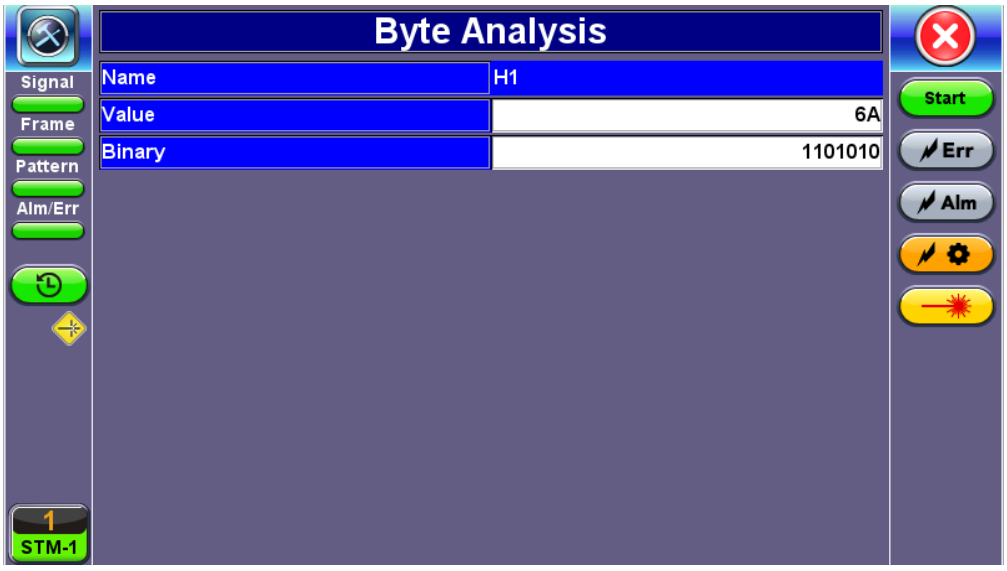
Pointers

H1/H2/H3 Bytes (STS Pointers) *(SONET only)*

- Enable transfer of STS-3 frames with STS-N frames and are processed by the MS terminating equipment

AU Pointers Bytes (H1/H2/H3) *(SDH only)*

- Enable transfer of STM-1 frames with STM-N frames and are processed by the MS terminating equipment



H1 (AU) Pointer Byte

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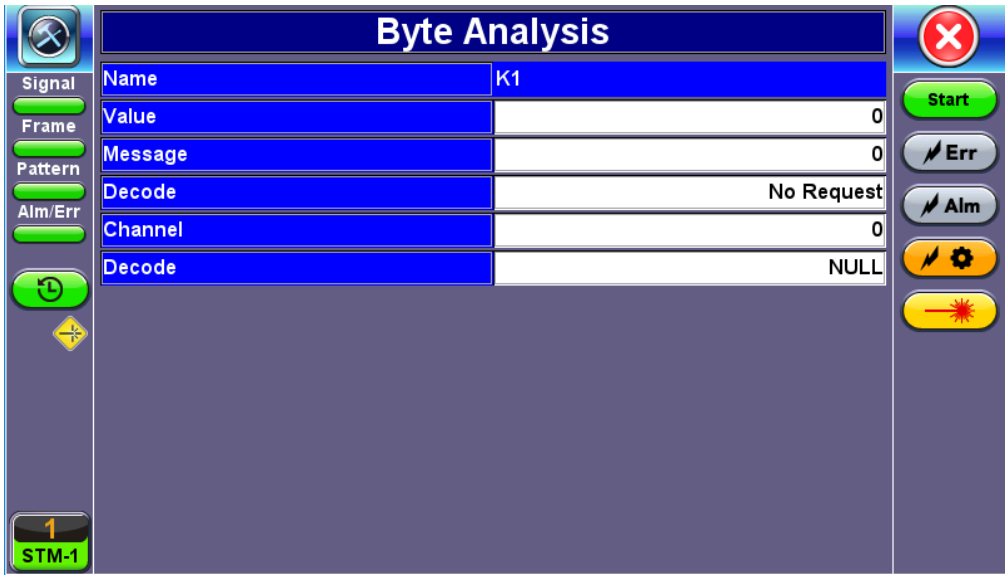
Line Layer / Multiplexer Section

B2 Byte (MS-BIP)

- A 24-bit interleaved even parity code used to determine if transmission errors have occurred over the Multiplexer Section
- Its calculated over all the bits of the STM-1 frame for SDH and STS-3 frame for SONET, except those in the Regenerator Section overhead
- The computed checksum is placed in the MSOH of the following STM-1 frame for SDH and TOH of the following STS-N frame for SONET signals.

K1 Byte (APS-Linear)

- Used to activate and deactivate the switching between the main and protection paths on a multiplexer section
- APS message type conforms to ITU-T G.783 and Bellcore GR.253 for Linear network architectures
    - Bits 1-4 (G.783 Protocol)
        - 1111 Lockout of protection
        - 1110 Forced switch
        - 1101 Signal fail, high priority (1:n only)
        - 1100 Signal fail, low priority
        - 1011 Signal degrade, high priority (1:n only)
        - 1010 Signal degrade, low priority
        - 1000 Manual switch
        - 0110 Wait to restore
        - 0100 Exercise
        - 0010 Reverse request (bidirectional systems only)
        - 0001 Do not revert
        - 0000 No request
        - Other codes are unused
    - Bits 5-8 selects channel used by APS messages
        - 0000 Null channel
        - 0001 to 1110 Channels 1 thru 14
        - 1111 Extra traffic channel



K1 Byte (APS-Linear)

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K1 Byte (APS-Ring)

- Used to activate and deactivate the switching between the main and protection paths on a multiplexer section
- APS message type conforms to ITU-T G.841/ Bellcore GR.253 Ring Network architectures
    - Bits 1-4 are the condition
        - 1111 Lockout of protection

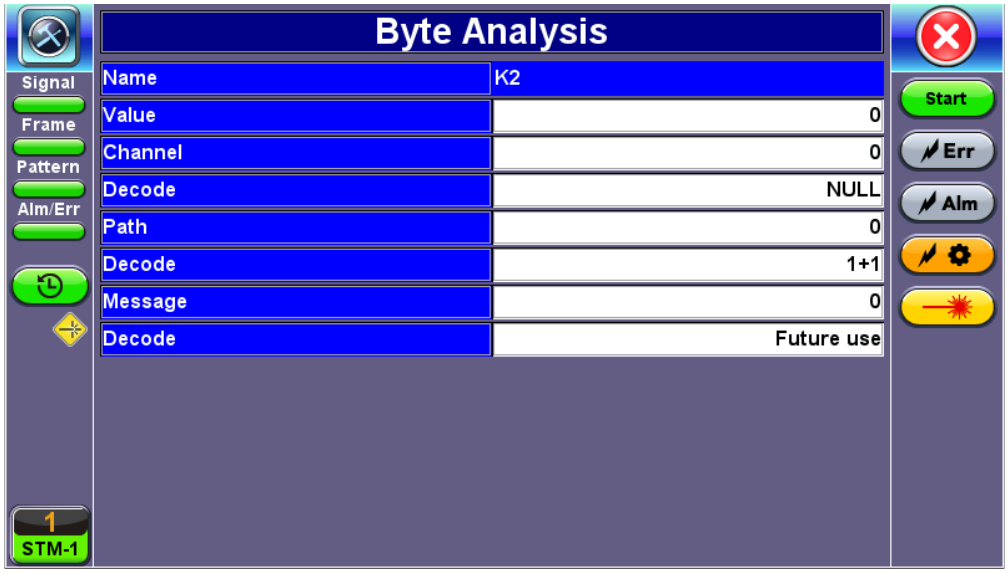
1110 Forced switch (span)
        - 1101 Forced switch (ring)
        - 1100 Signal fail (span)
        - 1011 Signal fail (ring)
        - 1010 Signal degrade (protection)
        - 1001 Signal degrade (span)
        - 1000 Signal degrade (ring)
        - 0111 Manual switch (span)
        - 0110 Manual switch (ring)
        - 0101 Wait to restore
        - 0100 Exercise (span)
        - 0011 Exercise (ring)
        - 0010 Reverse request (span)
        - 0001 Reverse request (ring)
        - 0000 No request
    - Bits 5-8 are the destination node ID
        - 0000 Null channel
        - 0001 to 1110 Channels 1 thru 14
        - 1111 Extra traffic channel

K2 Byte (APS-Linear)

- Conforms to ITU-T G.783 and Bellcore GR.253
- Used to activate and deactivate the switching between the main and protection paths on a multiplexer section
- Used to communicate Alarm Indication Signal (AIS) and Remote Defect Indication (RDI) conditions
    - Bits 1-4 selects bridged channel used
    - Bit 5 determines APS architecture
        - 1+1
        - 1:N
    - Bits 6-8
        - 110 MS-RDI
        - 111 MS-AIS
        - Others Not used

K2 Byte (APS-Ring)

- Conforms to and follows ITU-T G.841 Bellcore GR.253 recommendations
- Used to activate and deactivate the switching between the main and protection paths on a multiplexer section
- Used to communicate Alarm Indication Signal (AIS) and Remote Defect Indication (RDI) conditions
    - Bits 1-4 are the source node ID
    - Bit 5 is the path code
        - 0 Short path
        - 1 Long path
    - Bits 6-8
        - 000 Idle
        - 001 Bridged
        - 010 Bridged and switched
        - 110 MS-RDI
        - 111 MS-AIS
        - Others Not used



K2 Byte (APS-Linear)

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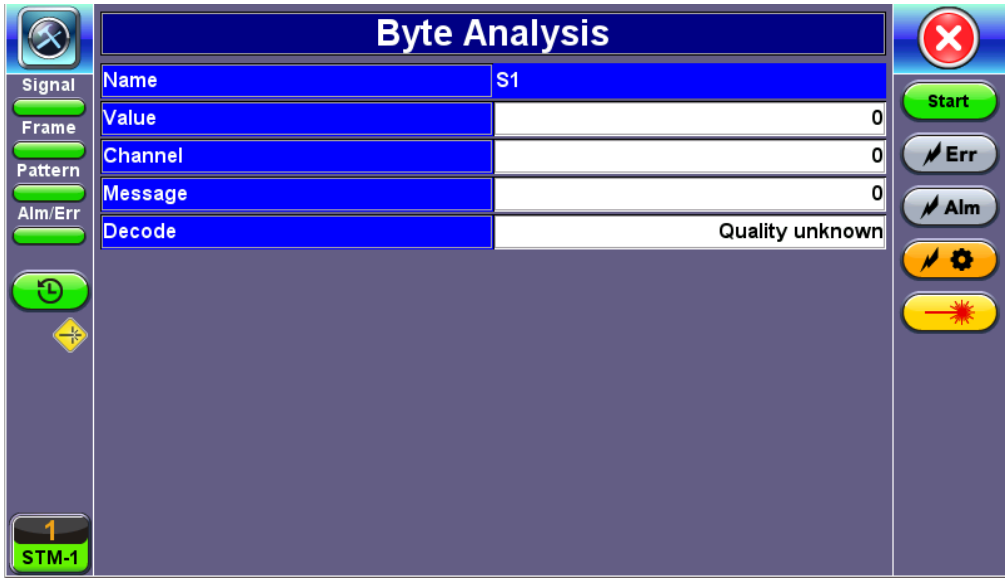
Data Communications Channel (DCC) Bytes (D4-D12)

- DCC – together these nine bytes form a 576kbps message channel for OAM purposes.
- They can be used for internally or externally generated messages or BER function.

S1 Byte (Synchronization Status)

- Synchronization status message byte contains information about the quality of the embedded timing and is used to inform the remote Multiplexer of the clock quality used to generate signals.
  - Bits 1-4 carry synchronization messages
  - Bits 5-8
    - 0000 Synchronized - Traceability Unknown
    - 0001 Stratum 1
    - 0100 Transit Node Clock
    - 0111 Stratum 2
    - 1010 Stratum 3
    - 1100 SDH Minimum Clock
    - 1101 Stratum 3e
    - 1110 Previsional by the Network Operator
    - 1111 Not used for synchronization
    - Other bytes are reserved



S1 Byte (Synchronization Status)

Order Wire Byte (E2)

- A 64kbps voice communication channel between multiplexers.
- It's a channel used by craft persons and will be ignored as it passes through regenerators.
- The relief byte is used for ring protection

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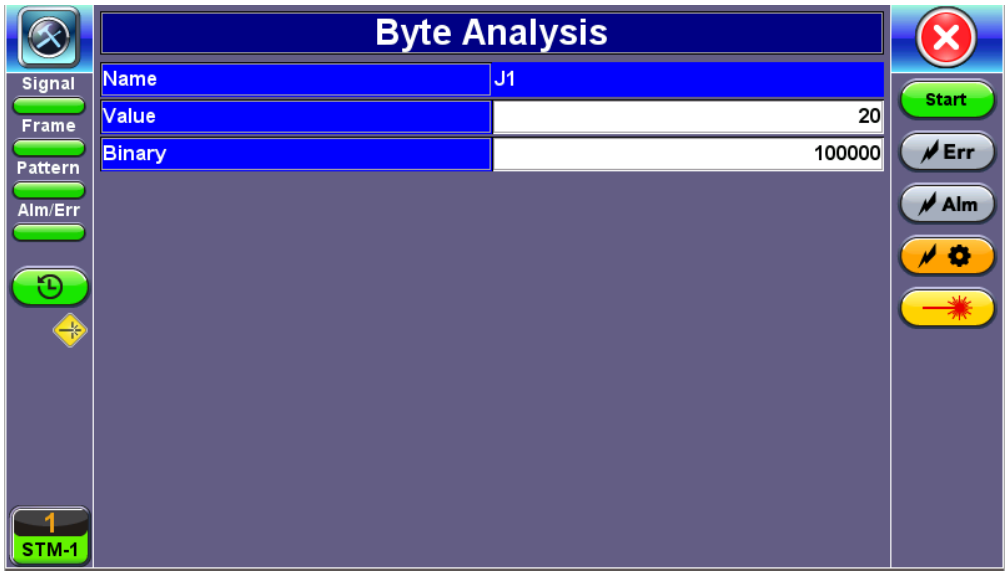
7.3.2.2 Path Overhead Layer

The following is a partial list of POH bytes and their corresponding functions:

- **J1 byte (STS Path Trace)**
  - High Order VC-N path trace byte
  - A unique message is assigned to each path in the SDH or SONET network – therefore the path trace can be used to check continuity between any location on a transmission path and the path source
  - This user programmable byte repeatedly transmits a 15-byte string plus 1 (CRC-7) byte so that a receiver can continually verify its connection with the transmitter
  - A 64-byte free-format string is also permitted
  - The message is transmitted one byte per VC-4 frame (SDH) or STS-3 frame (SONET)



J1 Byte (HP Path Trace)

- **B3 byte**
  - Even code parity which determines if a transmission error has occurred over a path
  - Its value is calculated over all the bits of the previous VC-4 (SDH) or STS-3 (SONET)
  - The computed checksum is placed in the B3 byte before scrambling

- **C2 byte: HP signal label for SDH mode and STS path signal label for SONET mode**
  - SDH: Indicates mapping of the VC-n.
  - SONET: Indicate the type of payload being transported in the STS, SPE, including the status of the mapped payloads.
  - The table below indicates the standard C2 binary values:

SDH: C2 Byte Structure per ITU-T G.707 Recommendations			
Bits 1 to 4	**Bits 5 to 8**	**Hex value**	**Description**
0000	0000	00	Unequipped
0000	0001	01	Equipped non-specific
0000	0010	02	TUG structure
0000	0011	03	Locked TU-n
0000	0100	04	Asynchronous mapping of 34 Mbit/s or 45Mbit/s into a C3 container
0001	0010	12	Asynchronous mapping of 140Mbit/s into a C4 container
0001	0011	13	ATM mapping
0001	0100	14	MAN DQDB mapping
0001	0101	15	FDDI mapping
0001	1000	18	HDLC/LAPS
0001	1010	1A	10 Gigabit Ethernet mapping (IEEE 802.3)
0001	1011	1B	Generic Framing Protocol (GFP)
0001	1100	1C	10 Gigabit Fiberchannel mapping
0010	0000	20	Asynchronous mapping of ODUk
1111	0000	FE	ITU-T 0.181 test signal mapping
1111	1111	FF	VC-AIS (TCM)

SONET: C2 byte structure per GR.253 recommendations	
Code[hex]	**Payload type**
00	Unequipped
01	Equipped non-specific (standard payload)
02	Floating VT mode
03	Locked VT mode
04	Asynchronous mapping for DS3
12	Asynchronous mapping for 139.264Mbps
13	Mapping for ATM
14	Mapping for DQDB
15	Asynchronous mapping for FDDI
16	Mapping for HDLC over SONET
E1	STS-1 payload with 1 VT-x payload defect
E2	STS-1 payload with 2 VT-x payload defects
E3	STS-1 payload with 3 VT-x payload defects
E4	STS-1 payload with 4 VT-x payload defects
E5	STS-1 payload with 5 VT-x payload defects
E6	STS-1 payload with 6 VT-x payload defects
E7	STS-1 payload with 7 VT-x payload defects
E8	STS-1 payload with 8 VT-x payload defects
E9	STS-1 payload with 9 VT-x payload defects
EA	STS-1 payload with 10 VT-x payload defects
EB	STS-1 payload with 11 VT-x payload defects
EC	STS-1 payload with 12 VT-x payload defects
ED	STS-1 payload with 13 VT-x payload defects
EE	STS-1 payload with 14 VT-x payload defects
EF	STS-1 payload with 15 VT-x payload defects
F0	STS-1 payload with 16 VT-x payload defects
F1	STS-1 payload with 17 VT-x payload defects
F2	STS-1 payload with 18 VT-x payload defects
F3	STS-1 payload with 19 VT-x payload defects
F4	STS-1 payload with 20 VT-x payload defects
F5	STS-1 payload with 21 VT-x payload defects
F6	STS-1 payload with 22 VT-x payload defects
F7	STS-1 payload with 23 VT-x payload defects
F8	STS-1 payload with 24 VT-x payload defects
F9	STS-1 payload with 25 VT-x payload defects

FA	STS-1 payload with 26 VT-x payload defects
FB	STS-1 payload with 27 VT-x payload defects
FC	STS-1 payload with 28 VT-x payload defects, or STS-1, STS-3C, etc., with a non-VT payload defect (DS3, FDDI, etc.)

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- **G1 byte (Path status)**
  - High Order path status byte
  - Used to convey the path terminating status back to the originating path, thus allowing bidirectional monitoring of the complete path
  - Bits 1-4: Remote Error Indication (HP-REI for SDH or REI-P for SONET) indicates number of bit errors detected by B3
  - Bit 5: Remote Defect indication (HP-RDI for SDH or RDI-P for SONET) set to 1 if signal failure is detected
  - Bits 6-7: Enhanced RDI information to differentiate between payload defects (HP-PLM for SDH or PLM-P for SONET), connectivity defects (HP-TIM, HP-UNQ for SDH or TIM-P, UNQ-P for SONET) and server defects (HP-AIS, LOP for SDH or AIS-P, LOP-P for SONET)

SDH POH Bytes

- **F2 byte (HP user channel)**
  - High Order Path user channel
  - VC-4 path user channel used for communication between path elements

- **H4 byte (TU Indicator)**
  - Position or Sequence Indicator
  - Multiframe phase indicator used for tributary structured payloads

- **F3 byte (LP) user channel**
  - Used for communication between path elements and is payload dependent.

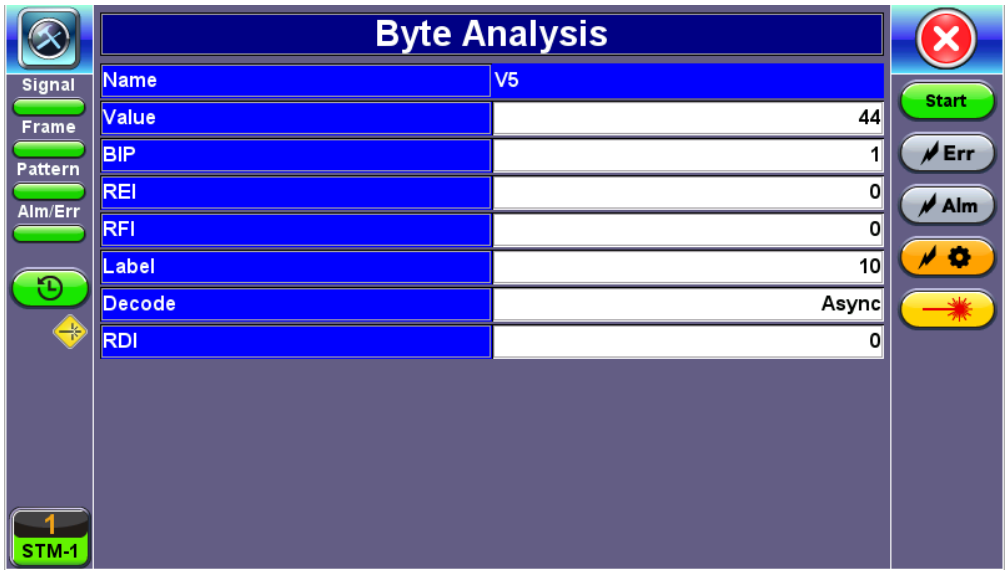
- **K3 byte (HP APS)**
  - Bits 1-4 are used for protection switching of VC-3 & 4 paths.
  - Bits 5-8 are a currently not used

- **N1 byte (HP)**
  - Allocated to provide a High Order (HP) Tandem Connection monitoring function for contiguously concatenated VC-4, VC-4 and VC-3 levels.
    - Bits 1-4: Used as an Incoming Error Count (IEC) per G.707
    - Bit 5: Operates as the TC-REI to indicate errored blocks occurring within the tandem connection
    - Bit 6: Operates as the OEI to indicate errored blocks egressing the VC-n
    - Bits 7-8: Operate in 76 multi-frame structure;
  - Frames 1-8 > Frame Alignment Signal (FAS)
    - Frames 9-72 > The Access Point Identifier of the tandem connection (TC-API)
    - Frames 73-76 > TC-RDI indicating defects that have occurred in the tandem connection to the far-end
    - Frame 74 > ODI indicating to the far-end that AU/TU-AIS has been inserted into egressing AU-n TU-n due to defects before or within the tandem connection
    - Frames 73-76 > Reserved capacity

- **V5 byte (LP signal label)**
  - Byte contains error analysis, signal label and path status information
  - Continuous monitoring of anomalies or defects and payload composition at the path end or along the path
    - Bits 1-2 provides error checking (BIP-2)
    - Bit 3 is the LP-REI (0 = no error, 1 = errors)
    - Bit 4 is the LP-RFI (0 = no error, 1 = errors)
    - Bits 5-7 provide the VC-12 signal label
      - 000 Unequipped
      - 001 Equipped (non-specific)
      - 010 Asynchronous
      - 011 Bit synchronous
      - 100 Byte synchronous
      - 101 Extended

- 110 0.181 test signal (TSS4)
- 111 VC-AIS

- Bit 8 is the VC12 path LP-RDI normally set to zero unless there is an error condition (AIS)



V5 Byte (VT signal label)

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- **J2 byte (LP)**
  - Used to transmit a configurable 16-byte identifier that enables the receiving path to continuously verify its connection with the transmitter
  - Uses the same byte structure as the J0 and J1 bytes

- **N2 byte (LP)**
  - Provides LP/VT tandem connection monitoring function (LP-TCM) for the VC-11 and VC-12 levels
    - Bits 1-2: even parity error checking BIP-2 for the tandem connection
    - Bit 3: Set to “1”
    - Bit 4: Incoming AIS indicator (0 = no defect; 1 = defect occurred before tandem connection)
    - Bit 5: TC-REI indicating errored blocks caused in the tandem connection
    - Bit 6: OEI indicating errored blocks of the egressing VC-n
    - Bits 7-8: Operate in a 76 multi-frame structure:
  - Multiframe structure consists of:
    - Frames 1-8 >Frame Alignment Signal (FAS)
    - Frames 9-72 > The Access Point Identifier of the tandem connection (TC-API)
    - Frames 73-76 > TC-RDI indicating defects that have occurred in the tandem connection to the far-end
    - Frame 74 > ODI indicating to the far-end that AU/TU-AIS has been inserted into egressing AU-n/ TU-n due to defects before or within the tandem connection
    - Frames 73-76 > Reserved capacity

N2 Byte Structure per ITU-T G.707 Recommendations							
Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
BIP-2		Fixed [1]	I-AIS	TC-REI	OEI	TC-API, TC-RDI, ODI, Reserved	

- **K4 byte (LP path Extended Label)**
  - When bits 5-7 of V5 byte are set to 101 (value = 5), then the signal label in K4 byte becomes valid where:
    - Bit 1 is allocated to the extended signal label
    - Bit 2 is allocated to virtual concatenation
    - Bits 3 and 4 are unassigned and are reserved for LP APS signaling
    - Bits 5, 6, 7 are allocated for optional use
    - Bit 8 is unassigned
    - Bits 12-19 contain the

K4 Multiframe Structure per ITU-T G.707 Recommendations																													
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	27	29	30	31	32
Multiframe Alignment Signal											Extended Signal Label								0	R	R	R	R	R	R	R	R	R	R	R
Frame Count					Seq. Indicator																										

K4 Byte Structure per ITU-T G.707 Recommendations							
Bit 1	Bit 2	Bit 3	Bit4	Bit 5	Bit 6	Bit 7	Bit 8
Extended Signal Label	Virtual concatenation overhead	Unassigned		Optional Use			Unassigned

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SONET POH Bytes

- **F2 byte (Path user channel)**
  - STS Path user channel
  - STS-3# path user channel used for communication between path elements
- **H4 byte (VT Indicator)**
  - Position or Sequence Indicator
  - Multiframe phase indicator used for tributary structured payloads
- **Z3/Z4 byte (STS Path)**
  - Allocated for future use. Have no defined value. The receiver is required to ignore their content.
- **Z5 byte (STS Path TCM)**
  - Allocated to provide a STS Path Tandem Connection monitoring function for contiguously concatenated STS-3 levels.
    - Bits 1-4: Used as an Incoming Error Count (IEC)
    - Bit 5: Operates as the TC-REI to indicate errored blocks occurring within the tandem connection
    - Bit 6: Operates as the OEI to indicate errored blocks egressing the STS-n
    - Bits 7-8: Operate in 76 multi-frame structure:
  - Frames 1-8 > Frame Alignment Signal (FAS)
    - Frames 9-72 > The Access Point Identifier of the Tandem Connection (TC-API)
    - Frames 73-76 > TC-RDI indicating defects that have occurred in the tandem connection to the far-end
    - Frame 74 > ODI indicating to the far-end that AU/TU-AIS has been inserted into egressing STS-n VTG-n due to defects before or within the tandem connection
    - Frames 73-76 > Reserved capacity

Z5 Byte Structure							
Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
IEC (IAIS)				TC-REI	OEI	TC-APId, TC-DI, ODI, Reserved	

- **V5 byte (VT path overhead)**
  - The first byte of a VT SPE provides the functions of error checking, signal label and path status.
  - Continuous monitoring of anomalies or defects and payload composition at the path end or along the path
    - Bits 1-2 provides error checking (BIP-2)
    - Bit 3 is the REI-V (0 = no error, 1 = errors), that is sent back towards an originating VT PTE if errors were detected by the BIP-2.
    - Bit 4 is reserved for mapping-specific functions.
    - Bits 5-7 provide the VT signal label
      - 000 Unequipped
      - 001 Equipped (non-specific)
      - 010 Asynchronous mapping for DS1
      - 011 Bit synchronous mapping for DS1
      - 100 Byte synchronous mapping for DS1
    - Bit 8 is the VT path RDI-V normally set to zero unless there is an error condition (AIS)

V5 Byte Structure							
BIP-2		REI-V	RFI-V	Signal Label			RDI-V
1	2	3	4	5	6	7	8

- **J2 byte (VT path trace)**
  - Used to transmit a configurable 16-byte identifier that enables the receiving path to continuously verify its connection with the transmitter
  - Uses the same byte structure as the J0 and J1 bytes

- **Z6 byte (VT-TCM)**
  - Provides VT tandem connection monitoring function (TCM-V) for the VT-1.5, VT-2 levels.
    - Bits 1-2: even parity error checking BIP-2 for the tandem connection
    - Bit 3: Set to “1”
    - Bit 4: Incoming AIS indicator (0 = no defect; 1 = defect occurred before tandem connection)
    - Bit 5: TC-REI indicating errored blocks caused in the tandem connection
    - Bit 6: OEI indicating errored blocks of the egressing STS-1n
    - Bits 7-8: operate in a 76 multi-frame structure:

- Multiframe structure consists of:
  - Frames 1-8 > Frame Alignment Signal (FAS)
  - Frames 9-72 > The Access Point Identifier of the Tandem Connection (TC-API)
  - Frames 73-76 > TC-RDI indicating defects that have occurred in the tandem connection to the far-end
  - Frame 74 > ODI indicating to the far-end that AIS-P/V has been inserted into egressing STS-1n VT-n due to defects before or within the tandem connection
  - Frames 73-76 > Reserved capacity

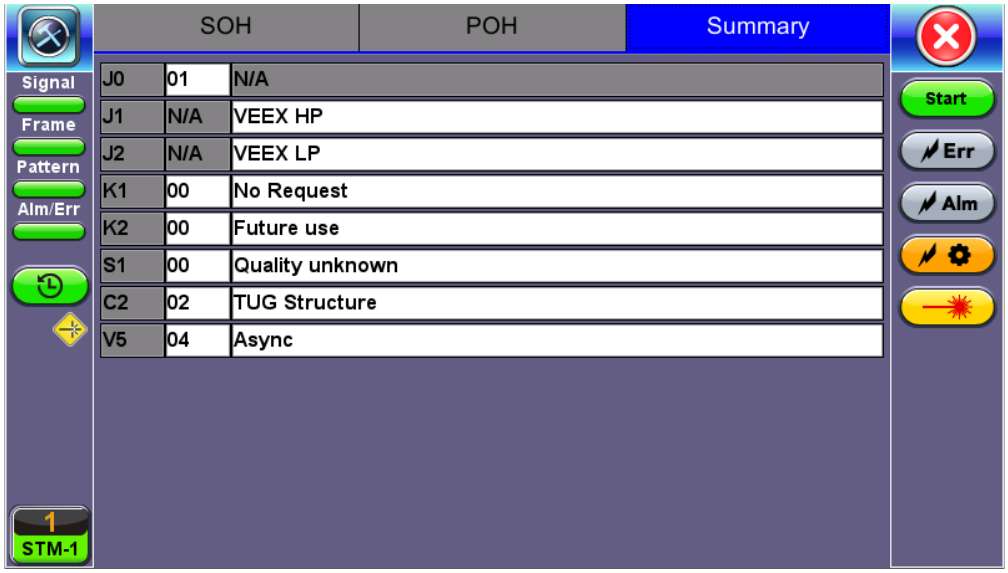
Z6 Byte Structure							
Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
TC-BIP		"1"	IAIS	TC-REI	OEI	TC-APId, TC-RDI, ODI, rserved	

- **Z7 byte (VT path Extended Label)**
  - If bits 5-7 of V5 byte are set to 101 (value = 5), then:
    - The signal label in Z7 byte becomes valid where:
      - This is a 32-bit multi-frame string
      - Bit 1 is allocated to the extended signal label
      - Bit 2 is allocated to virtual concatenation
      - Bits 3 and 4 are unassigned and are reserved for VT APS signaling
      - Bits 5, 6, 7 are allocated for optional use
      - Bit 8 is unassigned

Summary

- The Summary tab displays the summary screen listing the major bytes of the received signal.
- Displays the Path Trace Identifiers (J0, J1, J2), APS (K1, K2), Synchronization status (S1), and HP (C2) and LP (V5) Signal Label bytes.
  - Column #1 - Indicates the byte type
  - Column #2 - Provides the hexadecimal value of the byte (if applicable)
  - Column #3 - Provides a byte decode (Please refer to the byte definitions for an explanation of the listed bytes)

- *For Path traces, (SP) indicates a space between the message characters.*
- *The message will be displayed in red when an alarm condition is detected.*



Summary

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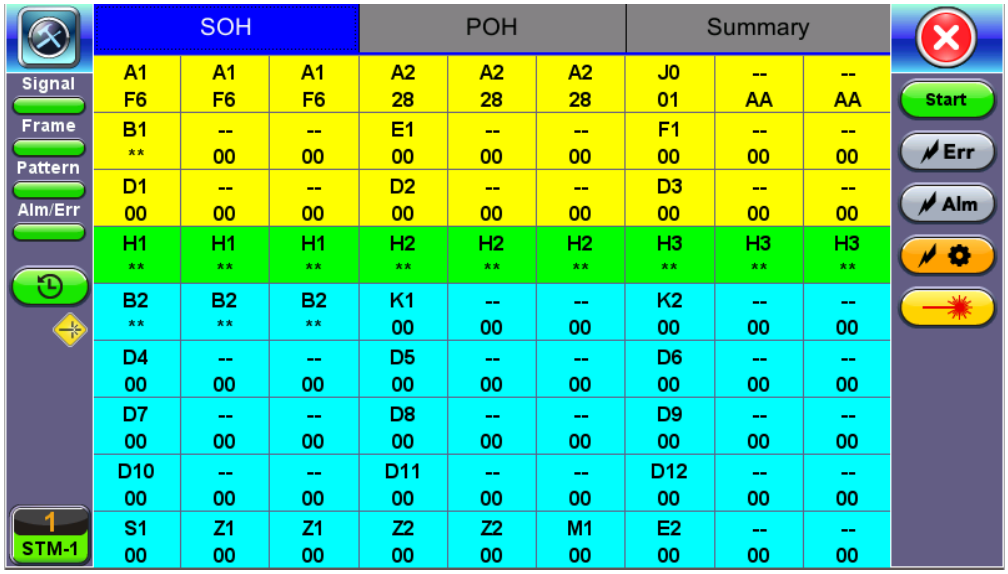
7.3.3 Overhead Generator

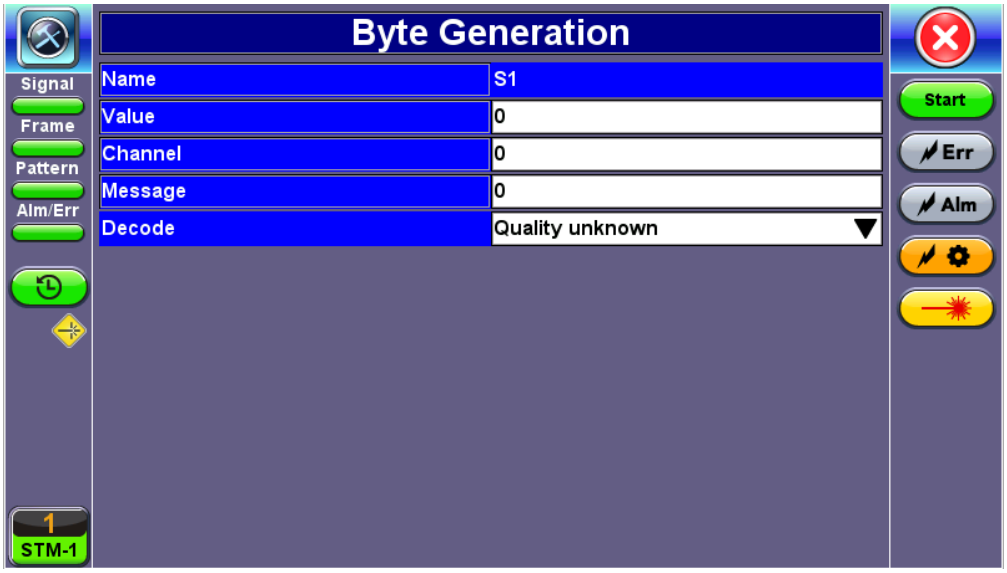


SOH

Tap the Overhead Generator icon to display the OH screens shown below. There are three tabs:

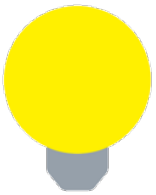
- **SOH TX**, which allows editing of select bytes associated with the Section Overhead. Editing of J0, K1, K2, S1 is permitted as follows:
  - Hexadecimal value using pop-up keypad.
  - Binary values using simple on-screen bit toggle or pop-up keypad.
  - Convenient drop-down selections. In some instances, the selections will be available over multiple pages.

While programming of most overhead bytes is possible using the OH Generator feature, dedicated functions are available for Pointer Tasks, Payload Labels, Trace Identifier, APS Testing, TCM testing. In some instances, more advanced editing is possible using the dedicated functions.



S1 Byte from SOH

- **POH TX**, which allows editing of select bytes associated with the Path Overhead.
  - Editing of J1, C2, H4, G1, Z5, and J2, V5, Z6 is permitted as follows:
    - Hexadecimal value using pop-up keypad.
    - Binary values using simple on-screen bit toggle or pop-up keypad.
    - Convenient drop-down selections. In some instances, the drop-down options will be available over multiple pages.



Overhead Generator

Programming most overhead bytes is possible using the OH Generator feature, however dedicated test functions are available for Pointer Tasks, Payload Labels, Trace Identifier, APS Testing, TCM testing. In some instances, more advanced editing is possible using the dedicated functions.

Summary

Displays the Path Trace Identifiers (J0, J1, J2), APS (K1, K2), Synchronization status (S1), HP (C2), and LP (V5) Signal Label bytes. The operation is the same as the Overhead Analyzer function.

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7.3.4 Pointer Tasks

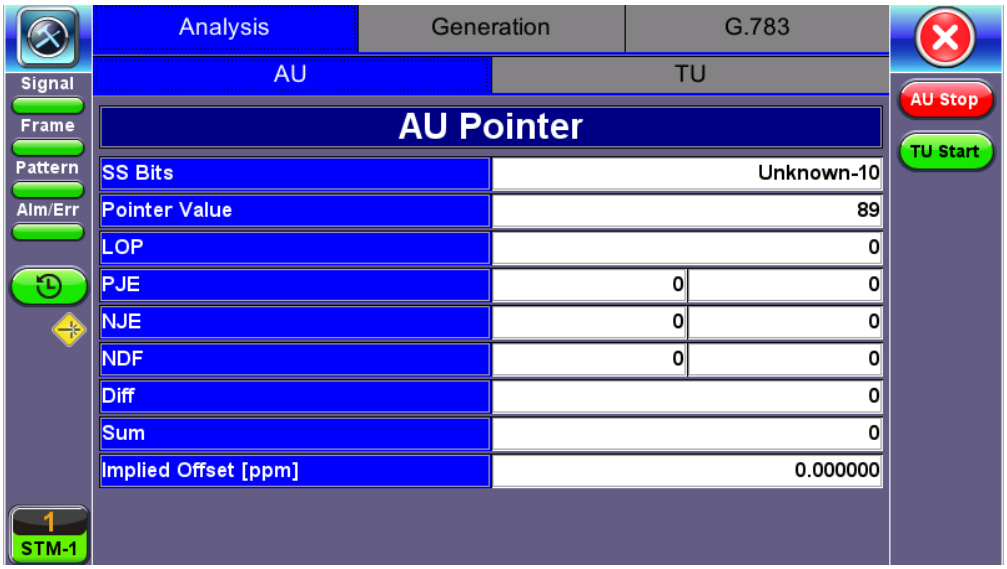
Tap the Pointer Tasks icon to display the Pointer testing screens.

7.3.4.1 Pointer Analysis

Pointers keep signals synchronous by compensating for timing differences without having to use stuffing bits. Pointers are allowed to move up or down every three frames however the actual rate should be slower. The Administrative Unit (AU) and the Tributary Unit (TU) each has its own pointer and the unit has two tabs for displaying the values and measurements.

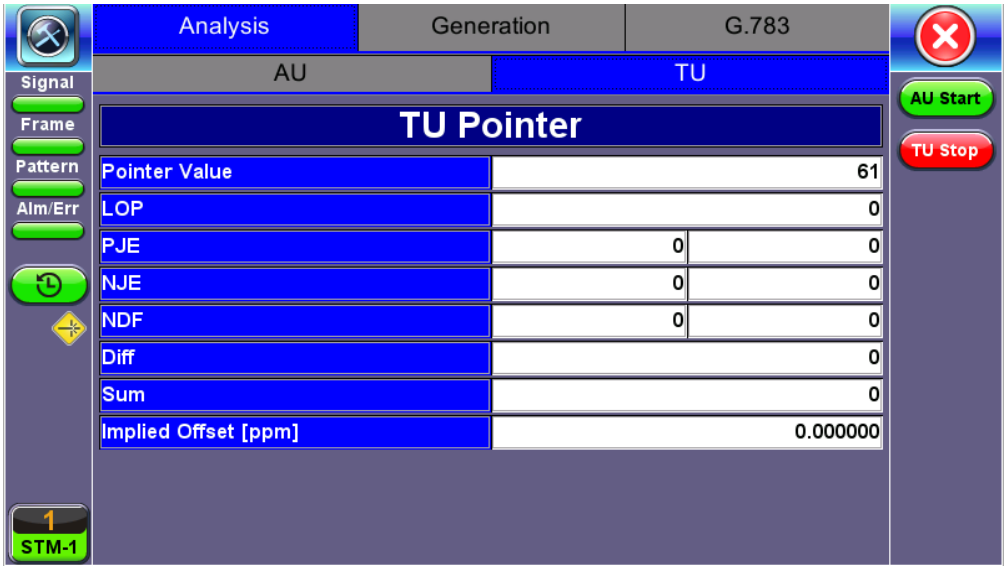
- **For AU (SDH) and STS (SONET) pointers:**
  - SS bits – Displays bits 5 and 6 of the H1 byte to indicate SDH/SONET [10], SONET [00], Unknown [01] and [11] signal type
  - Pointer value – Displays the H1 and H2 values (addresses) indicating the offset in bytes between the pointer and first byte of the AU-n (SDH) or STS-n (SONET)
  - LOP (Loss of Pointer)
  - PJE and NJE
  - NDF or New Data Flag. NDF is enabled when all bits match “1001” (or "0001", "1101", "1011" and "1000") and is disabled when all bits match "0110" (or "1110", "0010", "0100", "0111").

- Difference and Sum
- Implied offset



Analysis > AU tab

- **For TU (SDH) and TV (SONET) pointers:**
  - Pointer value
  - LOP (Loss of Pointer)
  - PJE and NJE
  - NDF or New Data Flags
  - Difference and Sum



Analysis > TU tab

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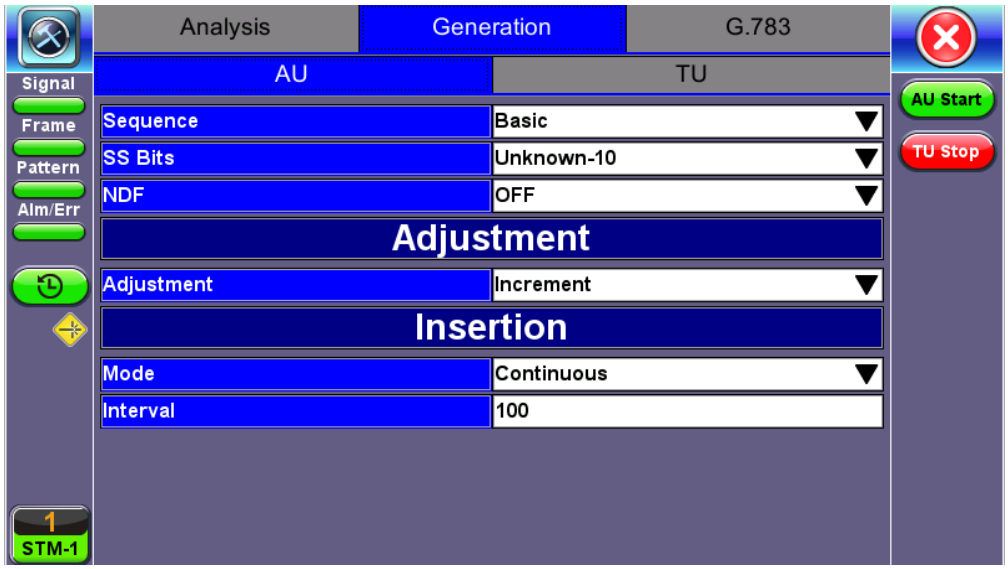
7.3.4.2 Pointer Generation

The Pointer generator is able to generate individual pointer movements as follows:

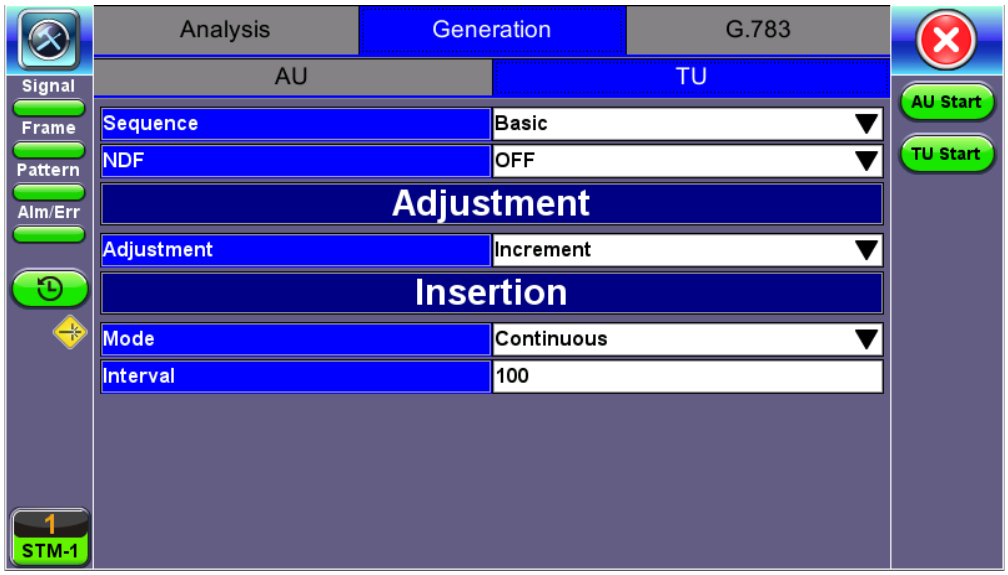
- **For AU (SDH) and STS (SONET) pointers:**
  - SS bits: Program bits 5 and 6 of the H1 byte to be either SDH/SONET [10], SONET [00], Unknown [01] or [11].
  - Pointer value: Transmits a new pointer address or value with or without a new data flag (NDF). Configurable in a range of 0 to 782 pointers.
  - Increment (INC) or Decrement (DEC) pointers with identical polarity by 1 byte in single steps.

- Insert pointers continuously or singularly. Set the interval value in frames for continuous insertion.



Generator > AU tab

- **For TU pointers (SDH only)**
  - TU Pointer value: Set value in a range of 0 to 784 (TU-3) and 0 to 139 (TU-12)
  - TU-11 Pointer value: Set value in a range of 0 to 109 (TU-11)
  - Increment (INC) or Decrement (DEC) pointer value by 1 byte is single steps



Generator > TU tab

For VT pointers (SONET only)

- VT Pointer value: Set value in a range of 0 to 109 (VT-1.5) and 0 to 139 (VT-2)
- Increment (INC) or Decrement (DEC) pointer value by 1 byte is single step

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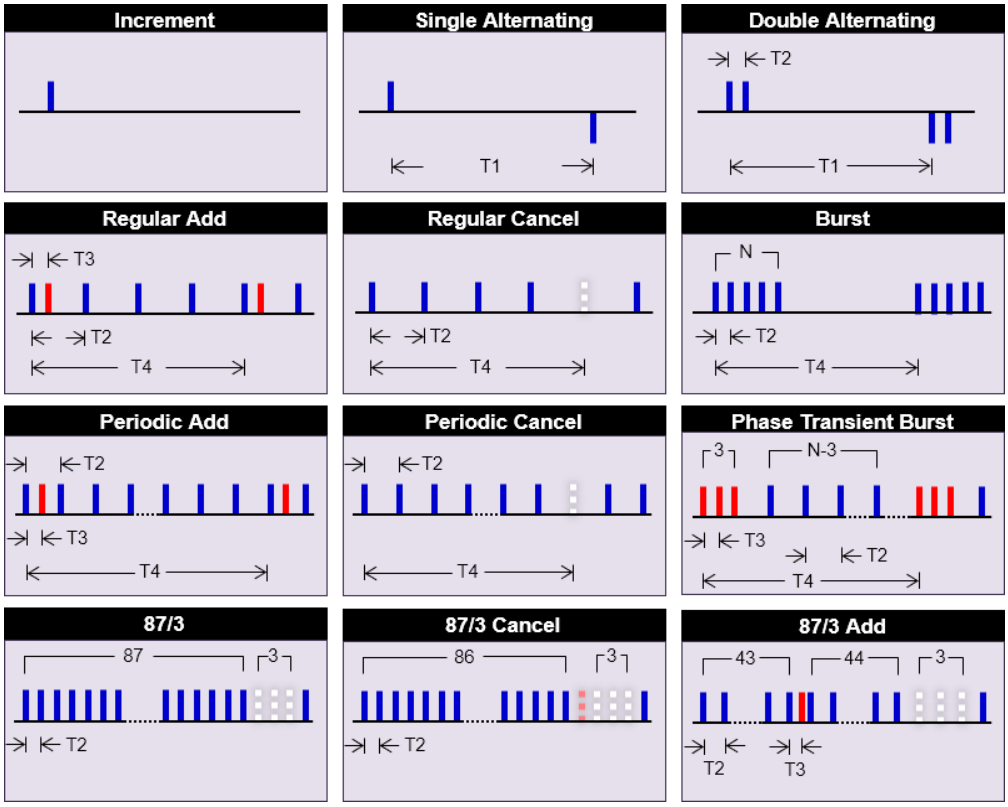
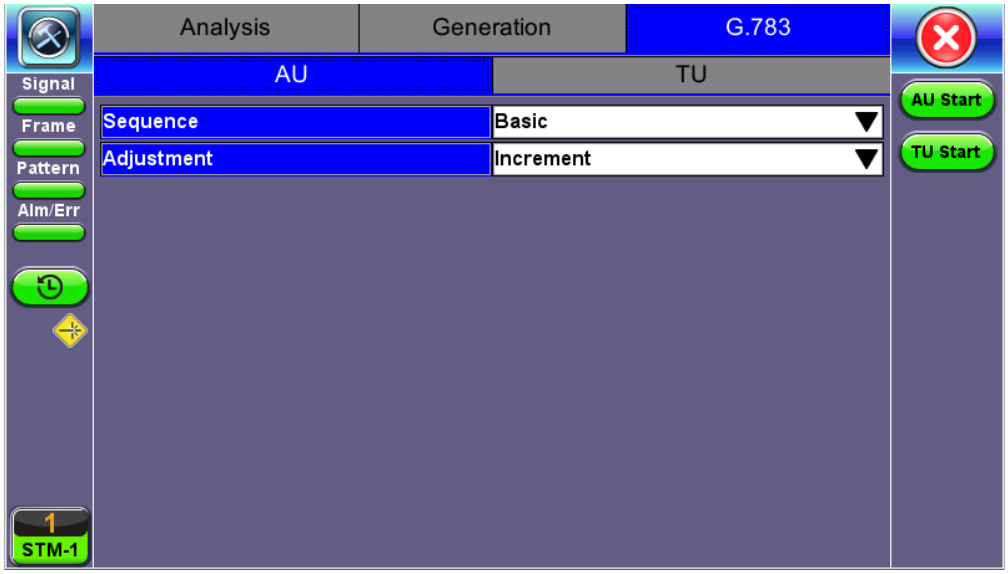
7.3.4.3 Pointer Sequences

The Pointer generator is also able to generate Standard ITU-T G.783 and ANSI T1.105.03 and Bellcore GR-253 sequences as follows:



Pointer Sequences

- **Sequence:** Decide how to affect the pointer sequence
- **Basic:** Specify whether the pointer is increasing or decreasing
    - Select Inc to increase the pointer value
    - Select Dec to decrease the pointer value
    - Select New Value to set new pointer value
- **Single Alternating:** Increase or decrease the pointer value
- **Burst:** Generate a sequence of changes in the pointer value in one direction only (increase or decrease)
- **Transient Burst:** Generate changes in the phase of the pointer adjustment
- **Periodic:** Generate periodic changes in the pointer value
- **87-3:** Generate an 87-3 pattern (87 consecutive pointer adjustments, 3 consecutive pointer value, with no adjustments)
- **87-3 Add**: Generate an 87-3 pattern (87 consecutive pointer adjustments, 3 consecutive pointer value, added to have an additional pointer value)
- **87-3 Cancel**: Generate an 87-3 pattern (87 consecutive pointer adjustments, 3 consecutive pointer value, reduced the number of adjustments by one)
- **Unit**: Select the type of unit to count: Frames
    - N: Specify the number of pointer adjustments in a row: 1—9999 (default=6)
    - T: Specify the average pointer spacing in time. T is known as T1 to T5 in G.783: (default=4)
        - T1, T4: 0.25ms to 600s or 2 to 4,800,000 frames/multiframes
        - T2, T3: 0.25ms to 10s or 2 to 80,000 frames/multiframes
        - T5: 0ms to 600s or 0 to 4,800,000 frames/multiframes



G.873 > AU tab

G.783 Identifier	Pointer Adjustments	Mnemonic
Single Alternating	Single of opposite polarity	+-
Regular Add	Regular plus one double	+&Add
Regular Cancel	Regular with one missing	+&Cancel
Double Alternating	Double of opposite polarity	++-
Single	Single	+
Burst	Burst	+++Burst
87-3	STS periodic 87-3 pattern	+87/3
87-3 Add	STS periodic 87-3 Add position	+87/3 & Add
87-3 Cancel	STS periodic 87-3 Cancel position	+87/3 & Cancel
Periodic Add	Periodic Add position	+Periodical & Add
Periodic Cancel	Periodic Cancel position	+Periodical & Cancel

Pointer Sequence Testing

- It is recommended to run one sequence with positive adjustments followed by a sequence with negative adjustments. Performing the measurement at the maximum positive and negative frequency offset applicable to the line rate increases the stress on the pointer processor.
- The test procedure includes an initialization period followed by a cool down period of 30 seconds with no pointer movements.

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7.3.5 Trace Identifier

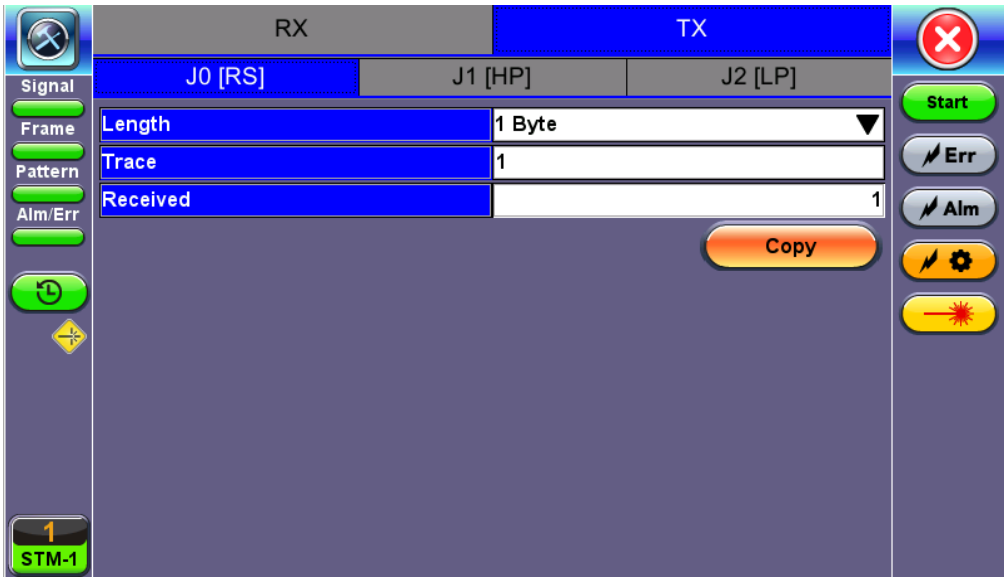
Tap the Trace Identifier icon to display the path trace testing application and screens.

There are dedicated tabs for Transmitted and Received (expected) path traces and setups.

7.3.5.1 Transmitted Traces (TX)

- J0 [RS/Section]: Regenerator section trace/Section Layer trace
  - Program a 1 or 16-byte identifier to check the connection between regenerators
- J1 [HP/STS Path]: High order path section trace/STS path section trace
  - Program a 16 or 64-byte identifier to check the high order transmission path
- J2 [LP/VT Path]: Low order path section trace
  - Program a 16 or 64-byte identifier to check the low order transmission path

To program or edit the transmitted trace, tap the applicable trace box to display the pop-up keyboard.



TX - JO [S]

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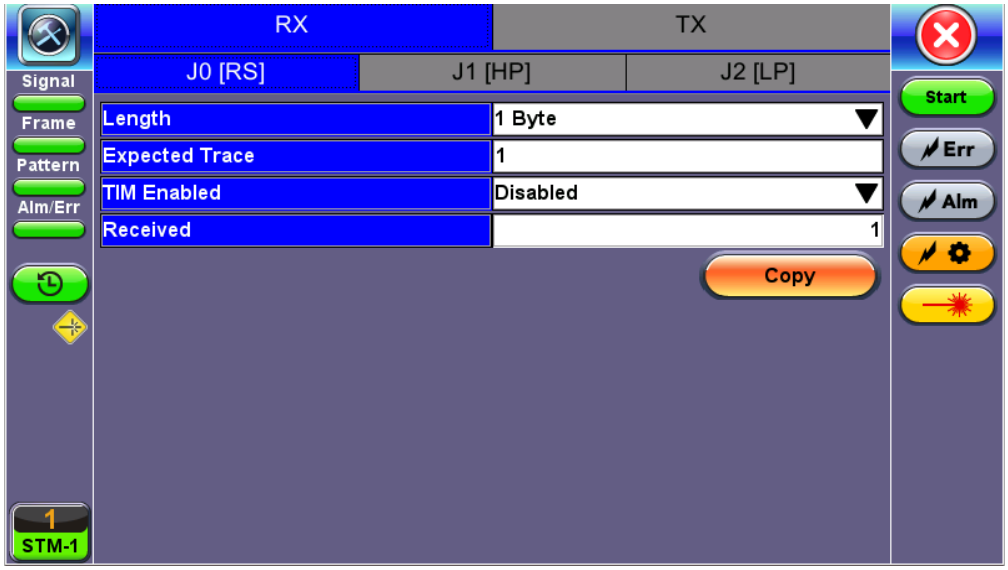
7.3.5.2 Received Traces (RX)

- J0 [RS/Section]: Regenerator section trace/Section Layer trace
  - Program a 1 or 16-byte identifier to set and check the expected trace
  - Enable or disable the TIM (Trace Identifier Mismatch) alarm
- J1 [HP Path/STS Path]: High order path section trace/STS path section trace
  - Program a 16 or 64-byte identifier to set and check the expected trace
  - Enable or disable the TIM (Trace Identifier Mismatch) alarm
- J2 [LP Path/VT Path]: Low order path section trace
  - Program a 16 or 64-byte identifier to set and check the expected trace
  - Enable or disable the TIM (Trace Identifier Mismatch) alarm

To program or edit the received trace, tap on the applicable trace box and this will launch the QWERTY keyboard.



RX - JO [S]

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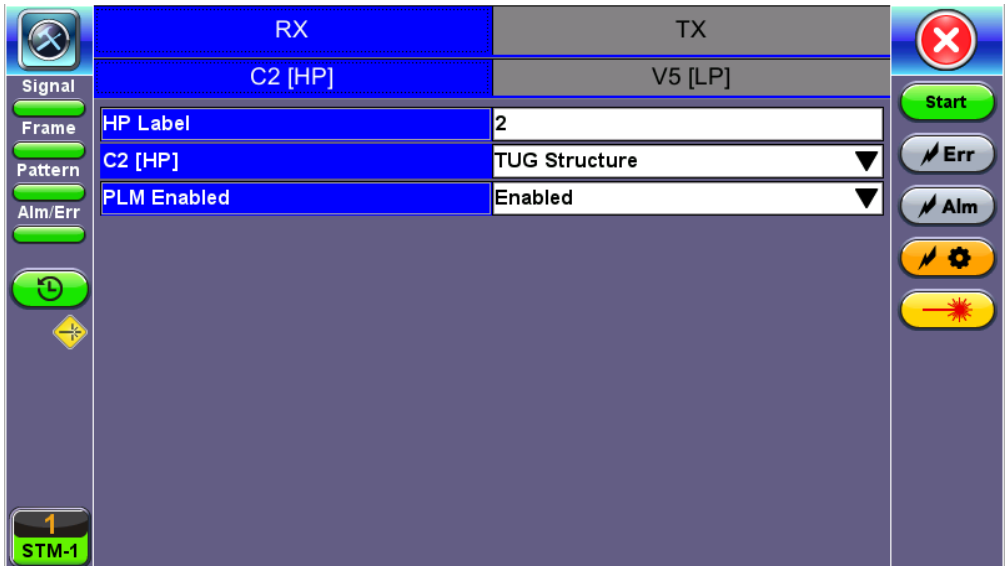
7.3.6 Payload Labels

This function is used to set the C2 and V5 Path Signal Labels which indicate the content of the High order and Low order VCs.

Tap the Payload Label icon to display the payload label screens. There are dedicated tabs for Transmitted and Received payload labels and setups:

- **C2 [HP Path/STS Path]: Path signal label**
  - Specifies the mapping type in the VC-n (SDH) or STS-1n (SONET)
  - Program the TX or RX label by editing the hexadecimal value or by using the convenient drop-down menu selection
  - For the RX label, enable or disable the Payload Mismatch (PLM) Alarm



RX C2 [HP]

- **V5 [LP Path/VT Path]: Path signal label**
  - Program the TX and RX label by editing the hexadecimal value or by using the convenient drop-down menu selection
  - For the RX label, enable or disable the Payload Mismatch (PLM) Alarm

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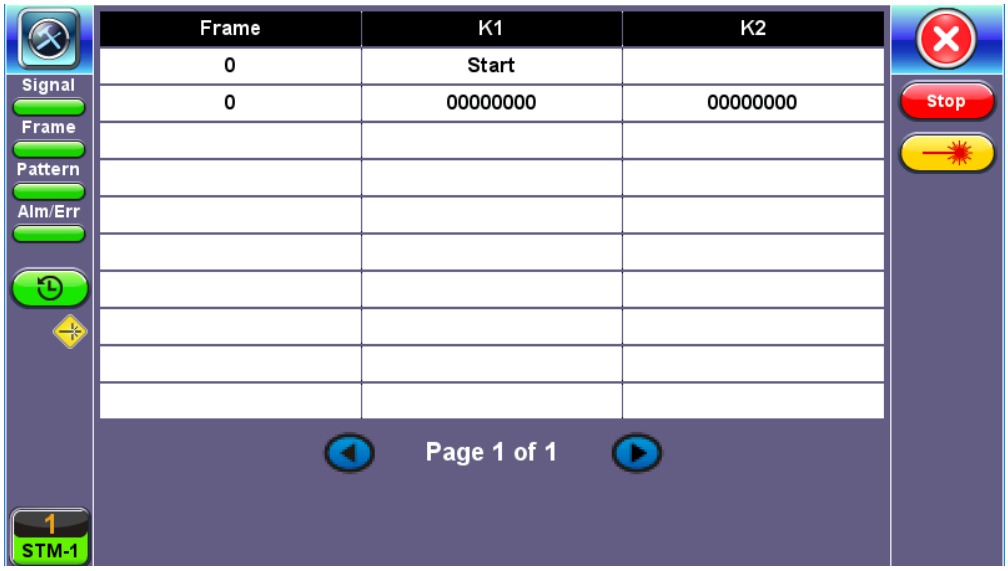
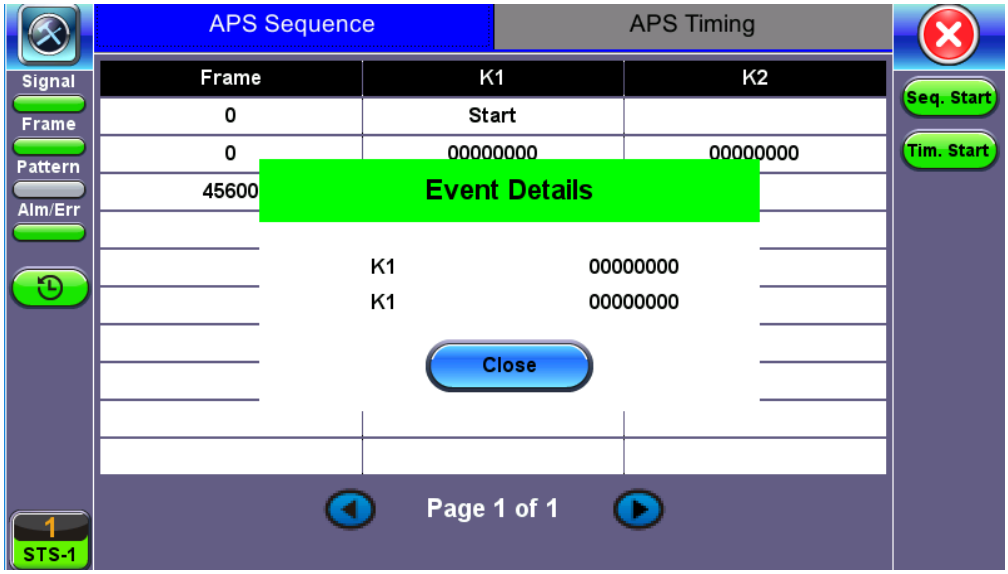
7.3.7 APS Tasks

7.3.7.1 APS Sequence

The associated K1/K2 sequence and received K1/K2 bytes may be captured. Press **Seq. Start** to begin capturing bytes. Tap on a frame or byte in the table to see event details for the selected frame or byte.



APS Sequence



Event Details

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7.3.7.2 APS Timing

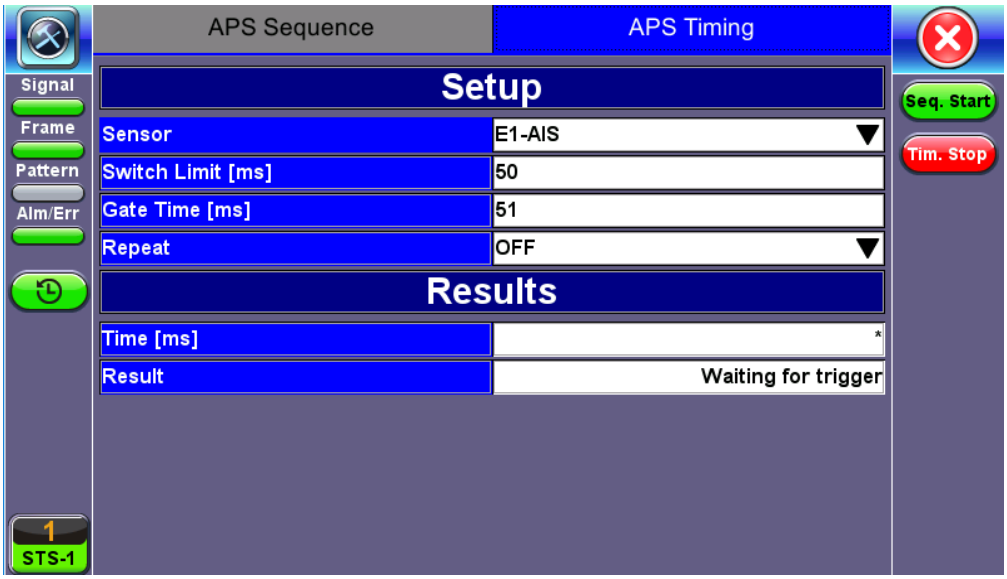
This function measures the Automatic Protection Switching (APS) limits of the network. APS applies only to the Multiplex sections of a SDH or SONET network and enables network elements to re-route traffic to a backup circuit in the event of network failure or problems. The protection mechanism is coordinated by the K1 and K2 bytes in the Multiplexer Section Overhead.

- **APS Standards**
  The principles and protocols of APS in SDH and SONET networks are defined in ITU-T G.783 and G.841 and Bellcore GR-253 recommendations for Linear and Ring network architectures respectively. According to recommendations, the re-routing of the signal has to occur within 50ms. Protection switching is initiated as a result of one of the following conditions:

- “Hard” Failure (SF) condition – Loss of Signal (LOS), MS-AIS, BER > 1 x 10^{-3}.
- “Soft” Failure (SD) condition – Signal degradation when BER exceeds a predetermined threshold. Normally over a provisioned range of 1 x 10^{-5} to 1 x 10^{-9}.

Tap the APS Testing icon to display the APS testing screen shown below.

- **Sensor:** Select the trigger that will initiate the APS measurement
  - The selections are LOS, LOF, SDH FAS, B1, MS-AIS, MS-RDI, MS-REI, B2, AU-AIS, AU-LOP, B3, HP-RDI, HP-REI, TU-AIS, 2M-AIS, 2M-LOF, LSS and TSE (bit errors)
- **Switch Time Limit**: Configurable in the range from 15ms to 200ms
  - Typically 50ms according to ITU-T recommendations
- **Gate Time**: Configurable in the range from 50ms to 4 seconds
  - Used to measure total service disruption when multiple switches or micro interrupts occur
- **Repeat**: ON/OFF
  - Configurable to measure on a continuous basis
- **Time Start**: Press to begin the test



APS Timing Setup

- **APS Test Procedure:**
  - The test set should be connected to a tributary port of network element or transmission system to ensure that the switching time is measured for the service transported by the network
  - Ensure that no errors or alarms are present on the transmission system because this will impact the measurement
  - The measurement will be triggered depending on the condition configured
  - The test set measures how long the AIS event remains present after the event is first recognized and will continue to measure the total disruption time in the event of multiple disruptions

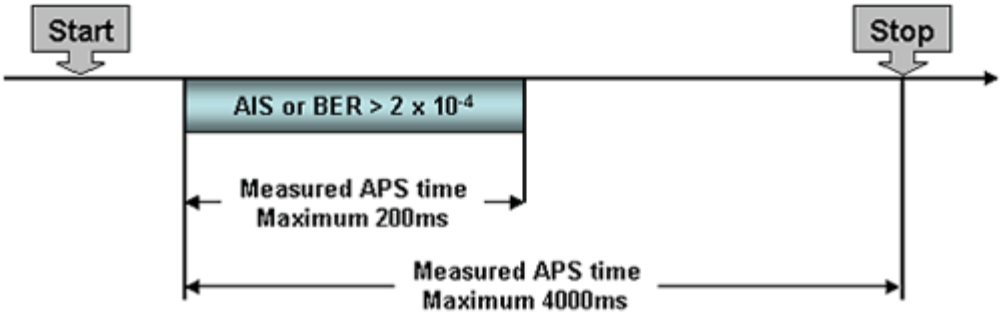


Figure 1: Perfect service disruption

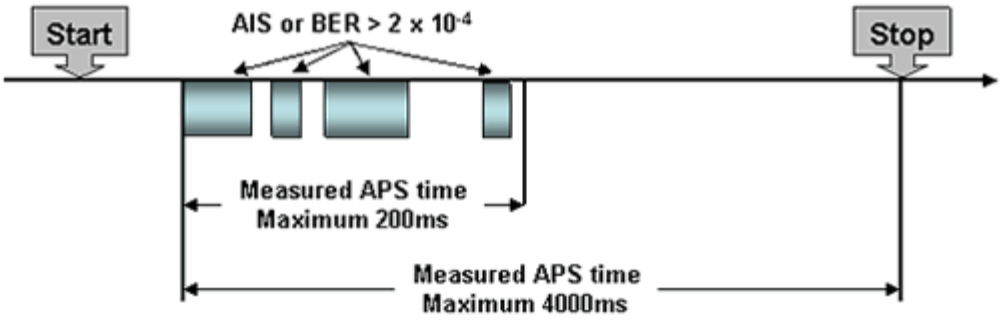


Figure 2: Multiple service disruption or micro interrupts

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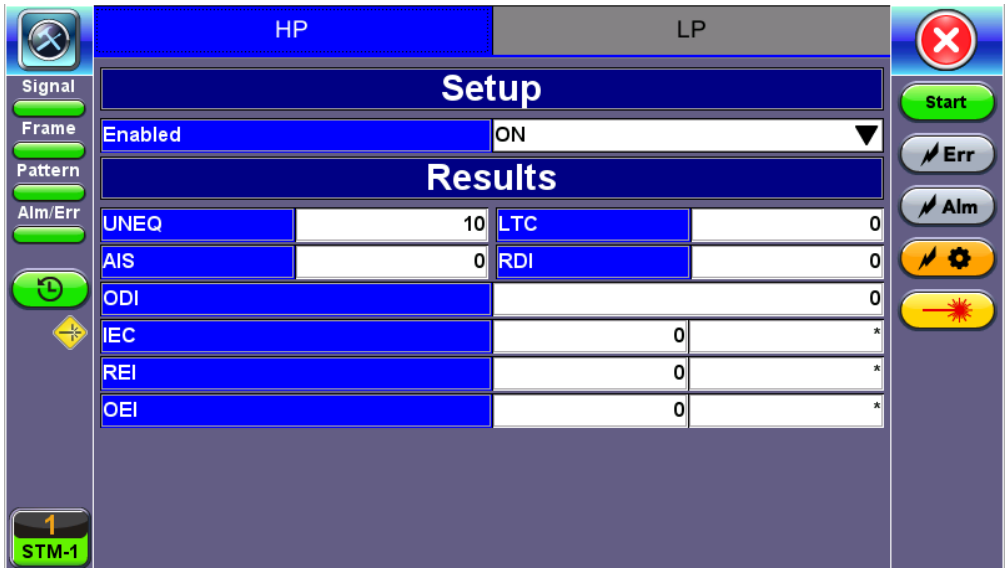
7.3.8 Tandem Connection Monitoring (TCM)



HP Setup

- **TCM Standards**
  The Tandem paths are defined in ITU recommendation G.707 Annex D and Annex E
  - G.707 Annex D for VC4 and VC3
  - G.707 Annex E for VC2 and VC1
  - G.707 defines a tandem connection source and sink and describes the responses of each when defect (alarm) and error conditions are detected
  - Tandem connection maintenance signals are carried in:
    - N1 byte for VC4 and VC3
    - N2 byte for VC2 and VC
    - Z5 byte for STS-N

- Z6 byte for VT
- These two bytes are structured similarly, but their functions are not identical

N1 Byte Structure							
b1	b2	b3	b4	b5	b6	b7	b8
IEC [IAIS]				TC-REI	OEI	TC-APId, TC-DI, ODI, reserved	
N2 Byte Structure							
b1	b2	b3	b4	b5	b6	b7	b8
TC-BIP		"1"	IAIS	TC-REI	OEI	TC-APId, TC-DI, ODI, reserved	

- **IEC:** Incoming Error Count. Indicates IAIS when set to "1110" (see below)
- **IAIS:** Incoming AIS alarm
- **TC-REI:** Tandem Connection Remote Error Indication
- **OEI:** Outgoing Error Indication
- **TC-APId:** Tandem Connection Remote Defect Indication
- **ODI**: Outgoing Defect Indication
- **TC-BIP:** 2-bit Bit Interleaved Parity for Tandem Connection

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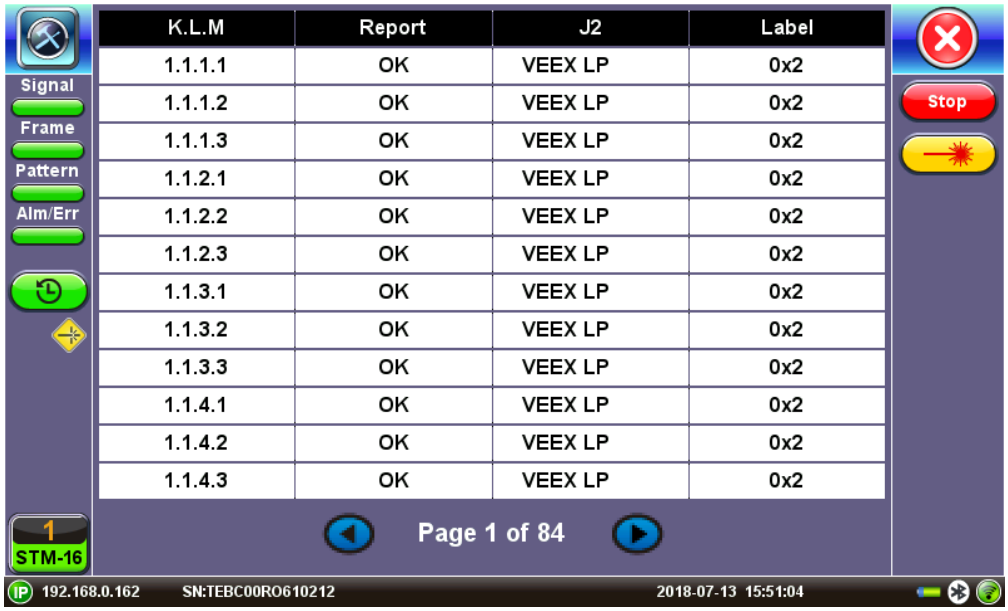
7.3.9 Tributary Scan

This function requires VC12 or VT-1.5 mapping and allows for a quick check of the signal structure, trace identifier, and the payload.

An important part of any Add Drop Multiplexer (ADM) installation process is the verification of the path routing. Considering that an STM-1 contains 63 x VC-12's and an STS-3 contains 84 x VT-1.5's, checking each path manually can be very time consuming.

The unit automatically performs a sequential BER teston each tributary channel. SDH tributary (C12 channel) - mapping can be either via AU-4 or AU-3. SONET tributary (VT channel) - mapping can be via STS-N. The unit checks for alarms in the received signal, the structure, and for synchronization of the selected test pattern in all channels. The result for each channel is entered in a table:

- K.L.M.: ITU-T Tributary numbering scheme
- Report: Pass (OK)
- J2 trace: Corresponds to the VT trace being transmitted
- Label: Corresponds to the V5 byte signal label being transmitted



K.L.M	Report	J2	Label
1.1.1.1	OK	VEEX LP	0x2
1.1.1.2	OK	VEEX LP	0x2
1.1.1.3	OK	VEEX LP	0x2
1.1.2.1	OK	VEEX LP	0x2
1.1.2.2	OK	VEEX LP	0x2
1.1.2.3	OK	VEEX LP	0x2
1.1.3.1	OK	VEEX LP	0x2
1.1.3.2	OK	VEEX LP	0x2
1.1.3.3	OK	VEEX LP	0x2
1.1.4.1	OK	VEEX LP	0x2
1.1.4.2	OK	VEEX LP	0x2
1.1.4.3	OK	VEEX LP	0x2

Tributary Scan

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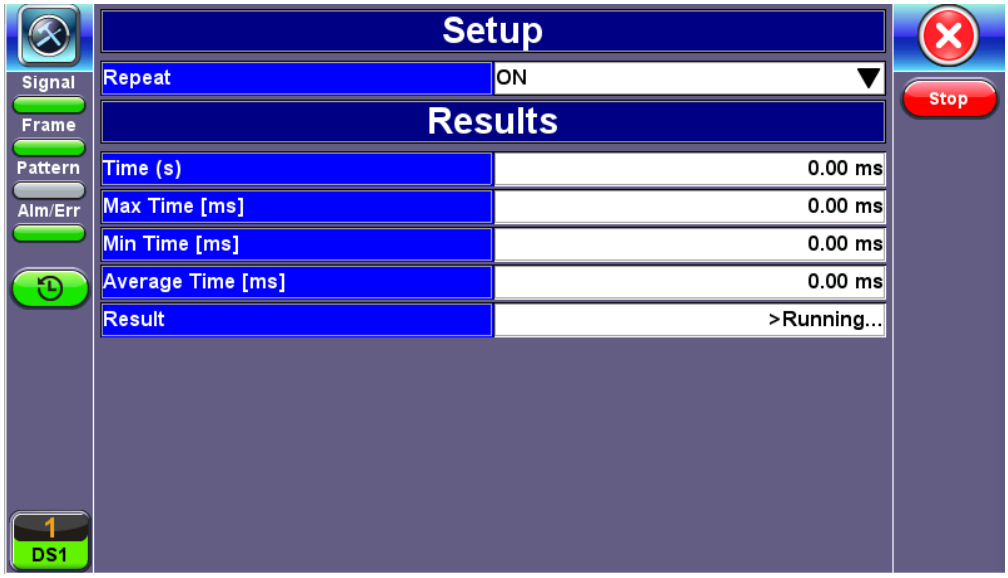
7.3.10 Round Trip Delay

The Round Trip Delay (Propagation Delay) measurement works by sending a test pattern with an error. The time it takes for the error to reach the receiver is the propagation time through the network. Select Repeat for continuous measurement. If it's off, it will only make one measurement.

- **Repeat**: ON/OFF. *Off* makes only one measurement. Turn *On* for continuous measurement.



Round Trip Delay Results

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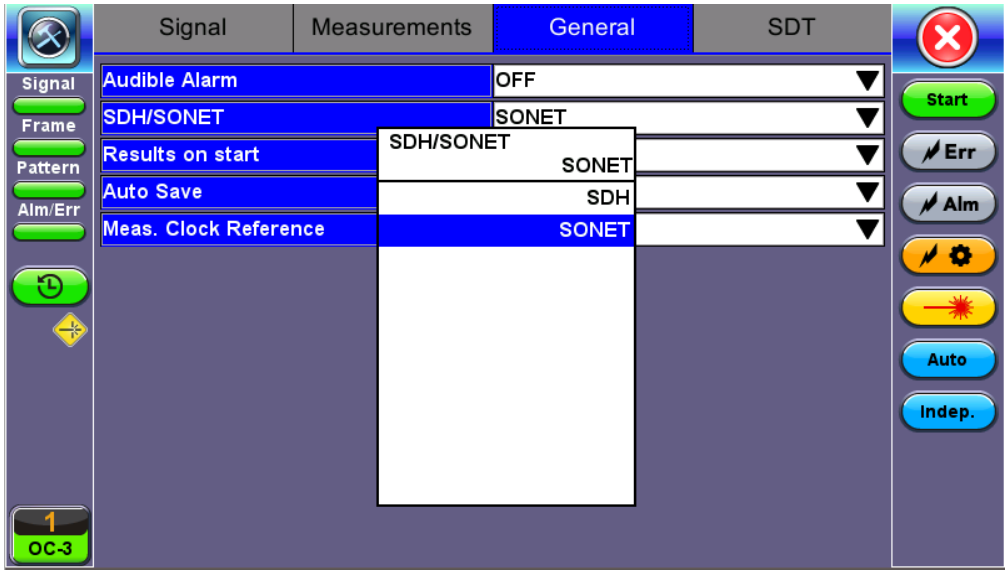
8.0 SONET



Selecting SONET from the General tab

Accessing SONET Testing

To display SONET options for the TX and RX block configuration, tap on the **General** tab from the Setup screen and select *SONET* from the **SDH/SONET** drop-down menu.

*Depending on whether SDH or SONET is selected from the **SDH/SONET** option under the **General** tab, TX and RX configuration screens will look slightly different.*

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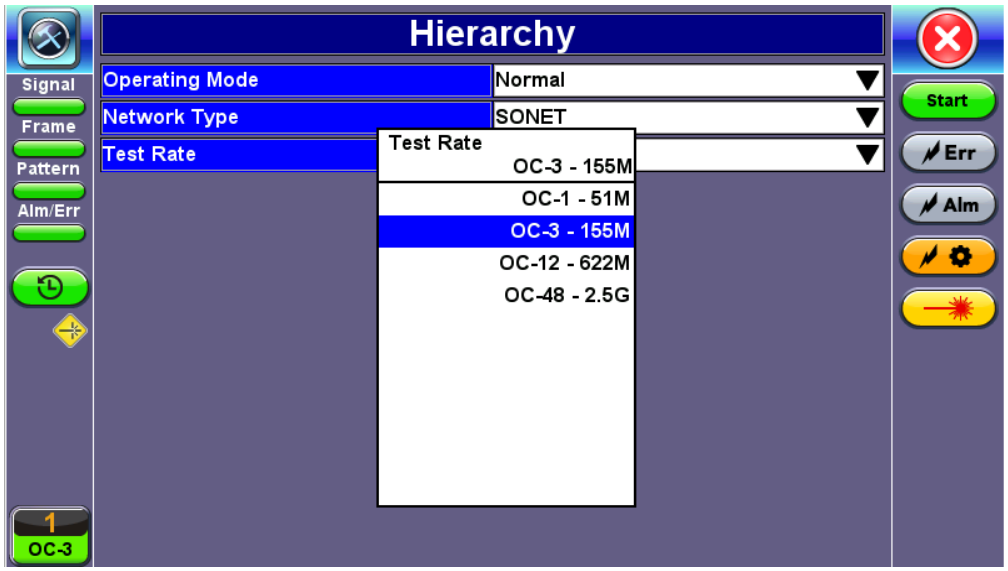
8.1 Signal (Transmitter/Receiver) Setup

This section of the manual describes the SONET configuration capabilities. The block diagram of the Tx and Rx structure is described in Signal Overview. Tap on a block in the diagram to set up Hierarchy, Interface, Structure, Payload, and Pattern options.

