USER MANUAL

RXT-6200 & RXT-6000e

100G Universal Test Module

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

 D07-00-130P_RevA00

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1.0 About This User Manual

This user manual is suitable for novice, intermediate, and experienced users and is intended to help you successfully use the features and capabilities of the various modules for test platforms. It is assumed that you have basic computer experience and skills, and are familiar with IP and telecommunication concepts, terminology, and safety.

Every effort was made to ensure that the information contained in this manual is accurate. However, information is subject to change without notice. We accept no responsibility for any errors or omissions. In case of discrepancy, the web version takes precedence over any printed literature.

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Customer Care:

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Website: www.veexinc.com

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2.0 Safety Information

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

Optical Connectors

The test set platform displays 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 patch cords.
2. Never look directly into an optical patch cord or an XFP's or SFP’s connector interface while the laser is enabled. Even though XFP and SFP 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.

Safe Module Handling

While replacing test modules, all work on the open panel must be performed only by suitably qualified personnel who is familiar with the dangers both to people and to the instrument itself.

- Modules are not hot swappable. The platform must be turned off and unplugged from VAC mains when removing or inserting test modules.
- For safety and EMC (Electromagnetic Compatibility), empty module slots must be properly covered with blank panel covers.
- Prevent foreign objects from entering the UX400, before, during and after module exchange or re-configuration process. They could create short circuits or damage internal fans.
- Always store test modules by themselves in individual ESD protected packaging (with no loose elements, like screws or tools).

Lithium-ion Battery Precautions

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

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

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

Always charge the unit's battery pack inside the test platform battery bay using the AC/DC adapter supplied by VeEX.

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

Electrical Connectors

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

ESD: Electrostatic Discharge Sensitive Equipment

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

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

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3.0 Introduction

The RXT-6200 and RXT-6000e test module is equipped with most common transceiver form-factor ports and optional legacy test interfaces. It offers up to two simultaneous 100GE tests.

Installation, commissioning, monitoring, and maintenance tasks are simplified thanks to a combination intuitive features and powerful test functions. Novice users benefit from the easy-to-use GUI, while experienced users will appreciate an array of advanced features such as OTL/PCS, CAUI-4/XLAUI Lane BERT, overhead monitor/control, Tandem Connection Monitoring, Service Disruption, Protocol Capture/Decode, BERT, Throughput test, and much more.

RXT-6200

Platform Highlights

- Independent Dual-Port testing, up to 2x 112G
- CFP4 (LR4 & SR4) and QSFP28 interfaces for 100GE, OTU4 and 50GE applications
- Supports IEEE 802.3bj Clause 91 RS-FEC as required for SR4
- QSFP+ for 40GE, OTU3
- SFP28 interface for 25GE, 32/16G FC, 24G CPRI 10 and 25G eCPRI Layer 4 with RS-FEC
- SFP+ for 100Base-FX, 1000Base-X, 10GEBase-X, OTU2/2e/1e/1, STM-64/16/4/1/0, OC192/48/12/3/1, and Fiber Channel 16/10/8/4/2/1G and CPRI up to 12G
- RJ45 for 10/100/1000Base-T applications

RXT-6000e

Platform Highlights

- CFP2 (LR4 & SR10) and QSFP28 interfaces for 100GE, OTU4 and 50GE applications
- Supports IEEE 802.3bj Clause 91 RS-FEC as required for SR4 and SR10
- CFP4 support via CFP2-to-CFP4 adapter
- QSFP+ for 40GE, OTU3
- SFP28 interface for 25GE, 32/16G FC, 24G CPRI 10 and 25G eCPRI Layer 4 with RS-FEC
- SFP+ for 100Base-FX, 1000Base-X, 10GEBase-X, OTU2/2e/1e/1, STM-64/16/4/1/0, OC192/48/12/3/1, and Fibre Channel 16/10/8/4/2/1G and CPRI up to 12G
- RJ45 for 10/100/1000Base-T applications
- Optional PDH/DSn with standard connectors

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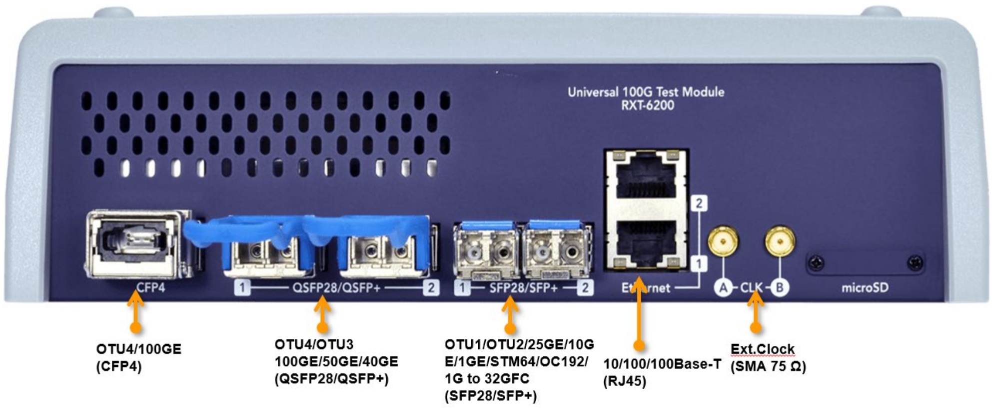
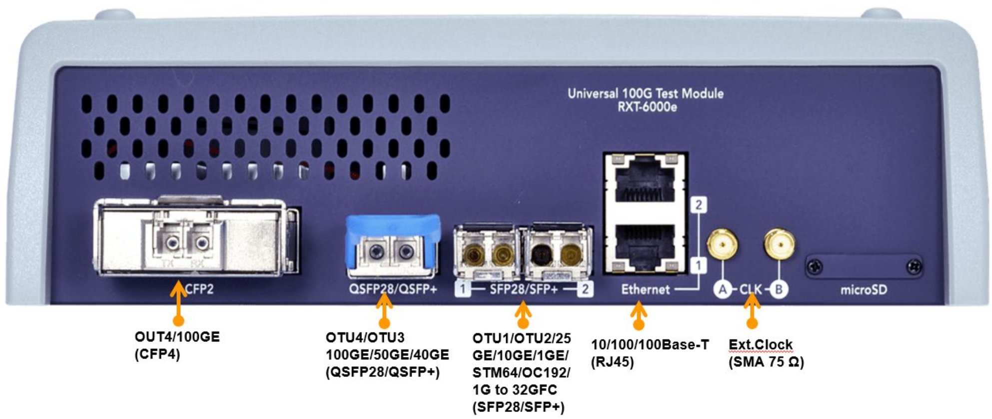
3.1 Connector Panels & Test Ports

RXT-1200 with RXT-6200 blade



RXT-1200 with RXT-6000e blade



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4.0 Basic Operations

For information on Basic Operations, Home menu, Launching Test Applications, and other features specific to the RXT-6200 and RXT-6000e Host Chassis, refer to the RXT-1200 Platform Manual.

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5.0 Utilities

Refer to the RXT Platform Manual for information about all Utilities and Tools available.

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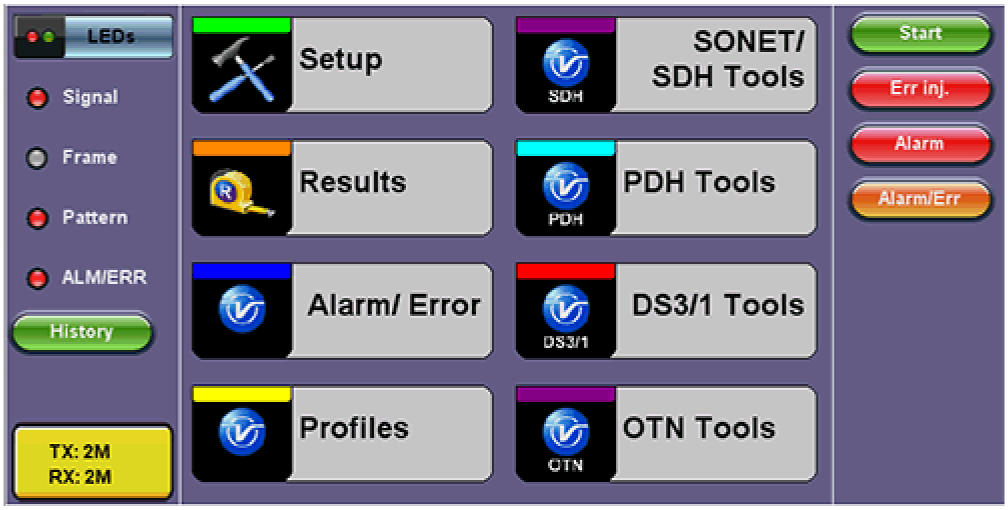
6.0 Setup: SDH/SONET/OTN

Accessing Setup: Please see the RXT-1200 Platform manual Getting Started section to launch Test Applications.

SONET Home Menu



The Setup page has tabs for setting the OTN, and SDH/SONET.

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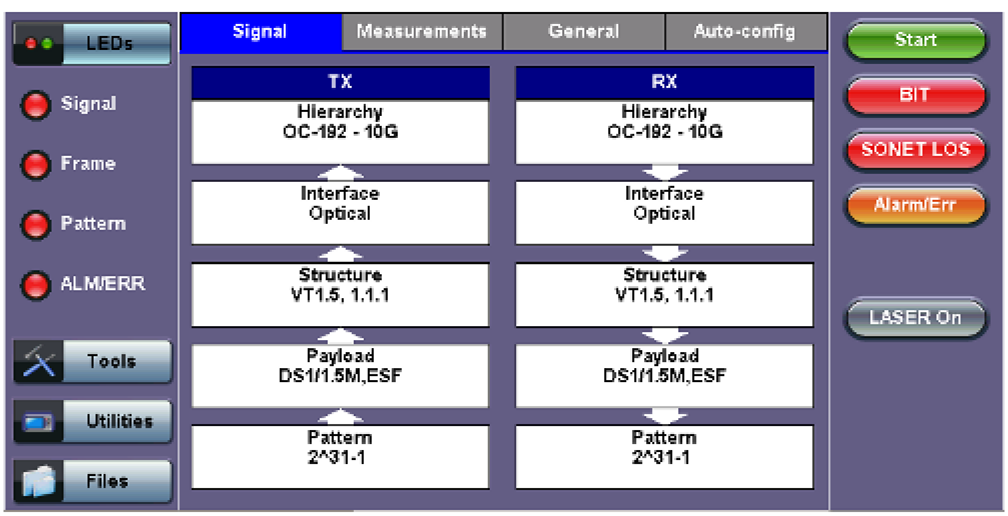
6.1 Signal Overview

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 that brings up a new dialog window displaying additional input and specific selection settings.

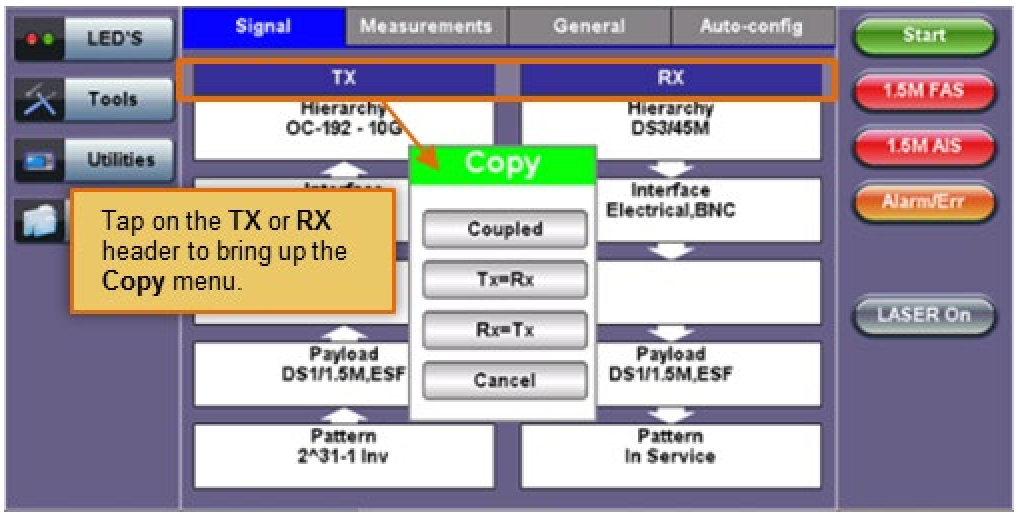
The Transmitter transmits as soon as a valid configuration is entered. The Receiver will check for a valid signal on its input so the measurement function is synchronized.

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.

Coupling TX and RX

When the TX and RX signal structures are required to be identical or symmetrical, coupling the Transmitter and Receiver is possible. Tap on the blue "TX" or "RX" header to bring up the Copy menu. Copy menu options are Coupled, Tx=Rx, and Rx=Tx.

Accessing the Copy Menu



Copy Menu Options

- **Coupled:** TX and RX configurations are grouped as one block; TX and RX will have identical configuration. To uncouple TX and RX settings, tap on the blue "Coupled" heading and select Independent from the Copy Menu.
- **Tx=Rx:** Tx blocks will copy the settings made in the Rx blocks
- **Rx=Tx:** Rx blocks will copy the settings made in the Tx blocks

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 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.

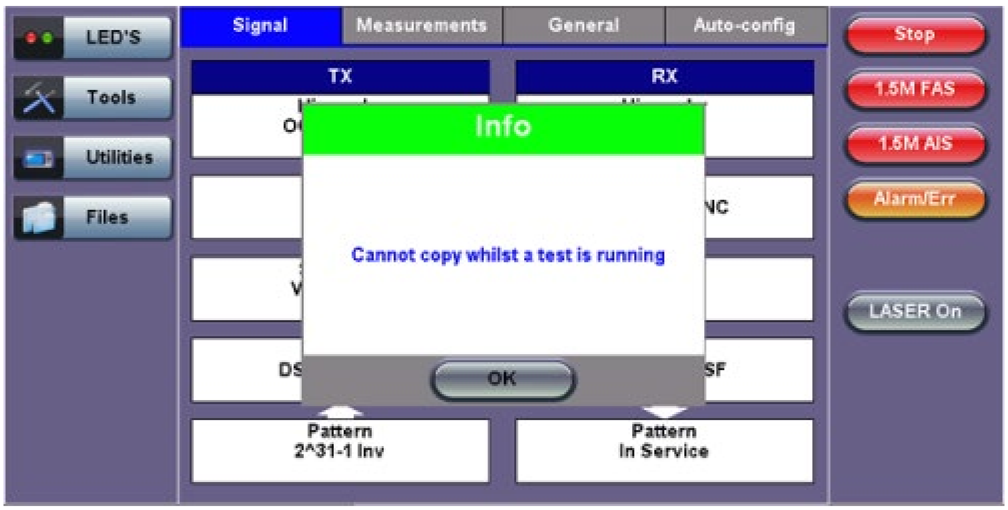
Structure: Applies to SDH/SONET signal and allows the user to configure lower order mapping and the channel number.

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

Pattern: Applies to SDH/SONET 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.

Warning Message
While a test is running, it is possible to view the signal configuration, but it is not possible to change the setup or modify other measurement settings. This warning screen is only shown during initial setup to alert the user.

Warning Message



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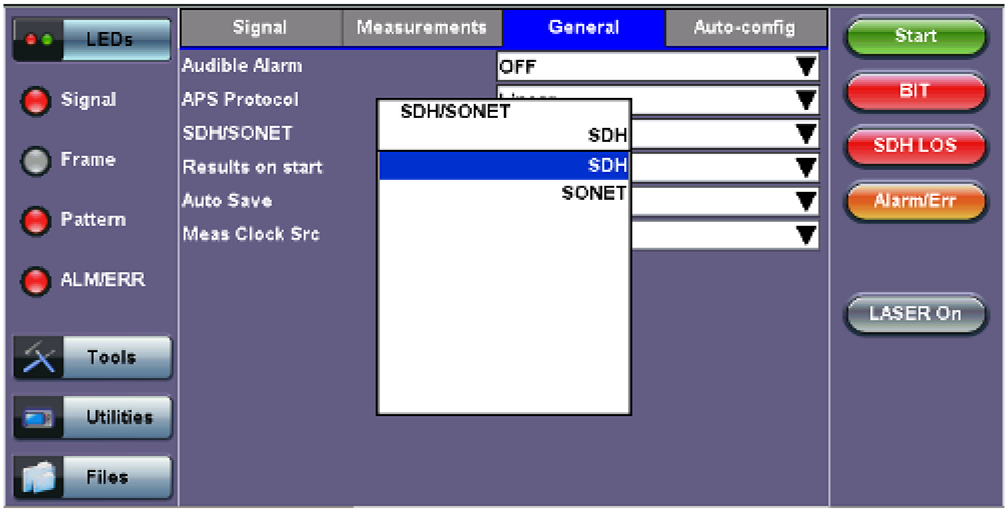
6.2 Setup: SDH

Selecting SDH from the General tab



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

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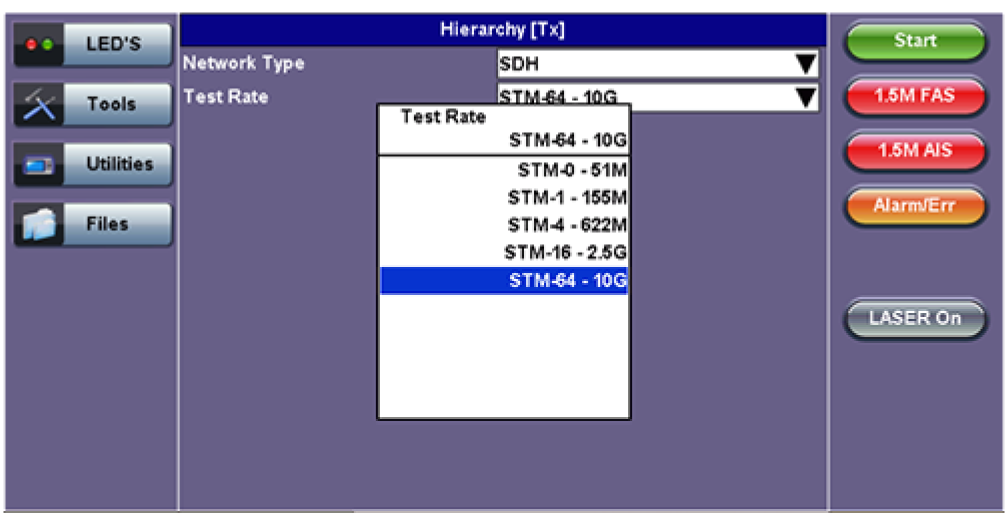
6.2.1 Transmitter Setup

This section of the manual describes the SDH configuration capabilities. The block diagram of the Tx and Rx structure is described in 6.1 Signal Overview.

Hierarchy

Tapping the Hierarchy box opens the Tx Hierarchy Setup screen.

Tx Hierarchy Setup



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

Test Rate: Options are STM-0, STM-1, STM-4, STM-16 and STM-64 (referring to 51M, 155M, 622M, 2.5G and

9.953G respectively).

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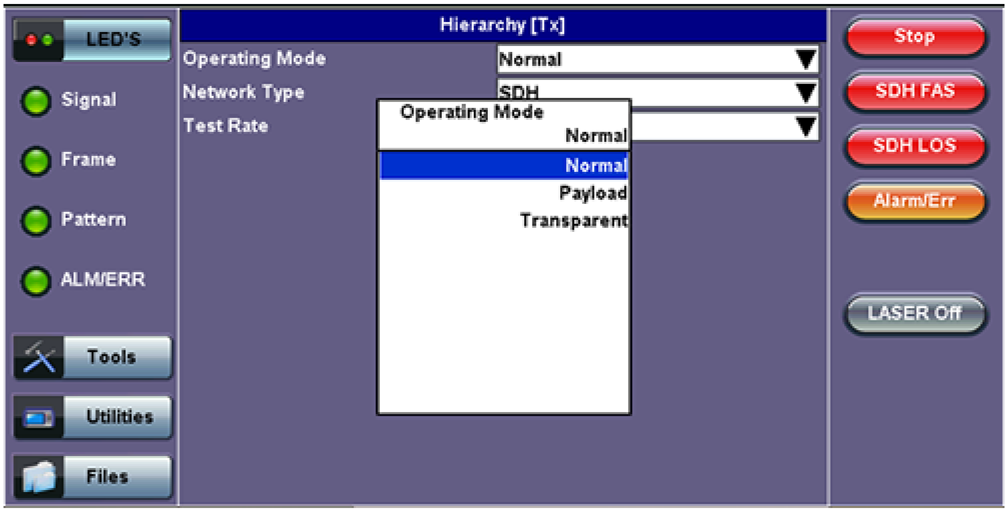
Tx Hierarchy - Normal Operating Mode



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 and APS. To select Payload Through, the payload has to be the same for the relevant ports.

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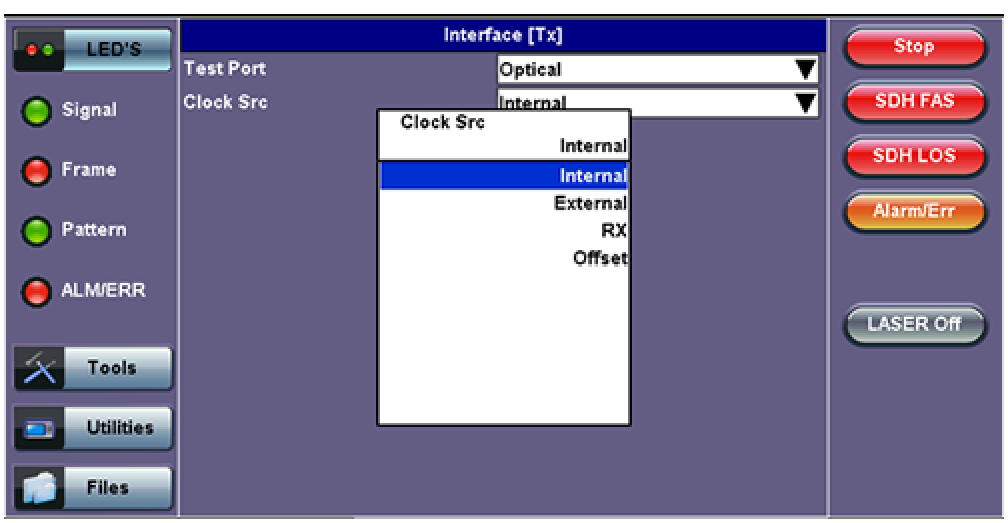
Interface

Tapping the Tx Interface box opens the Tx Interface Setup screen.

Tx Interface Setup



Test Port: Optical

- Optical interface is available for STM-0, STM-1, STM-4, STM-16 and STM-64 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, 2Mbps, or 64kbps signal on the SMA, RX2 balanced, or RX2 BNC unbalanced interfaces.
- **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.

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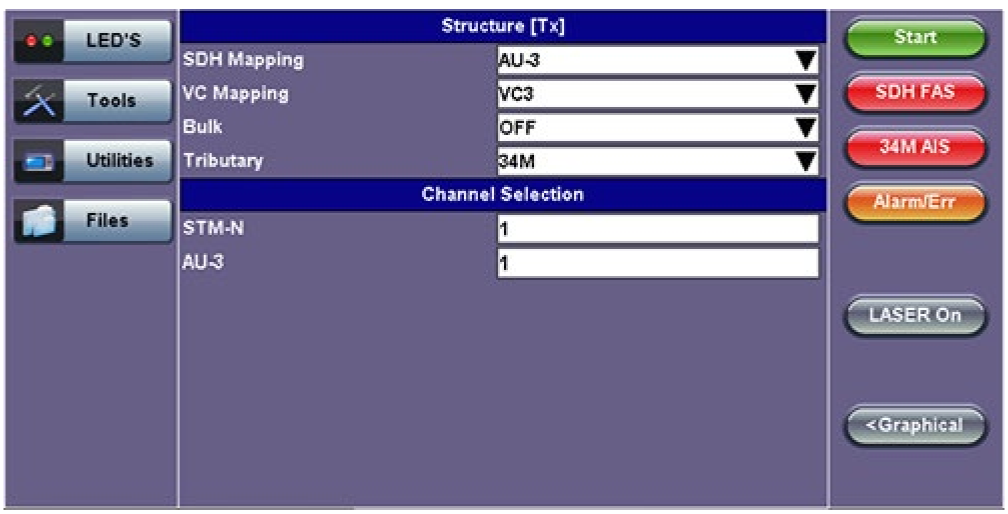
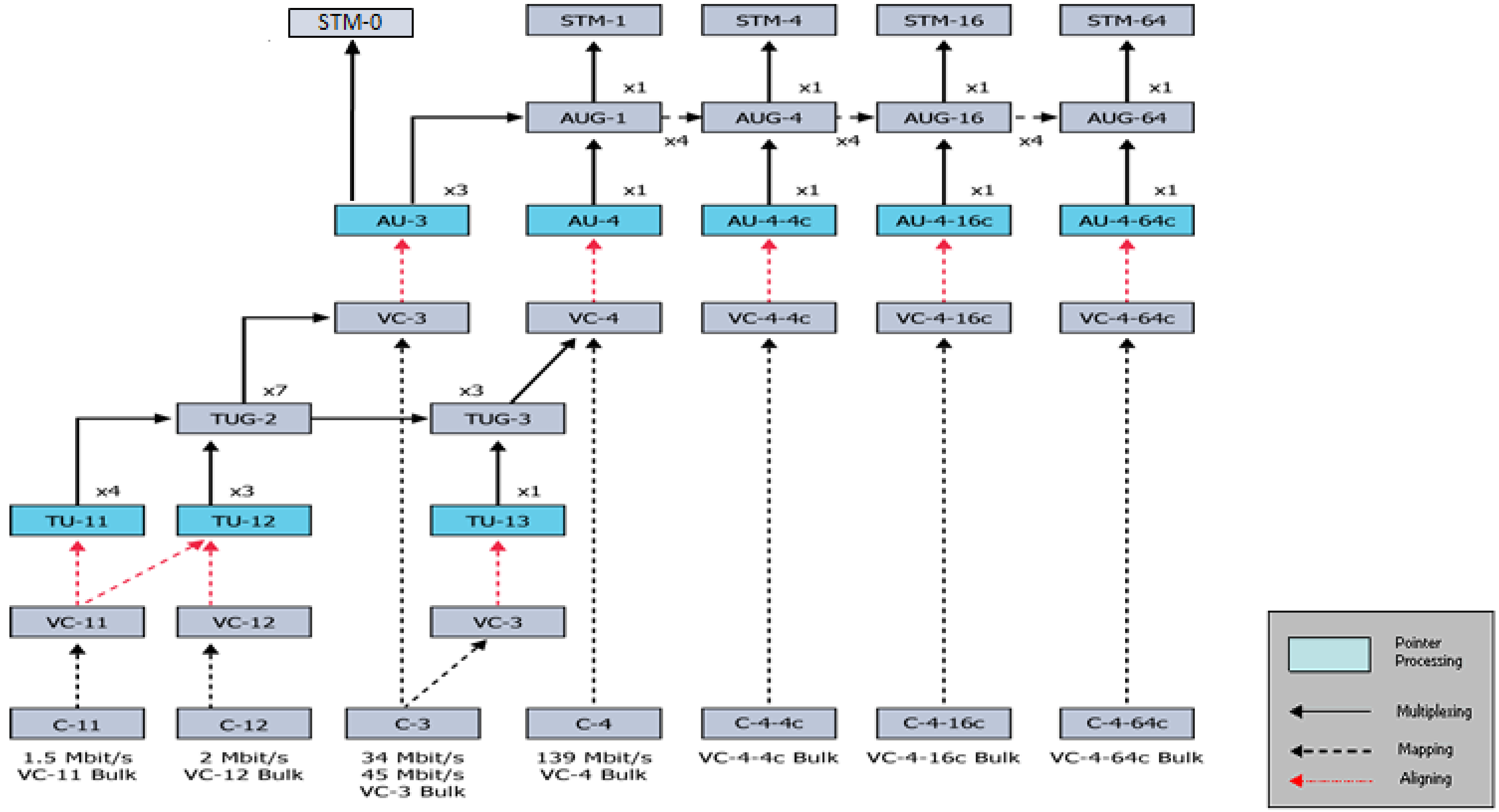
Structure

Tapping the Tx Structure box opens the Tx Structure Setup screen which shows two display modes: Text mode and Graphical mode. Tap on the **Text/Graphical** button to switch between the two modes.

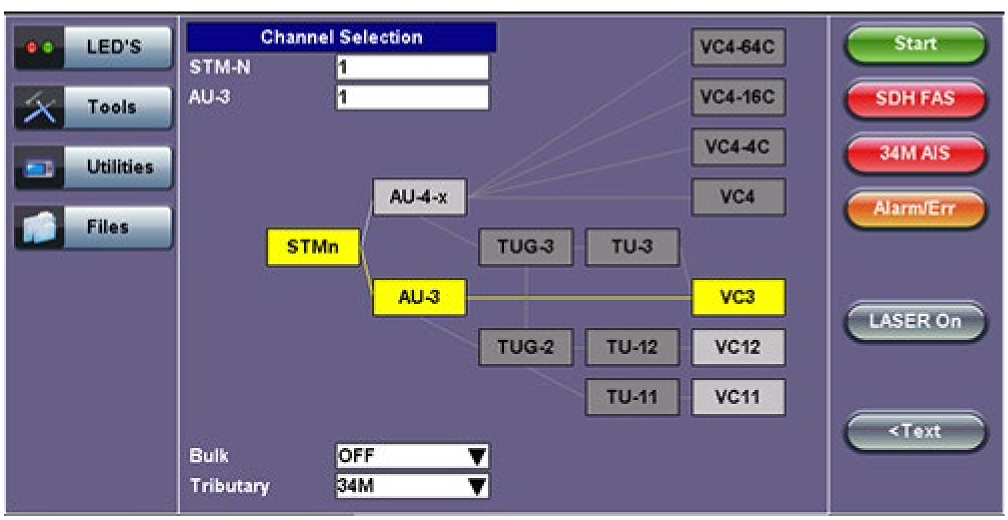
Tx Structure Setup - Text Mode



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



Tx Structure Setup - Graphical Mode



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 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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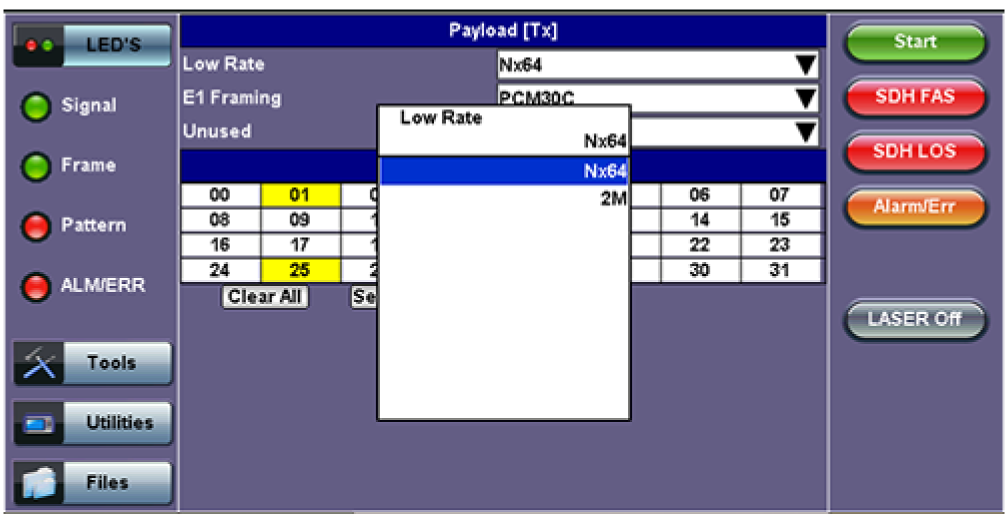
Payload

Tapping the Tx Payload box opens the Tx Payload Setup screen.

Tx Payload Setup



Rate: 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)

Framing: 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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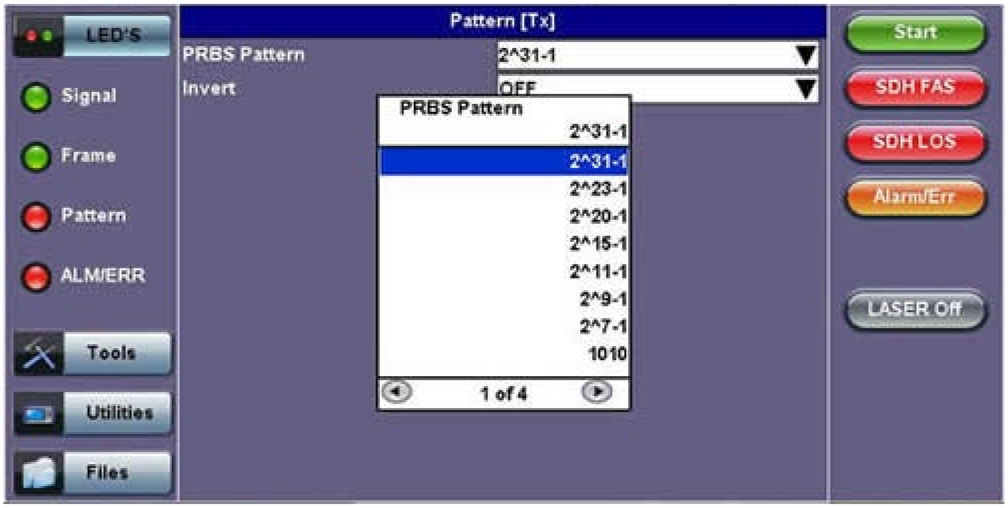
Pattern

Tapping the Tx Pattern box opens the Tx Pattern Setup screen.

Tx 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.

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

Invert: Inversion of polarity is also available.

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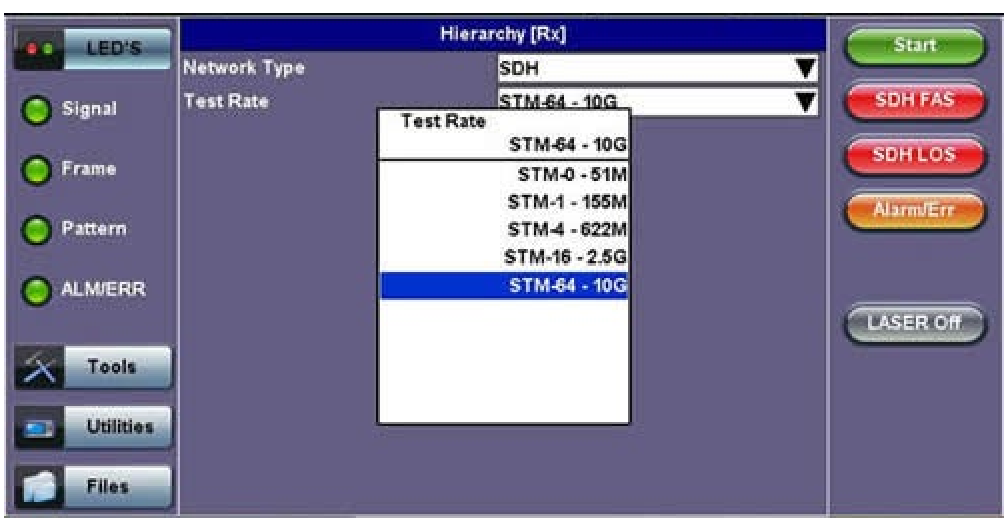
6.2.2 Receiver Setup

Hierarchy

Tapping the Hierarchy setup box opens the Rx Hierarchy screen. The Hierarchy setup options for the Rx are the same as for the Tx described previously.

Rx Hierarchy Setup



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Interface

Tapping the Interface setup box opens the Rx Interface screen. The Interface setup options for the Rx are the same as for the Tx described previously, except for clock offset, which is only available in Tx.

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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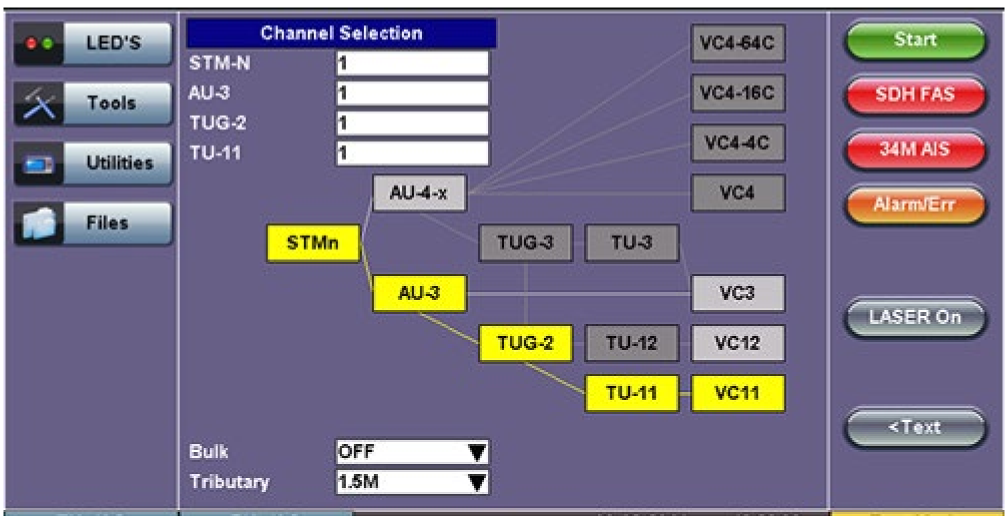
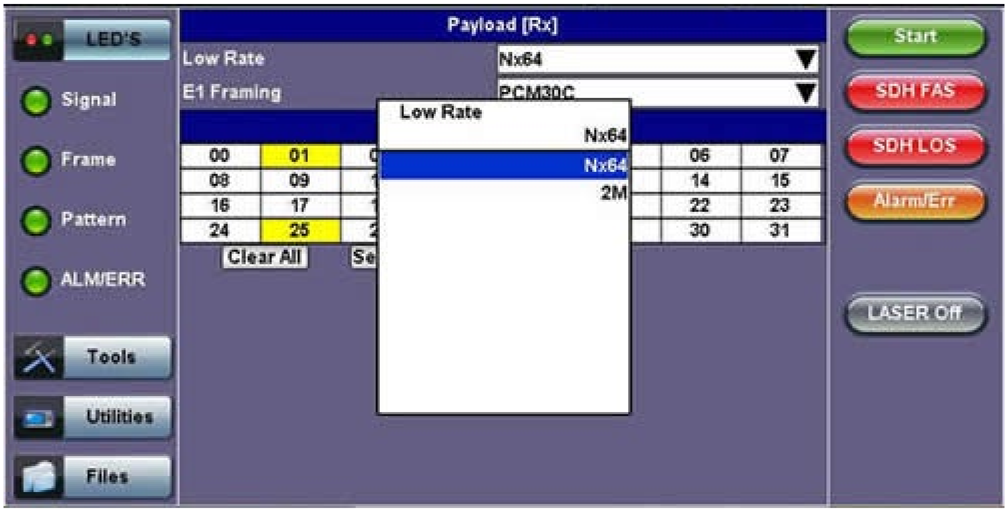
Structure and Payload

SDH Rx Structure and Payload configurations are the same as for SDH Tx setup described previously.

Rx Structure Setup



Rx Payload Setup



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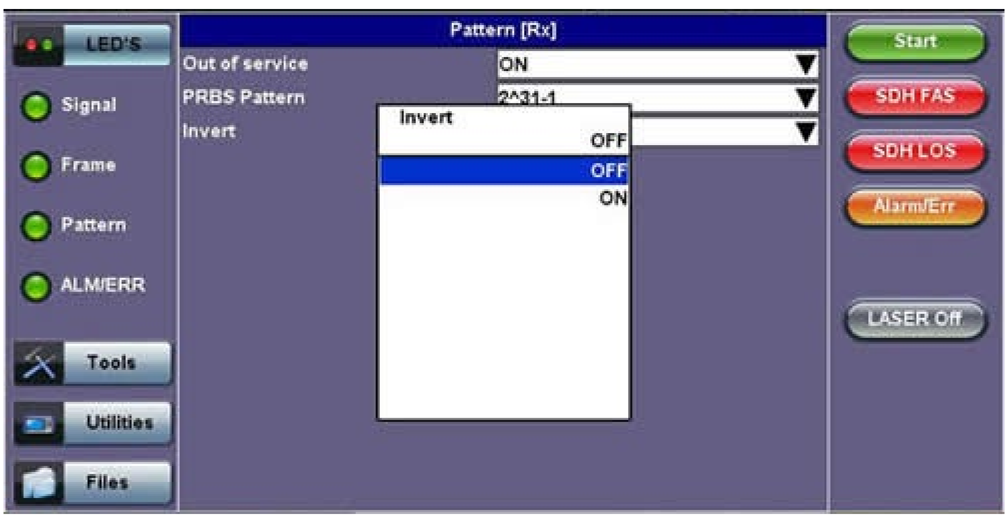
Pattern

Tapping the Pattern box opens the Rx Pattern setup screen. The pattern setup options for the Rx are the same as for the Tx described previously, except for the Out of Service selection, which 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.

Rx Pattern Setup



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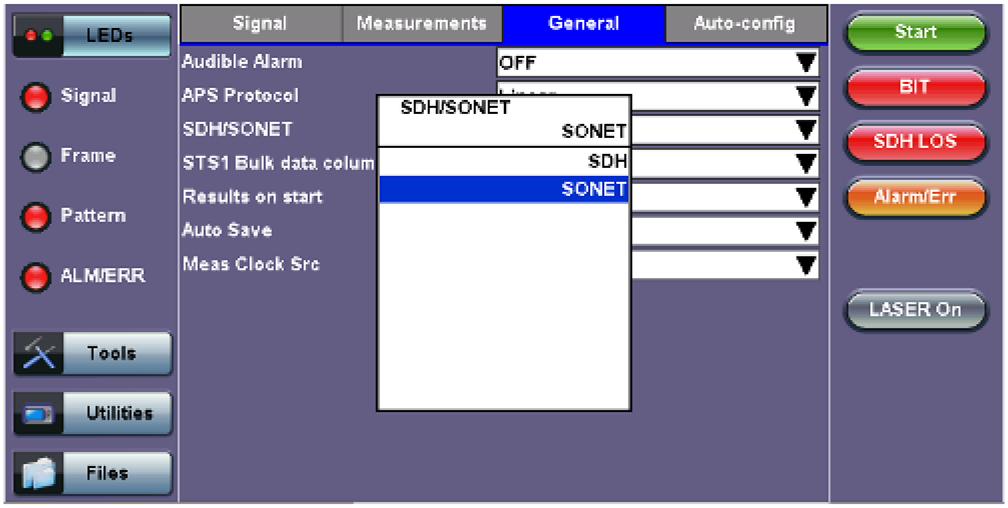
6.3 Setup: SONET

Selecting SONET from the General tab



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.