8.1.1 Hierarchy



Coupled Hierarchy Setup

- **Operating Through Mode:**
  - **Normal Mode:** Unit working as normal SONET mode.
  - **Payload Through Mode:** Overhead overwrite Editing Thru mode allows for some intrusive error and alarm injection through overhead manipulation.
  - **Transparent Through Mode:** All the traffic goes through the unit untouched and the unit can monitor it. It is comparable to Monitor Mode with a 10/90 splitter. In Transparent Mode, the unit regenerates the signal in amplitude. The clock is recovered from the received signal.

Through modes are used to test network behavior under certain conditions, such as alarms and APS. To select Payload Through, the payload has to be the same for the relevant ports.

- **Network Type:** Only optical interface selection is available on the unit.
- **Test Rate:** Options are STS-1, OC-3, OC-12, and OC-48.

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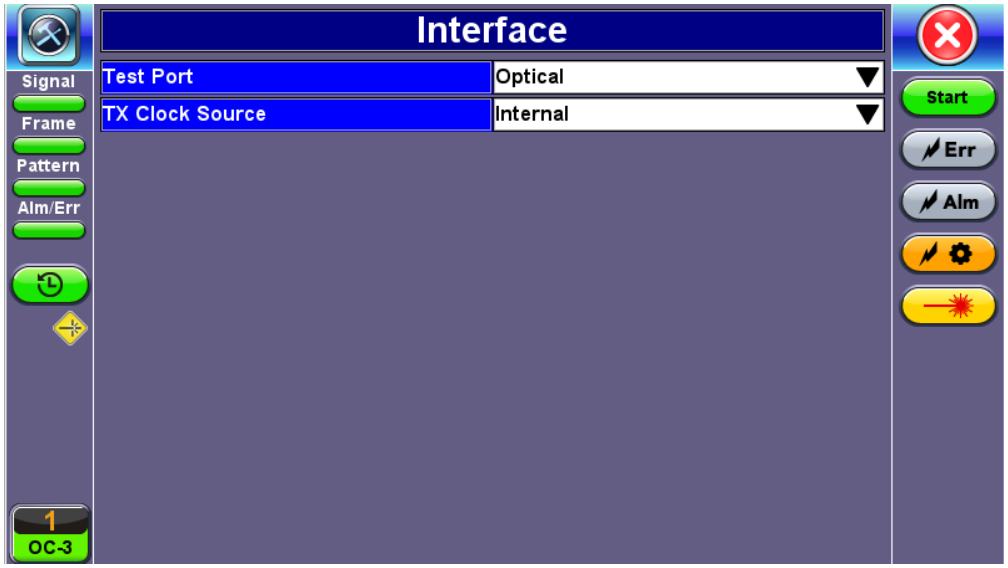
8.1.2 Interface

In this screen both electrical and optical options can be selected.



Interface Setup

Test Port: Optical or Electrical.

- Optical interface is available for OC-1, OC-3, OC-12, and OC-48 signals.
- Electrical interface is available for STS-1 and STS-3 signals.

Clock Source: Can be configured as follows.

- **Internal clock:** The clock for the transmitter is derived from the internal clock. The internal clock has an accuracy of +/- 3.5ppm conforming to G.812 recommendations.
- **External clock:** The clock for the transmitter is derived from a 1.5MHz, 2MHz, 1.5Mbps, or 2Mbps on the SMA.
- **Rx**: The clock for the transmitter is derived from the received signal, and the jitter of the incoming signal is suppressed.
- **Offset:** The clock for the transmitter is derived from internal clock generator. It can change the offset while measurements are running. Use the numeric key to increase and decrease the frequency shift, up to 0.01ppm. Frequency offset: ± 50ppm with 1, 0.1, 0.01ppm resolution.

Remember to use an optical attenuator to prevent receiver overload or damage – refer to the SFP chart below to determine safe levels. Avoid looping back the Tx and Rx on a 1550nm XFP or SFP using a patchcord only as this will damage the SFP.

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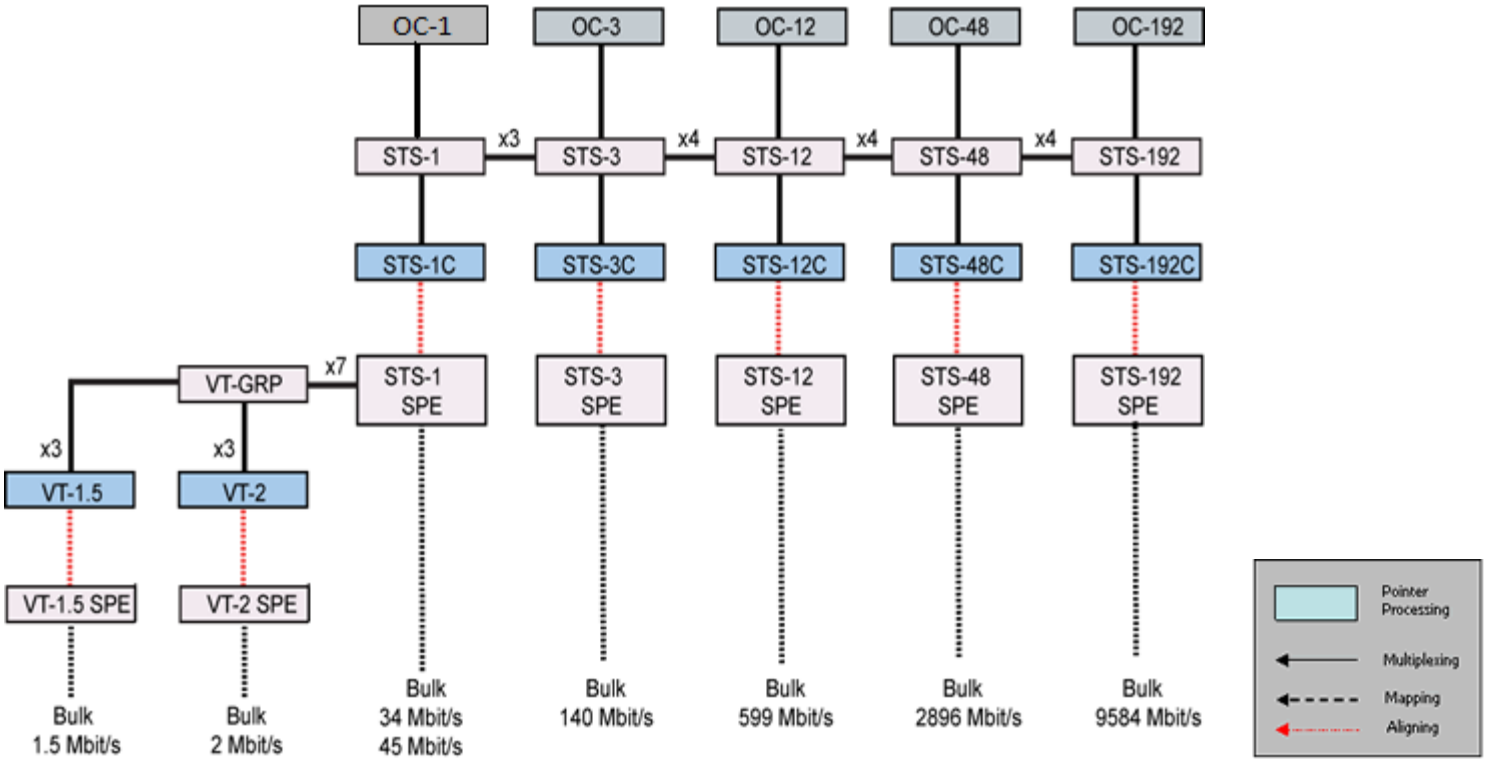
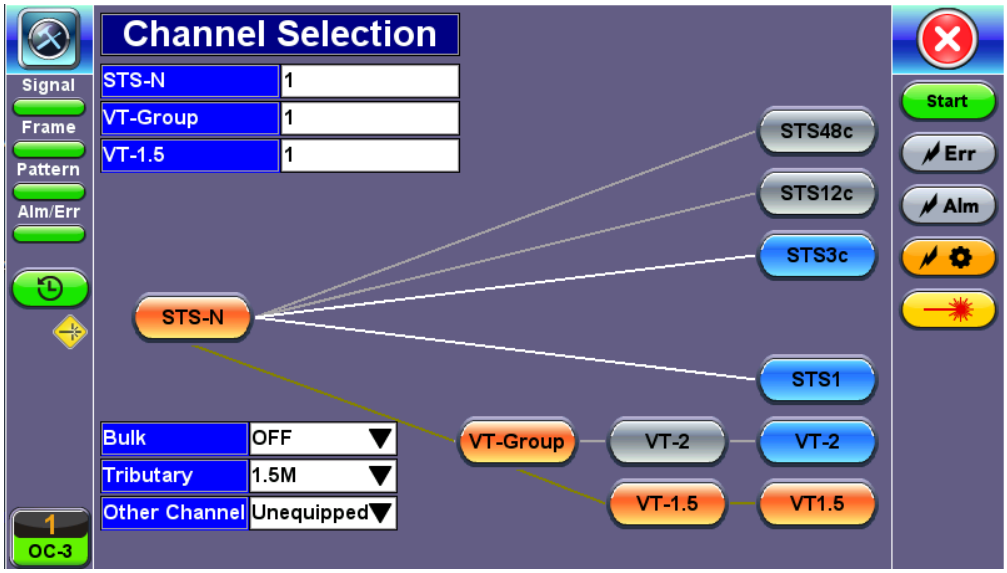
8.1.3 Structure

Mapping: STS-192C, STS-48C, STS-12C, STS-3C, STS-1 and VT1.5 is available. VT-2 is optional. STS mappings per Bellcore GR-253 and ANSI T1.105 recommendations are supported. The multiplexing structure is shown below.





Structure Setup

- **Bulk:** Tap the check box to enable the setting. In Bulk mode, the entire VT container is filled with a test pattern per ITU-T 0.181 recommendations.
- **Tributary:** Preset to DS1, E1, DS3, and E3 depending upon the options and mapping.
- **Other channels:** Select Unequipped to mark the rest of the tributaries (non-test channels) as not equipped. Select Broadcast to transmits the same test channel structure and test pattern in all the tributaries.
- **Sync:** Asynchronous, Bit synchronous and Byte synchronous payload mapping selection

Channel Selection: The Tx channel is selected by entering the KLM position of the SDH/SONET channel within the signal channel. K (STS-N), L (VT-GRP), and M (VT-1.5 or VT-2) refer to the tributaries at each multiplexing levels and depend on the test signal configuration.

- **VT-GRP:** In order to carry a mixed size of VTs in a STS-1 SPE in an efficient manner, VT Group (VTG) is defined. The size of the VTG is 12 columns, which is the least common multiple of the four sizes of VTs. Only one type of VT can be contained within each VTG. Therefore, a VTG can be formed by byte interleave multiplexing 3 VT-2s and 4 VT-1.5s
- **VT-1.5**: Each VT 1.5 frame consists of 27 bytes (3 columns of 9 bytes) These bytes provide a transport capacity of 1.728Mbps, and thus, can accommodate the transport of a DS1 signal. 28 VT 1.5s may be multiplexed into the STS-1 SPE.
- **VT-2**: Each VT-2 frame consists of 36 bytes (4 columns of 9 bytes) These bytes provide a transport capacity of 2.304Mbps, and can accommodate the transport one E1 signal. 21 VT-2s may be multiplexed into the STS-1 SPE.
- The tributary numbering used above is per Bellcore GR.253/ANSI T1.105 standard.

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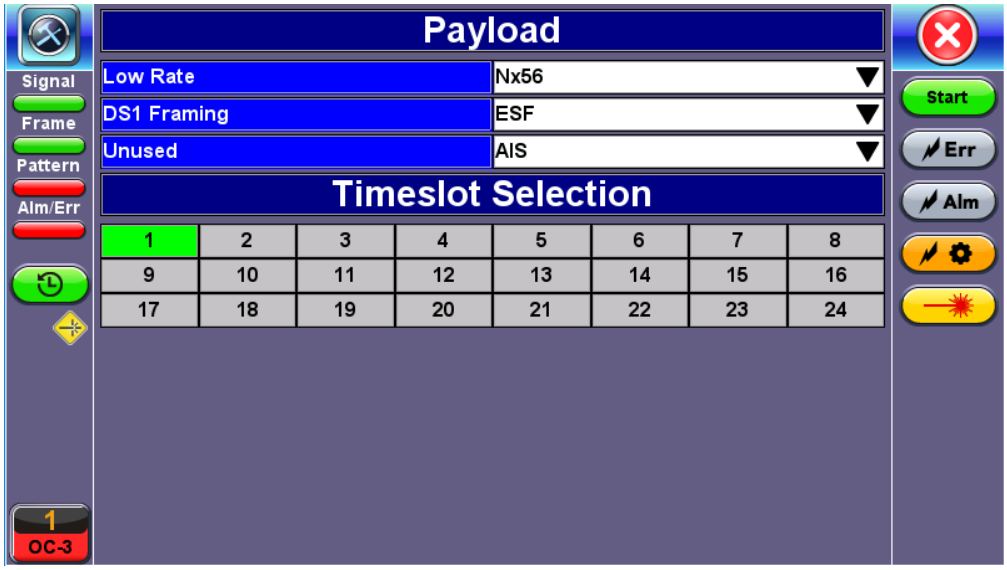
8.1.4 Payload

The Payload options presented will depend on the test signal structure programmed. **Low Rate** indicates the lowest data rate in the structure, containing the test pattern.



Payload

In VT-1.5 mapping mode, The Low Rate options are 1.544M or Fractional DS1 (Nx64 or Nx56) where:

- 1.544M: Configures the transmitter for full rate testing at 1.544Mbps

Fractional DS1 (Nx64 or Nx56): Configures the transmitter for fractional testing using N or M 64kbps timeslots (contiguous or non-contiguous timeslots)

In STS-1 mapping mode/Tributary set to DS3, the Low Rate option are 45M or 1.544M Mux (DS3/DS1 Mux) or Fractional DS1 (Nx64 or Nx56) Mux where:

- 45M: Configures the transmitter for full rate testing at 45Mbps
- 1.544M Mux mode: Configures the transmitter for full rate testing at 45Mbps signal with DS1 payloads (1 to 28 channels)

Fractional DS1 Mux mode: Configures the transmitter for full rate testing at 45Mbps signal with DS1 payloads (1 to 28 channels) for fractional testing using N or M 64kbps or 56kbps timeslots (contiguous or non-contiguous timeslots)

In VT-2 mapping mode, the Low Rate options are 2M or Fractional E1 (Nx64) where:

- 2M: Configures the transmitter for full rate testing at 2.048Mbps
- Fractional E1: Configures the transmitter for fractional testing using N or M 64kbps timeslots (contiguous or non-contiguous timeslots)

In STS-1 mapping mode/Tributary set to E3, the Low Rate options are 34M or 2M Mux (E3/E1 Mux) or Fractional E1 Mux (E3/E1 Mux w/Nx64) where:

- 34M: Configures the transmitter for full rate testing at 34Mbps
- 2M Mux mode: Configures the transmitter for full rate testing at 34Mbps signal with E1 payloads (1 to 16 channels)
- Fractional E1 Mux mode: Configures the transmitter for full rate testing at 34Mbps signal with E1 payloads (1 to 16 channels) for fractional testing using N or M 64kbps timeslots (contiguous or non-contiguous timeslots)

In DS1 mode, the options are unframed, D4 (SF) and ANSI T1.107 (ESF).

In DS3 mode, the options are unframed, M13 and C-Parity.

In E1 mode, the options are unframed, PCM31, PCM31C, PCM30, and PCM30C. Framing conforms to G.704 and G.706 recommendations and are briefly described below.

In E3 mode, the options are unframed, framed G.751.

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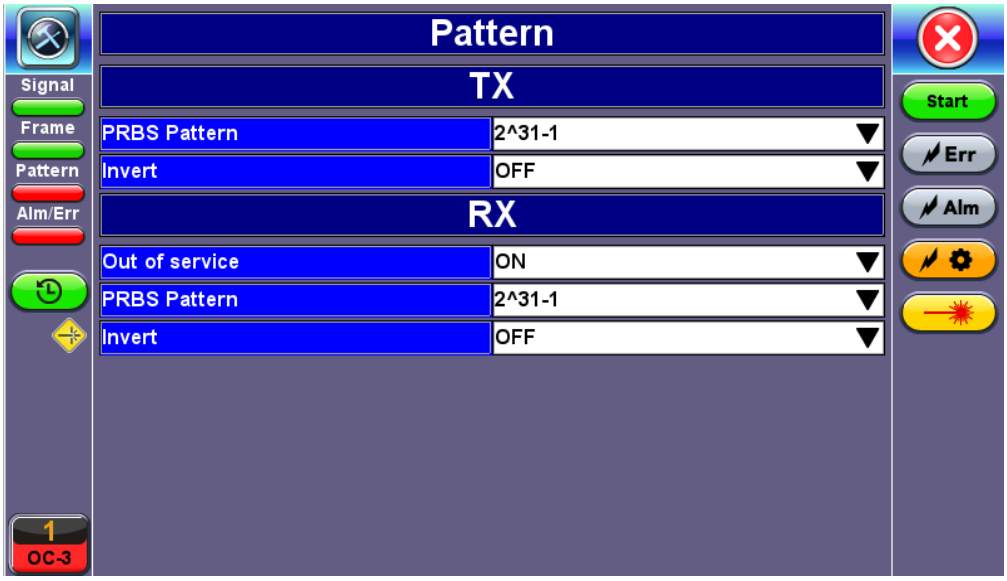
8.1.5 Pattern



Pattern Setup

Pattern: Use the pattern drop-down box to select the test pattern which will be inserted into the transmitted signal. Pseudo Random Bit Sequences (PRBS) defined by ITU-T 0.150 and 0.151 standards, fixed words and 24-bit or 32 bit user defined patterns are available.

If the 32 bit user pattern entered is incorrect, the default pattern will be 0xFFFFFFFF.

Out of Service *(RX only)*: Should be selected if the incoming signal is expected to contain a known test pattern. Deselect this option if signal is expected to contain live traffic.

Invert: Inversion of polarity is also available.

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8.2 Results

Refer to SDH/SONET Results in the SDH section for more information.

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8.3 SDH/SONET Tools

Refer to SDH/SONET Tools in the SDH section for more information.

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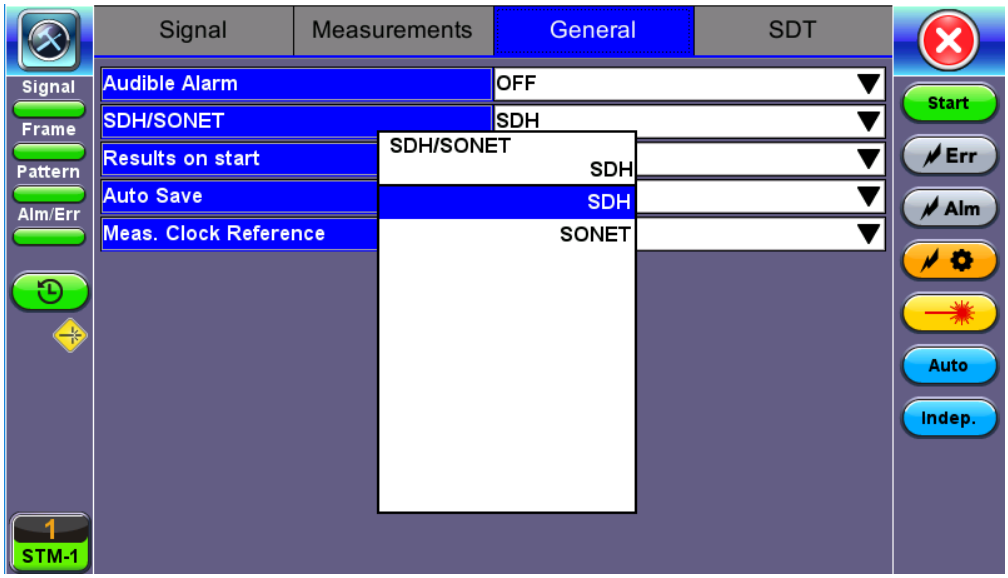
9.0 OTN/SDH and OTN/SONET



Selecting SDH from the General tab

Selecting OTN/SDH or OTN/SONET

From the **General** tab, select SDH or SONET from the menu then select *OTN* from **Network Type** (Hierarchy tab > Network Type).

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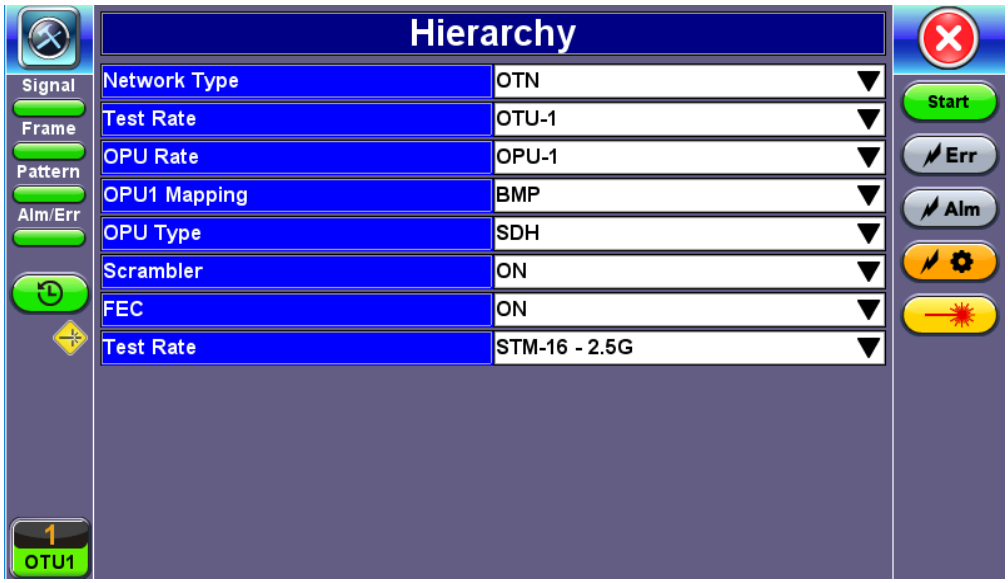
9.1 OTN/SDH Signal (Transmitter/Receiver) Setup

This section of the manual describes the OTN configuration capabilities. The block diagram of the Tx and Rx structure has been described in Signal Overview. Tap on a block diagram to open the setup menu for the selected parameter.

Hierarchy

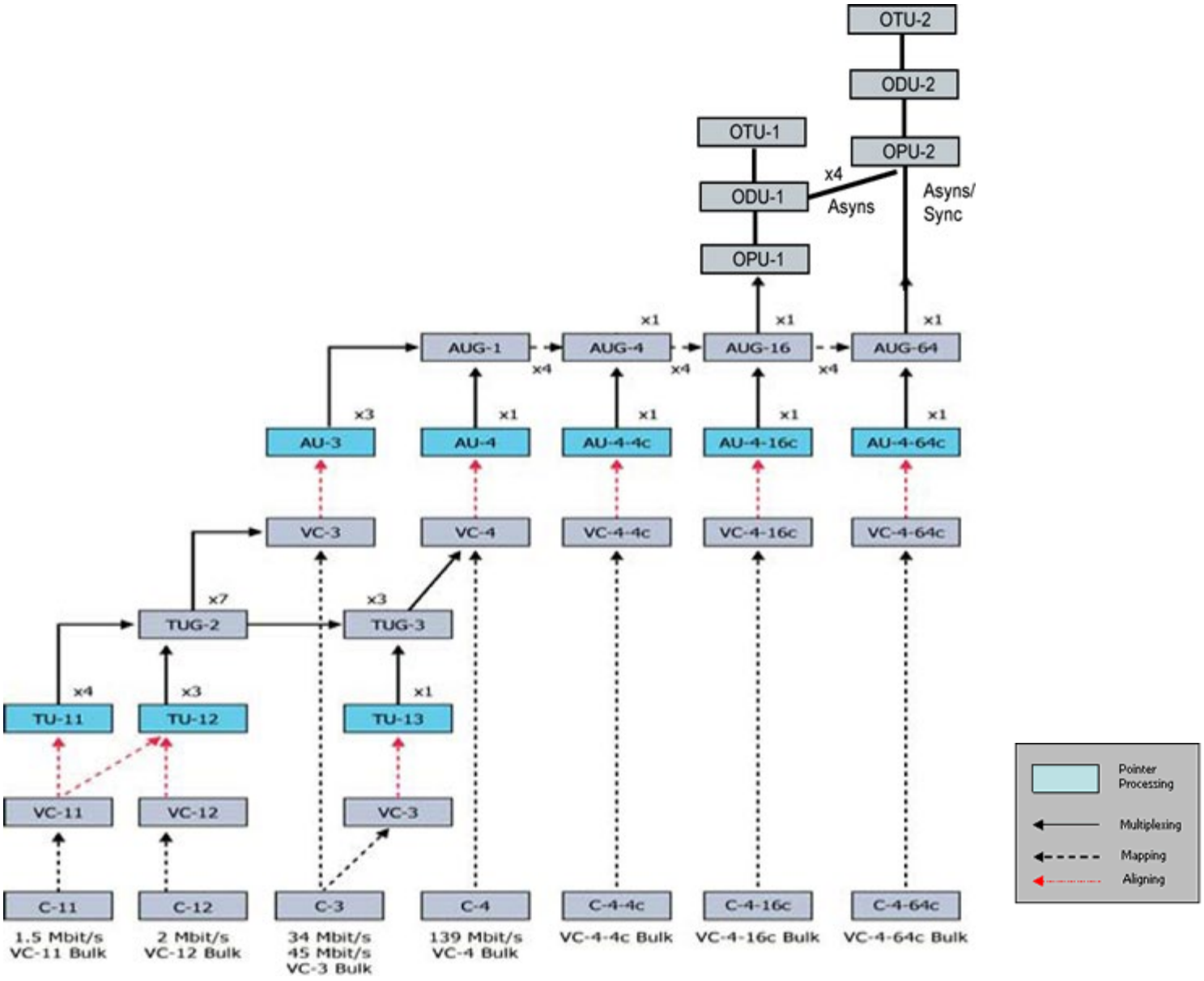
Tapping the **Hierarchy** box opens the Tx Hierarchy Setup screen.



Coupled Hierarchy Setup

- **Network Type:** In the OTN mode, only optical interface options are available
- **Test Rate:** OTU-1
- **OPU Rate:** OPU-0, OPU-1
- **OPU1 Mapping:** BMP, AMP
- **OPU0 Mapping:** GMP
- **OPU Type:** PRBS (OPU1 only), SDH

ITU-T G.709 and both AU-4 and AU-3 signal mappings per G.707 recommendations are supported. The multiplexing structure is shown below.



- **Scrambler:** ON/OFF
- **FEC:** FEC encoder can be ON/OFF (activated / deactivated)
- **Test Rate:** STM-1-155M, STM-4-622M, STM-16-2.5G

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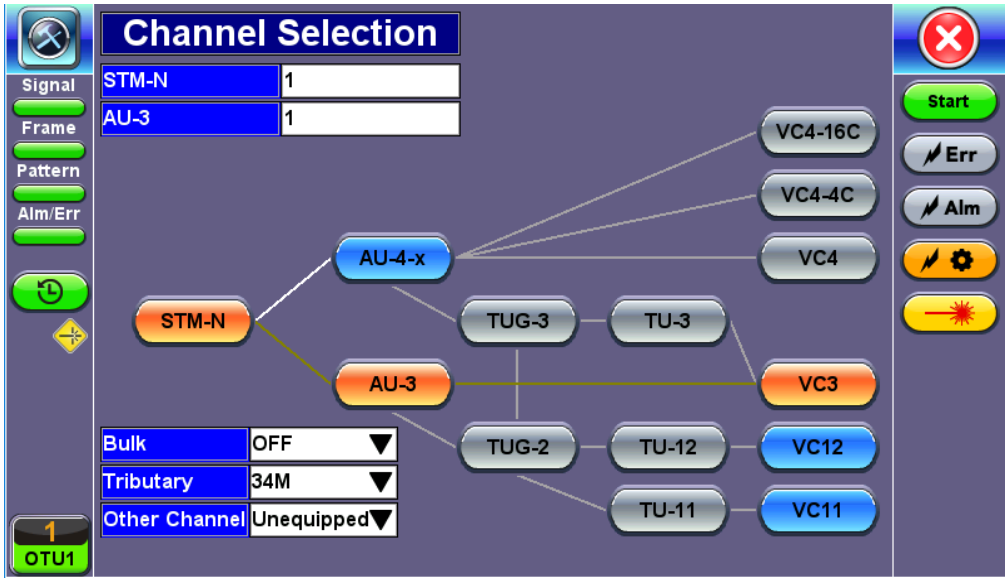
Interface, Structure, Payload, and Pattern

Interface, Structure, Payload, and Pattern TX block configurations are identical to configurations in Transmitter Setup in the SDH chapter. Refer to that section for further details.



Structure Mapping

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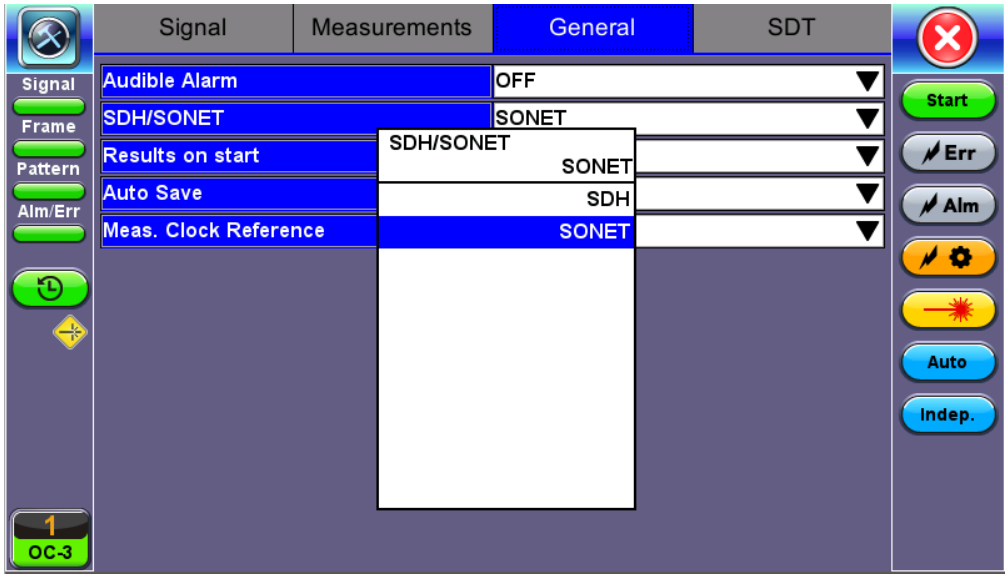
9.2 OTN/SONET Signal (Transmitter/Receiver) Setup



Selecting SONET from the General tab

Accessing OTN/SONET

To verify that the Tx and Rx block diagrams are OTN/SONET, make sure that *SONET* is selected from the **SDH/SONET** drop-down menu under the **General** tab and OTN is selected from **Network Type** (Hierarchy tab > Network Type).

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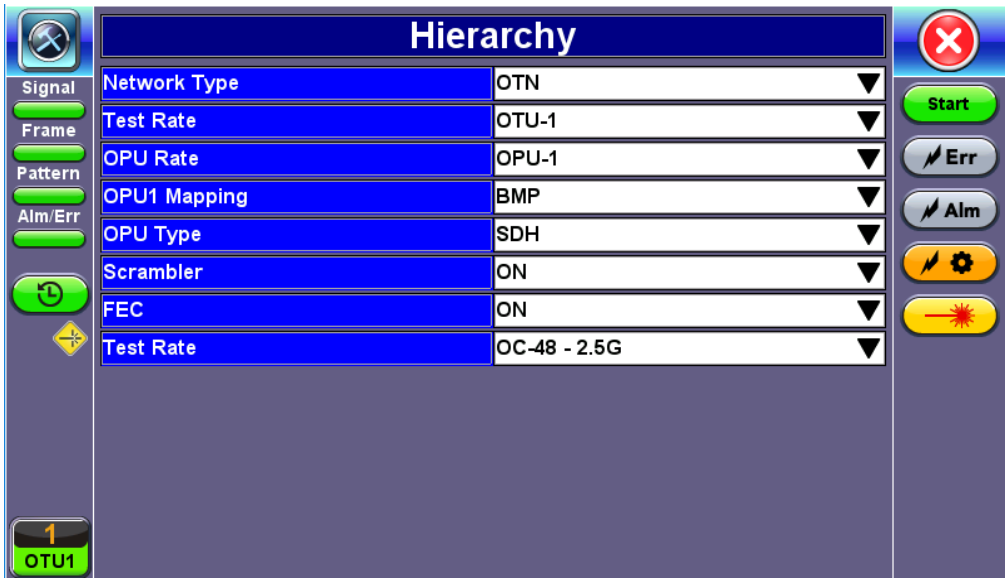
Transmitter/Receiver Setup

This section of the manual describes the OTN configuration capabilities. The block diagram of the Tx and Rx structure is described in Signal Overview. Tap on a block diagram to open the setup menu for the selected parameter.

Hierarchy

Tapping the **Hierarchy** box opens the Tx Hierarchy Setup screen.



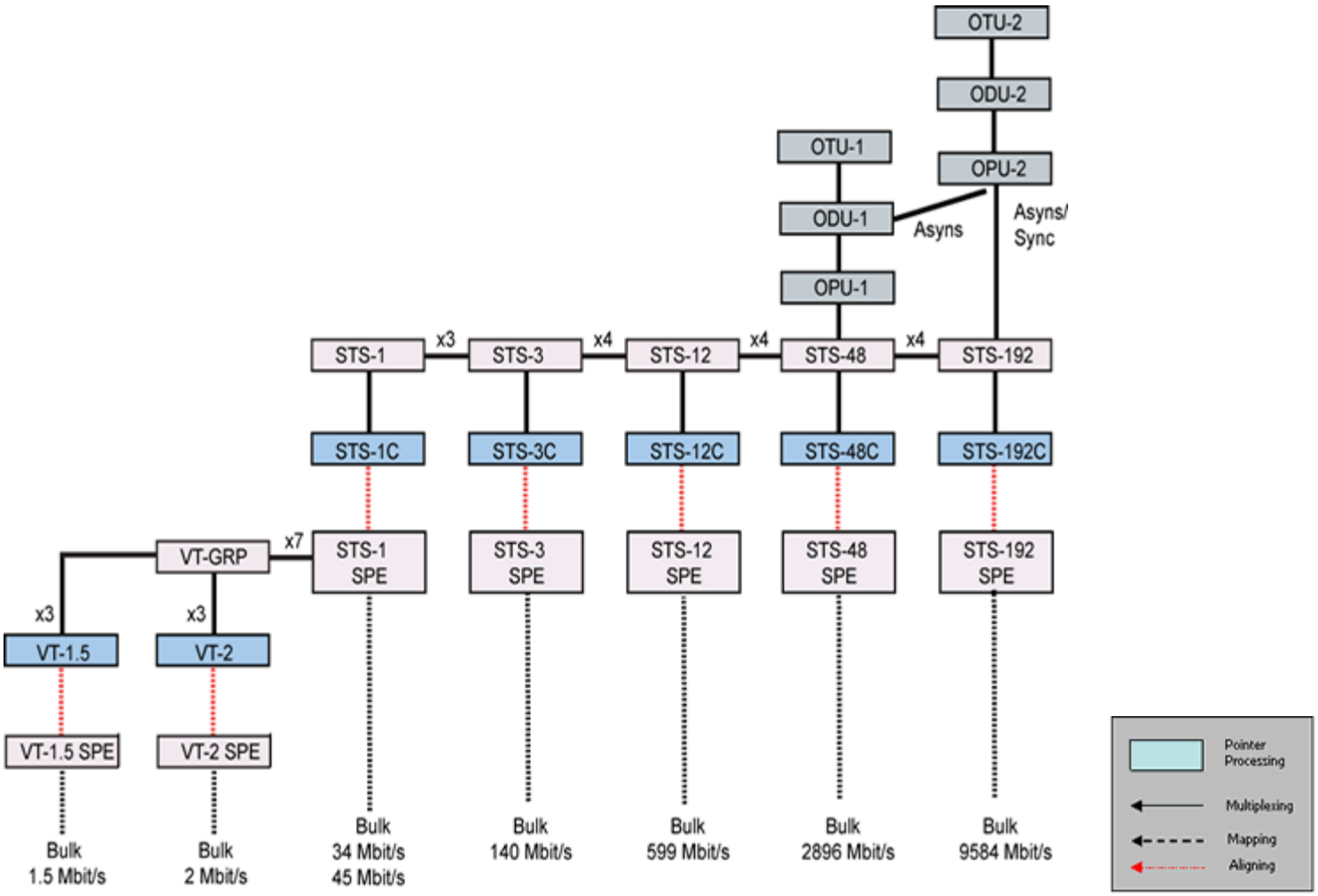
Hierarchy Setup

Network Type: In the OTN mode, only optical interface options are available

Test Rate: Options are OTU-1 (2.66G)

OTN Mapping: SYNC, ASYNC, and PRBS pattern

ITU-T G.709 and STS mappings per Bellcore GR-253 and ANSI T1.105 recommendations are supported. The multiplexing structure is shown below.



Scrambler: ON/OFF

FEC: FEC encoder can be ON/OFF (activated / deactivated)

Test Rate: OC-3-155M, OC-12-622M, OC-48-2.5G

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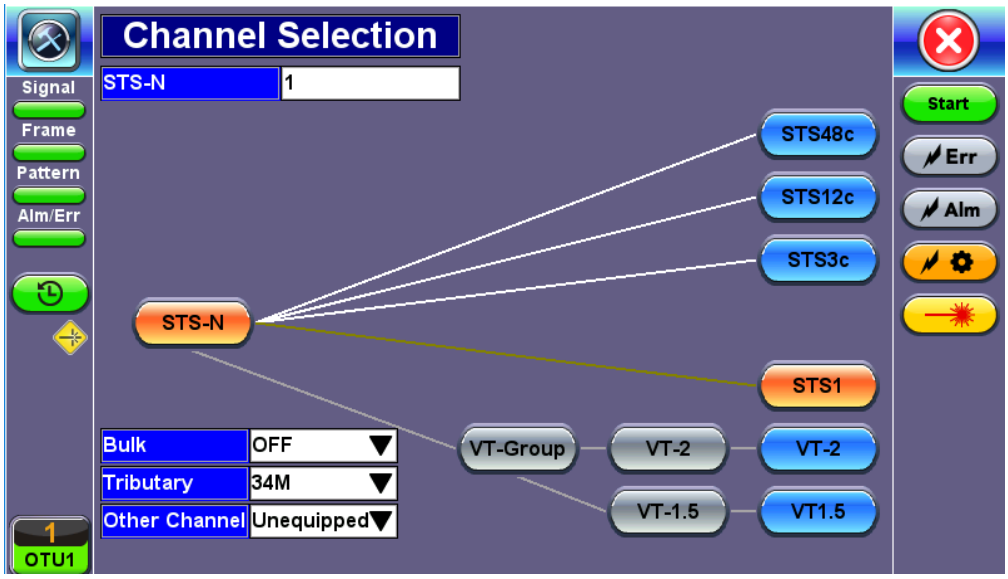
Interface, Structure, Payload, and Pattern

Interface, Structure, Payload, and Pattern TX block configurations are identical to configurations in Transmitter Setup in the SONET chapter. Refer to that section for further details.



Structure Mapping

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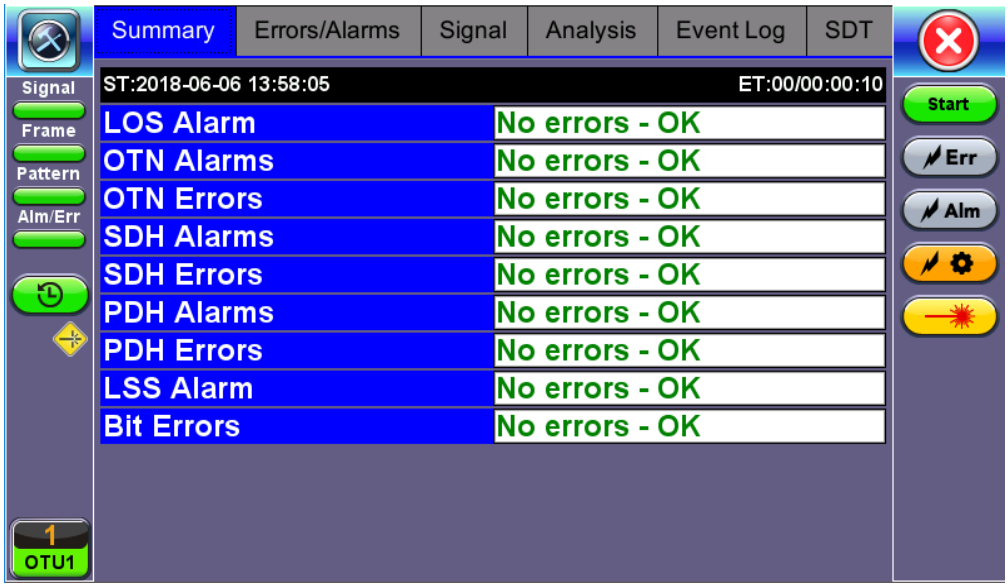
9.3 Results: OTN

Measurements are accessed by tapping the Results icon in the main menu. The results comprise a range of tabbed pages, similar to the setup pages.

9.3.1 Summary

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



OTN/SDH Summary

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9.3.2 Errors and Alarms

The Error/Alarm tab brings up several pages showing the errors and alarm status.

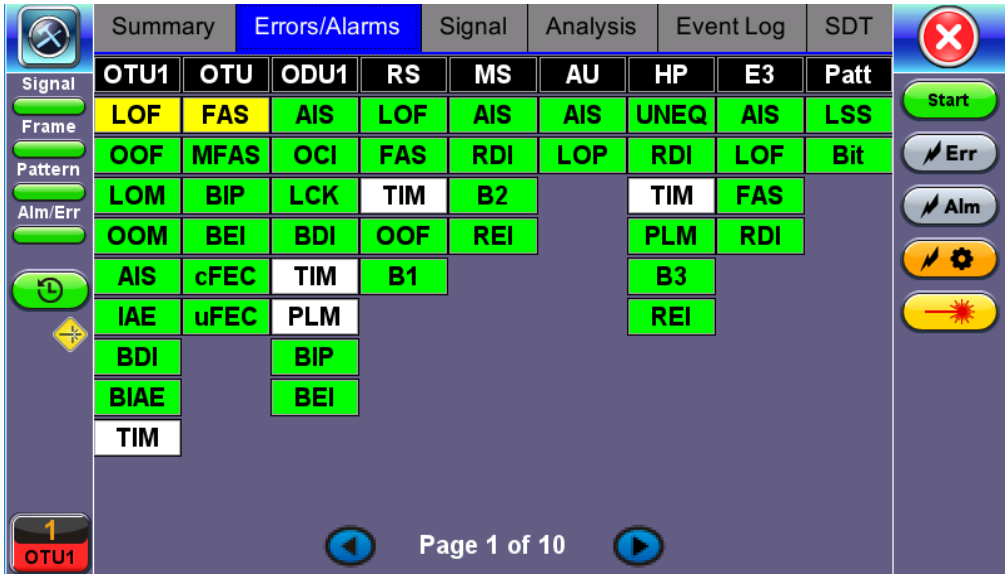
Page 1 provides an overview of all the Errors and Alarms applicable to the signal or network under test. The color of the page tab is normally blue; however, it will turn red when an alarm error condition has been detected or recorded.

The soft LEDs on screen are arranged logically and will depend on signal hierarchy, structure, payload and framing selected. The soft LEDs have a tricolor function:

Green: No error or alarm is present.

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

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



Errors/Alarms (Page 1)

*Tapping the colored LEDs will automatically link directly to the applicable result screen which provides detailed information. Depending on the settings chosen in **Setup** > **Signal**, the Alarms/Errors displayed and page length will vary, but the order in which they are presented remain the same (from physical layer on the left, to payload and test pattern on the far right).*

The colored headers are described in the table below:

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

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

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

SDH errors/alarms are described in Errors and Alarms in the SDH Results section.

SONET errors/alarms are described in Errors and Alarms in the SONET Results section.

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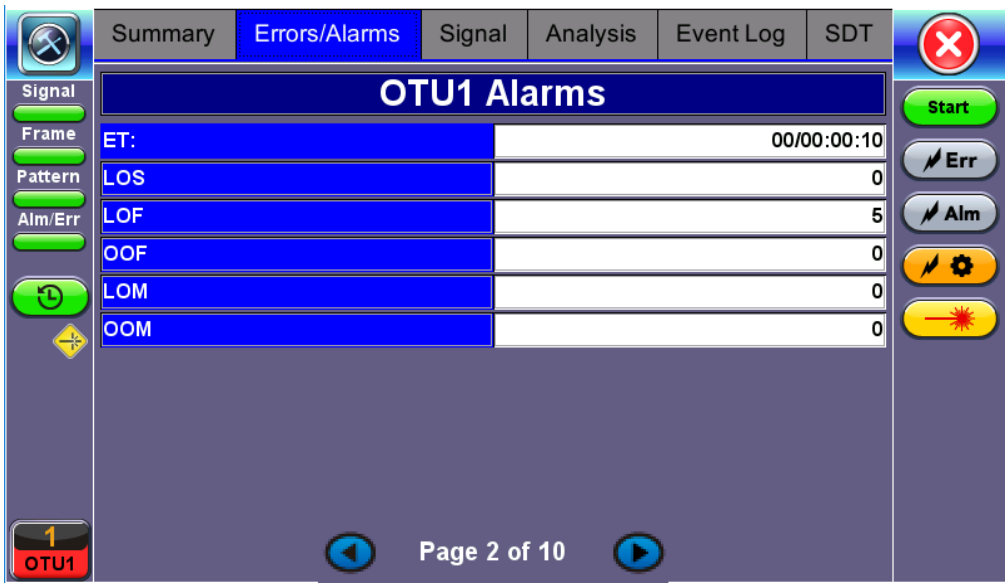
Errors/Alarms

Errors/alarms listed on each page are presented in a logical order associated with the signal under test. All errors are evaluated and stored. The Elapsed Time [ET] is shown in the right hand corner of the header. Error conditions are displayed in red including count and rate. The Errors/Alarms tab brings up several pages of the following errors and alarms statuses:

- OTU/ODU/OPU Alarms/Errors
- SDH/SONET Errors/Alarms
- PDH Alarms/Errors
- BERT Errors
- Section (SOH) and Line Overhead Alarms
- High Order Path and Low Order Path
- STS path and VT path

Refer to the SDH, SONET, or OTU/ODU Error and Alarm definitions tables for a description of each error/alarm.



Errors/Alarms

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9.3.3 Event Log

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

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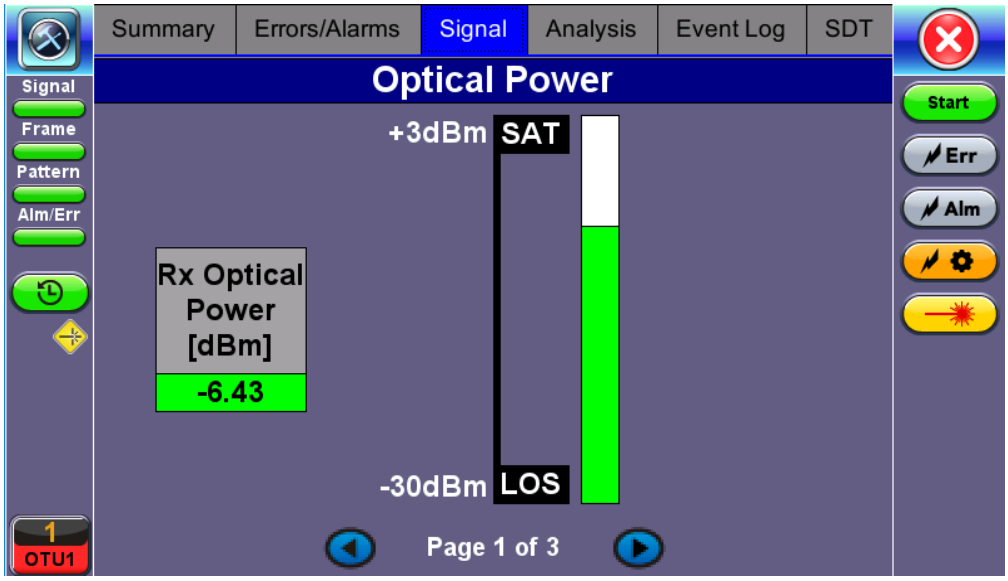
9.3.4 Signal (Pages 1 to 4)

The signal tab displays the Level, Frequency and related screens. 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.

Optical Level (Page 1):

- The optical level measurement for the OTU-1 signal is displayed in dBm.
- Loss of Signal (LOS) and the Saturation levels is shown both graphically and in dBm.



Signal - Optical Power (Page 1)

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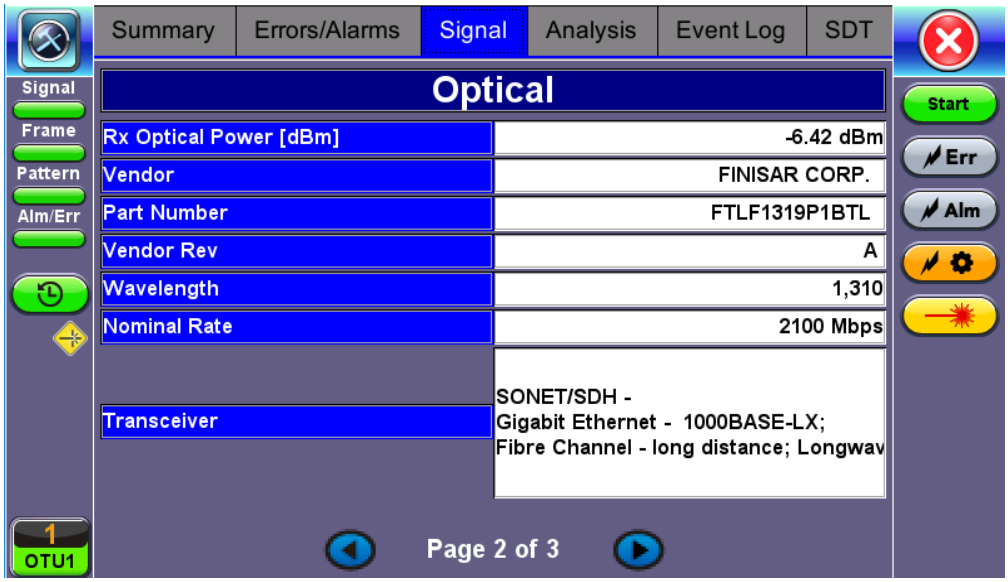
Optical Information (Page 2)

Page 2 displays the Optical module information.



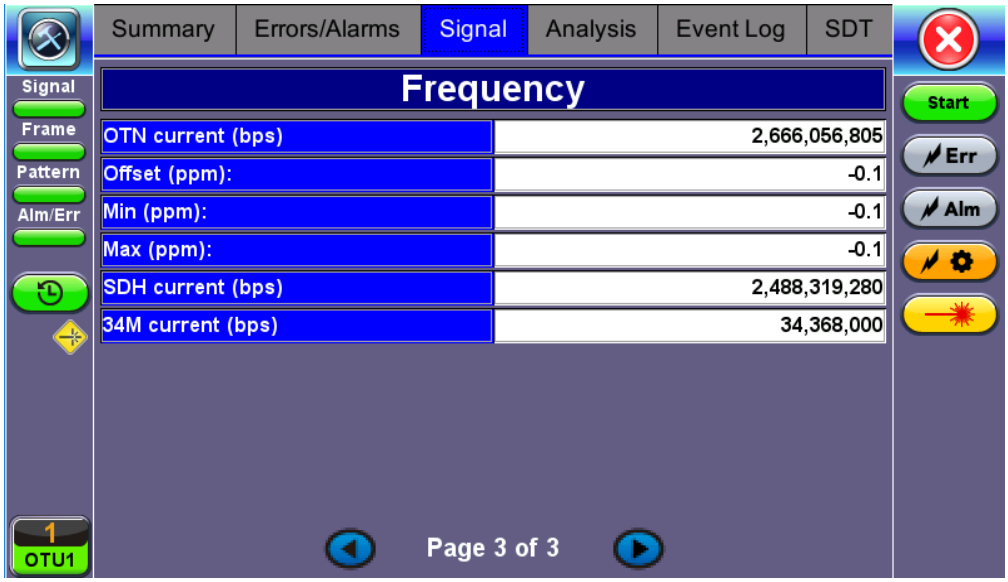
Signal - Optical Information (Page 2)

Frequency (Page 3)

The received signal frequency and offset is measured and displayed.

For OTN signals, the measurement is performed on the optical interfaces (SFP for OTU-1) or (XFP for OTU-2).

- **OTN Current:** Indicates the frequency of the input signal
- **Offset (ppm):** Indicates the difference between the standard rate and the bit rate of the input signal
- **Min (ppm):** Indicates the difference between the standard rate and the minimum deviation detected in the input signal
- **Max (ppm):** Indicates the difference between the standard rate and the maximum deviation detected in the input signal
- **SDH Current:** Indicates the frequency of the SDH or SONET signal carried with the OTU frame
- **Current:** Indicates the frequency of the PDH or T-Carrier payload. Options 1.5Mbps, 45Mbps, 34Mbps, 139Mbps



Signal - Frequency (Page 3)

Go back to top Go back to TOC

9.3.5 Performance Analysis

Refer to Performance Analysis in the SDH section for more information on this test application.

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9.3.6 Service Disruption Test (SDT) Results

Refer to SDT Results in the SDH section for more information.

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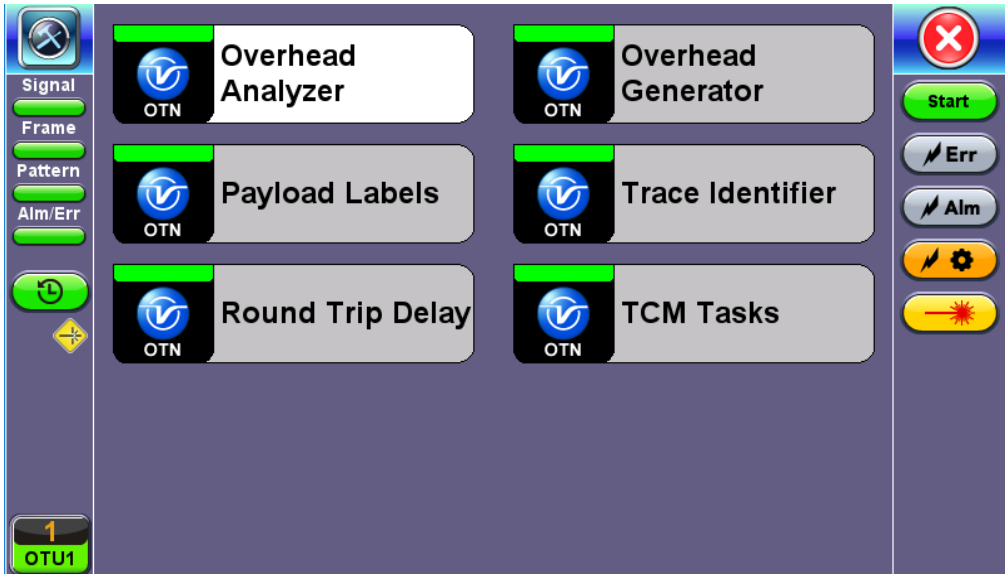
9.4 OTN Tools

9.4.1 Shortcuts

Accessing OTN Tools

Tap on Home (main menu) > **OTN Tools**



OTN Tools Menu

OTN Tools features the following test applications:

- **Overhead Analyzer:**
  - Displays the Optical Channel Transport Unit (OTU)
  - Displays Optical Channel Data Unit (ODU)
  - Displays Optical Channel Payload Unit (OPU) bytes of the received channel
- **Overhead Generator:**
  - Used to edit Optical Channel Transport Unit (OTU)
  - Used to edit Optical Channel Data Unit (ODU)
  - Used to edit Optical Channel Payload Unit (OPU) bytes of the transmitted channel
- **Trail Trace Identifier:**
  - TTI is similar to the J0 byte in SONET/SDH. It is used to identify the signal from the source to the destination within the network.
  - TTI contains the so called Access Point Identifiers (API) which are used to specify the Source Access Point Identifier (SAPI) and Destination Access Point Identifier (DAPI).
  - The APIs contain information regarding the country of origin, network operator and administrative details.
- **Payload Structure Identifier:**
  - PSI field transports a 256-byte message aligned with the ODU multiframe.
  - PSI0 contains the Payload Type (PT) identifying the payload being transported.
    - The OPU Payload Type (PT) is a single byte defined within PSI to indicate the composition of the OPU signal, or in other words, the type of payload being carried in the OPU.
- **TCM Tasks:**
  - Used to analyze or edit the sequence of TCMi (i = 1 to 6) bytes by generating alarms and errors in the Tandem connection sub-layer.
- **Round Trip Delay (Propagation Delay):** Measurement works by sending a test pattern. Bit errors are transmitted in the pattern. The time it takes for the error to reach the receiver is the propagation time through the network.

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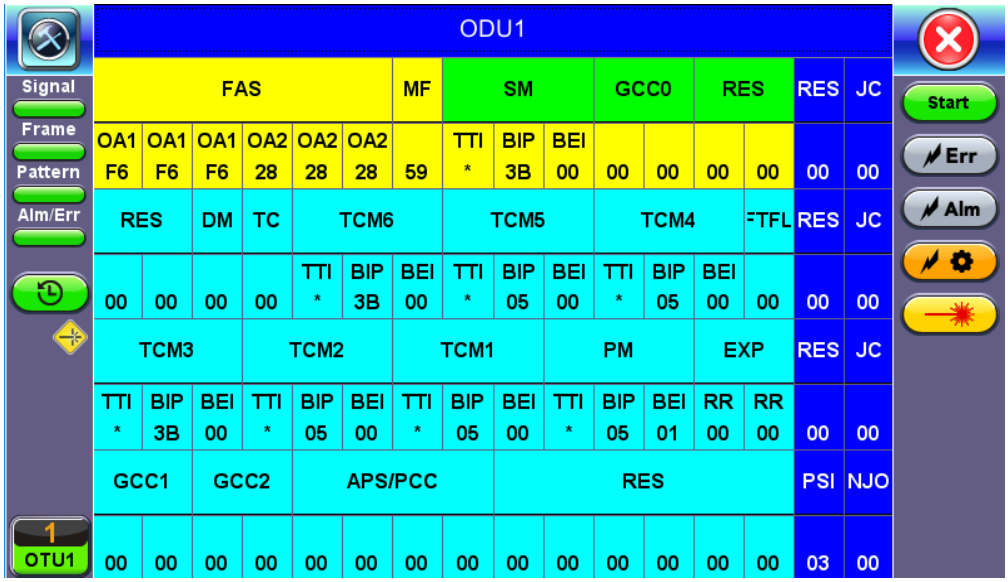
9.4.2 Overhead Analyzer & Generator

Tap the Overhead Analyzer icon to display the OH screens shown below.



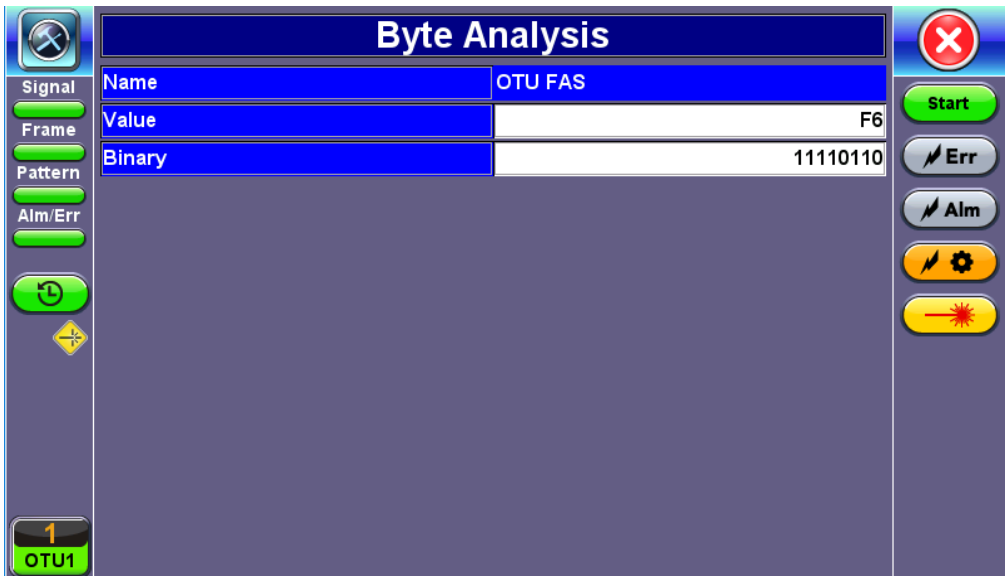
Overhead Analyzer Menu

OTU OPU ODU

The Overhead is color coded for simplified viewing.

Decoding Bytes

Tapping the applicable byte enables an automatic decode – a byte description including the Hexadecimal and Binary value is provided. For some bytes, an advanced decode of the various bits is also available.



Byte Analyzer - Advanced Decode

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9.4.2.1 OTN Frame Analysis

The OTU framing is divided into two portions: FAS and MFAS.

Frame Alignment Signal (FAS)

- Uses the first six bytes and, similar to SONET/SDH, it is used to provide framing for the entire signal
- In order to provide enough 1/0 transitions for synchronization, scrambling is used over the entire OTU frame, except for the FAS bytes

- **MultiFrame Alignment Signal (MFAS)**
  - Byte is used to extend command and management functions over several frames
  - The MFAS counts from 0 to 255, providing a 256 multiframe structure

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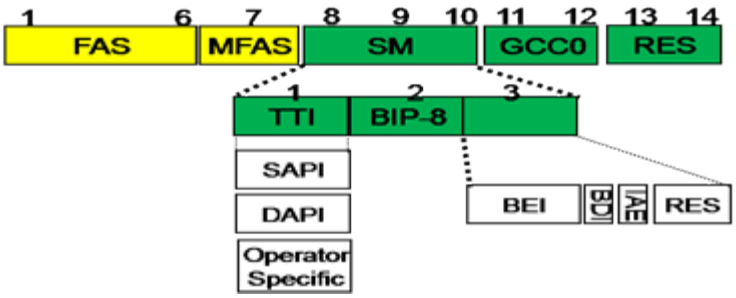
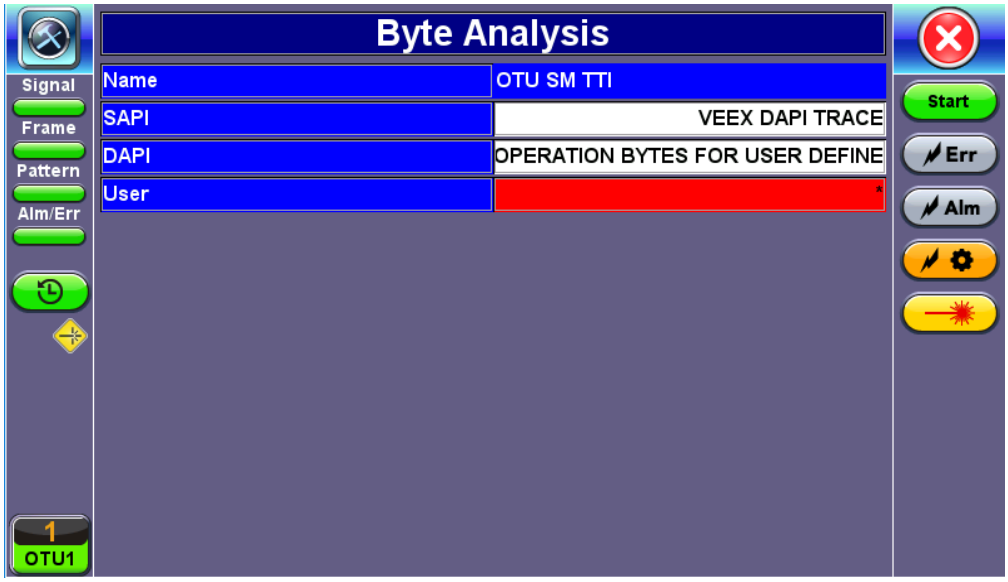
9.4.2.2 Optical Transport Unit (OTU) Analysis

The OTU overhead is comprised of the SM, GCC0, and RES bytes.



- **Section Monitoring (SM)**
  - Bytes are used for the Trail Trace Identifier (TTI), Parity (BIP-8) and the Backward Error Indicator (BEI) (also known as the Backward Incoming Alignment Error [BIAE]), Backward Defect Indicator (BDI), and Incoming Alignment Error (IAE).
  - The TTI is distributed over the multiframe and is 64 bytes in length. It is repeated four times over the multiframe.



SM TTI Type

- **General Communication Channel 0 (GCC0)**
  - Clear channel used for transmission of information between OTU termination points

Reserved (RES) bytes are currently undefined in the standard.

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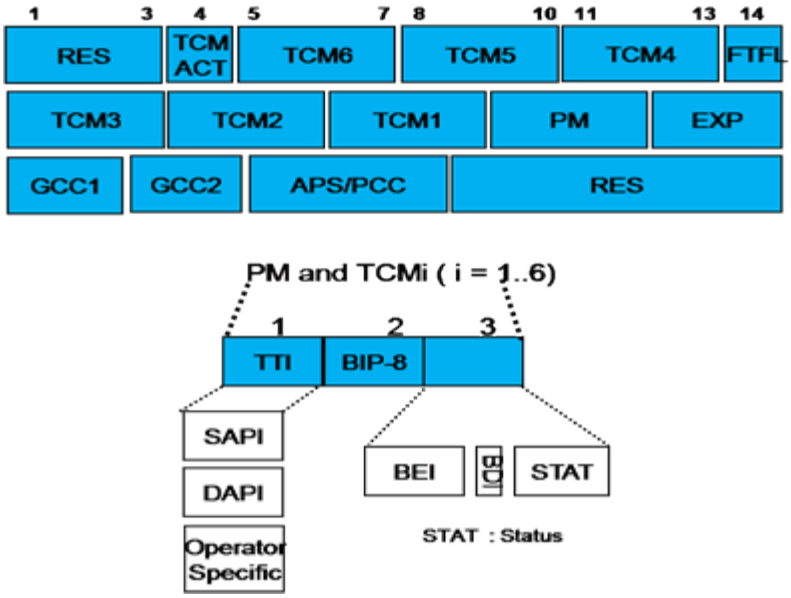
9.4.2.3 Optical Data Unit (ODU) Analysis

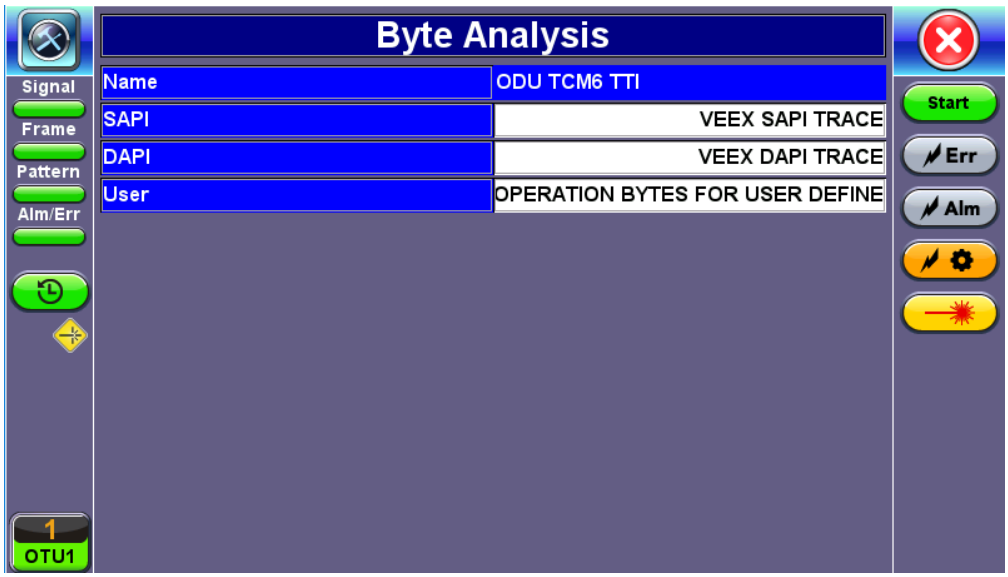
The ODU overhead is divided into several fields: RES, PM, TCMi, TCM ACT, FTFL, EXP, GCC1/GCC2 and APS/PCC.



Reserved (RES) bytes are undefined and set aside for future applications.

- **Path Monitoring (PM)**
  - Field is similar to the SM field described above. It contains the TTI, BIP-8, BEI, BDI, and Status (STAT) subfields.

- **TCMi:**
  - There are six Tandem Connection Monitoring (TCMi) fields that define the ODU TCM sub-layer, each containing TTI, BIP-8, BEI/BIAE, BDI, and STAT subfields associated to each TCM level (i=1 to 6).
  - The STAT subfield is used in the PM and TCMi fields to provide an indication of the presence or absence of maintenance signals.



TCM6 TTI Type

- **Fault Type and Fault Location (FTFL)**
  - Reporting communication channel field used to create a message spread over a 256-byte multiframe
  - Provides the ability to send forward and backward path-level fault indications

ITU-T G.709 Figure 15-20

FTFL message structure									
0	1		126	127	128	129			255
Forward field					Backward field				

0	1	9	10	127
Fault indication field	Operator identifier field	Operator specific field		
Forward field				

ITU-T G.709 Figure 15-20

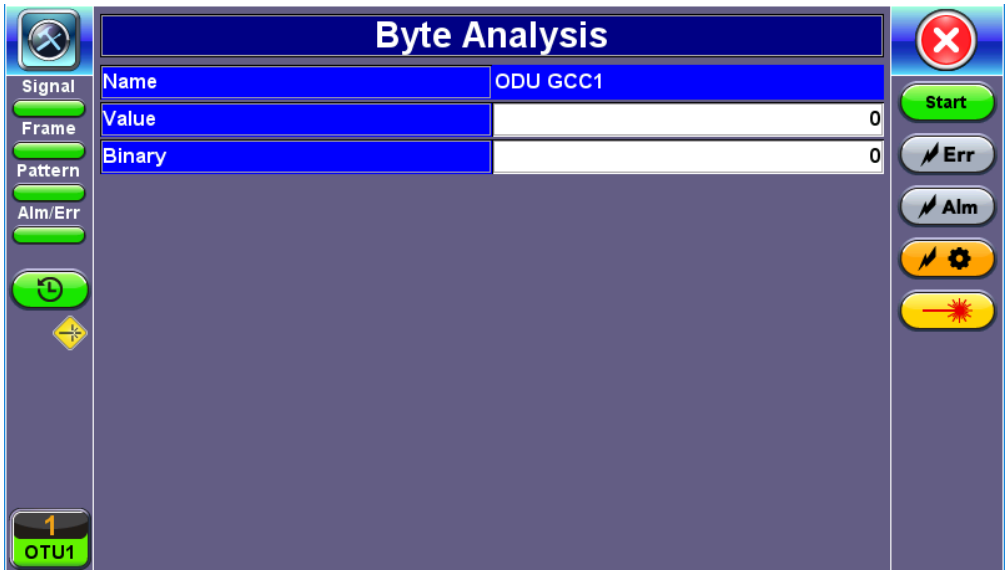
128	129	137	138	255
Fault indication field	Operator identifier field	Operator specific field		
Backward field				

ITU-T G.709 Figure 15-21

Fault indication codes	
Fault Code	Definition
0000 0000	No fault
0000 0001	Signal fail
0000 0010	Signal degrade
0000 0011 .. .. 1111 1111	Reserved for future standardization

ITU-T G.709 Figure 15-6

- **Experimental (EXP)**
  - Field not subject to standards and is available for network operator applications
- **General Communication Channels 1 and 2 (GCC1/GCC2)**
  - Fields are very similar to the GCC0 field, except that each channel is available in the ODU



GCC1 Type

- **Automatic Protection Switching and Protection Communication Channel (APS/PCC)**
  - Supports up to eight levels of nested APS/PCC signals associated to a dedicated-connection monitoring level depending on the value of the multiframe

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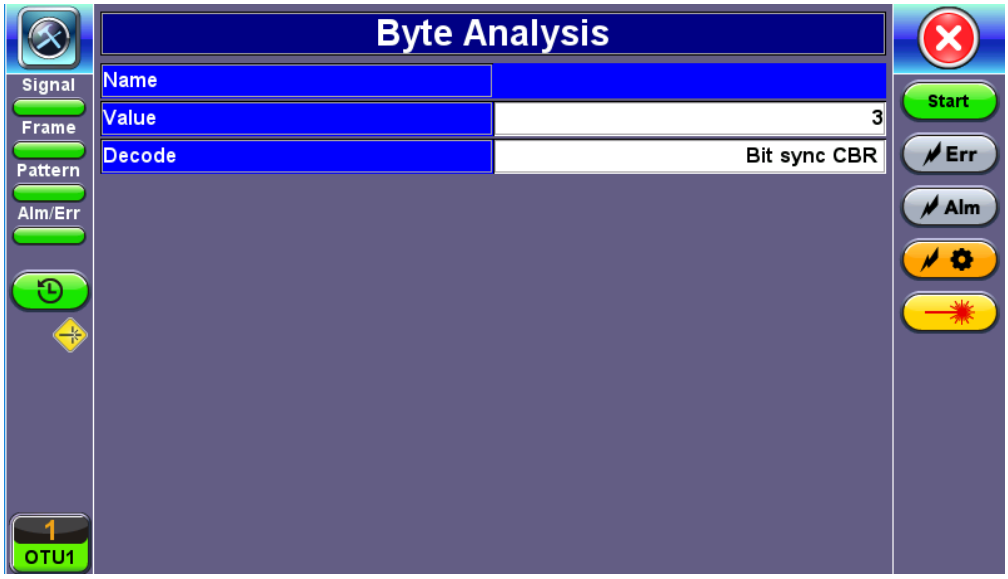
9.4.2.4 Optical Payload Unit (OPU) Analysis

- **Payload Structure Identifier (PSI)**
  - Primary overhead field associated with the OPU
  - A 256-byte multiframe whose first byte is defined as the Payload Type (PT). The remaining 255 bytes are currently reserved.



OPU PSI Type

The other fields in the OPU overhead are dependent on the mapping capabilities associated to the OPU. For an asynchronous mapping (the client signal and OPU clock are different), Justification Control (JC) bytes are available to compensate for clock rate differences. For a purely synchronous mapping (client source and OPU clock are the same), the JC bytes become reserved. Further details on mapping are available in ITU G.709.

		Columns		
		15	16	17
Rows	1	RES	JC	
	2	RES	JC	
	3	RES	JC	
	4	PSI	NJO	PJO

	1 2 3 4 5 6 7 8	
JC	Reserved	JC

PSI	0	PT
	1	RES
	..	
	..	
	255	

JC (bits 7,8)	NJO	PJO
00	Justification	Data
01	Data	Data
10	Not generated	
11	Justification	Justification

OPU2. O/H for synch mapping of 10 Gb/s SDH/SONET

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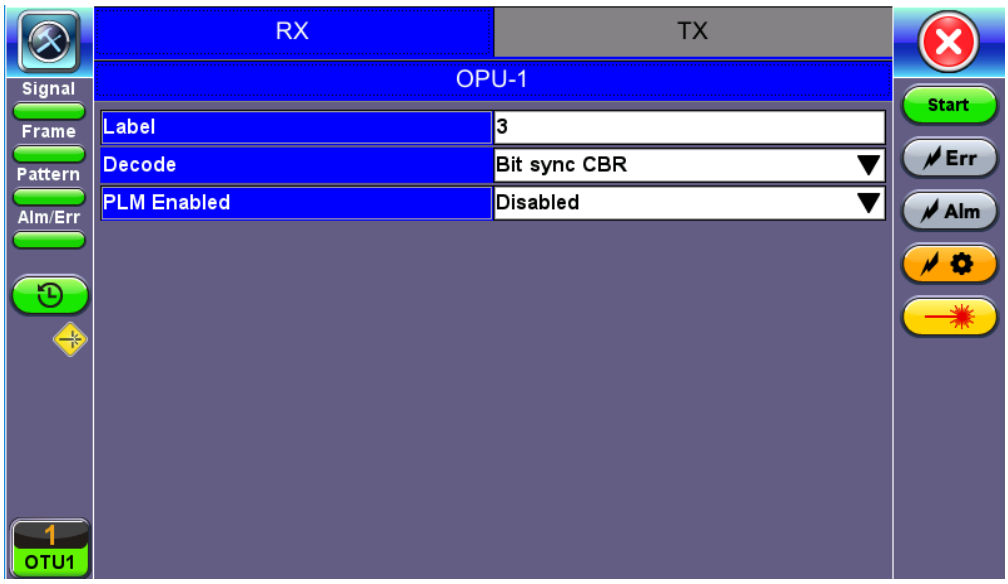
9.4.3 Payload Label (Payload Structure Identifier)

Tap the Payload Label icon to display the screen shown below. Tabs for Tx and Rx label settings are provided.



Payload Label

PSI[0] contains a one-byte Payload type. PSI[1] to PSI[255] are mapping and concatenation specific.

C2 Byte Structure per ITU-T G.707 Recommendations	
Hex Code	**Interpretation**
01	Experimental mapping
02	Asynchronous CBR mapping
03	Bit synchronous CBR mapping
04	ATM mapping
05	GFP mapping
06	Virtual Concatenated signal
10	Bit stream with octet timing mapping
11	Bit stream without octet timing mapping
20	ODU multiplex structure
55	Not available
66	Not available
80-8F	Reserved codes for proprietary use
FD	NULL test signal mapping
FE	PRBS test signal mapping
FF	Not available
07	PCS Ethernet
08	FC-1200 into OPU2e
0A	STM-1 mapping into OPU0

0B	STM-4 mapping into OPU0

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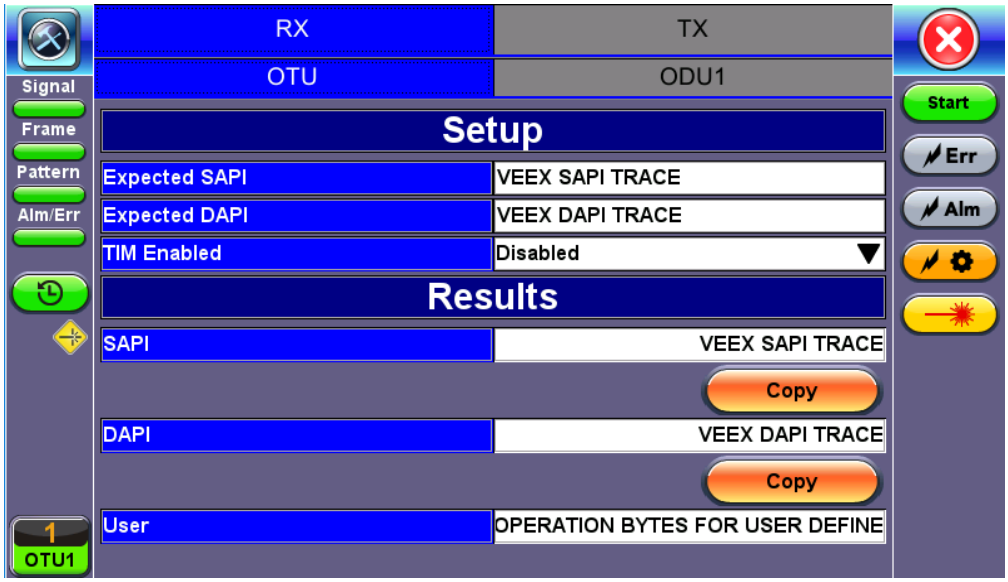
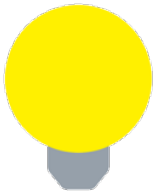
9.4.4 Trace Identifier (Trail Trace Identifier)

Tap the Trace Identifier icon to display the screen shown below. There are tabs for Tx and RX settings of the TTI.



Trace Identifier (Trail Trace Identifier)



Trail Trace Identifier

TTI similar to the J0 byte in SONET/SDH, is used to identify the signal from the source to the destination within the network. The TTI contains the so called Access Point Identifiers (API) which are used to specify the Source Access Point Identifier (SAPI) and Destination Access Point Identifier (DAPI). The APIs contain information regarding the country of origin, network operator and administrative details.

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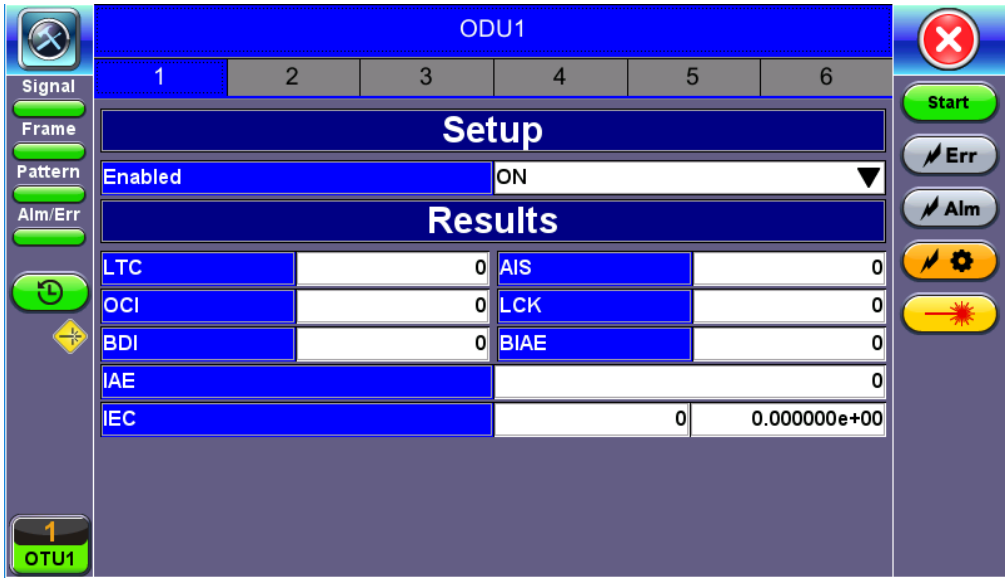
9.4.5 TCM Tasks (Tandem Connection Monitoring)

Tap the TCM Tasks icon to display the screen shown below.



TCM Tasks

Results are available for up to six tandem connections. The counts are numbers of seconds containing the error or indication.

Tandem connections and corresponding source and sink functions are defined in ITU-T G.707, G.709, and G.783.

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

- **LTC:** Loss of Tandem Connection Signal
- **OCI:** Open Connection Indication
- **AIS:** TC Alarm Indication Signal
- **LCK:** Locked Defect
- **BDI:** Backward Defect Indication
- **IAE:** Incoming Alignment Error
- **BIAE:** Backward Incoming Alignment Error
- **BEI:** TC Backward Error Indication

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9.4.6 Round Trip Delay

Round Trip Delay works in the same manner for all test ports. Refer to Round Trip Delay in the SDH/SONET section for more information on this test feature.

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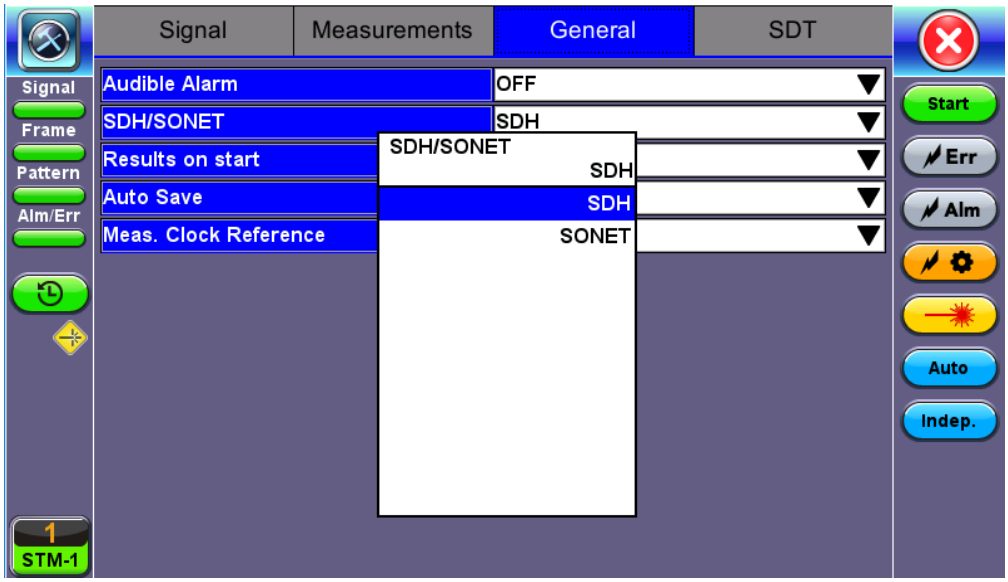
10.0 PDH and PDH/DSn



SDH/SONET selection from the General tab

Accessing PDH or PDH/DSn Testing

To display PDH options for the TX and RX block configuration:

1. Tap on the **General** tab from the Setup screen and tap on the **SDH/SONET** drop-down menu. Select *SDH* for PDH testing or *SONET* for PDH/DSn testing.
2. Tap on **Signal** tab > **Hierarchy** > **Network Type** and select *PDH* or *DSn/PDH* from the drop-down menu.

*Depending on whether SDH or SONET (international or North American) terminology was selected from the **SDH/SONET** option under the **General** tab, TX and RX configuration screens will look slightly different. Nonetheless, they both feature the same options described in this section.*

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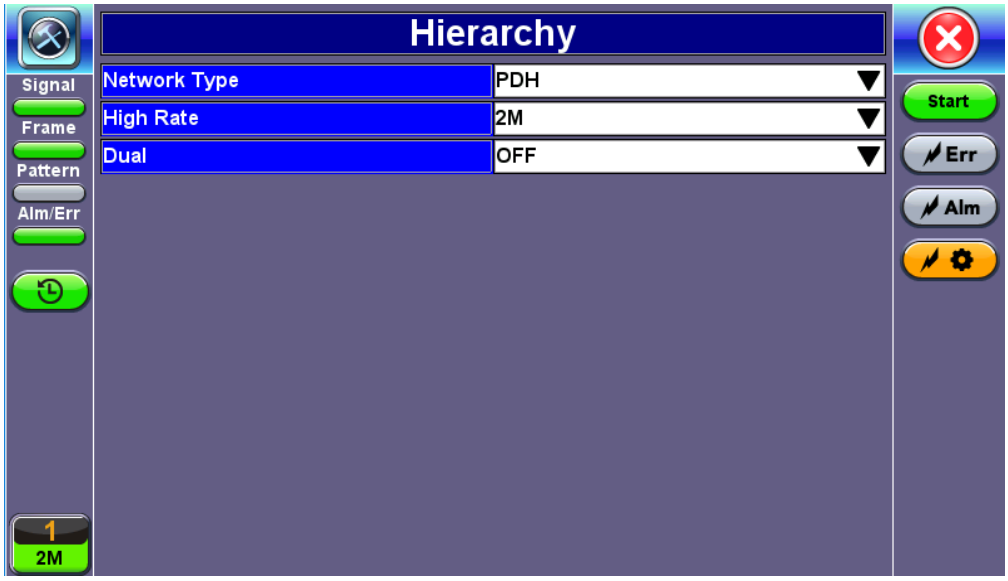
10.1 Signal Transmitter/Receiver Setup

The block diagram of the Tx and Rx structure is described in Signal Overview. Tap on a block diagram to open the setup menu for the selected parameter.

Hierarchy

The test interface and rate can be adjusted from the Hierarchy menu.



Hierarchy Setup

- **Network Type:** Select PDH as the network type.
- **High Rate:** This is the physical data rate on the test port. Options are 1.5Mbps (DS1), 2Mbps (E1), 8Mbps (E2), 34Mbps (E3), 45Mbps (DS3), 140Mbps (E4), 64k Codirectional. Refer to Low Rate for the logical test payload. Example: A DS3 (high) physical interface carrying a multiplexed DS1 (low) logical test channel.
- **Dual (RX only):** Dual DS1 or E1 Receiver Option ON/OFF: Receiver 2 sets exact same configuration as Receiver 1.

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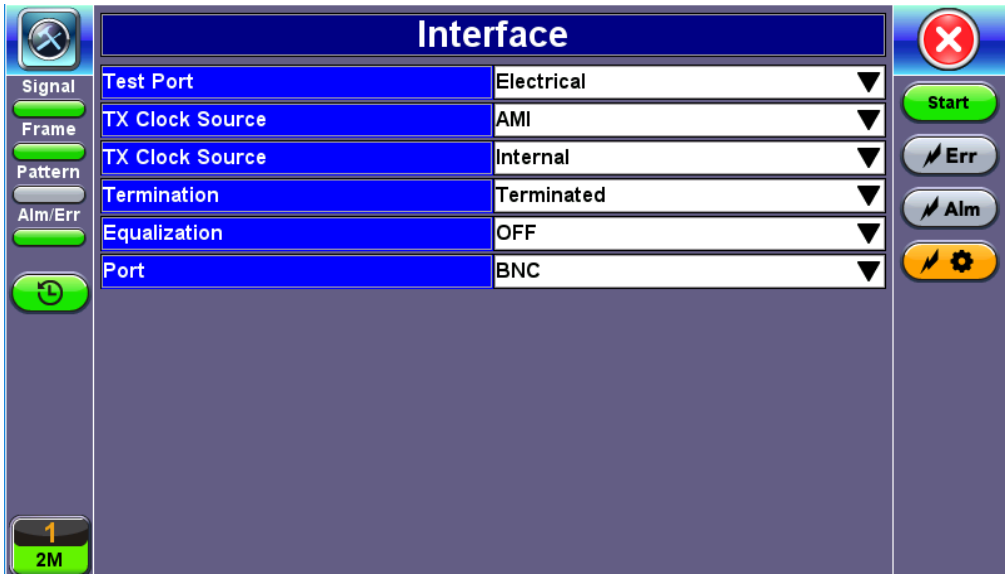
Interface



Interface Setup

Test Port: If a PDH structure has been selected in the Hierarchy setup, the optical options will be disabled under the test port menu

Line Code *(TX only)*: Line code options will vary depending on the High Rate chosen in Hierarchy setup

- In DS1 mode, the line code options default to B8ZS or AMI
- In DS3 mode, the line code is B3ZS or AMI
- In E1 mode, the line code options default to HDB3 or AMI. Normal E1 systems use HDB3 line coding while AMI is reserved for special applications
- In E3 mode, the line code is HDB3 or AMI
- In E4 mode, the line code is CMI

Tx Line Level *(TX only; DS1, DS3 only)*: Simulates attenuation and distortion caused by the cable

- DS1/1.5M: (LBO) 0, -7.5dB, -15dB, -22.5dB
- DS3/45M: High, DSX, DSX 450', DSX 900'

Clock Source *(TX only)*, can be configured as follows:

- **Internal clock:** The clock for the transmitter is derived from the internal quartz oscillator. The internal clock has an accuracy of +/- 3.5ppm conforming to G.812 recommendations.
- **External clock:** 1.5MHz, 2MHz, 1.5Mbps, and 2Mbps signals are present on the SMA connector. Only 2Mbps signals are available on the RX2 balanced and RX2 BNC unbalanced ports.
- **RX:** The clock for the transmitter is derived from the received signal and the jitter of the incoming signal is suppressed.
- **Offset:** The clock for the transmitter is derived from internal clock generator. It can change the frequency offset while measurements are running. Use numeric key to increase and decrease the frequency shift, up to 0.01ppm. Frequency offset: ±50ppm with 1, 0.1, 0.01ppm resolution.
- **Atomic 10MHz:** If the test set is fitted with the optional built-in atomic clock oscillator (+/-0.05ppb free-running), user can select this precision clock to transmit with highly accurate frequency. The atomic clock could be used in free-running or GPS disciplined modes.

Balanced: Check when using the RJ-48 or Bantam connectors. The transmitter output impedance will be set to 120 or 100 ohms. The Primary test port is "1" on top panel. If unchecked, the unit will assume that testing is taking place on the 75 ohms unbalanced BNC connector for E1 mode.

Termination *(RX only)*: The sensitivity of the receiver can be set for ITU-T and ANSI standard termination, Protected Monitoring Points (PMP), or to High Impedance connections.

The options under the termination menu are as follows:

- **Terminated:** The received signal is terminated with a 75 ohm (BNC), 120 ohm (RJ48) or 100 ohm (Bantam) impedance enabling the unit to decode the signal over a wide range of cable losses.
- **Monitor:** To be used when the measurement is made at a Protected Monitoring Point (PMP) of network equipment. The PMP level can range between -20 and -26dB.
- **Bridge:** Available on in DS1 or E1 mode. Select this mode for a high impedance monitor test or when the receiver is connected directly in parallel to DS1 or E1 line carrying live traffic. The isolation circuit of the unit protects the DS1 or E1 signal from any possible disruption.

DS3/45M features the following termination options:

- High
- DSX
- Monitor
- Low

Equalization *(RX only; DS1 only)*: Turn it on to compensate for cable distortion (applicable to certain DS1 application)

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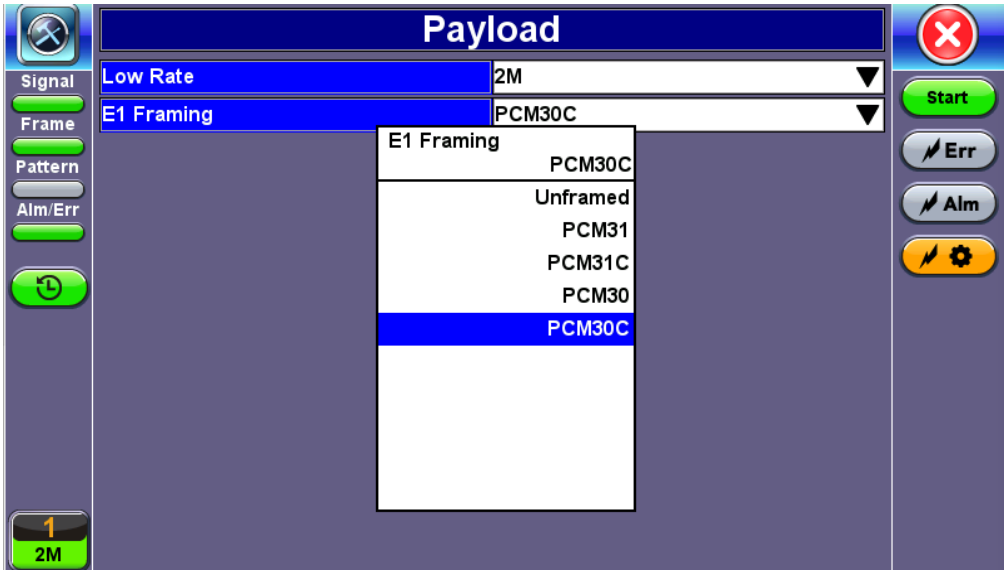
Payload



Payload Setup

Low Rate (test payload):

In DS1 (1.544Mbps) mode, the options are 1.544M or Fractional DS1 (Nx64 or Nx56) where:

- 1.544M: Configures the transmitter for full rate testing at 1.544Mbps
- Fractional DS1 (Nx64 or Nx56): Configures the transmitter for fractional testing using any combination of N or M 64kbps or 56kbps timeslots (contiguous or non-contiguous timeslots)

In DS3 (45Mbps) mode, the options are 45M, 1.544M Mux (DS3/DS1 Mux) or Fractional DS1Mux (Nx64 or Nx56) where:

- 45M: Configures the transmitter for full rate testing at 45Mbps
- 1.544M (DS3/DS1 Mux): Configures the transmitter for full rate testing at 45Mbps signal with DS1 payloads (1 to 28 channels)
- Fractional DS1 Mux: Configures the transmitter for full rate testing at 45Mbps signal with DS1 payloads (1 to 28 channels) for fractional testing using N or M 64kbps or 56kbps timeslots (contiguous or non-contiguous timeslots)

In E1 (2Mbps) mode, the options are 2M, or Fractional E1 (N x64) where:

- 2M: Configures the transmitter for full rate testing at 2.048Mbps
- Fractional E1 (N x64): Configures the transmitter for fractional testing using N or M 64kbps timeslots (contiguous or non-contiguous timeslots)

In E2 (8Mbps) mode, the options are 8M, 2M, or Fractional E1 (Nx64) where:

- 8M: Configures the transmitter for full rate testing at 8Mbps
- 2M (E3/E1 Mux): Configures the transmitter for full rate testing at 8Mbps signal with E1 payloads (1 to 16 channels)
- Fractional E1 (E1Mux w/ Nx64): Configures the transmitter for full rate testing at 8Mbps signal with E1 payloads (1 to 16 channels) for fractional testing using N or M 64kbps timeslots (contiguous or non-contiguous timeslots)

In E3 (34Mbps) mode, the options are 34M, 2M Mux (E3/E1 Mux), 8M, or Fractional E1 (Nx64) Mux where:

- 34M: Configures the transmitter for full rate testing at 34Mbps
- 2M (E3/E1 Mux): Configures the transmitter for full rate testing at 34Mbps signal with E1 payloads (1 to 16 channels)
- 8M (E3/E1 Mux): Configures the transmitter for full rate testing at 34Mbps signal with E1 payloads (1 to 16 channels)
- Fractional E1 (E3/E1Mux w/ Nx64): Configures the transmitter for full rate testing at 34Mbps signal with E1 payloads (1 to 16 channels) for fractional testing using N or M 64kbps timeslots (contiguous or non-contiguous timeslots)

In E4 (140Mbps) mode, the option is 140M. This configures the transmitter for full rate testing at 140Mbps.

Framing:

- In DS1 mode, the options are unframed, D4 (SF) and ANSI T1.107 (ESF).
- In DS3 mode, the options are unframed, M13 and C-bit.

In E1 mode, the options are unframed, PCM31, PCM31C, PCM30, and PCM30C. Framing conforms to G.704 and G.706 recommendations and are briefly described below. Te C indicates whether the CRC4 checking is turned ON or OFF.

- In E2 mode, the option is framed G.742.
- In E3 and E4 mode, the options are unframed, framed G.751.

For Nx64 and Nx56 rates:

Select the timeslot by tapping the applicable boxes. Deselect the time slot by tapping the box again.

- **Unused:** AIS, Idle
- **Channel**: Input channel number to structure test payload.
- **Other channels:** Unequipped—used to fill up unused (idle) timeslots, broadcast

Unframed signal types are not supported in the Nx64 fractional mode because framing is required to determine the location of timeslots.

Timeslots 1-31 correspond to channels 1-31 when using PCM-31 framing. When using PCM-30 framing, timeslots 1-15 correspond to channels 1-15, while timeslots 17-31 correspond to channels 16-30. Timeslot 16 is used for the Multi Frame Alignment Signal.

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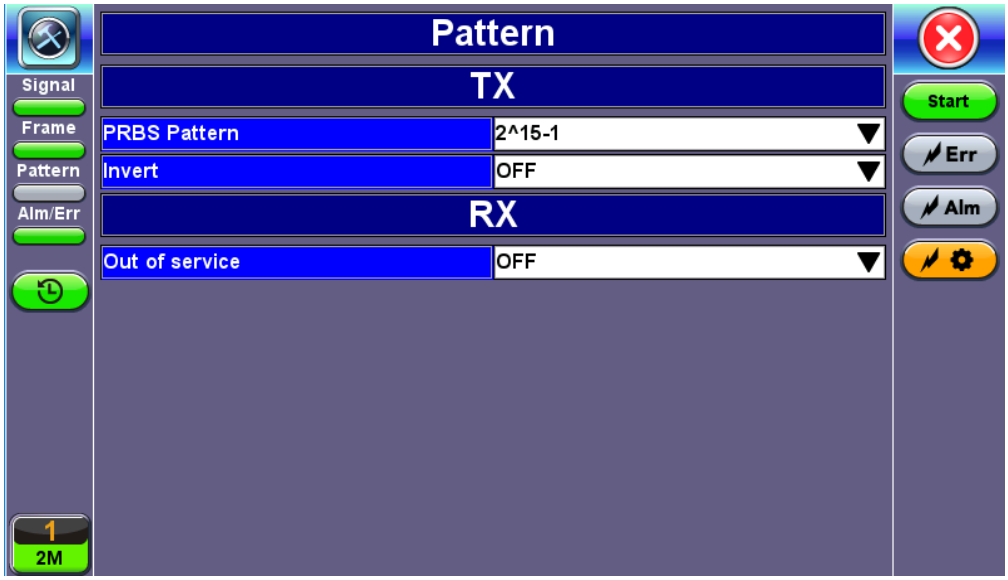
Pattern

Any binary test sequence can be applied to all PDH/DSn and SDH/SONET rates; however, ITU-T recommends certain sequences depending on the bit rate under test.



Pattern Setup

Out of Service *(RX only)*: Should be selected if the incoming signal is expected to contain a known test pattern. Deselect this option if signal is expected to contain live network traffic – this will disable the pattern detection process to avoid reporting constant LSS (Loss of test Sequence Synchronization).

Pattern: Use the pattern drop-down box to select the test pattern which will be inserted into the transmitted signal. Pseudo Random Bit Sequences (PRBS) defined by ITU-T 0.150 and 0.151 standards, Quasi-Random Signal Source (QRSS). Short sequences, fixed words and 24-bit or 32-bit user defined patterns are available. Up to 10 fixed 32-bit test patterns can be programmed using hexadecimals. ***Note****: If the 32-bit user pattern entered is incorrect, the default pattern will be 0xFFFFFFFF. The 24-bit pattern must be entered in binary format.*

Invert: Inversion of polarity is also available.

ITU-T specification 0.150 recommends the following test patterns:

Tandem Connection Monitoring (TCM) Definitions per ITU-T G.707, G.709, and G.783		
PRBS	**Zeros**	**Application**
2^9-1	8	Error measurements for bit rates ≤ 14,400 kbits/s
2^11-1	10	Error & jitter measurements for bit rates of nx64 kbit/s & 64 kbits/s & 64 kbits/s
2^15-1	15	Error & jitter measurements for T1, E1, E3 and DS3 bit rates
2^20-1	14	Error & jitter measurements for T1, E1, E3 and DS3 bit rates
2^23-1	23	Error & jitter measurements for E3 and E4 bit rates
2^31-1	31	Delay measurements for E3, DS3, and E4 bit rates

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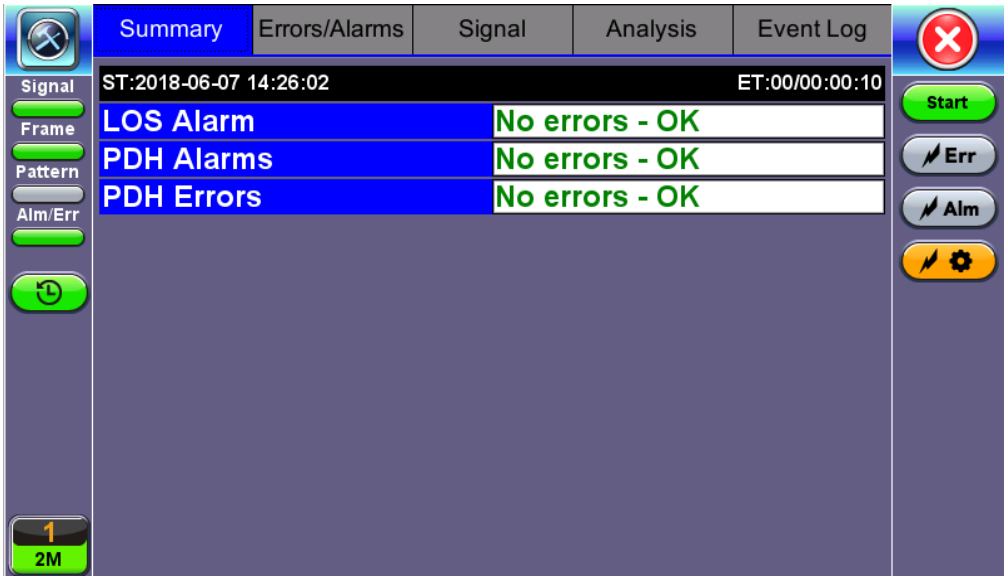
10.2 Results

10.2.1 Summary

The Summary tab displays an overview of the major test parameters. At a glance, the user is able to see if there are any alarms, errors, or signal failure.



Summary tab

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10.2.2 Errors and Alarms

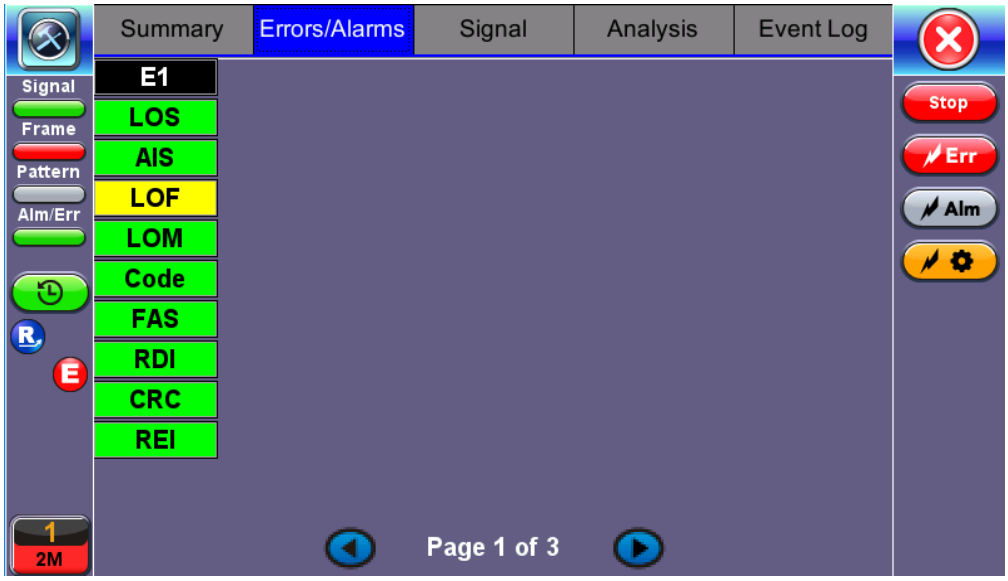
The Error/Alarm tab brings up several pages showing the errors and alarm status. Alarms/Errors results provides an overview of all the Errors and Alarms applicable to the signal or network under test. The color of the page tab is normally blue; however, it will turn red when an alarm error condition has been detected or recorded.

The soft LEDs on screen are arranged logically and will depend on signal hierarchy, structure, payload and framing selected. The soft LEDs have a tricolor function:

Green: No error or alarm is present.

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

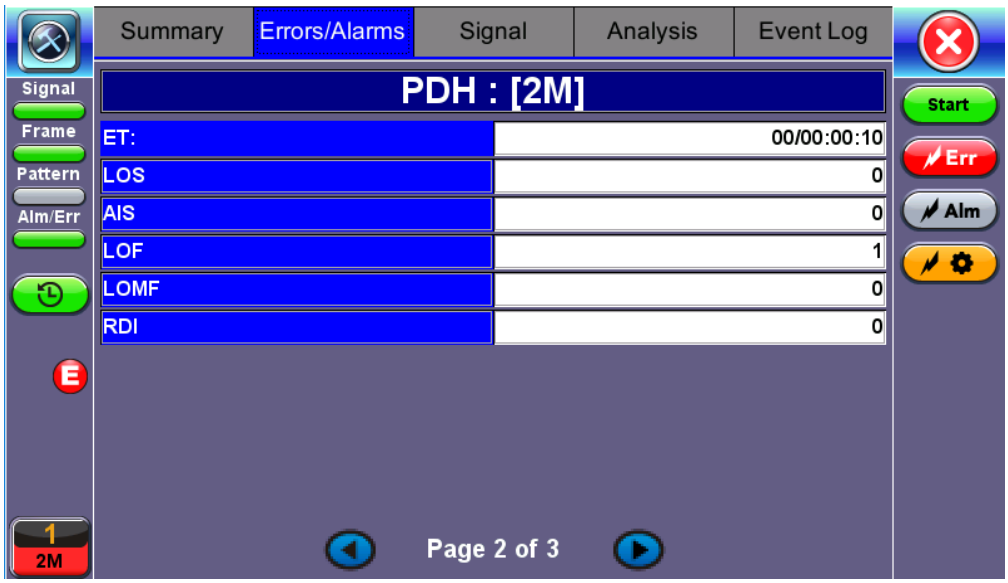
Yellow: Indicates a history condition. An error or alarm was detected during the measurement interval but it is no longer present or active.



Errors/Alarms (Page 1)

*Tapping the individual soft LED will automatically link directly to the applicable result screen which provides detailed information. Depending on the settings chosen in **Setup** > **Signal**, the Alarms/Errors displayed and page length will vary, but the order in which they are presented remain the same.*

Errors/alarms listed on each page are presented in a logical order associated with the signal under test. All errors are evaluated and stored. The Elapsed Time [ET] is shown in the right hand corner of the header. Error conditions are displayed in red including count and rate. The Errors/Alarms tab brings up several pages of PDH errors and alarms statuses.



Errors/Alarms - PDH

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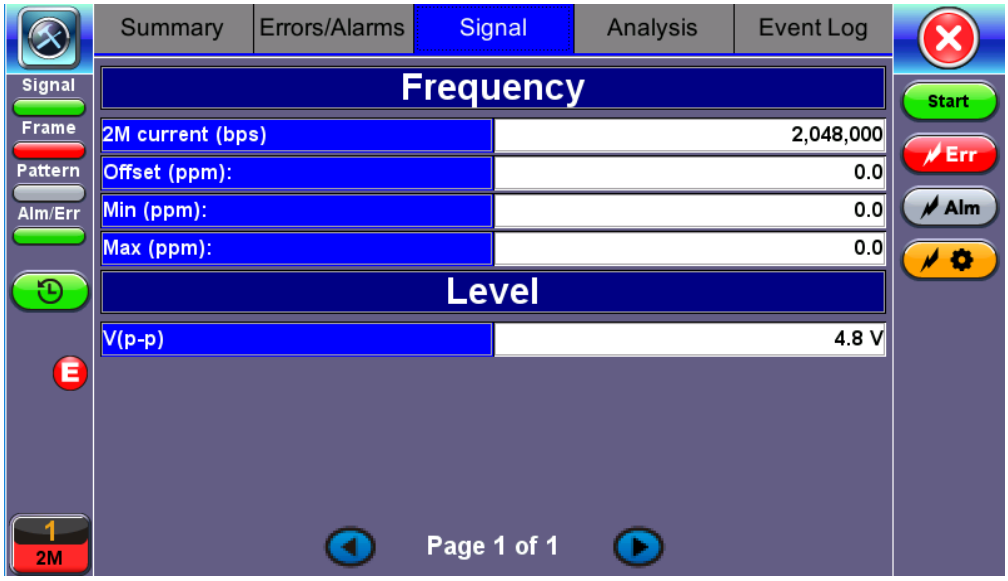
10.2.3 Signal

The Signal tab brings up the frequency and level result screen.



Signal tab

Frequency: The received signal frequency and offset is measured and displayed. For E1 signals, the measurement is performed on both balanced 100 ohm and unbalanced 75 ohm interfaces.

- **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

A Min (ppm) and Max (ppm) function can be used to ensure that the received signal is within a certain clock tolerance and that the network element is transmitting correctly. The frequency limits for the various signal types according to ITU-T recommendations are presented in the table below.

Frequency Tolerances for PDH and T-Carrier Systems	
Signal	**Frequency Specification**
E1 PDH	2048 Mbps ± 112 bps (± 54.6 ppm)
E3 PDH	34368 Mbps ± 846 bps (± 24.6 ppm)
E4 PDH	139264 Mbps ± 2730 bps (± 19.6 ppm)
DS1 T-Carrier	1544 Mbps ± 57 bps (± 36.6 ppm)
DS3 T-Carrier	44736 Mbps ± 1101 bps (± 24.6 ppm)

Level: Measures the Peak and Peak-Peak voltage values of the incoming signal. The levels for the various signal types according to ITU-T G.703 recommendations are presented.

Frequency Tolerances for PDH and T-Carrier Systems				
Signal	Bit Rate	Line code	Input	
			Termination	Level
E1	2 Mbit/s	HDB3	75 ohm unbalanced BNC 120 ohm balanced RJ45	Terminate: 2.37 Volt peak Monitor: 2.37 Volt peak with 20 or 26dB gain Terminate: 3.0 Volt peak Monitor: 3.0 Volt peak with 20 or 26dB gain
E3	34 Mbit/s	HDB3	75 ohm unbalanced BNC	Terminate: 1.0 Volt peak Monitor: 1.0 Volt peak with 20 or 26dB gain
E4	140 Mbit/s	CMI	75 ohm unbalanced BNC	Terminate: 1.0 Volt peak Monitor: 1.0 Volt peak with 20 or 26dB gain

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10.2.4 Performance Analysis

Refer to Performance Analysis in the SDH section for more information on this test application.

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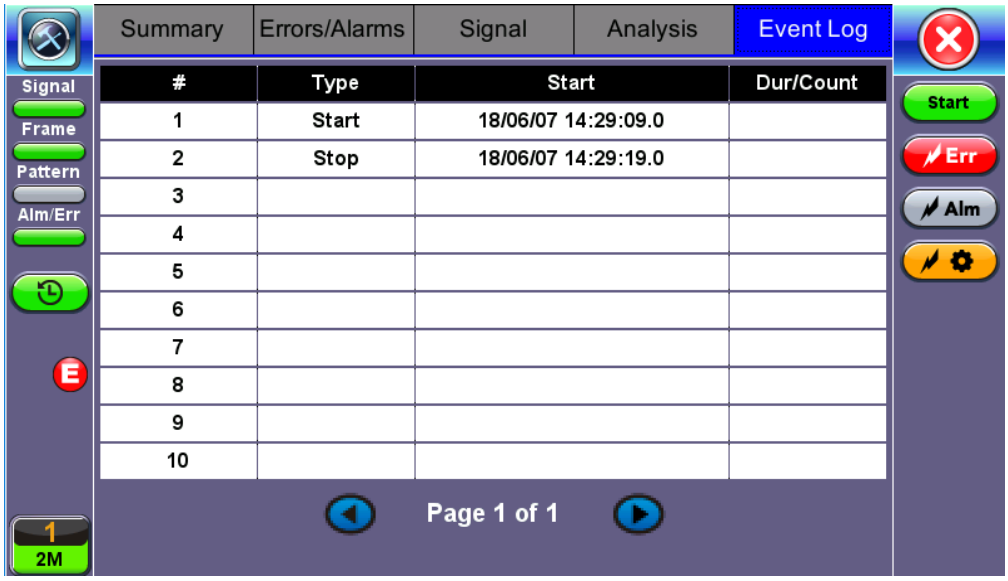
10.2.5 Event Log

The Event log tab brings up the screen listing the Error and Alarm events recorded during a test. The events are presented in chronological sequence:

- **Number (#):** Event number, events are numbered sequentially
- **Type:** Indicates alarm or error type
- **Start:** Indicates when the alarm or error was detected
- **Dur/Count:** Indicates for how long the alarm or error was detected and provides duration (alarms) and ratio/count (errors). The duration format is day:hour:minute:second
- **Pages:** Scroll through the pages depending on the number of events recorded



Event Log

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10.3 PDH Tools

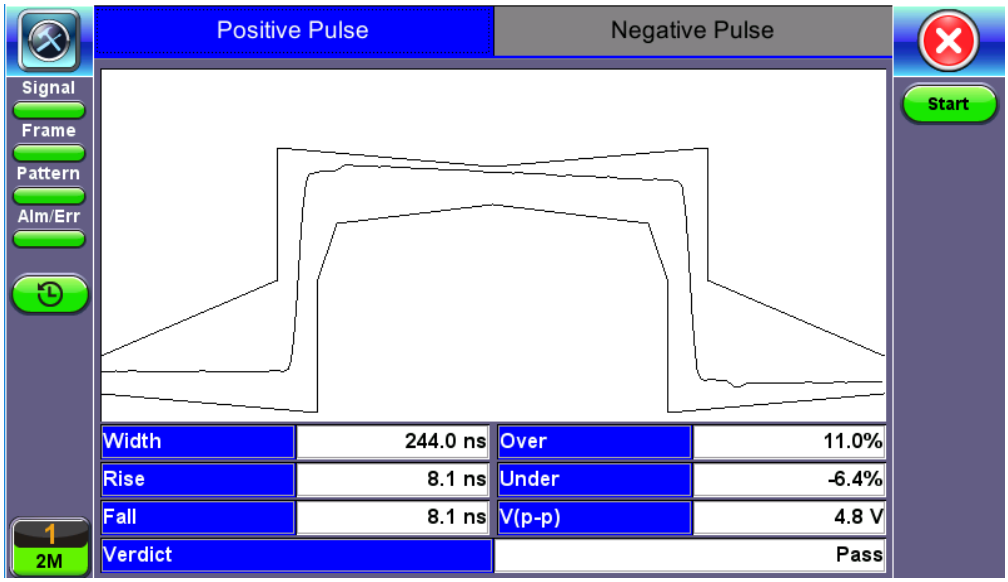
PDH Tools are available for RJ48/BNC and SFP+ connector ports. Available test applications and menu options will vary depending on the port in use.

10.3.1 E1 Pulse Mask

This function captures and analyzes E1 (2.048Mbps) pulse shape. The purpose of maintaining the correct pulse shape is to reduce inter-symbol interference – if the logic 1s and 0s cannot be detected by the receiver correctly, bit and code errors will result.

The pulse amplitude and overall shape are superimposed and compared with the ITU-T G.703 pulse conformance template. Telecommunications signals require specific load impedance for pulse mask compliance testing to be accurate. When high frequency pulses are transmitted down a transmission line, a portion of the pulse will be reflected when and wherever it encounters an impedance mismatch. The reflection is proportional to the impedance mismatch (i.e., the greater the mismatch, the greater the reflection of the pulse). To avoid reflections impacting the E1 measurement, the test set will terminate twisted pair cables with 120 ohms and coax cable with 75 ohms impedance. Note that 75 Ohm and 120 Ohm twisted pair cables each have different nominal amplitudes associated with them; for the 75 Ohm coax cable, the pulse amplitude must be 2.37V ± 10% while for 120 Ohm twisted pair cables, the pulse amplitude must be 3.0V ± 10%.

According to the G.703 recommendation, E1 pulses need only be measured at the transmitter output, and are *not* required to meet the pulse template over a variety of cable lengths. This of course will not provide information on distortions caused by misalignment and other impairments of the line. The test set on the other hand can connect to a live system at the TX output port via a Protected Monitoring Point (PMP) or at the far-end of a transmission line. In either case, the signal will be attenuated or amplified as necessary to compensate for test point or cable attenuation characteristics.



E1 Pulse Mask

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10.3.2 E1 Framed Words

The Sa bits, or spare bits, are part of the NFAS (non-Frame Alignment Signal), which is sent at the beginning (time slot 0) of each odd frame.

1	2	3	4	5	6	7	8
E	**1**	**A**	**Sa4**	**Sa5**	**Sa6**	**Sa7**	**Sa8**

- E = Ebit (Far-end CRC block error indication)
- A = Alarm (Remote Defect Indication)
- San = Sa bits

The Sa bits have multiple applications, including point-to point serial communications or messaging. One of their applications is to carry the Synchronization Signaling Message (SSM), which notifies the far end of the Clock Quality Level (QL) being used to generate the E1 signal and whether it could be used as a timing source for other signals. The SSM is a repetitive four bit code.

The test set allows monitoring of all Sa bits simultaneously. Users can manually edit/encode each of the Sa TX fields by tapping on the TX fields and using the keypad to enter any 8-bit sequence.

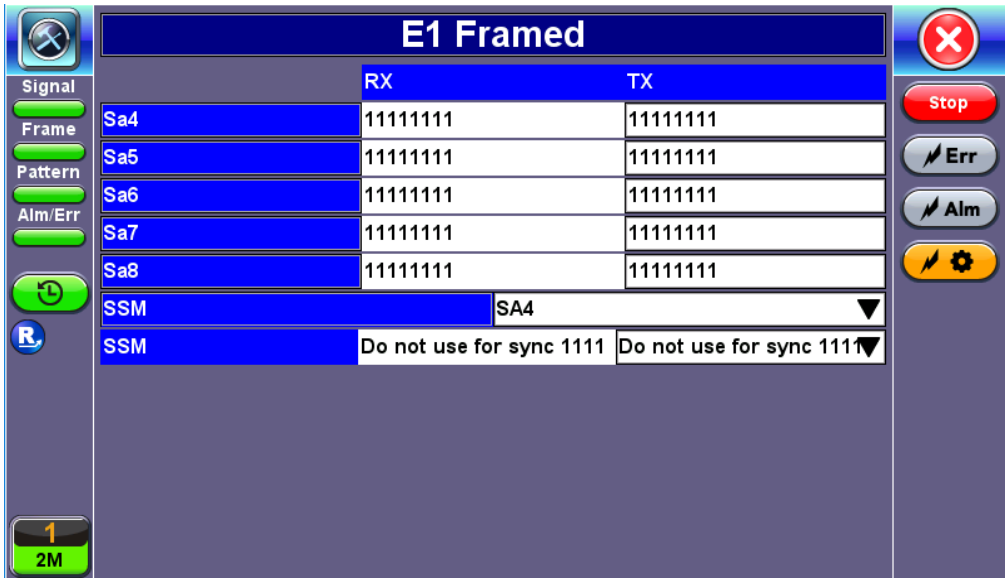
The SSM functionality is available for PCM31C, PCM30C, and PCM30 framing modes. When SSM is turned ON by selecting an Sa channel, users can select pre-encoded 4-bit codes to transmit in the selected channel. The SSM code is repeated continuously (displayed as an 8-bit word). If an invalid SSM QL sequence is manually entered, the test set will decode the first four bits.

By default, the SSM selection field is set to OFF (no TX encoding or RX decoding).

If SSM = SaN (N=4-8), users will be able to use the TX "Sync QL" field pull-down to encode the desired Quality Level.

- The default encoding is still "Do not use for Sync 1111"
- Selecting a Sync QL value for the TX will update the affected Sa Bits TX field
- Editing the affected Sa Bit Field will update the encoding label shown in Sync QL field

Sync Quality Level Values	
Quality Unknown	0000
Reserved	0001
G.811 PRC	0010
Reserved	0011
SSU-A	0100
Reserved	0101
Reserved	0110
Reserved	0111
SSU-B	1000
Reserved	1001
Reserved	1010
SETS/SEC	1011
Reserved	1100
Reserved	1101
Reserved	1110
Do not use for sync	1111



E1 Sa Bits SSM QL

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10.3.3 Round Trip Delay

Round Trip Delay works in the same manner for all test ports. Refer to Round Trip Delay in SDH/SONET Tools for more information.

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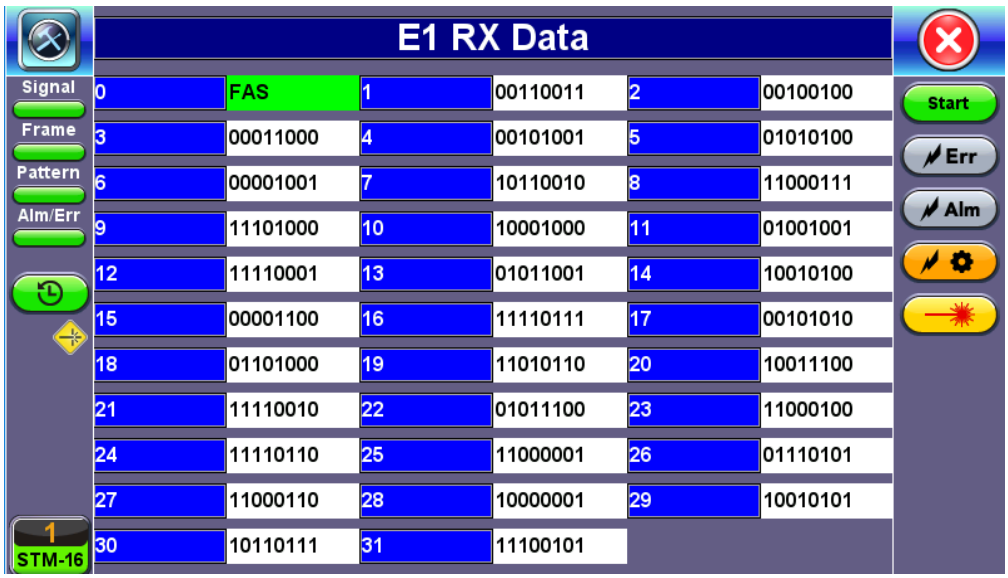
10.3.4 E1 RX Data

The PDH E1 RX data shows received data and captures the current timeslots.



E1 RX Data

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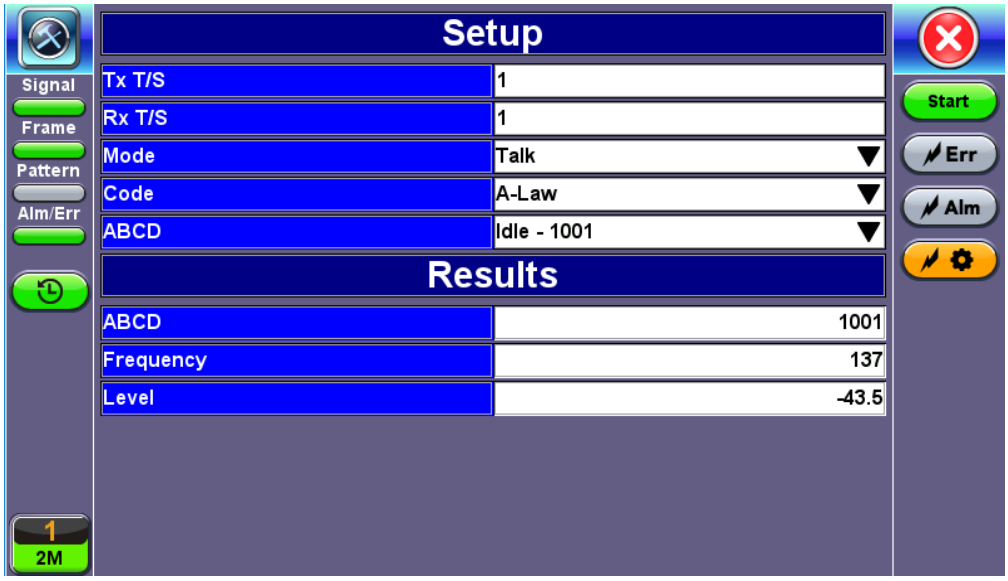
10.3.5 E1 VF

Tapping the VF in the PDH Tools screen displays the VF Tasks. The VF menu performs a variety of talk/listen functions.



VF Tasks

VF Testing

Do not attempt to enter VF Tasks if the Frame LED is not green.
Green LEDs indicate that the framing found on the received signal matches the framing selected in the Setup screen.
It is impossible to talk, listen, or perform other channelized functions in the absence of frame synchronization, since channels can be identified only within a framed signal.

Setup:

- **Time Slot:** Channel to test for both transmitting and receiving. Input a number from 1 - 31.
- **Mode:** Talk or send a tone on the transmit signal. It is possible to transmit audio data from the external headset into selected timeslot.
- **Code:** u-Law or A-Law.
- **Transmitted Frequency (Tone only):** 50 to 3950Hz.
- **Transmitted Level (Tone only):** -60 to 3dBm.
- **Programmable ABCD:** Change the signalling bits transmitted with the associated transmit channel. These bits will be transmitted only if the test set is using MFAS (PCM-30) framing, found in Setup > Payload. Pressing IDLE(1001), SEIZE(0001), User (manually set) will place that signal onto the A/B/C/D position. D: Manual edit ABCD (User) or IDLE, SEIZE.

Results:

- Measure signal frequency and level in selected timeslot
- Listen to the voice channel in the selected timeslot by plugging in an external VeEX headset to the connector panel. Audio connector **A** connects to the E1 and DS1 interface while audio connector **B** connects to SDH or VoIP Channels (if available).
- **ABCD:** View the received Channel Associated Signalling System (CAS) bits in selected T/S channel
- **Data:** View the live 8-bit channel data as it is received from the selected channel

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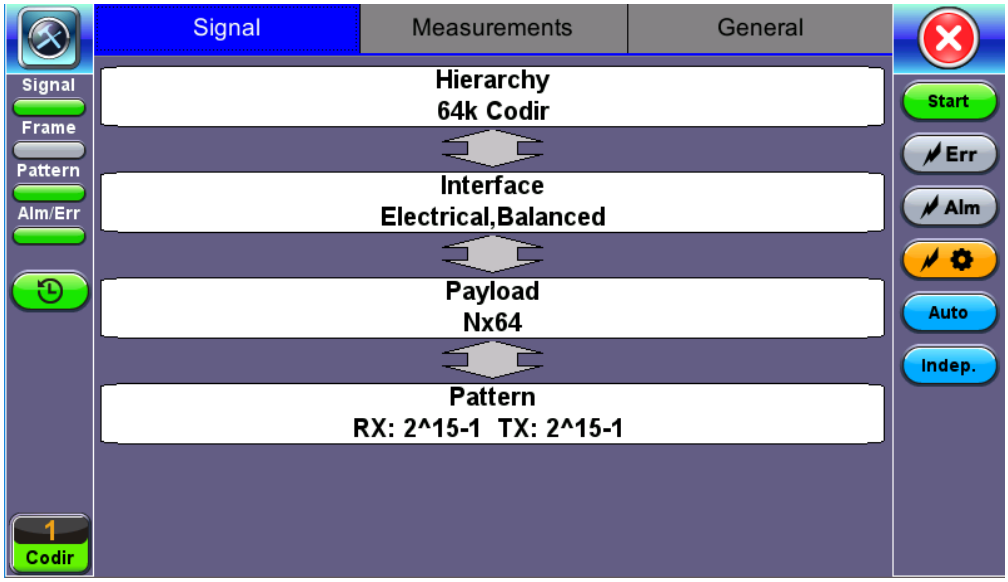
10.4 G.703 64k Codirectional

Accessing G.703 64k Codirectional Testing

To display 64k Codirectional TX and RX settings:

1. Tap on the **General** tab from the Setup screen and select *SDH* from the **SDH/SONET** drop-down menu.
2. Tap on **Signal** tab > **Hierarchy** > **Network Type** and select *PDH* from the **Network Type** drop-down menu and *64k Codir* from **High Rate**.

10.4.1 Signal Transmitter/Receiver Setup

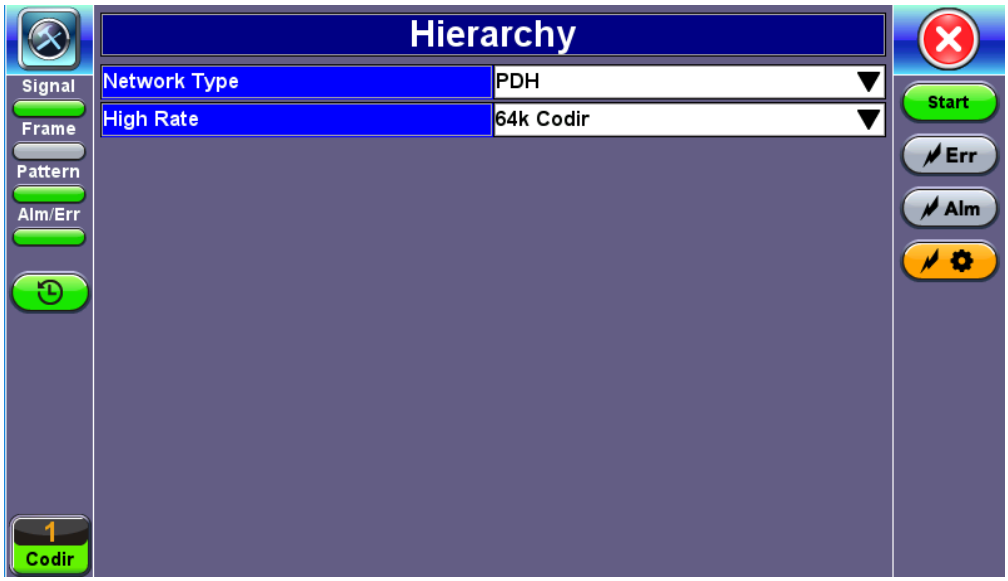


Signal Block Diagram

The block diagram of the Tx and Rx structure is described in Signal Overview. Tap on a block diagram to open the setup menu for the selected parameter.

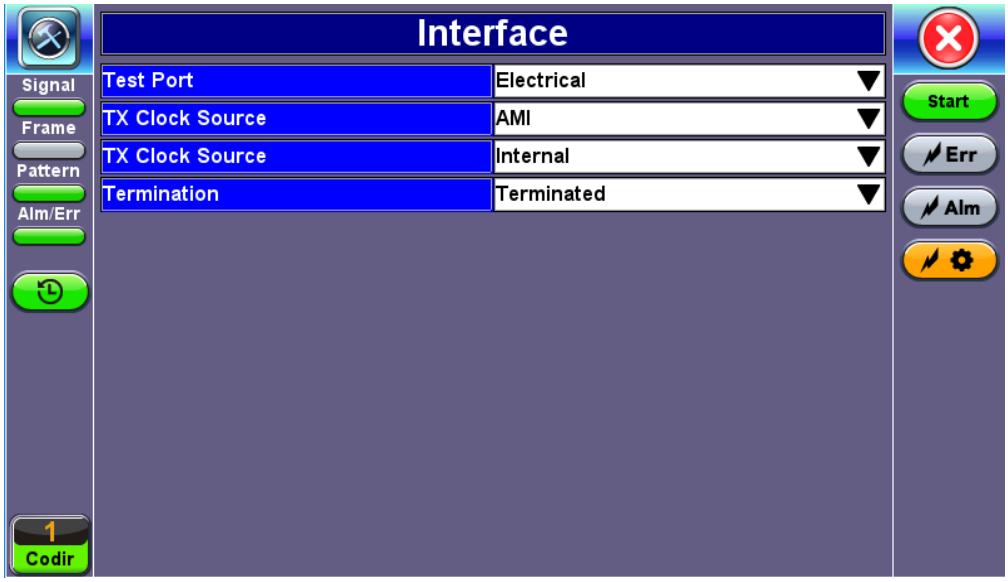
Hierarchy

PDH is chosen as the **Network Type** and *64k Codir* as the **High Rate**.



Hierarchy Setup

Interface



Interface Setup

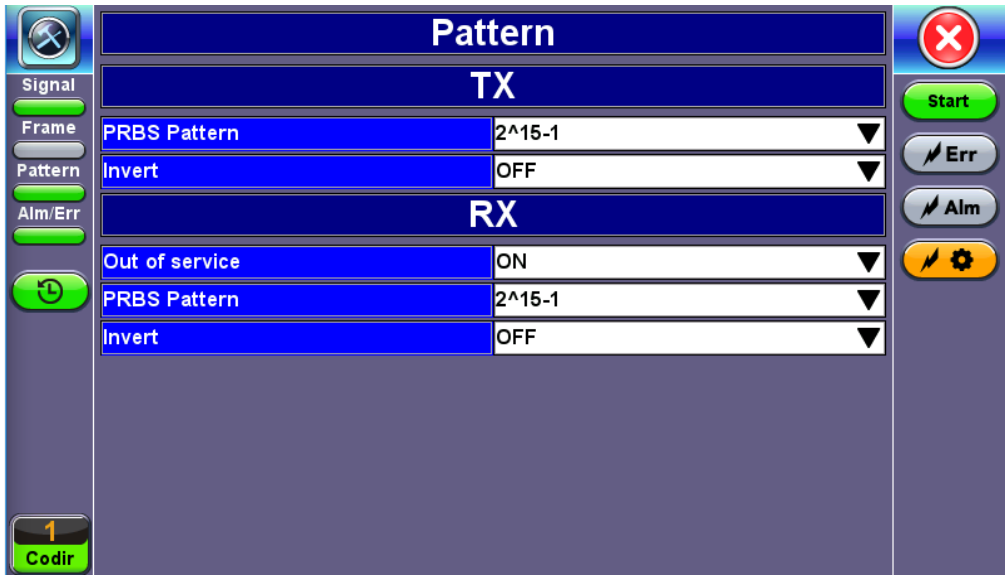
The Tx Interface Setup screen features the following options:

Test Port: The electrical interface is selected as the only option for this application

Clock Source: Can be configured as follows:

- **Internal clock:** The clock for the transmitter is derived from the internal oscillator. The internal clock has an accuracy of +/- 3.5ppm conforming to G.812 recommendations.
- **External clock:** 1.5MHz, 2MHz, 1.5Mbps, 2Mbps, and 10MHz signals are present on the SMA connector. Only 2Mbps signals are available on the RX2 balanced and RX2 BNC unbalanced ports.
- **From RX:** The clock for the transmitter is derived from the received signal and the jitter of the incoming signal is suppressed.
- **Offset:** The clock for the transmitter is derived from internal oscillator. It can change the frequency offset while measurements are running. Use numeric key to increase and decrease the frequency shift. Frequency offset: ±50ppm with 1, 0.1, 0.01ppm resolution.
- **Atomic 10MHz** (Atomic Clock option required): The built-in Atomic Clock hardware option can provide highly accurate and stable frequency references

Test Pattern



Setup - Signal - Pattern

Out of Service *(RX only)*: Should be selected if the incoming signal is expected to contain a known test pattern. Deselect this option if signal is expected to contain live network traffic – this will disable the pattern detection process to avoid reporting constant LSS (Loss of test Sequence Synchronization).

Pattern: Use the pattern drop-down box to select the test pattern which will be inserted into the transmitted signal. Pseudo Random Bit Sequences (PRBS) defined by ITU-T 0.150 and 0.151 standards, fixed words and 24-bit or 32 bit user defined patterns are available. ***Note:*** *If the 32 bit user pattern entered is incorrect, the default pattern will be 0xFFFFFFFF.*

Invert: Inversion of polarity is also available.

ITU-T specification 0.150 recommends the following test patterns:

Tandem Connection Monitoring (TCM) Definitions per ITU-T G.707, G.709, and G.783		
PRBS	**Zeros**	**Application**
2^9-1	8	Error measurements for bit rates ≤ 14,400 kbits/s
2^11-1	10	Error & jitter measurements for bit rates of nx64 kbit/s & 64 kbits/s & 64 kbits/s
2^15-1	15	Error & jitter measurements for T1, E1, E3 and DS3 bit rates
2^20-1	14	Error & jitter measurements for T1, E1, E3 and DS3 bit rates
2^23-1	23	Error & jitter measurements for E3 and E4 bit rates
2^31-1	31	Delay measurements for E3, DS3, and E4 bit rates

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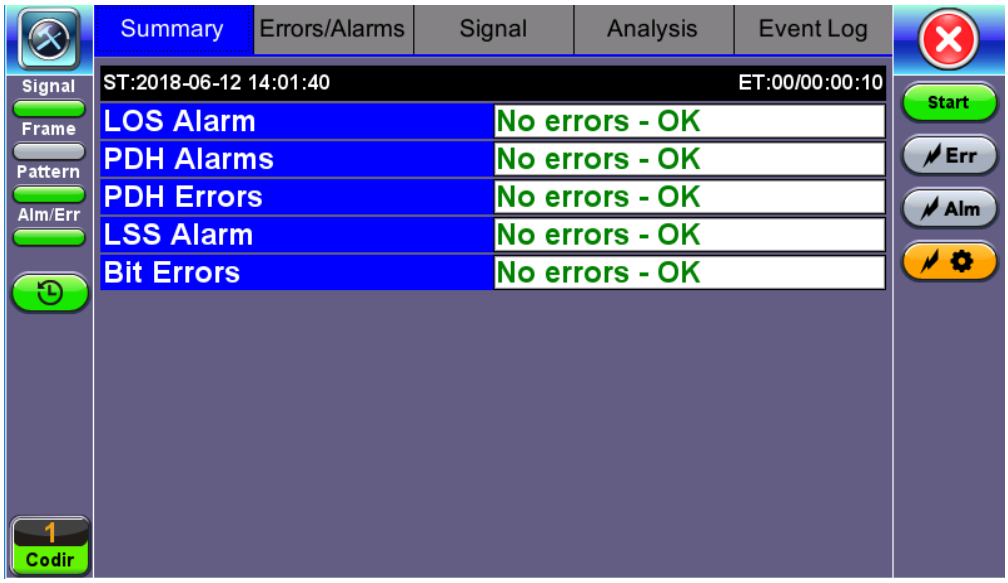
10.4.2 Results



Results - Summary

64k Codirectional results feature similar measurements and are displayed in an identical format as PDH Results. Refer to PDH Results for more information.

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10.4.3 Round Trip Delay

Round Trip Delay works in the same manner for all test ports. Refer to Round Trip Delay in the SDH/SONET section for more information on this test feature.

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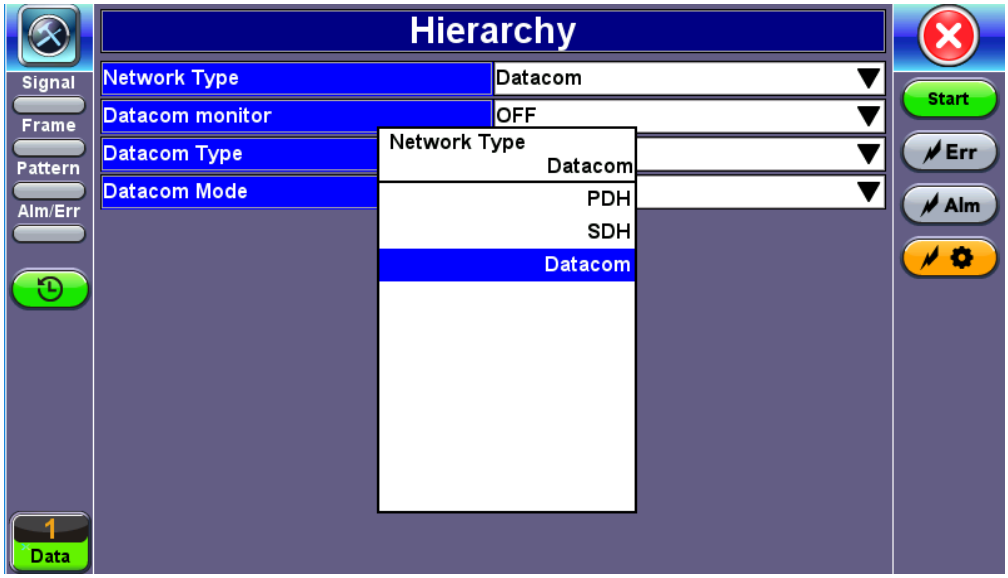
11.0 Datacom



Datacom selection from the Signal tab

To determine the datacom electrical interface, confirm that the correct adapter is used. The adapter is labeled DTE or DCE.

Accessing Datacom Testing

To display Datacom options for the TX and RX block configuration, tap on **Signal** tab > **Hierarchy** > **Network Type** and select *Datacom* from the drop-down menu.

*Depending on whether SDH or SONET (international or North American) terminology was selected from the **SDH/SONET** option under the **General** tab, TX and RX configuration screens will look slightly different. Nonetheless, they both feature the same options described in this section.*

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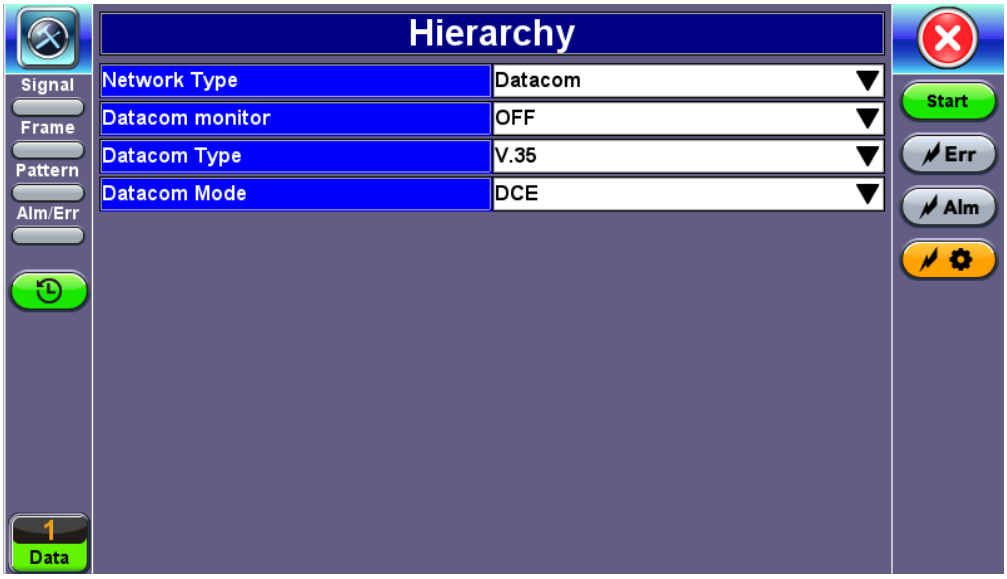
11.1 Signal Transmitter/Receiver Setup

The block diagram of the Tx and Rx structure is described in Signal Overview. Tap on a block diagram to open the setup menu for the selected parameter.

Hierarchy

The test interface and rate can be adjusted from the Hierarchy menu.



Hierarchy Setup

- **Network Type:** Select Datacom as the network type.
- **Datacom Monitor:** Allows for monitoring of a datacom circuit using the X-adapter cable
- **Datacom type**: V.35, RS449, X.21, V.24/RS449S and RS232A.
- **Datacom MODE**: DCE or DTE
  - DCE: Emulate Data Circuit Equipment facing a DTE
  - DTE: Emulate Data Terminal Equipment facing a DCE

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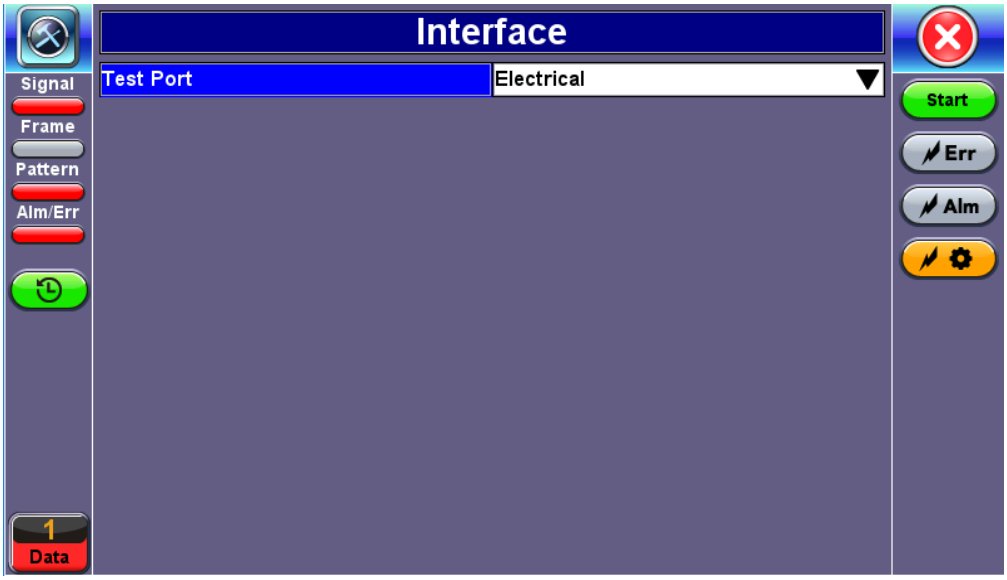
Interface



Interface Setup

- **Test Port:** Electrical

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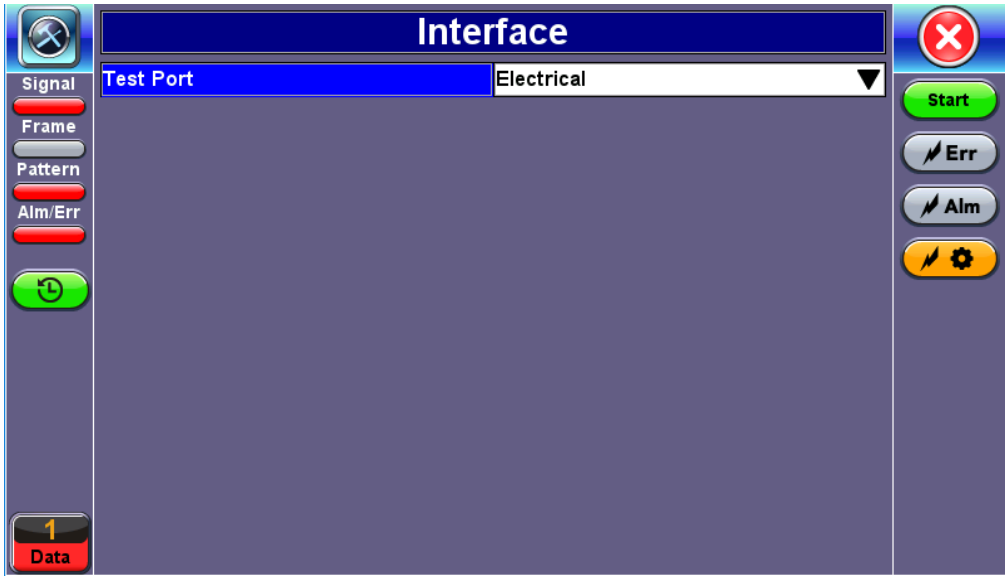
Payload

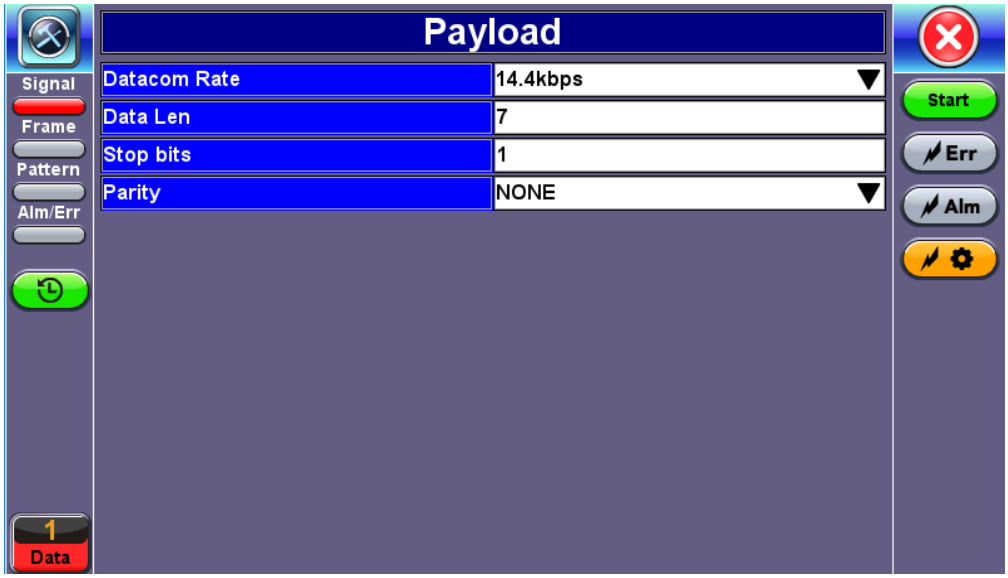


Payload Setup

Datacom Rate: Data rates (emulate and monitor)

- **X.21**: 50bps to 2,048kbps
- **RS-232 Async**: 50bps to 128kbps
- **RS-232/V.24 Sync**: 50bps to 2,048kbps
- **V.35**: 50bps to 2,048kbps
- **RS-449/V.36**: 50bps to 10Mbps

Test Configuration for RS232 Async Mode



RS232 Async Mode yields the following payload settings:

- **Data Length**: 6, 7, 8 bits. Determine how many bits will be transmitted for each character of information. The DTE and DCE should be the same.
- **Stop bits**: 1, 2 bits. Determines how many STOP bits will be transmitted for each character of information. The DTE and DCE should be the same.
- **Parity**: NONE, ODD, EVEN. Determine how many PARITY bits will be transmitted for each character of information. The DTE and DCE should be the same.

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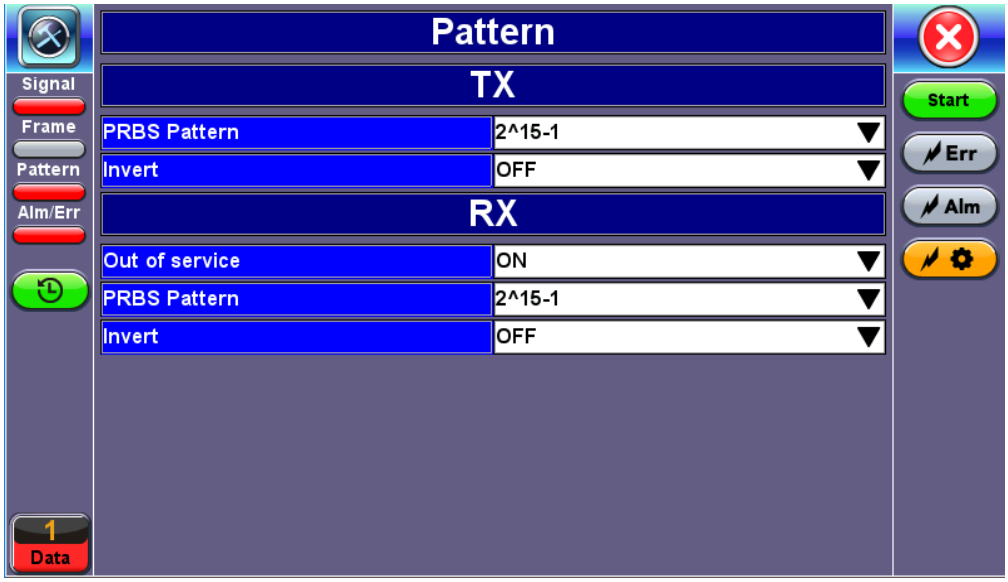
Pattern



Pattern Setup

Out of Service *(RX only)*: Should be selected if the incoming signal is expected to contain a known test pattern. Deselect this option if signal is expected to contain live network traffic – this will disable the pattern detection process to avoid reporting constant LSS (Loss of test Sequence Synchronization).

Pattern: Use the pattern drop-down box to select the test pattern which will be inserted into the transmitted signal. Pseudo Random Bit Sequences (PRBS) defined by ITU-T 0.150 and 0.151 standards, fixed words, and 24-bit or 32-bit user defined patterns are available. Up to 10 fixed 32-bit test patterns can be programmed using hexadecimals. *If the 32-bit user pattern entered is incorrect, the default pattern will be 0xFFFFFFFF. The 24-bit pattern must be entered in binary format.*

Invert: Inversion of polarity is also available.

ITU-T specification 0.150 recommends the following test patterns:

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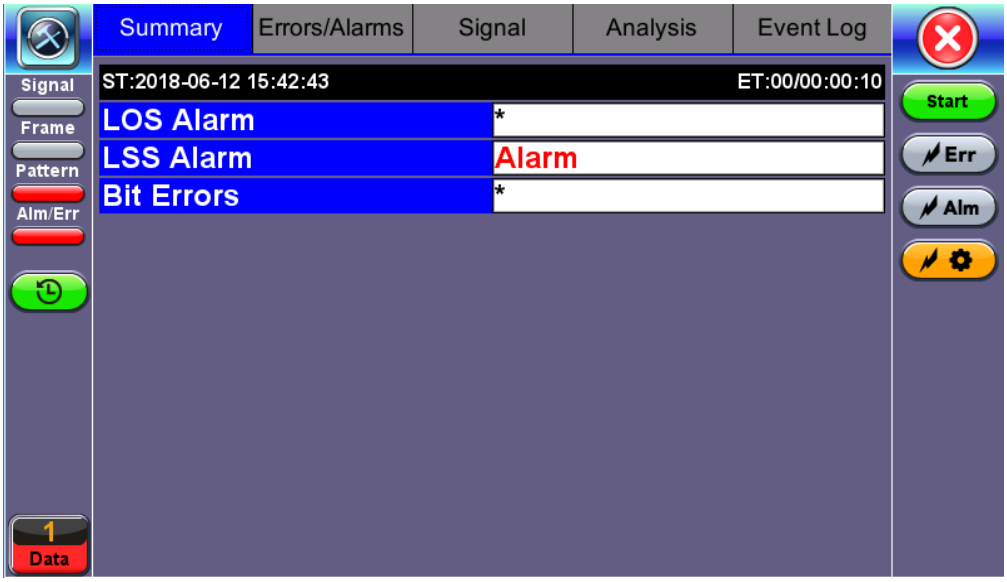
11.2 Results

11.2.1 Summary

The Summary tab displays an overview of the major test parameters. At a glance, the user is able to see if there are any alarms, errors, or signal failure.



Summary tab

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11.2.2 Errors and Alarms

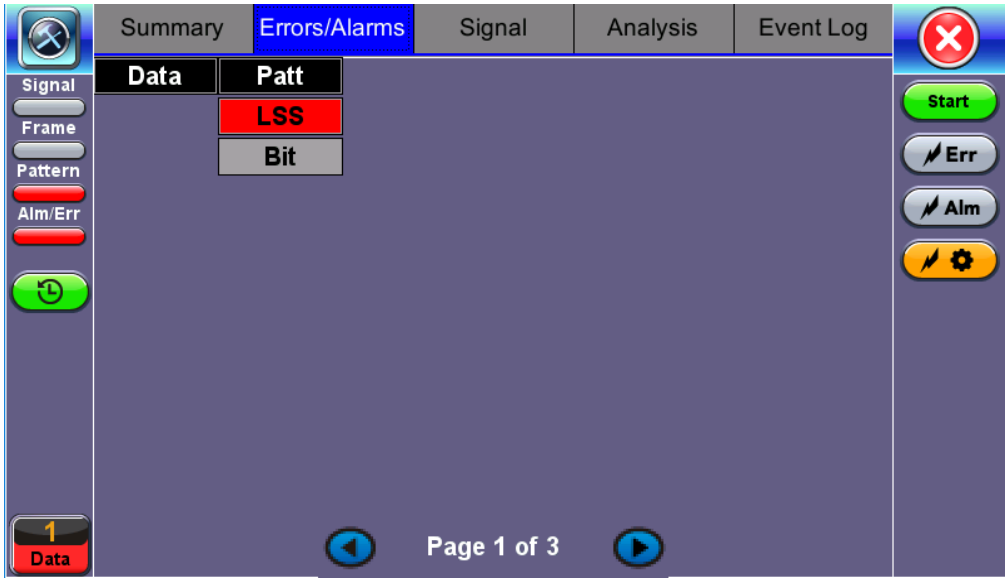
The Error/Alarm tab brings up several pages showing the errors and alarm status. Alarms/Errors results provides an overview of all the Errors and Alarms applicable to the signal or network under test. The color of the page tab is normally blue; however, it will turn red when an alarm error condition has been detected or recorded.

The soft LEDs on screen are arranged logically and will depend on signal hierarchy, structure, payload and framing selected. The soft LEDs have a tricolor function:

Green: No error or alarm is present.

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

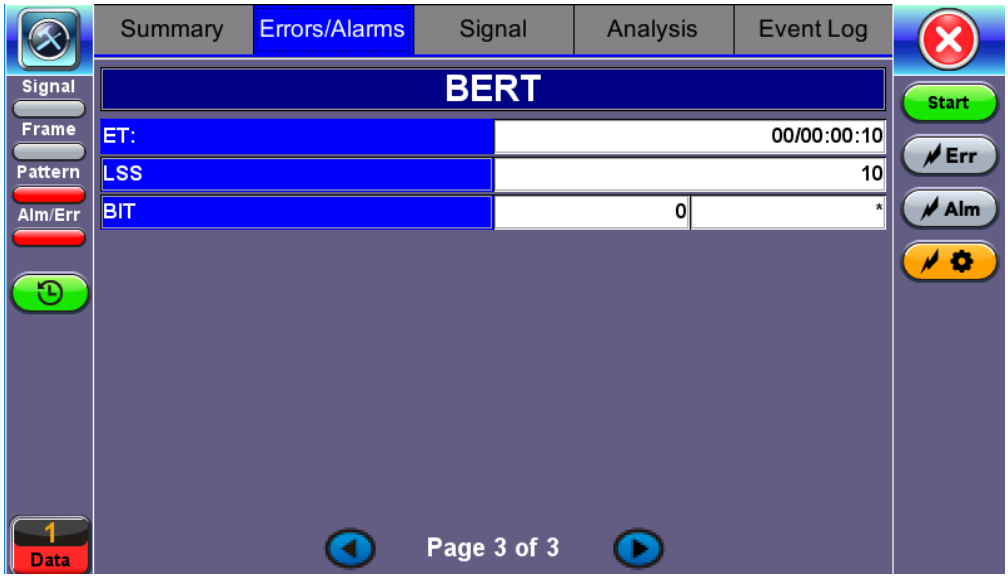
Yellow: Indicates a history condition. An error or alarm was detected during the measurement interval but it is no longer present or active.



Errors/Alarms (Page 1)

*Tapping the individual soft LED will automatically link directly to the applicable result screen which provides detailed information. Depending on the settings chosen in **Setup** > **Signal**, the Alarms/Errors displayed and page length will vary, but the order in which they are presented remain the same.*

Errors/alarms listed on each page are presented in a logical order associated with the signal under test. All errors are evaluated and stored. The Elapsed Time [ET] is shown in the right hand corner of the header. Error conditions are displayed in red including count and rate. The Errors/Alarms tab brings up a few pages of Datacom errors and alarms statuses.



Errors/Alarms - BERT

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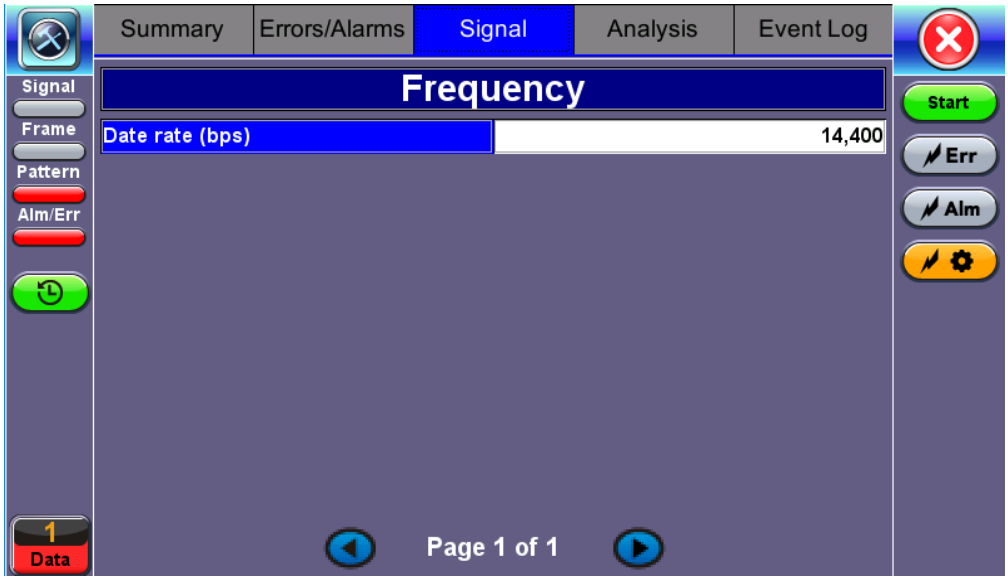
11.2.3 Signal

The Signal tab brings up the frequency screen.



Signal tab

Frequency: The received signal frequency and offset is measured and displayed.

- Data rate
- Calculated line rate

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11.2.4 Performance Analysis

Refer to Performance Analysis in the SDH section for more information on this test application.

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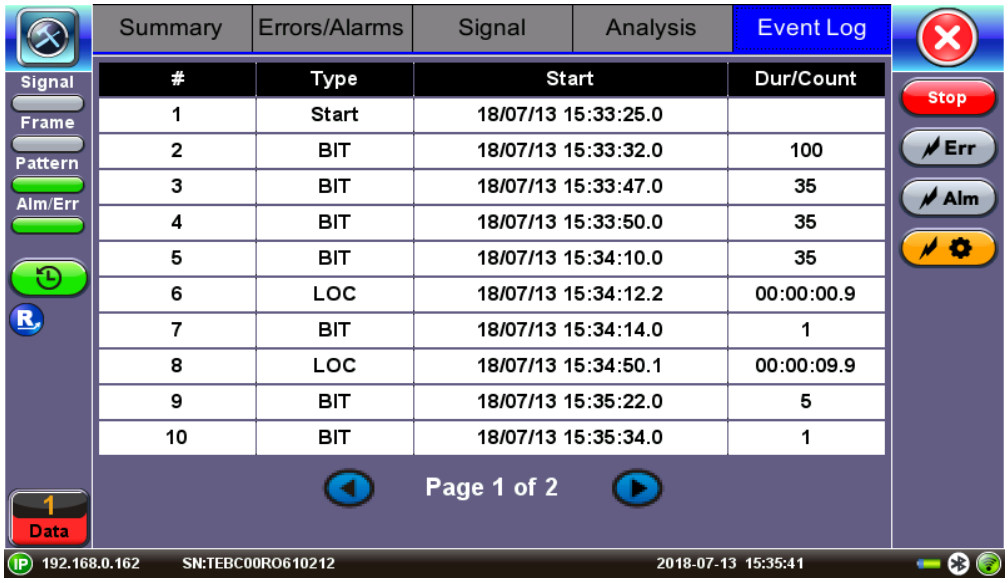
11.2.5 Event Log

The Event log tab brings up the screen listing the Error and Alarm events recorded during a test. The events are presented in chronological sequence:

- **Number (#):** Event number, events are numbered sequentially
- **Type:** Indicates alarm or error type
- **Start:** Indicates when the alarm or error was detected
- **Dur/Count:** Indicates for how long the alarm or error was detected and provides duration (alarms) and ratio/count (errors). The duration format is day:hour:minute:second
- **Pages:** Scroll through the pages depending on the number of events recorded



Event Log

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12.0 DS1/3 Tools

DS1 SFP+ Menu

DS1 Bantam BNC Menu

Depending on the chosen test port menu, test application availability will vary.

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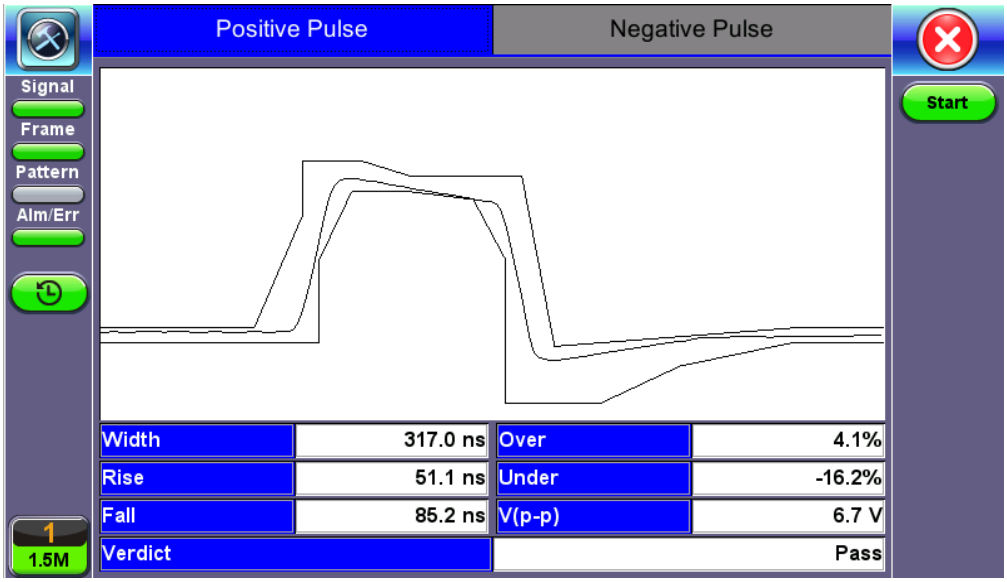
12.1 DS1 Pulse Mask

This function captures and analyzes DS1 (1.544Mbps) pulse shape. The purpose of maintaining the correct pulse shape is to reduce inter-symbol interference – if the logic 1s and 0s cannot be detected by the receiver correctly, bit and code errors will result.

The pulse amplitude and overall shape are superimposed and compared with the Telcordia TR-TSY-000499 and ITU-T G.703 pulse conformance template. Telecommunications signals require specific load impedance for pulse mask compliance testing to be accurate. When high frequency pulses are transmitted down a transmission line, a portion of the pulse will be reflected when and wherever it encounters an impedance mismatch. The reflection is proportional to the impedance mismatch (i.e., the greater the mismatch, the greater the reflection of the pulse).



DS1 Pulse Mask

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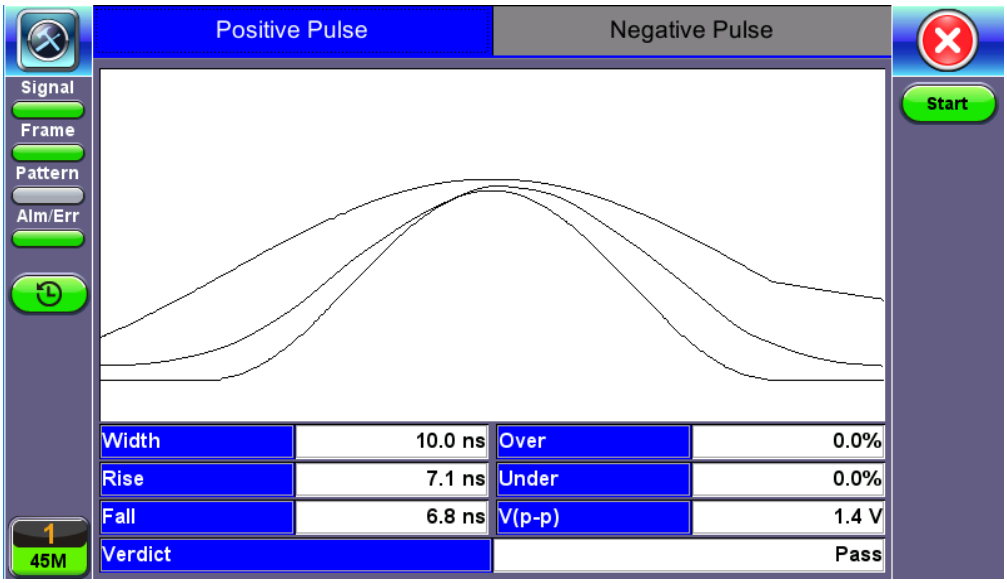
12.2 DS3 Pulse Mask

This function captures and analyzes the DS3 (44.736Mbits/s) pulse shape. The purpose of maintaining the correct pulse shape is to reduce inter-symbol interference – if the logic 1s and 0s cannot be detected by the receiver correctly, bit and code errors will result.