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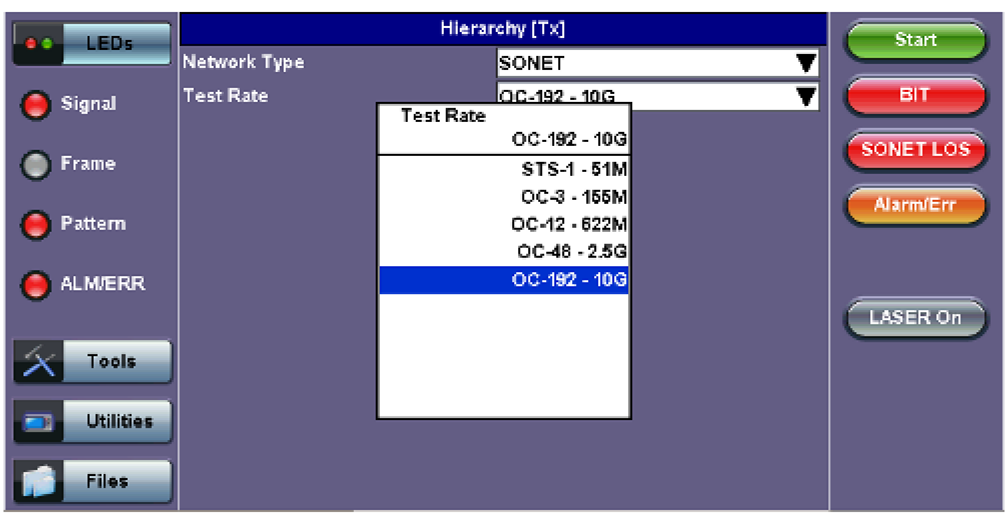
6.3.1 Transmitter Setup

This section of the manual describes the SONET configuration capabilities. The block diagram of the Tx and Rx structure is described in 6.0 Setup.

Hierarchy

Tapping the Hierarchy box opens the Tx Hierarchy Setup screen.

Tx Hierarchy Setup



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

Test Rate: Options are STS-1, OC-3, OC-12, OC-48, OC-192 (referring to 51M, 155M, 622M, 2.5G and 9.953G respectively).

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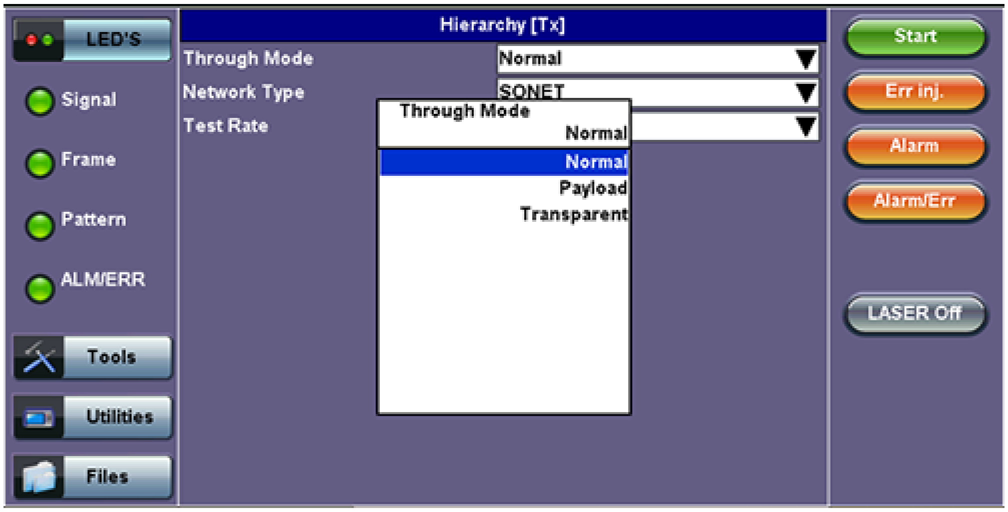
Hierarchy > Through Mode

Tapping the Hierarchy box opens the Tx Hierarchy Setup screen.

Tx Hierarchy Setup - Through Mode



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.

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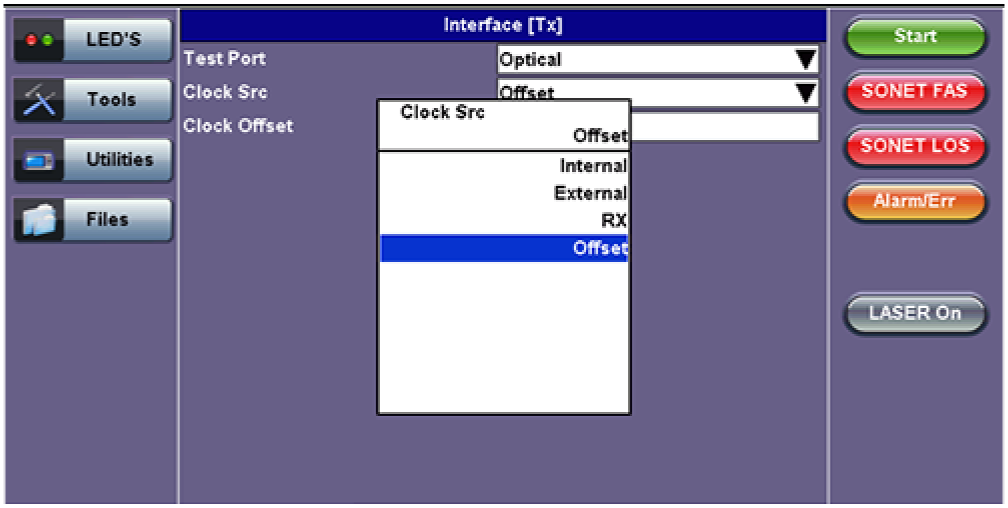
Interface

Tapping the Tx Interface box opens the Tx Interface Setup screen. In this screen both electrical and optical options can be selected.

Tx Interface Setup



Test Port: Optical

- Optical interface is available for OC-1, OC-3, OC-12, OC-48 and OC-192 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, 2Mbps, or 64kbps signal on the SMA, RX2 balanced, or RX2 BNC unbalanced interfaces.
- **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.

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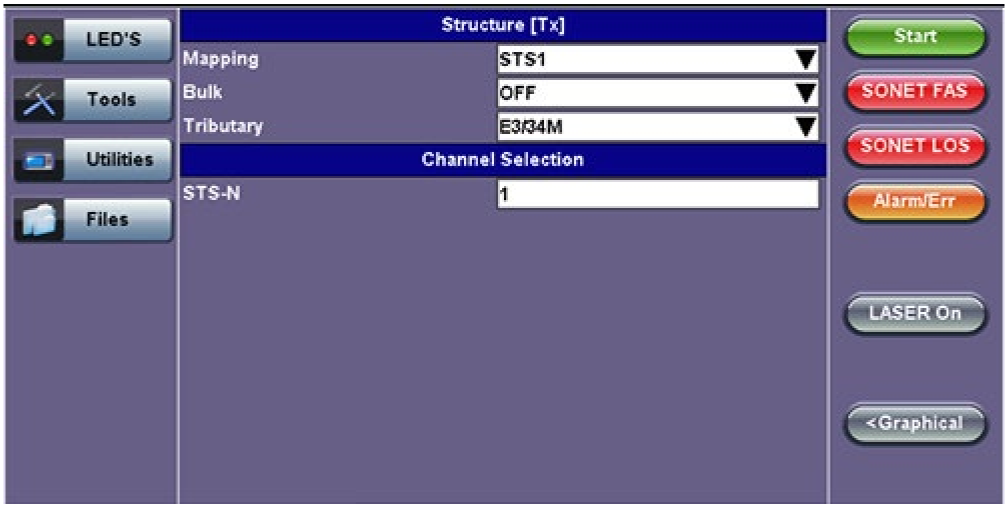
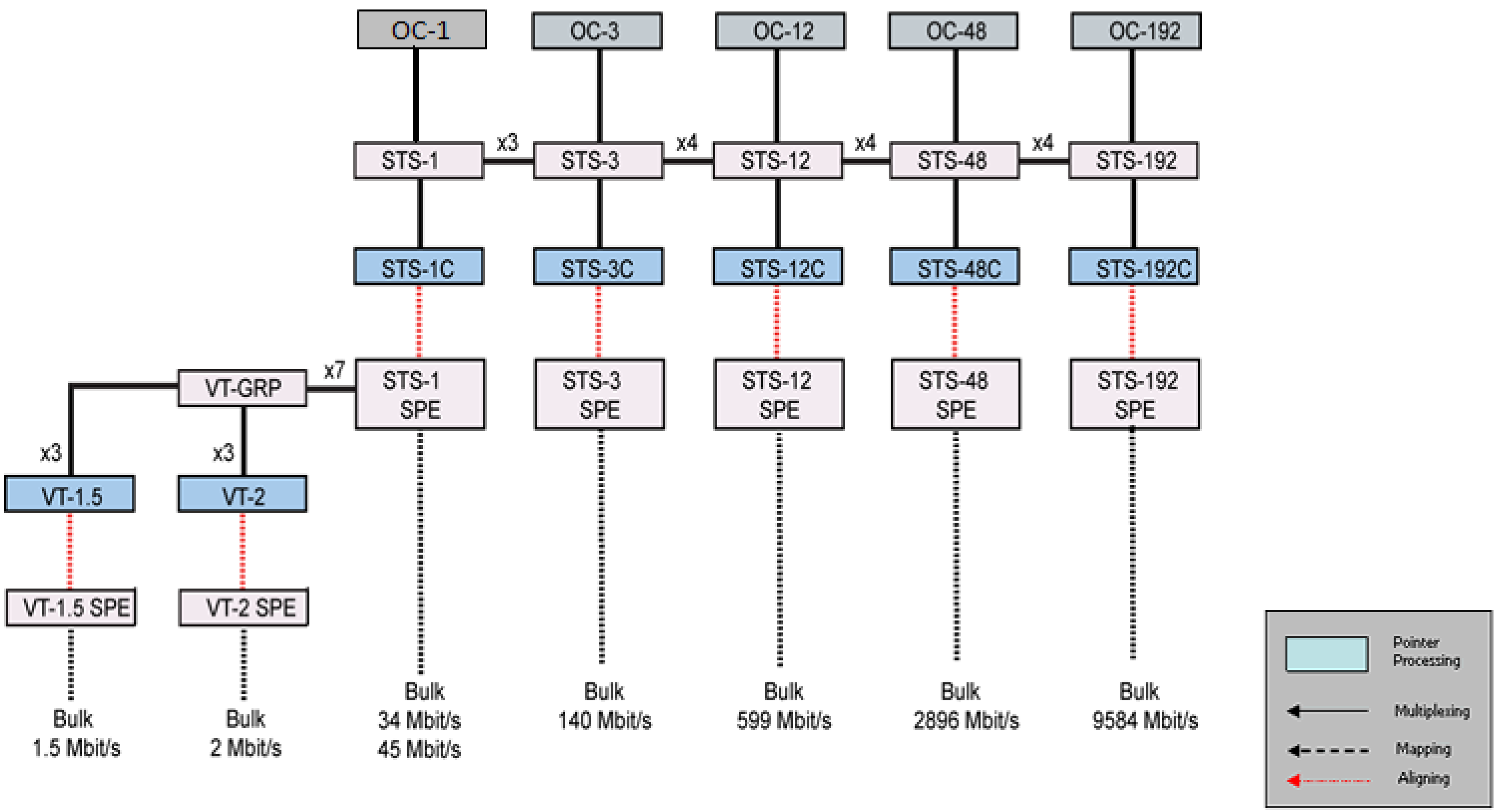
Structure

Tapping the Tx Structure box opens the Tx Structure Setup screen which shows two display modes: Text mode and Graphical mode. Tap on the **Text/Graphical** button to switch between the two modes.

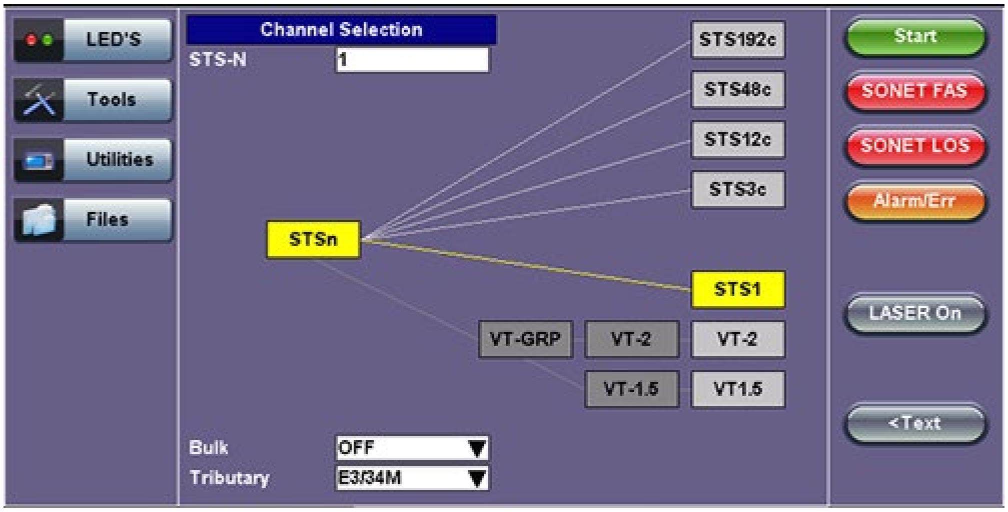
Tx Structure Setup - Text Mode



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.



Tx Structure Setup - Graphical Mode

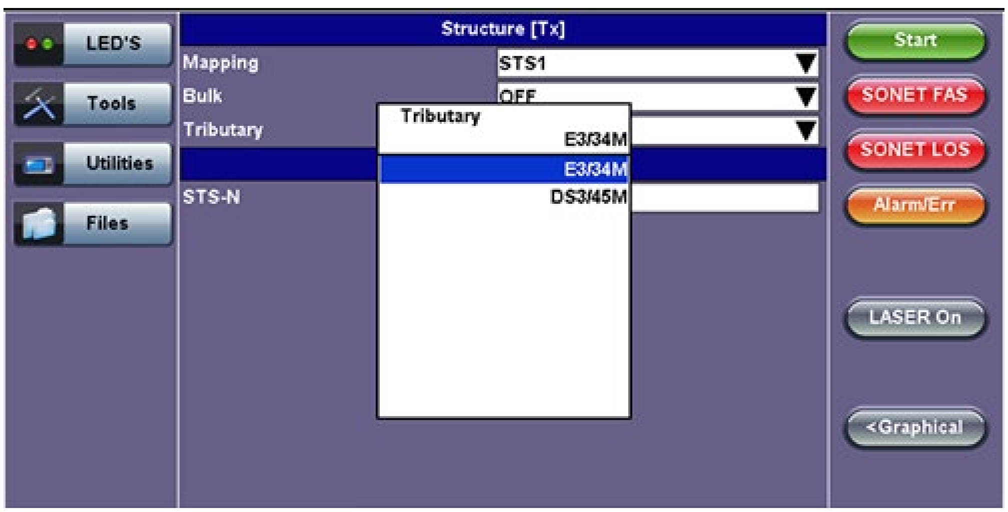


Channel Selection: The Tx channel is selected by entering the STS-N, VT-GRP, and VT-1.5 SPE channel.

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.

Tx Structure Setup - Tributary



- **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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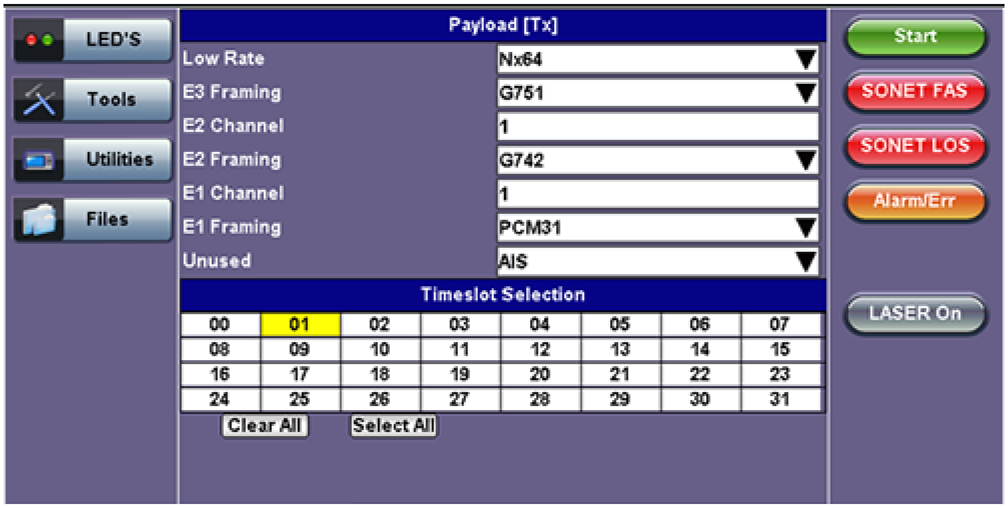
Payload

Tapping the Tx Payload box opens the Tx Payload Setup screen.

Tx Payload Setup



Rate: Depends on mapping selected:

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)

Framing: 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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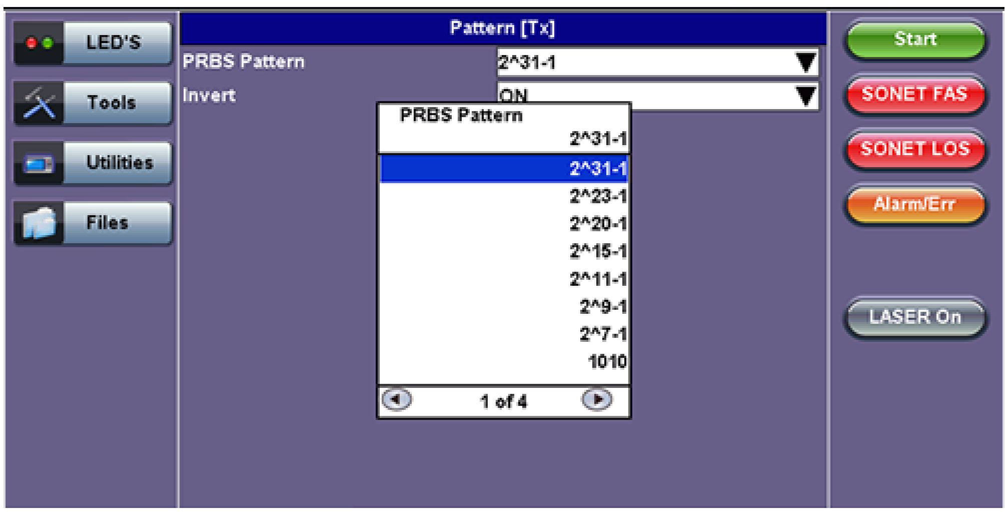
Pattern

Tapping the Tx Pattern box opens the Tx Pattern Setup screen.

Tx 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. Note, if the 32 bit user pattern entered is incorrect, the default pattern will be 0xFFFFFFFF.

Invert: Inversion of polarity is also available.

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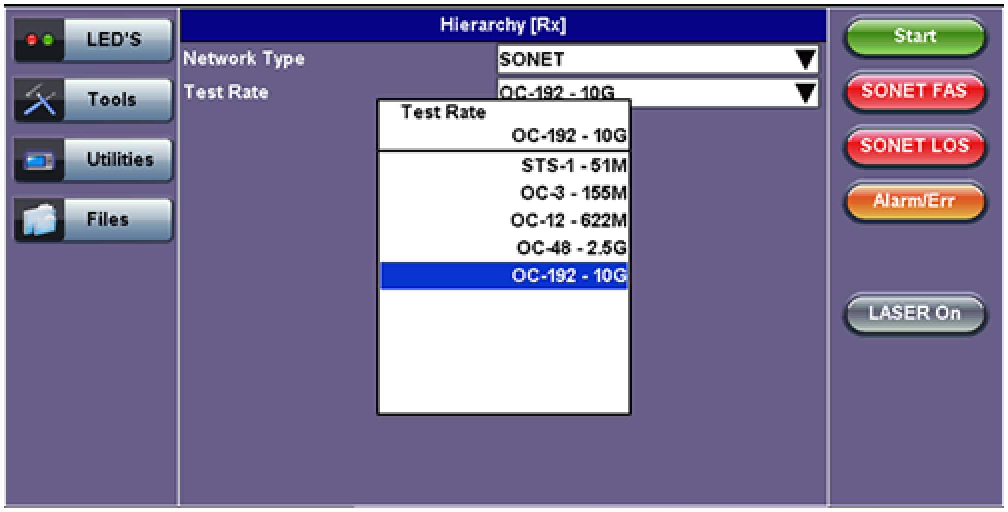
6.3.2 Receiver Setup

Hierarchy

Tapping the Hierarchy setup box opens the Rx Hierarchy screen. The Hierarchy setup options for the Rx are the same as for the Tx described previously.

Rx Hierarchy Setup



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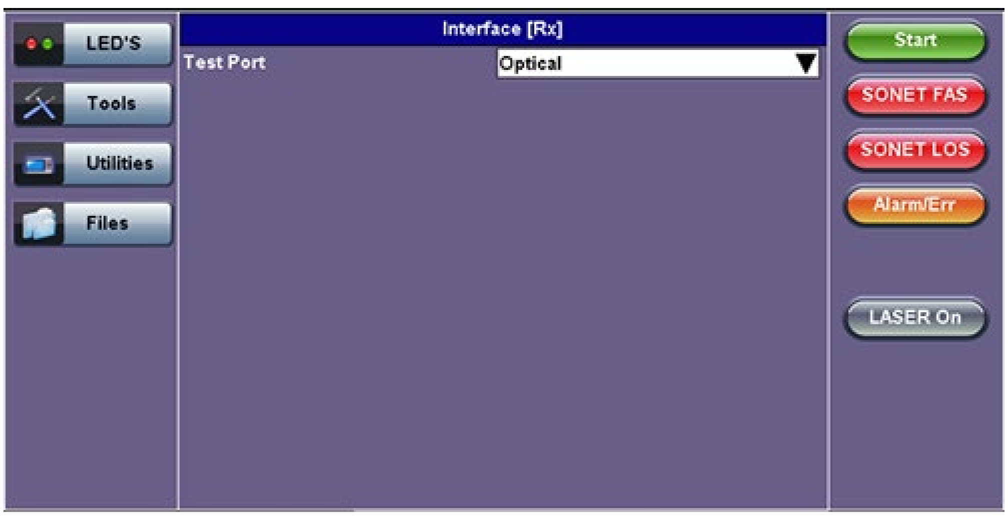
Interface

Tapping the Interface setup box opens the Rx Interface screen. The Interface setup options for the Rx are the same as for the Tx described previously, except for clock offset, which is not possible.

Interface Rx Setup



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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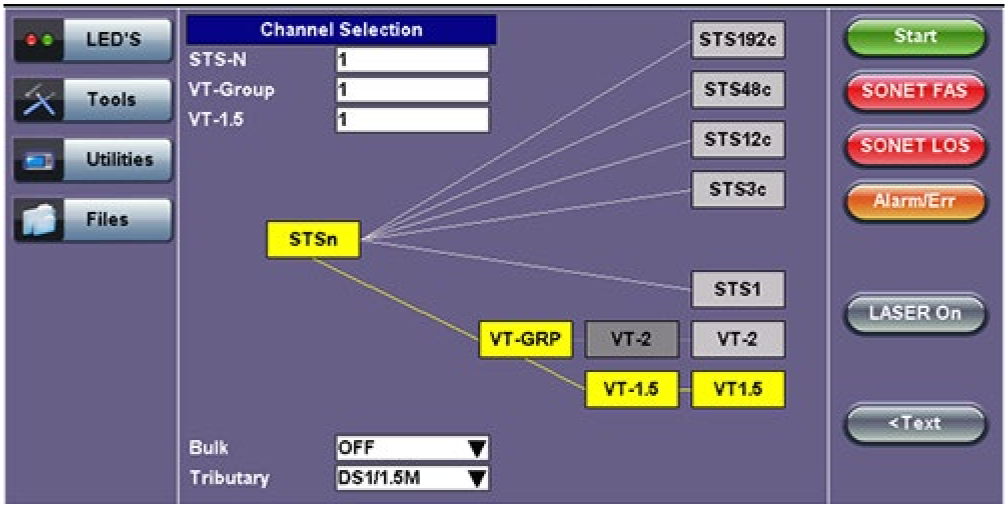
Structure

Tapping the Structure setup box opens the Rx Structure screen. The Structure setup options for the Rx are the same as for the Tx described previously.

Rx Structure Setup - Graphical Mode



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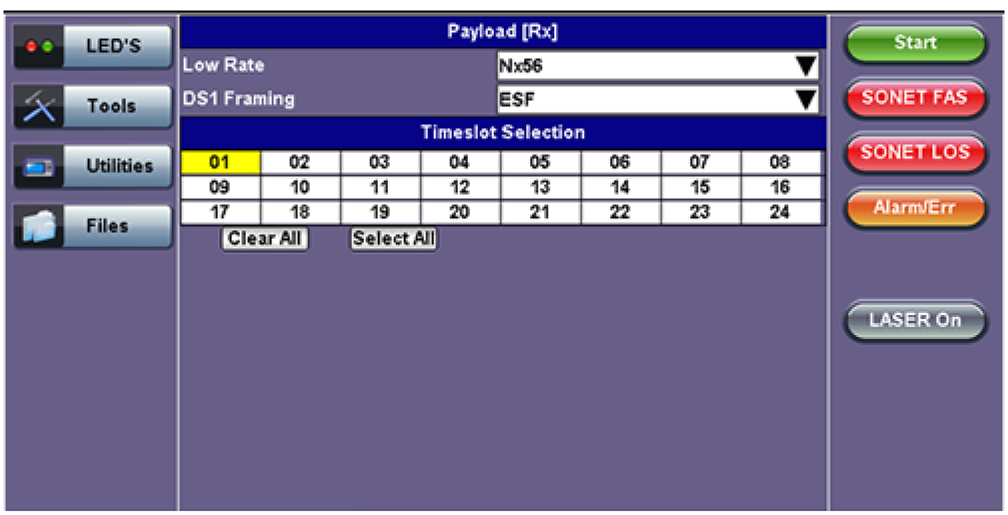
Payload

Tapping the Payload setup box opens the Rx Payload screen. The Payload setup options for the Rx are the same as for the SONET Tx setup described previously.

Rx Payload Setup



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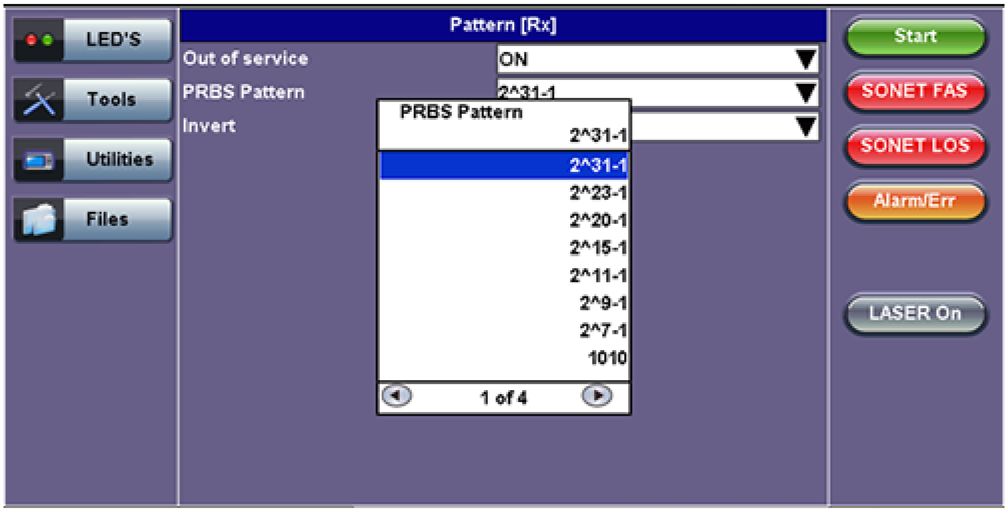
Pattern

Tapping the Pattern box opens the Rx Pattern setup screen. The pattern setup options for the Rx are the same as for the Tx described previously, except for the Out of Service selection, which 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.

Rx Pattern Setup



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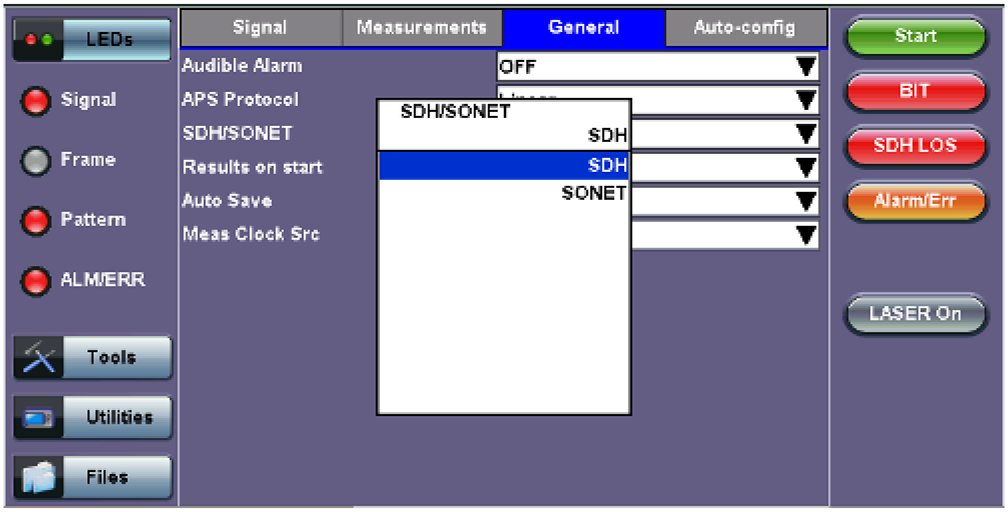
6.4 Setup: OTN/SDH

Selecting SDH from the General tab



To verify that the Tx and Rx block diagrams are OTN/SDH, verify that SDH is selected from the **SDH/SONET** drop-down menu under the **General** tab.

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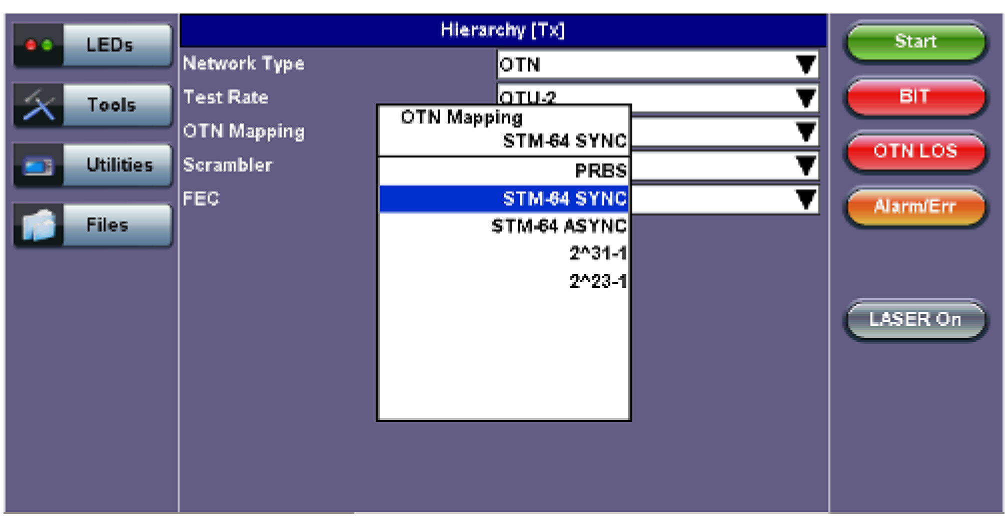
6.4.1 OTN Transmitter Setup

This section of the manual describes the OTN configuration capabilities. The block diagram of the Tx and Rx structure has been described in 6.0 Setup.

Hierarchy

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

Tx Hierarchy Setup

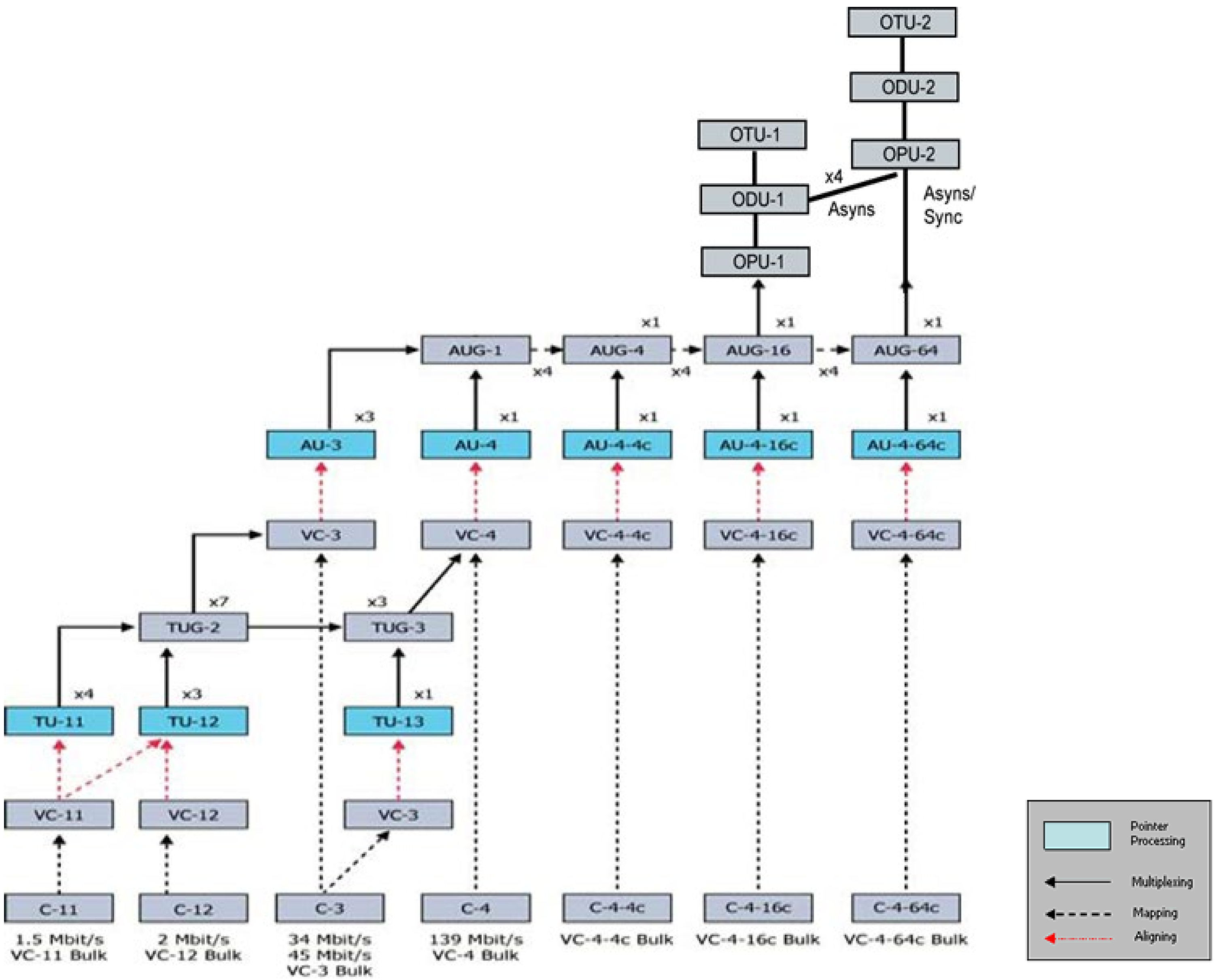


Network Type: In the OTN mode, only optical interface options are available

Test Rate: Options are OTU-1 and OTU-2 (referring to 2.66G and 10.709G respectively)

OTN Mapping: SYNC, ASYNC, and PRBS pattern

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)

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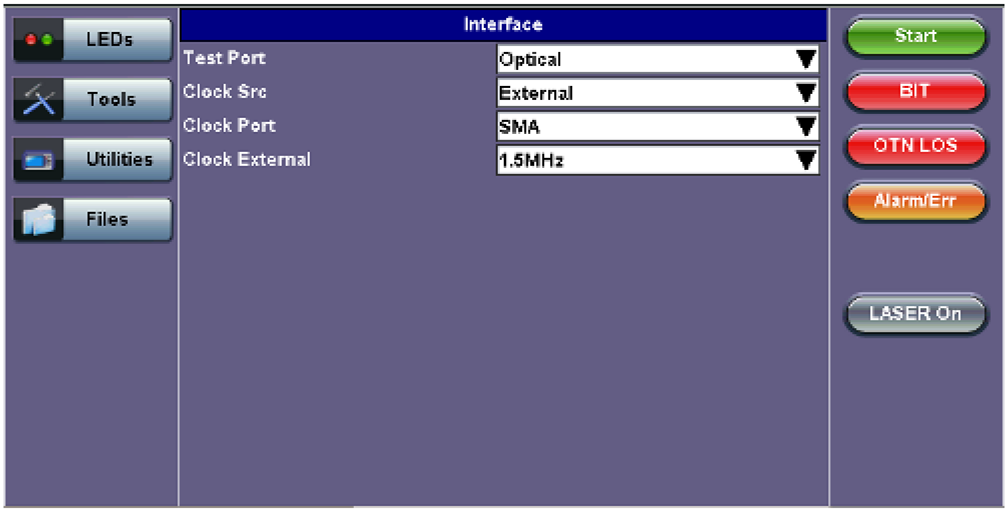
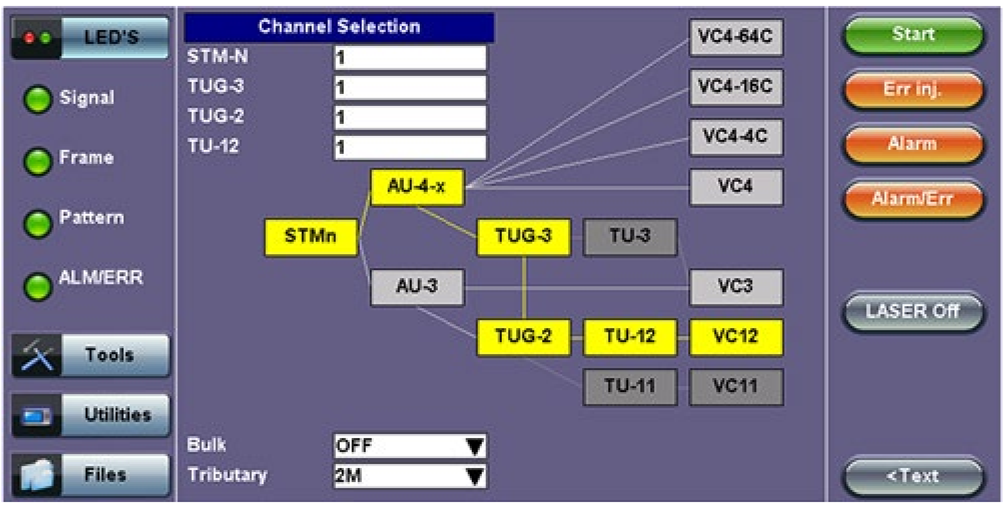
Interface, Structure, Payload, and Pattern

Interface, Structure, Payload, and Pattern TX block configurations are identical to configurations in [Transmitter Setup](#) in the SONET chapter. Please refer to that section for further details.

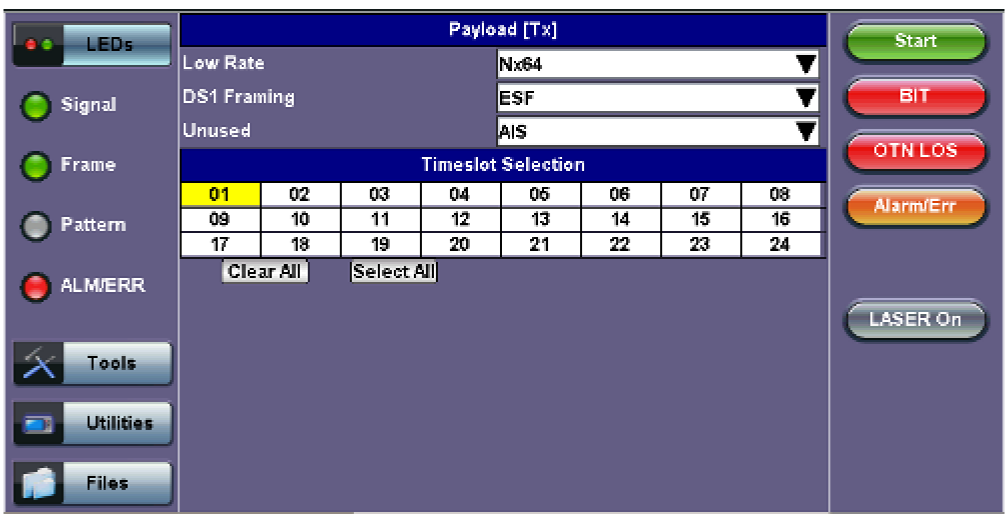
Tx Interface Setup



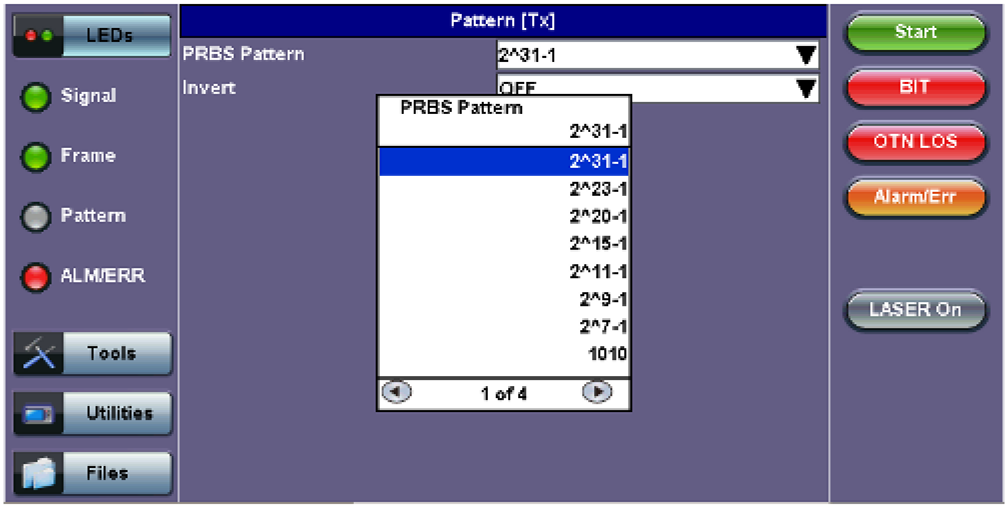
Tx Structure Setup - Graphical Mode



Tx Payload Setup



Tx Pattern Setup



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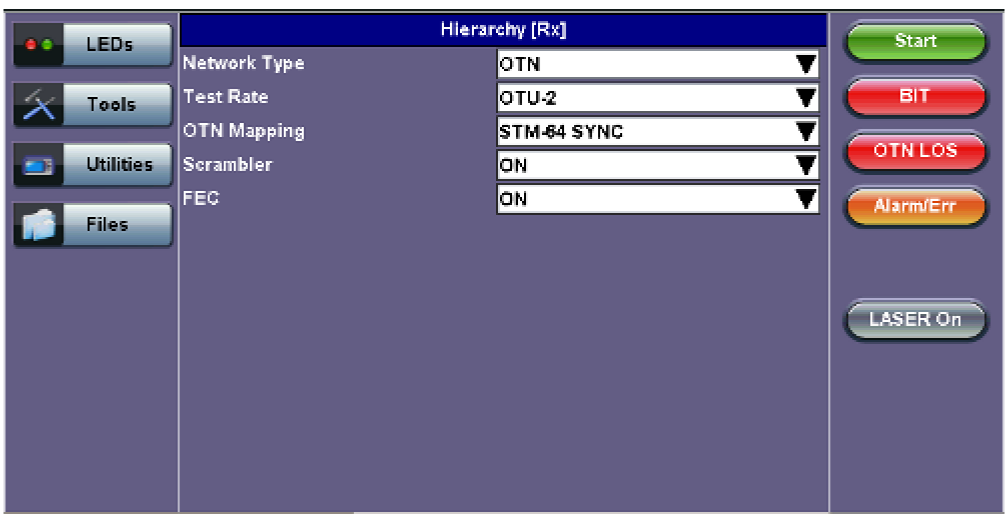
6.4.2 Receiver Setup

Hierarchy

Tapping the **Hierarchy** setup box opens the Rx Hierarchy screen. The Hierarchy setup options for the Rx are the same as for the Tx described previously.