The pulse amplitude and overall shape are superimposed and compared with the Telcordia TR-TSY-000499 and ITU-T G.703 pulse conformance template. Telecommunications signals require specific load impedance for pulse mask compliance testing to be accurate. When high frequency pulses are transmitted down a transmission line, a portion of the pulse will be reflected when and wherever it encounters an impedance mismatch. The reflection is proportional to the impedance mismatch (i.e., the greater the mismatch, the greater the reflection of the pulse).



DS3 Pulse Mask

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12.3 Round Trip Delay

DS1 Round Trip Delay is the same measurement described as the Round Trip Delay in SDH/SONET Tools. Please see that section for more details.

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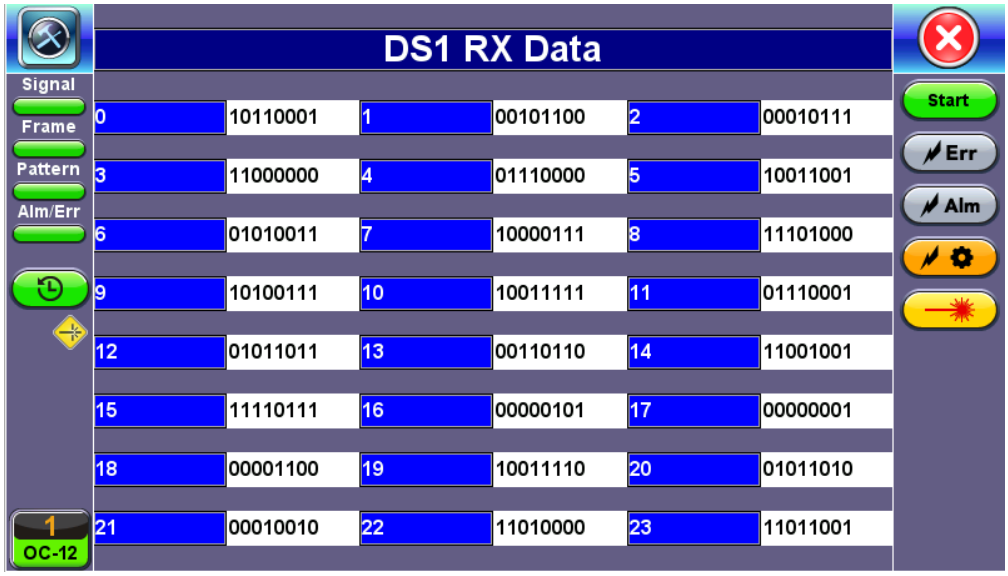
12.4 DS1 RX Data

DS1 RX data shows received data and captures the current timeslots.



DS1 Data

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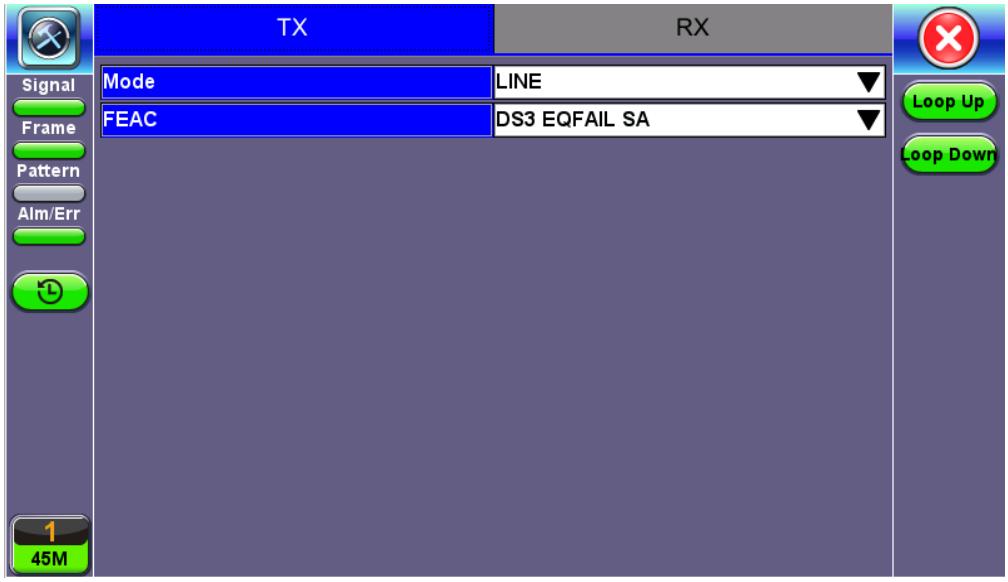
12.5 DS3 FEAC Tasks

DS3 FEAC responses (Far End Alarm and Control Channel Responses)

Enabling this option allows loopback to be configured from any “far-end” equipment connected on the other end of the line. These can be used to send and receive loop up codes and information from the far-end T3 device. Enable or disable this option through a drop-down menu in this field.

- **Loop Up**: 00010010 11111111 sent >10 repetitions
- **Loop Down**: 00100100 11111111 sent >10 repetitions

FEAC alarms are sent from the remote end device towards the local device by means of the C bit in the Subframe. When a failure is declared on the remote end unit, this is how it notifies the near end unit. Some FEAC Codes are shown below.

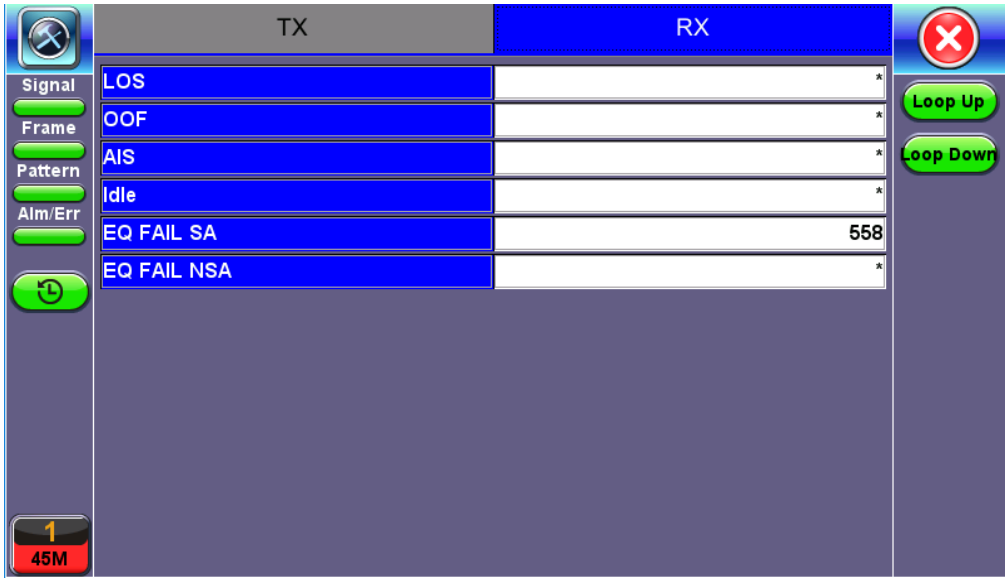


FEAC Tasks TX Setup

Alarm TYPE

DS3 Equip. Failure (Service Affecting)
DS3 LOS
DS3 OOF
DS3 AIS RCV
DS3 IDLE RCV
DS3 EQUIQ FAIL (NON-SERVICE AFFECT)
COMMON EQUIP. FAIL (NSA)
MULTIPLE DS1 LOS
DS1 EQUIP FAIL
SINGLE DS1 LOS
DS1 EQUIP FAIL (NON-SERVICE AFFECT)

LOOP TYPE: Options: NIU, LINE



FEAC Tasks RX

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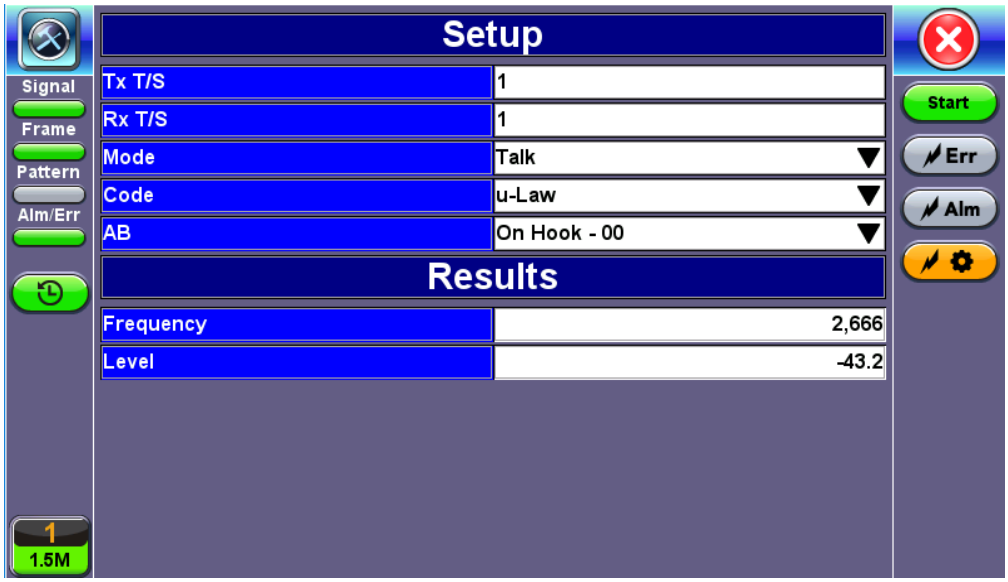
12.6 DS1 VF Tasks

The VF Tasks menu performs a variety of talk/listen functions.



DS1 VF Tasks Setup

Do not attempt to enter VF Tasks if the Frame LED is not green. Green LEDs indicate that the framing found on the received signal matches the framing selected in the Setup screen. It is impossible to talk, listen, or perform other channelized functions in the absence of frame synchronization, since channels can be identified only within a framed signal.

The VF Tasks screen features the following options:

Setup

- **Tx and Rx T/S:** Input the number of channels (1-24) to test for transmitting and receiving time slots.
- **Mode:** Talk or send a tone on the transmit signal. Transmit audio data from the external headset into the selected timeslot.
- **Code:** Select u-Law or A-Law.
- **ABCD:** Options are ON-HOOK, OFF-HOOK, WINK, or User (Manually set). Change the signalling bits transmitted with the associated transmit channel. In SF-D4 framing these will be A/B and ESF framing will place that signal onto the A/B/C/D position.
- **Programmable ABCD:** Manual (User) or IDLE, SEIZE.
- **Transmitted Frequency:** Input a frequency to transmit from 50 to 3950 Hz.
- **Transmitted Level:** Input a frequency to transmit from -60 to 3dBm.

Results:

- Measure signal frequency and level in selected timeslot
- Listen to the voice channel in the selected timeslot by plugging in an external VeEX headset to the connector panel. Audio connector **A** connects to the E1 and DS1 interface while audio connector **B** connects to SDH or VoIP Channels (if available).
- **ABCD:** View the received Channel Associated Signalling System (CAS) bits in selected T/S channel
- **Data:** View the live 8-bit channel data as it is received from the selected channel

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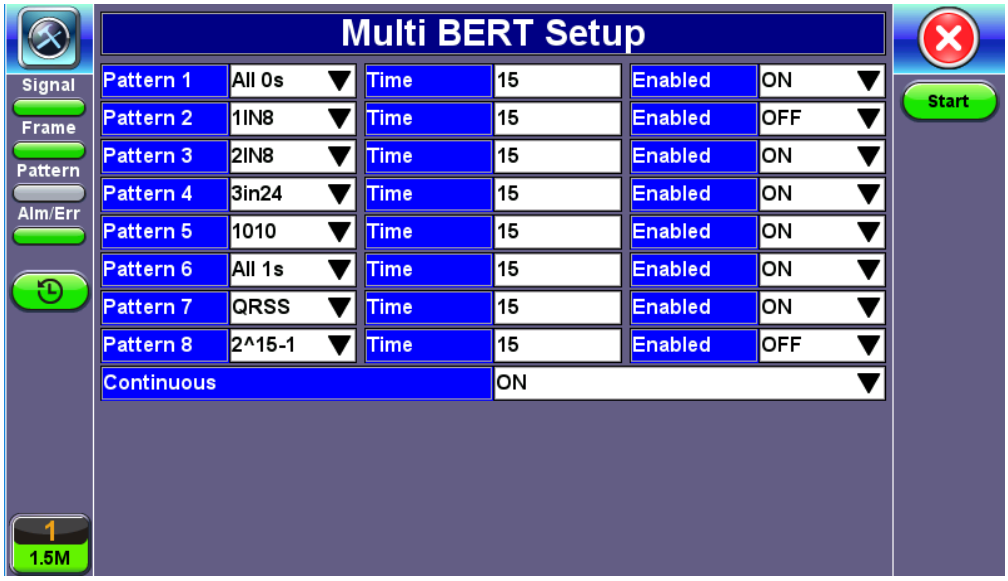
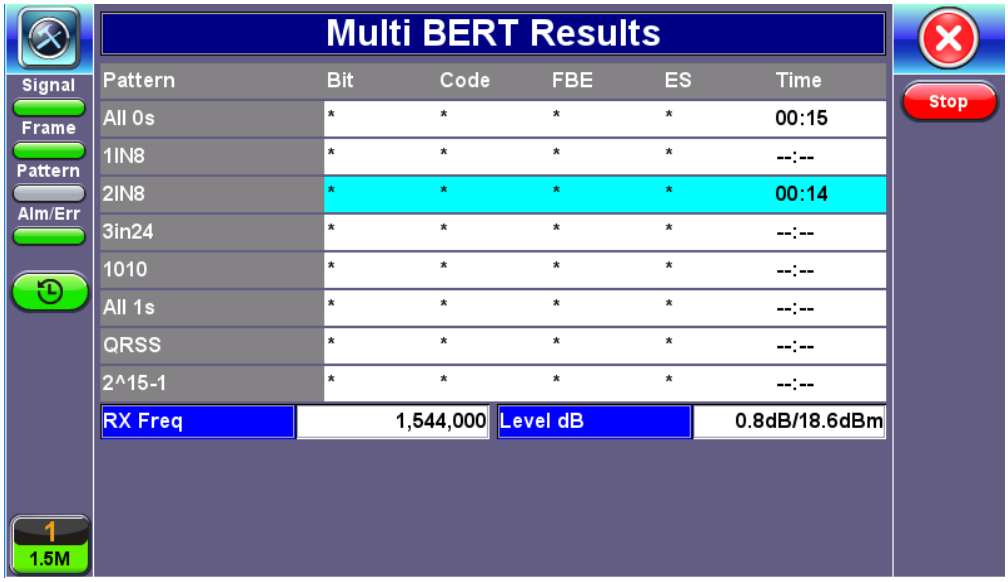
12.7 DS1 (Stress) Multi-BERT

DS1 (Stress) Multi-BERT brings into service and troubleshoots DS1 links quickly by automatically generating different test patterns in a sequential BER test. Since certain test patterns can help identify and test for specific problems or behaviors, the test sequence can be customized with specific test patterns and timings to target these test scenarios, like checking for proper line coding settings, framing, or clock recovery. Up to 8 BER tests can run in sequence. Setting Continuous to ON will repeat the test sequence after the last Pattern is generated.



DS1 (Stress) Multi-BERT Setup



DS1 (Stress) Multi-BERT Results

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13.0 Ethernet

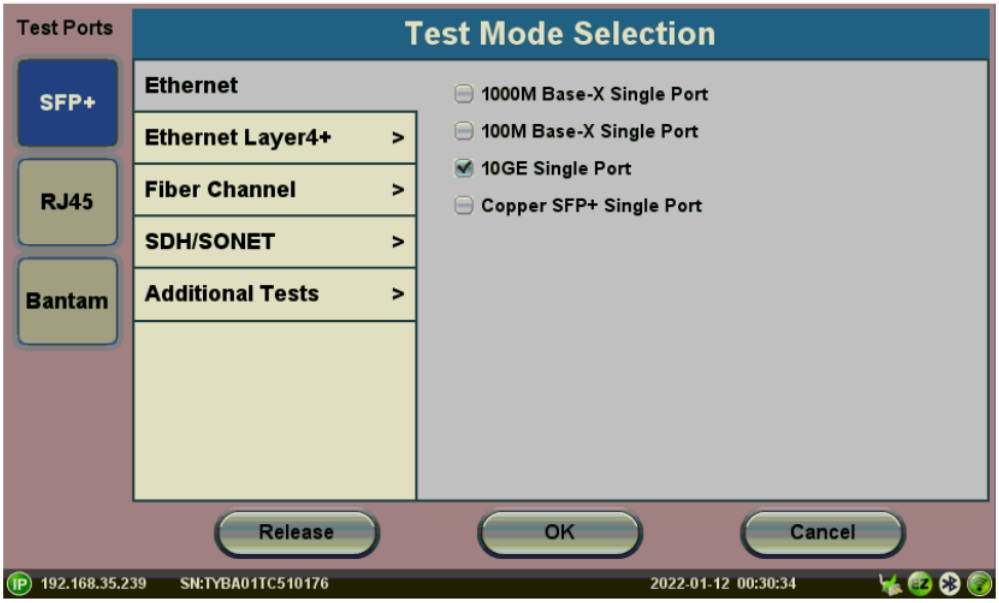
13.1 Ethernet Setup

13.1.1 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 at the top of the screen  . Tap on a technology group then select a test interface.

After selecting the test interface, tap **OK** or **Accept** button (depending on your interface) located at the bottom of the pop-up window.



Test Mode Selection

The configuration parameters (header, bandwidth, etc. for each application (on each of the ports) are completely independent from one another. All test feature combinations are allowed and completely independent (Loopback, BERT, Throughput, RFC2544, VSAM) in dual port operation. However, some advanced tools, such as IPTV, VLAN scan, Packet Capture, etc. are available in single port testing mode only. The user interface will provide an error message when a feature is not available in dual port operation.

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).

13.1.2 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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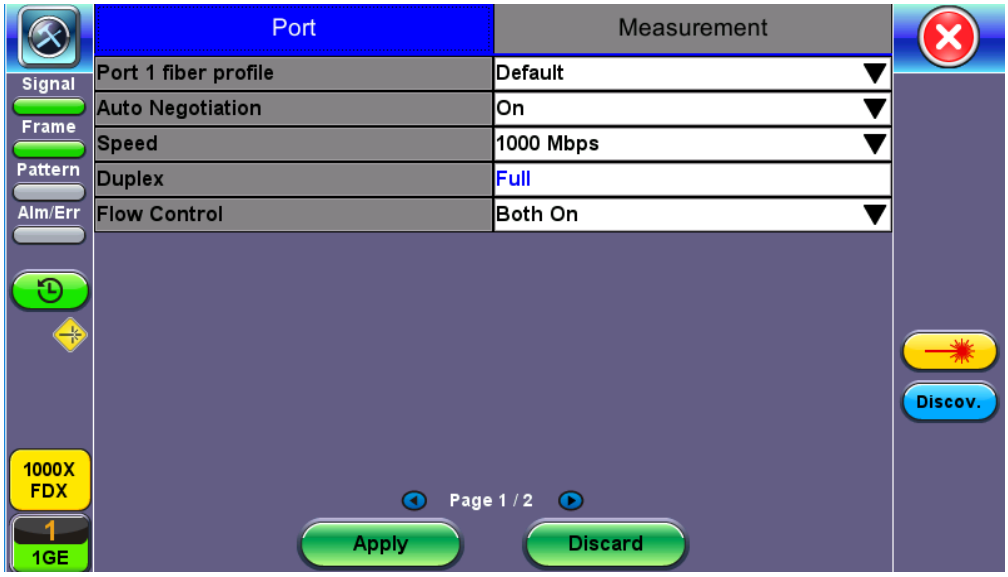

100/1000Base-X Port Setup

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.

  For information on configuring SyncE operation, see Port Page 2 - Mode Selection in the Synchronous Ethernet section.

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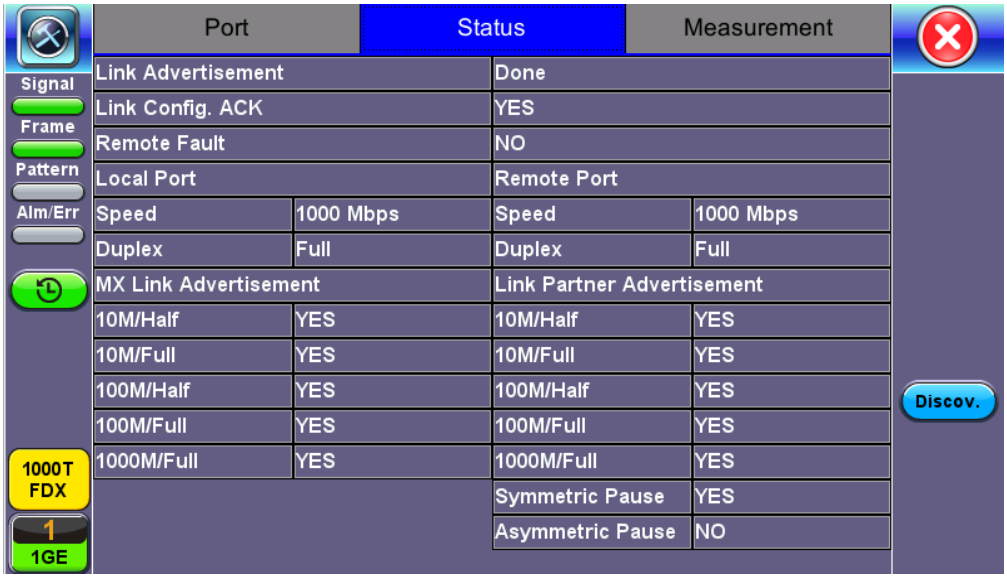
Status



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.

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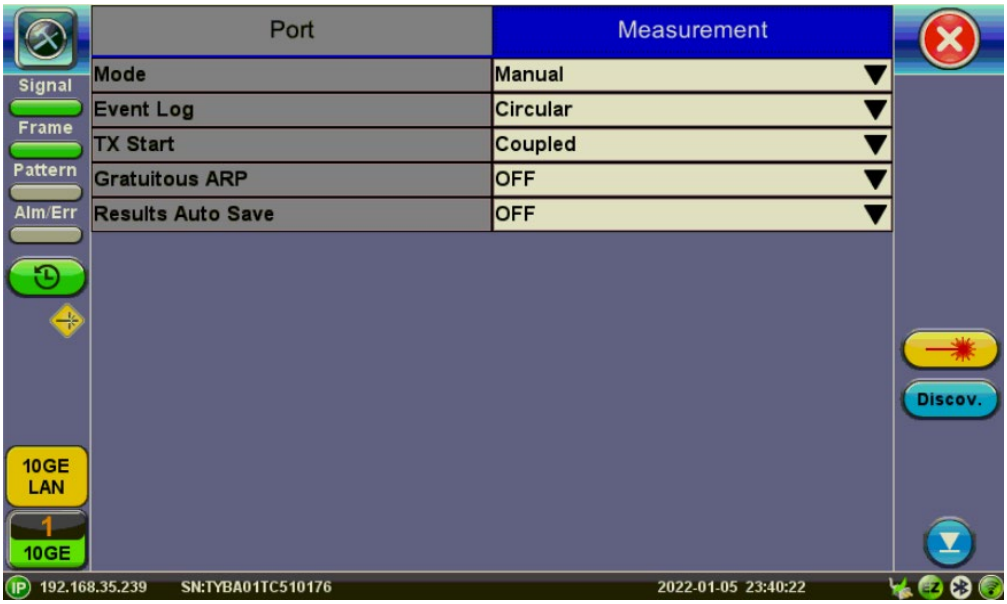
13.1.3 Measurement Settings



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.

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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13.1.4 MX Discover and Control

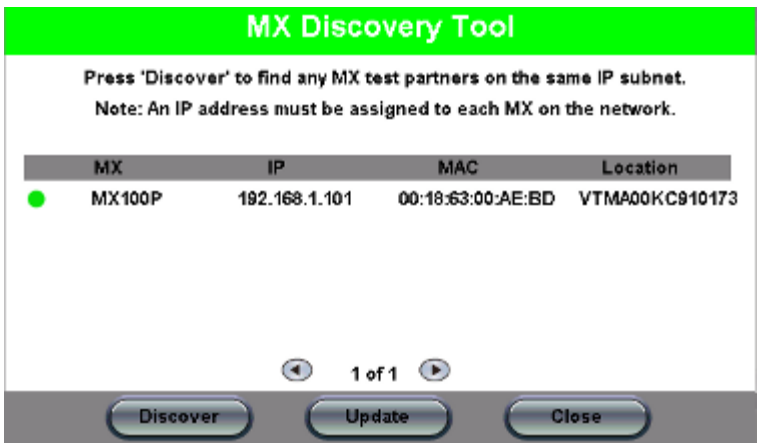
Before proceeding with MX Discover or Control, be sure to assign an IP address to each test port. To assign an IP address, proceed to the home menu and select the IP icon. Refer to IP Connection for additional instructions.

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

Loop Control

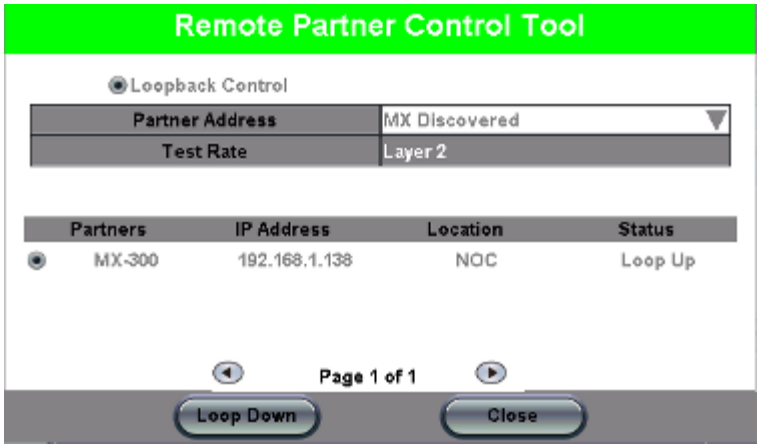
The **Loop Control** button becomes available on the right side menu when any Ethernet application (V-SAM, RFC 2544, Throughput,

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.

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13.2 IP

13.2.1 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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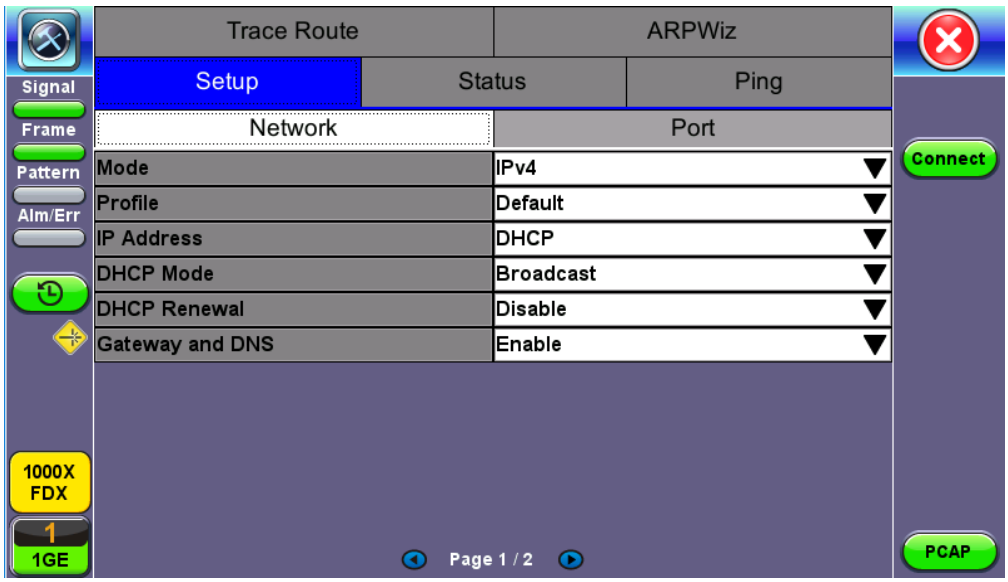
13.2.1.1 Setup

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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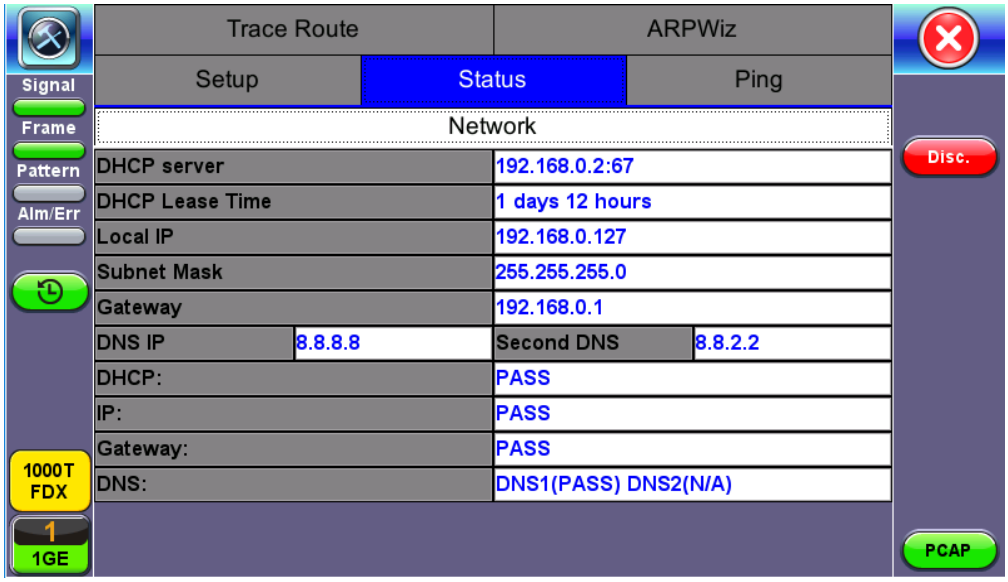
13.2.1.2 Status

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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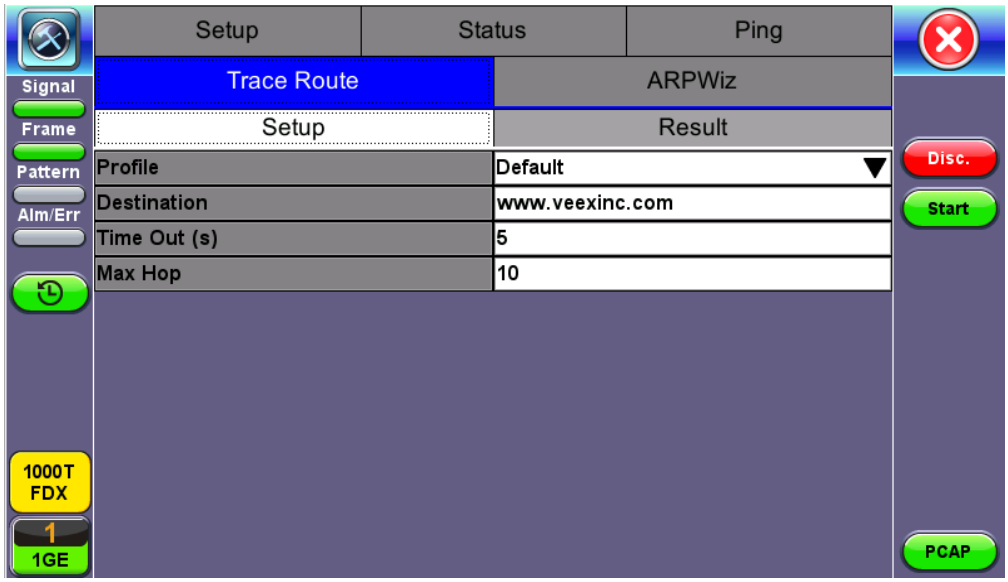
13.2.2 Trace Route

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.



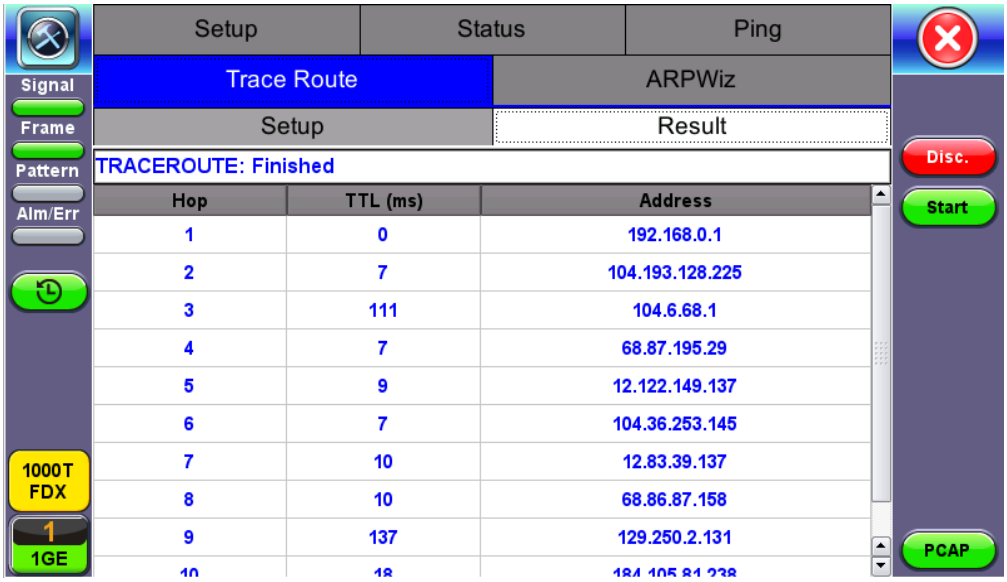
Trace Route - Setup

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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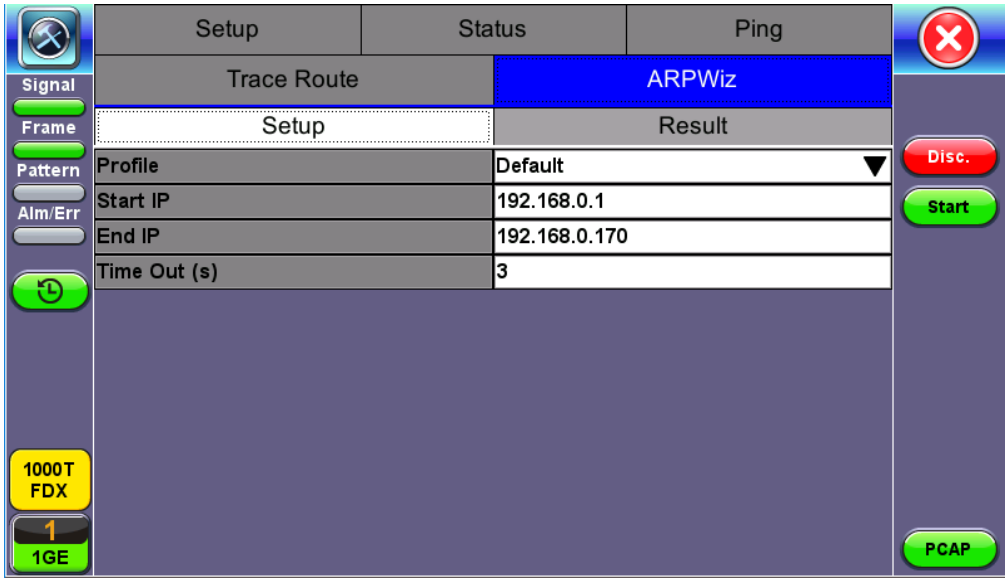
13.2.3 ARP Wiz

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.

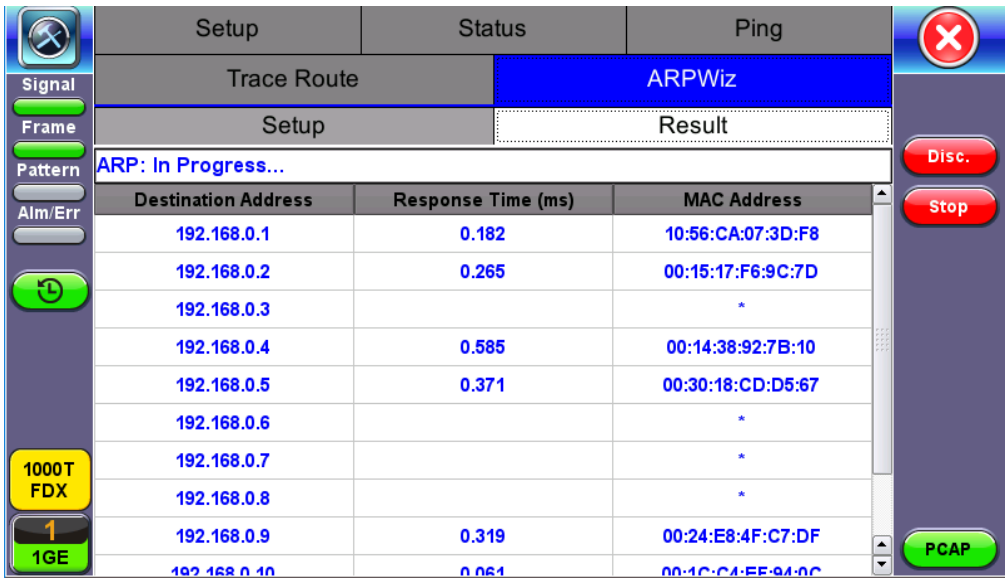


ARP Wiz Setup

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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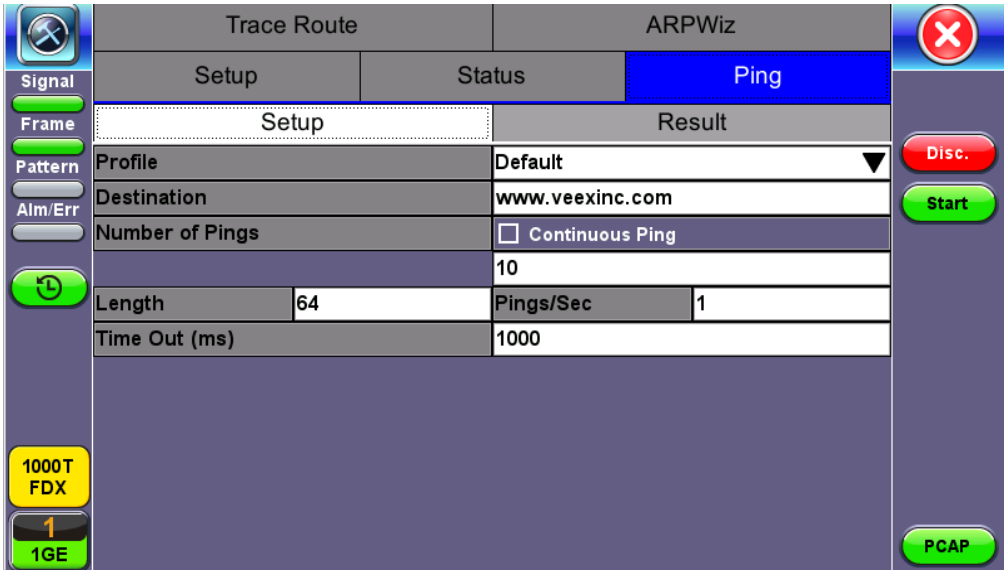
13.2.4 Ping

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

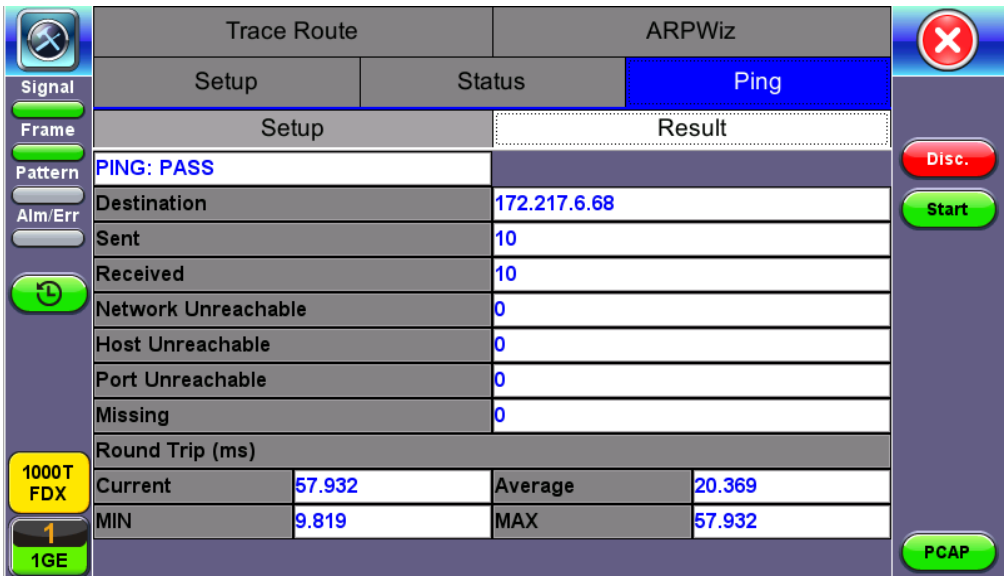
Ping Setup

- **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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13.3 BERT

13.3.1 BERT Setup

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

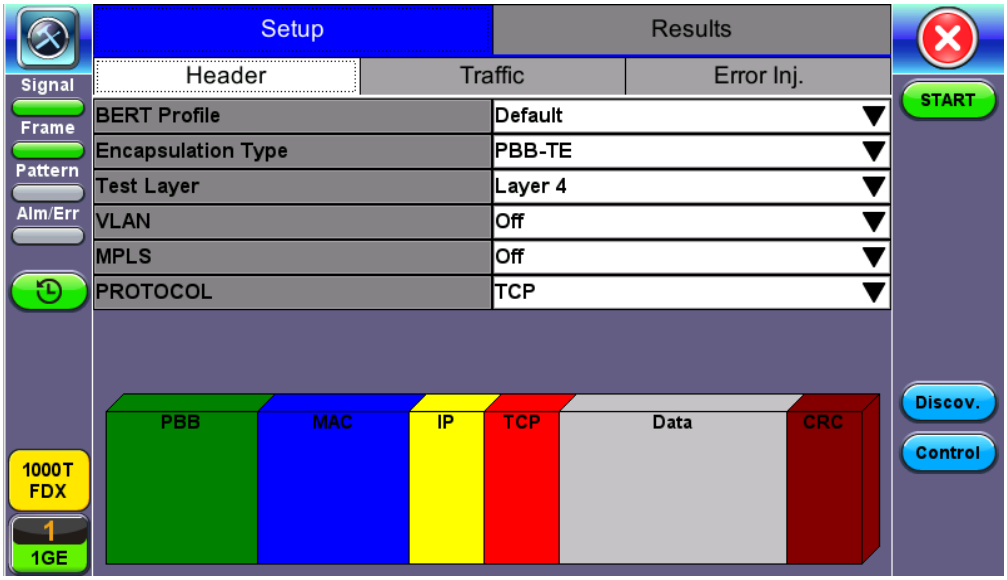
Overview:
BER testing at Layer 1, 2, 3, and 4 is supported. The BERT can be configured to use either regular PRBS test patterns, stress patterns (specifically for 10Gigabit Ethernet) or user defined test patterns to simulate various conditions. The test layer, frame header, traffic profile, error injection, 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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13.3.1.1 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.

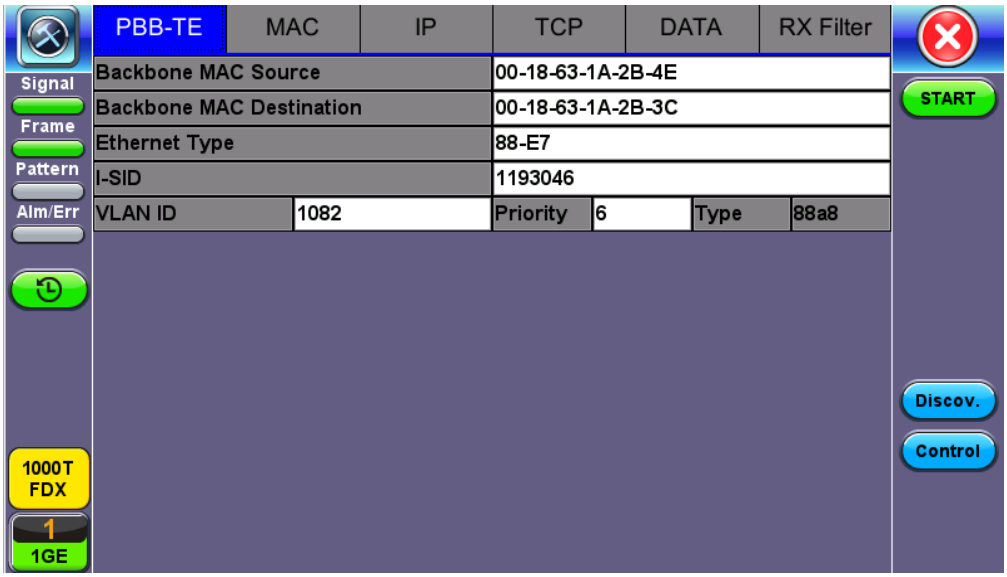
- **Encapsulation Type:** None, Provider Backbone Bridge (PBB-TE), or Multiprotocol Label Switching (MPLS-TP). MPLS-TP is a simplified version of MPLS. Provider Backbone Bridge MAC-in-MAC (IEEE 802.1ah) encapsulation are configured trunks that add resiliency and configurable performance levels in the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

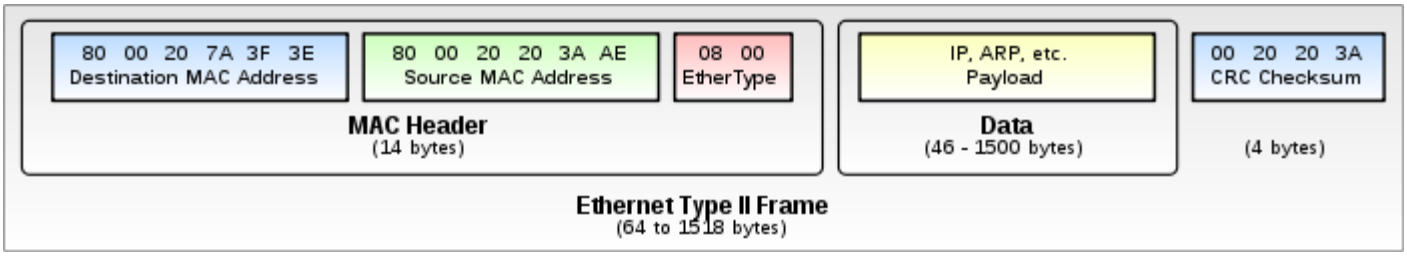
- **Test:** Select the test layer to perform the BERT
  - Options are Layer 1 Unframed, Layer 1 Framed, Layer 2, Layer 3, and Layer 4

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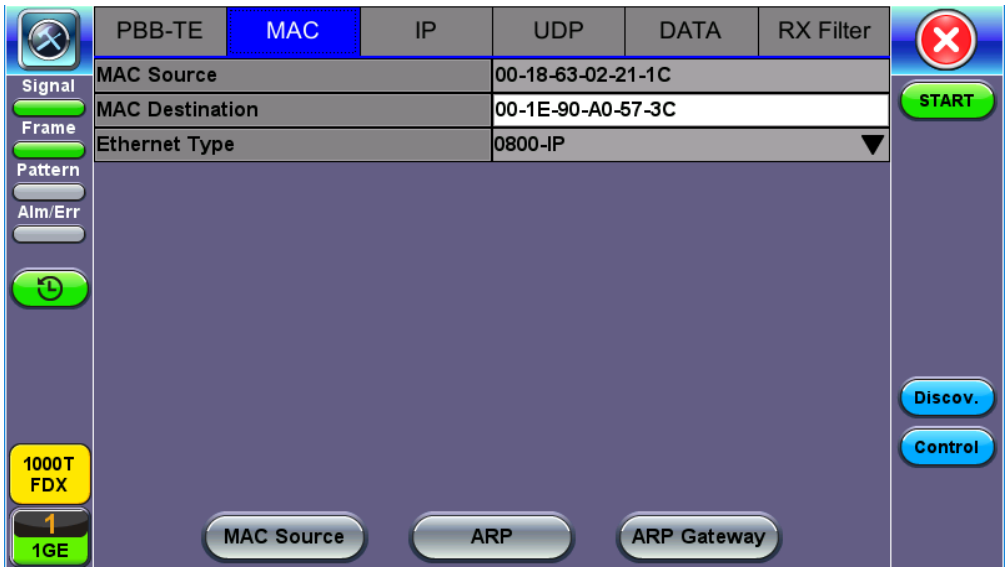
MAC, VLAN, MPLS, IP, and Test Pattern Configurations:

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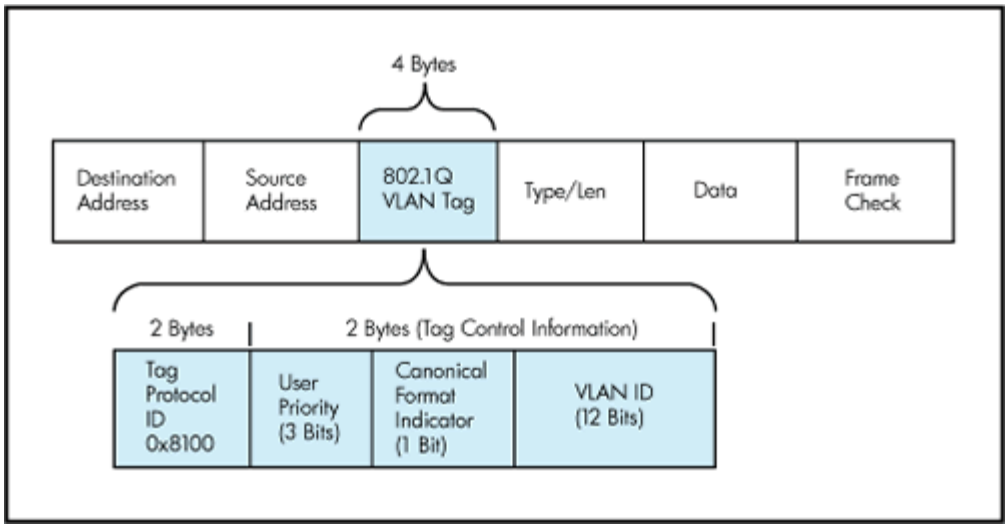
- **VLAN Tab:** In the VLAN tab the following parameters are configured:

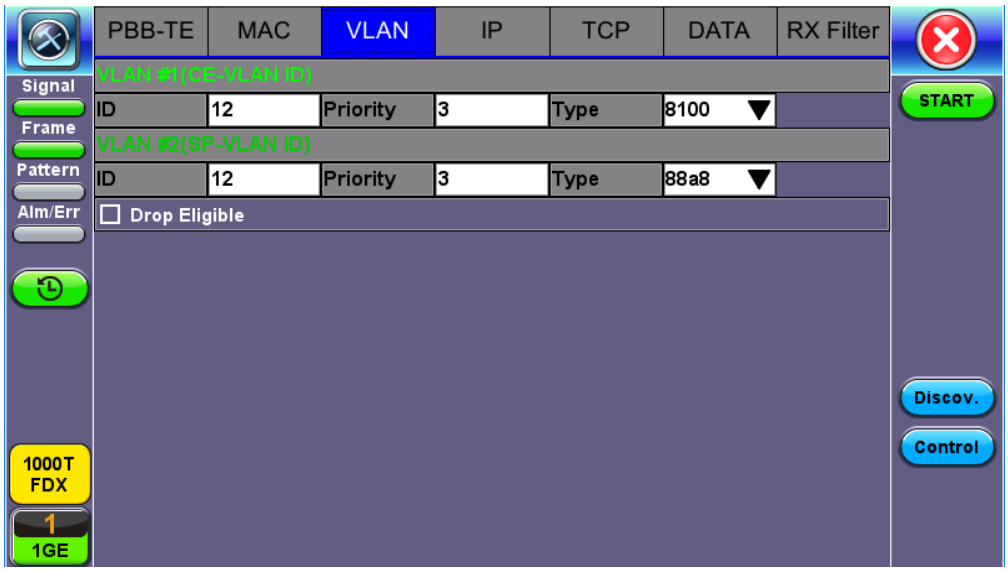
  - **VLAN ID:** Configurable in the range 1 to 4094.
    - VLAN ID is the identification of the VLAN, which is basically used by the standard 802.1Q.
    - It has 12 bits which allows the identification of 4096 (2^12) VLANs.
    - Of the 4096 possible VIDs, a VID of 0 is used to identify priority frames 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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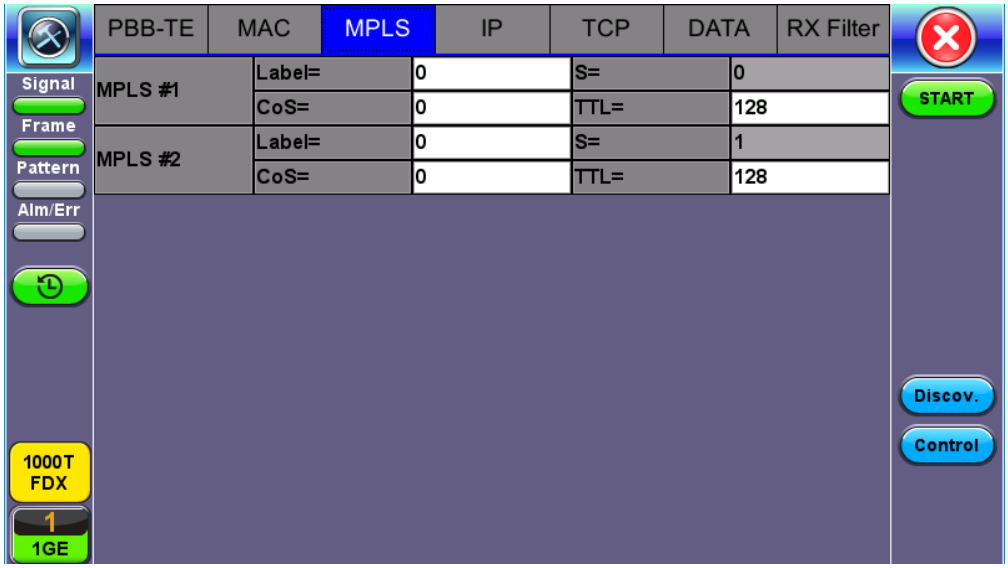
- **MPLS Tab:** In the MPLS tab the following parameters are configured:
  - **MPLS label:** Configurable in the range 16 through 1,048,575 (labels 0 to 13 are reserved).
    Composed of 20 bits which allows for the creation of over one million labels.
  - **CoS:** Configurable in the range 0 to 6.
    This field is three bits in length and maps directly to IP Precedence TOS bits to provide Class of Service (COS).
  - **S-bit:** Configurable 0 or 1.
    The S field is one bit in length and is used for stacking labels. This is important as it is used to indicate the last label in the label stack.
  - **TTL:** Configurable in the range 0 to 255. The default setting is 128 hops.
    Used to decrement the time-to-live counter.



BERT Setup - MPLS label configuration

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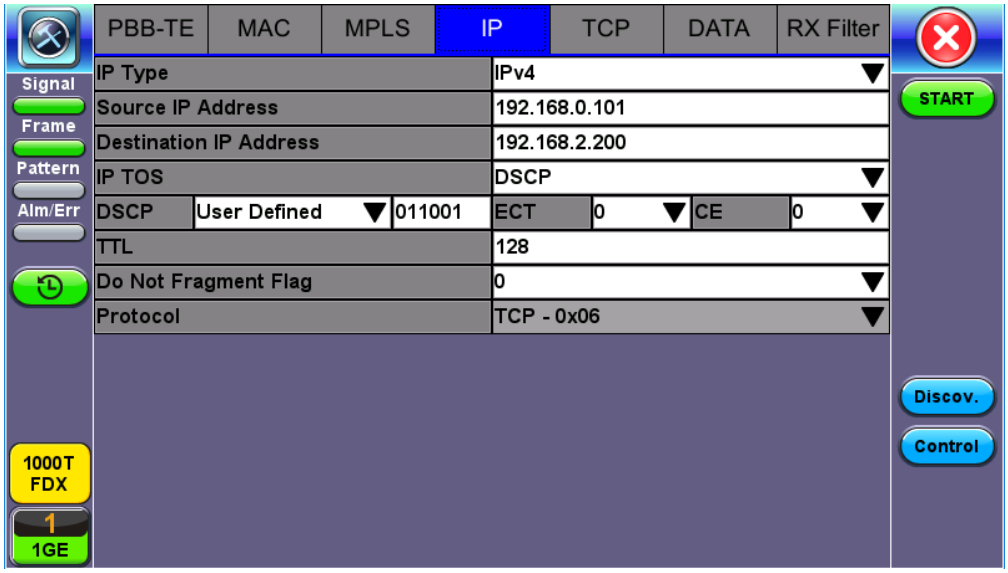
- **IP Tab:** In the IP tab the user must configure the destination IP address and source address. The user may also configure the following IP header fields:
  - **IP Type:** IPv4
  - **IP Src and IP Dest:** For IP Src, if the IP connection is up, refer to IP Connection. The source address is fixed 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.
      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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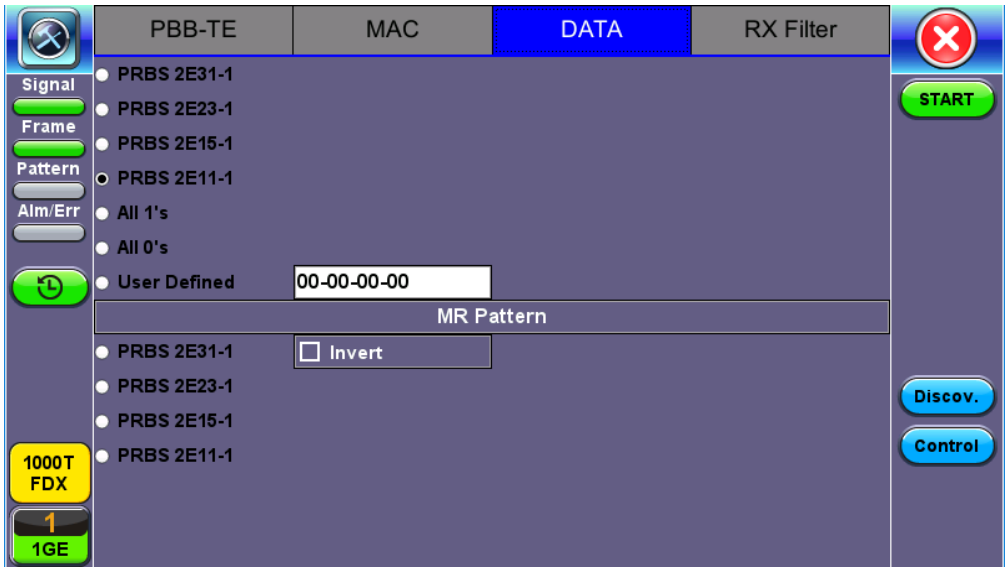
- **Data Tab:** User selects a test pattern that will be encapsulated in the Ethernet frame payload (for framed mode). Depending on the test layer, different test pattern options are available.
    - **Layer 2, 3, & 4 test patterns**
        - **PRBS:**
            - 2^31 -1 (147 483 647-bit pattern 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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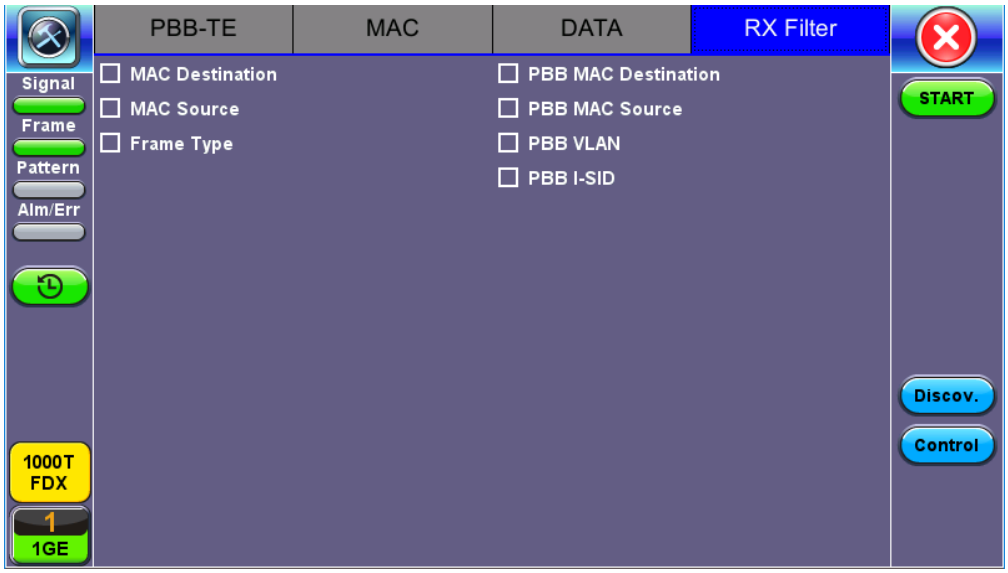
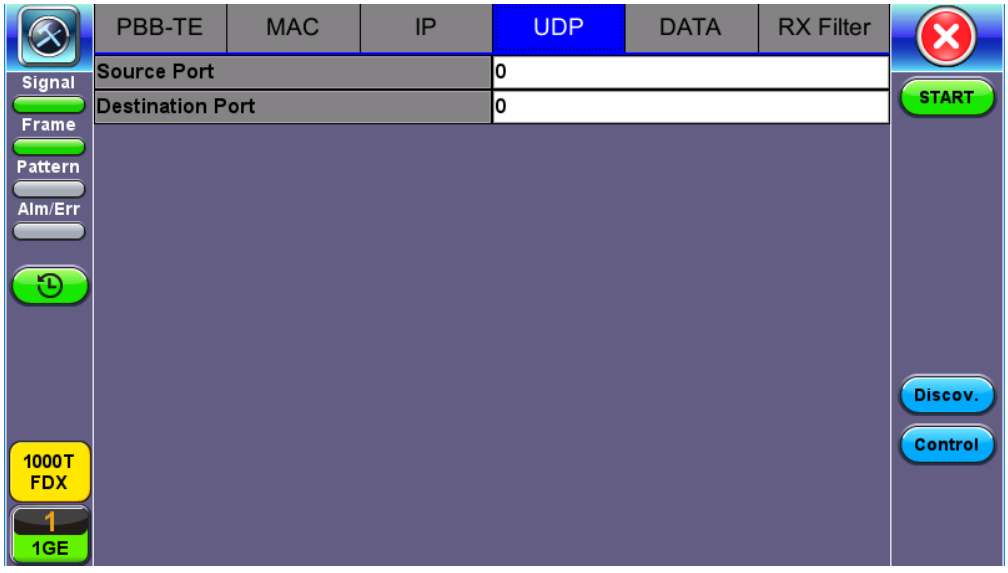
- **RX Filter Tab:** Allows the user to filter incoming streams. When checked, the incoming traffic flows not matching these criteria will not be considered for these results.
  - MAC Destination address
  - MAC Source address
  - VLAN
  - VLAN Priority
  - VLAN Eligible
  - Frame Type
  - Type of Service
  - 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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13.3.1.2 Traffic Settings

Traffic tab:

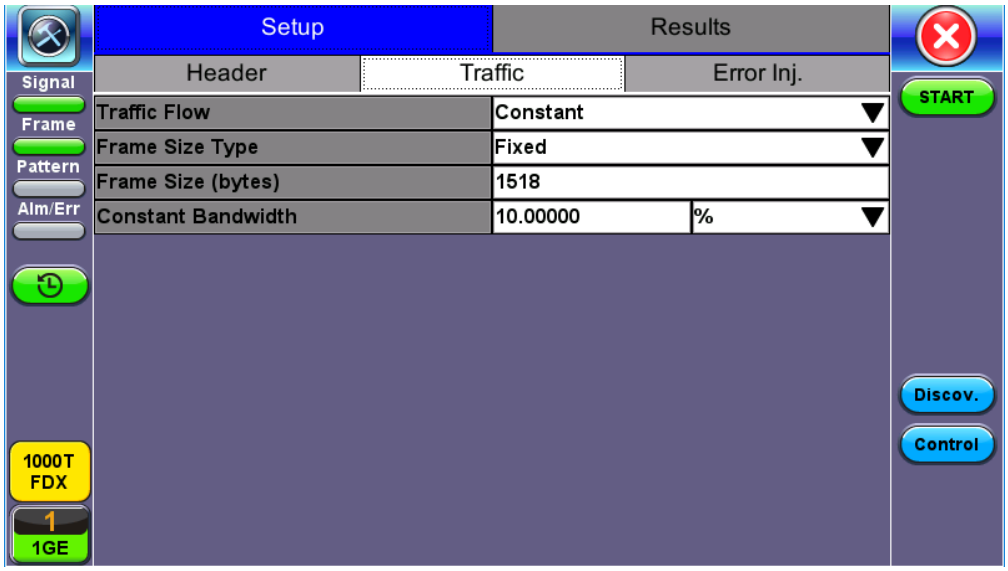
The user configures the traffic profile for the stream, including traffic flow, frame size, frame type, and transmit rate.

- **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

Frame Size Limitations

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

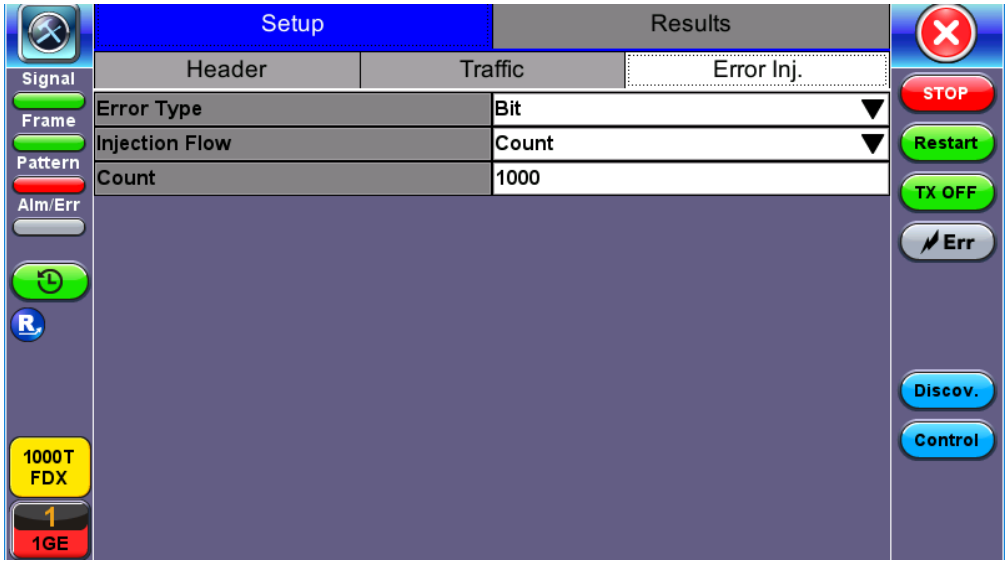
Go back to top Go back to TOC Go back to Throughput Traffic Settings (Per Stream Configuration)

13.3.1.3 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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13.3.1.4 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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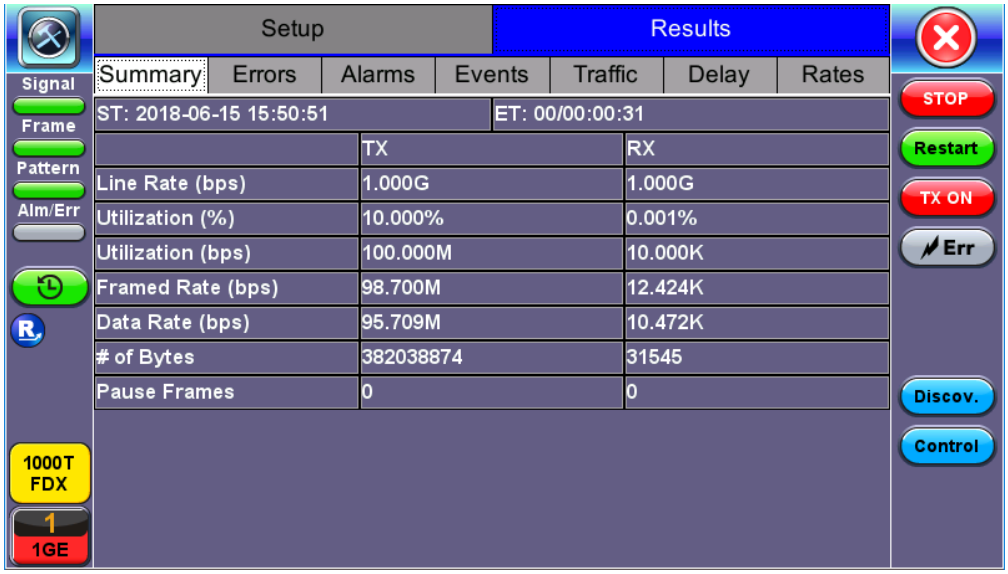
13.3.2 BERT Results

13.3.2.1 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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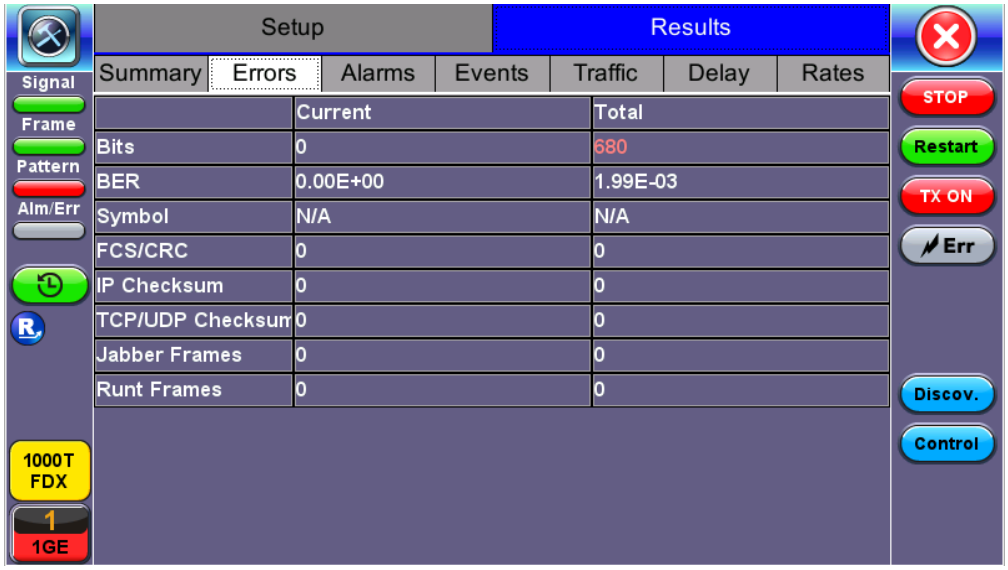
13.3.2.2 Errors

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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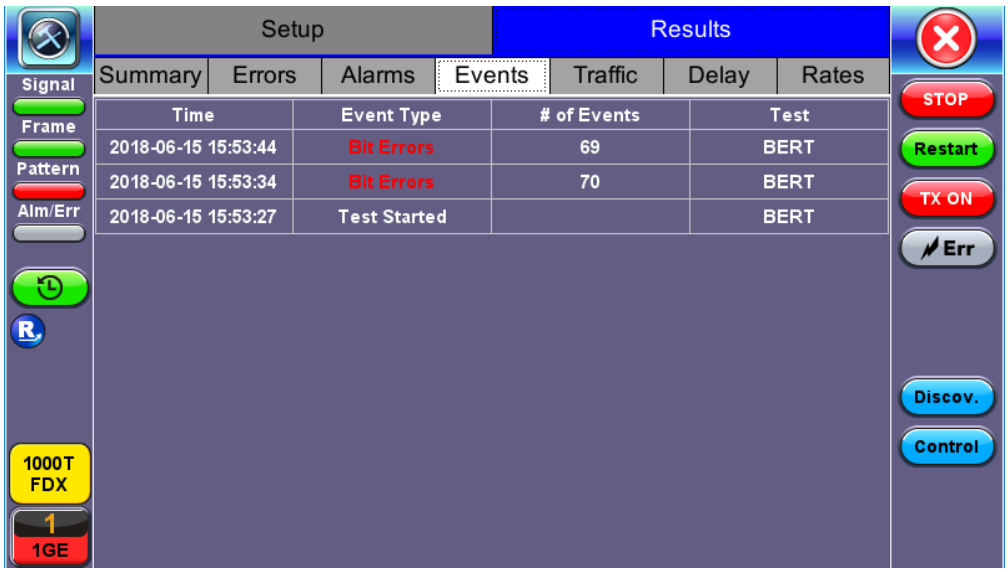
13.3.2.3 Events

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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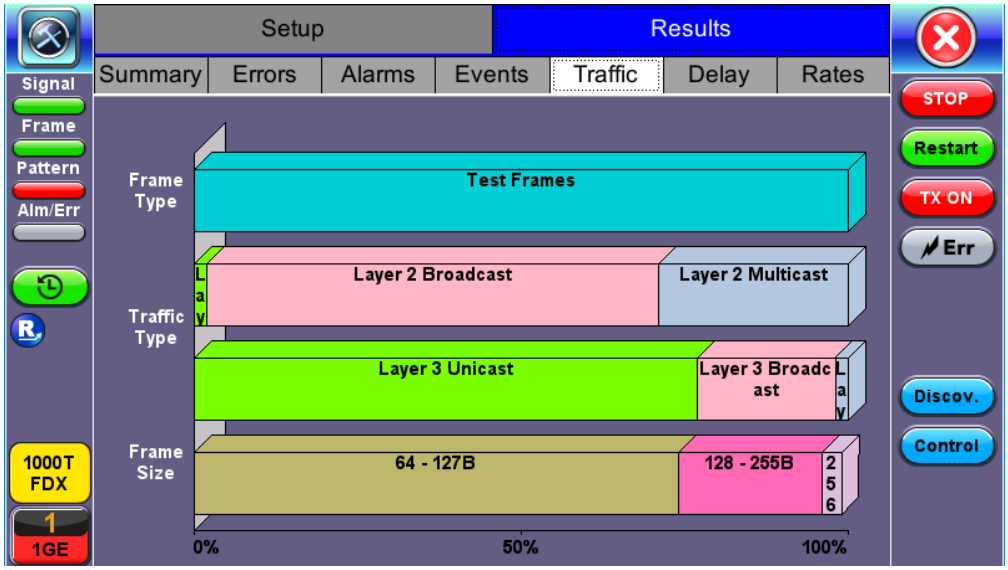
13.3.2.4 Traffic

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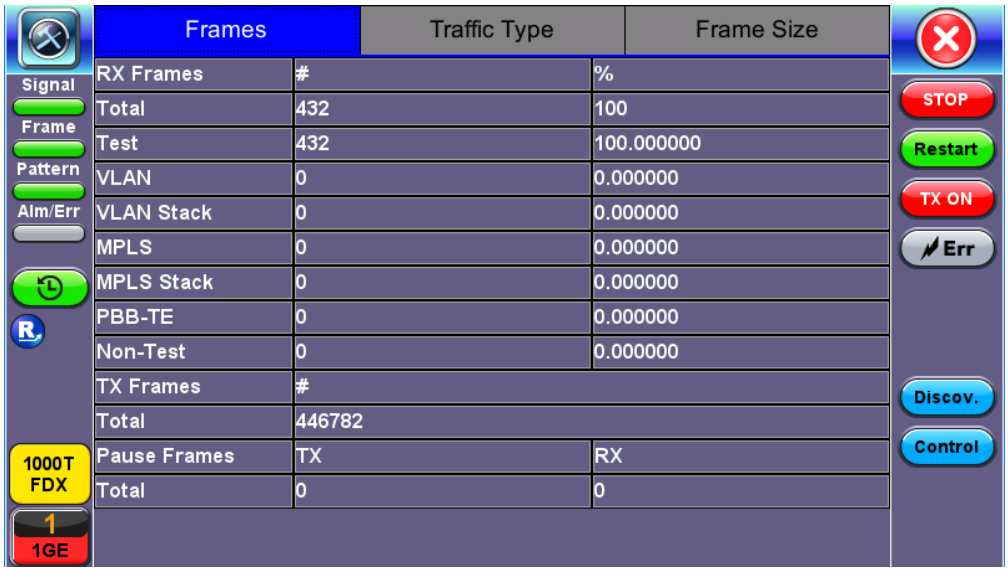
Frames tab: The following Frame distribution statistics are displayed in Count (#) and Percentage (%):

- **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

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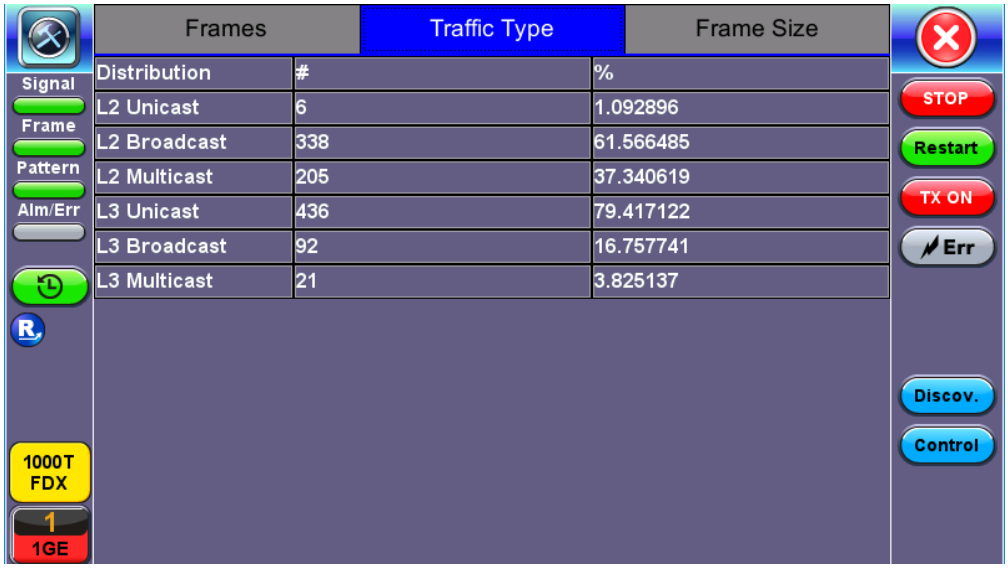
Traffic Type tab: The following Traffic distribution statistics are displayed in Count (#) and Percentage (%):

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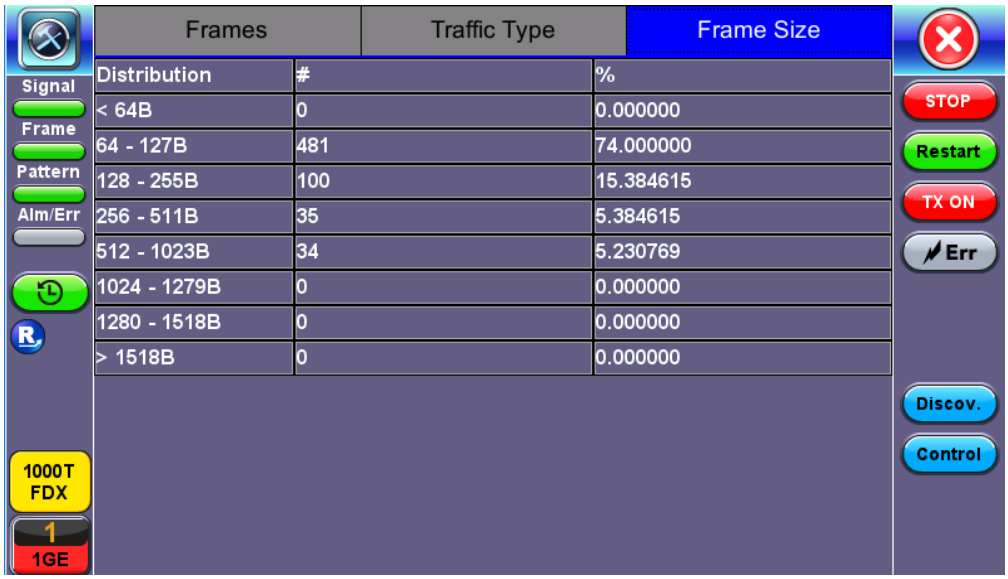
Frame Size tab: The following Frame distribution statistics are displayed in Count (#) and Percentage (%):

- < 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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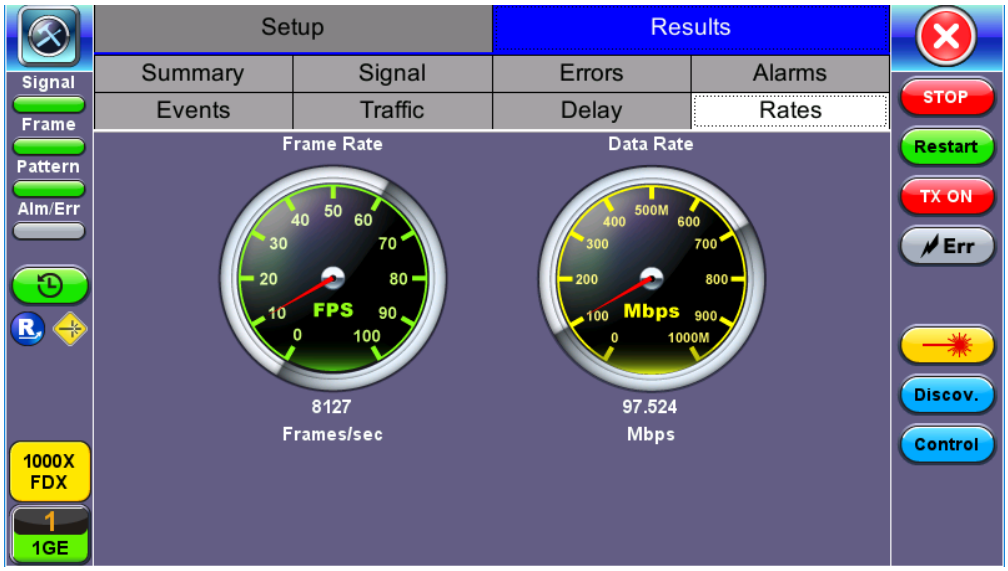
13.3.2.5 Rates

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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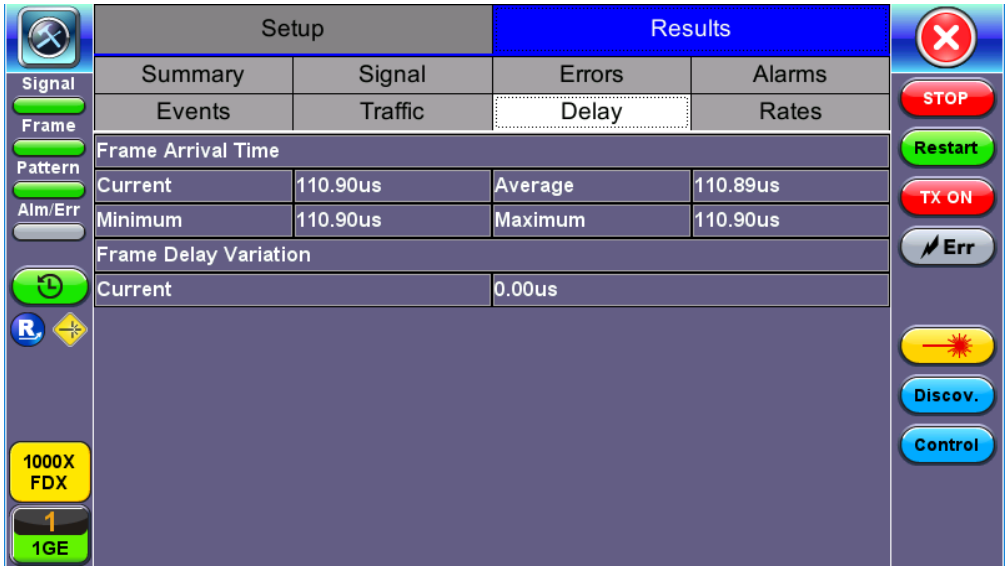
13.3.2.6 Delay

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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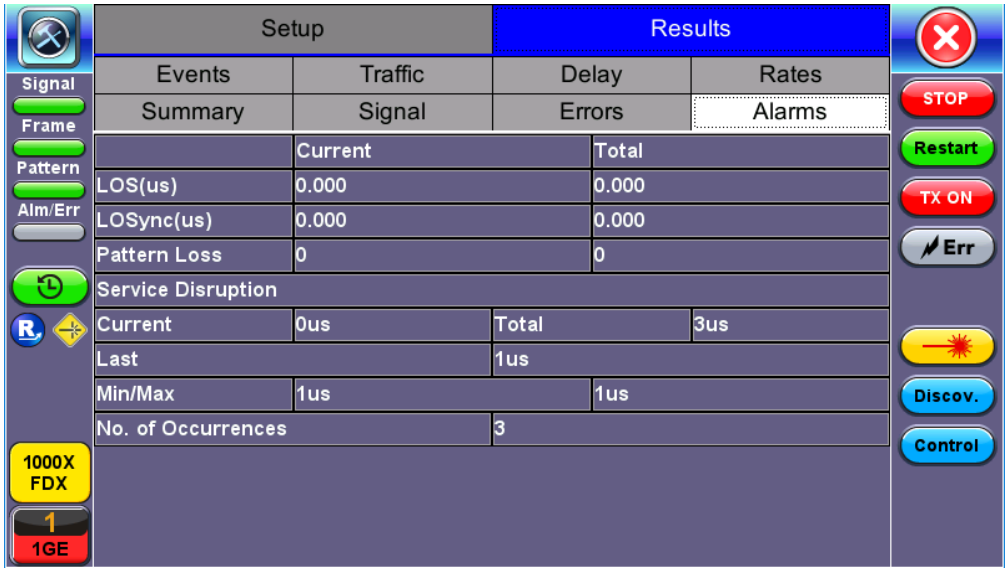
13.3.2.7 Alarms

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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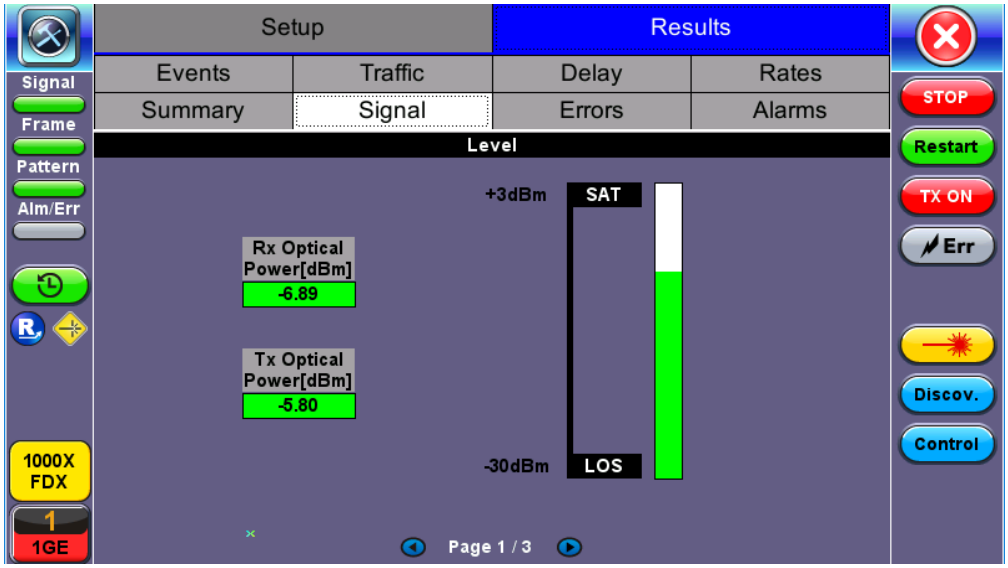
13.3.2.8 Signal

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.