Rx Hierarchy Setup



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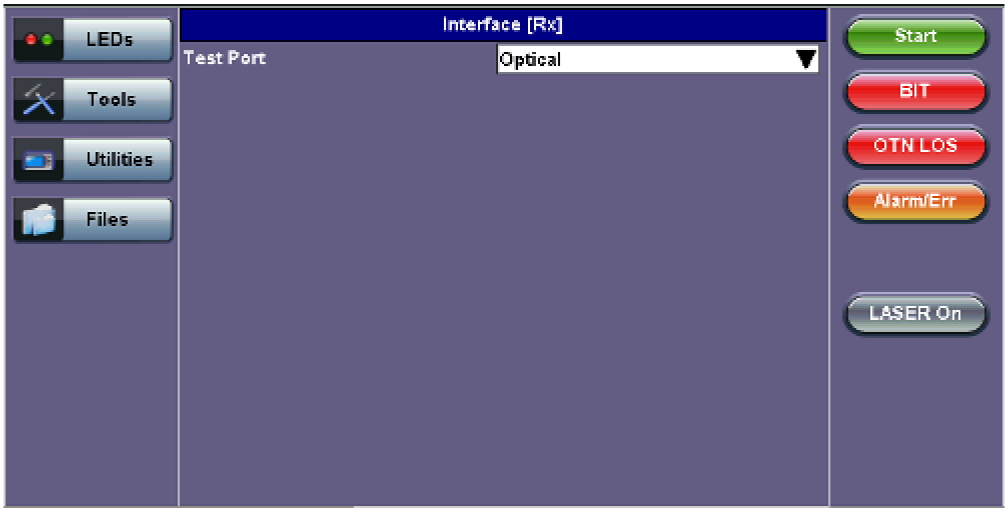
Interface

Tapping the **Interface** setup box opens the Rx Interface screen. The Interface setup options for the Rx are the same as for the Tx described previously, except for clock offset, which is only available in Tx.

Rx Interface



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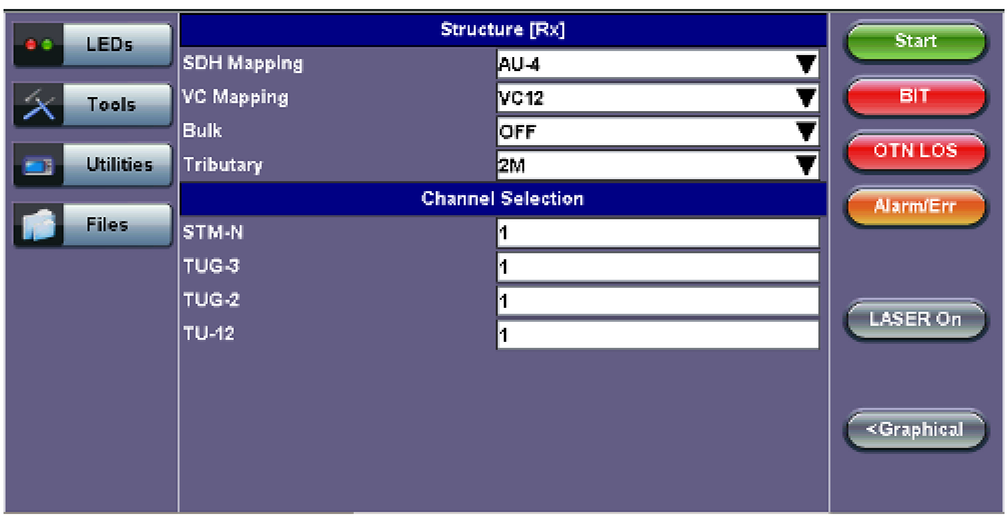
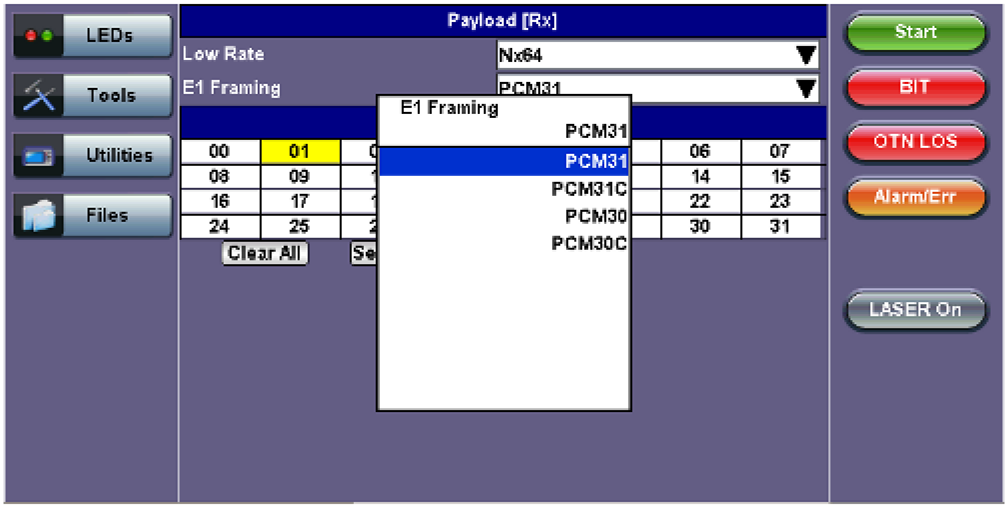
Structure and Payload

OTN/SDH Rx Structure and Payload configurations are the same as for OTN/SDH Tx setup described previously.

Rx Structure



Rx Payload



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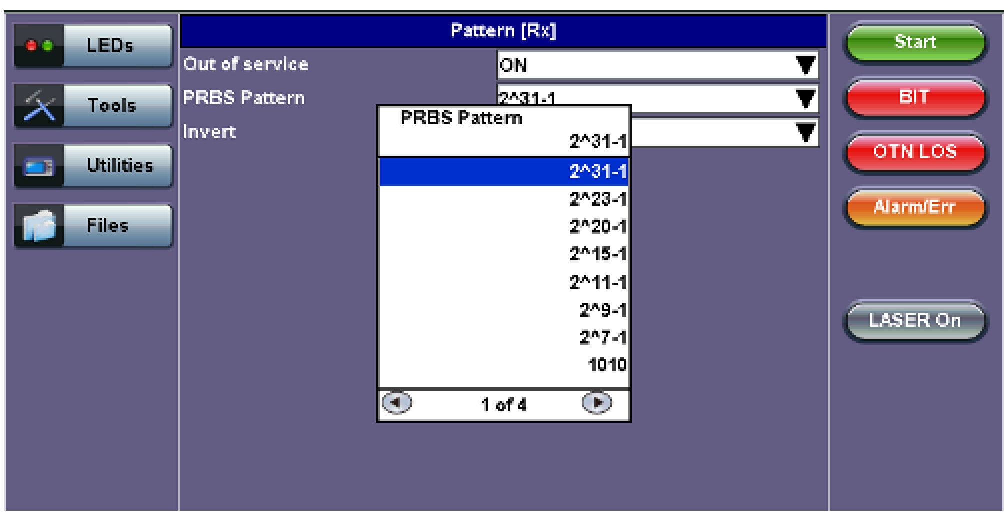
Pattern

Tapping the Pattern box opens the Rx Pattern setup screen. The Pattern setup options for the Rx are the same as for the Tx described previously, except for the **Out of Service** selection, which should be selected if the incoming signal is expected to contain a known test pattern. Deselect this option if the signal is expected to contain live traffic.

Rx Pattern



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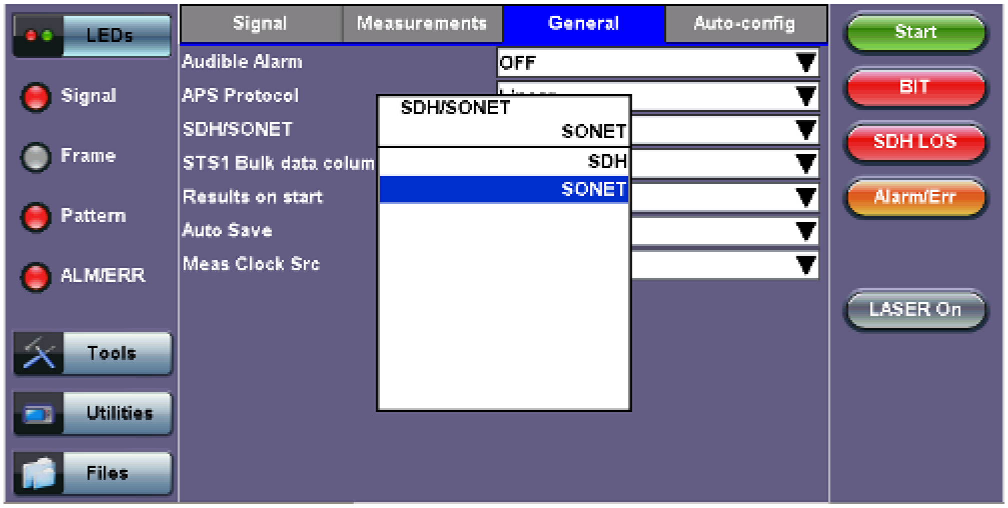
6.5 Setup: OTN/SONET

Selecting SONET from the General tab



To verify that the Tx and Rx block diagrams are OTN/SONET, verify that SONET is selected from the **SDH/SONET** drop-down menu under the **General** tab.

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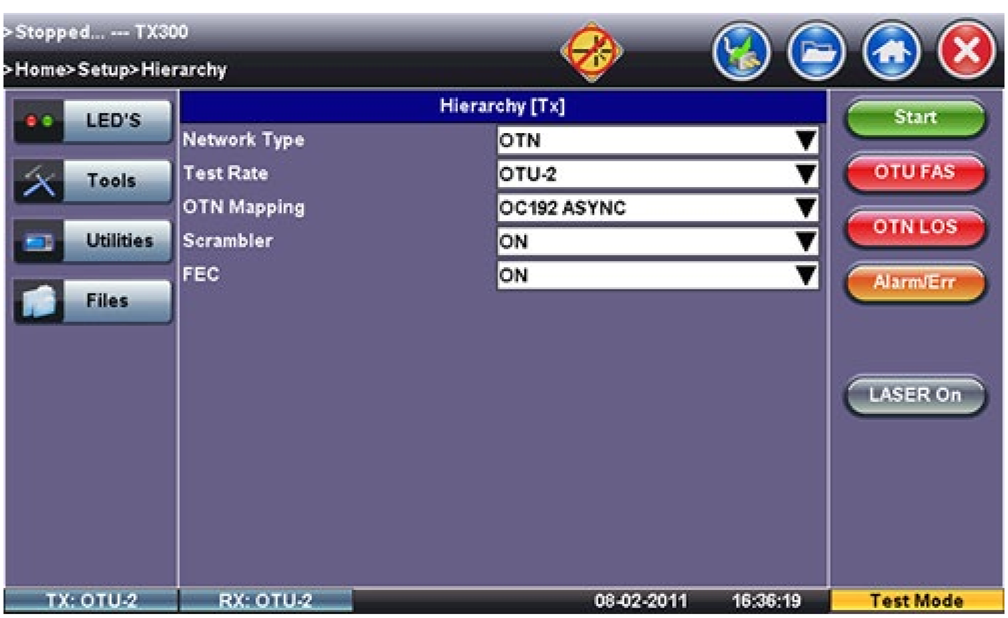
6.5.1 Transmitter Setup

This section of the manual describes the OTN configuration capabilities. The block diagram of the Tx and Rx structure is described in 6.0 Setup.

Hierarchy

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

Tx Hierarchy Setup

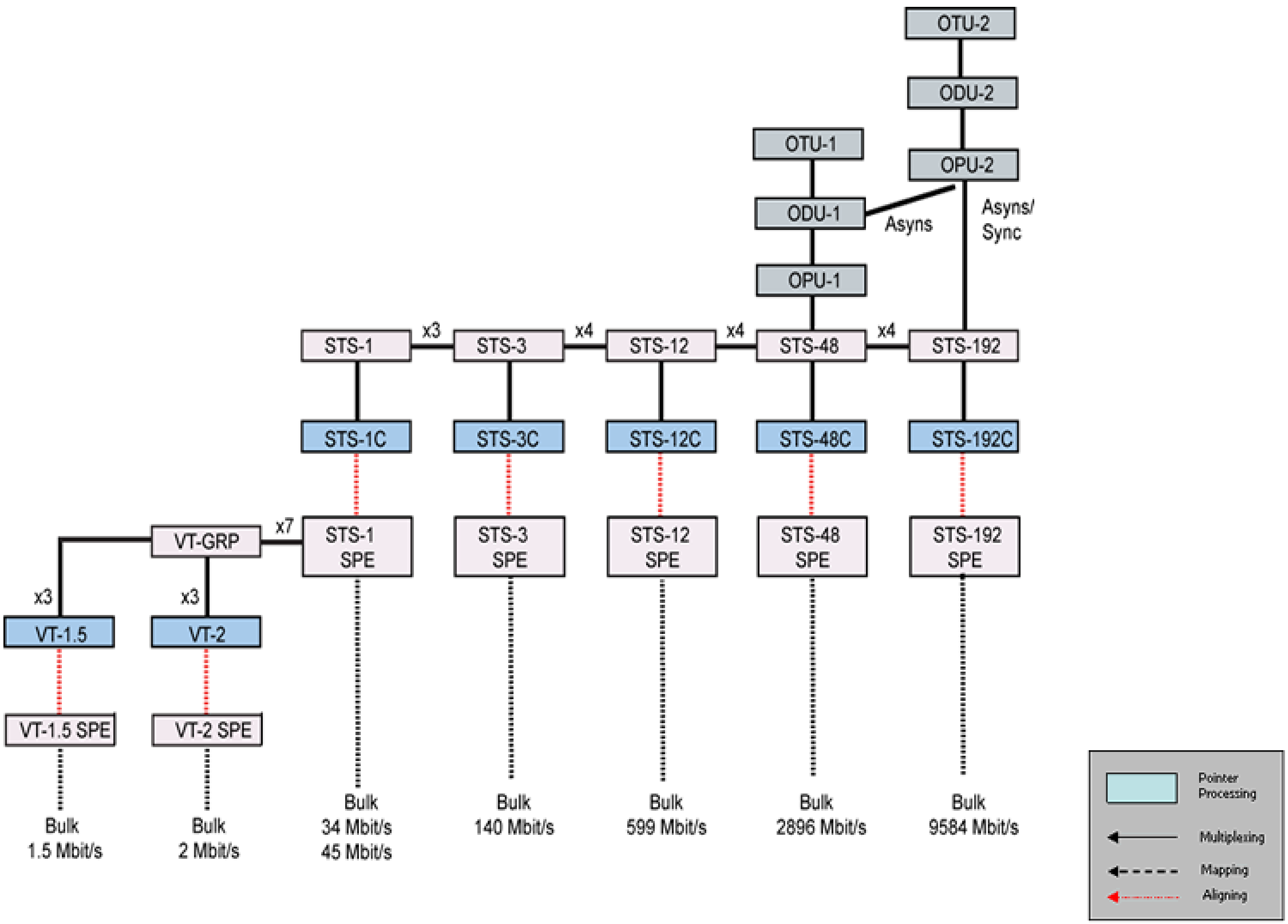


Network Type: In the OTN mode, only optical interface options are available

Test Rate: Options are OTU-1 and OTU-2 (referring to 2.66G and 10.709G respectively)

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)

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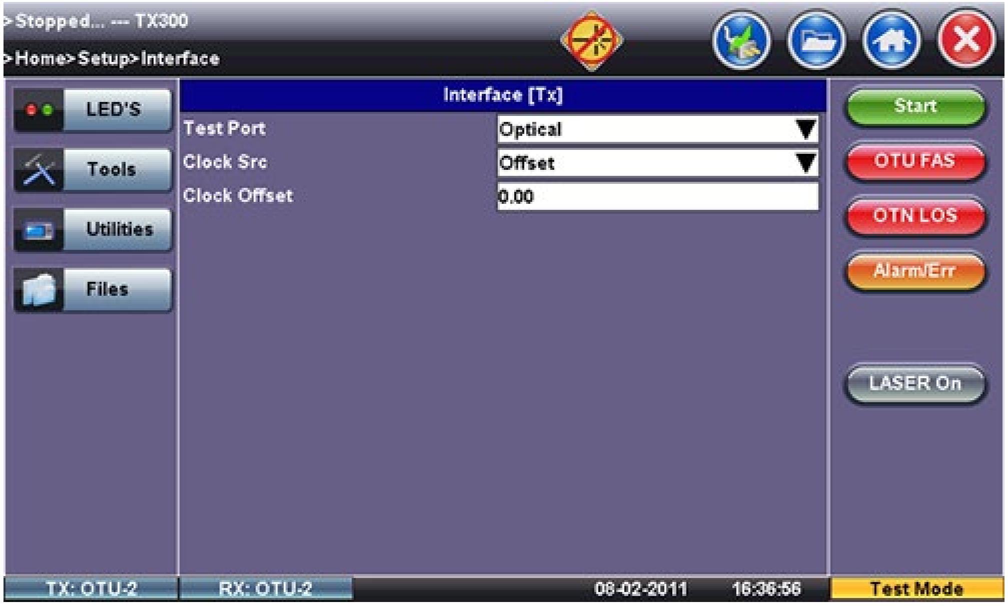
Interface, Structure, Payload, and Pattern

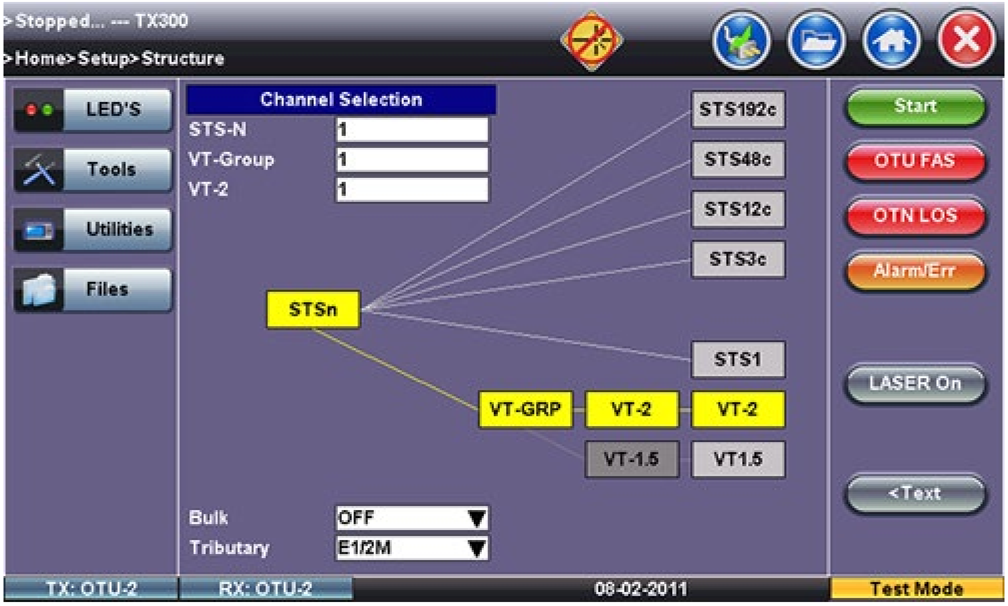
Interface, Structure, Payload, and Pattern TX block configurations are identical to configurations in 6.4.1 Transmitter Setup in the SONET chapter. Please refer to that section for further details.

Tx Interface Setup

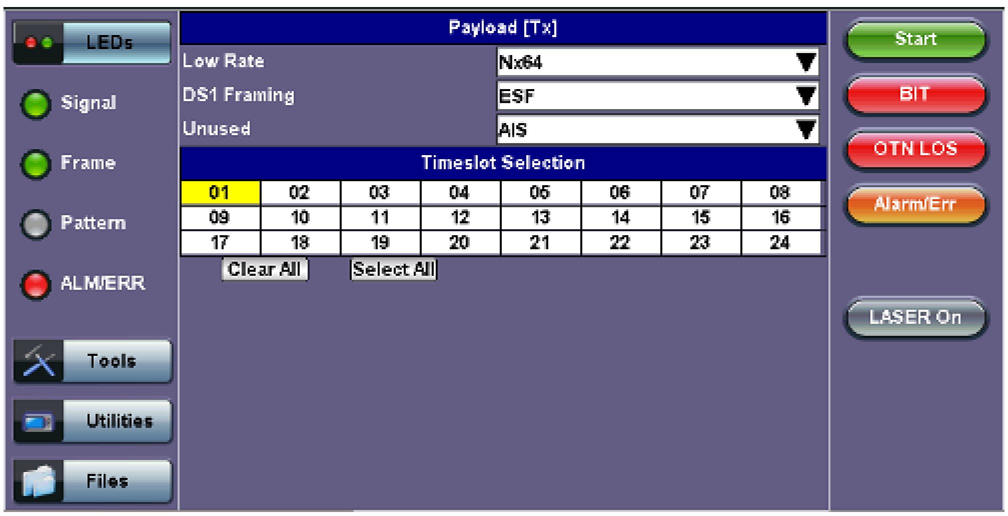


Tx Structure Setup - Text Mode

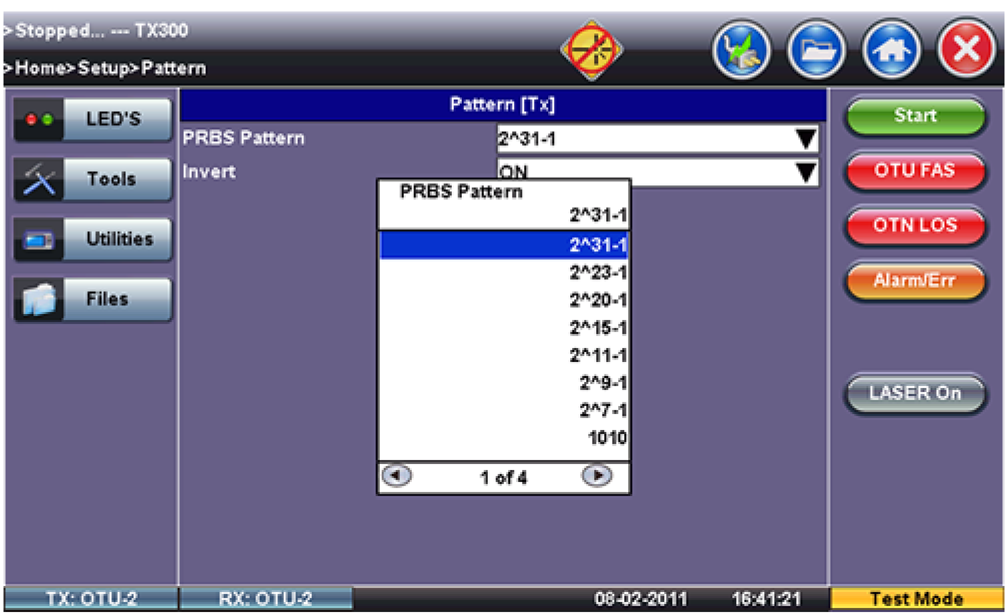
Tx Structure Setup - Graphical Mode



Tx Payload Setup



Tx Pattern Setup



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6.5.2 Receiver Setup

Hierarchy

Tapping the **Hierarchy** setup box opens the Rx Hierarchy screen. The Hierarchy setup options for the Rx are the same as for the Tx described previously.

Rx Hierarchy Setup

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Interface

Tapping the **Interface** setup box opens the Rx Interface screen. The Interface setup options for the Rx are the same as for the Tx described previously, except for clock offset, which is only available in Tx.

Rx Interface

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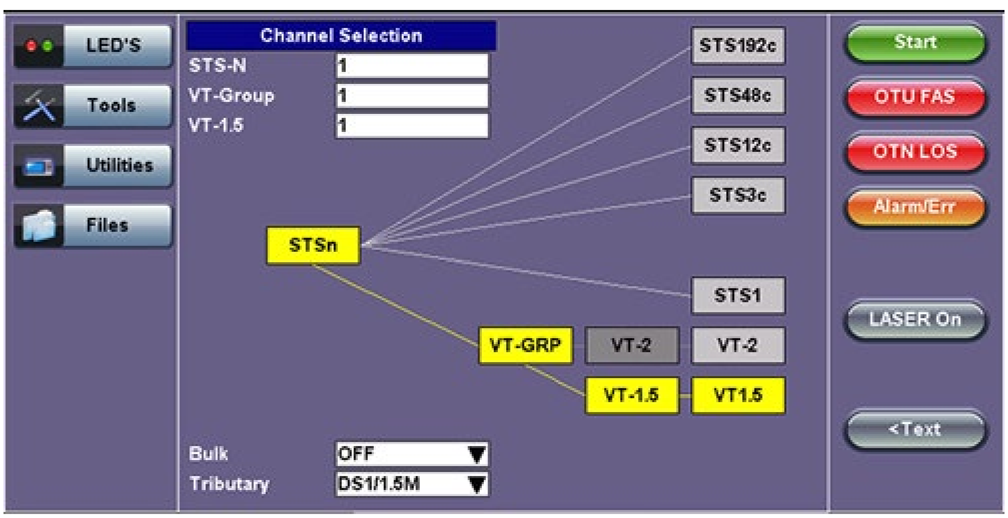
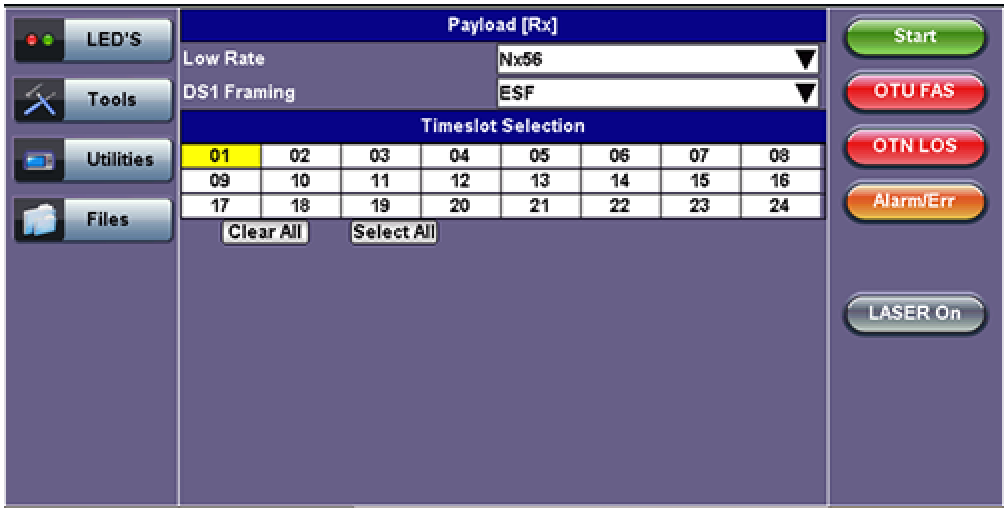
Structure and Payload

OTN/SONET Rx Structure and Payload configurations are the same as for OTN/SONET Tx setup described previously.

Rx Structure



Rx Payload



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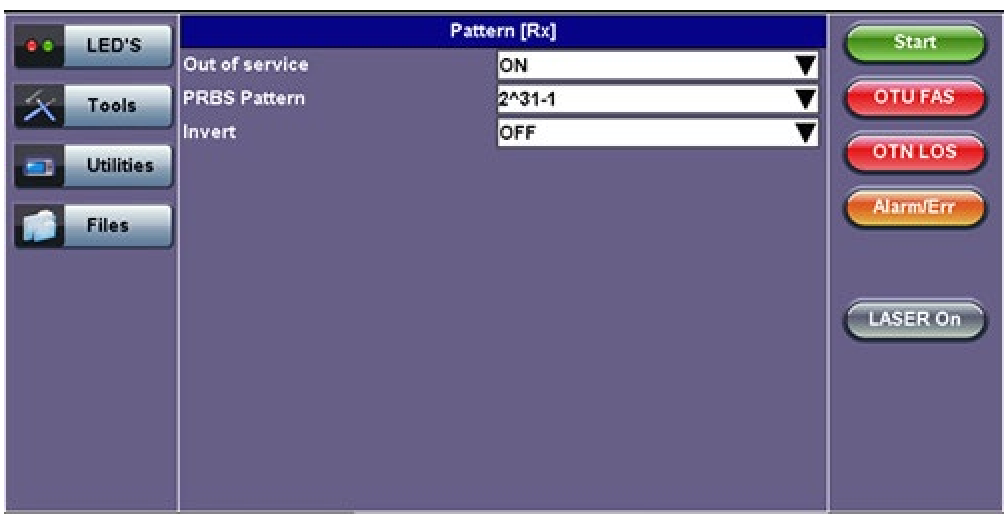
Pattern

Tapping the Pattern box opens the Rx Pattern setup screen. The Pattern setup options for the Rx are the same as for the Tx described previously, except for the **Out of Service** selection, which 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.

Rx Pattern



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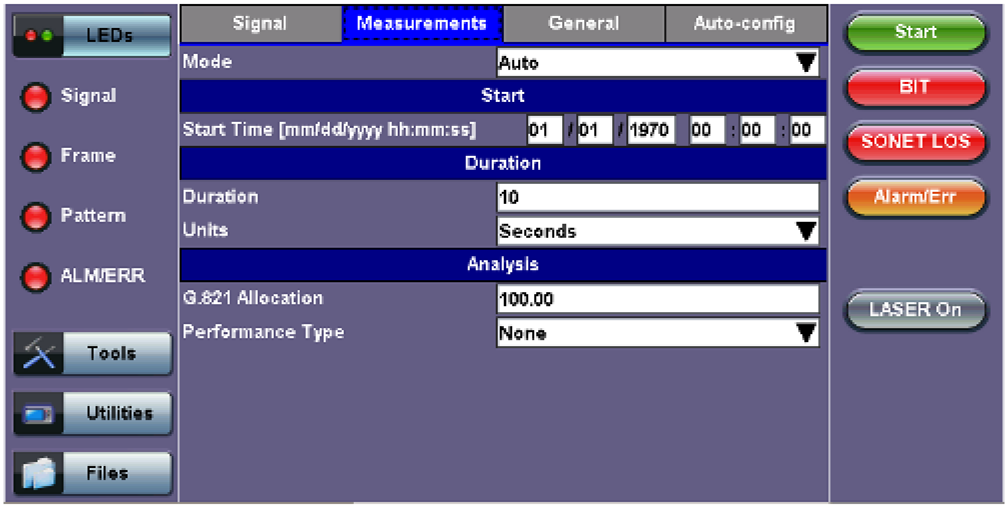
6.6 Measurement Configuration

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

Measurements tab



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6.6.1 Timer Setup

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

Mode: Manual, Timed, and Auto selections are available

- **Manual:** This is linked to the Start/Stop function on the drop-down menu
- **Timed:** The test duration can be set by the user. The test duration can be set in seconds, minutes, hours or days. The test is activated by the Start/Stop function on the drop-down menu
- **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 on the drop-down menu and the test will be activated automatically when the programmed start time is reached.

The timed mode will be required when running a M.2100 or M.2101 performance objective.

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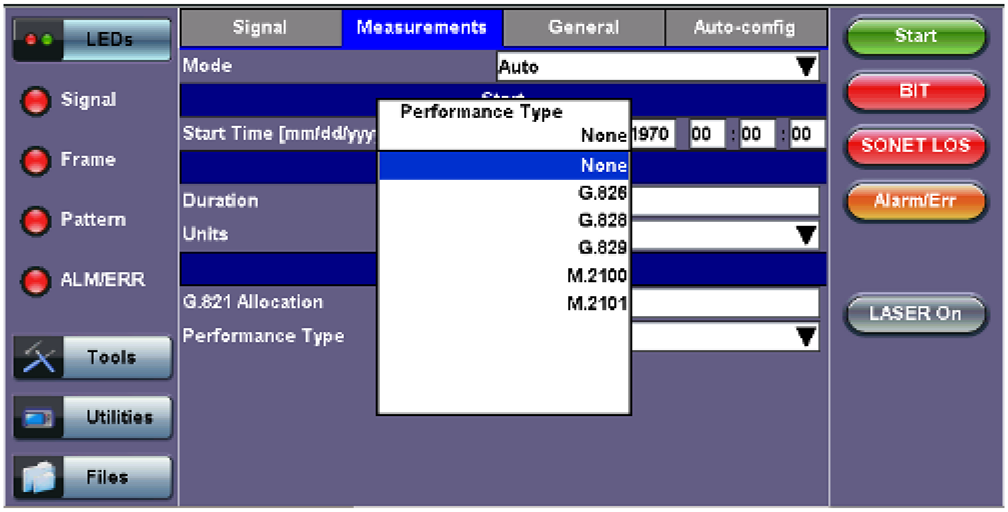
6.6.2 Performance Analysis

The Analysis setup page selects the ITU-T performance test that will be performed by the unit. Depending on Test mode, the selections include None, G.821, G.826, G.828, G.829, M.2100, and M.2101.

Analysis



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 extremely difficult
- **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 Measurement (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
- **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
  - 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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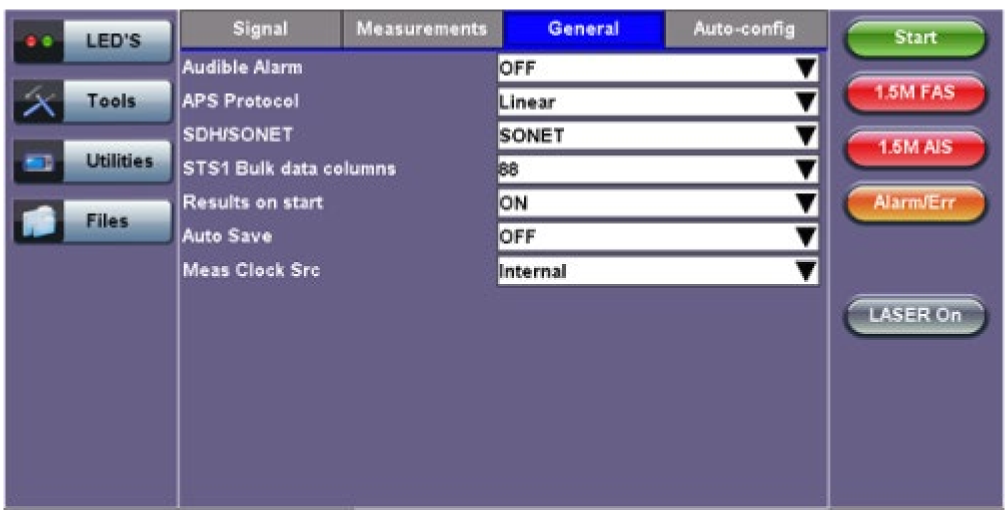
6.6.3 General

The General setup page configures the audible alarm and APS protocol settings.

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.
- **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.
- **Tx Laser Override:** (SONET/SDH MUX measurement) Enabling the Tx Laser Override causes whichever optical device the Rx is using to produce a signal. The Tx data produced is random. The signal is of use to multiplexers that require an input signal before they can transmit an optical signal. Tx Laser Override is only

available when Rx is optical and Tx is in PDH mode, (i.e. a Mux).

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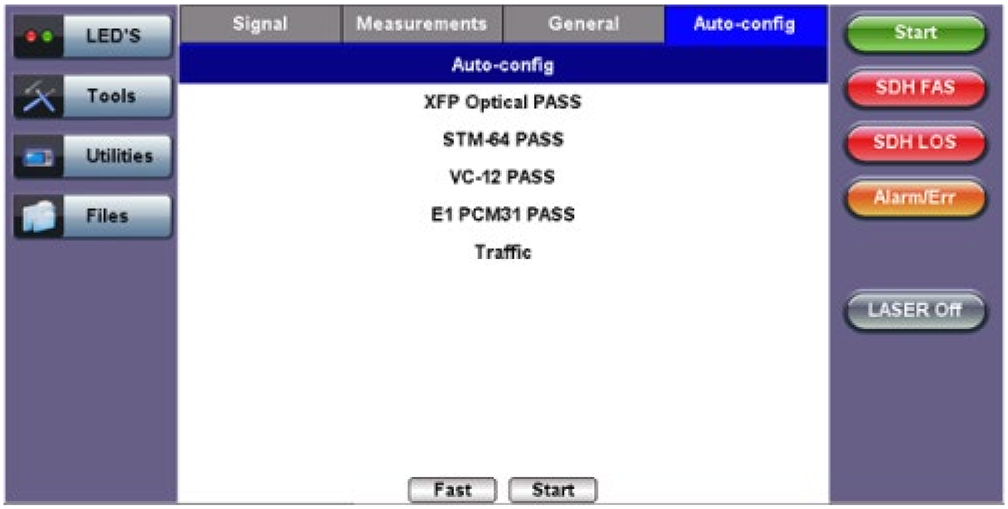
6.6.4 Auto-Config

The Auto-Configuration function is described below.

Auto-config tab



The **Auto-Config** function automatically sets the receiver of the test set. 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

Tap on the **Start** button 

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.

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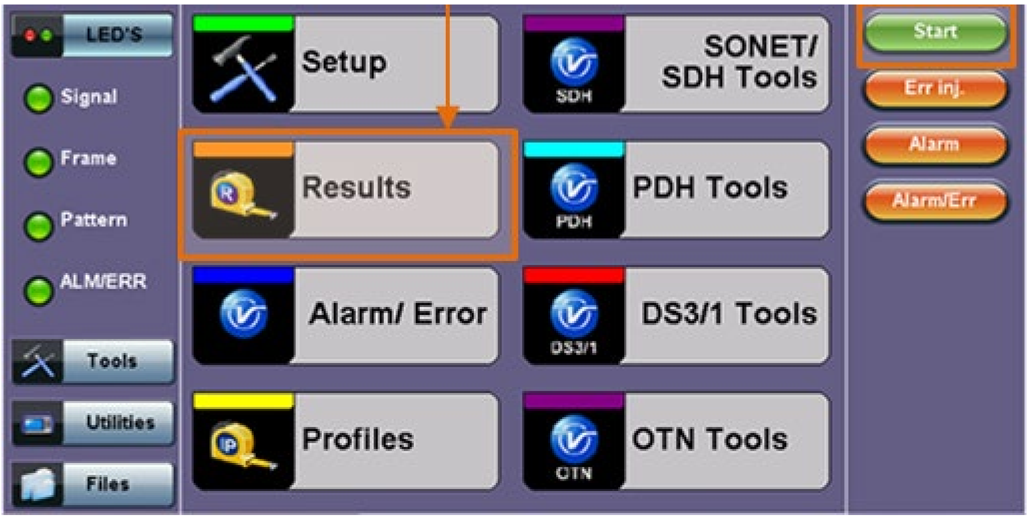
7.0 Results

Accessing Results

To access measurements for SDH, SONET, and OTN, tap on **Start**, which starts testing, or **Results**.

Results and Start Buttons



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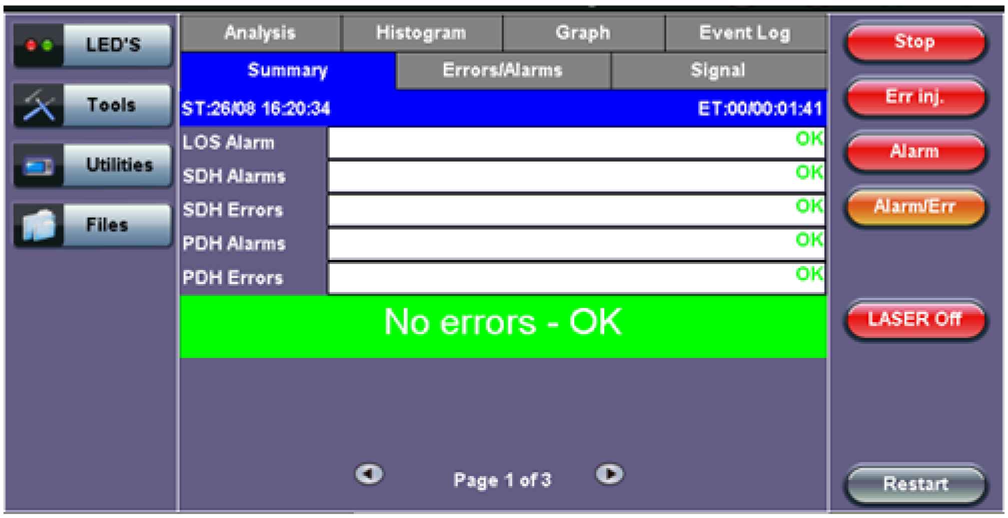
7.1 Results: SDH

7.1.1 Summary

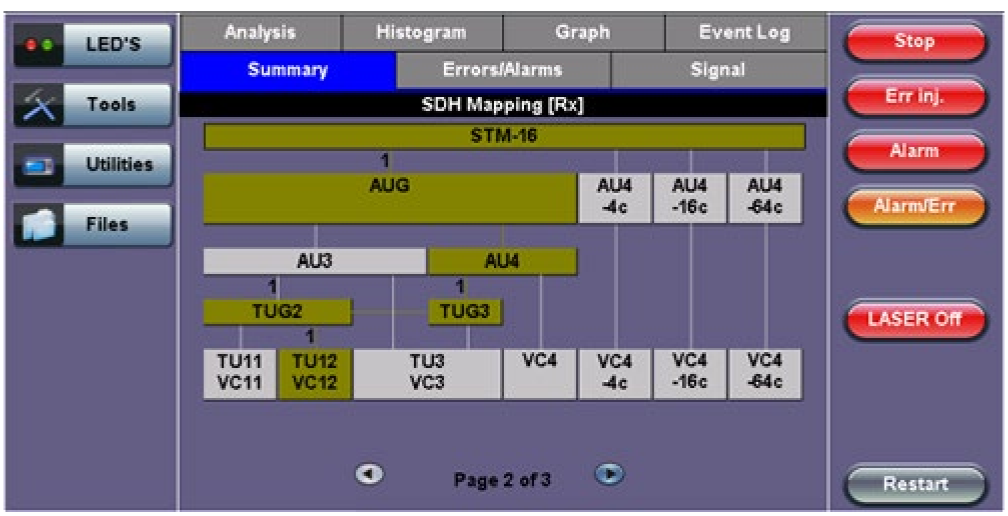
The Summary tab displays a summary of test results and parameters. At a glance, the user is able to see if there are any alarms, errors, or signal failure pertaining to the SDH signal and its payload.