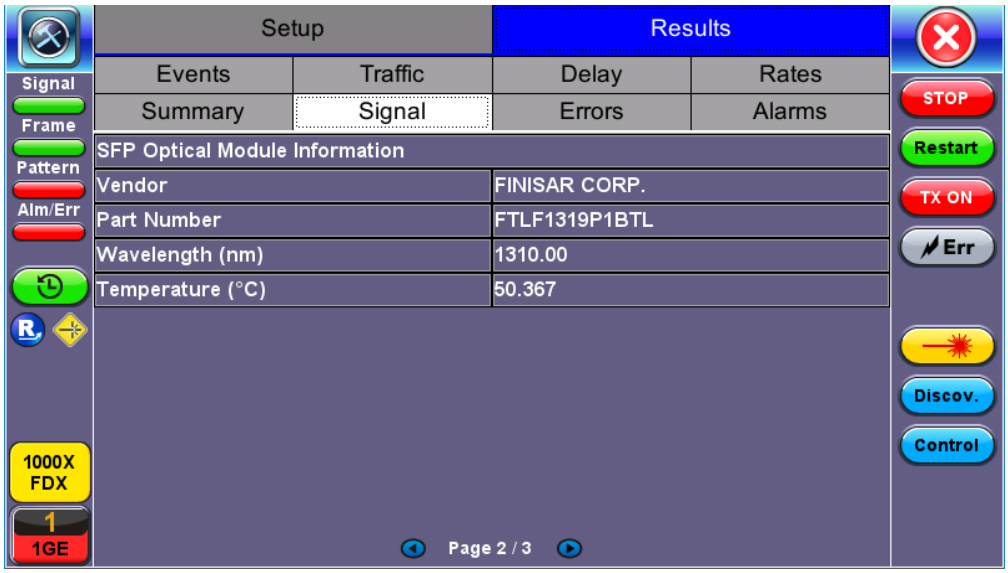
Loss of Signal (LOS) and the Saturation level for optical signals are shown graphically including the level measurement in dBm.



BERT Results - Signal

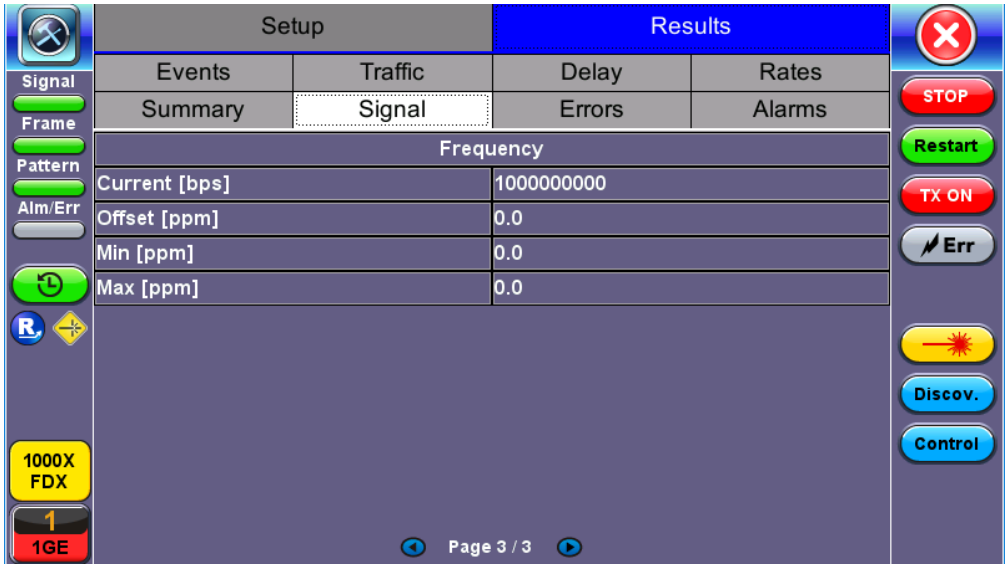
Signal (Page 2)

Page 2 displays the Optical module (SFP or XFP) 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 or XFP).

- **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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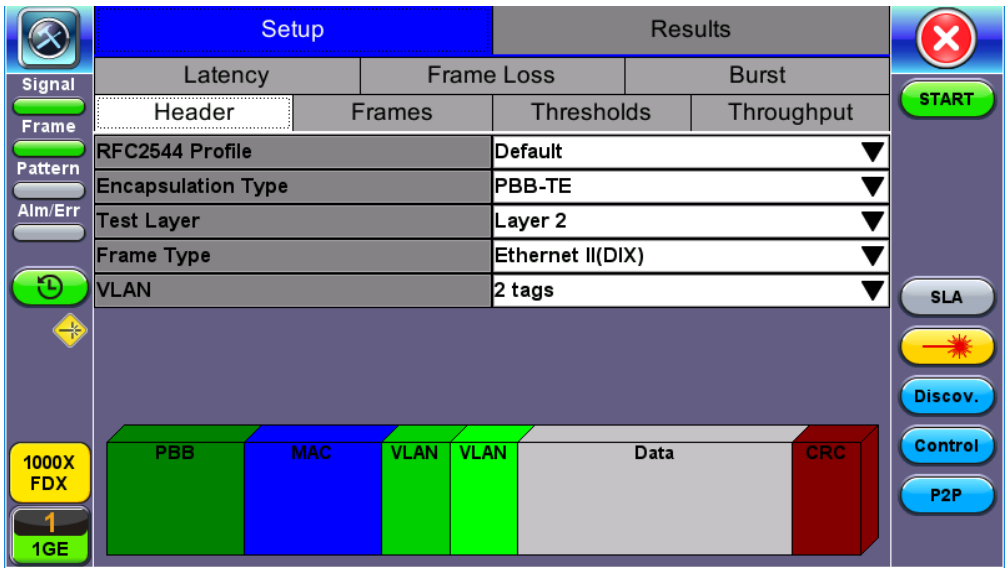
13.4 RFC 2544 Conformance Testing

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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13.4.1 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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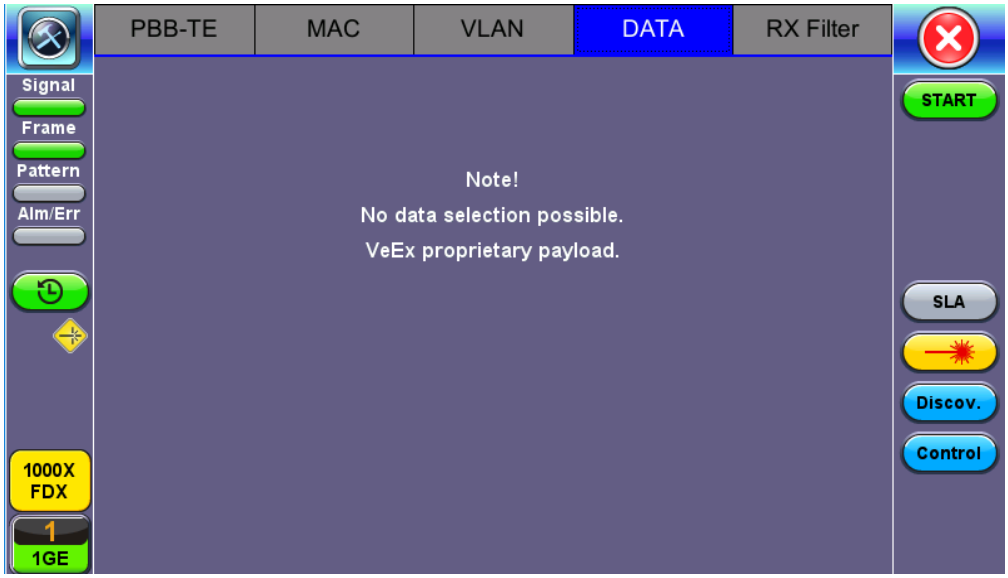
13.4.1.1 Header Settings

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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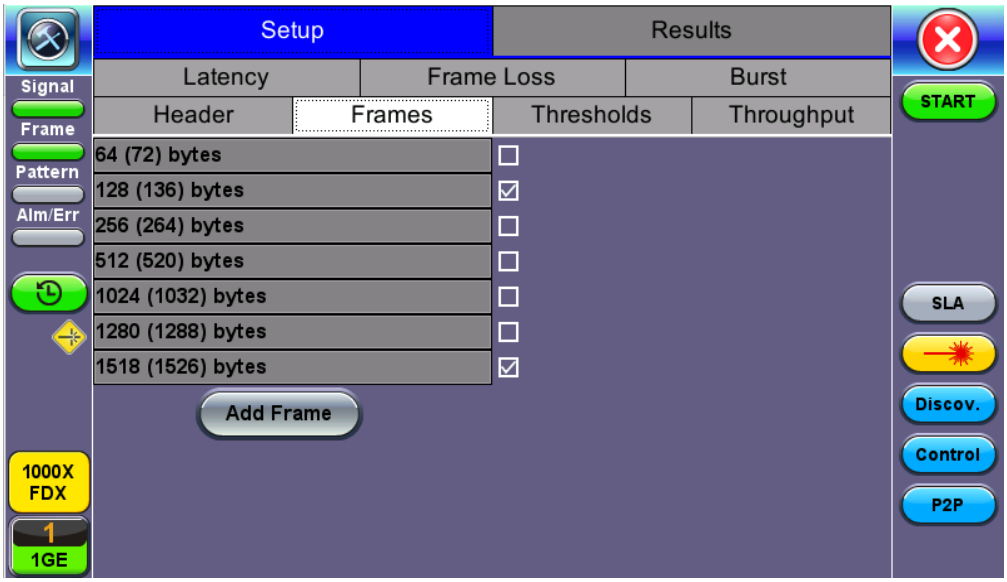
13.4.1.2 Frame Settings

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.
  - *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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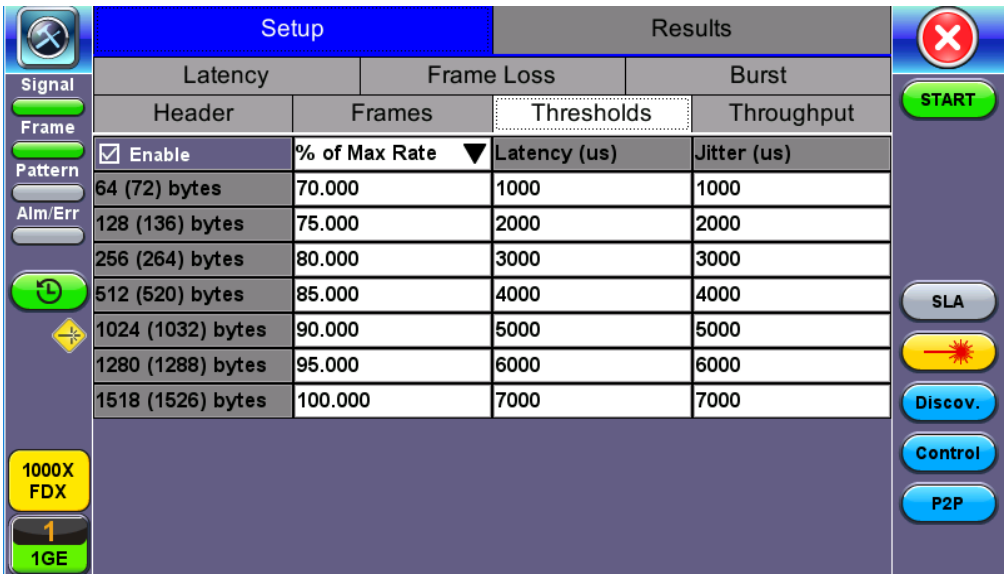
13.4.1.3 Threshold Settings

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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13.4.1.4 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.

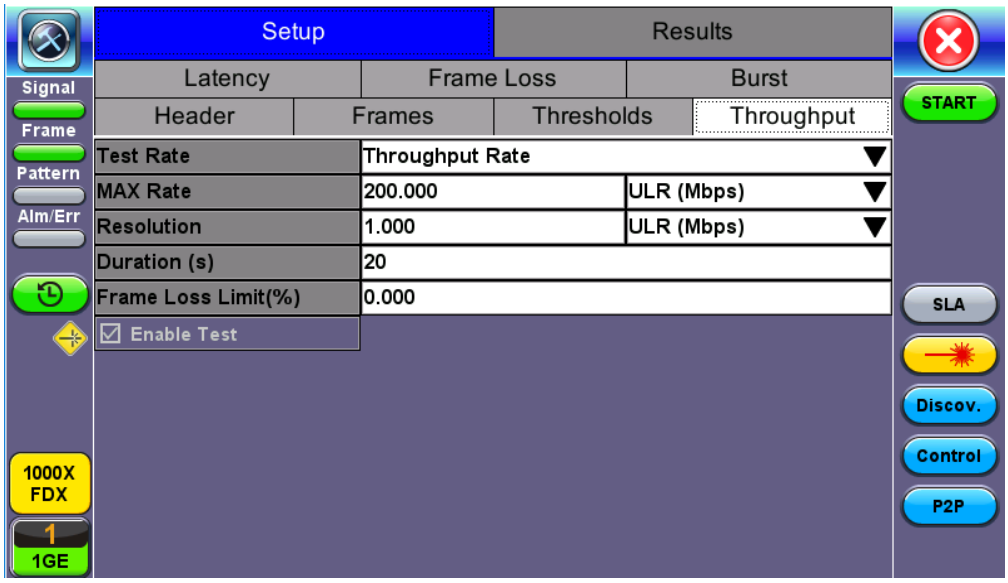
Throughput tab:

- **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:

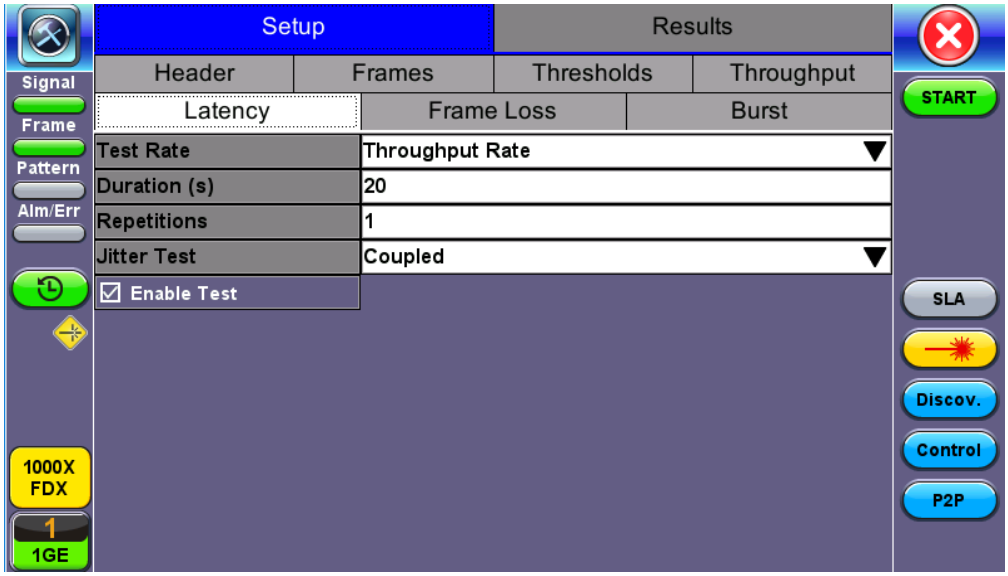
- **Test:** Throughput Rate or Custom Rate. The default value is throughput.
  - **Throughput rate**: Latency test will be performed at the throughput rate found for each of the tested frame sizes.
  - **Custom rate:** User configures a custom rate in % or Mbps.
  - **Custom Rate per frame size:** The 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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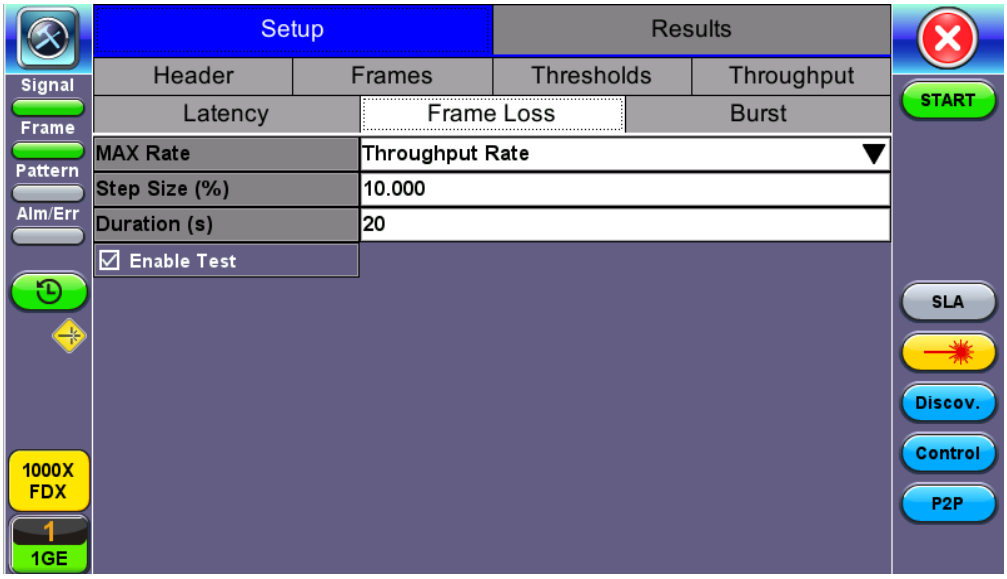
Frame Loss tab:

- **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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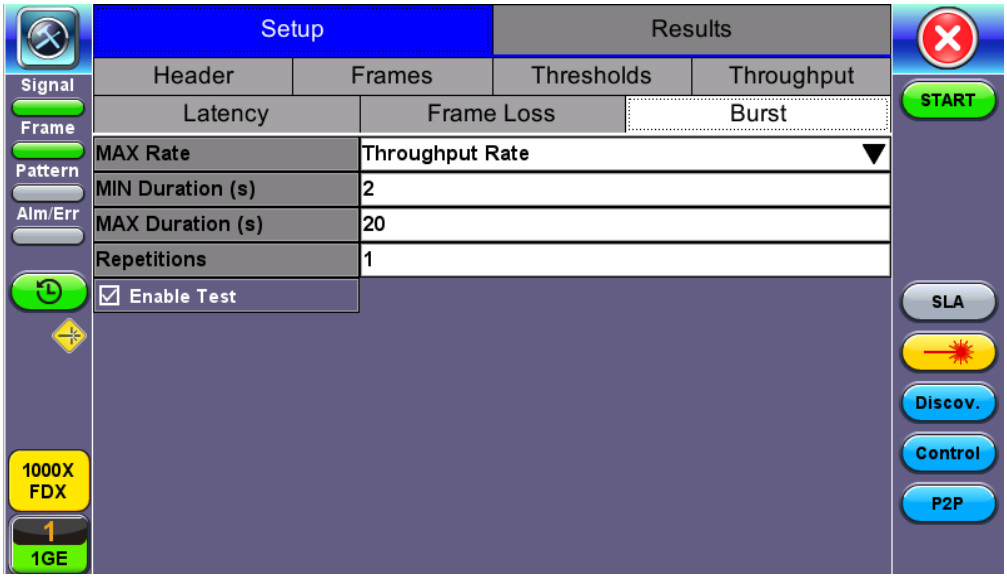
Burst (Back-to-Back) tab:

- **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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13.4.1.5 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.

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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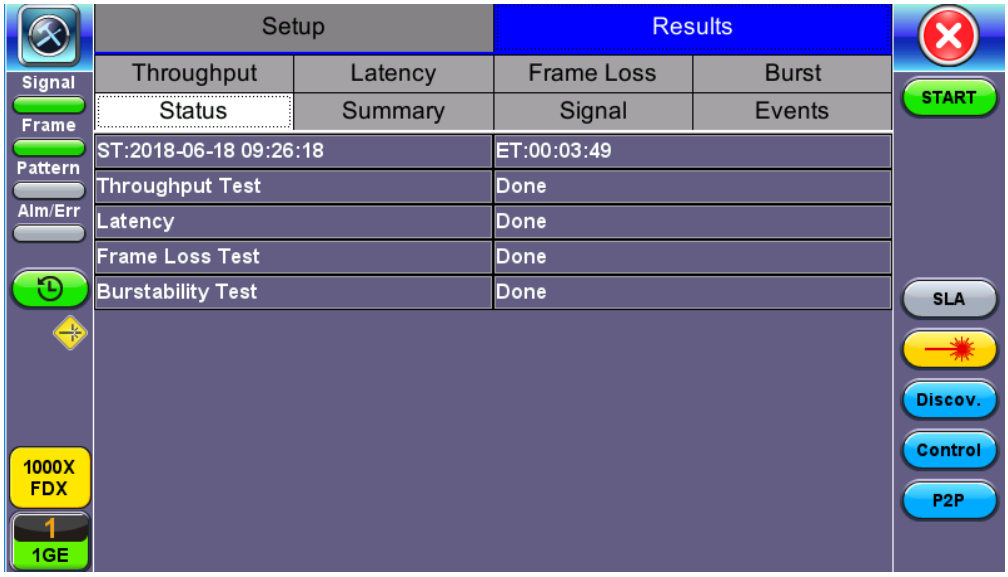
13.4.2 Results - Standard Mode

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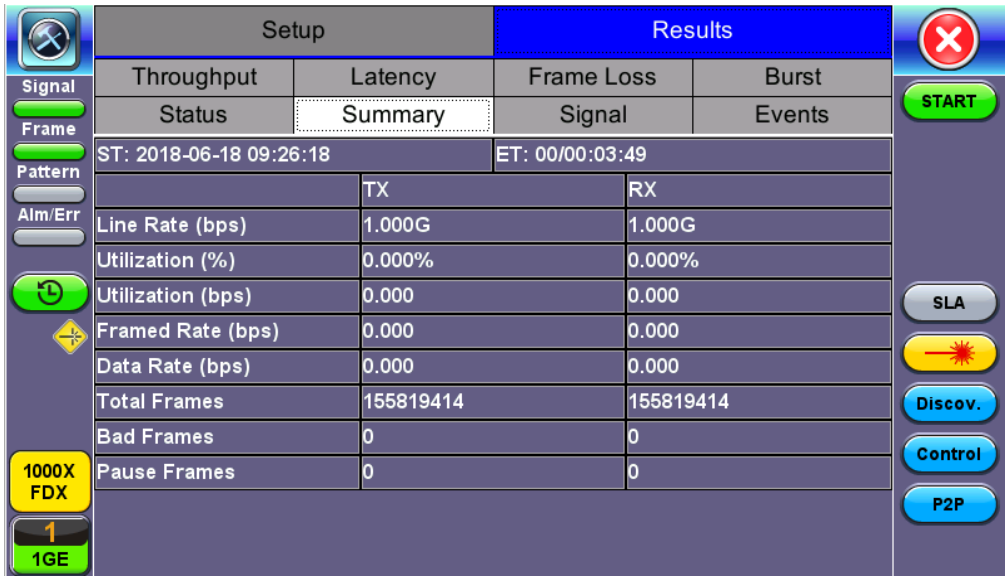
Summary tab: The following results including the Start (ST) and Elapsed (ET) times are displayed:

- **Line Rate** (Mbps)**:** Negotiated rate of the interface (10M, 100M, 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).
- **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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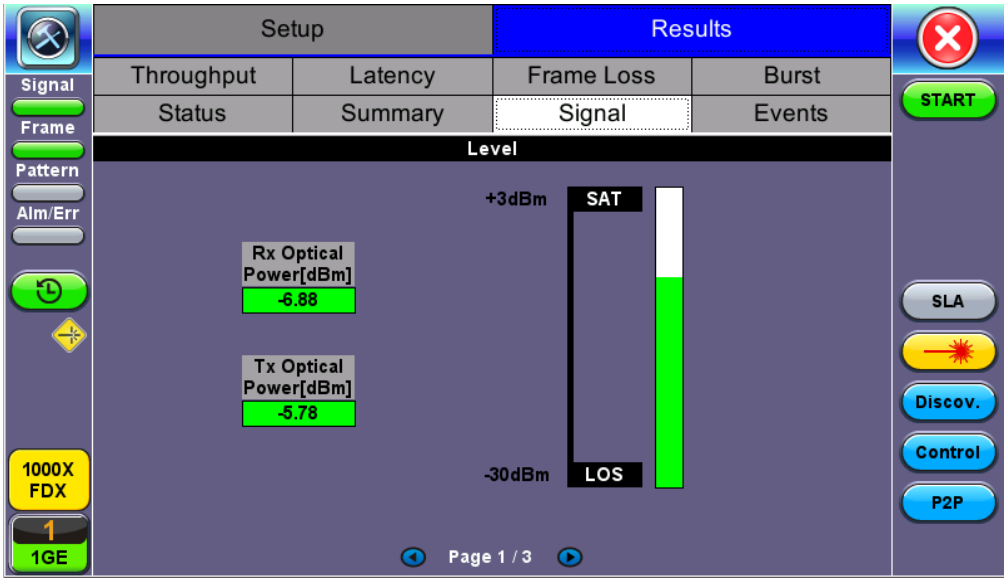
Signal tab: The Signal tab (fiber ports only) displays the optical level measured by the SFP transceiver. The RFC 2544 Signal tab is identical to the Signal tab for the BERT application. Refer to Signal from the BERT section for more information.



RFC 2544 Results - Signal (Page 1)

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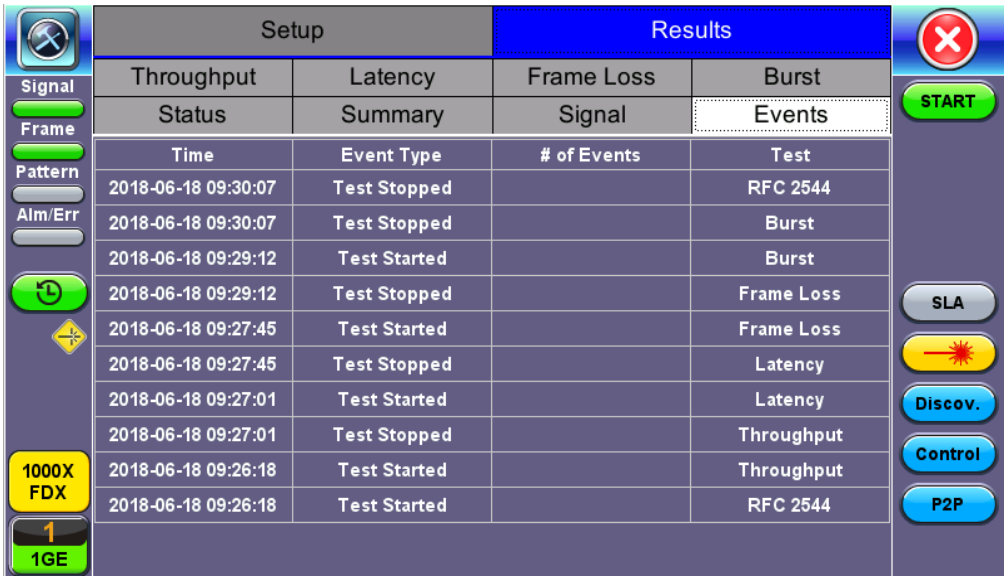
Events tab: A time stamped log of each test is displayed.



RFC 2544 Results - Events

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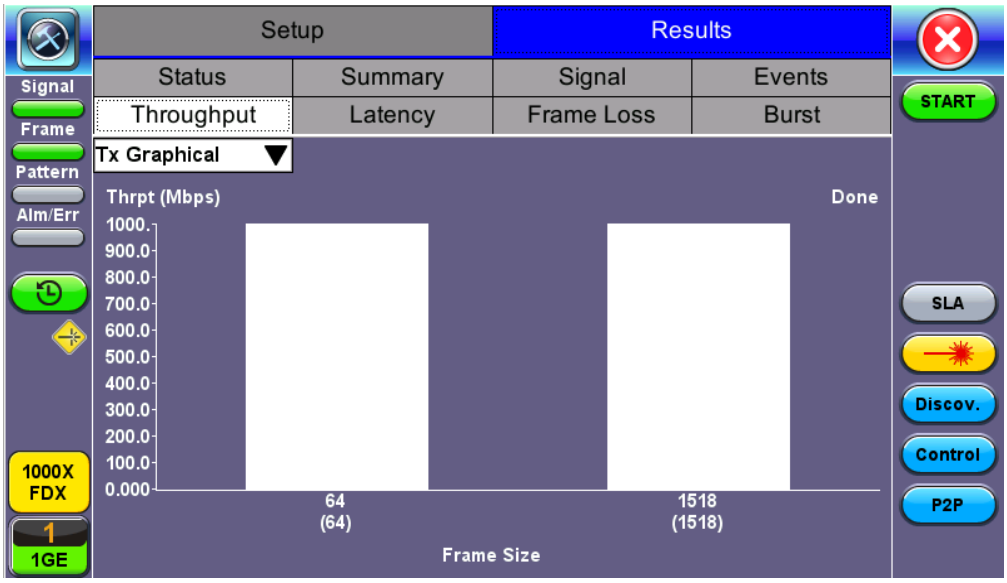
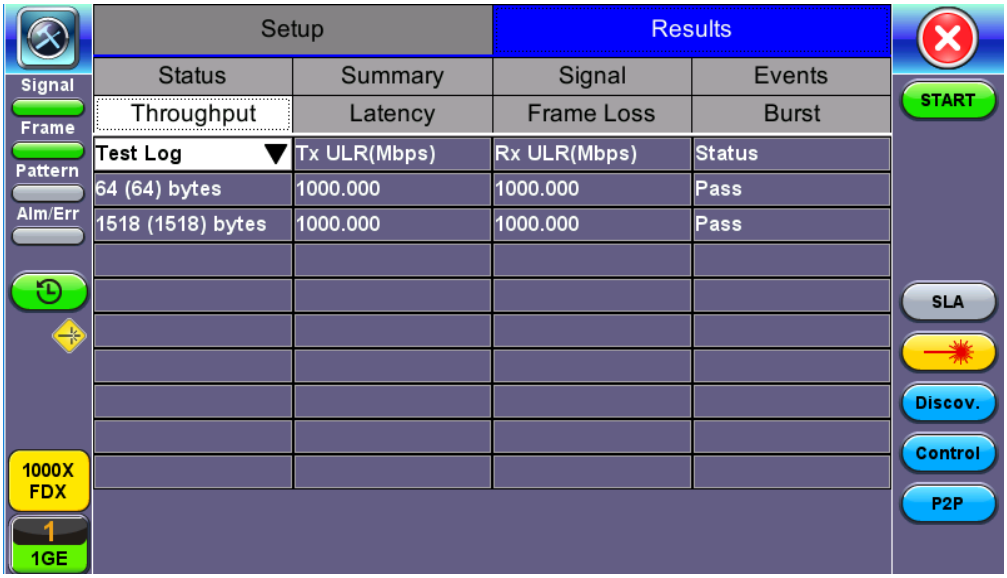
Throughput tab

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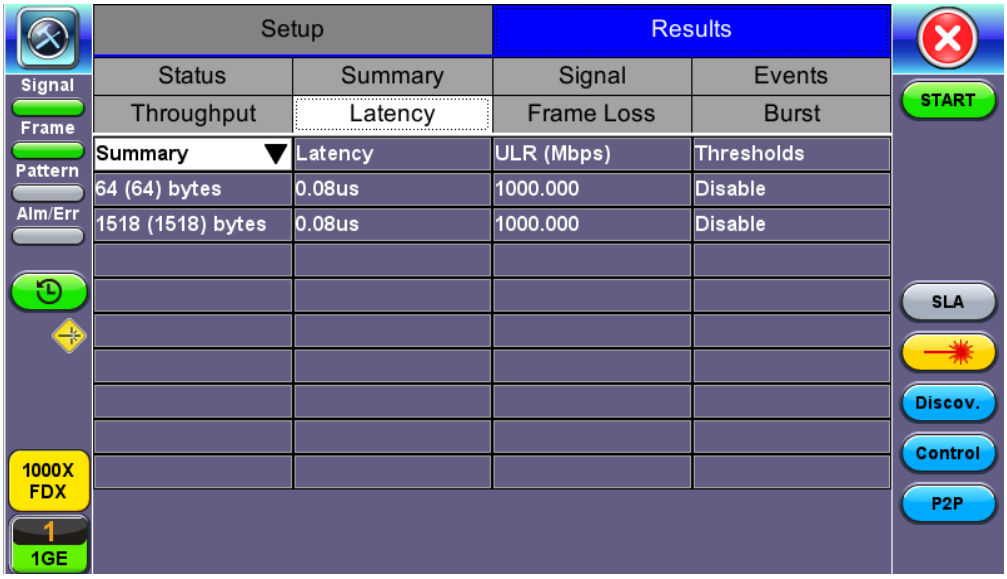
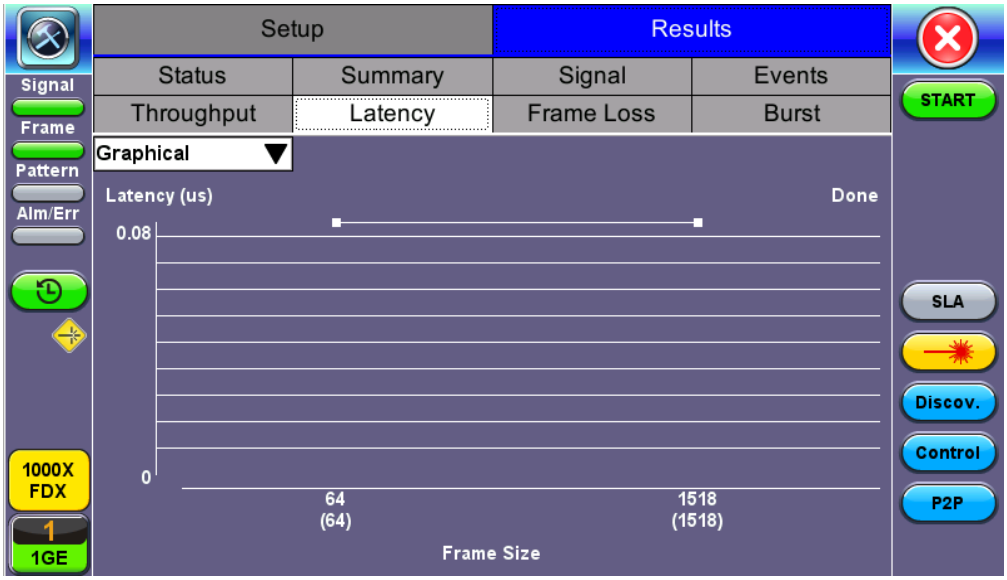
Latency and frame jitter measurements results are displayed in the following formats. Use the drop-down menu to select the Latency format:

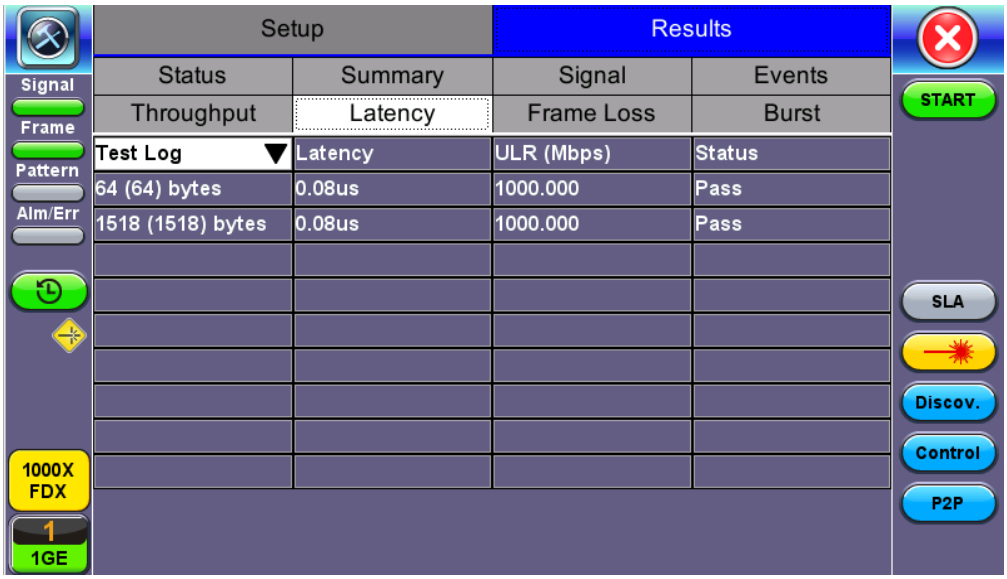
- **Graphical:** Latency results displayed in line graph form (Latency [us] vs Frame size [bytes]).
- Summary and Test log tables display:
  - byte size
  - **Latency (us):** Round trip delay latency.
  - **Rate (%):** Percentage of frames transmitted. Data rate used for latency test.
  - **Pass/Fail**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



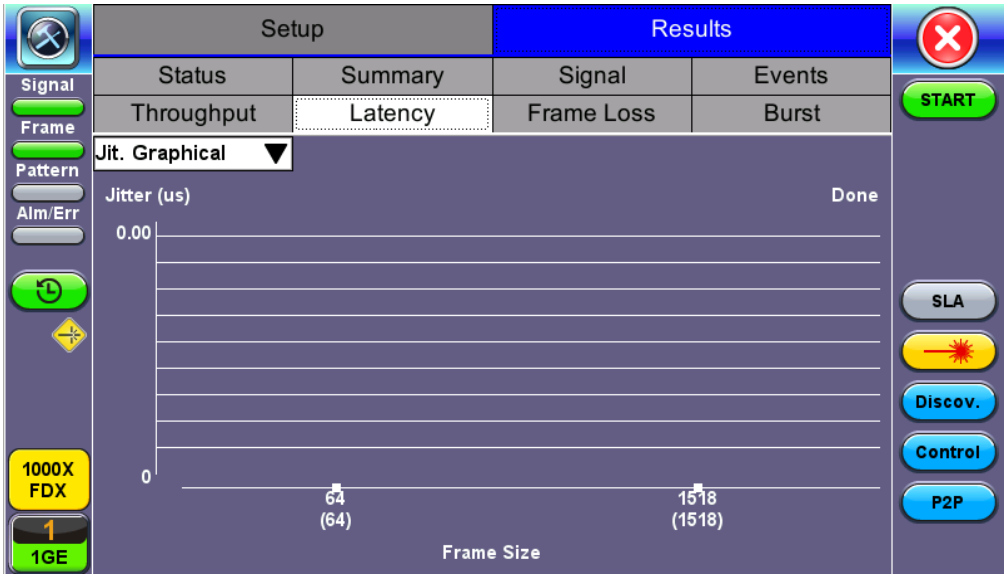
RFC 2544 Results - Latency (Summary)



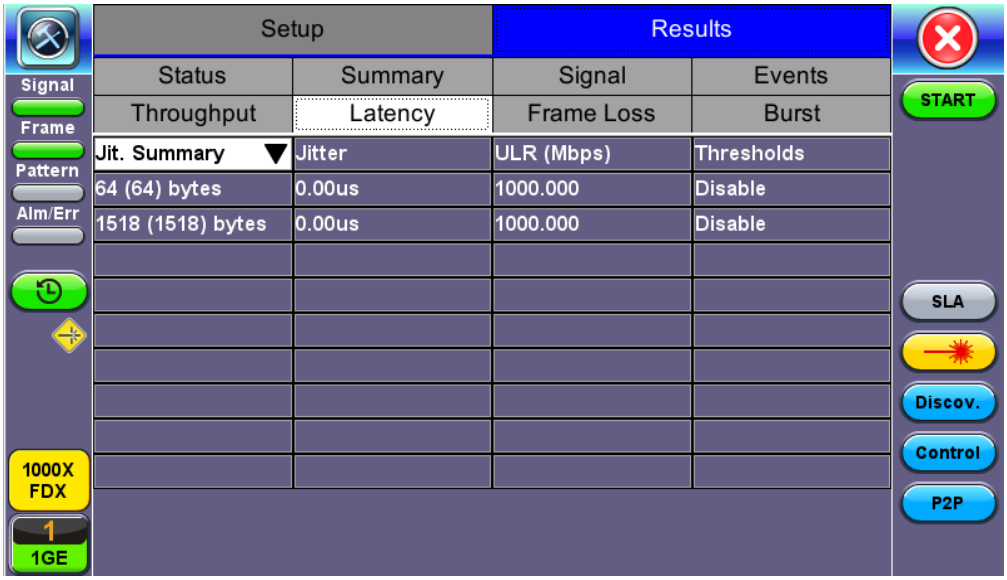
RFC 2544 Results - Latency (Graphical)



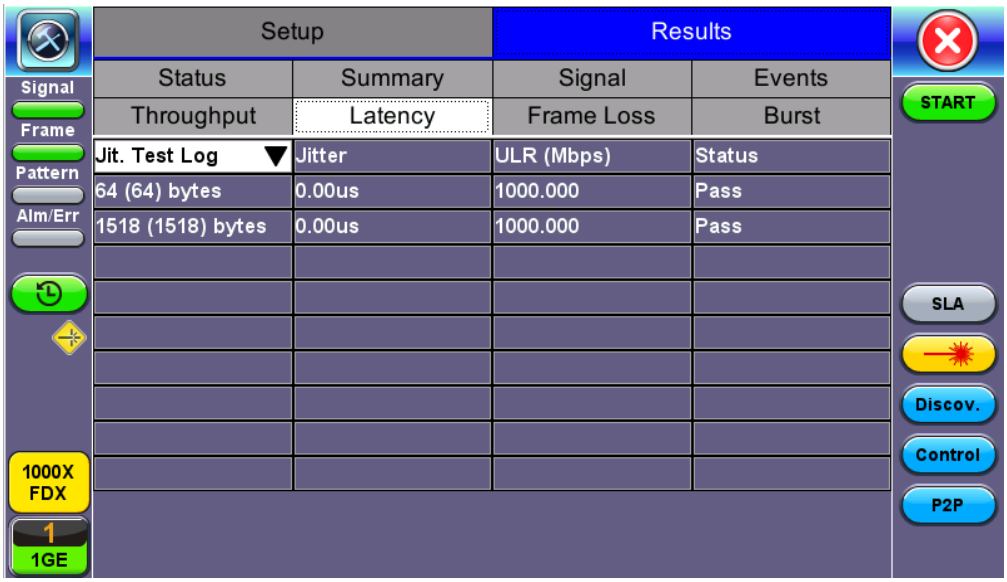
RFC 2544 Results - Latency (Test Log)



RFC 2544 Results - Latency (Jitter Graphical)



RFC 2544 Results - Latency (Jitter Summary)



RFC 2544 Results - Latency (Jitter Test log)

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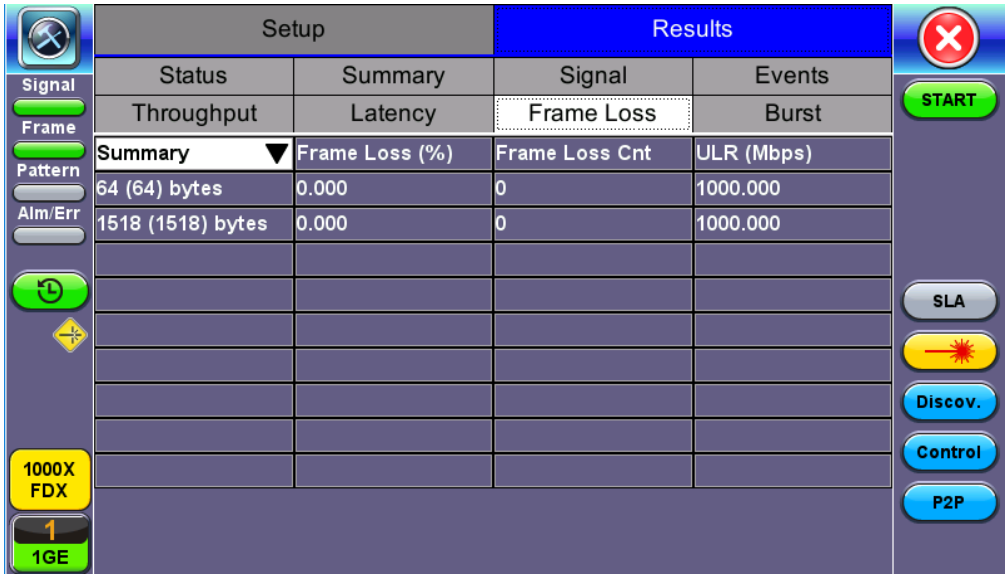
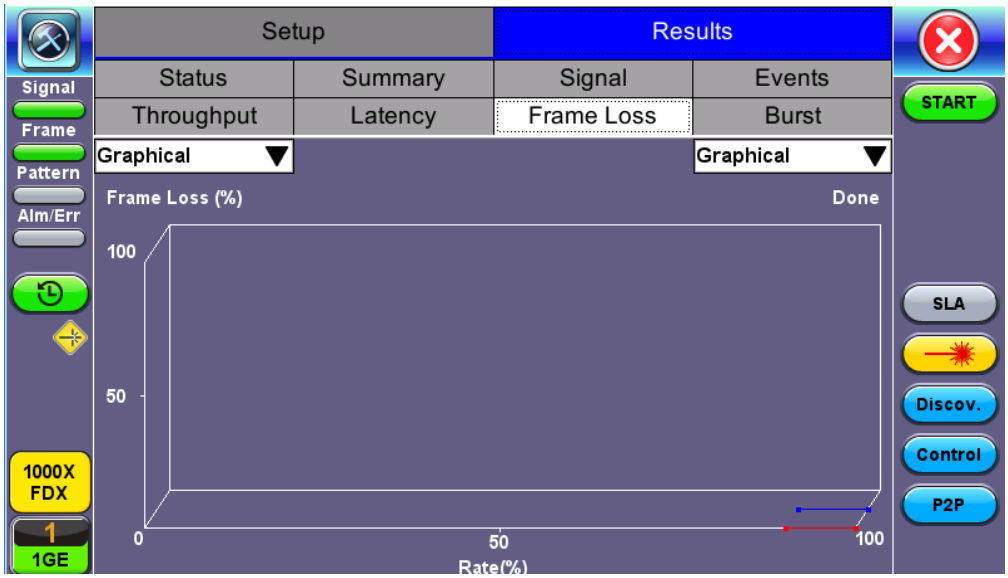
Frame Loss tab: Frame loss displays the percentage of frames not received. Use the drop-down menu to select the Frame Loss format:

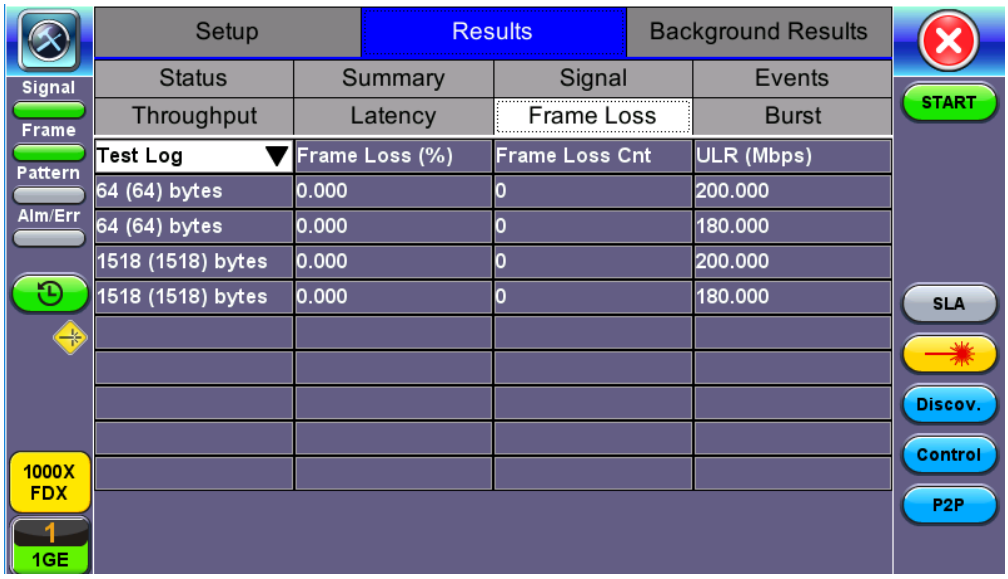
- Summary and Test log tables display test frame length, byte size, **frame loss (%)** from received traffic, and **rate (%)** transmitted.
- **Graphical:** Frame Loss displayed in line graph form (Frame size [bytes] vs Rate [%]). Tap on the **Graphical Type** drop-down menu on the right to view the 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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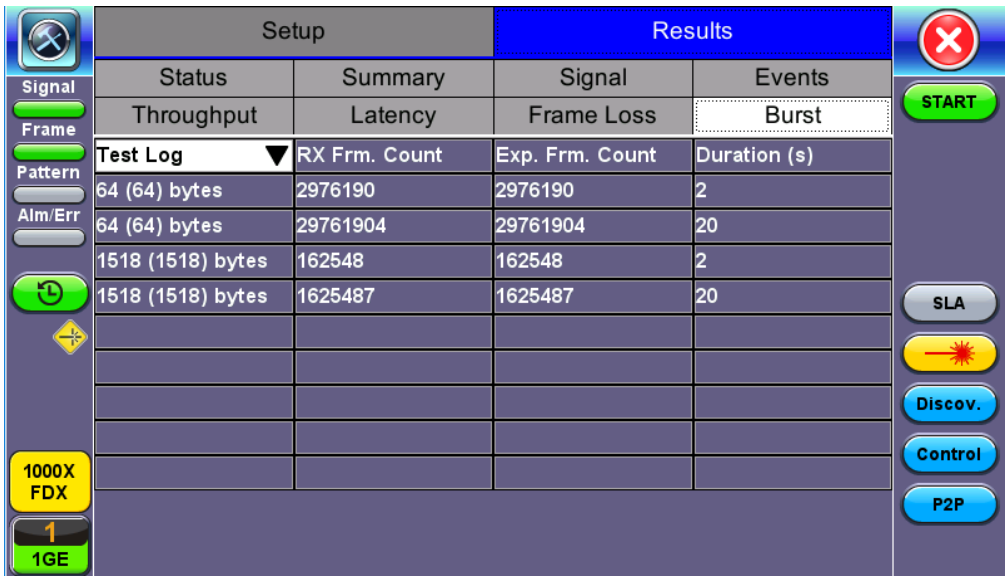
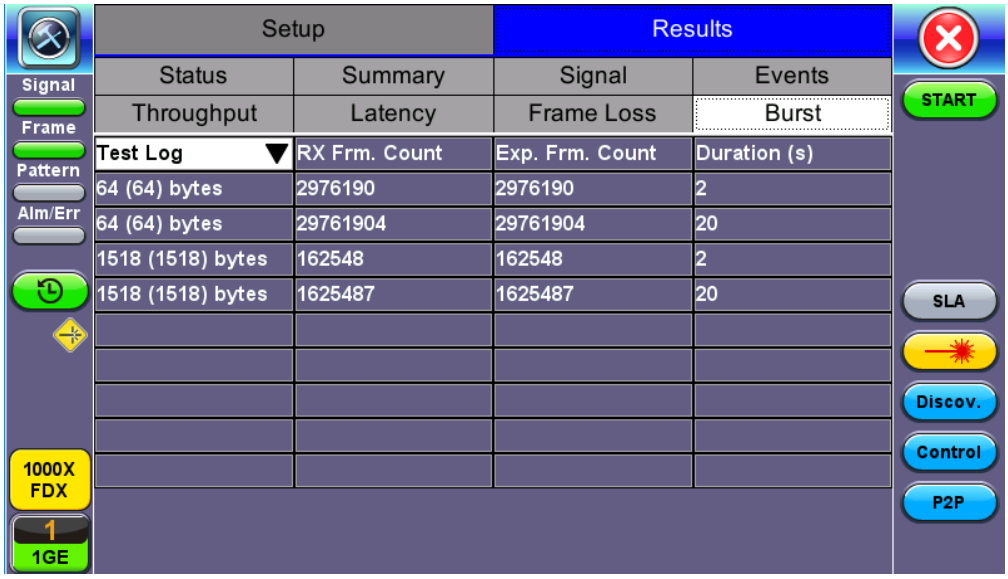
Burst tab: Burstability (back-back) results are the number of frames successfully transmitted/received at the line rate. It is displayed in the following formats:

- **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 (Test Log)

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13.4.3 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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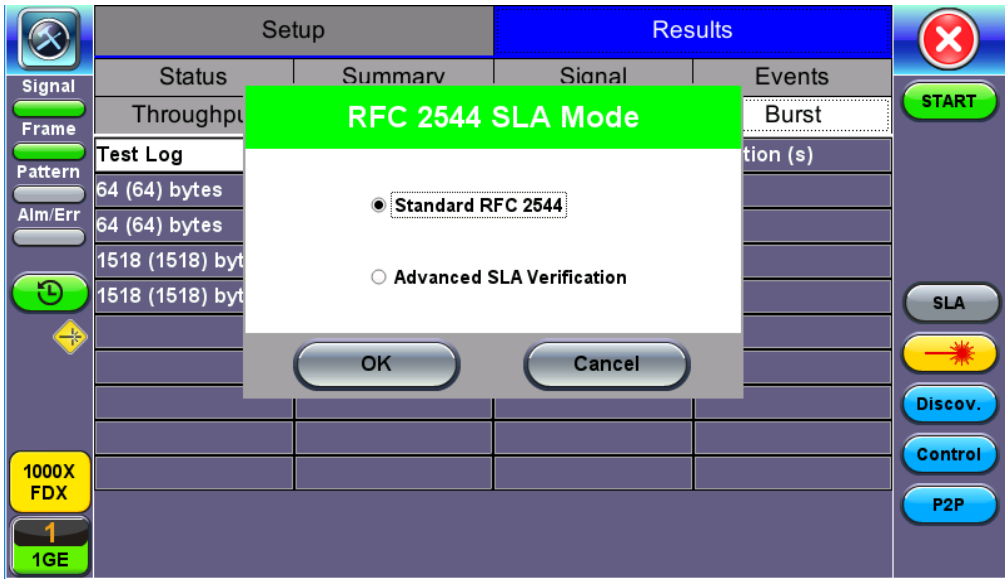
13.4.4 Advanced SLA Mode

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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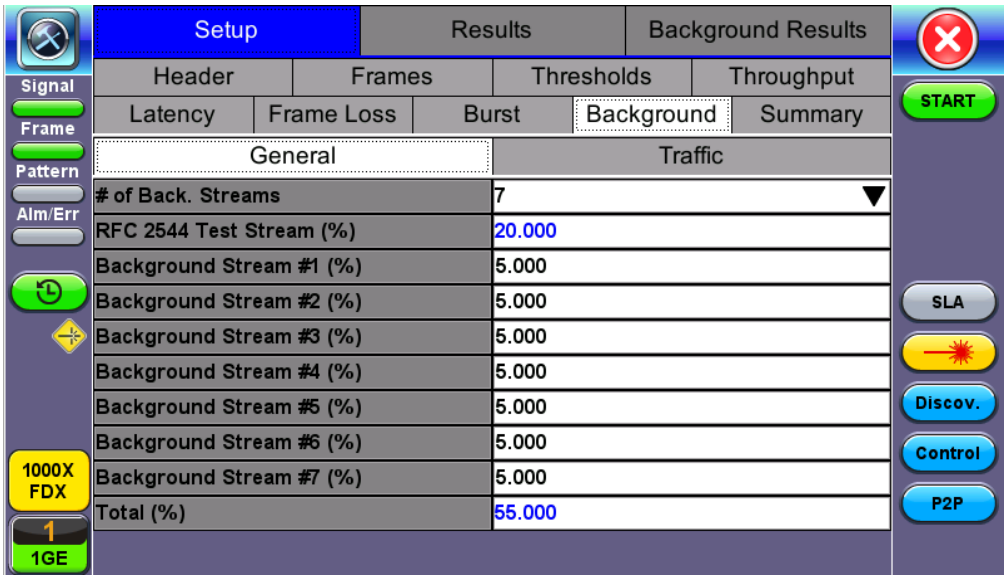
Background - General

- **# 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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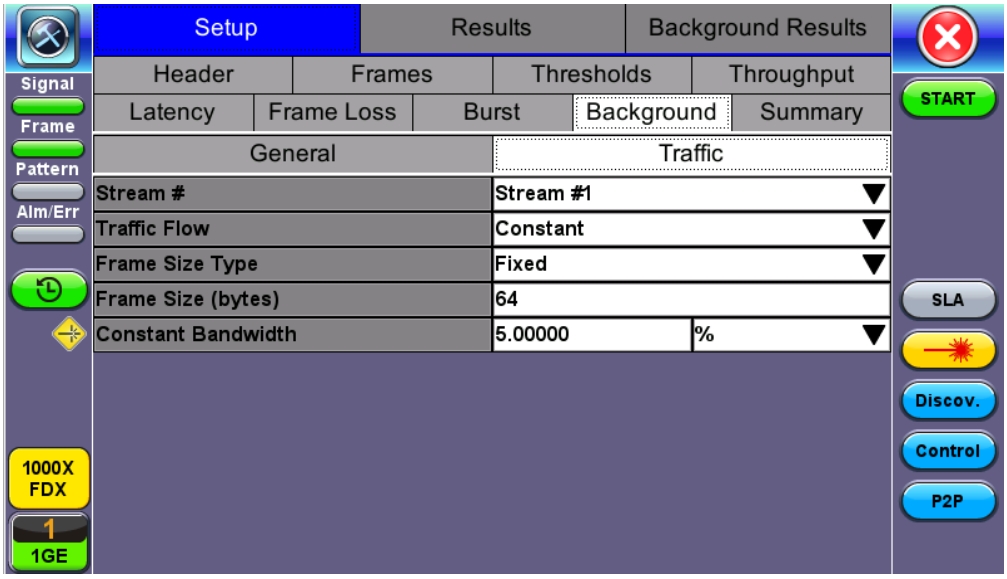
Background - Traffic

- **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.

  *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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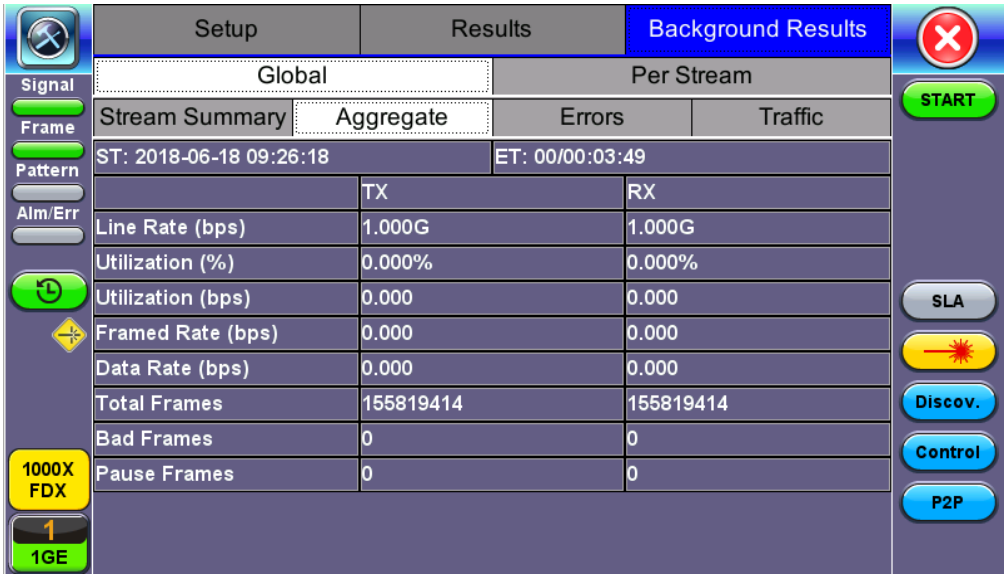
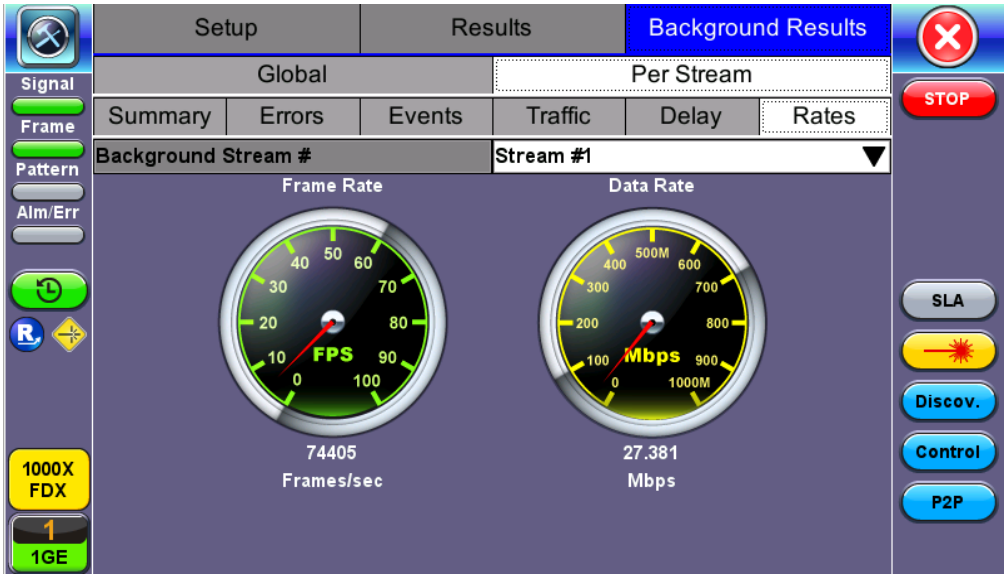
13.4.5 Background Results - Advanced SLA Mode

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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13.4.6 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.

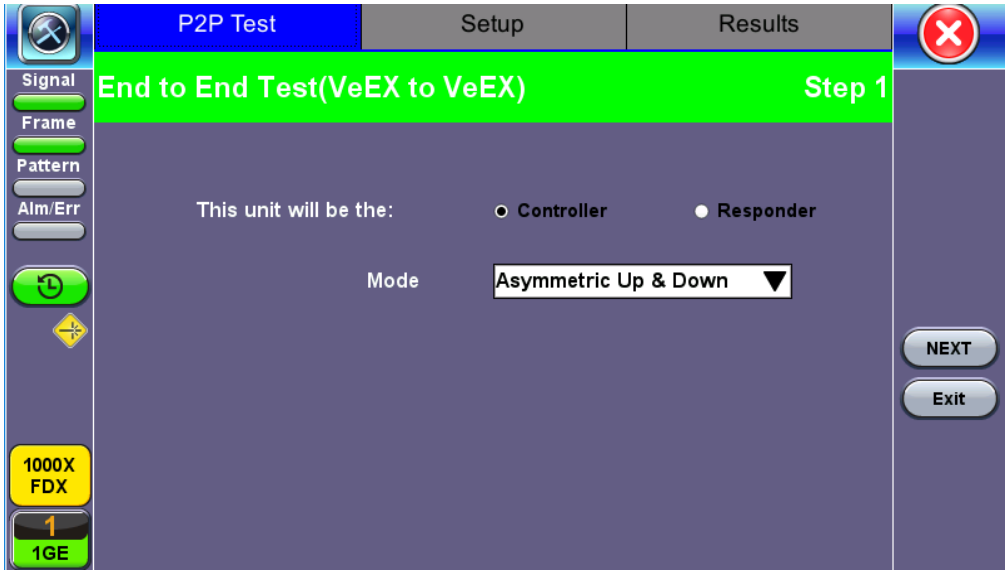
Asymmetrical links provide different line rates in the two directions. To verify the information for both the low and the high rates of the link, the user needs to send a test signal from one instrument located at one end of the link to an instrument at the other end of the link and vice versa to test 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**.

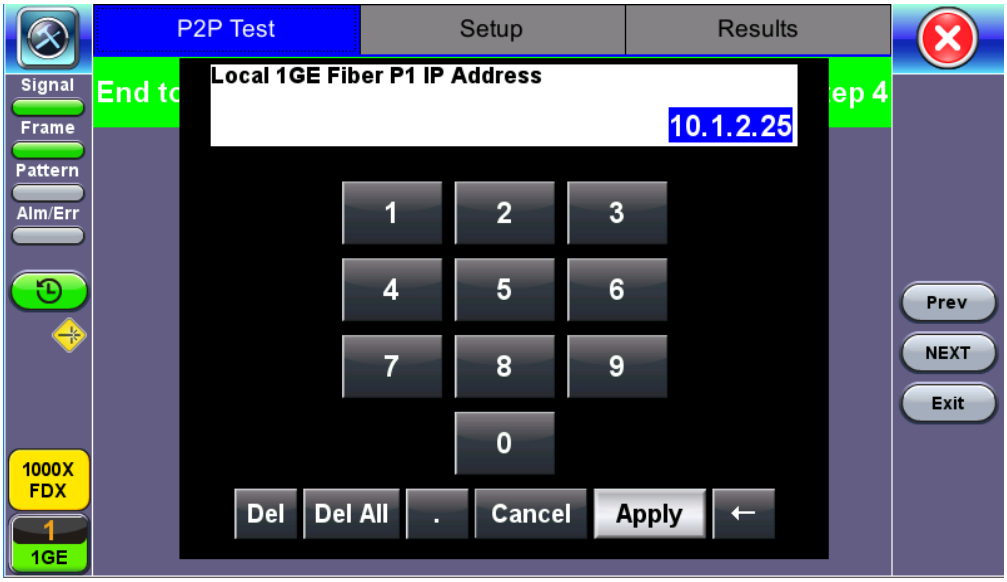
At any time during the process, tap on the right side navigation buttons to move to the **NEXT** screen, return to the **Previous** screen, or **Exit** the setup guide**.**



Set the Local unit as Controller or Responder

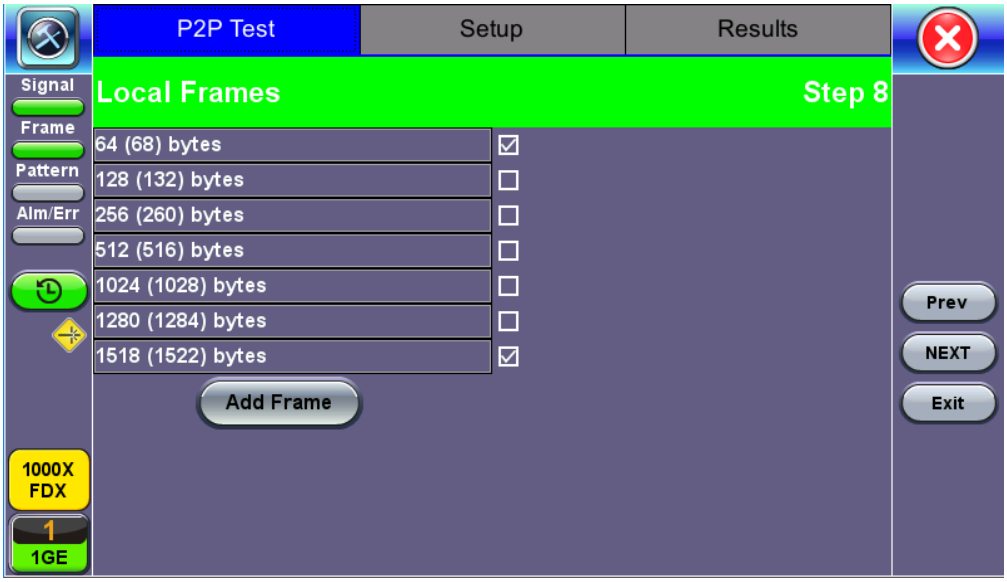
Unit as Controller Setup Process

- **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.



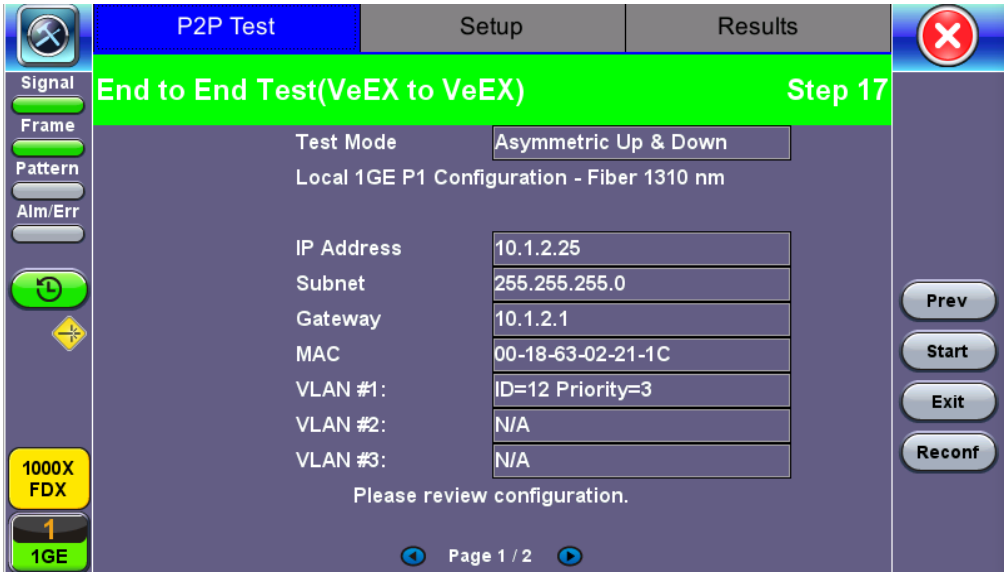
Input screen

- **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

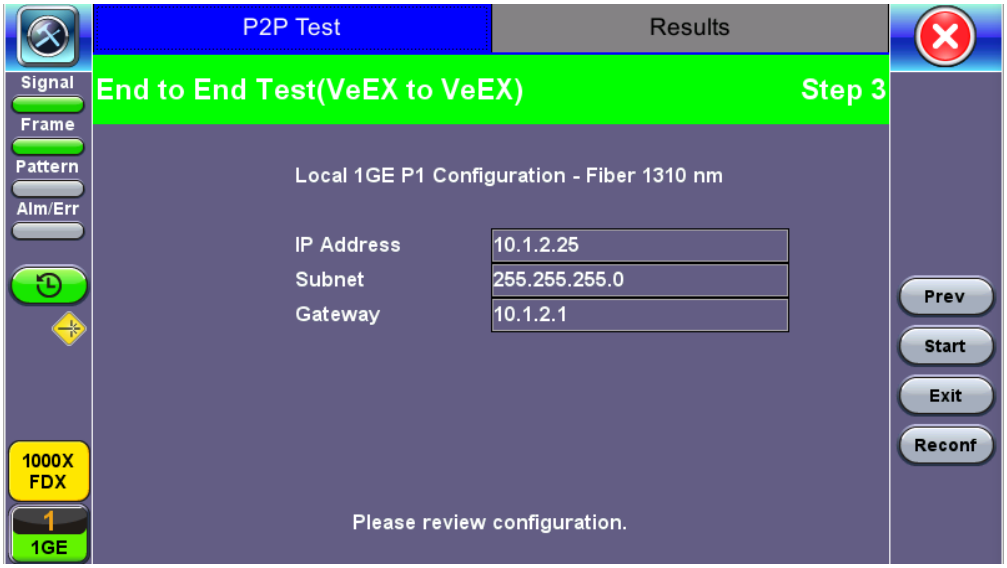
- **Steps 9-12:** Set up and enable/disable tests for the Local unit.
  - **Step 9:** Local Throughput testing setup. See the Throughput section for a description of menu options
  - **Step 10:** Local Frame Loss testing setup. See the Frame Loss section for a description of menu options.
  - **Step 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

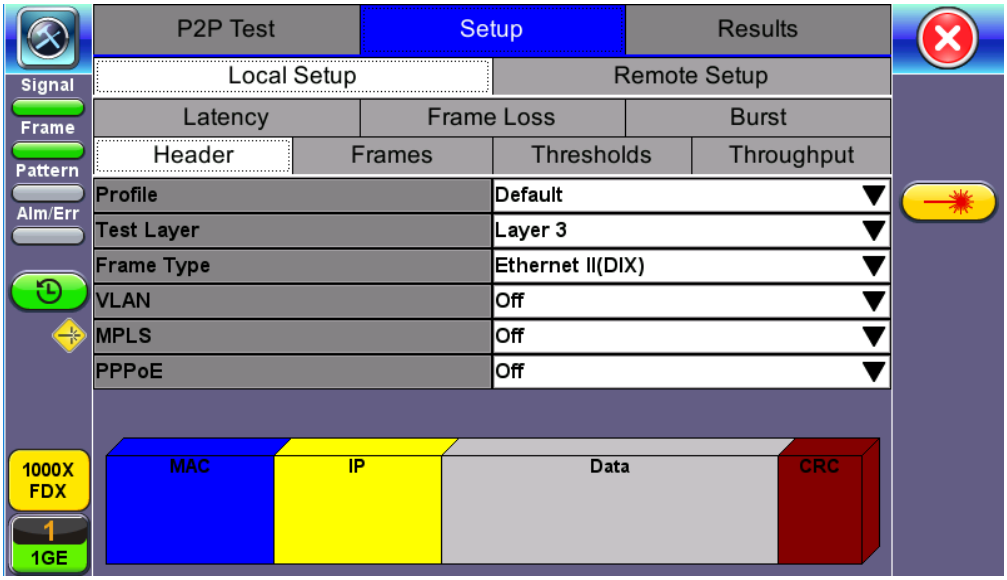
- **Step 0-2:** Tap on the white fields to setup the Local unit's IP Address, Subnet, and Gateway. Tap on **Next** to setup VLAN tags using the drop-down menu.
- **Step 3:** Review configuration selections. The option to **Start** testing or **Reconfigure** test settings becomes available.



Responder Summary Screen

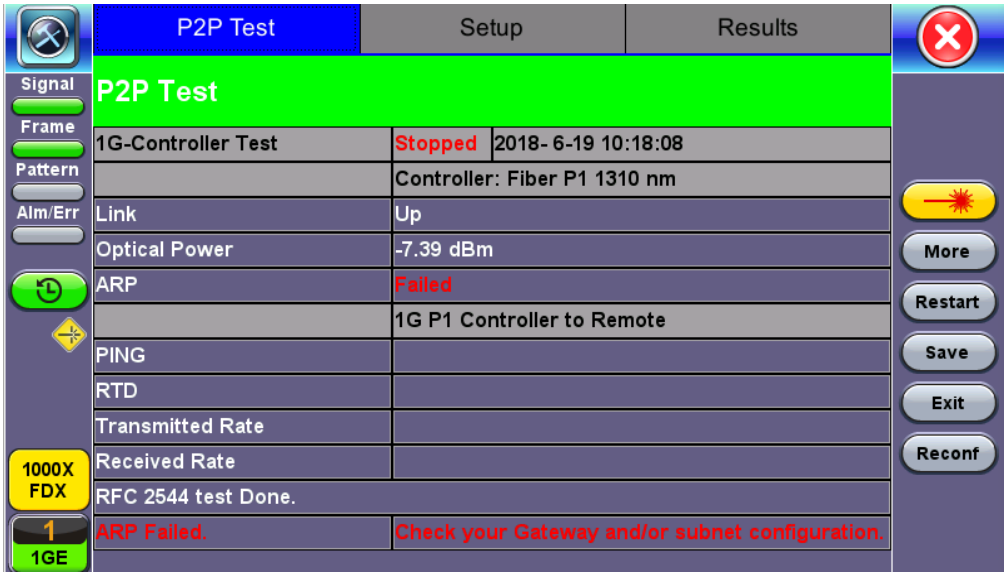
RFC 2544 Local and Remote Test Setup

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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13.5 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.

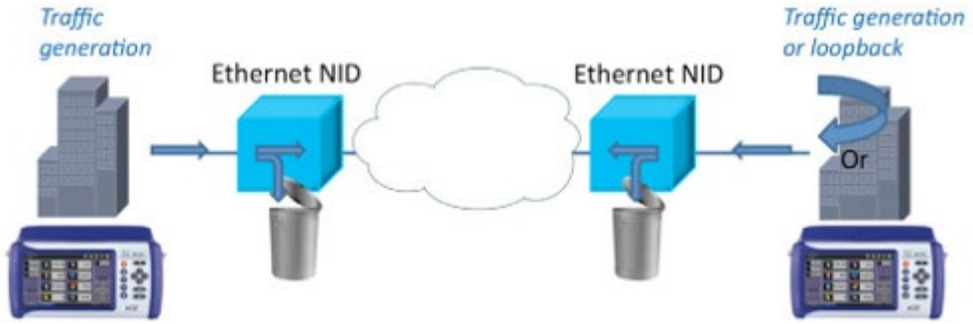
Comparison of RFC 2544 and Y.1564

	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

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.

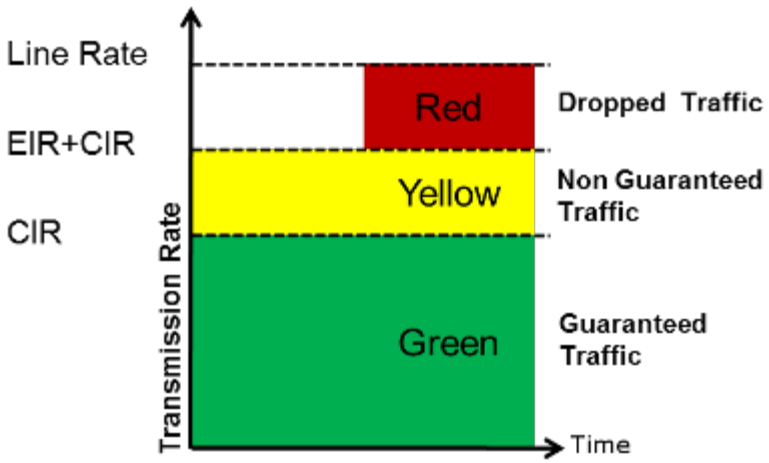


Test Application

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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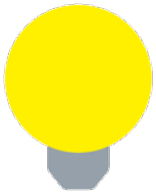
13.5.1 V-SAM Setup

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

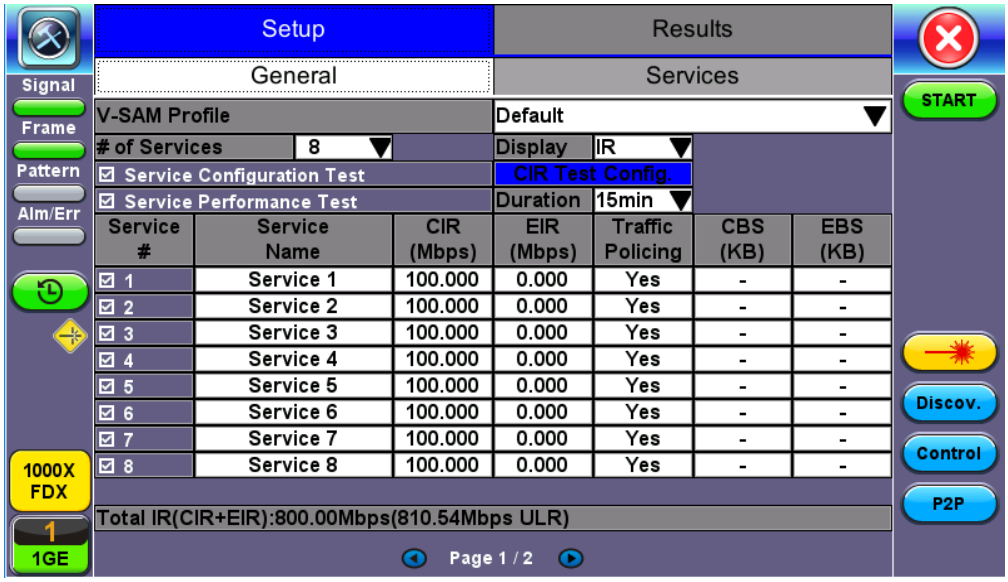
services can be chosen for a 10 GE interface.

- **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.

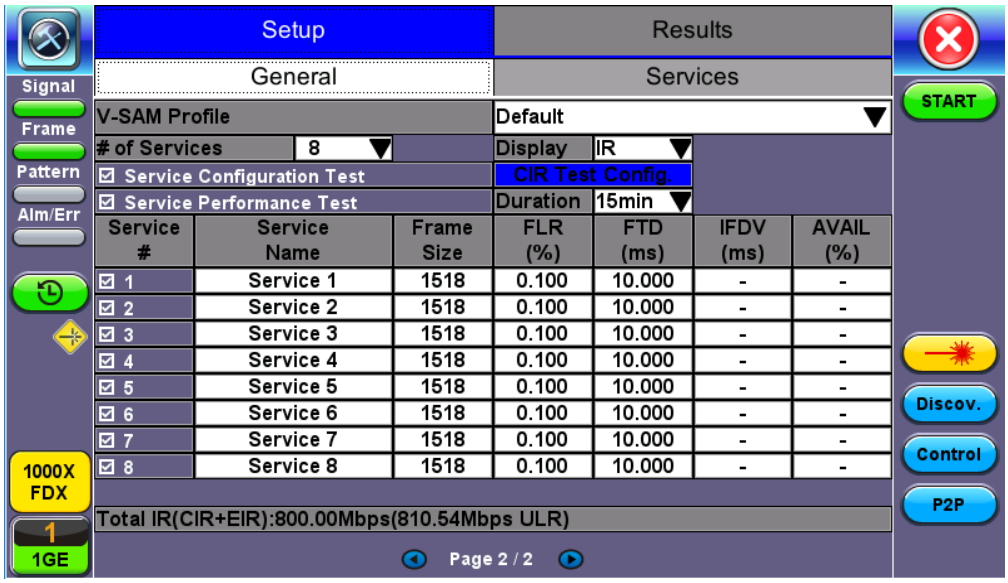


Enabling/Disabling Tests

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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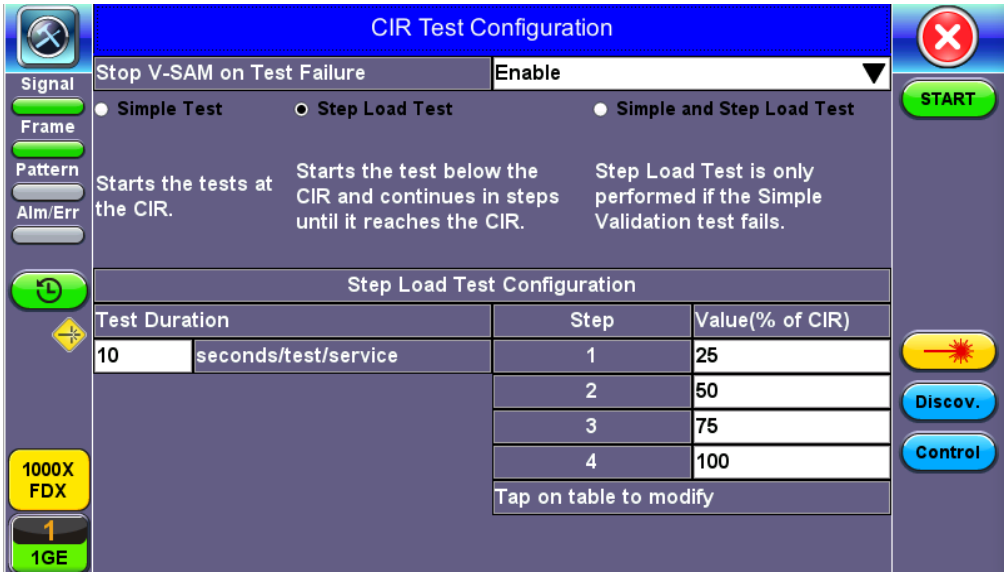
CIR Test Configuration

- **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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13.5.1.1 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.