Summary (Page 1)

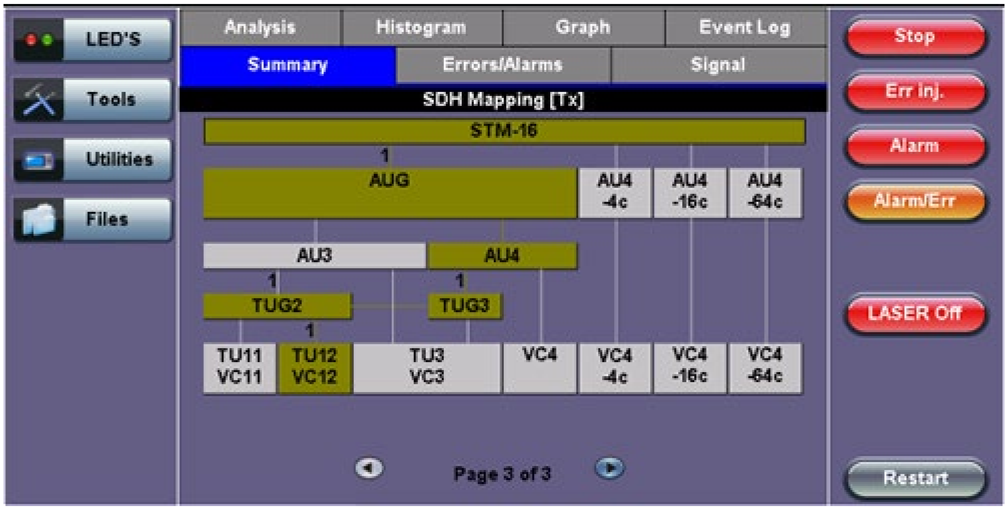


SDH mapping information is displayed on page 2 and 3.

Summary (Page 2)



Summary (Page 3)



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7.1.2 Errors and Alarms

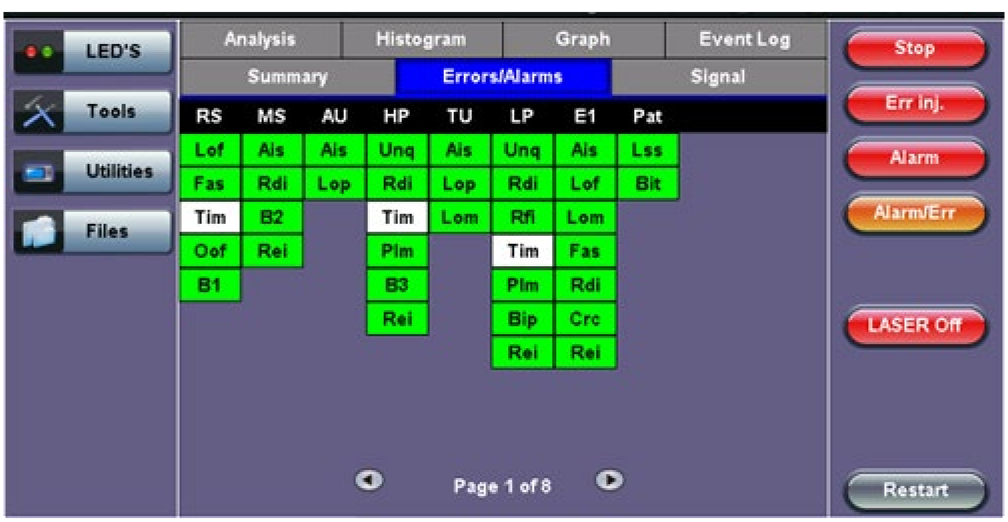
The Errors/Alarms tab brings up several pages showing the errors and alarms status.

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.

The LED headers are described in the table 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 defection criteria 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 or 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 0.25 ms.
OOF	Out of Frame - Declared when 4 consecutive SDH frames are received with invalid (errored) framing patterns. Maximum OOF detection time is 625 µs
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.

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

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 N x 24 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

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 - Declared when bits 1-4 of the G1 byte contain 0001 to 1000 pattern

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 Loss of Pointer - Declared when no valid pointer is detected in N consecutive super-frames (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

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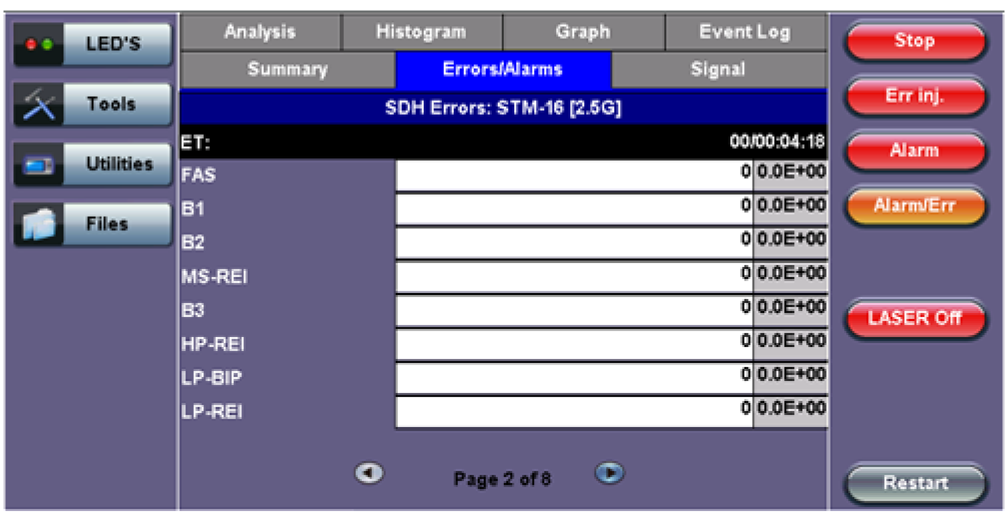
Errors/Alarms (Page 2)

Page 2 lists the SDH Errors in logical order that are associated with the signal under test. All errors are evaluated and stored. The Elapsed Time [ET] is shown in the right hand corner of the header. Error conditions are displayed in red including count and rate.

Errors/Alarms (Page 2)



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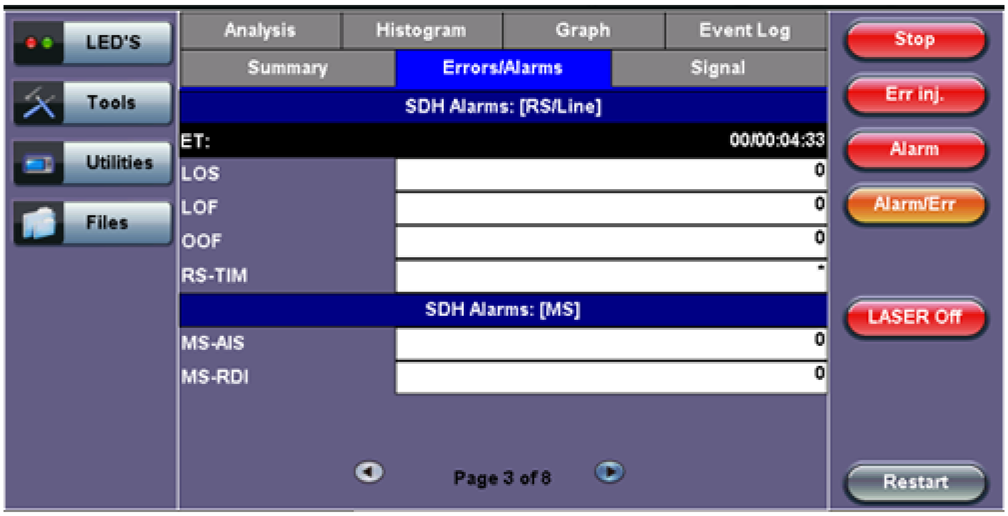
Errors/Alarms (Page 3)

Page 3 lists the Section and Line Overhead Alarms in logical order associated with the signal under test. All alarms are evaluated and stored. The Elapsed Time [ET] since the start of the test is shown in the upper right hand corner.

The alarms associated with the Section and Line are displayed separately for ease of interpretation.

Errors/Alarms (Page 3)



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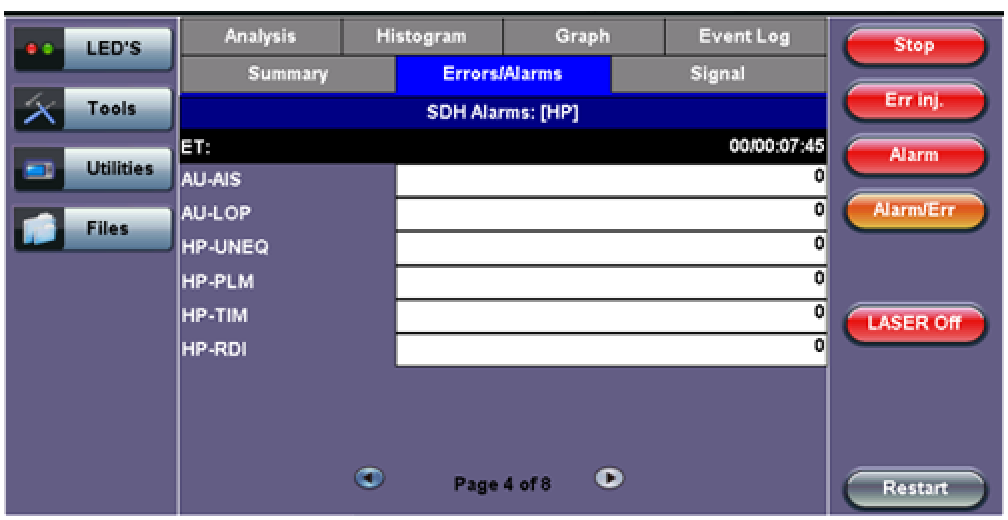
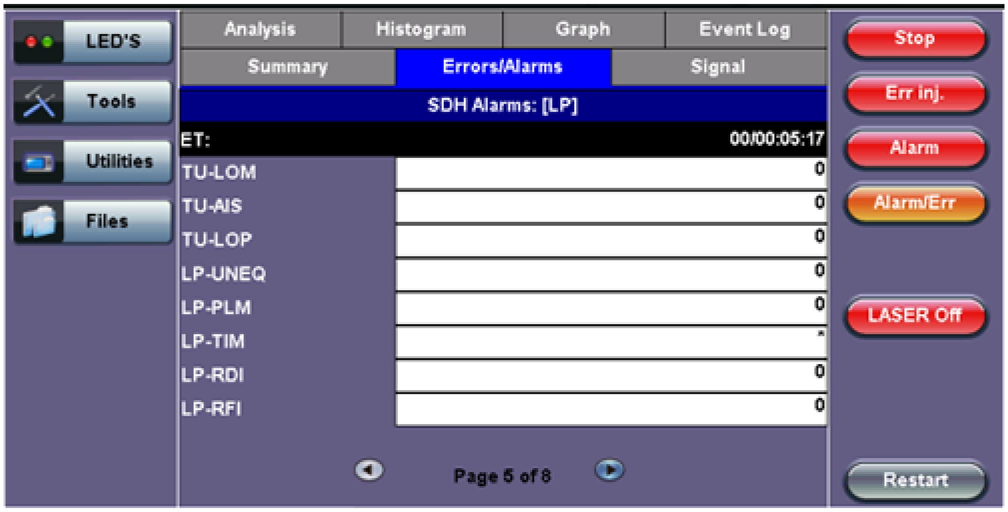
Errors/Alarms (Page 4 & 5)

Page 4 & 5 lists the High Order Path and Low Order path in logical order that are associated with the signal under test. All alarms are evaluated and stored.

Errors/Alarms (Page 4)



Errors/Alarms (Page 5)



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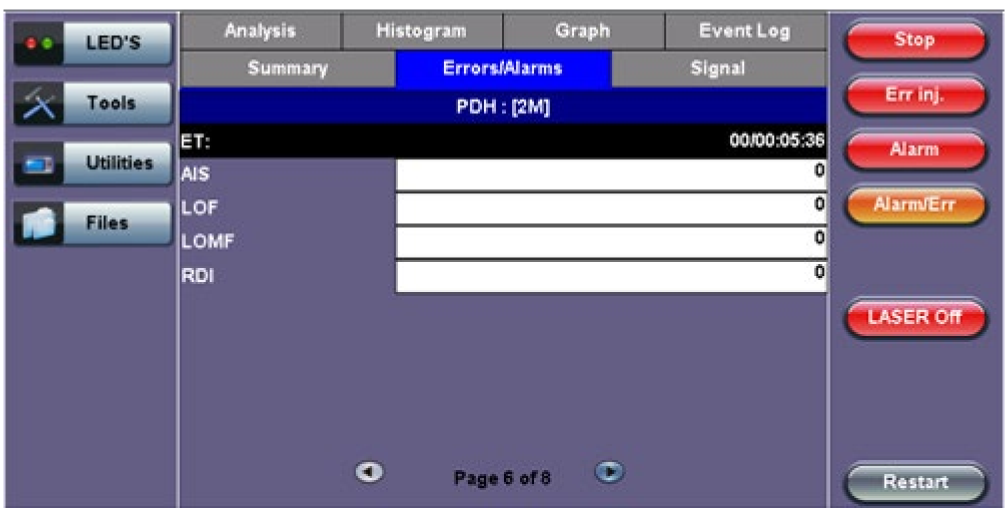
Errors/Alarms (Page 6)

Page 6 lists the PDH Alarms in logical order that are associated with the signal and payload under test. All alarms are evaluated and stored.

Errors/Alarms (Page 6)



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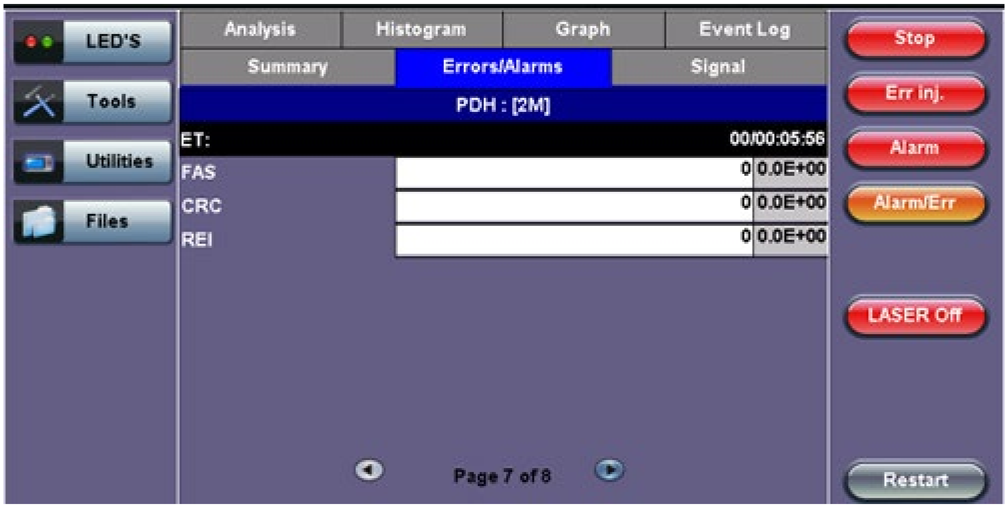
Errors/Alarms (Page 7)

Page 7 lists the PDH Errors in logical order that are associated with the signal and payload under test. All errors are evaluated and stored.

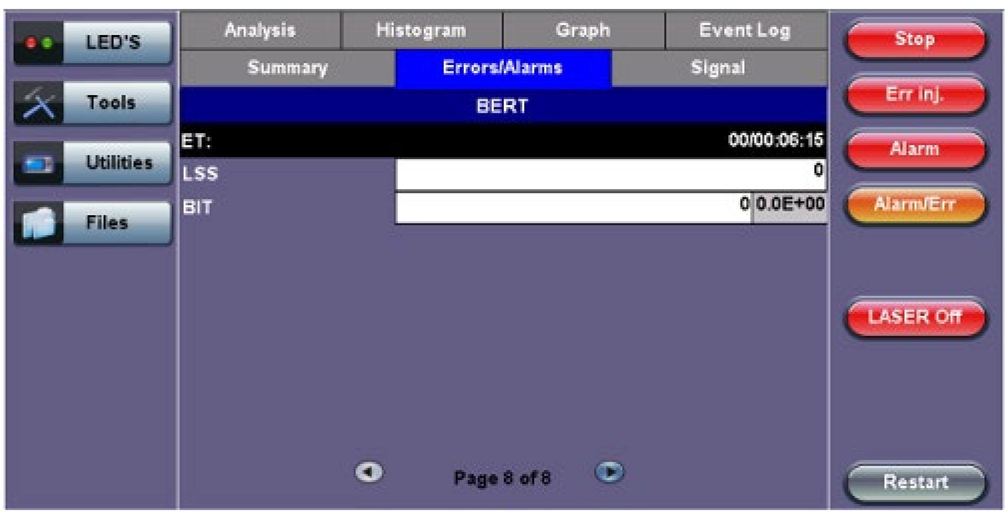
Errors/Alarms (Page 7)



Errors/Alarms (Page 8)

Page 8 lists the BERT Errors in logical order that are associated with the signal and payload under test. All errors are evaluated and stored.

Errors/Alarms (Page 8)



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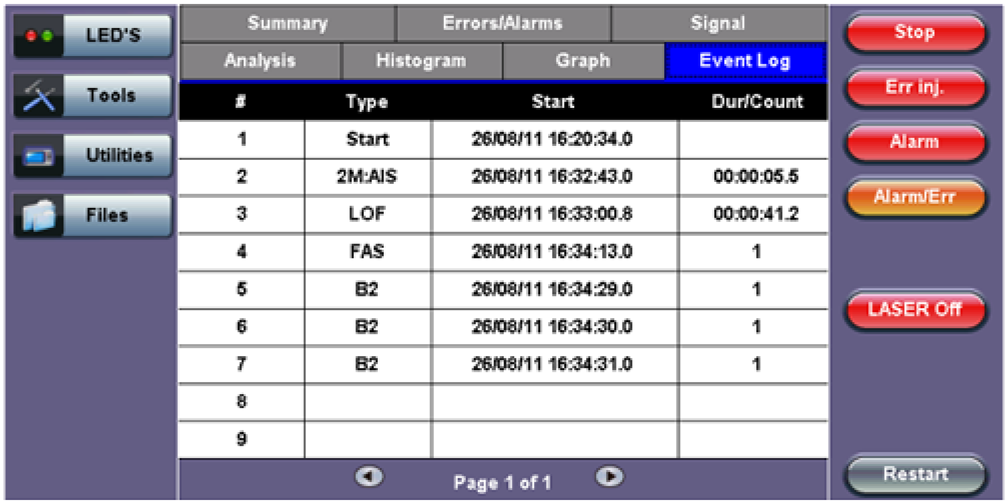
7.1.3 Event Log

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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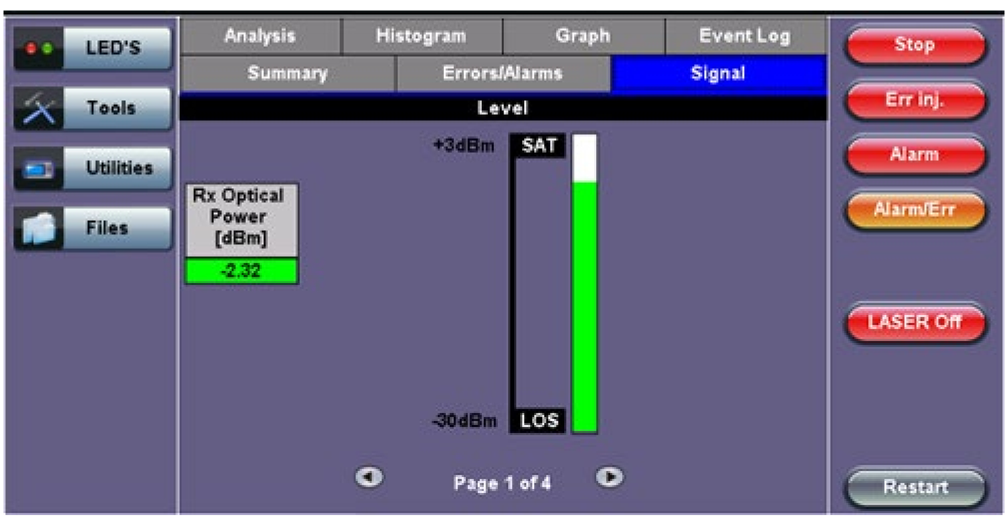
7.1.4 Signal

The signal tab displays the Level and Frequency screen. Page 1 displays the level measurement in electrical units (volts) for STM-1, STM-4, STM-16 and STM-64 signals.

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

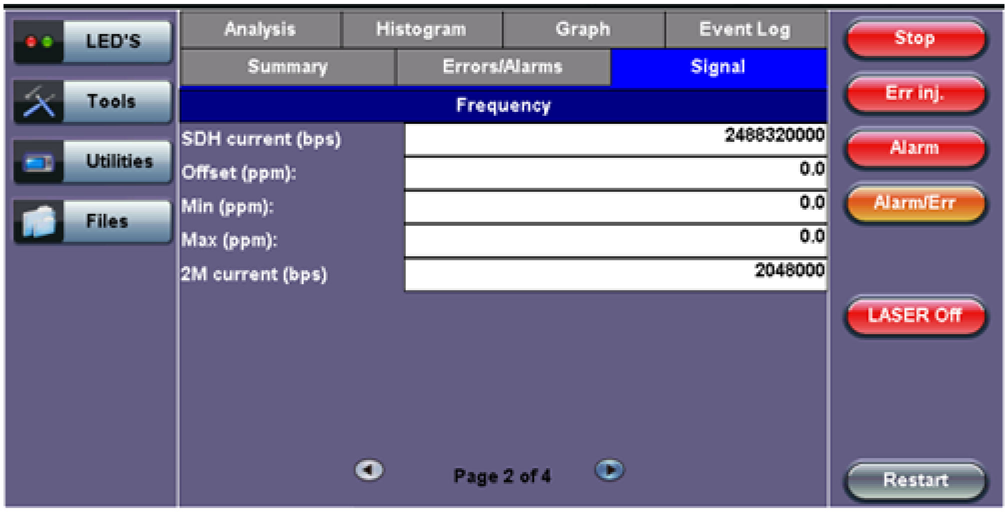
Signal (Page 1)



Frequency (Page 2)

The received signal frequency and offset is measured and displayed. For SDH signals, the measurement is performed on both electrical (BNC) and optical interfaces.