    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:

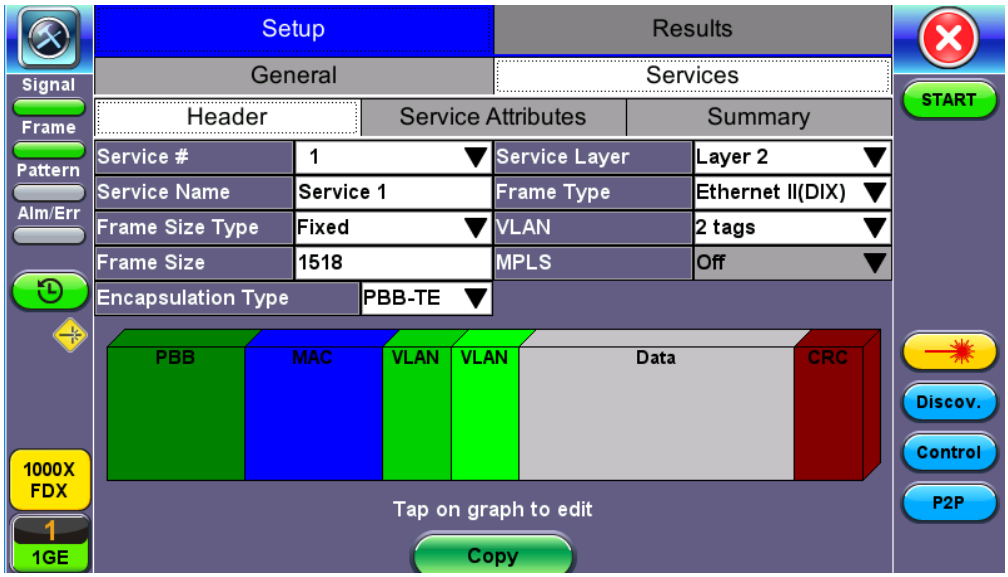
  - Backbone MAC Source
  - Backbone MAC Destination
  - Ethernet Type
  - I-SID
  - VLAN ID, Priority, Type

  MPLS-TP:

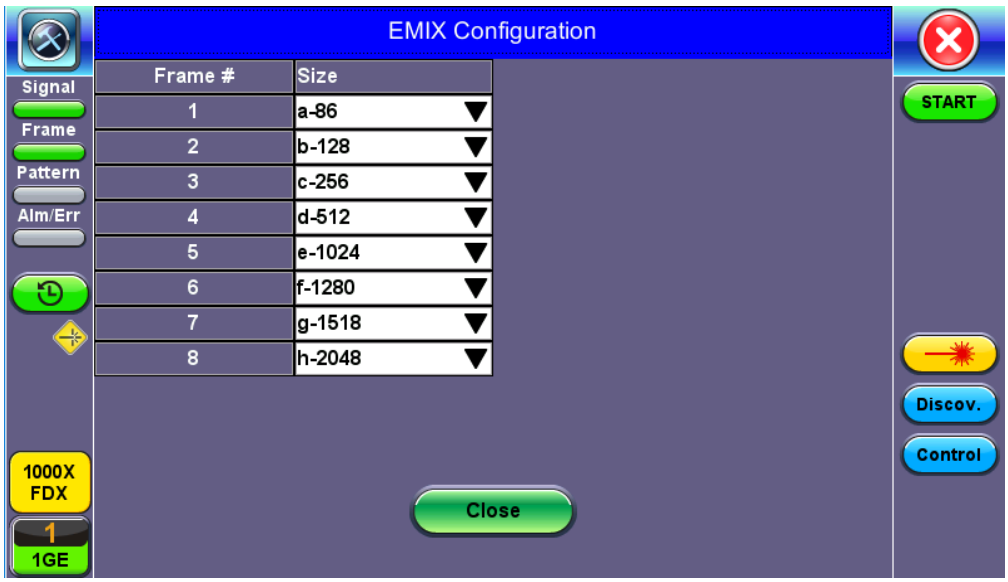
  - MPLS-TP MAC Source

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

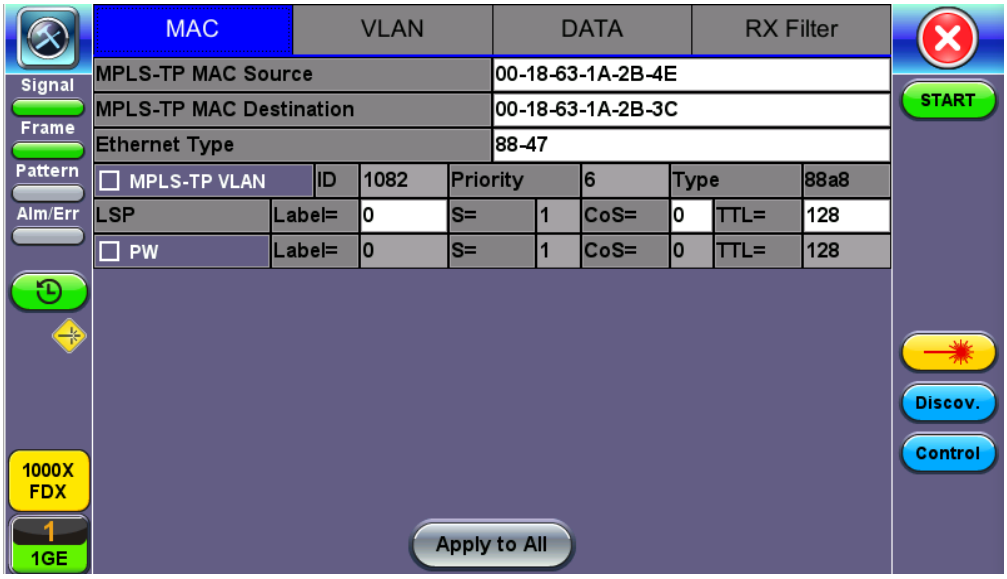
After making changes, tap **Apply to All**, for MPLS-TP configuration.
Please see RFC 2544 Setup and follow the setup procedure to configure the remaining Header Settings for V-SAM.



V-SAM Setup - Services - Header Settings



V-SAM Setup - Services - EMIX Frame Size Settings



V-SAM Setup - Services - MPLS-TP Settings

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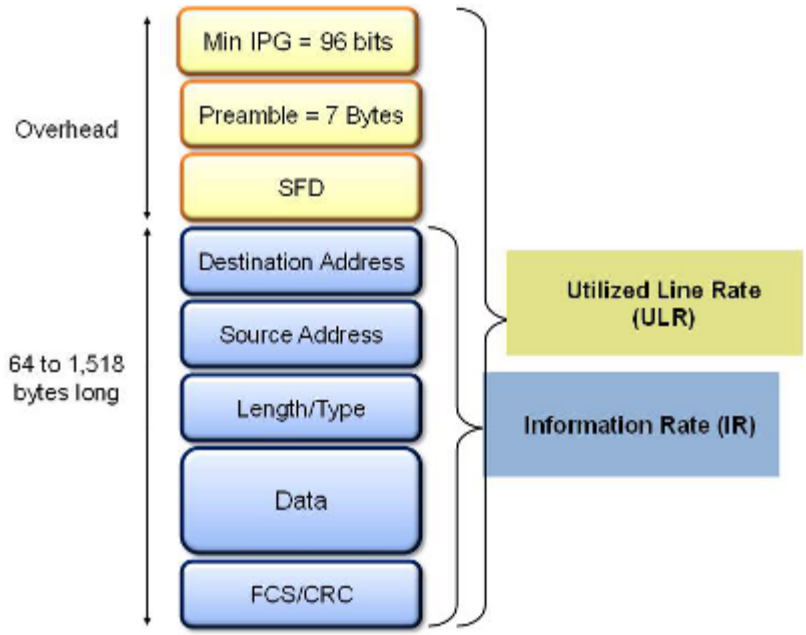
13.5.1.2 Service Attributes

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.

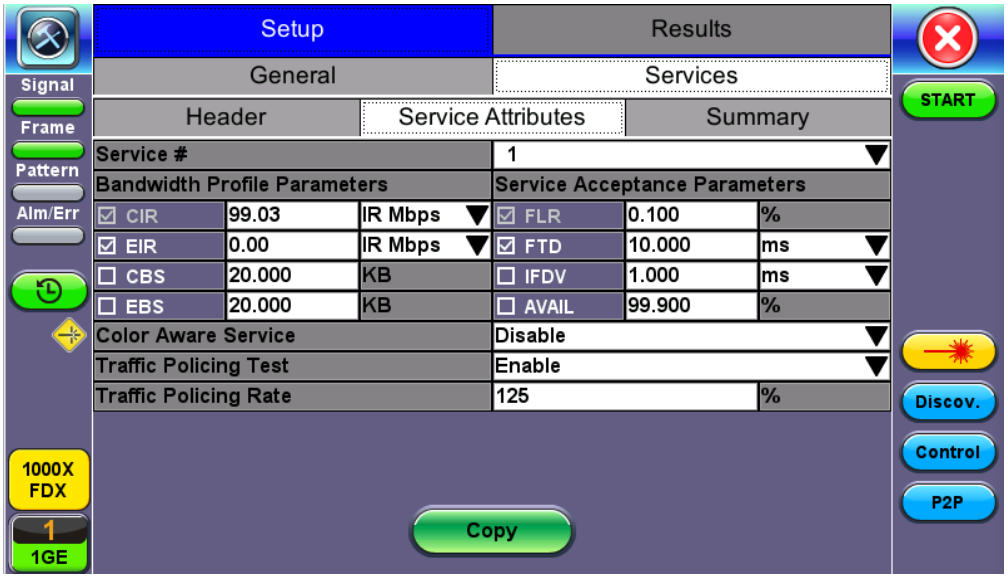


V-SAM Services - Header

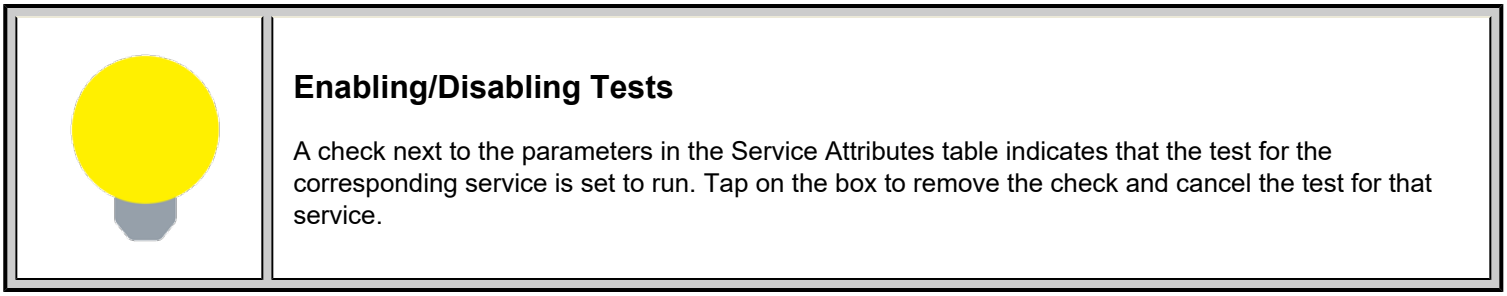
- **Excess Information Rate (EIR):** Maximum rate above the CIR at which the customer can send frames that will be forwarded on a best effort basis, but may be dropped in the event of congestion within the network. The combined CIR and EIR must

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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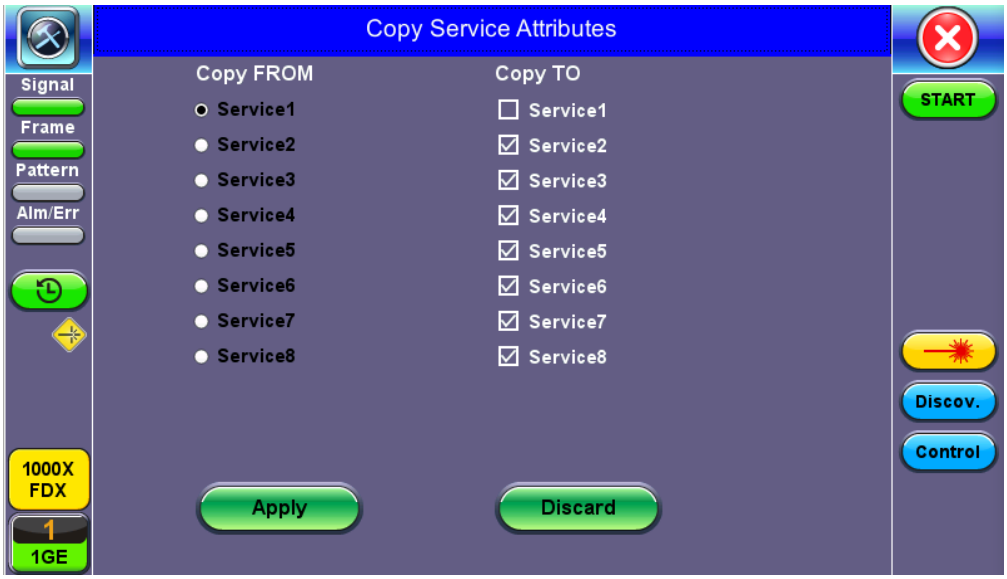
Service Acceptance Parameters

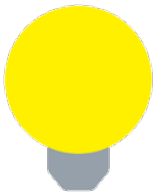
The user establishes Pass/Fail test criteria for the following Service Acceptance Criteria. Values define the minimum requirements to ensure that the service meets the Service Level Agreement (SLA):

- **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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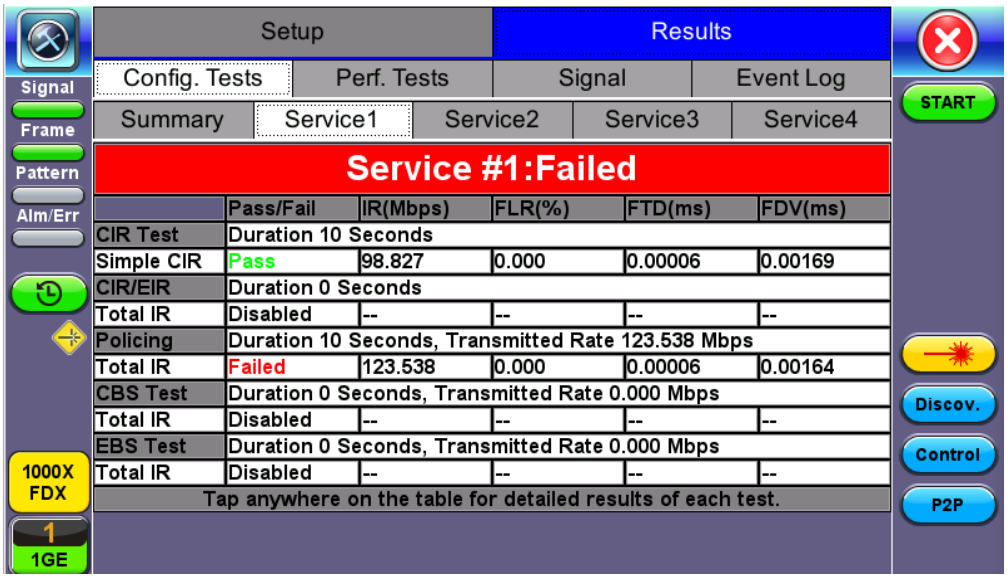
13.5.2 Results



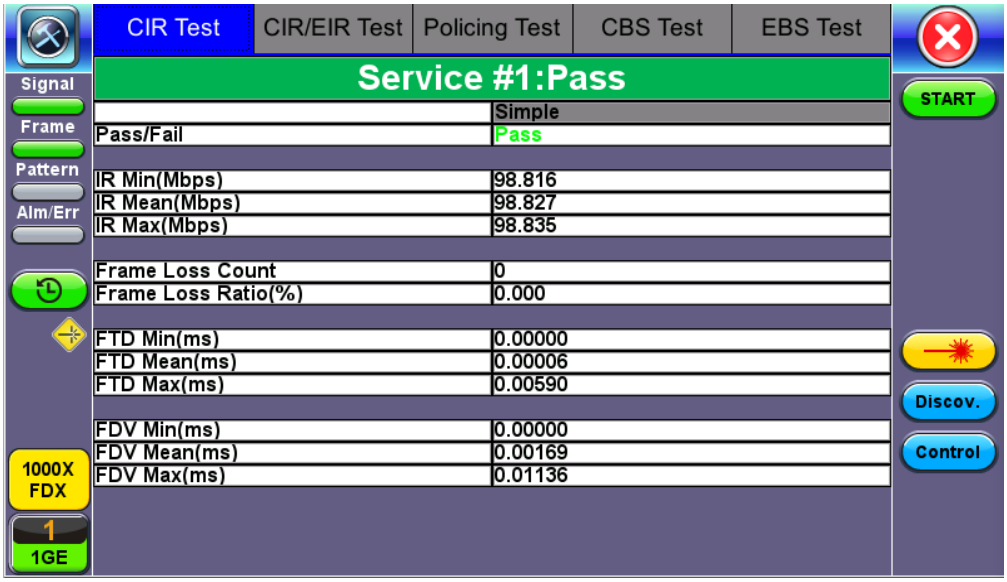
Results - Config. Tests - Service 1

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.

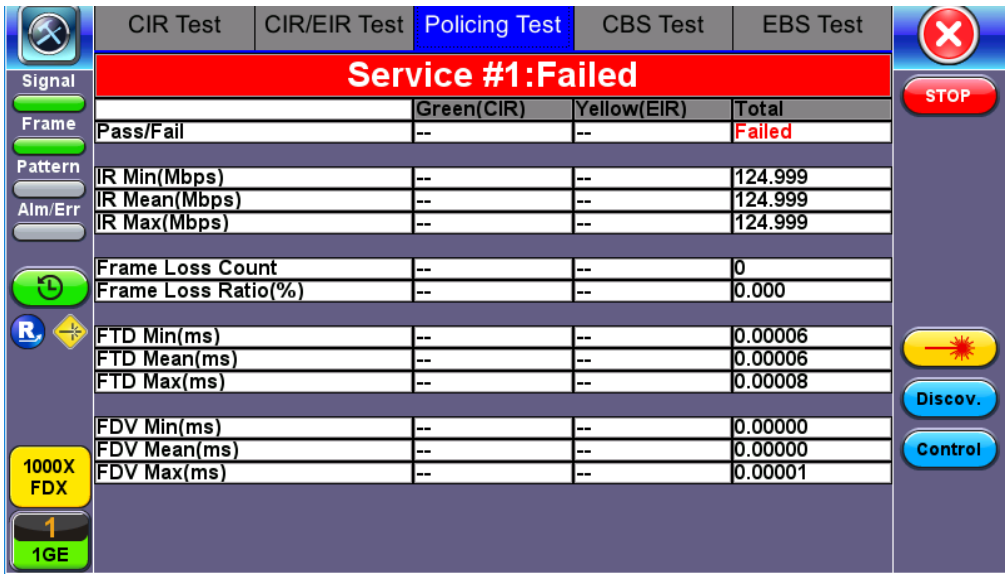


Tap the Table to View Test Details such as CIR Test

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.

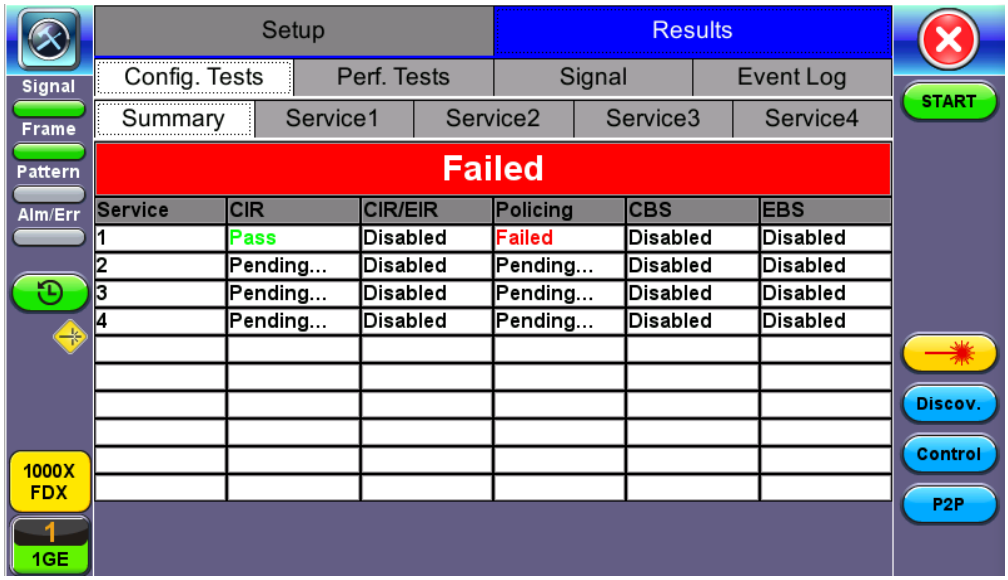
CIR/EIR test: The test passes if the received IR value is between the CIR (minus the margin allowed by the FLR) and CIR+EIR.



	Green(CIR)	Yellow(EIR)	Total
Pass/Fail	--	--	Failed
IR Min(Mbps)	--	--	124.999
IR Mean(Mbps)	--	--	124.999
IR Max(Mbps)	--	--	124.999
Frame Loss Count	--	--	0
Frame Loss Ratio(%)	--	--	0.000
FTD Min(ms)	--	--	0.00006
FTD Mean(ms)	--	--	0.00006
FTD Max(ms)	--	--	0.00008
FDV Min(ms)	--	--	0.00000
FDV Mean(ms)	--	--	0.00000
FDV Max(ms)	--	--	0.00001

Policing Test - Service 1

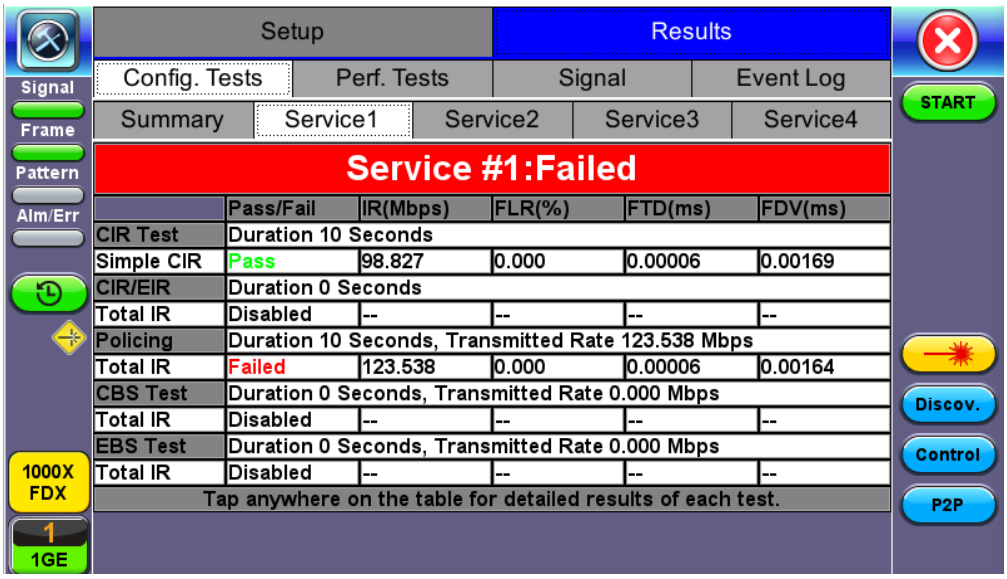
Policing test: The test passes if the received traffic rate is at least at the CIR (minus the margin allowed by the FLR) but does not exceed the allowed CIR+EIR.



Service	CIR	CIR/EIR	Policing	CBS	EBS
1	Pass	Disabled	Failed	Disabled	Disabled
2	Pending...	Disabled	Pending...	Disabled	Disabled
3	Pending...	Disabled	Pending...	Disabled	Disabled
4	Pending...	Disabled	Pending...	Disabled	Disabled

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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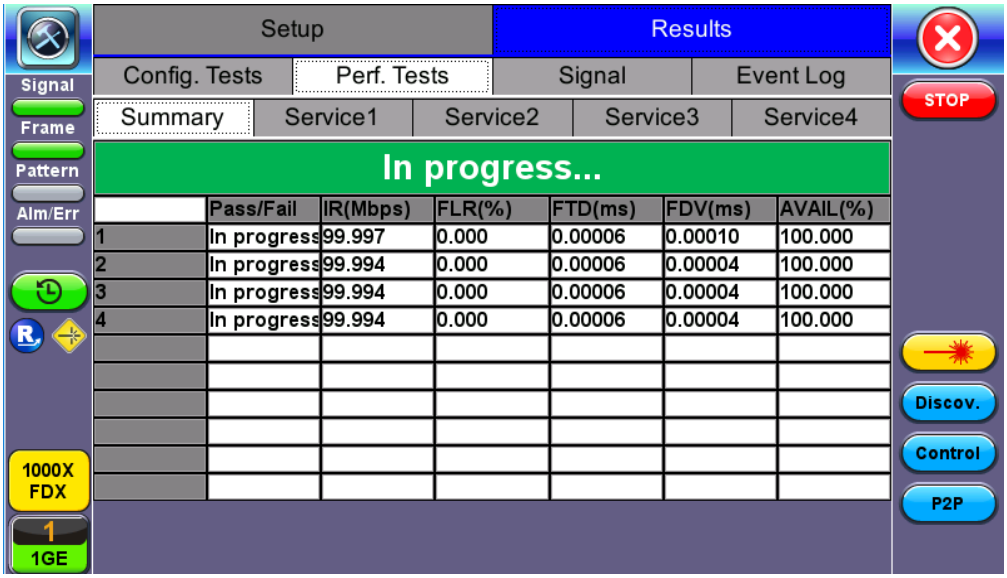
Performance Test

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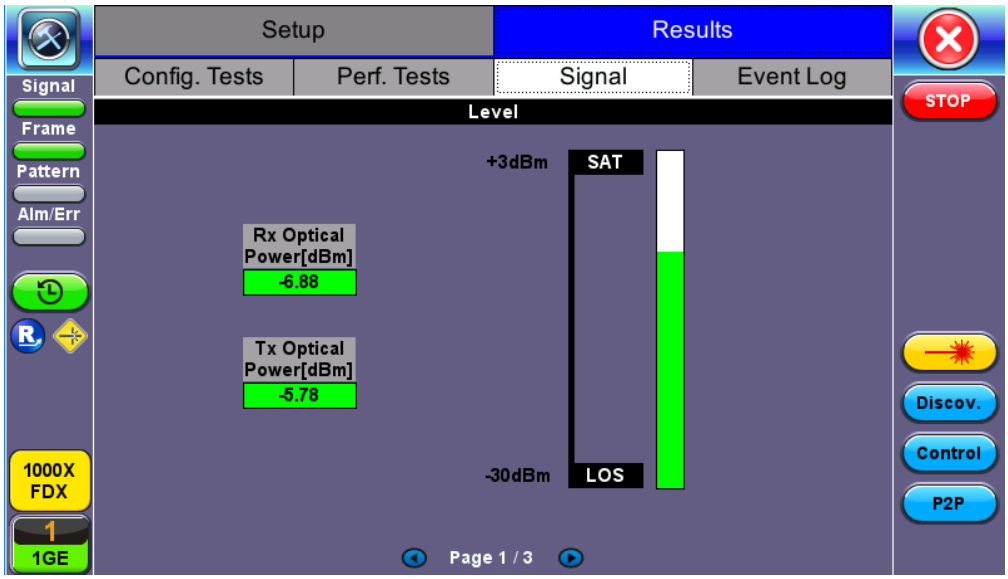
Signal tab: The Signal tab (fiber ports only) displays the optical level measured by the SFP transceiver. The RFC 2544 Signal tab is

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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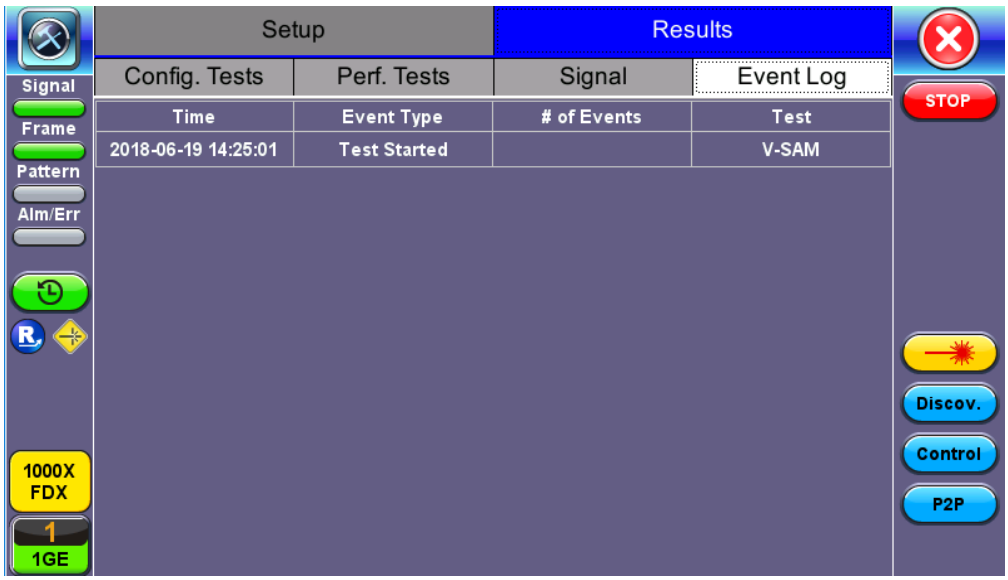
Event Log

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



Event Log

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13.6 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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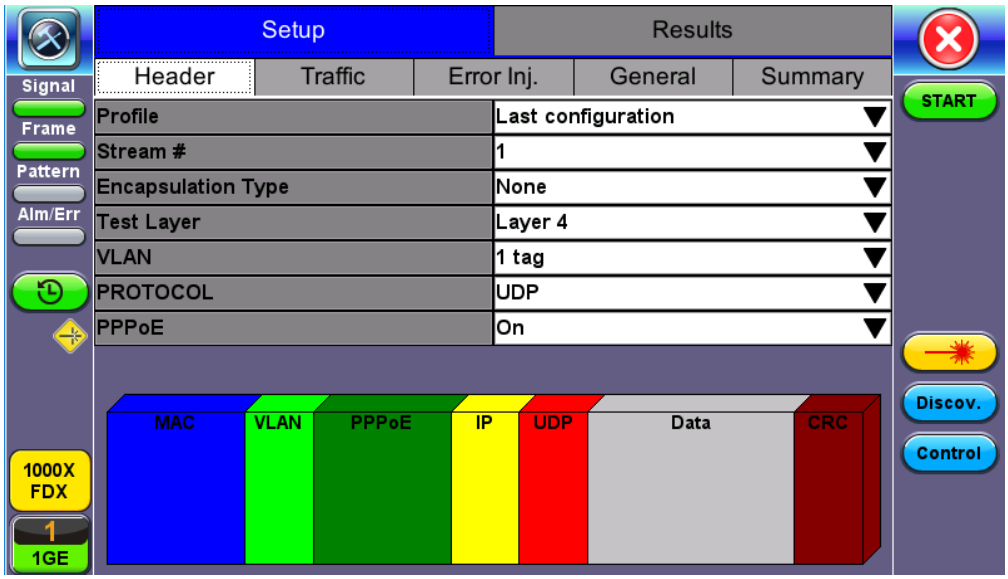
13.6.1 Setup

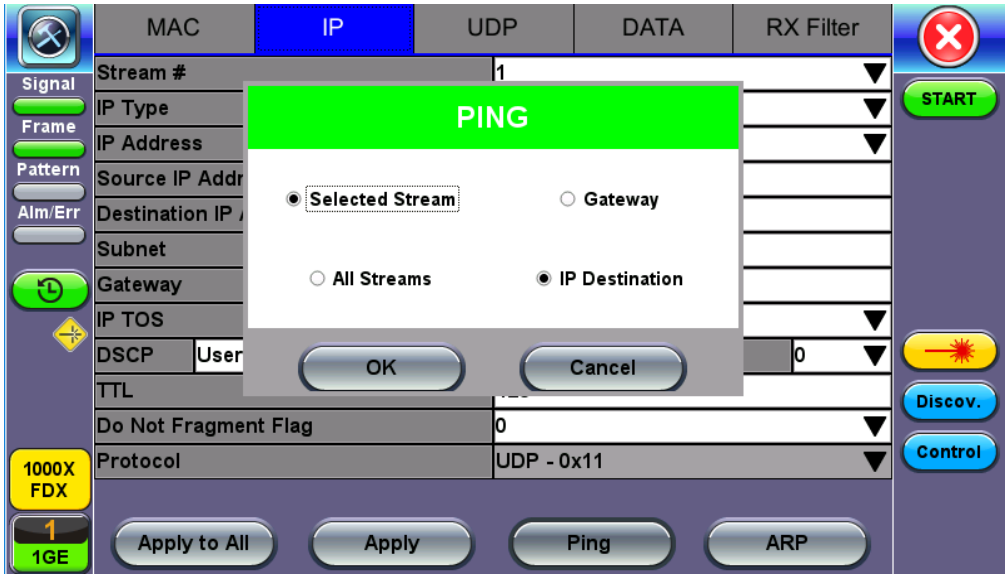
Unless otherwise noted, Frame Header, Traffic, and Error Injection setups are identical to the ones described in the BERT section. The following parameters must be configured prior to performing a Throughput test:

- 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)

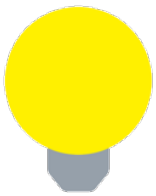


Setup Header

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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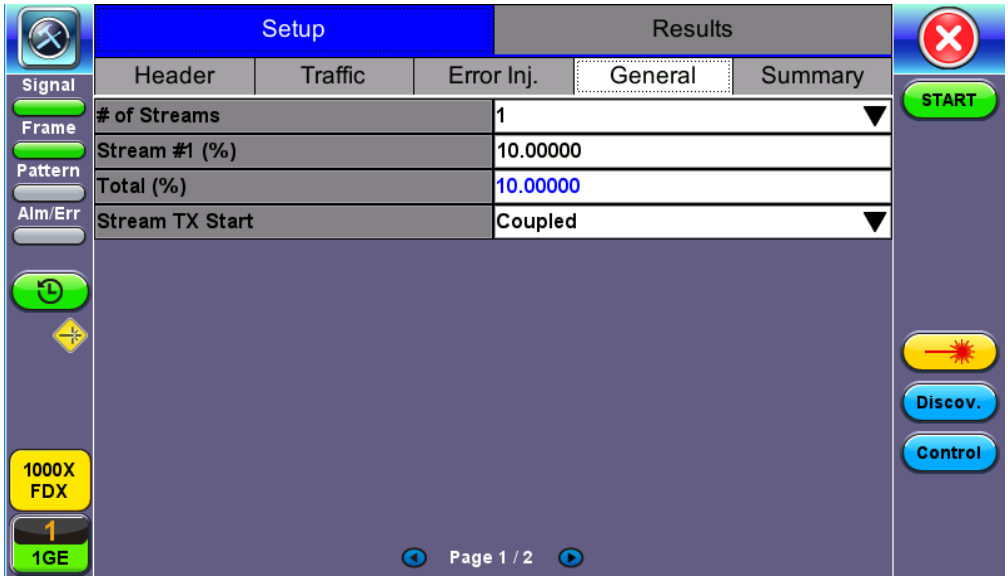
13.6.1.1 General Throughput Settings (Global Configuration)

Page 1:

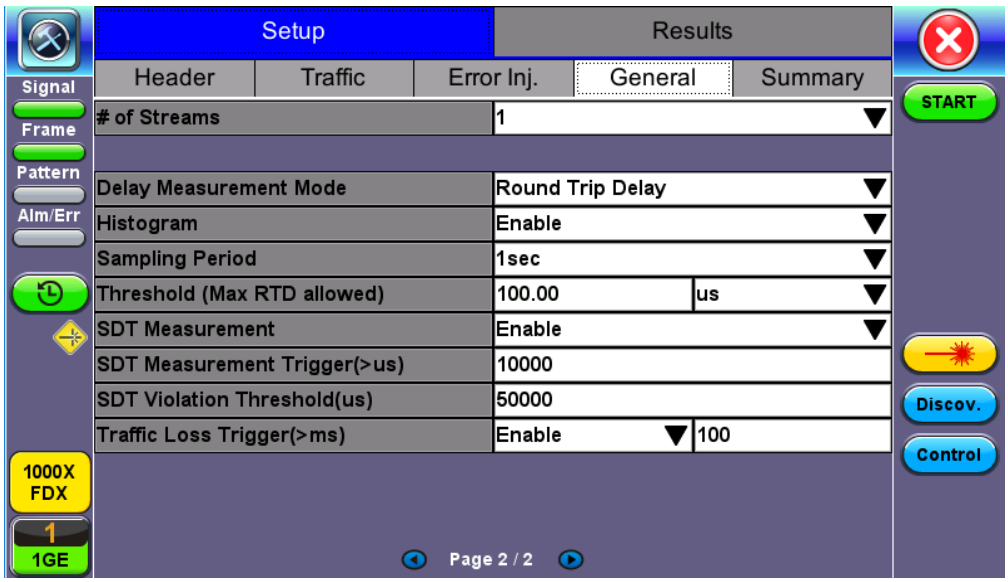
- **# of Streams:** From 1 to 10 streams.
- **Stream #:** Allocated Bandwidth per Stream: The total bandwidth for all streams cannot exceed 100%.
- **Total (%):** Sum of all stream rates in %.
- Stream TX Start: Coupled or Separated. Configures how the measurements are started for multiple streams.
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

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13.6.1.2 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.

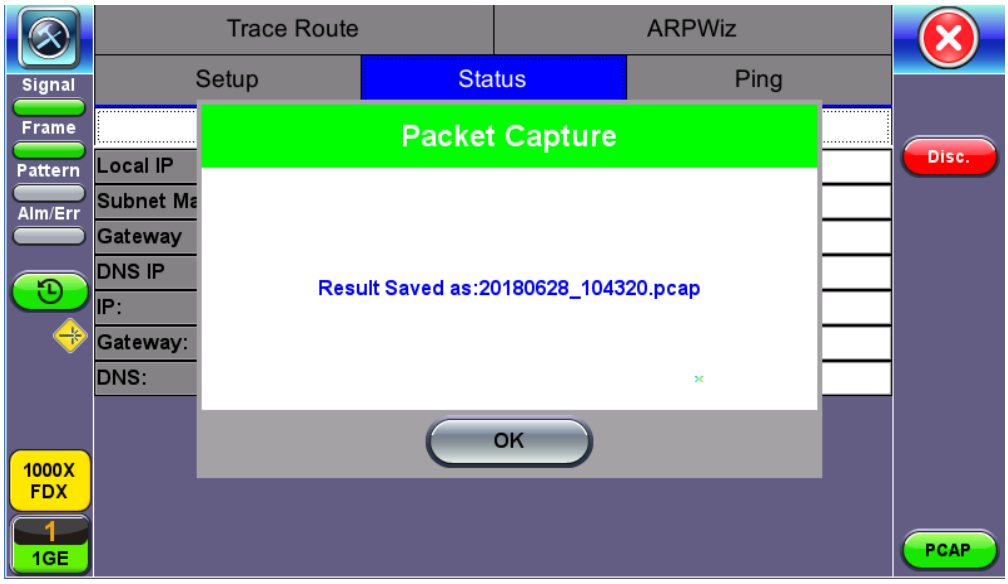
The **Control** button offers additional loopback control settings including User Defined. These features are described in MX Discover and Control.

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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13.6.1.3 Per Stream Configurations

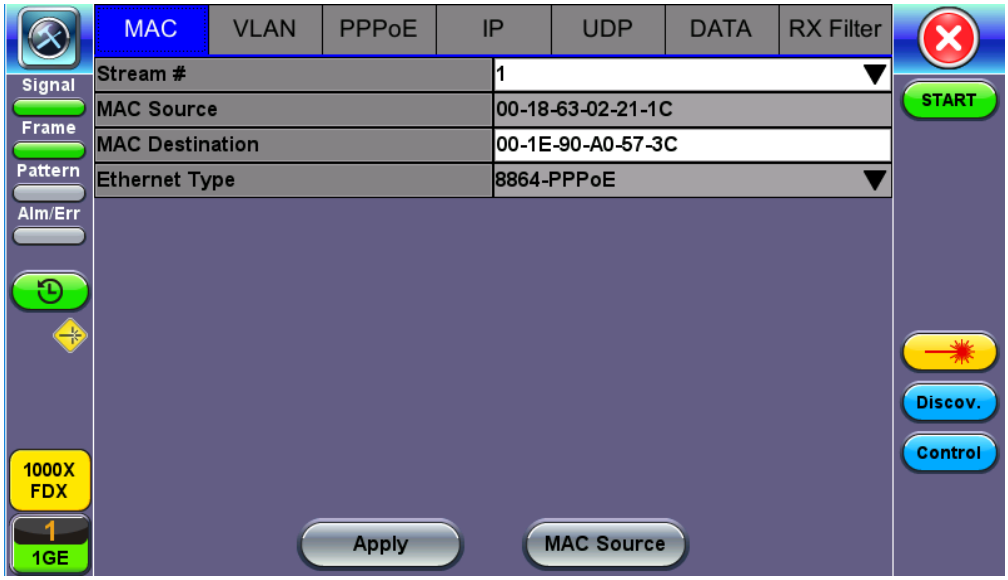
Frame Header, Traffic, and Error Injection setup is identical to the configuration for BERT testing. Refer to the corresponding BERT section for setup information on the following:

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

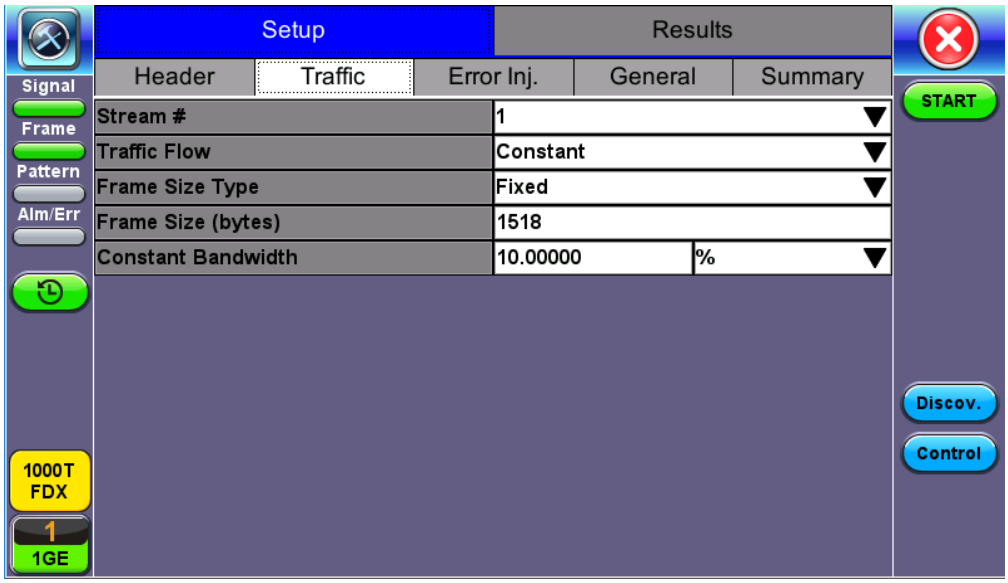
Error Injection

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

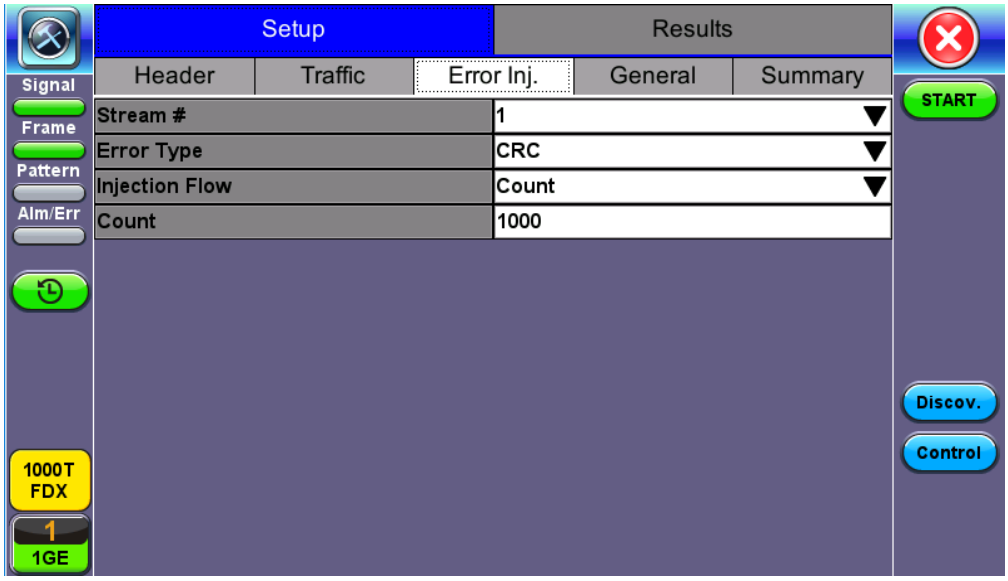
For information on header configuration refer to BERT Header Settings.



MAC Setup



Throughput Setup - Traffic Setup - Constant Traffic Flow

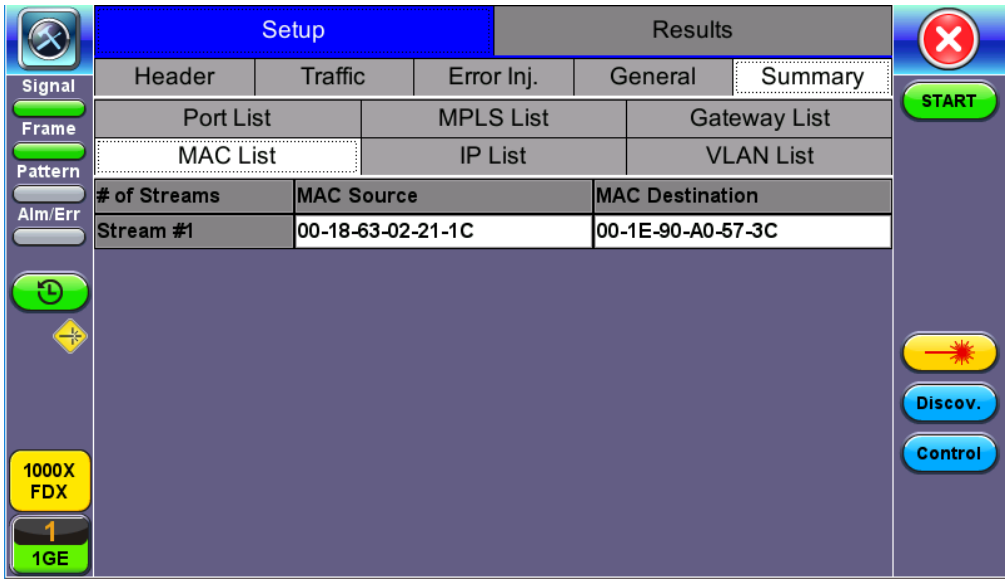


Throughput Test - Error Injection Settings per Stream

Go back to top Go back to TOC

13.6.1.7 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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13.6.1.8 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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13.6.2 Throughput Results

13.6.2.1 Viewing Throughput (Multiple Streams) Test Results

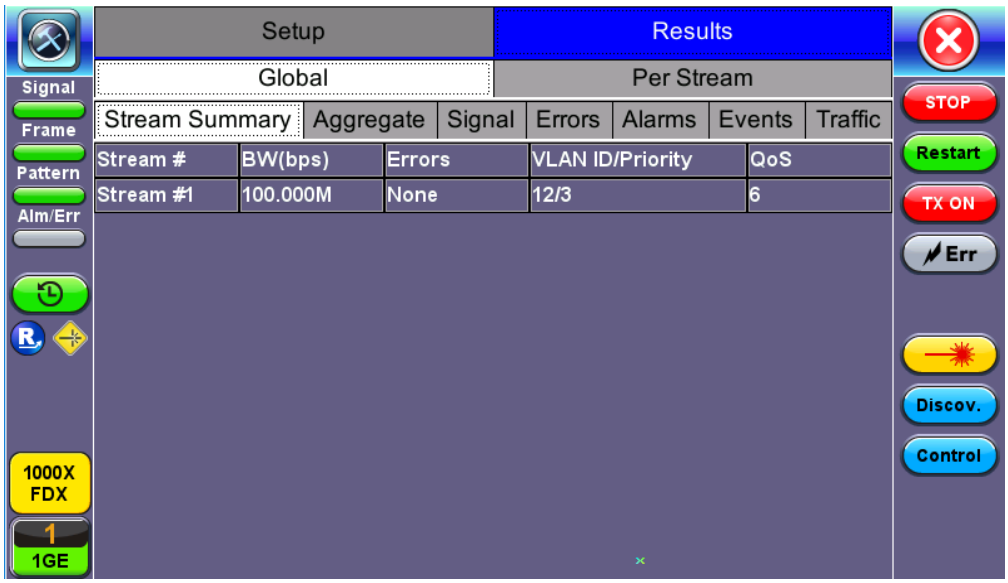
When the test is first started, the screen automatically changes to the Global/Aggregate results screen.

13.6.2.2 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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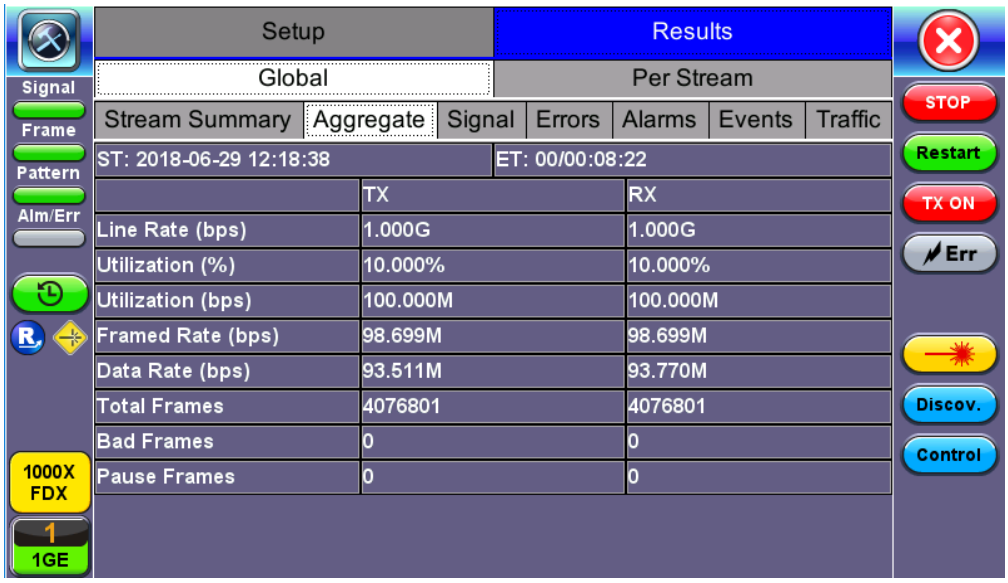
The Aggregate screen displays these parameters:

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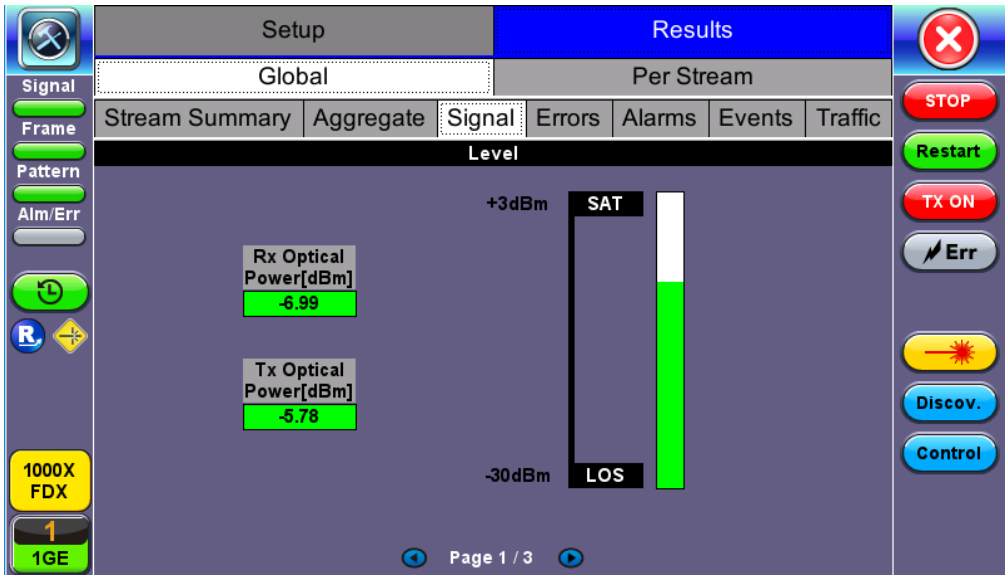
The **Global Signal** screen (fiber ports only) displays the optical level measured by the SFP or XFP transceiver. Page 1 displays the level measurement in dBm for the optical signal.

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



Throughput Results - Global Signal (Page 1)

Signal (Page 2)

Page 2 displays the Optical module (SFP or XFP) 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 or XFP).

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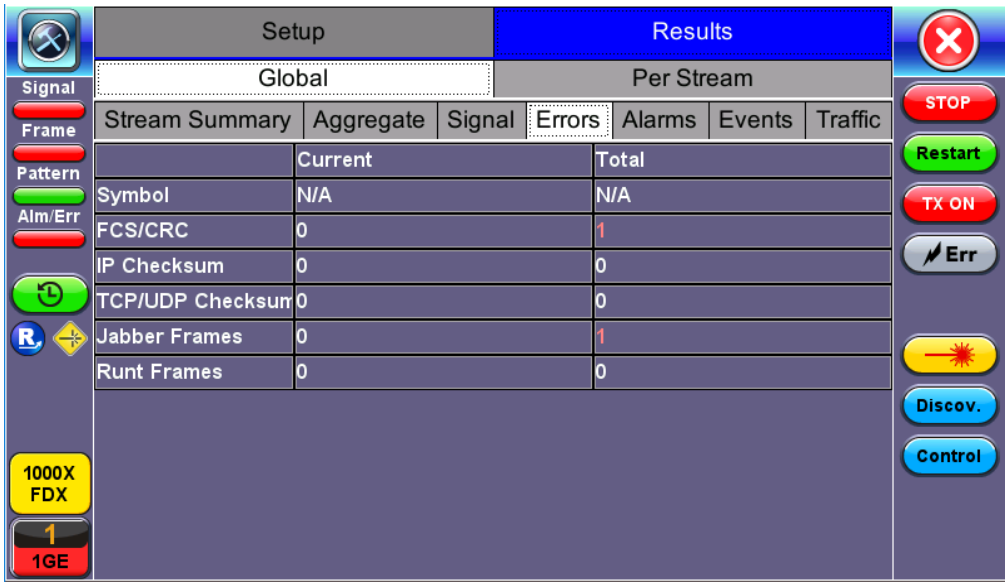
The **Global Errors** screen displays the Current and Total error count of all streams:

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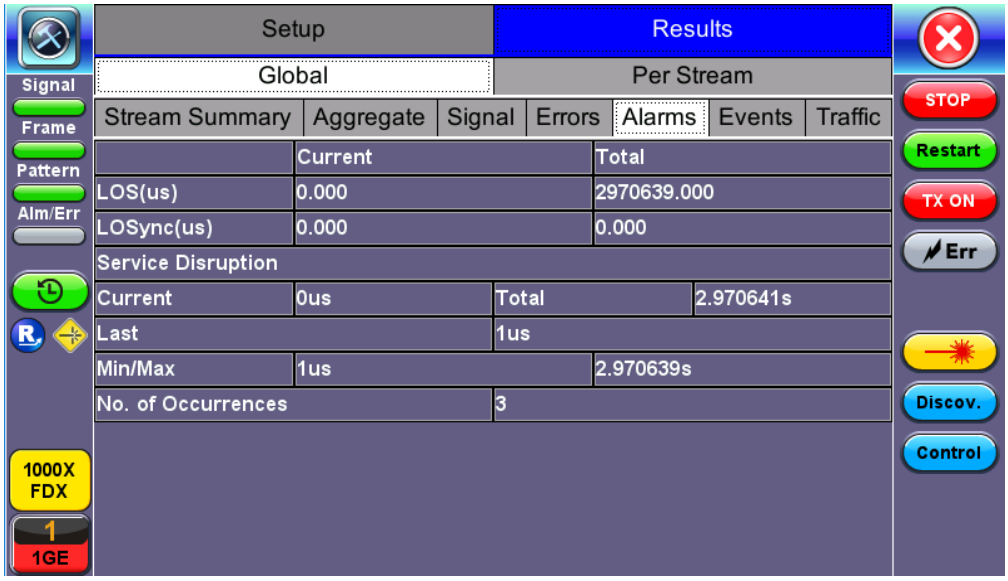
The **Global Alarms** screen displays the Current and Total alarm count of all streams:

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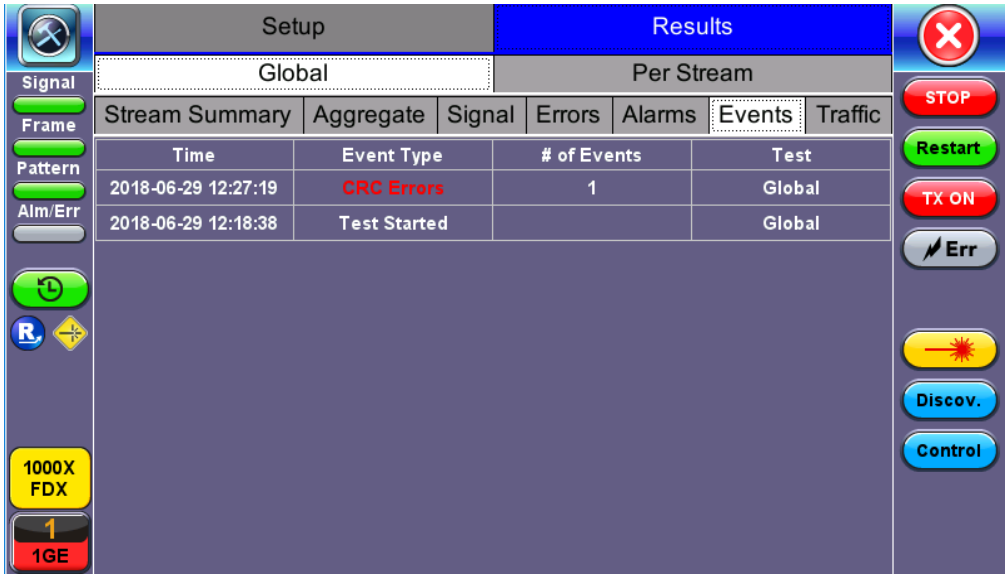
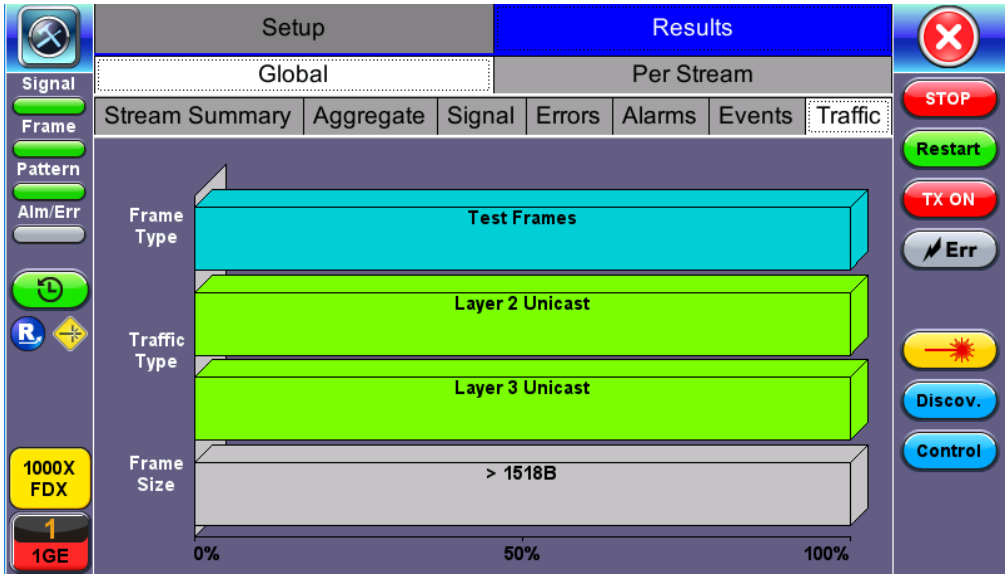
The **Global Events** screen displays the **Time**, **Event Type**, **Number of Events**, and **Test Type**.



Throughput Results - Global Events

The **Global Traffic** screen displays:

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

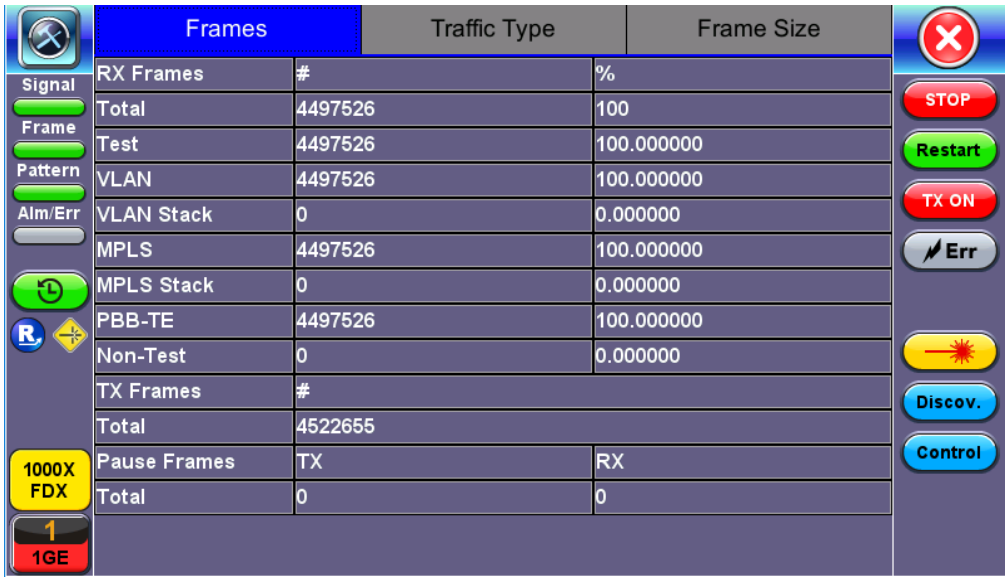


Throughput Results - Global Traffic Summary

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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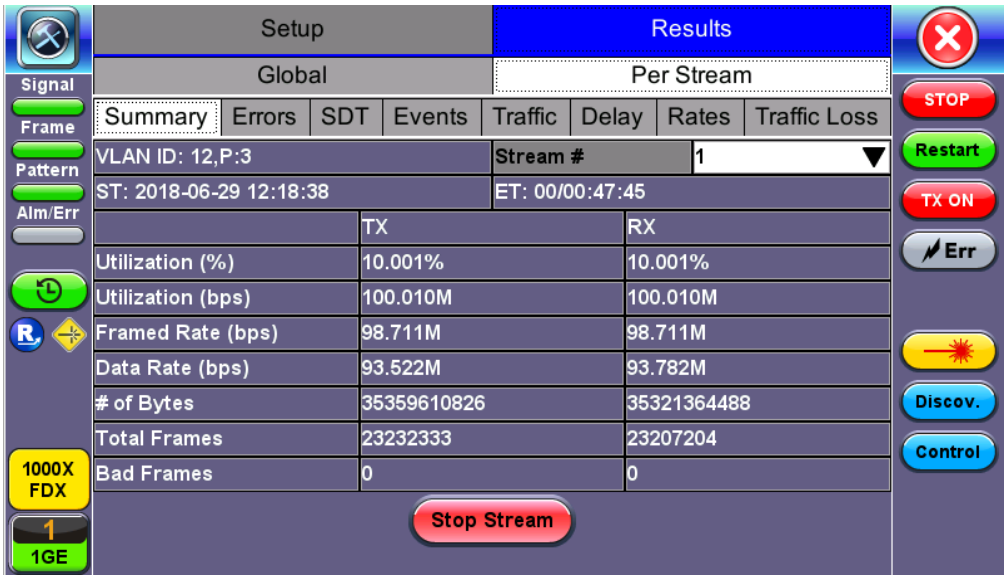
13.6.2.3 Per Stream Results

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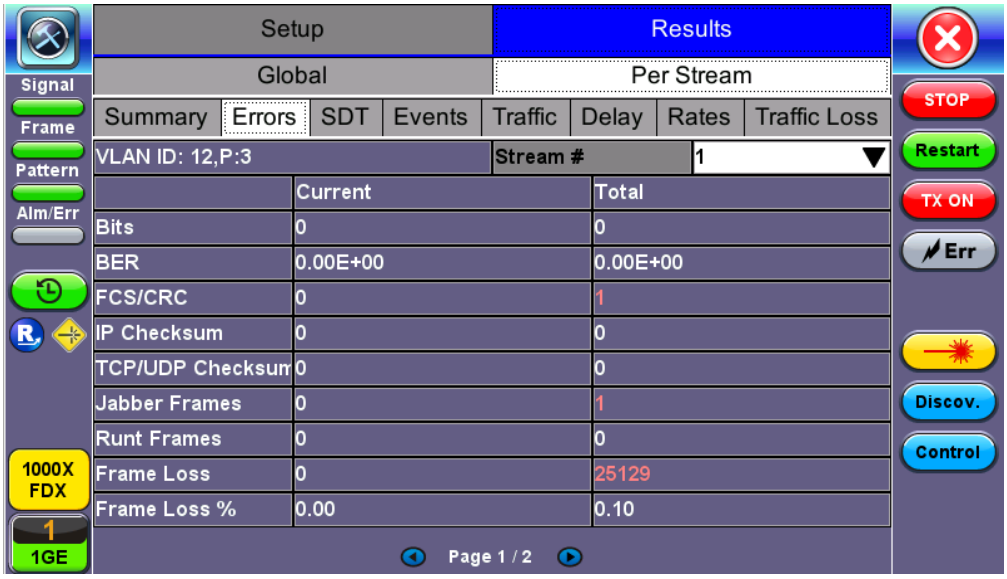
The **Per Stream Errors** screen displays the Current and Total error count of each stream.

- **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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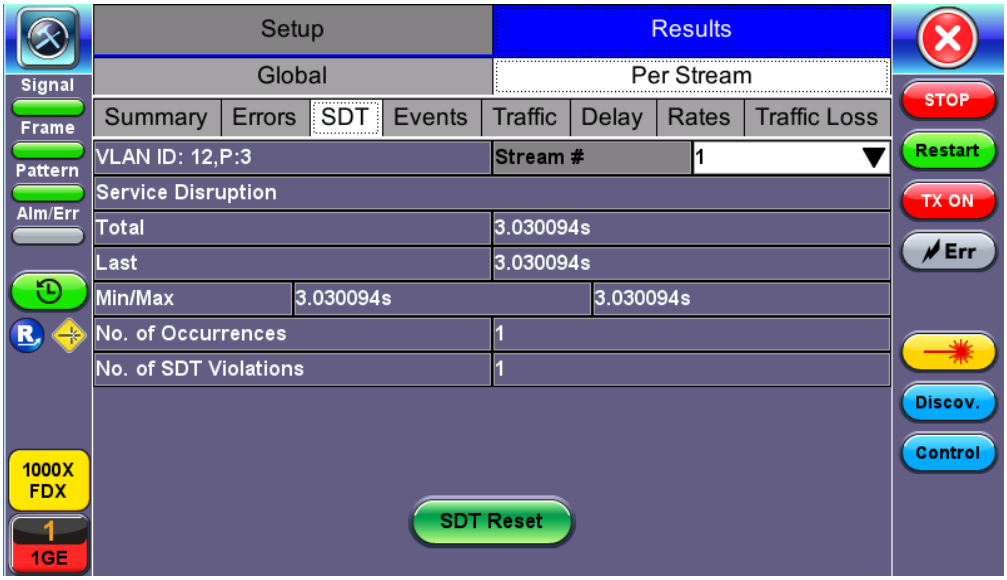
Service Disruption Test (SDT)

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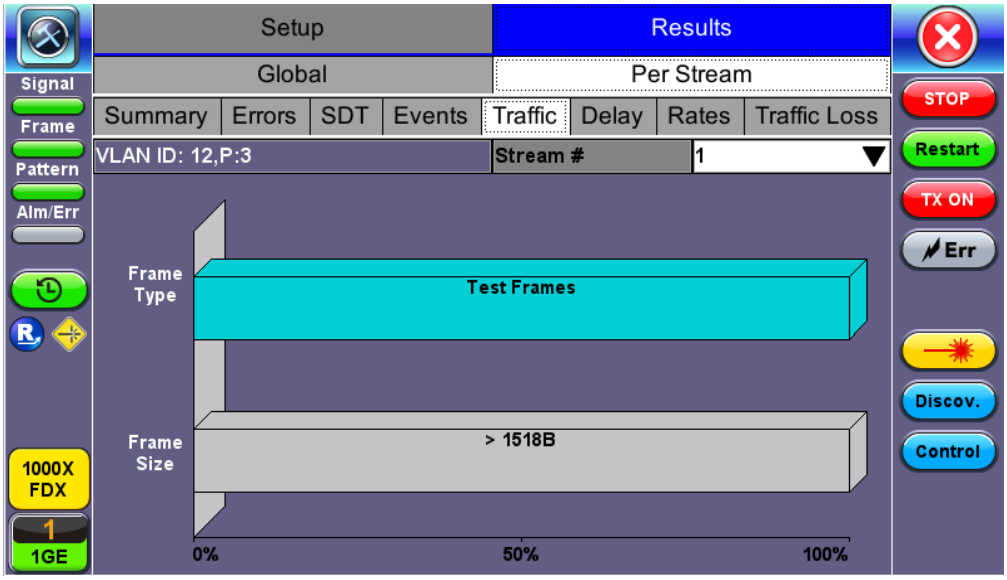
The **Per Stream Traffic** screen displays the frame type and frame size distribution pertaining to each stream.



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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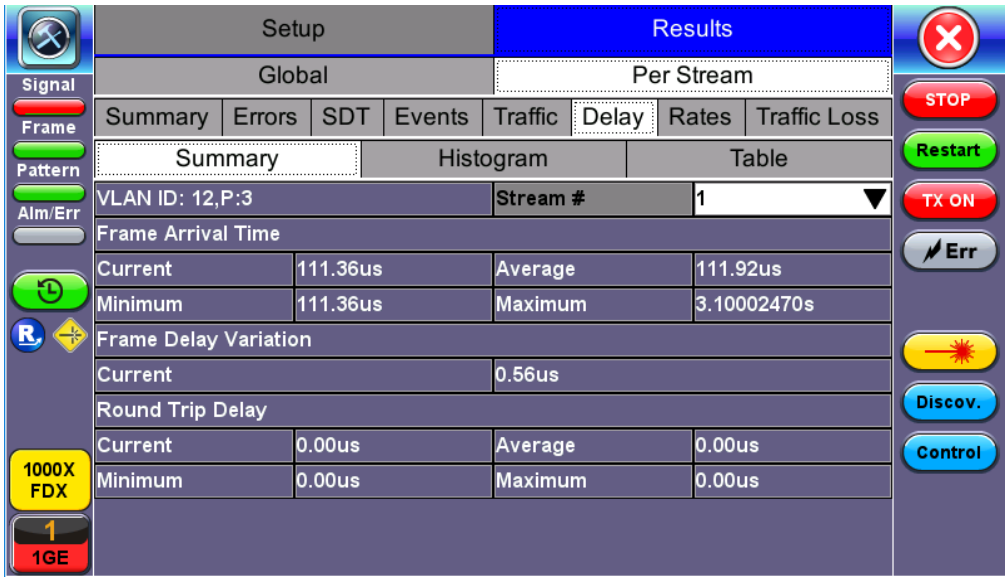
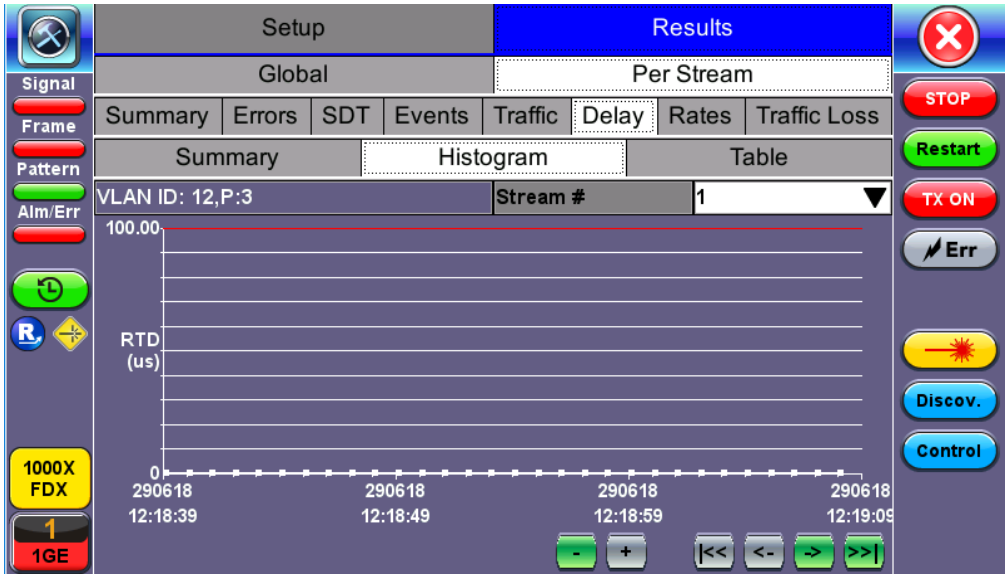
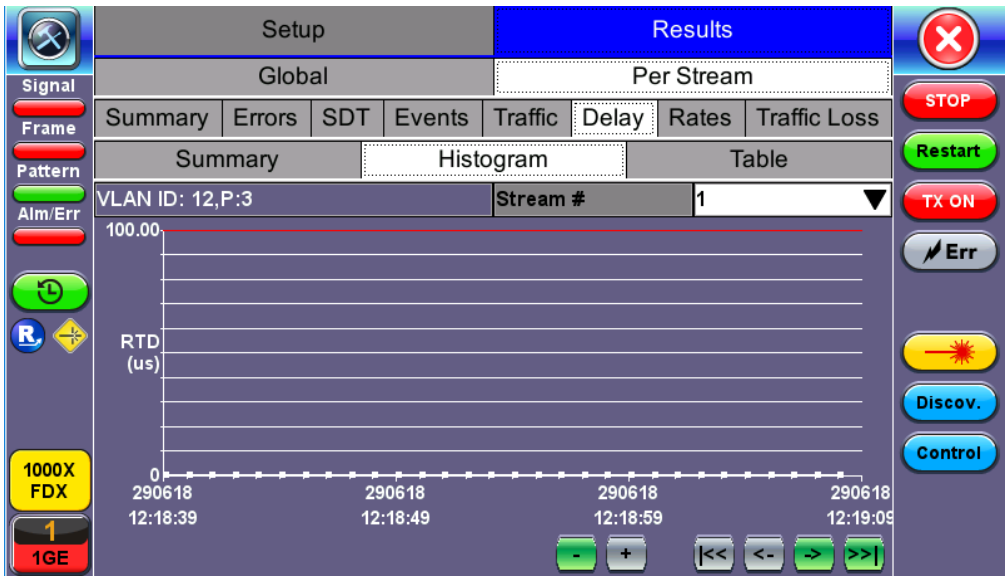
Round Trip Delay Results and Histogram



Delay per Stream - Summary



Round Trip Delay Histogram



Per Stream Delay Table

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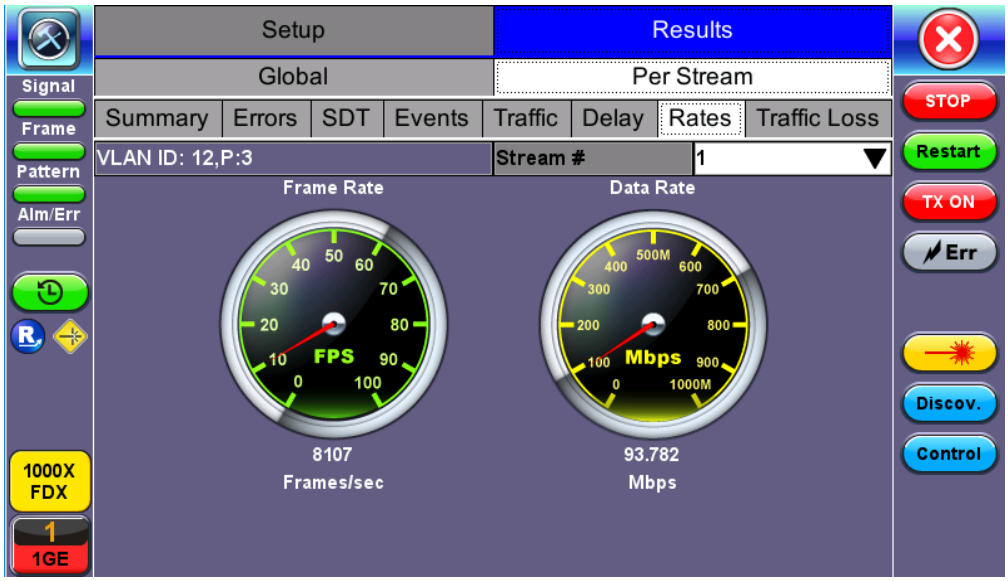
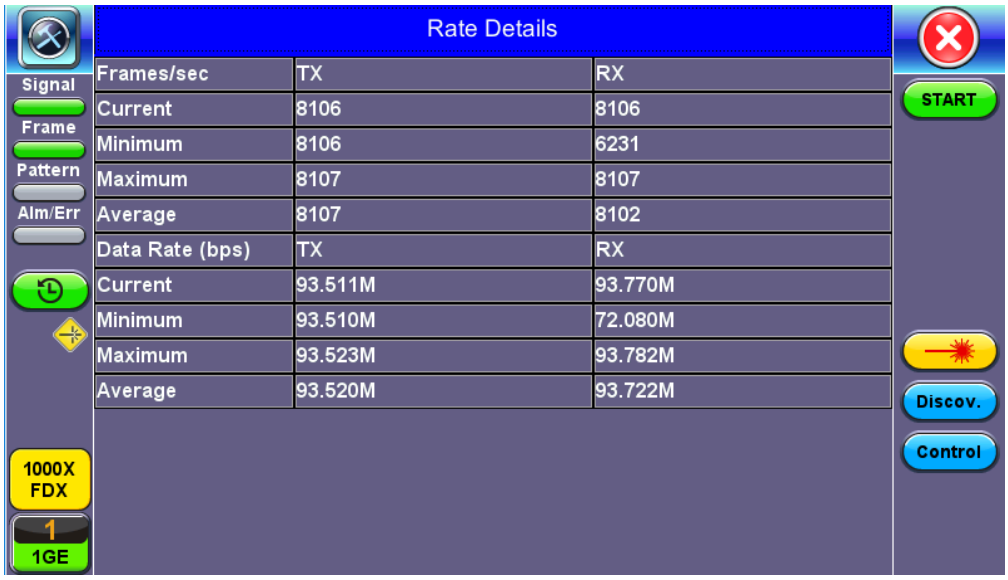
The **Per Stream Rate** screen displays the frame rate and data rate pertaining to each stream. Tap on either dial to see rate details.



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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13.6.2.4 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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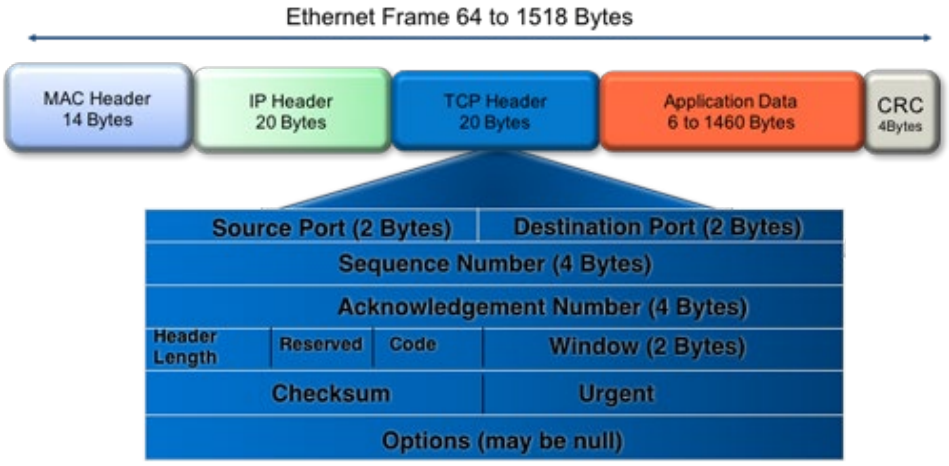
13.7 Layer 4+ Applications

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

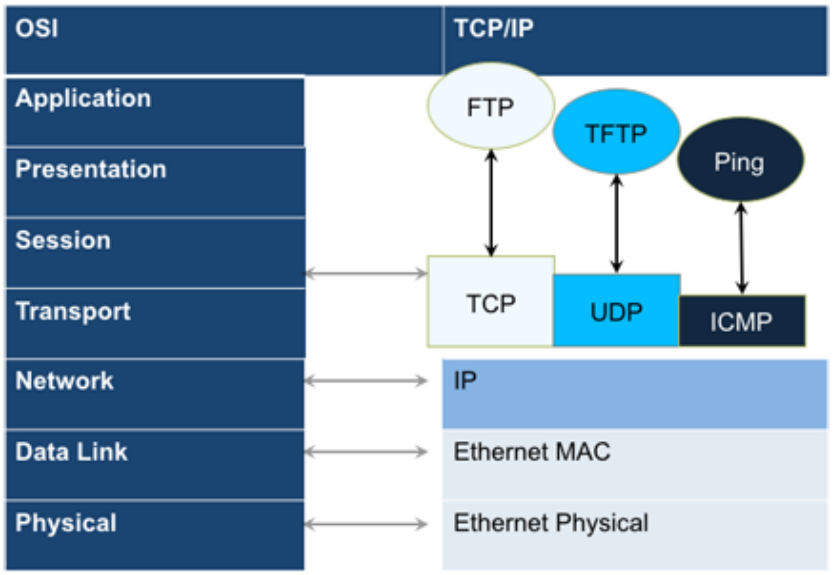
Fundamental TCP parameters are the ideal TCP Window Size and Throughput. The complete list of relevant measurements include:

- 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:

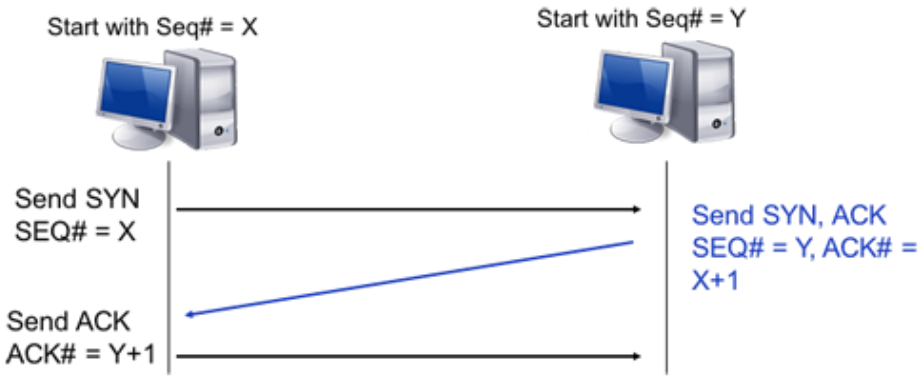
- End-to-end connection
- Multiplexing/Demultiplexing of separate sessions
- Flow control



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 acknowledgement



- **Step 1:** Client sends a SYN message with SYN flag set in the TCP header. The Sequence number specifies the number assigned to the first segment.

- **Step 2:** Server receives SYN packet and sends SYN + ACK packet SYN flag set, ACK flag set Sequence number specifies the server's starting sequence number. Acknowledgment number means that the server has received X and expects X+1.

- **Step 3:** Client receives SYN + ACK and send ACK back. ACK number means that server has received Y and expects Y+1.

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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 acknowledgement received, the test has to be done in a network that is not congested to obtain the real round trip delay (not accounting for network buffer delay).

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

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

Key Metrics:

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

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

BDP (Bytes) =

Link Bandwidth (bps) x RTT (s)/ 8

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

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

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

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 acknowledgement is missing. Segments can be retransmitted more than once.

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

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

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

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

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

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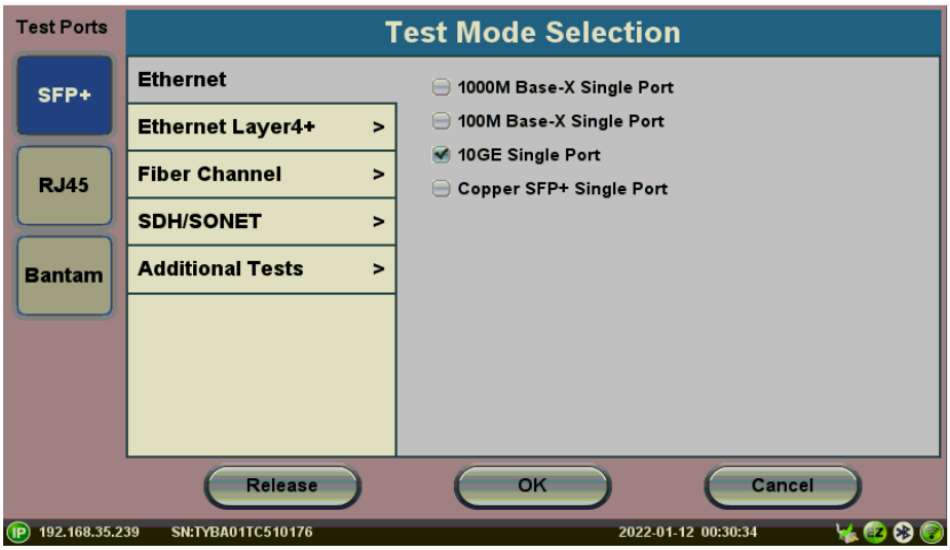
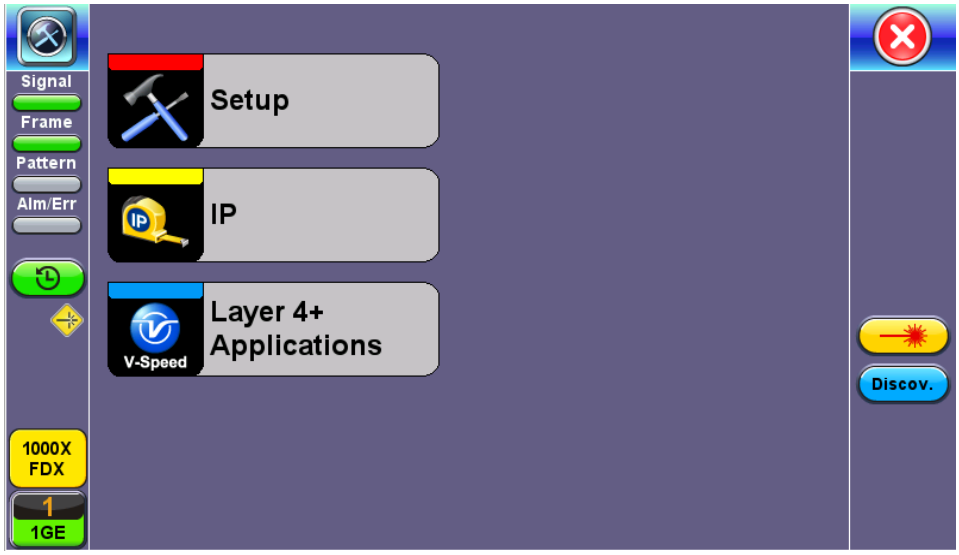
Layer 4+ Applications Configuration

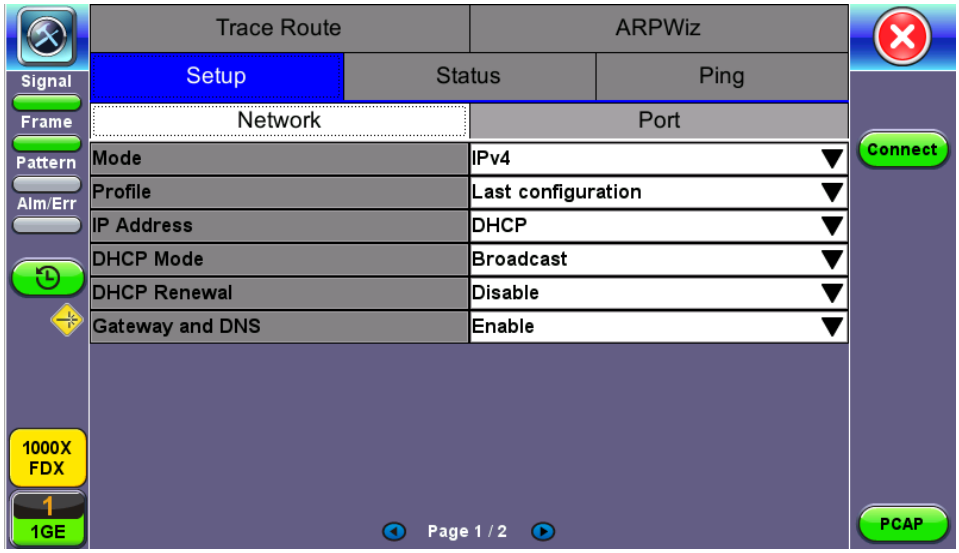
Before launching V-Perf, V-Test, or V-FTP tests, it's necessary establish an IP connection. For V-Perf testing, repeat these steps for both the far end and near end test sets.

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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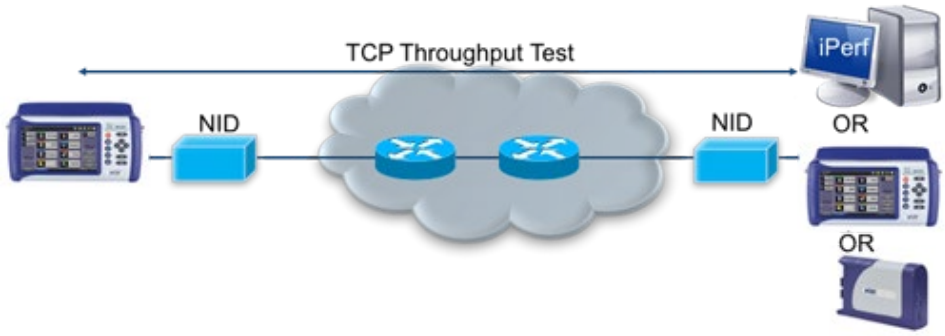
13.7.1 V-Perf

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

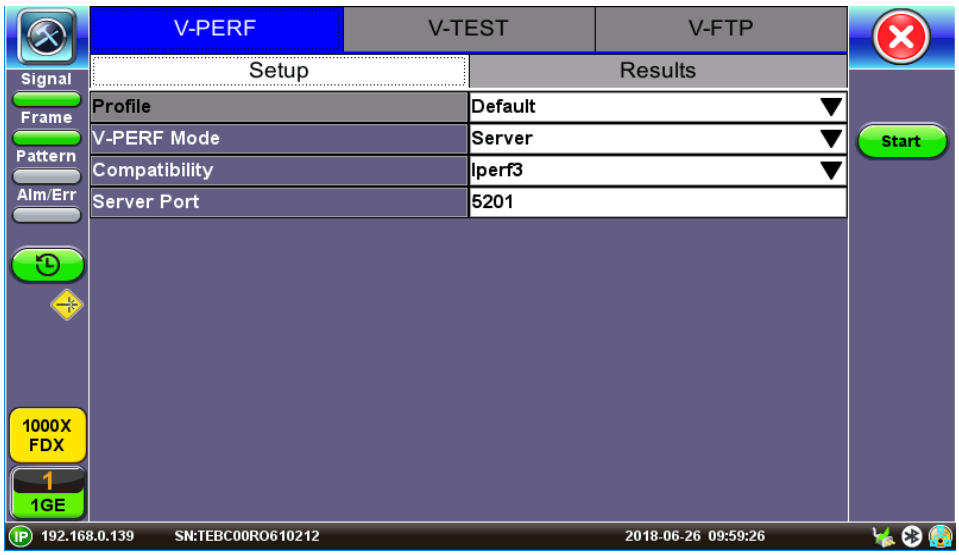
- Multi-Window size tests
- Measurements: TCP Throughput rate (min, max, average), Transfer file size and duration, Transfer time ratio, TCP Efficiency %, Buffer Delay %



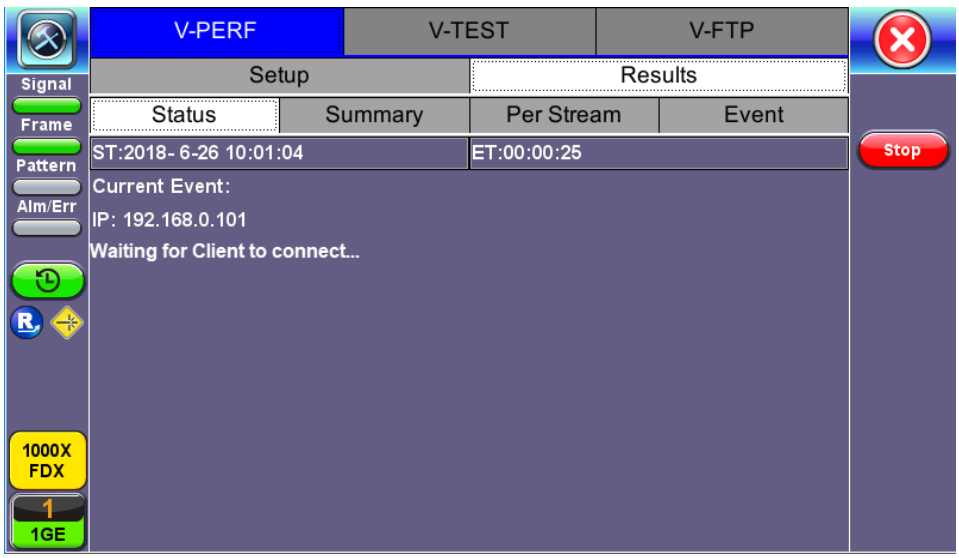
TCP Throughput Test Diagram

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**.



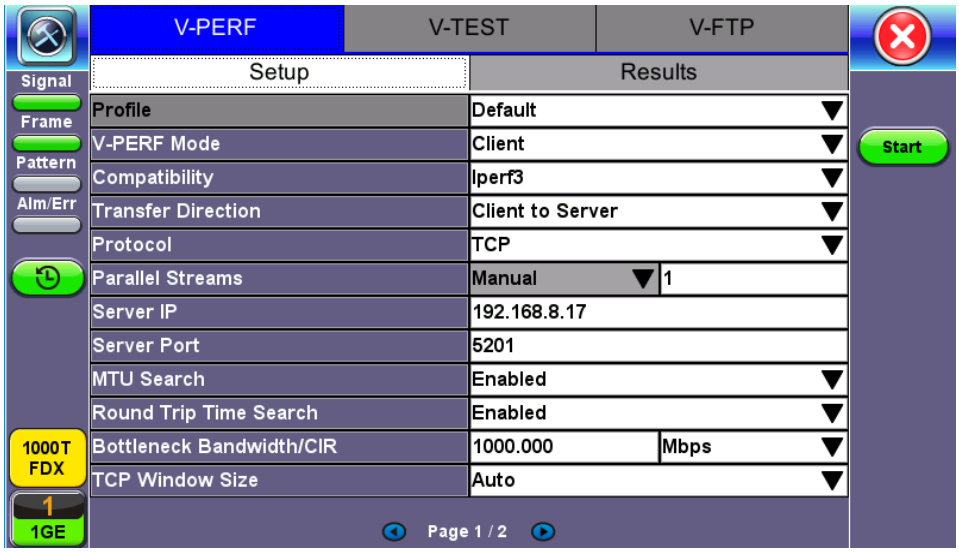
Test Set #1 - V-Perf Setup - Server



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

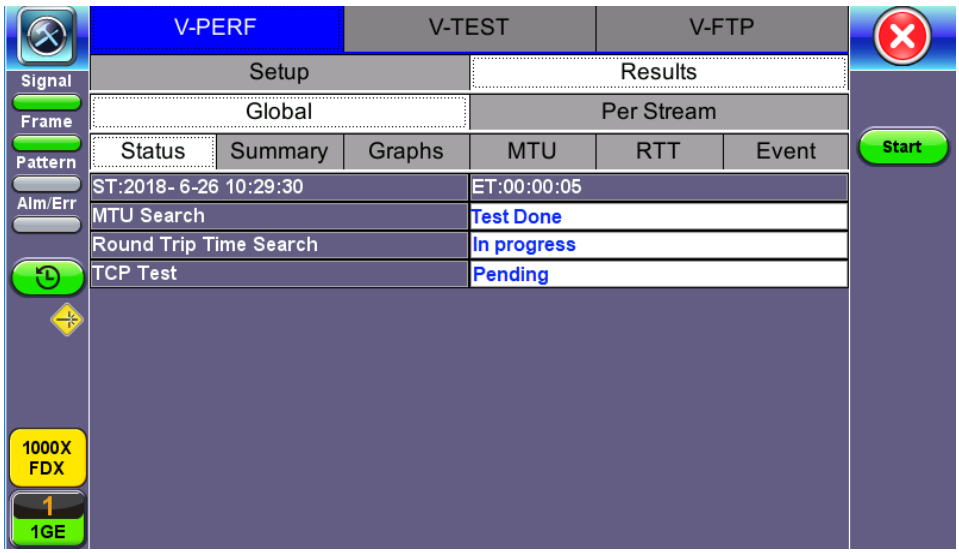
Search, Bottleneck Bandwidth, and Window Size options are also on Page 2.



Test Set #2 - V-Perf Setup - Client

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

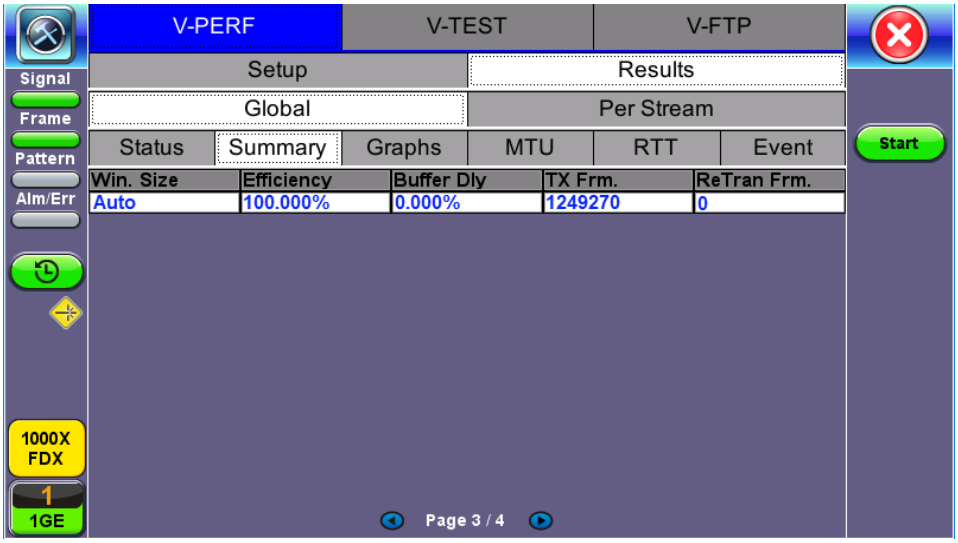
Status



Client - Results - Status

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

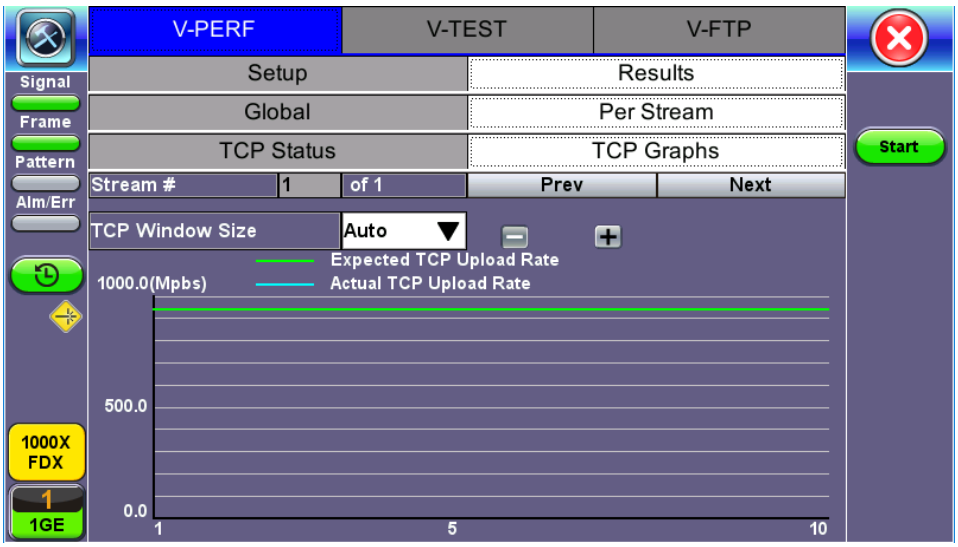
Summary



Client - Results - Summary

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

Graphs



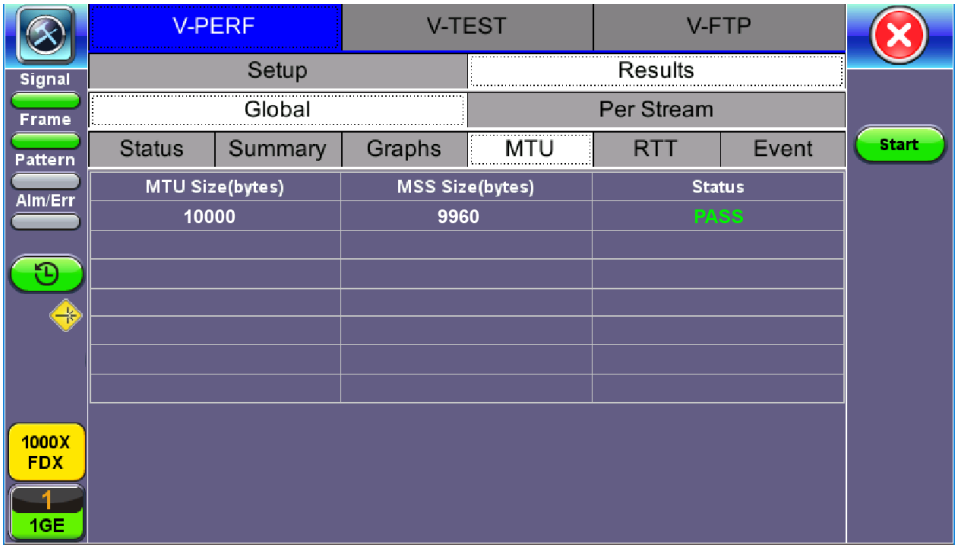
Client - Results - Per Stream TCP Graphs

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.

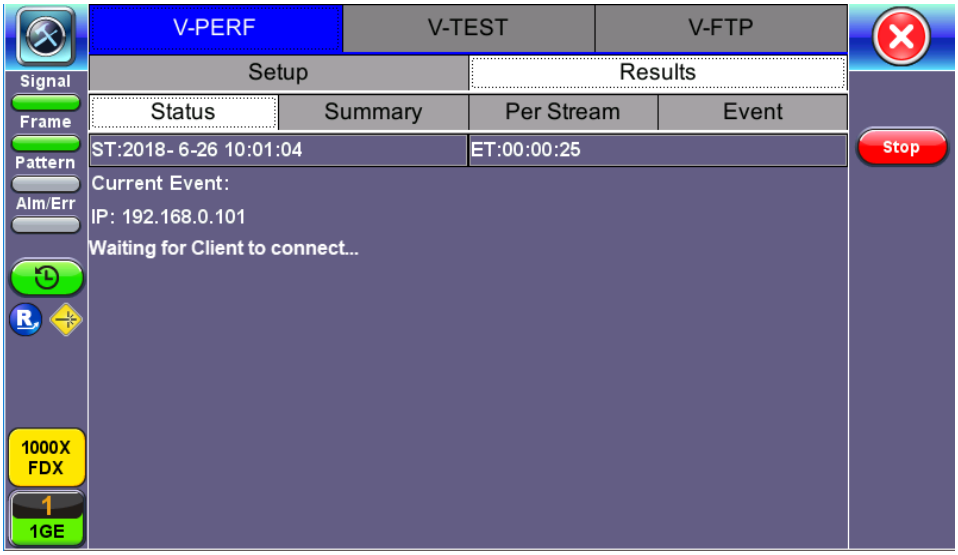
Per Stream results displays the TCP results for each stream.

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.

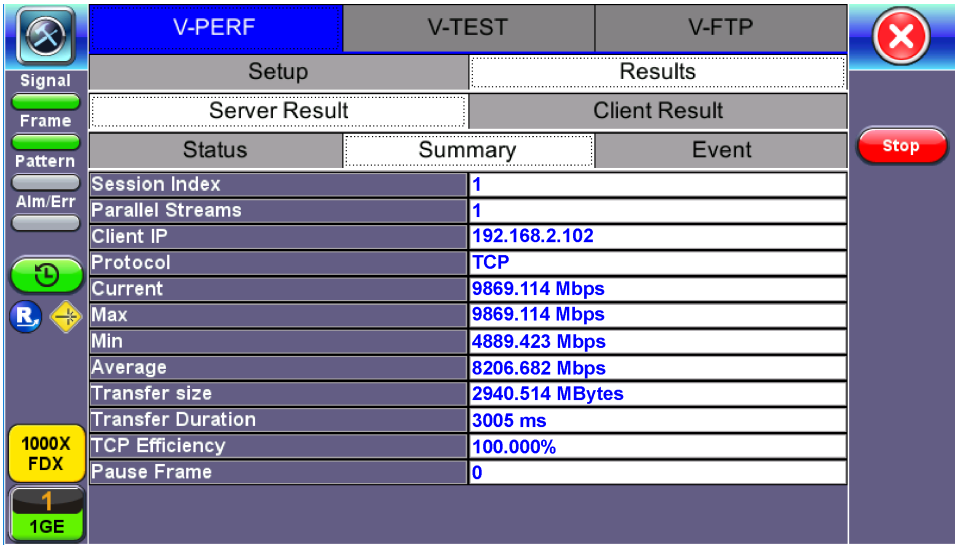
Server Results

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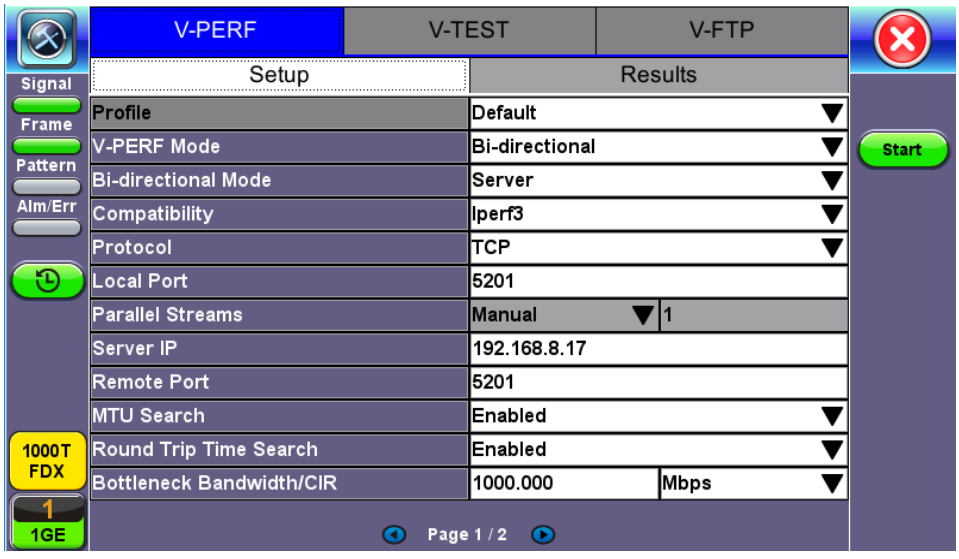
Bi-Directional Configuration and Results (VeEX Enhanced Testing Methodology Implementation)

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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13.7.2 V-Test

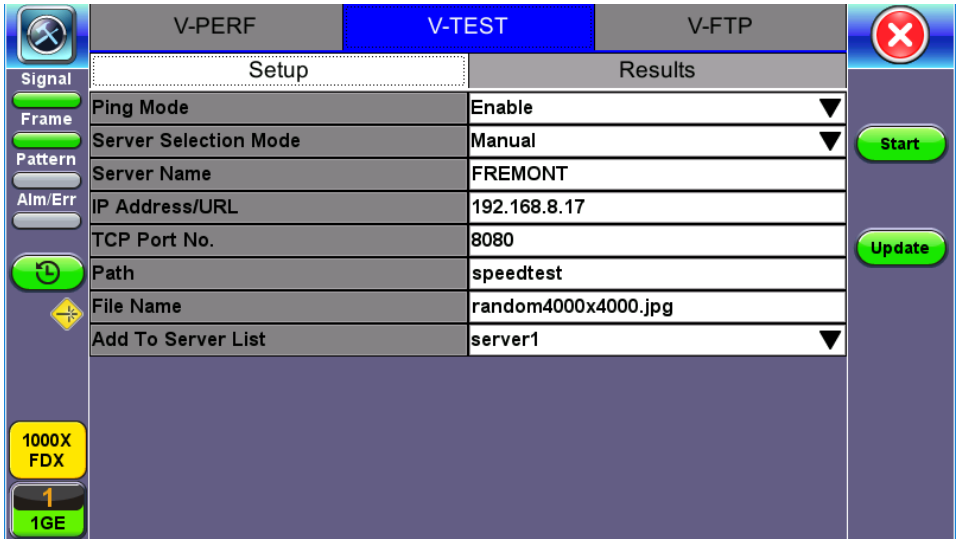
V-Test is a VeEX speed test. There are a few different server types that can be used to run the speed test. The following server types are available from **Server Selection Mode:**

- **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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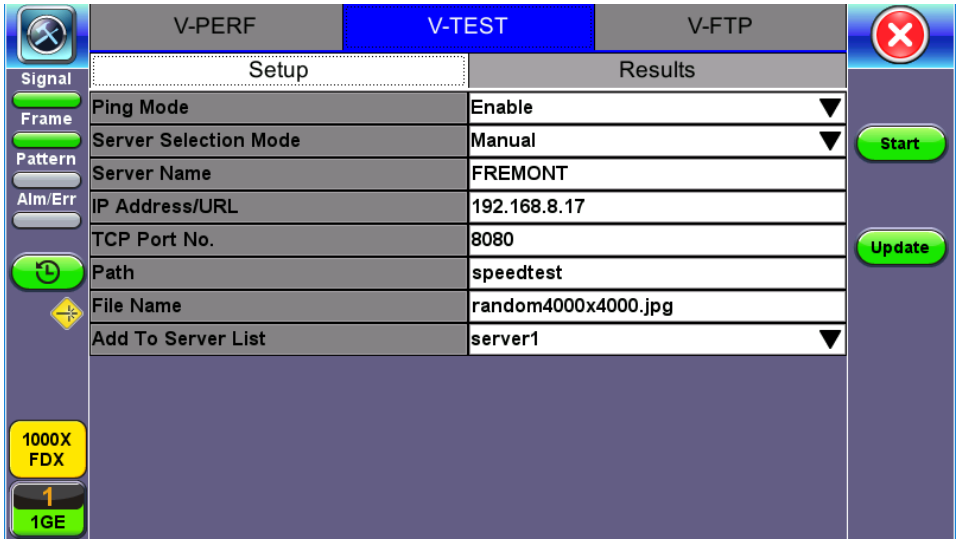
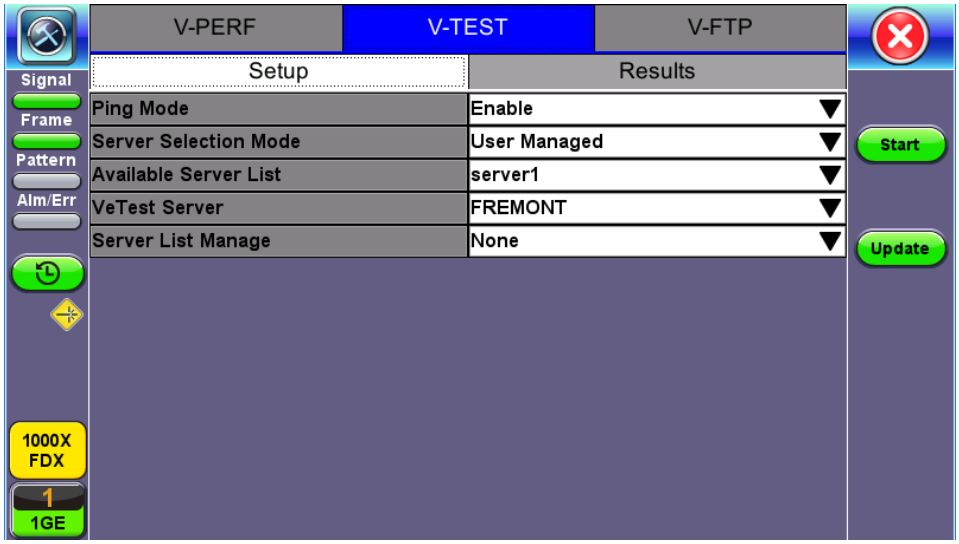
Creating New Server Profiles and Server Lists

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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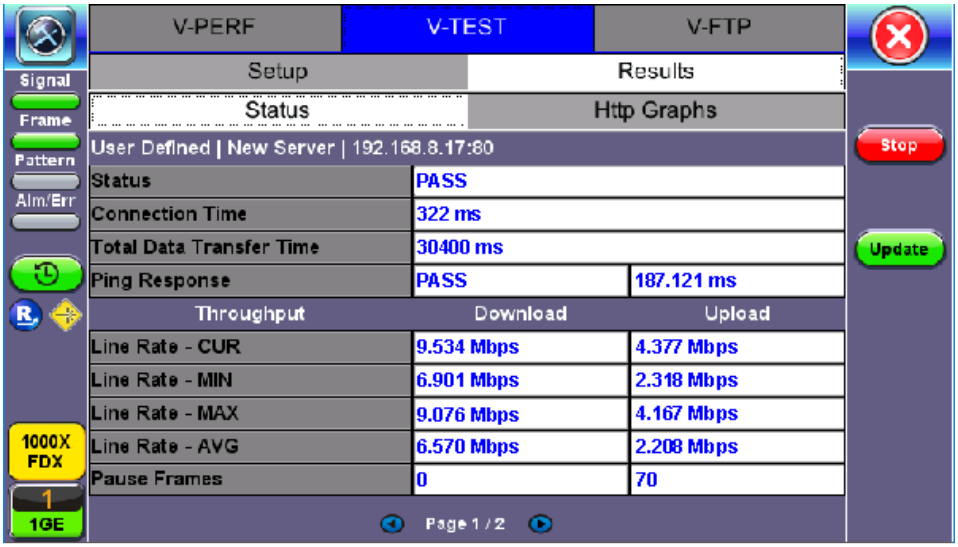
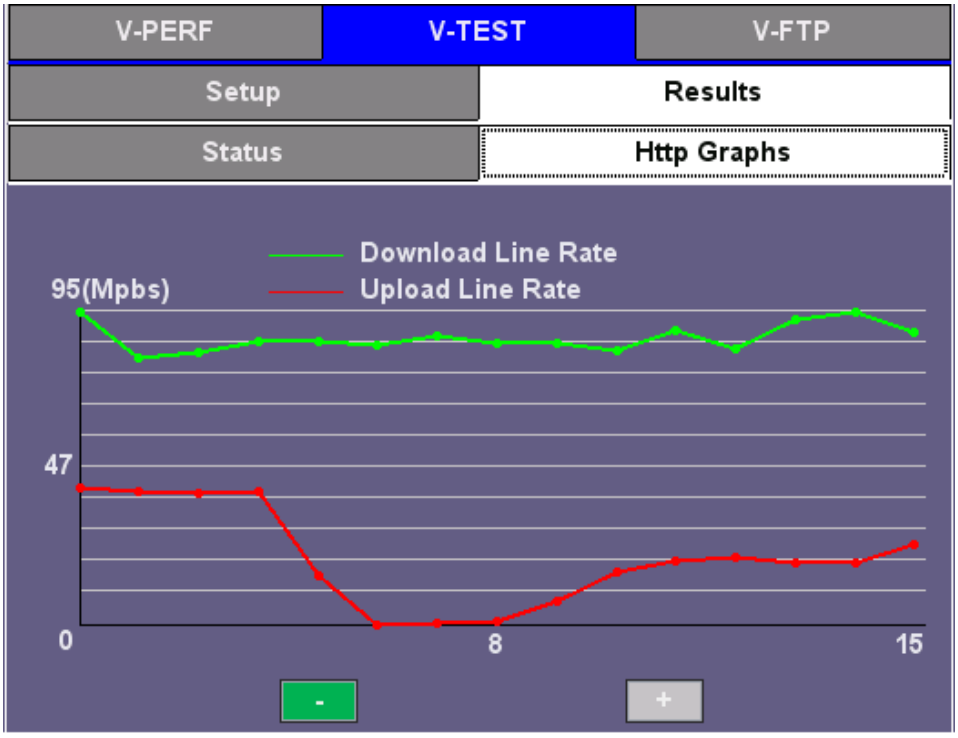
Starting a V-Test

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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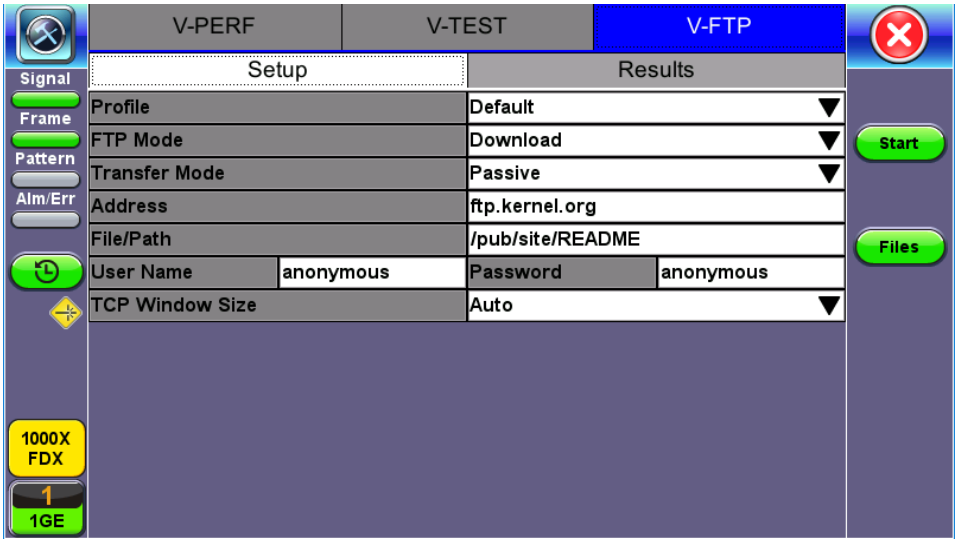
13.7.3 V-FTP

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

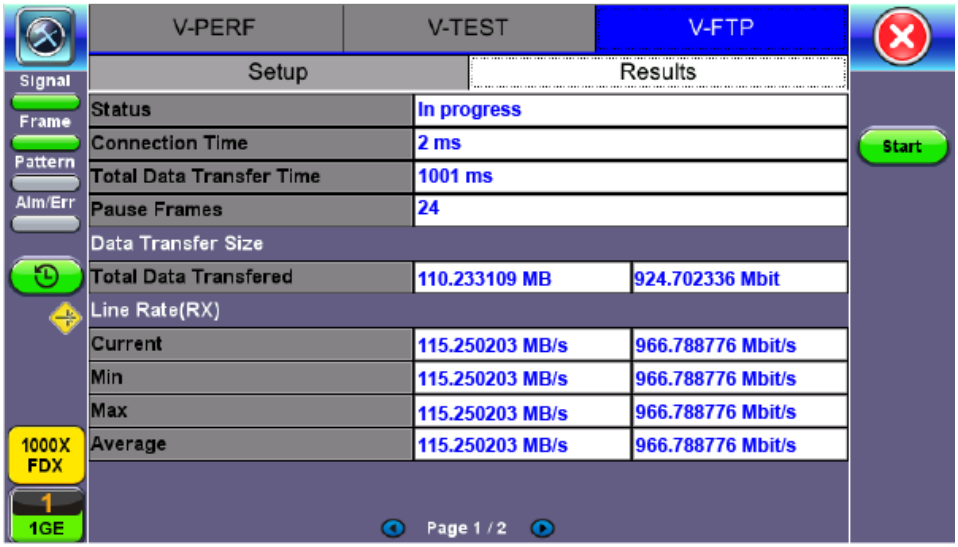
Running Download/Upload Tests

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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13.8 SyncE

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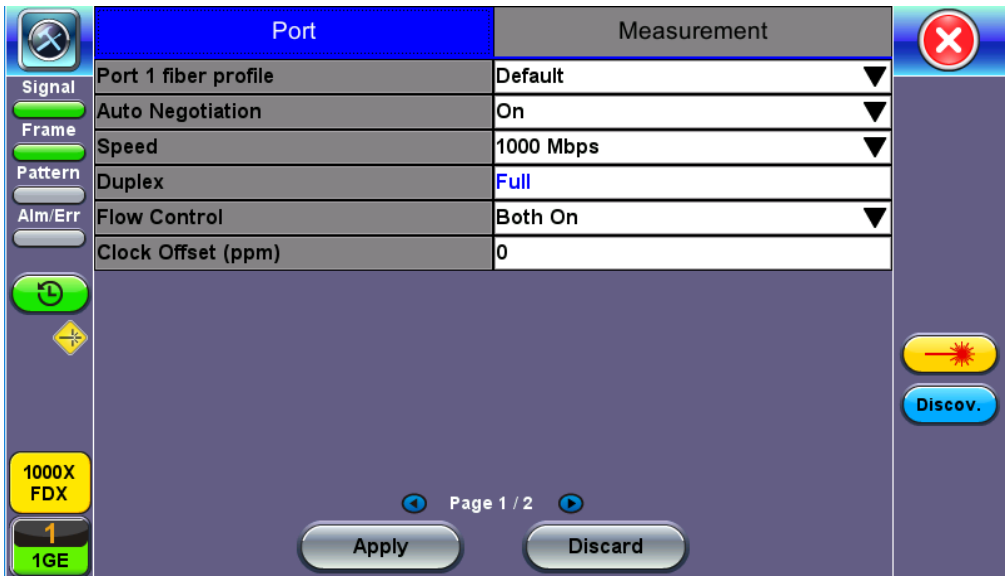
13.8.1 SyncE Setup

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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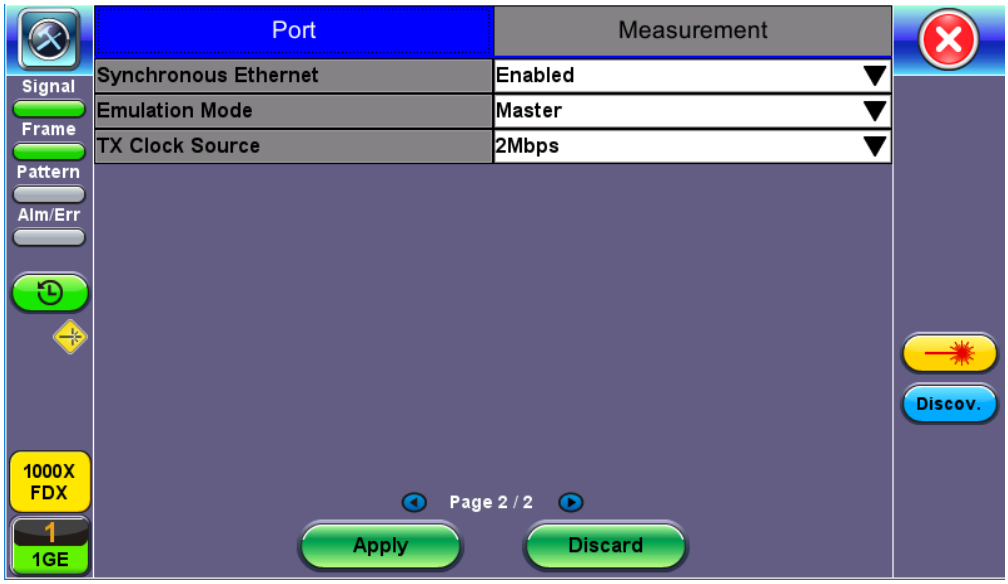
Port Page 2 - Mode Selection

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 andfor 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.
  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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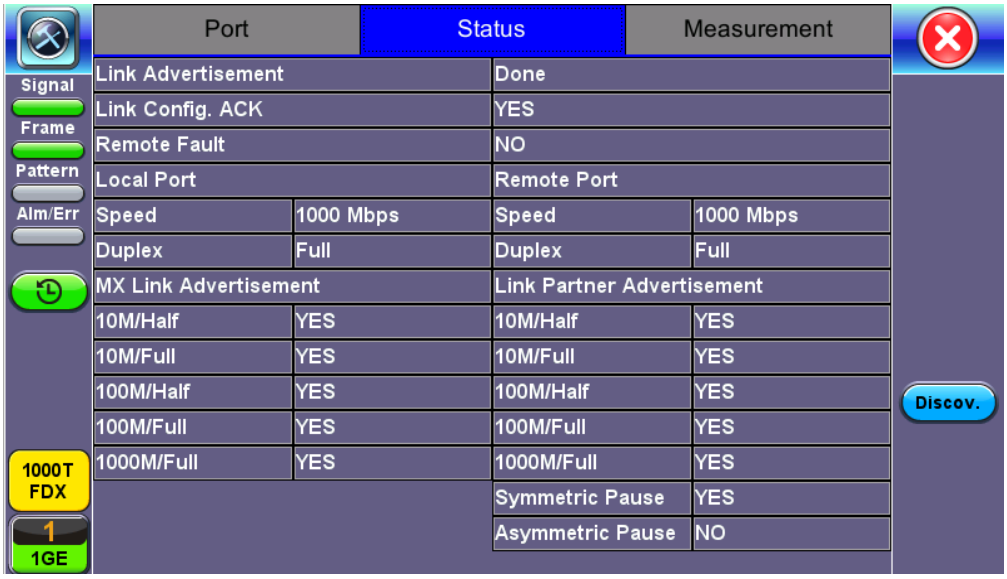
Status



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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13.8.2 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 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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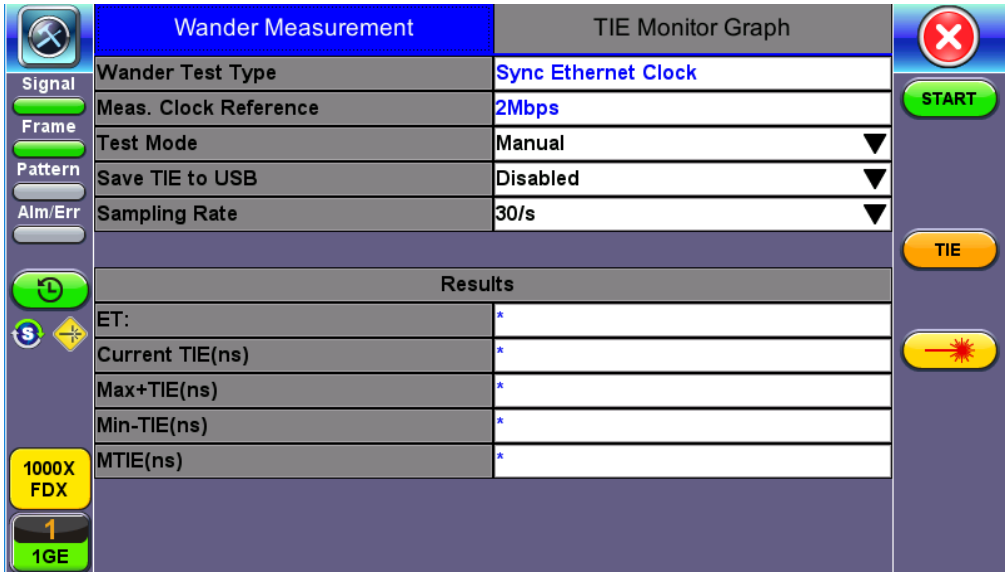
13.8.2.1 Setup



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.

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

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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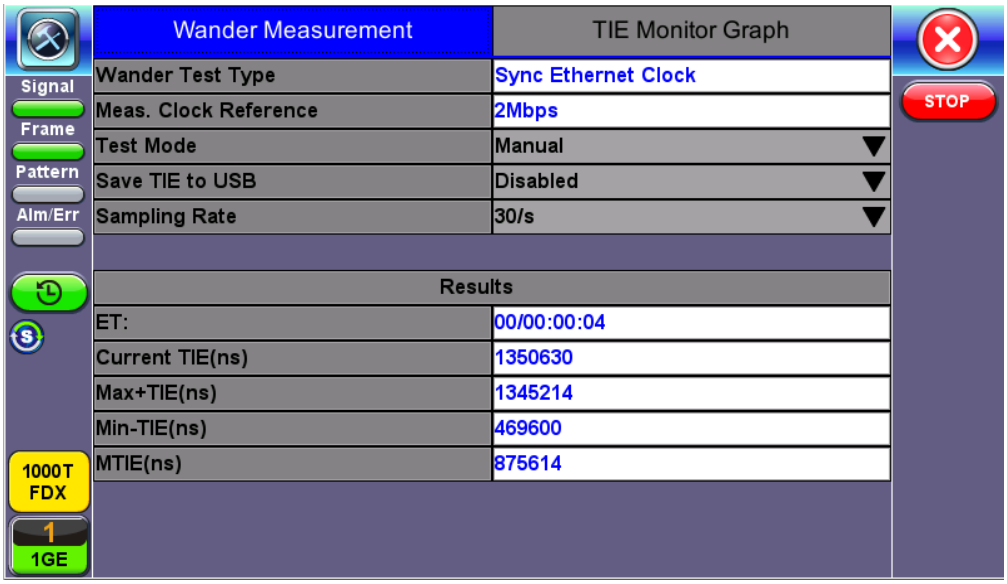
13.8.2.2 Results



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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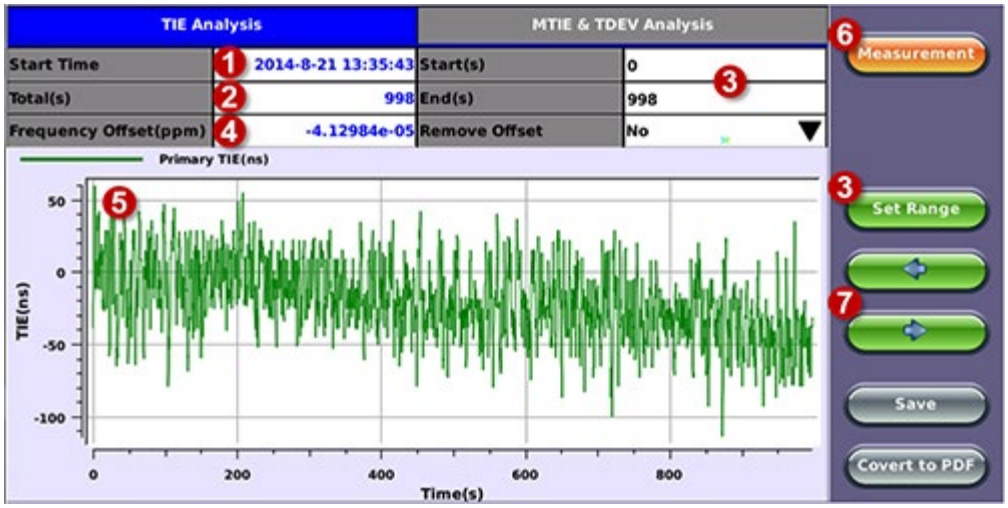
13.8.2.3 Built-in MTIE & TDEV Analysis (Optional)

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

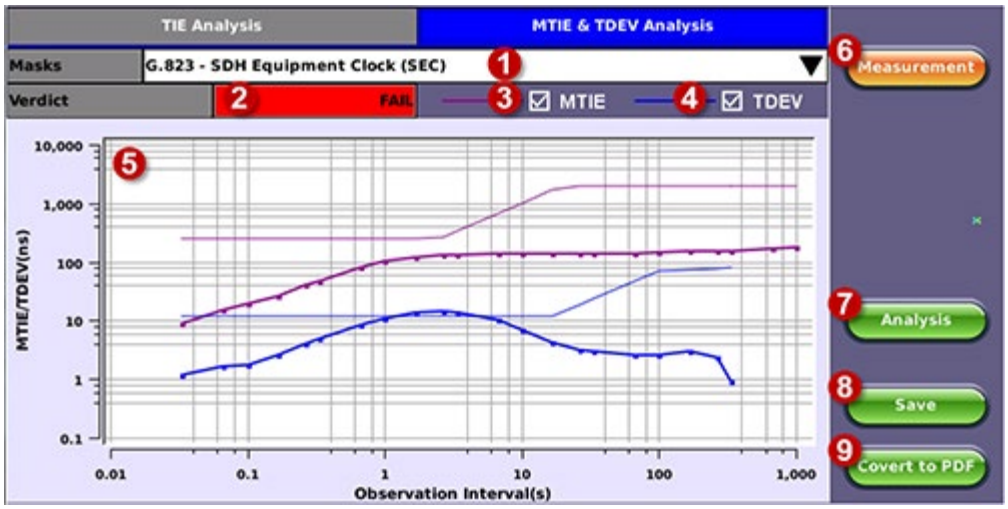


TIE Results

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

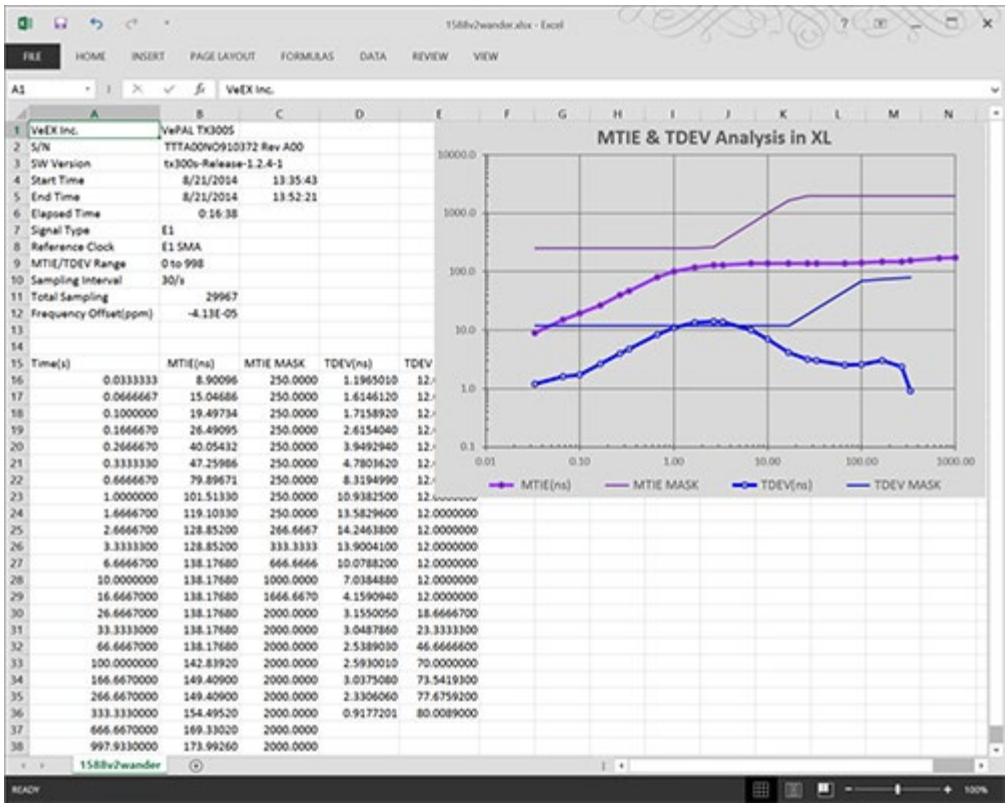


MTIE Results

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



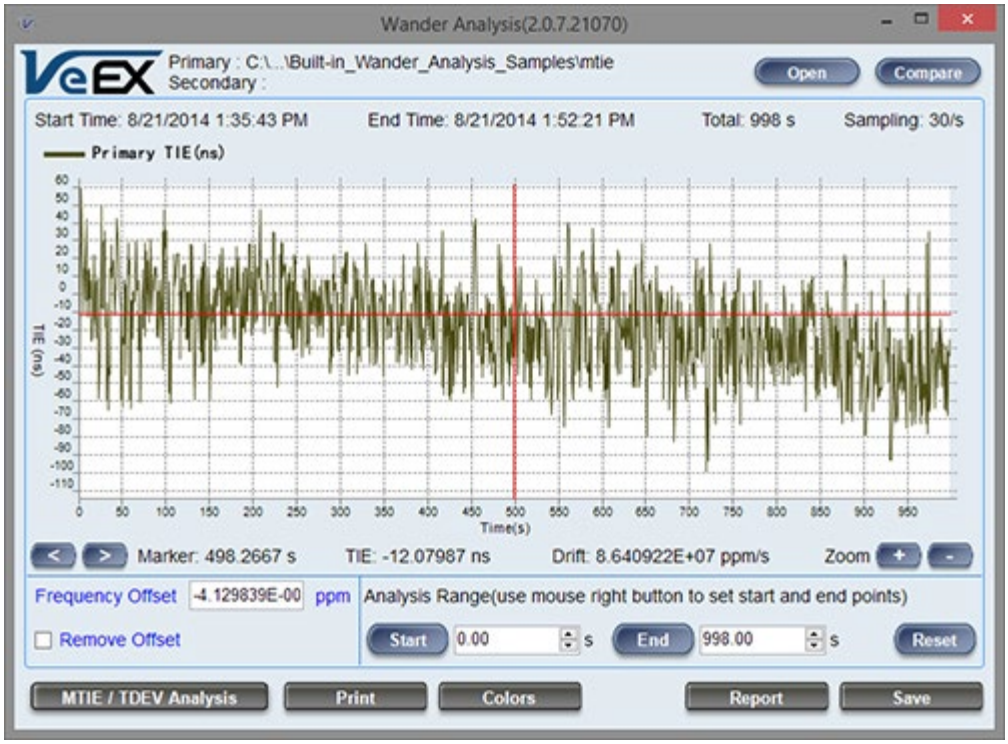
13.8.2.4 VeEX MTIE/TDEV Wander Analysis PC Software

- 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.

13.8.2.5 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.



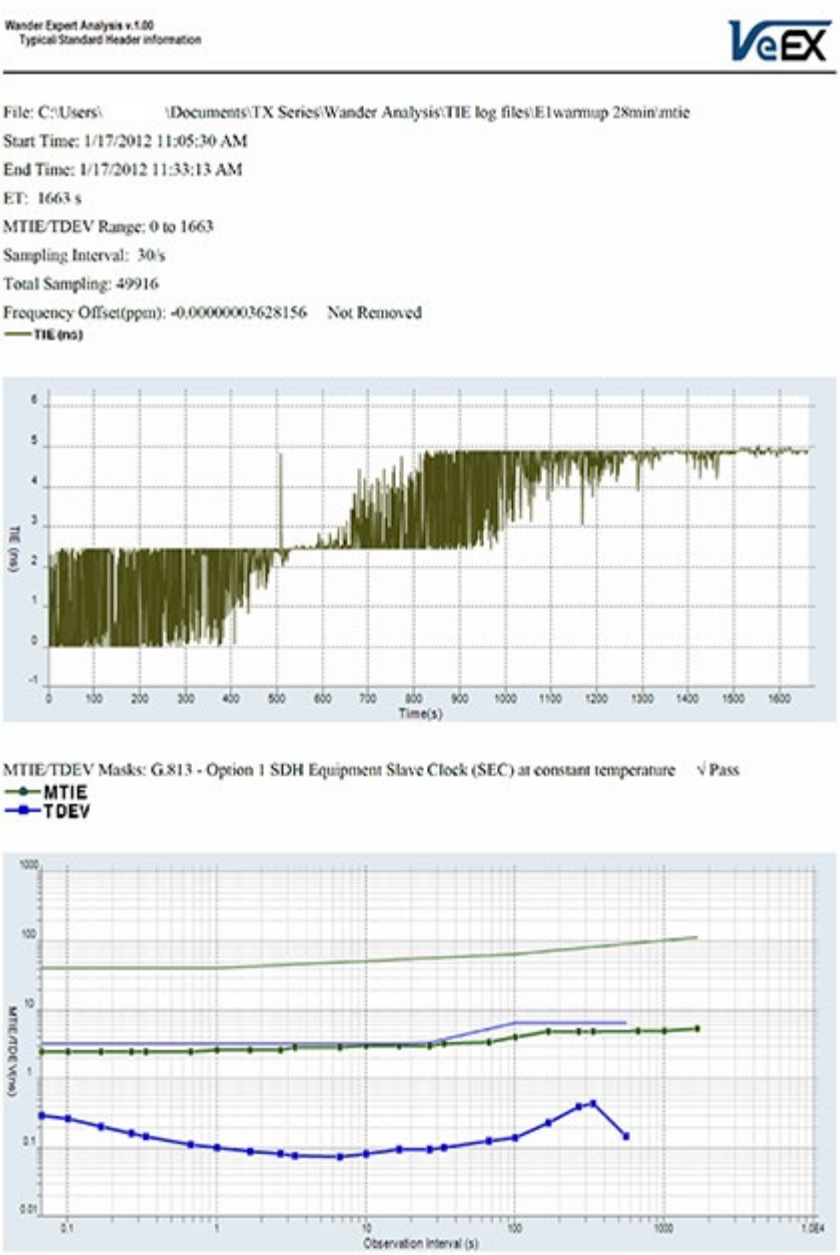
Click on the MTIE/TDEV Analysis button to go to the wander analysis function.

13.8.2.6 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.

13.8.2.7 MTIE & TDEV Analysis Report in PDF

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



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13.8.3 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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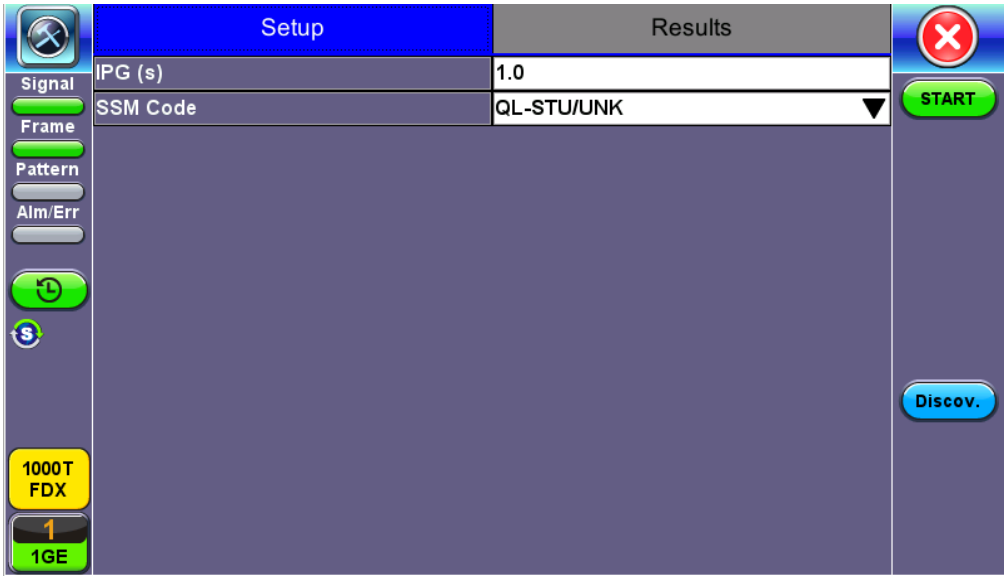
Setup

- **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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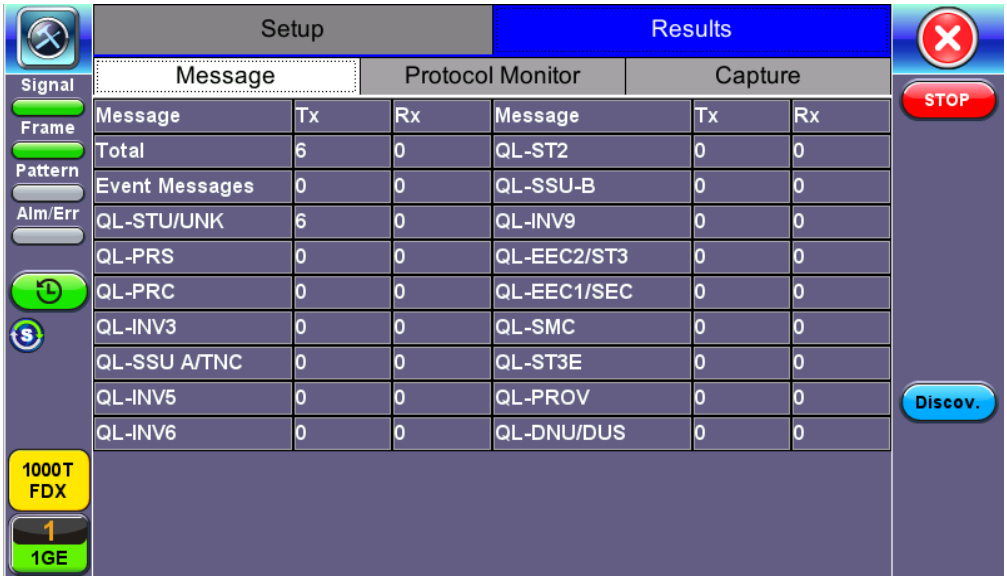
Results

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.



SyncE ESMC SSM Results- Message

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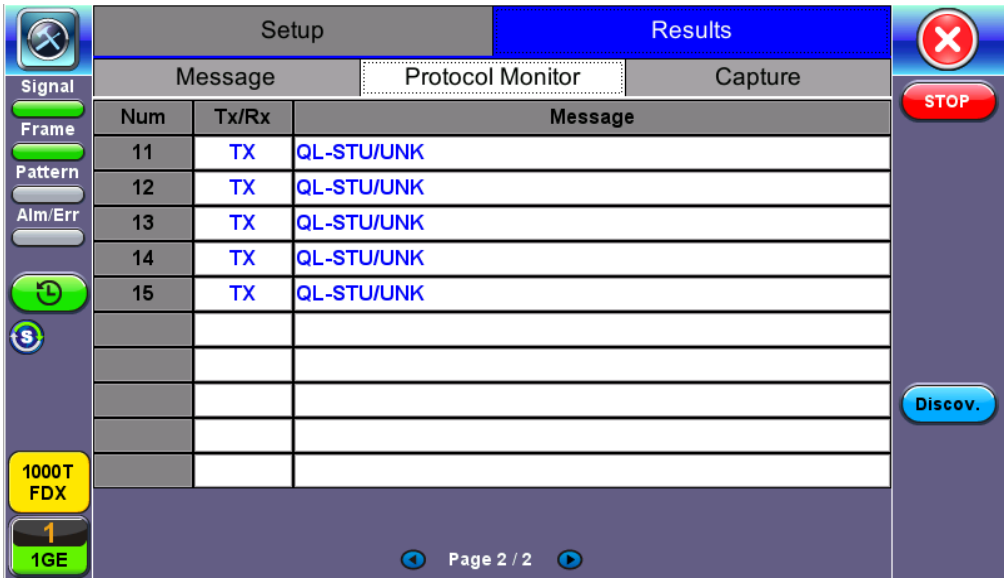
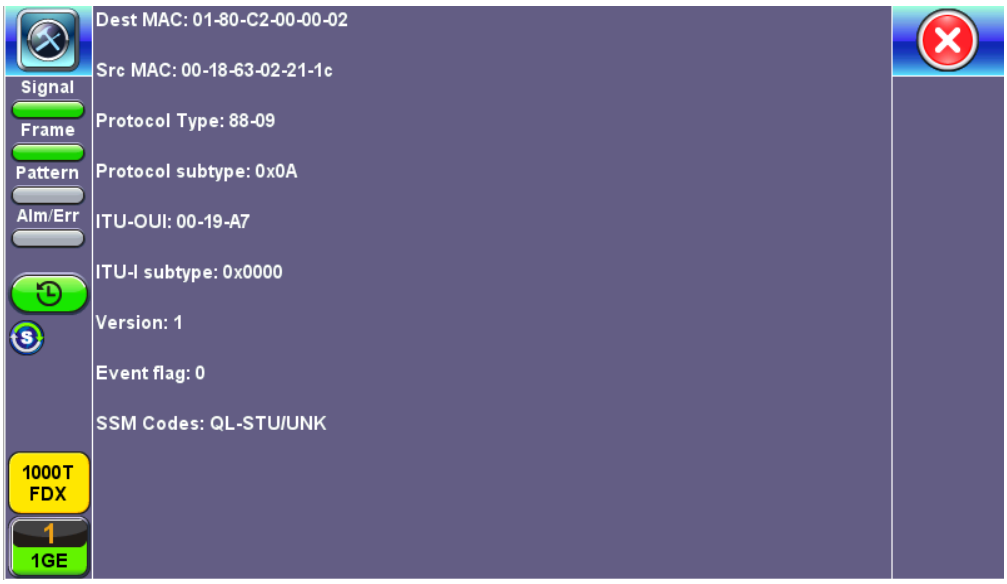
Monitor

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.



SyncE ESMC SSM Results- Protocol Monitor



Message Details

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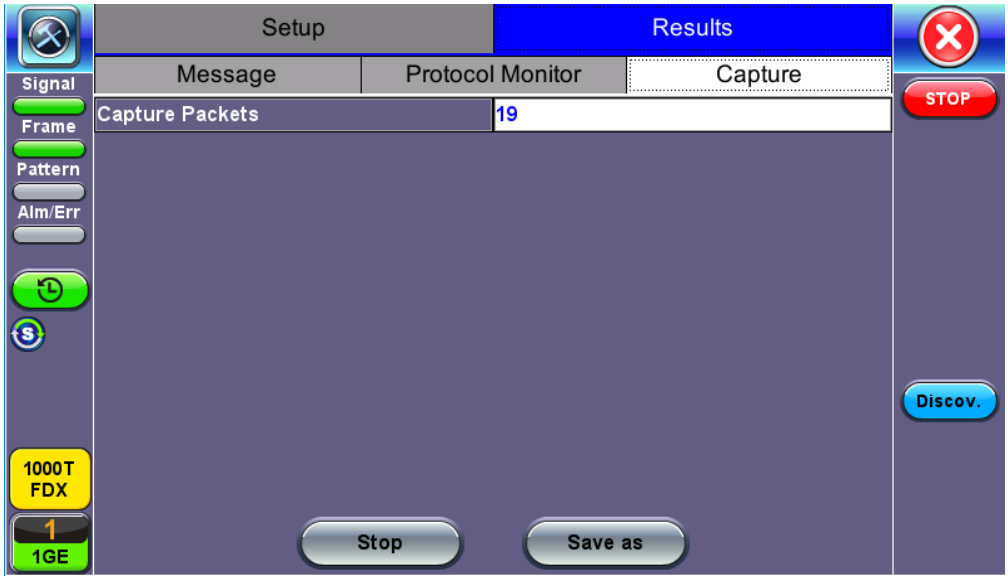
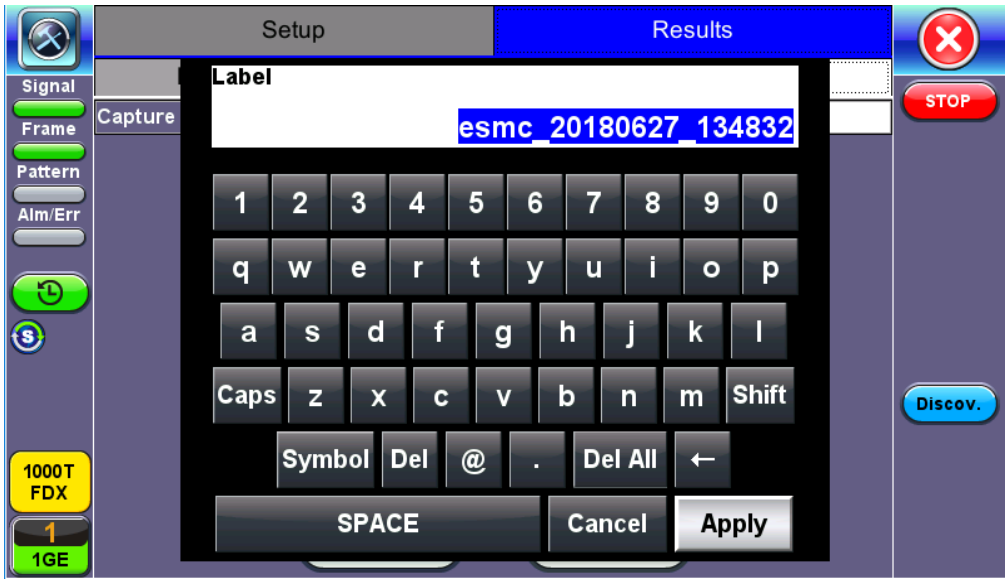
Capture

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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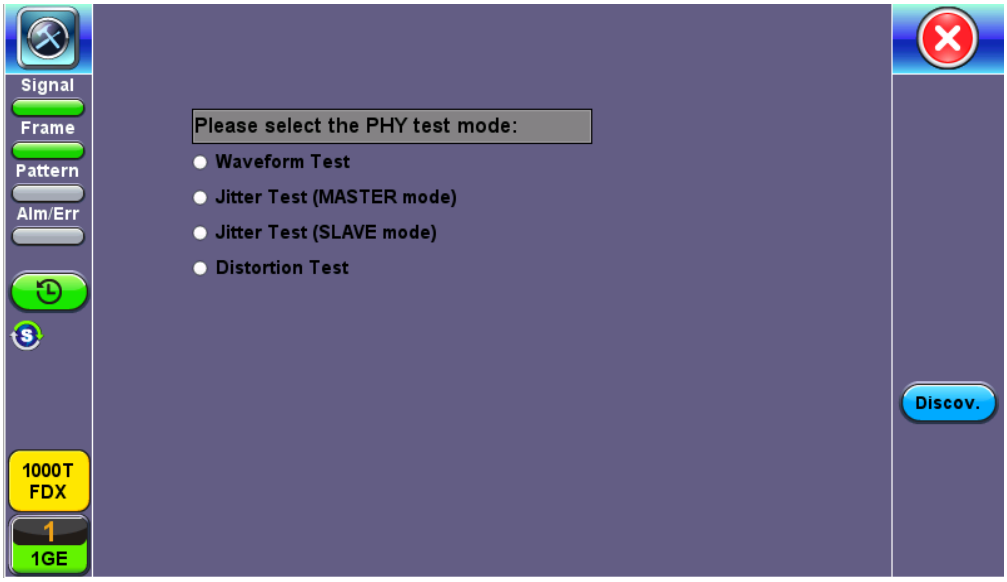
13.9 Phy Mode

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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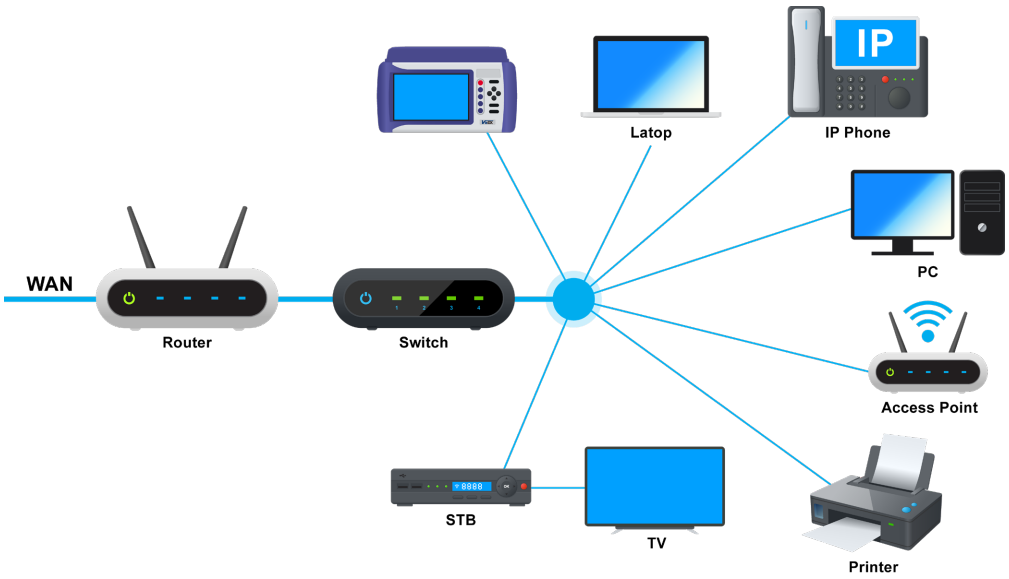
13.10 Net Wiz

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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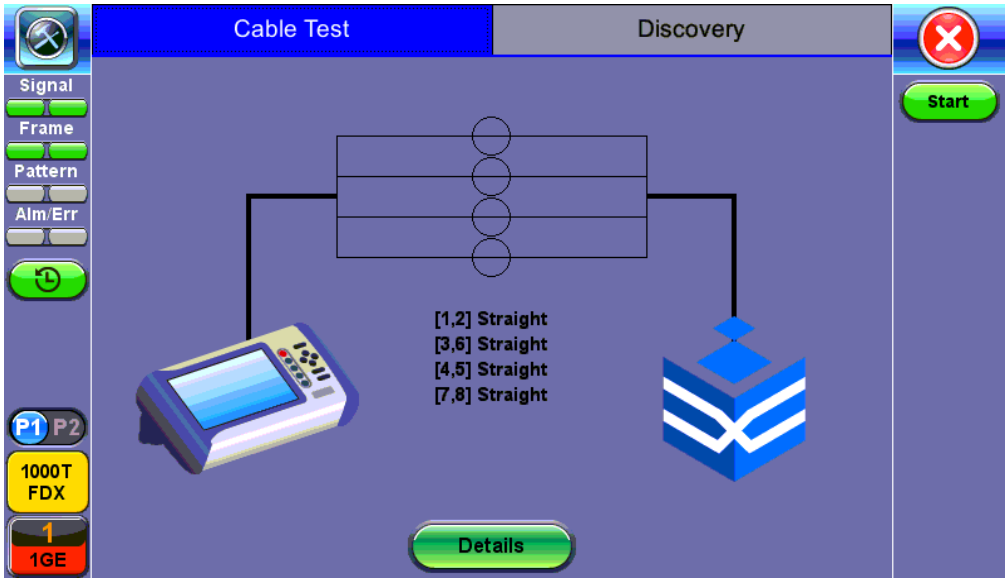
Cable Test



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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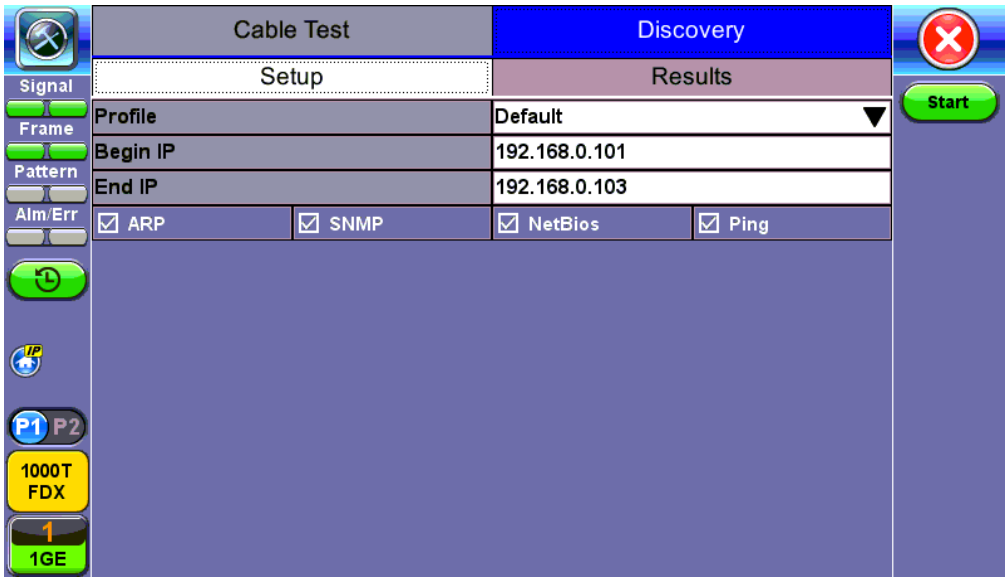
Discovery Setup



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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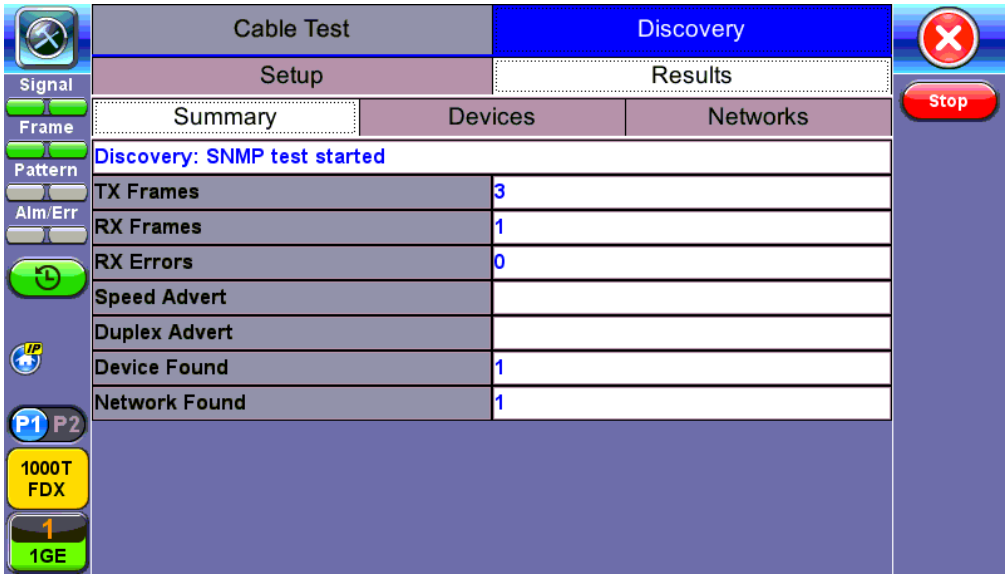
Discovery Results



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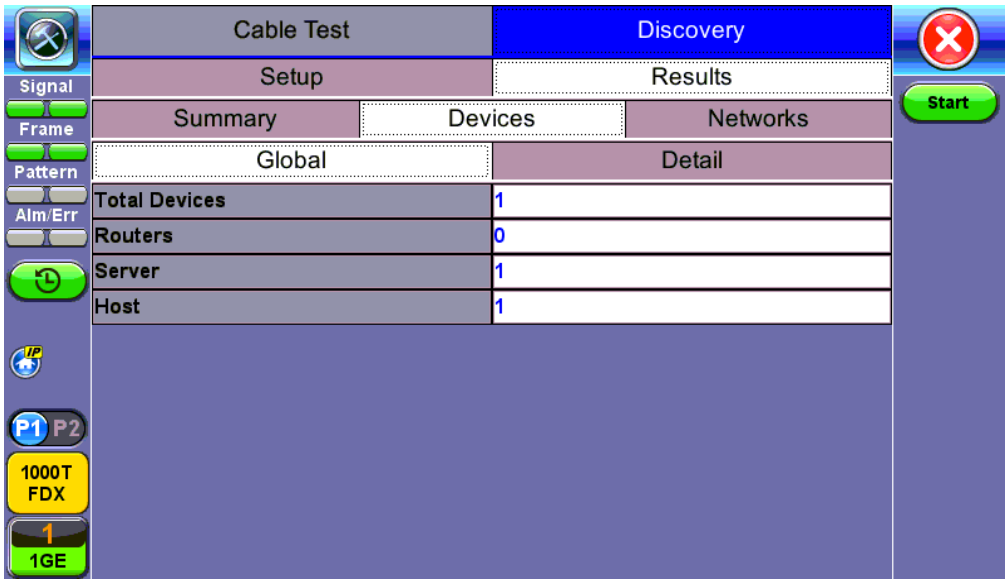
The **Devices** tab reports global and detailed device information.



Discovery Results - Devices - Global

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Global reports:

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

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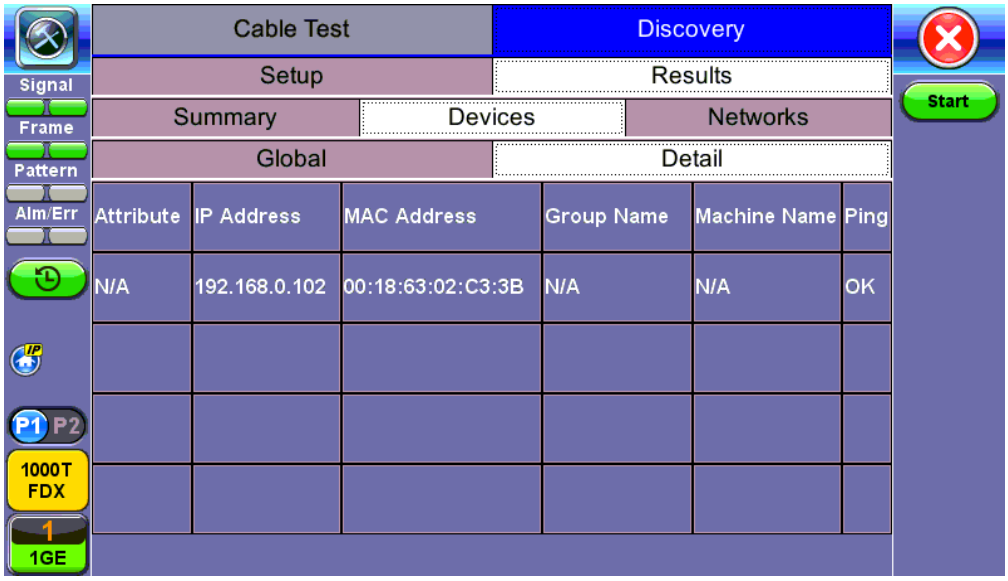

Discovery Results - Devices - Detail

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

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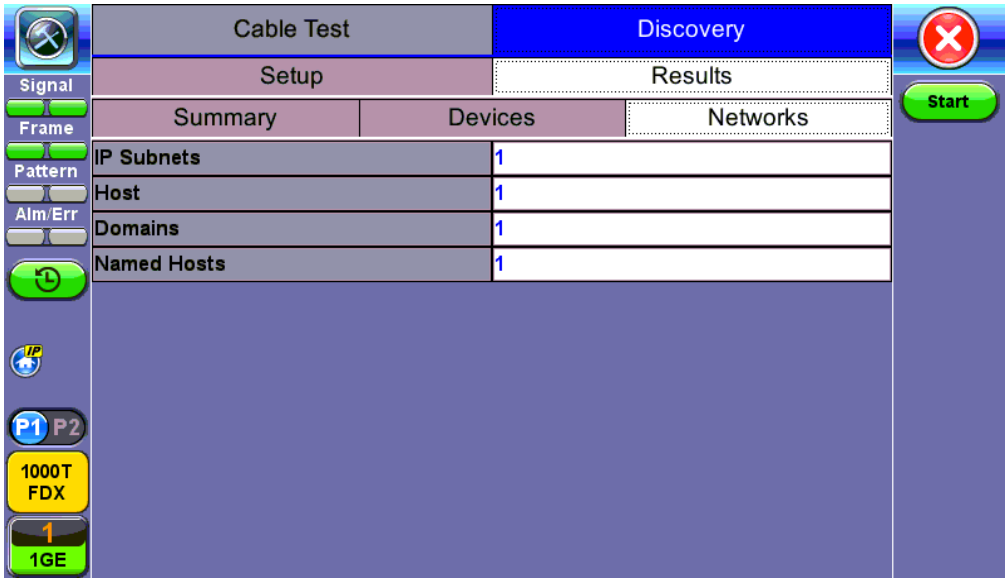

Discovery Results - Networks

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

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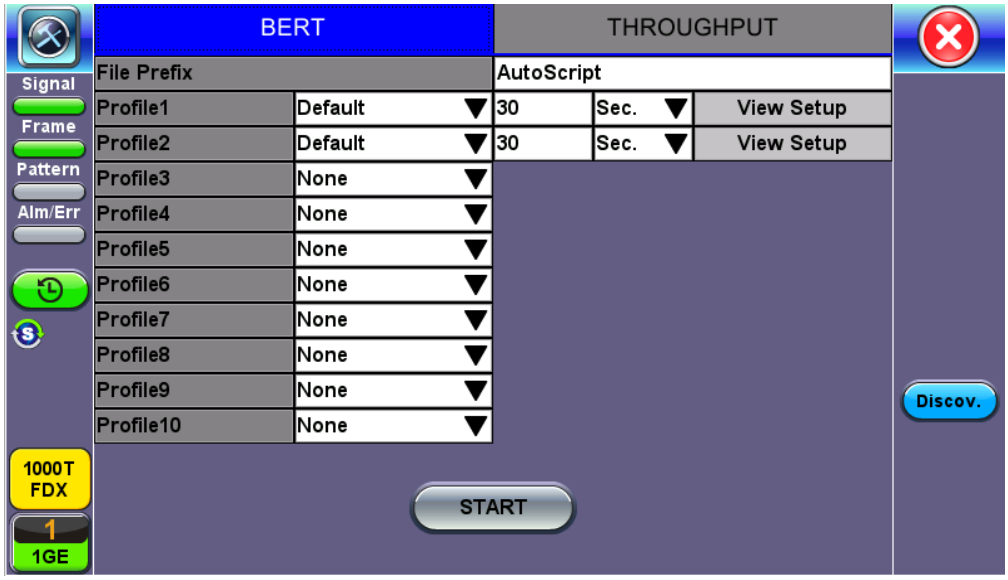
13.11 Autoscripting

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



Autoscripting - BERT Setup

Autoscripting Setup

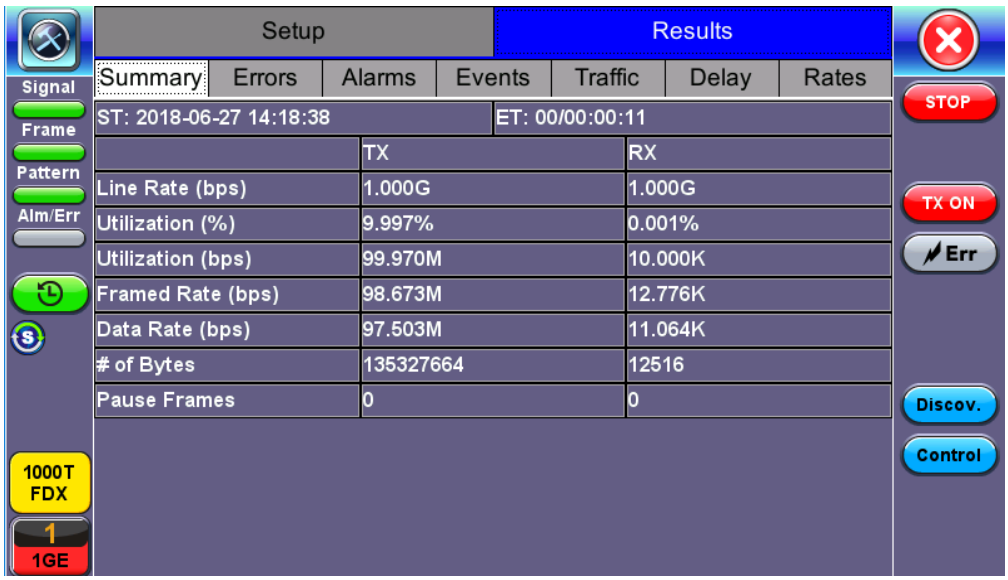
- **File Prefix:** Prefix added to name of test results. The default prefix is "Autoscript."
- **If Alarm/Error detected:** Choose to **Continue** or **Exit** testing if an alarm/error is detected.
- **Profile:** Select Default, Last Configuration, or None.
- Testing duration can be set for seconds,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

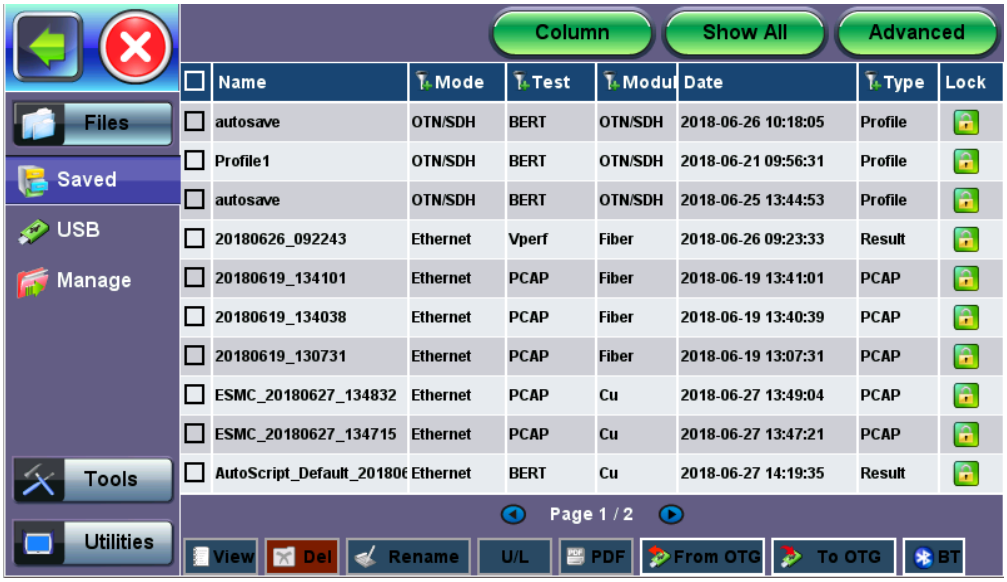
The soft LED light indicates the status of finished tests:

- **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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13.12 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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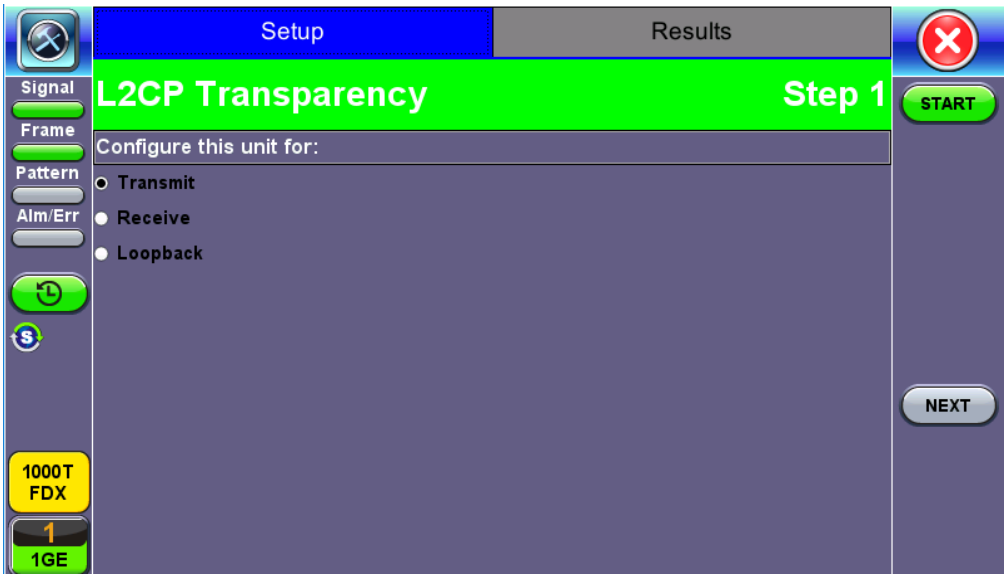
Setup

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

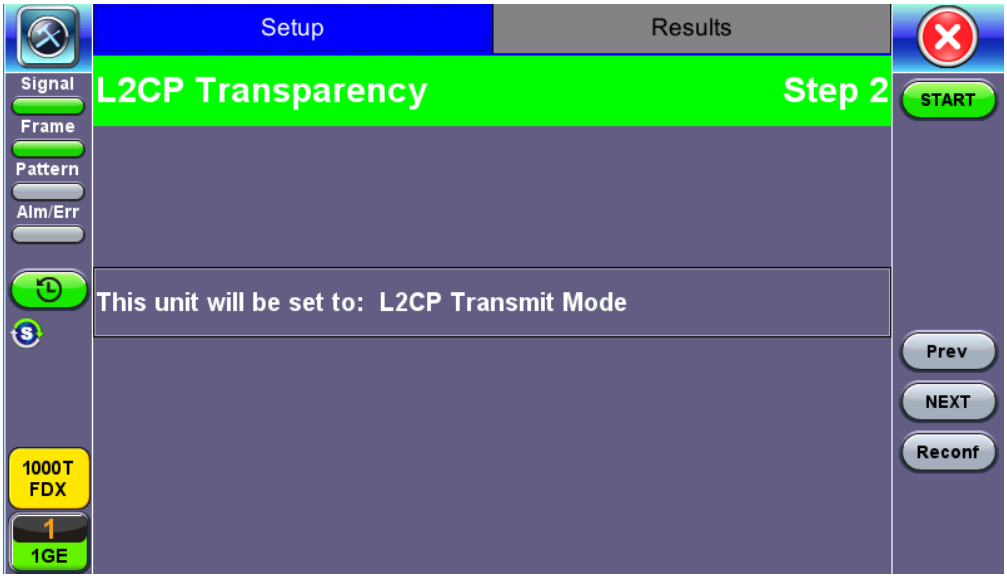
- **Transmit:** Unit is setup to transmit and Receive L2CP frames. If the unit is selected as a transmitter, the option to **Automatically Loop Up/Down** becomes available.
- **Receive:** Unit is setup to only Receive L2CP frames.
- **Loopback:** Unit loops incoming L2CP frames at Layer 1.



L2CP Transparency Test - Step 1

Step 2

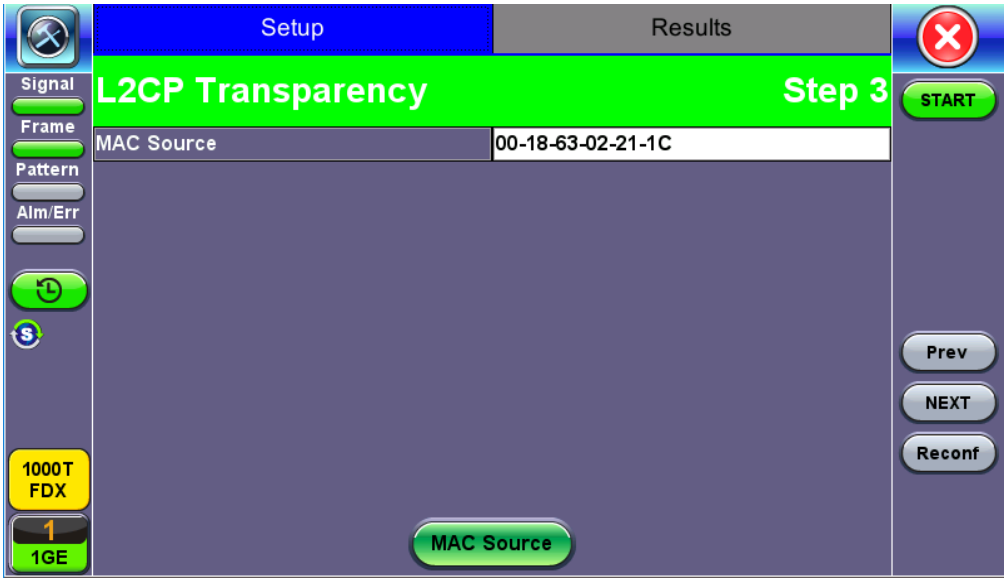
Step 2 confirms the test mode selection. If the unit is set to Receiver mode, setup is complete.



L2CP Transparency Test - Transmitter - Step 2

Step 3

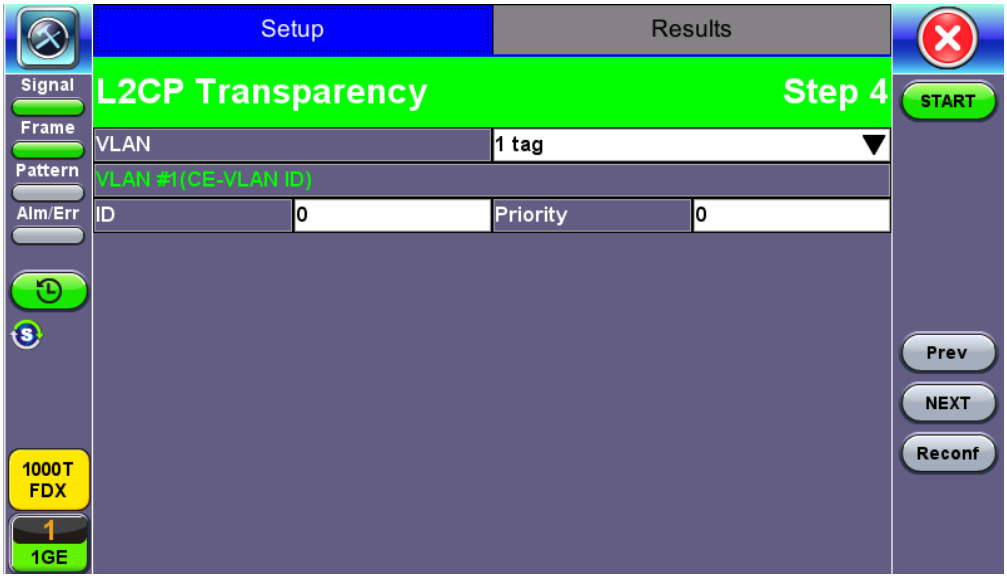
- If the unit is set to Receiver mode, setup for the receiver is complete.
- For Transmit mode, configure the MAC address that will be used as MAC Source for all the test frames or press the “MAC Source” function key to overwrite with the MAC address of the test set.



L2CP Transparency Test - Transmitter - Step 3

Step 4

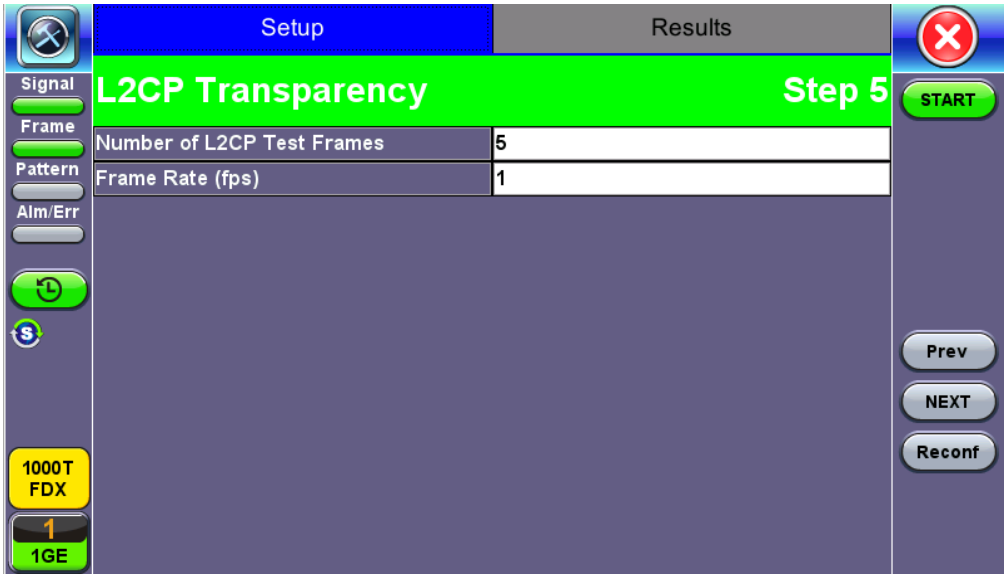
Configure the VLAN Tag(s) that will be used for the test frames. VLAN can be disabled or enabled with up to 3 tags.



L2CP Transparency Test - Transmitter - Step 4

Step 5

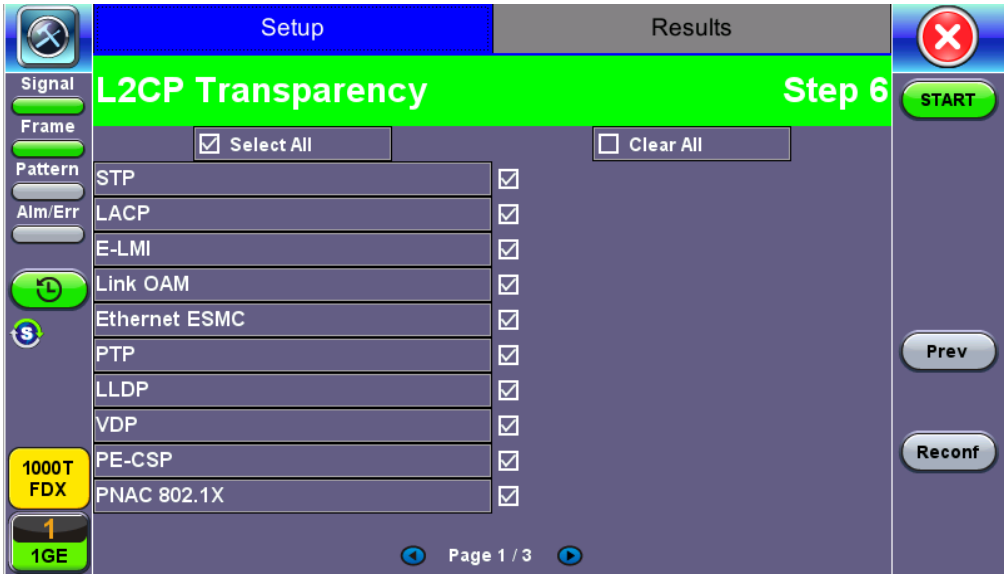
Select the number of test frames that will be transmitted for each L2CP. Configurable from 1 to 100. Configure Test Frame Rate: From 1 to 10 frames per second.



L2CP Transparency Test - Transmitter - Step 5

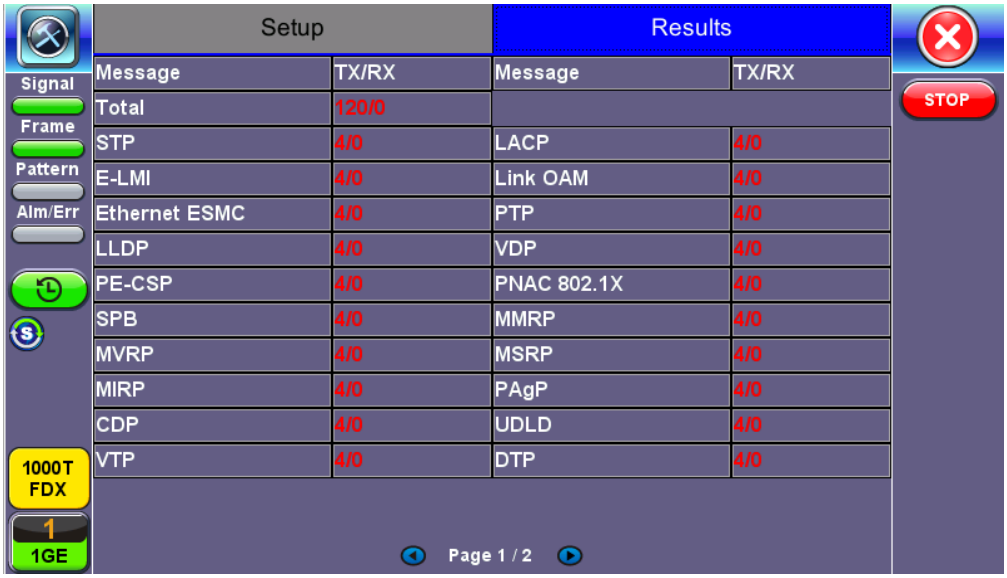
Step 6

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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14.0 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 acknowledgement frame it receives. However, as the distance between nodes or link partners increases, so does the time it takes for the transmitting node to receive the R_RDY frame because of signal propagation delay. The standard practice for a 1Gbps Fibre Channel link is to allow 1 buffer credit for each 2km of distance.

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14.1 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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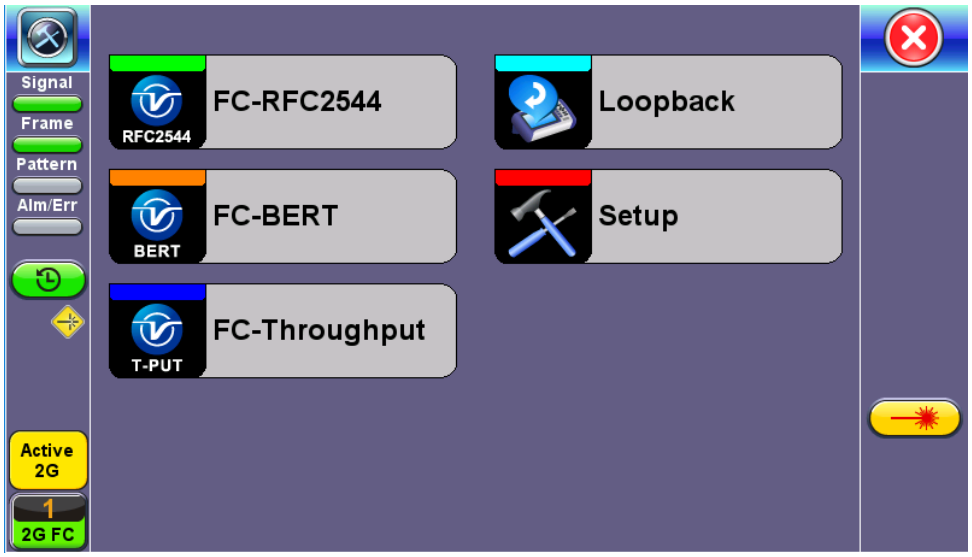
14.1.1 Test Applications

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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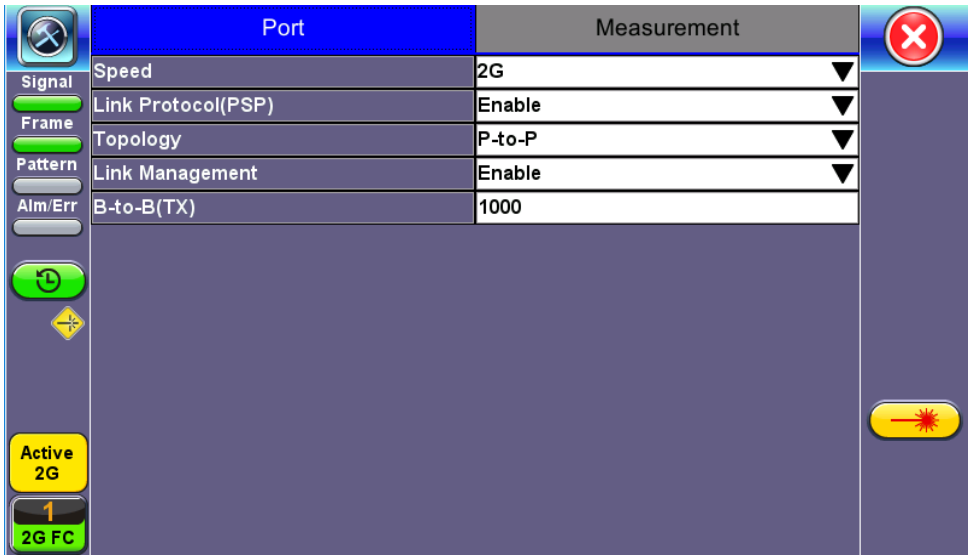
14.1.2 Port Configuration



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)

- **Link Protocol:** Enables or Disables the PSP
  - Enabling the Primitive Sequence Protocol (PSP) allows link management
  - Disabling the Primitive Sequence Protocol (PSP) forces the port into an Active state with no link management
    - PSP is an Ordered Set transmitted repeatedly which is used to establish and maintain a link.
    - PSP also when this setting is enabled
    - When a Primitive Sequence is received and recognized, a corresponding Primitive Sequence or Idle is transmitted in response. Recognition of a Primitive Sequence requires consecutive detection of 3 instances of the same Ordered Set.
    - The Primitive Sequences supported by the standard are:
      - Offline (OLS)
      - Not Operational (NOS)
      - Link Reset (LR)
      - Link Reset Response (LRR)

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

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

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

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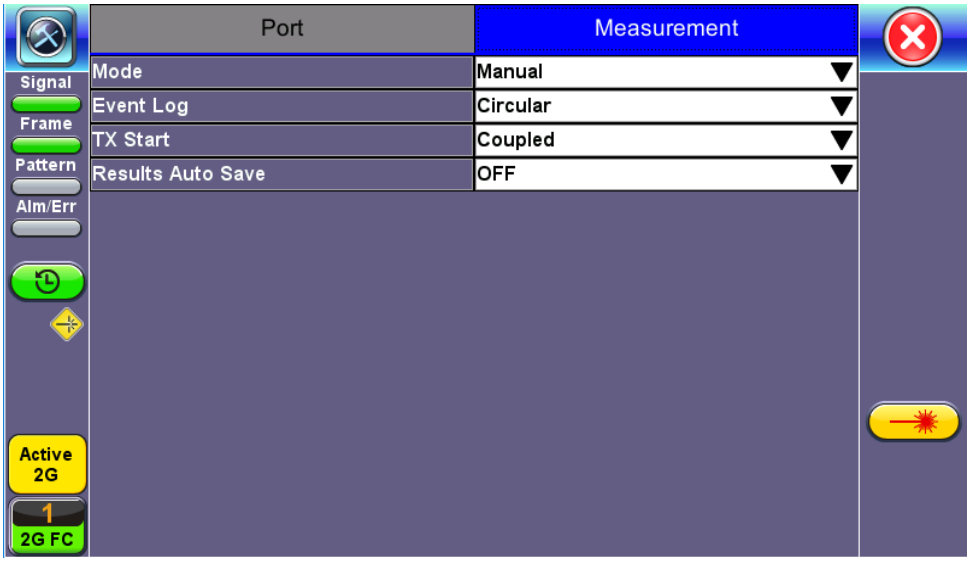

Fiber Channel - Measurement Setup

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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14.2 BERT/Throughput

14.2.1 Overview

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

- 1/2/4G Fiber Channel: The unit verifies the 8B/10B PCS Layer with a basic primitive set at FC-1 or FC-2 lower layers.

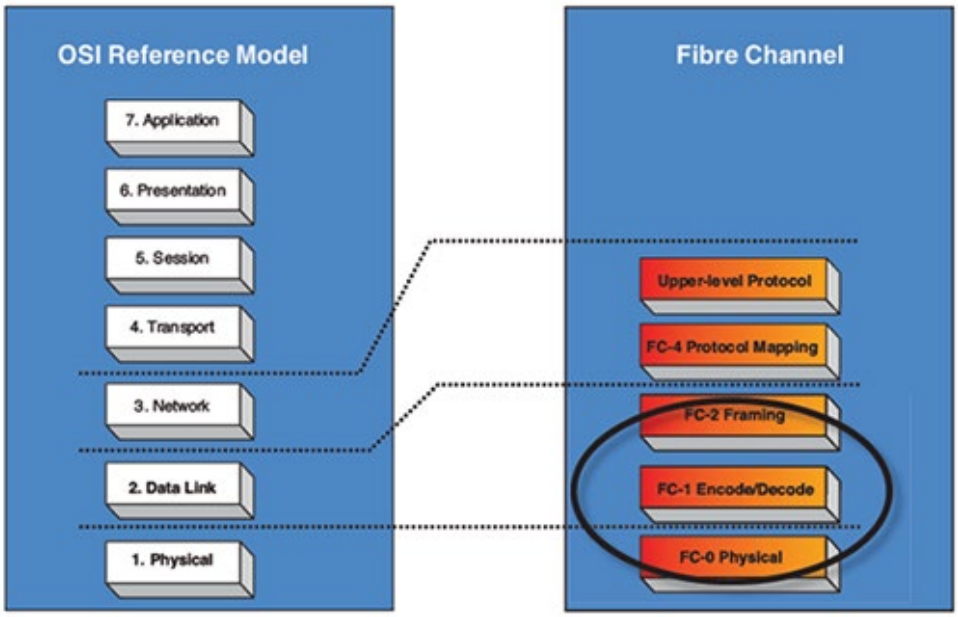
The unit supports the generation and monitoring of: bit errors, order sets, frame delimiters, frame transmission, and generation of primitive sequences. BERT diagnostics perform a bit-by-bit comparison to find bit errors in the received data pattern. Error Count and Error Rate for the latest sample are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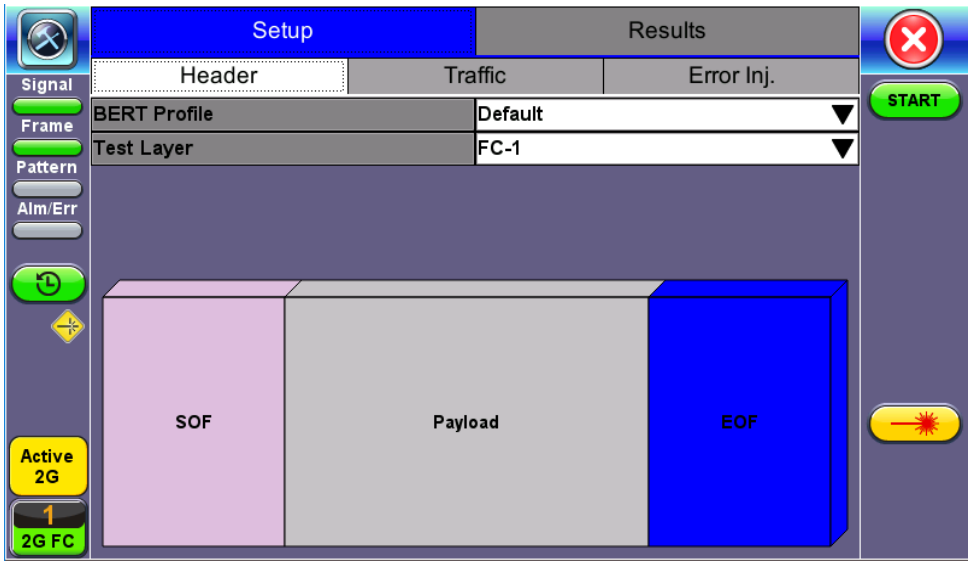
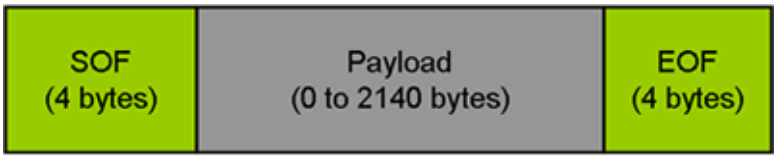
14.2.2 Setup



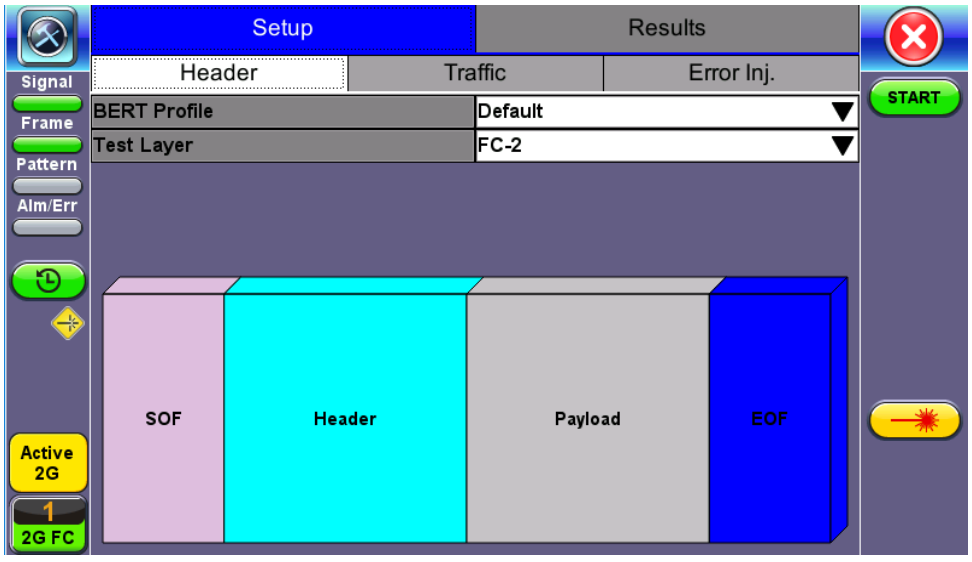
FC-1 BERT - Test Frame Setup

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.



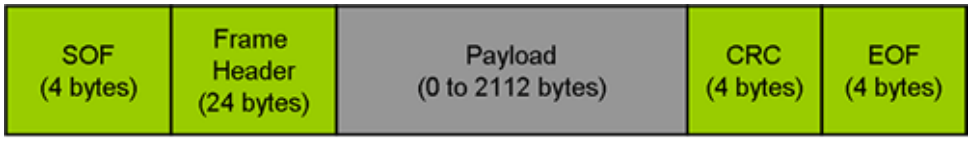
FC-1 Frame Structure



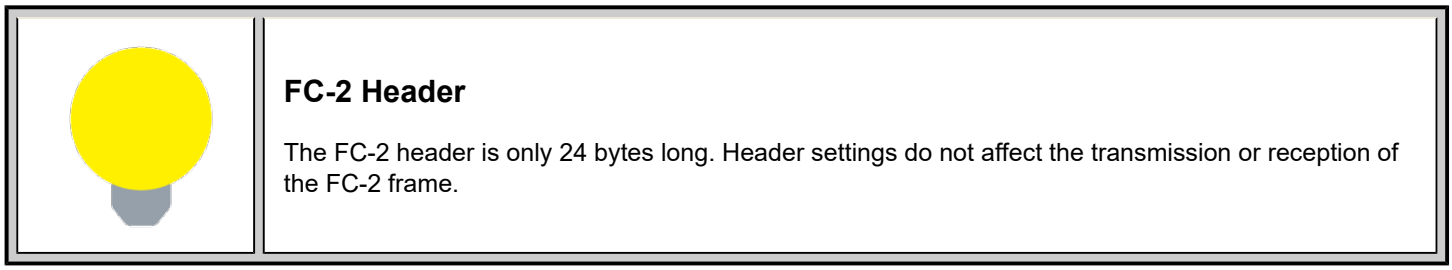
FC-2 BERT - Header Setup

- **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

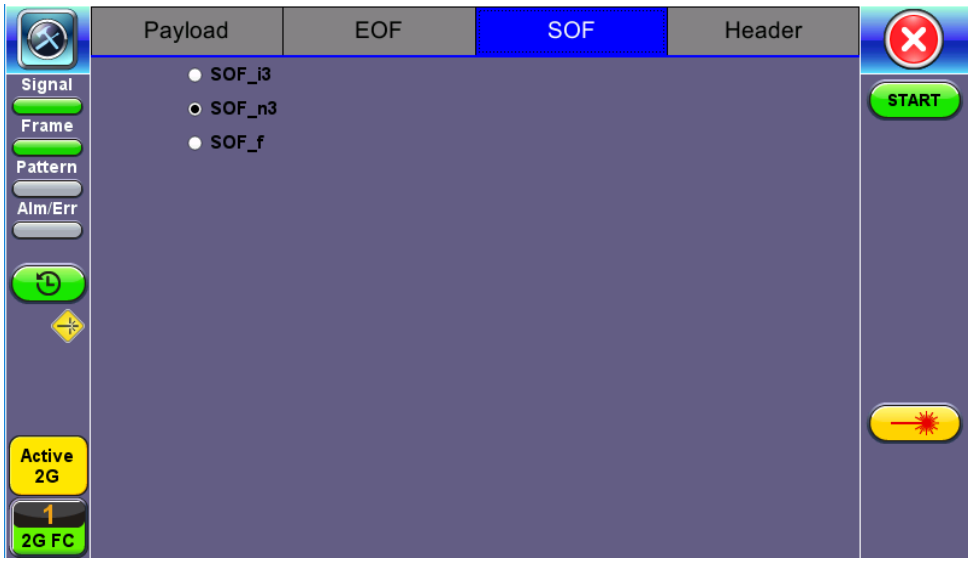
The Start-of-Frame (SOF) delimiter is an Ordered Set that immediately precedes the frame content. There are multiple SOF delimiters defined for Sequence control. SOF indicates that a Frame will immediately follow and indicates which class of service the Frame will use.

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



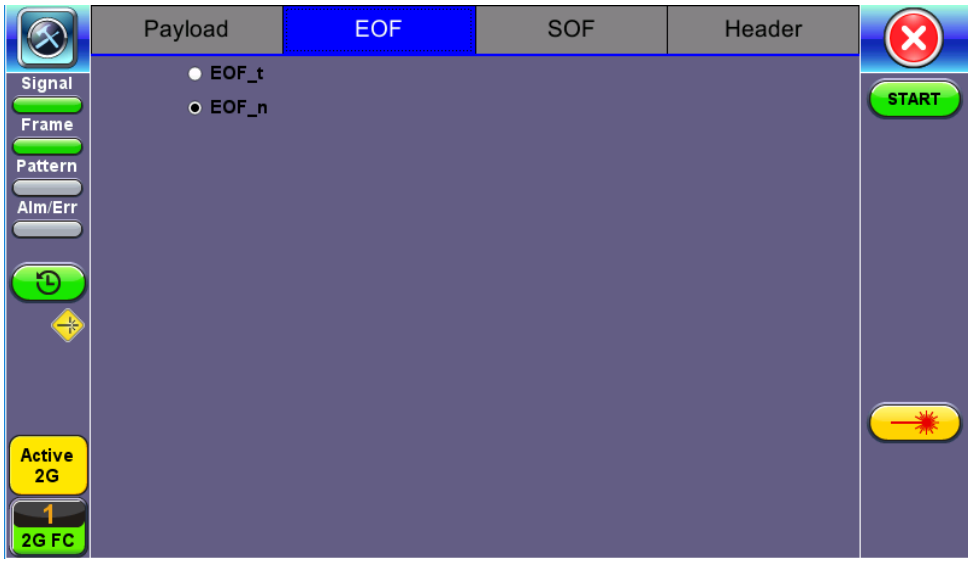
FC-2 BERT - SOF Setup

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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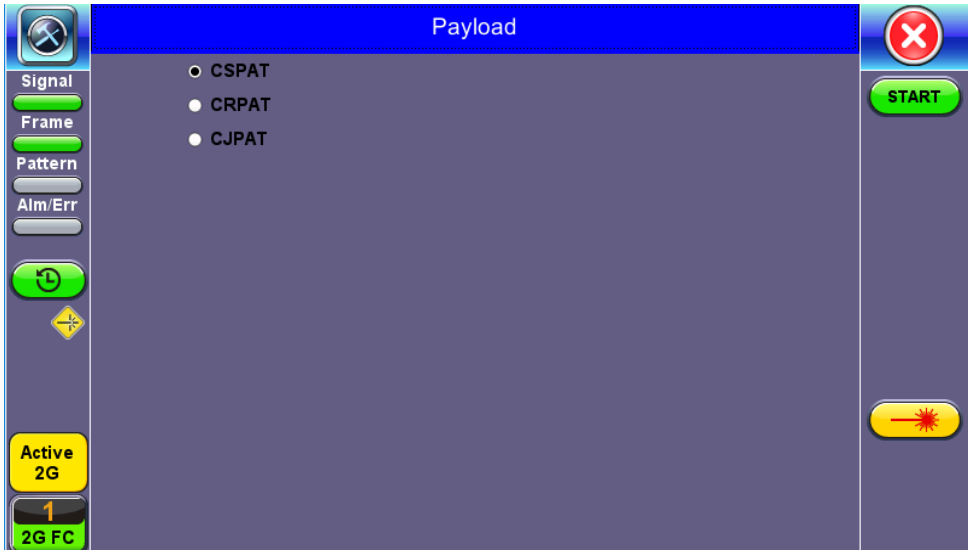
Payload

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.

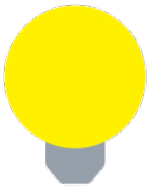
FC-1 Payload (test pattern)
Layer 1 test patterns are formatted using the 8B/10B symbol format and include the PCS layer as part of the BER pattern.

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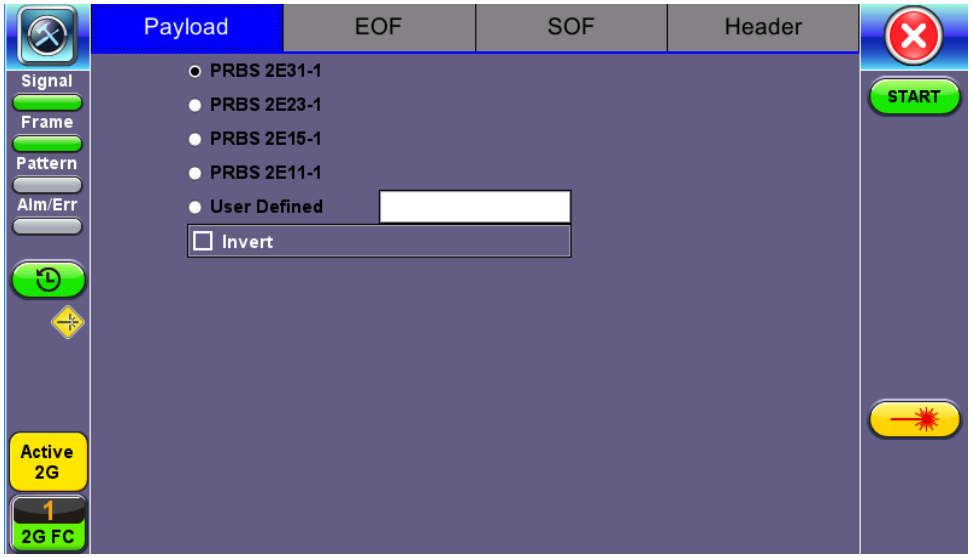
FC-2 Payload (test patterns)
Layer 2 "Compliant" test patterns are modified to resemble a true Fiber Channel frame - the pattern's format is similar to a basic frame which includes a Start of Frame Delimiter (SFD), End of Frame Delimiter (EFD), and Cyclic Redundancy Check (CRC).

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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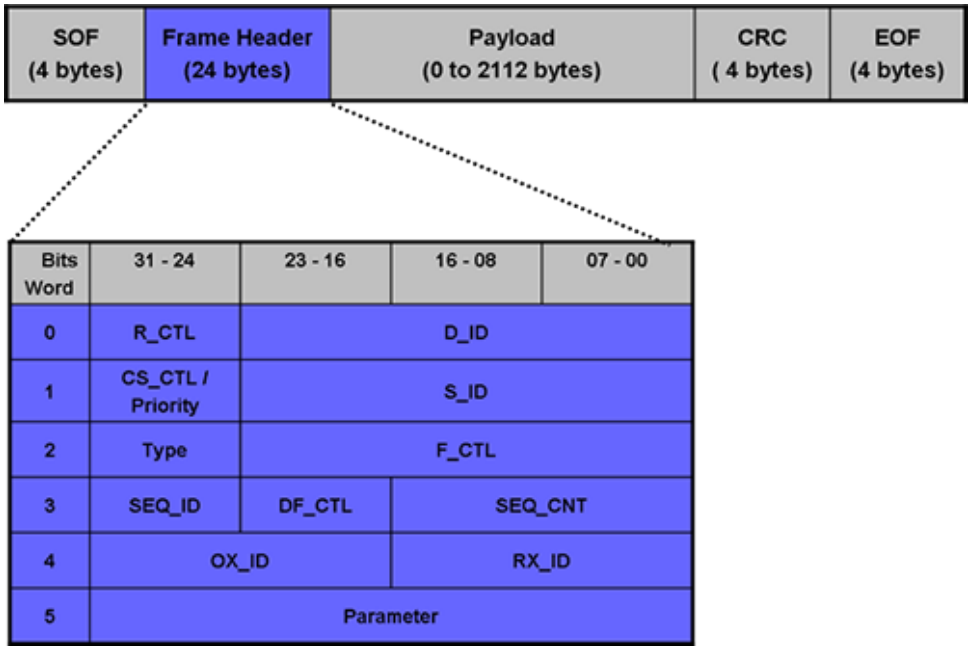
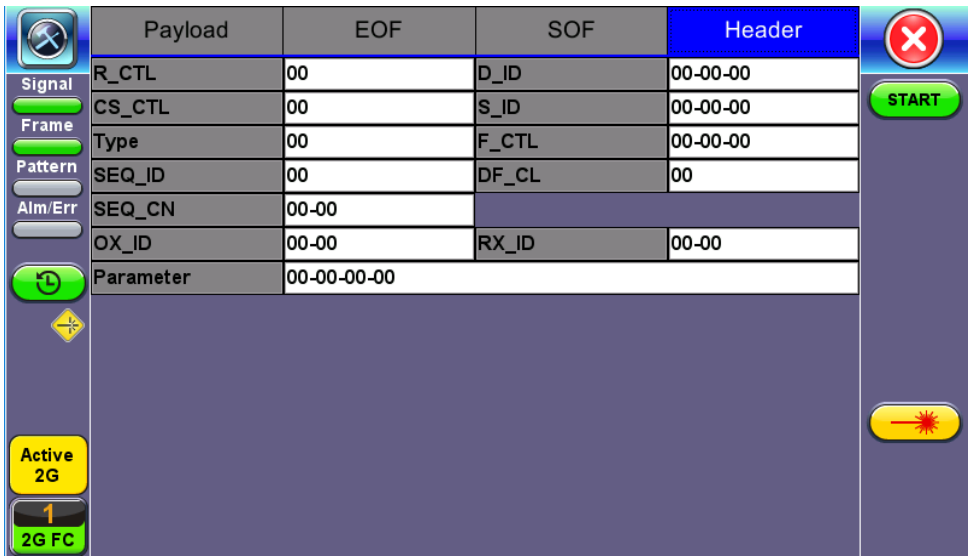
Header Setup (FC-2 only)

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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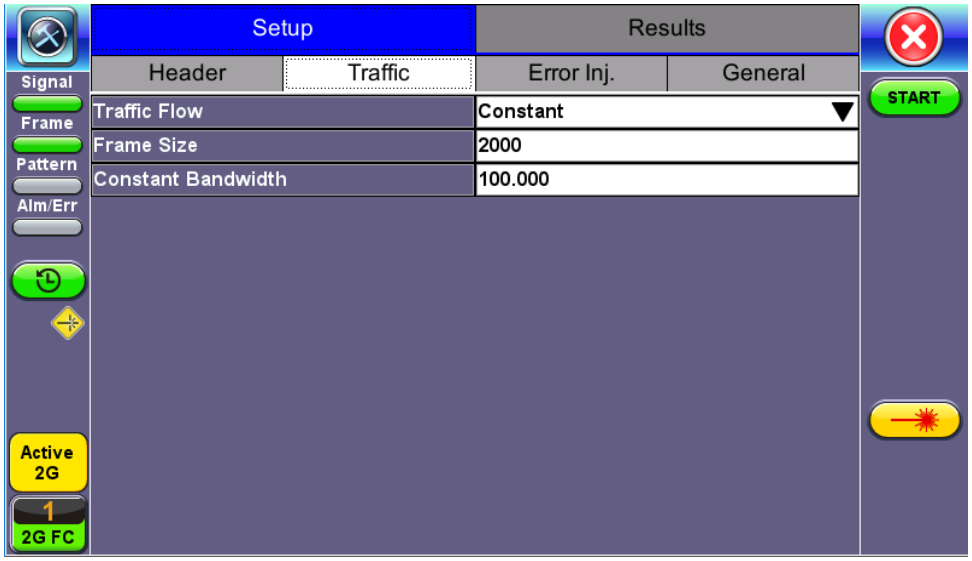
14.2.3 Traffic Generation and Error Injection

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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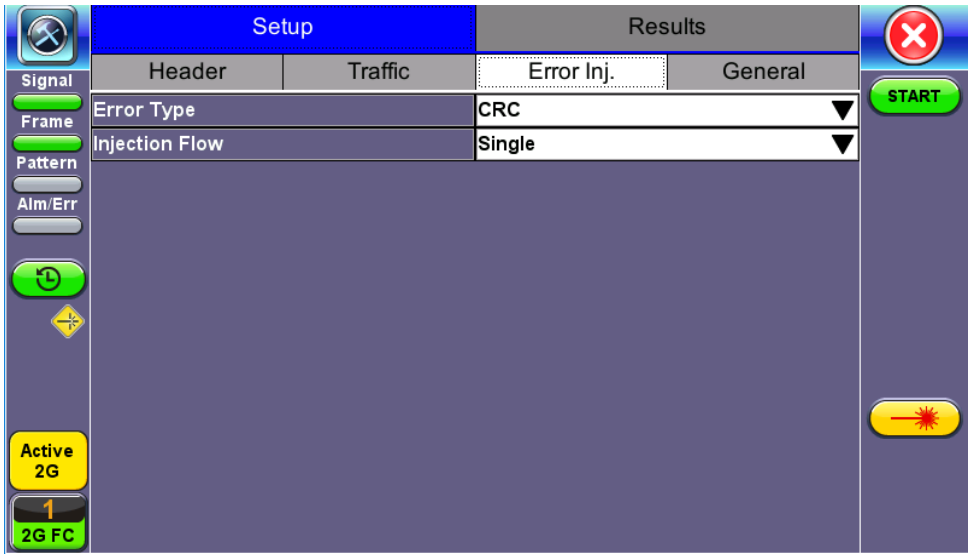
Error Injection Setup

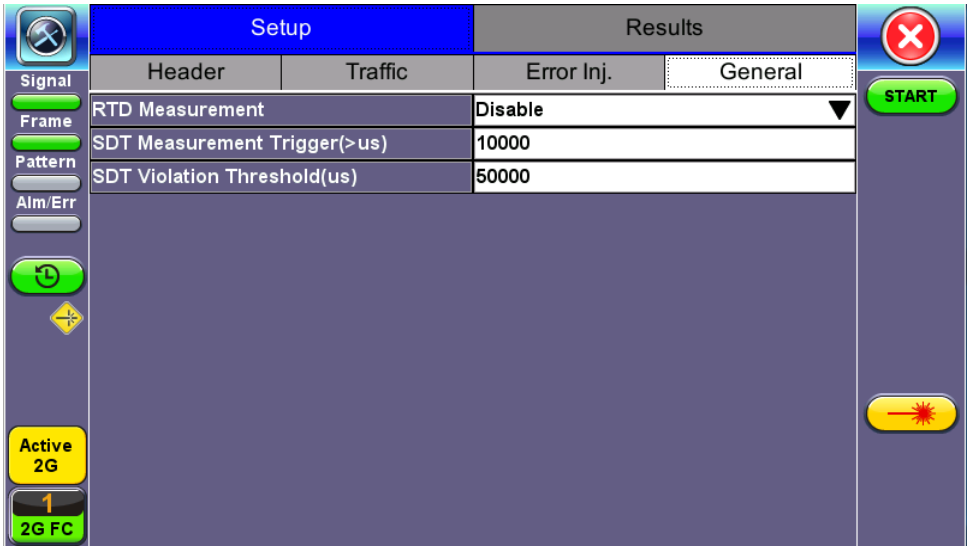
Error injection can be performed during a test. The type of errors and error injection rate or flow are configured in the Error Injection tab.

- **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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14.2.4 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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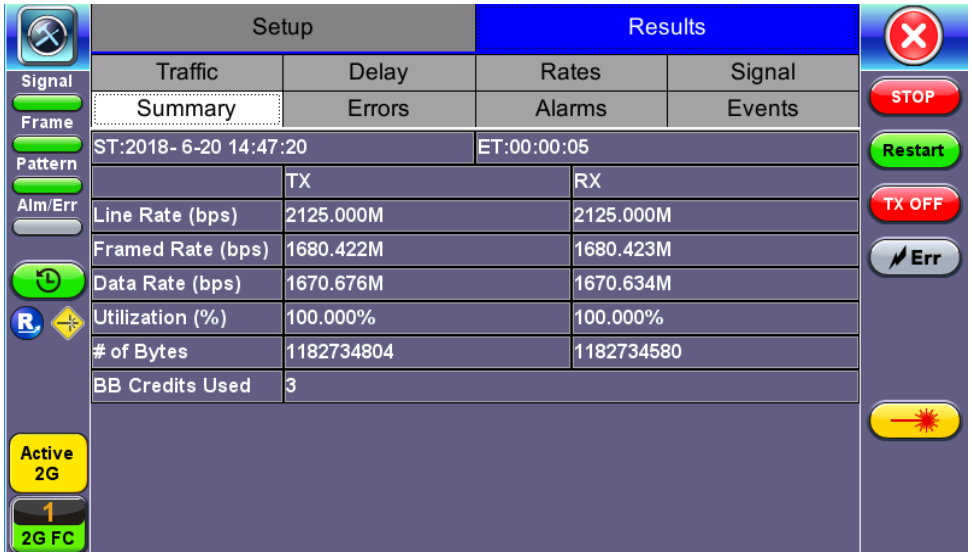
14.2.5 Results

Summary

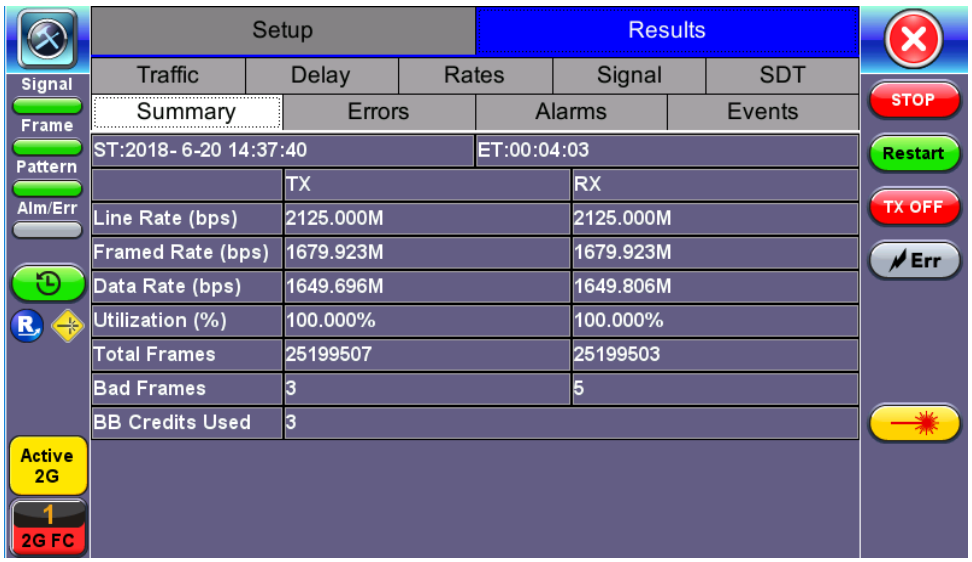
- **Line Rate:** Indicates the transmitted and received bit rate
  - 1.0625 Gbps, 2.125 Gbps, 4.25 Gbps displayed in Mbps
- **Framed Rate:** Total number of frames including overhead of any type per second (Mbytes)
- **Data rate:** Total count of frames with payload data per second (Mbytes)
- **Utilization:**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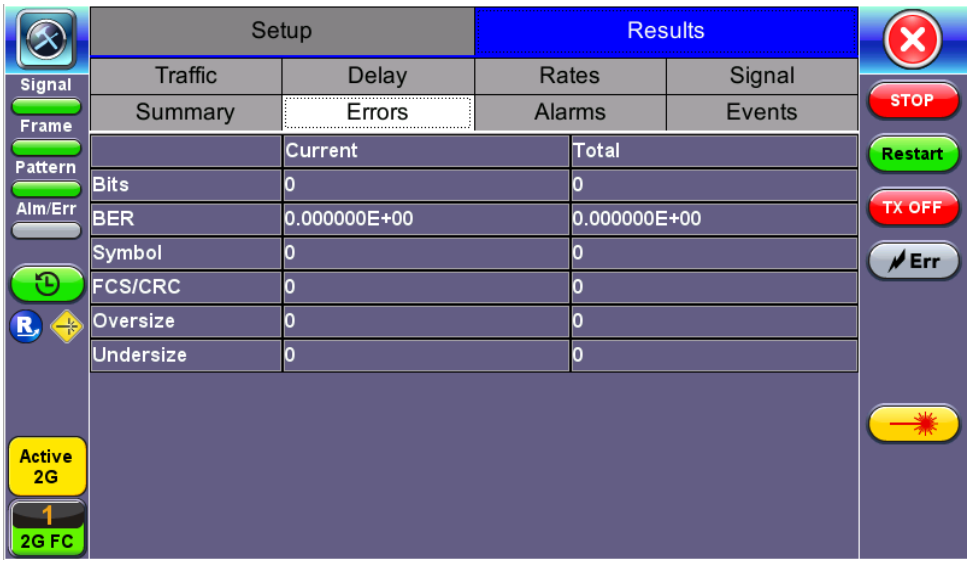
Errors

Current and Total values for:

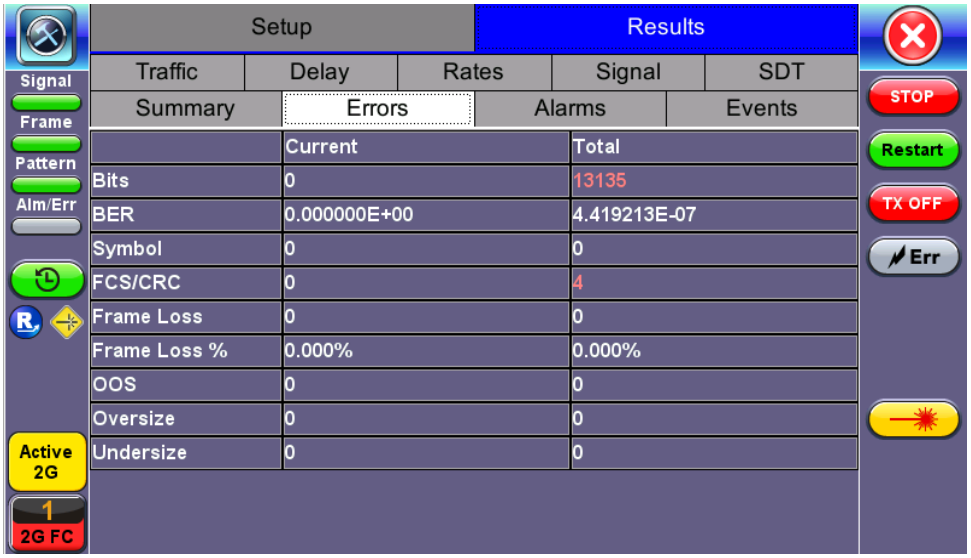
- **Bits:** Number of bits received
- **BER:** Bit error ratio based on PRBS received or ratio of payload bit errors to total received payload bits
- **Symbol:** Symbol error or Code Violation is a bit error or disparity error occurring in a primitive sequence or Ordered Set
- **FCS/CRC:** Number of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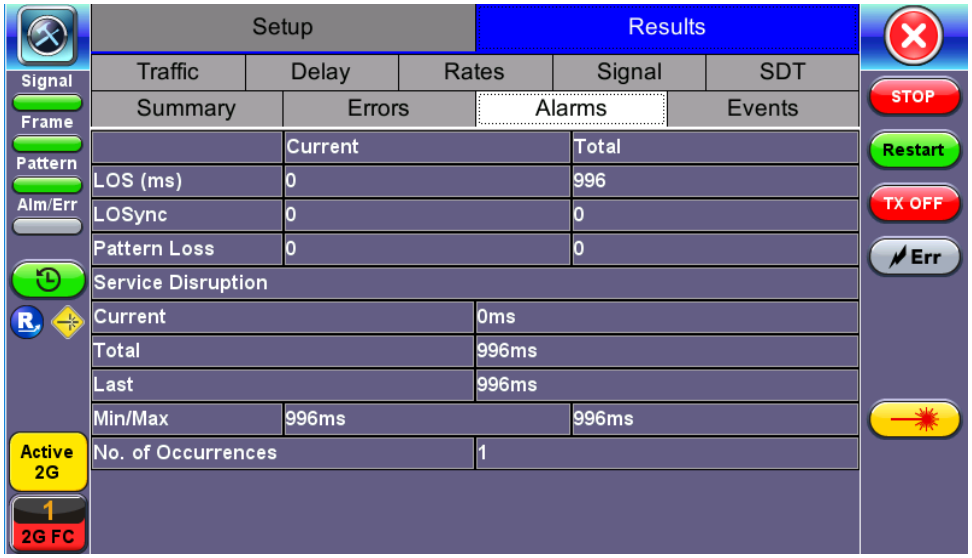
Alarms

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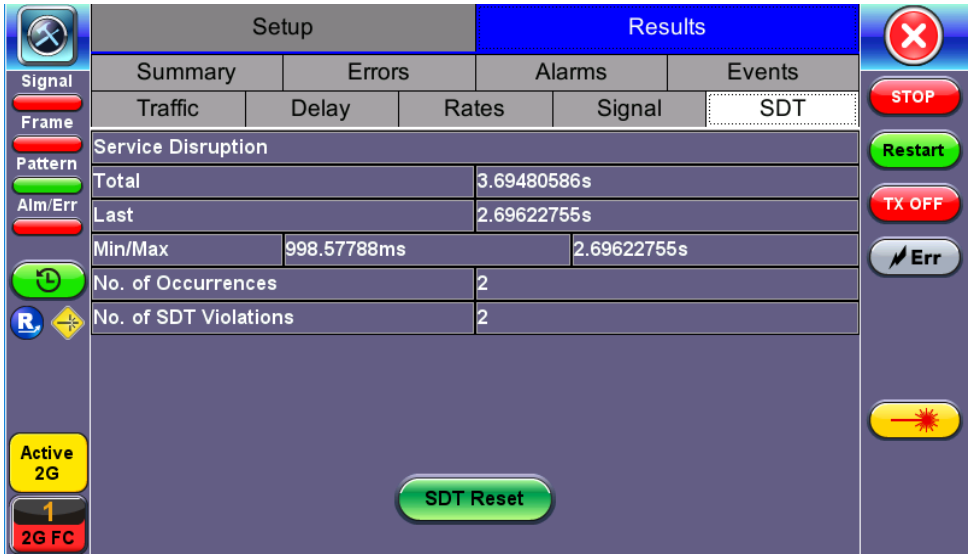
Service Disruption Test (SDT) ***(Throughput only)***

- **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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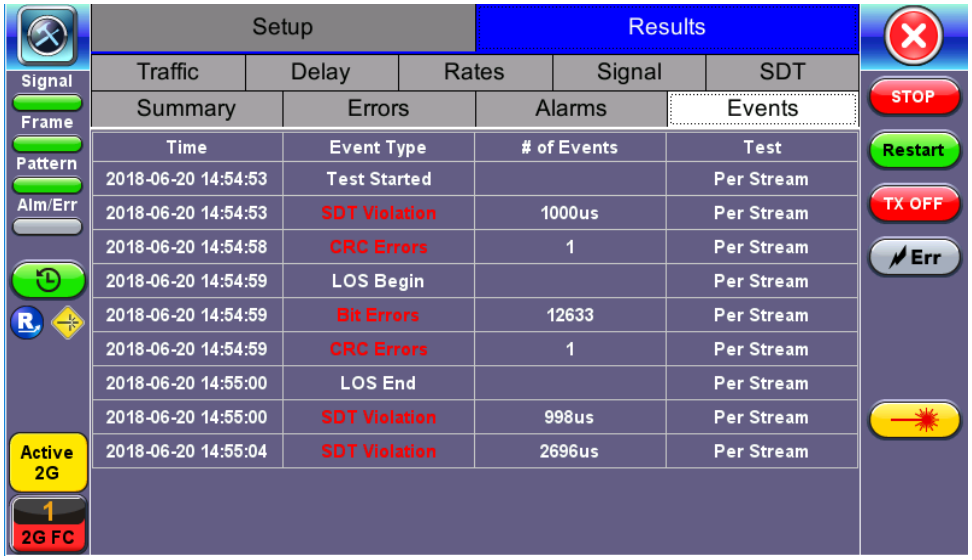
Events

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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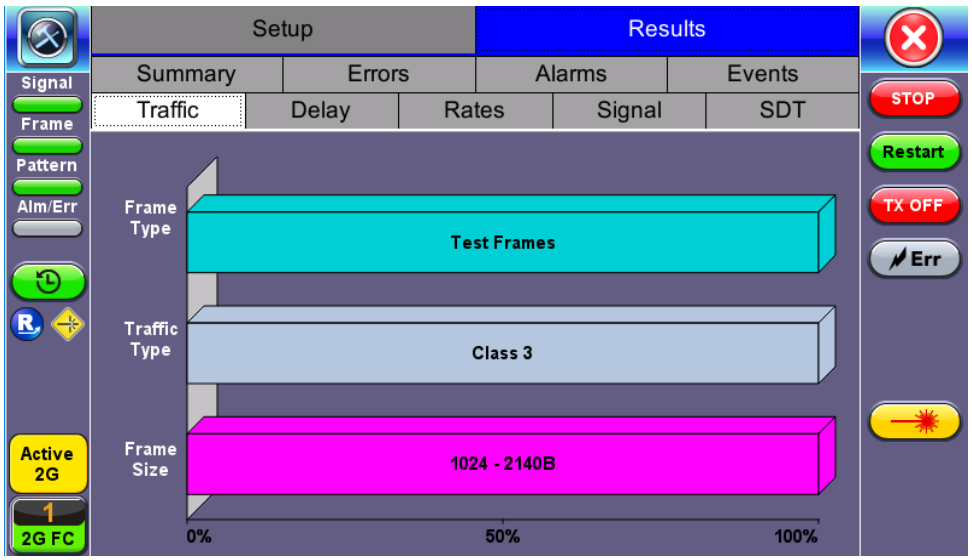
Traffic Distribution Overview

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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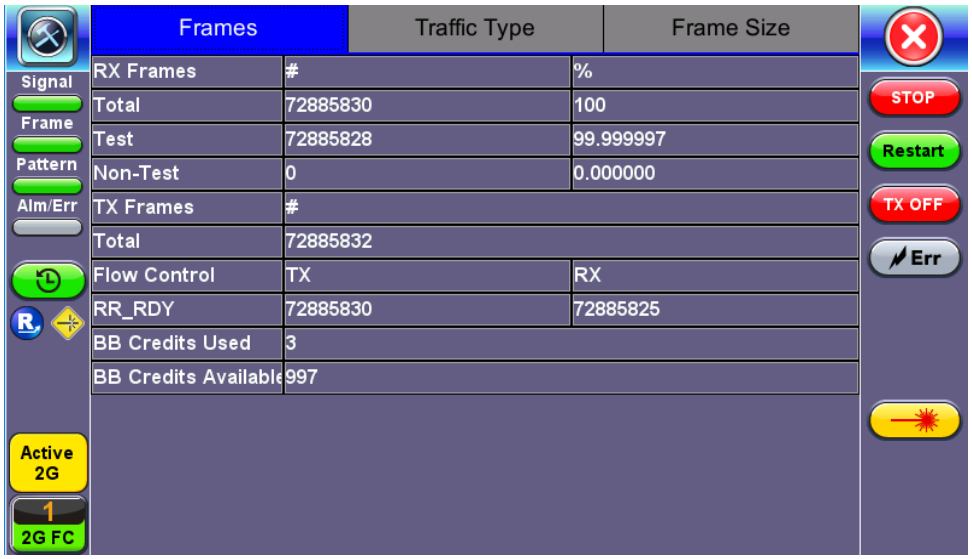
Traffic Distribution Details - Frames

- **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

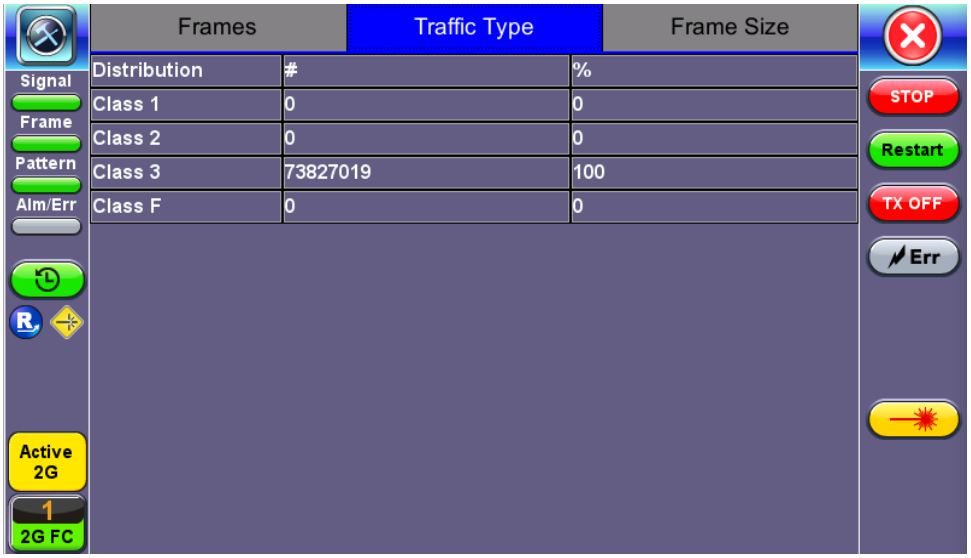
Fibre Channel supports three classes of services, and a fourth which is a combination of classes 1 and 2.

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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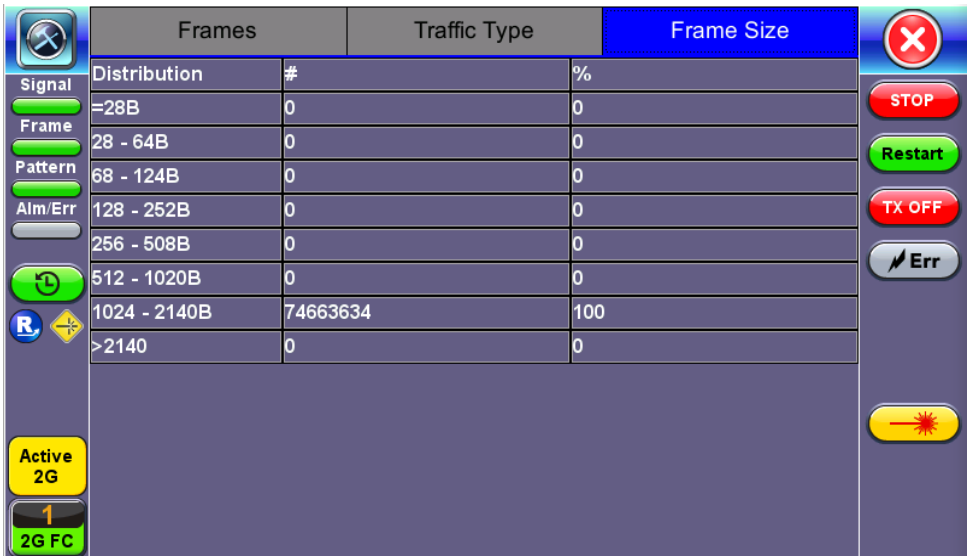
Frame Size Distribution

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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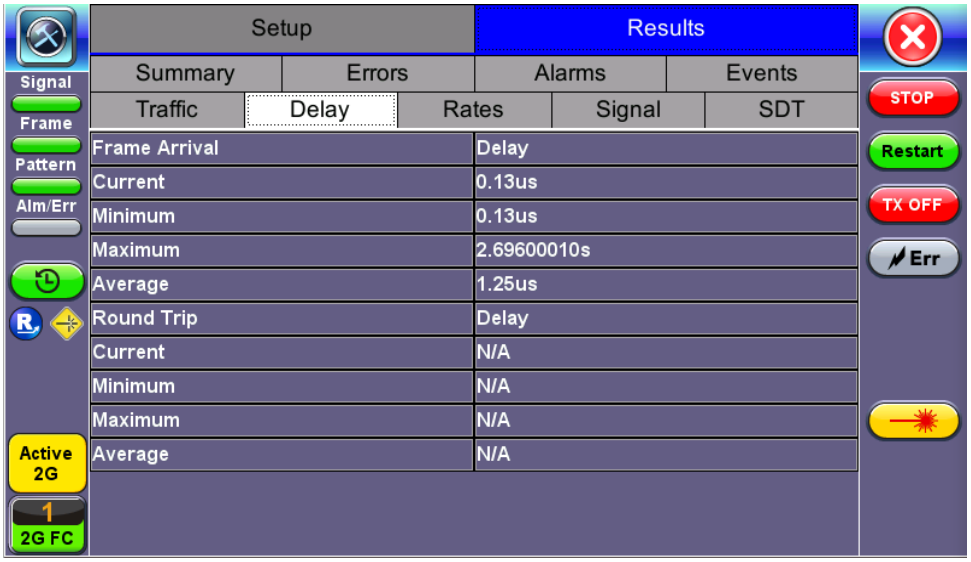
Delay

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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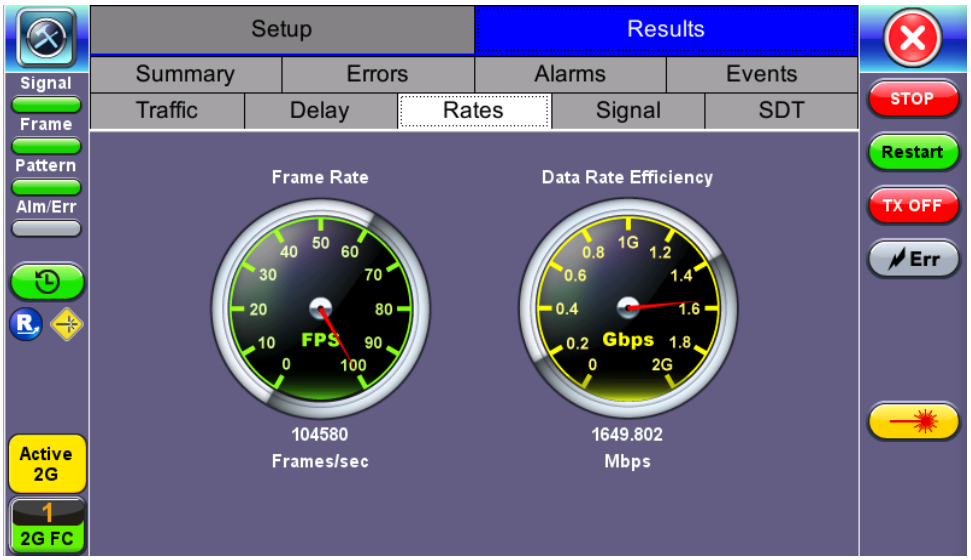
Frame Rate Summary

Graphical representation of the Frame rates and Data rates.



FC-BERT/FC-Throughput - Frame Rate Summary

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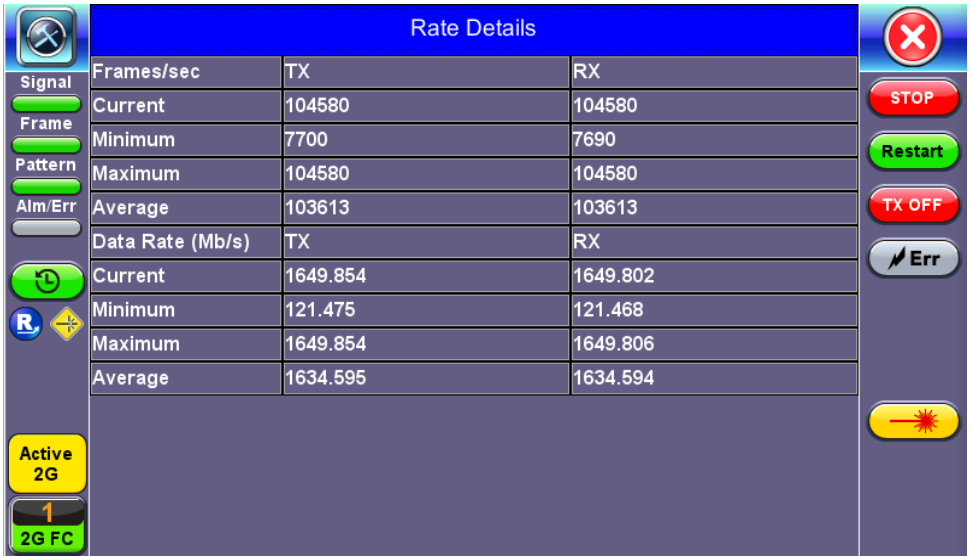
Frame Rate Details

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



FC-BERT/FC-Throughput - Frame Rate Details

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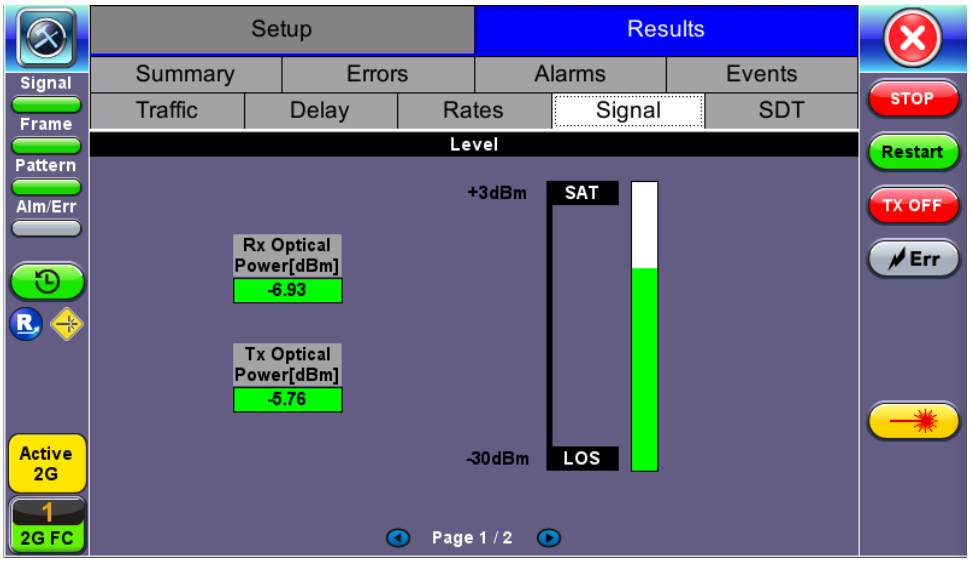
Signal

Level (Page 1)

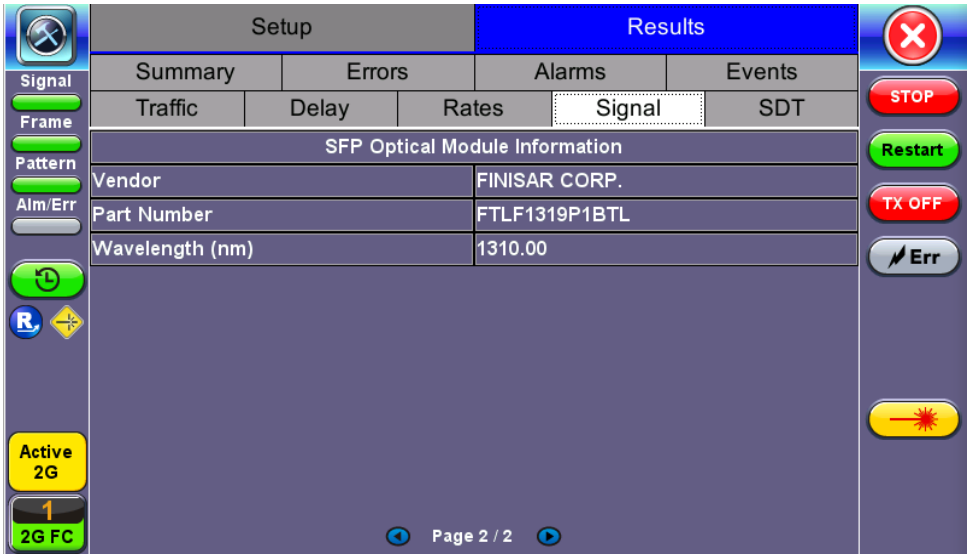
The Signal tab displays the Level and Frequency screen. Page 1 displays the level measurement Loss of Signal (LOS), and the Saturation level for optical signals is shown graphically, including the level measurement in dBm.



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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14.3 RFC 2544

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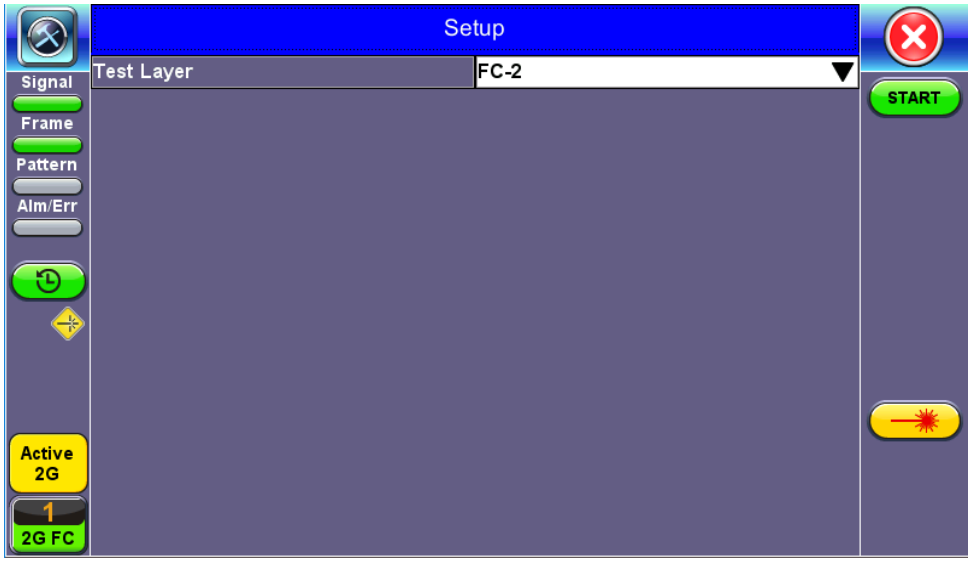
14.4 Loopback

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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15.0 Profiles

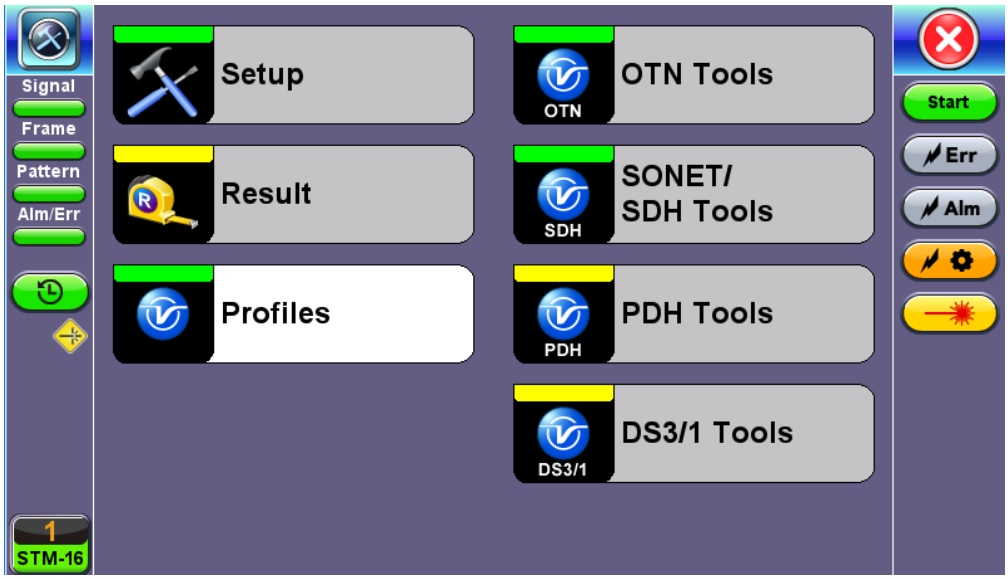
Profiles can be created in any application that has a "Profiles" drop-down menu available. The PDH, SDH, OTN, Ethernet and Fiber Channel applications, among others, all have the ability to save profiles.

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

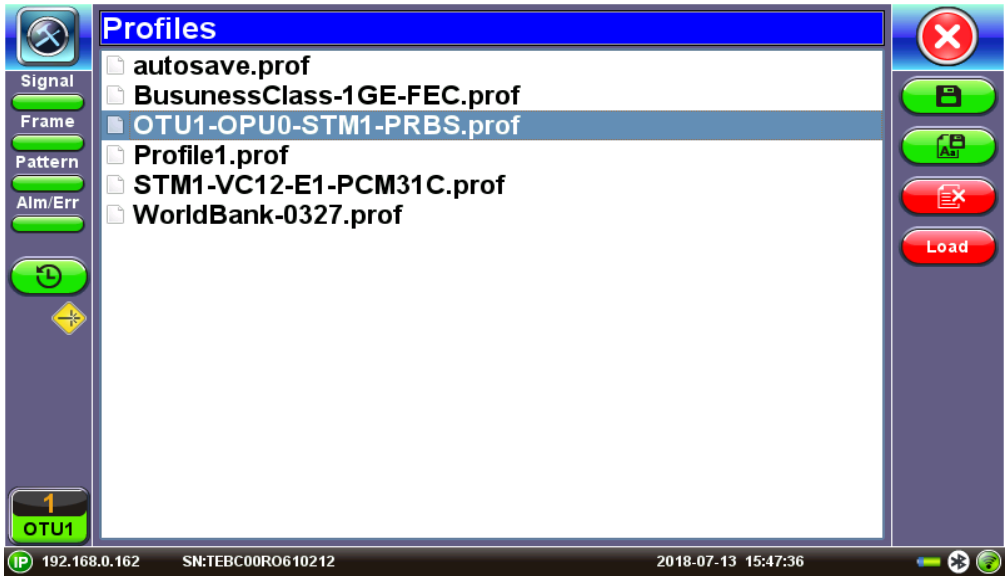
Accessing and Configuring Profiles

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

Profile Management Buttons	
	**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:** Select a test profile to load onto the test application



Home Menu with Profile Icon



Select a Profile to Manage

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16.0 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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