Signal - Frequency (Page 2)



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

- **SDH 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.
- **2M 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.

Low quality clock sources that deviate from the nominal value cause problems in the operation of network elements. It is necessary and recommended to measure the signal frequency at all hierarchies to reduce synchronization risks. To measure line frequency in service, the test set must be connected to a Protected Monitoring Point (PMP). The frequency of the signal is normally reported in Hz, while the deviation is reported in ppm. Tolerances for the various clock frequencies of SDH hierarchies are presented in the table below.

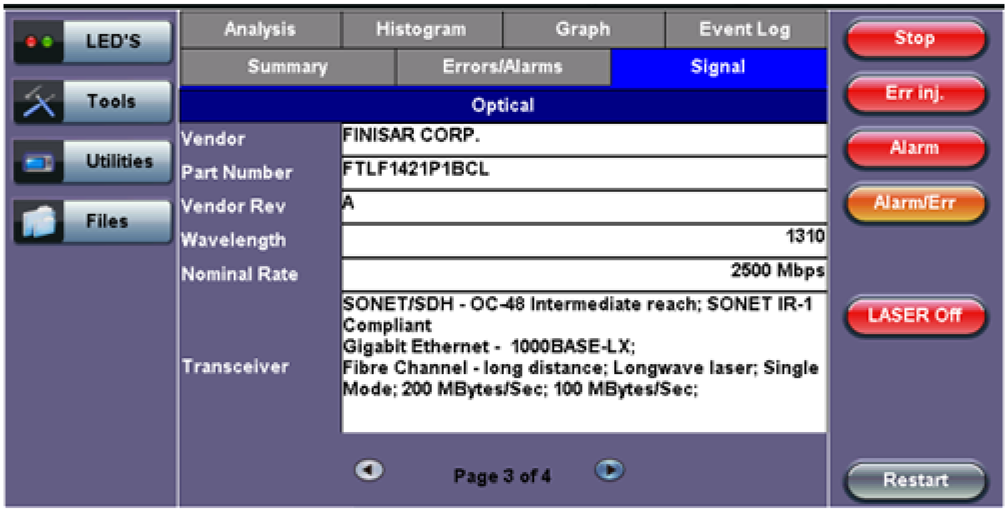
SONET/SDH Clock Frequencies and Tolerances	
Bit rate (Mbps)	**Tolerance (ppm)**
155,520	< 4.6ppm
622,080	< 4.6ppm
2,488,320	< 4.6ppm
9,953,280	< 4.6ppm

Level: Measures the Peak and Peak-Peak voltage values or optical power of the incoming signal.

Signal > Optical Information (Page 3)

Page 3 displays the Optical module information which includes Vendor name, Part number, and Optical Wavelength.

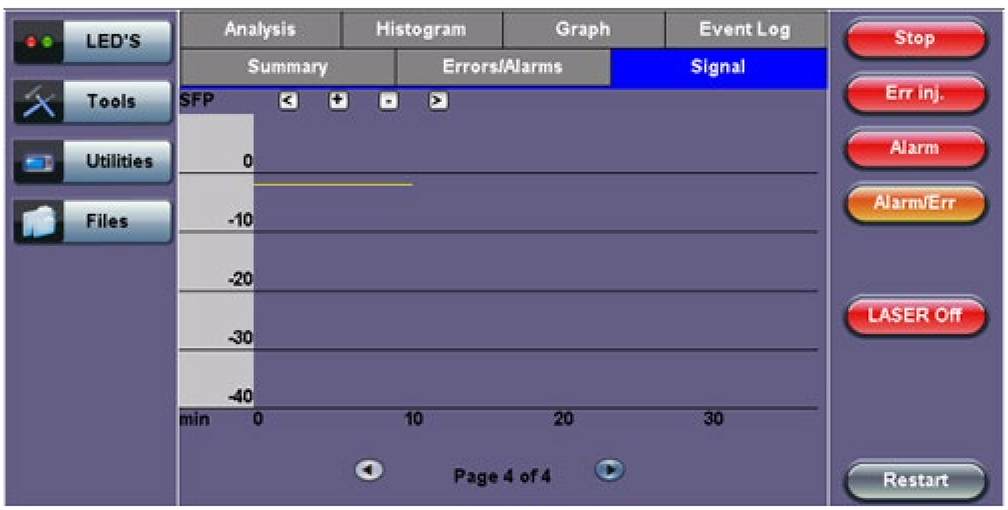
Signal - Optical (Page 3)



Signal > Optical Information (Page 4)

Page 4 displays the Optical module Power Measurement Graph.

Signal - Optical (Page 4)



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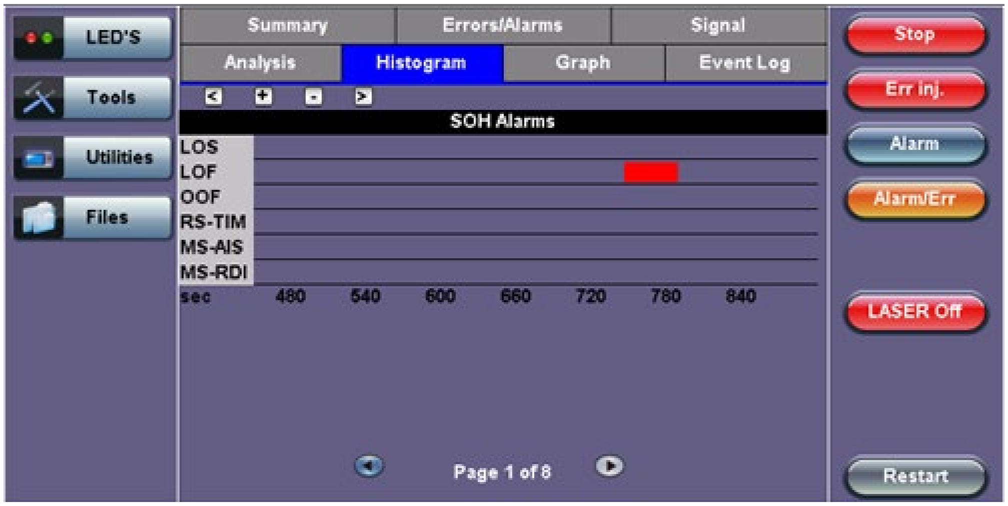
7.1.5 Histogram

The Histogram tab displays the screen showing a historical record of the Alarms and Errors recorded during the measurement interval. A dedicated Page is available for errors and alarms including BER.

Page 1 displays the **Alarms** associated with the **Section Overhead (SOH) Alarm**.

Histogram - SOH Alarms (Page 1)



The alarms and errors presented depend on the signal type and structure selected. A graphical timeline on the horizontal axis indicates when the event occurred. The upper left and right arrows allow the user to scroll through the measurement period while the + and – keys allow zooming in/out of the time axis.

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Histogram (Page 2)

Page 2 displays the **Errors** associated with the **Section Overhead (SOH)**.

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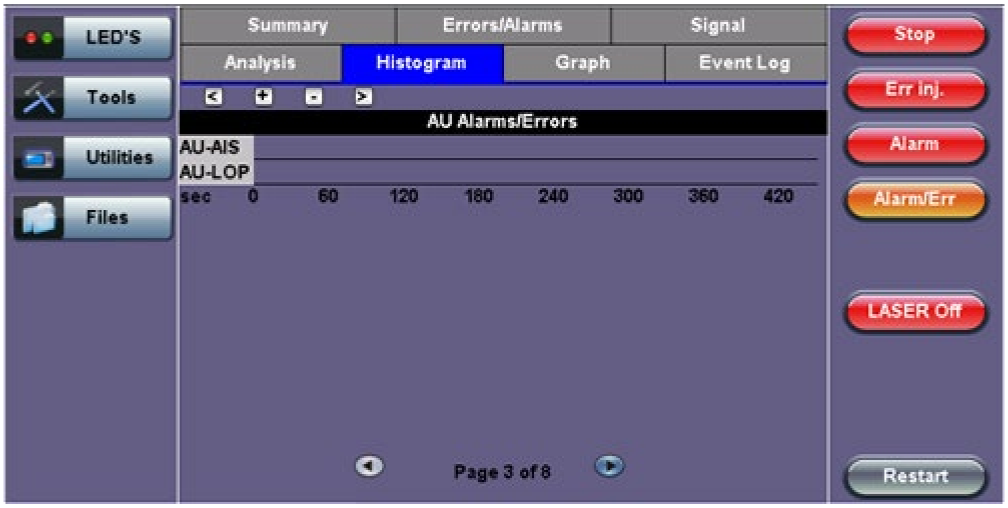
Histogram (Page 3)

Page 3 displays the **Alarms and Errors** associated with the **Administrative Unit (AU, SDH)**. The measured parameters are:

- AU-AIS (AU - Alarm Indication Signal)
- AU-LOP (AU - Loss of Pointer)

Histogram - AU Alarms/Errors (Page 3)



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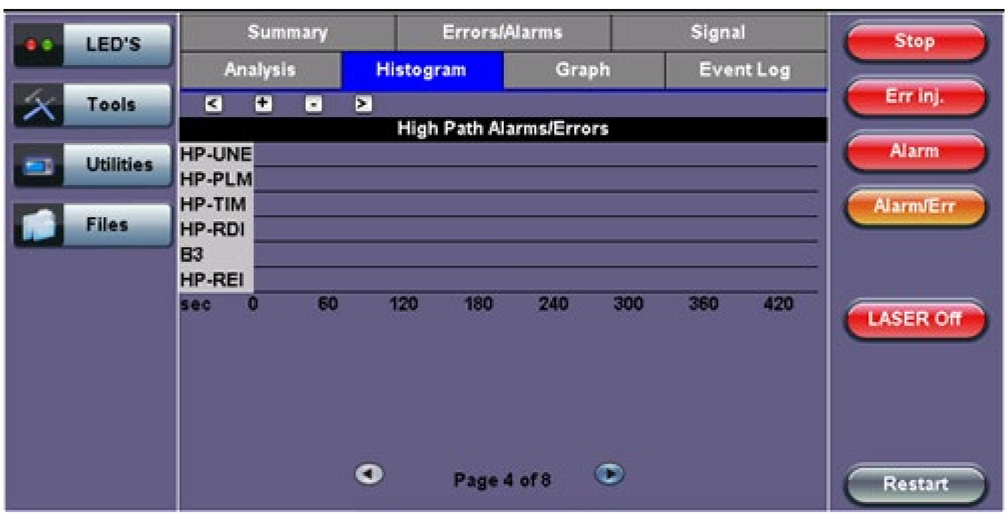
Histogram (Page 4)

Page 4 displays the **Alarms and Errors** associated with the **High Order Path (HP, SDH)**. The measured parameters are:

- HP-UNE (HP-Unequipped)
- HP-PLM (HP-Payload Mismatch)
- HP-TIM (HP-Trace Identifier Mismatch)
- HP-RDI (HP-Remote Defect Indication)
- B3 errors
- HP-REI (HP-Remote Error Indication)

Histogram - High Path Alarms/Errors (Page 4)



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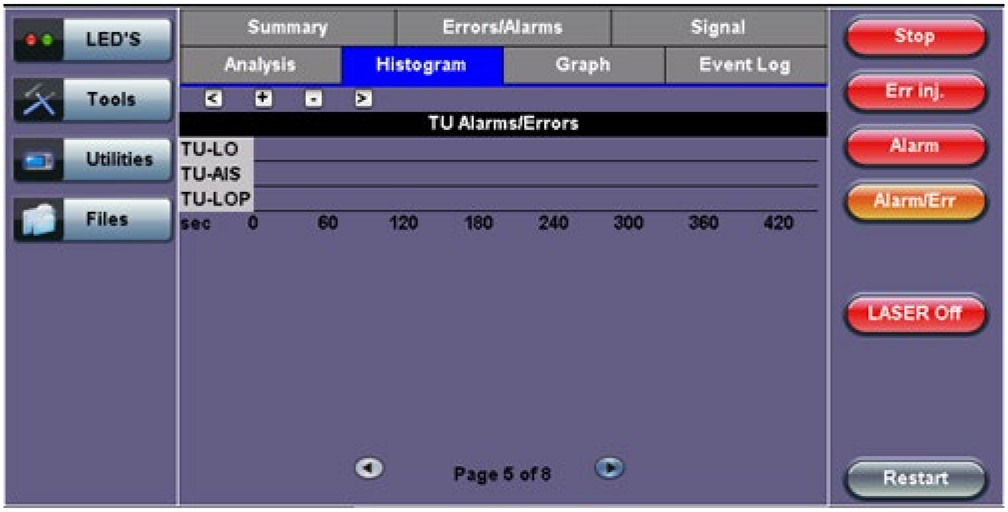
Histogram (Page 5)

Page 5 displays the **Alarms and Errors** associated with the **Tributary Unit (TU)**.

- TU-AIS (TU-Alarm Indication Signal)

- TU-LOP (TU-Loss of Pointer)

Histogram - TU Alarms/Errors (Page 5)



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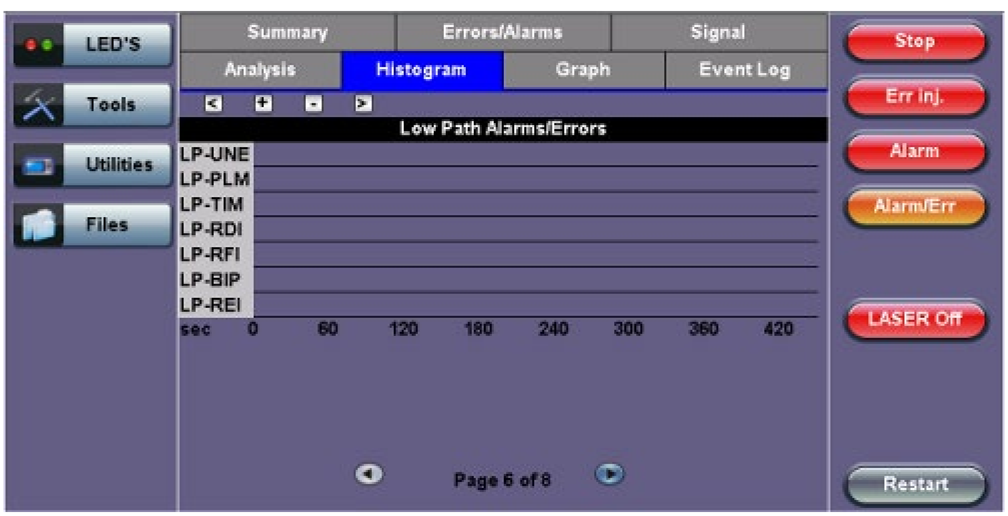
Histogram

Page 6 displays the **Alarms and Errors** associated with the **Low Order Path (LP,SDH)**. The measured parameters are:

- LP-UNE (LP-Unequipped)
- LP-PLM (LP-Payload Mismatch)
- LP-TIM (LP-Trace Identifier Mismatch)
- LP-RDI (LP-Remote Defect Indication)
- LP-RFI (LP-Remote Fault Indication)
- LP-BIP (LP-Bit Interleaved Parity)
- LP-REI (LP-Remote Error Indication)

Histogram - Low Path Alarms/Errors (Page 6)



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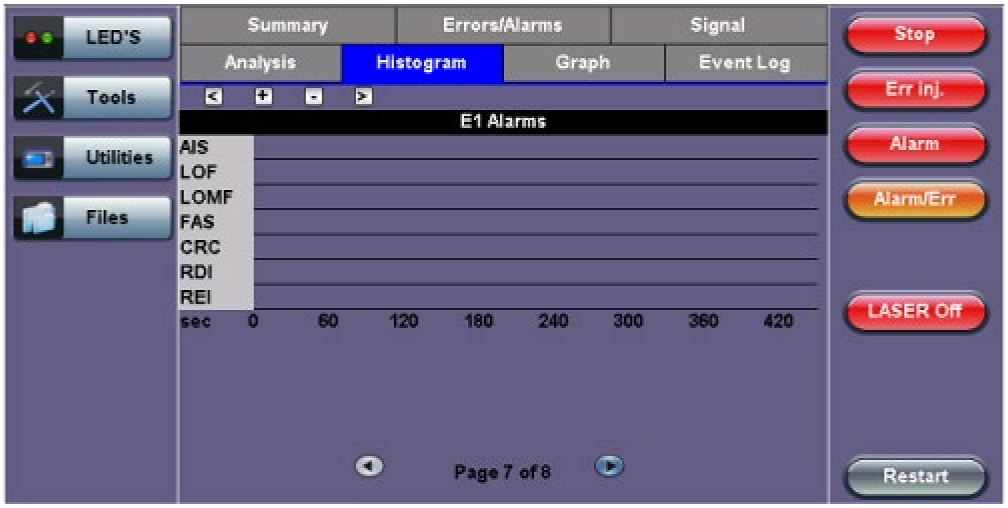
Histogram (Page 7)

Page 7 displays the **Alarms** associated with the payload. The measured parameters depend on the payload selected.

Histogram - E1 Alarms (Page 7)



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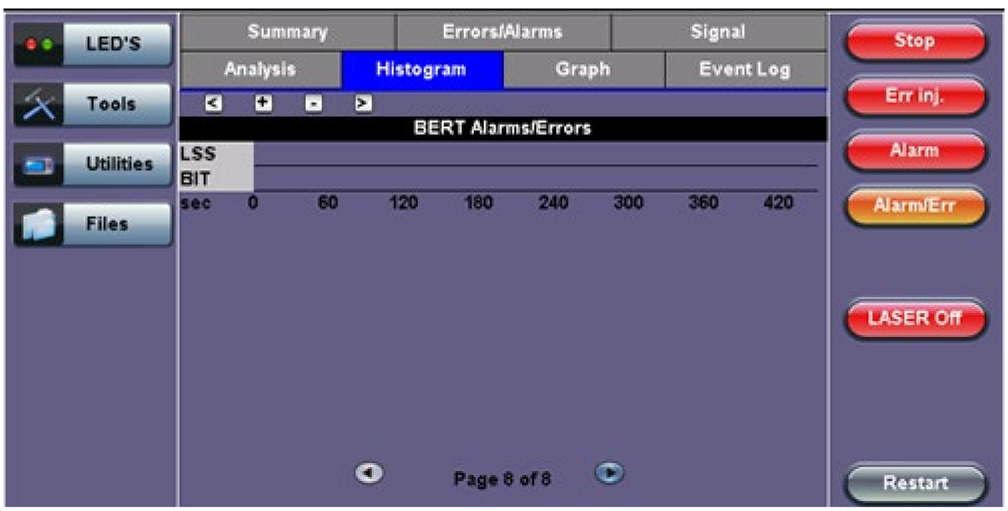
Histogram (Page 8)

Page 8 displays the **Errors** associated with the test pattern.

Histogram - BERT Alarms/Errors (Page 8)



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7.1.6 Graph

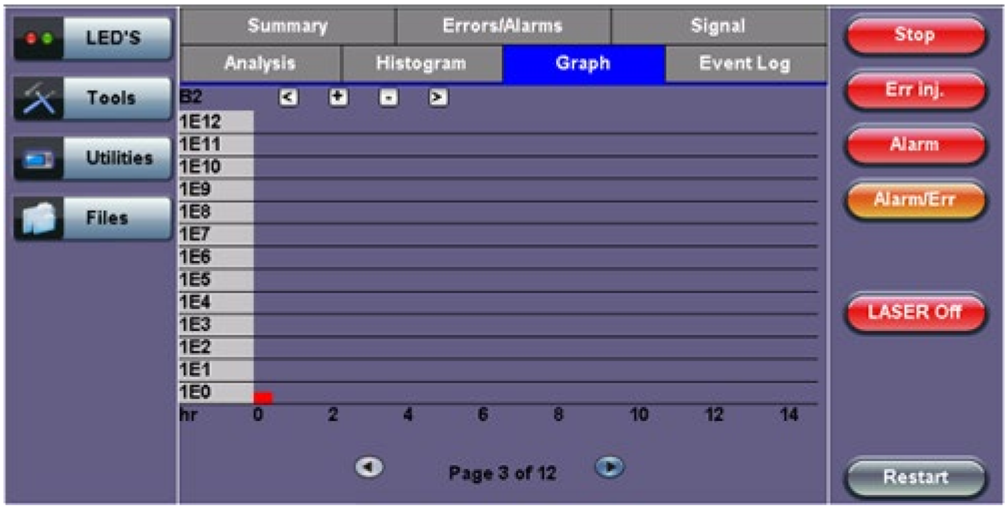
The Graph tab brings up the screen displaying a log of the Errors recorded during the measurement interval. A dedicated page is available for each of the following error types:

- FAS
- B1
- B2

- MS-REI
- B3
- HP-REI
- LP-BIP
- LP-REI
- PDH errors depending on payload

Scroll through the various pages to display the anomaly of interest. A status pop-up screen can be accessed by tapping on the graph area.

Graph (Page 3)



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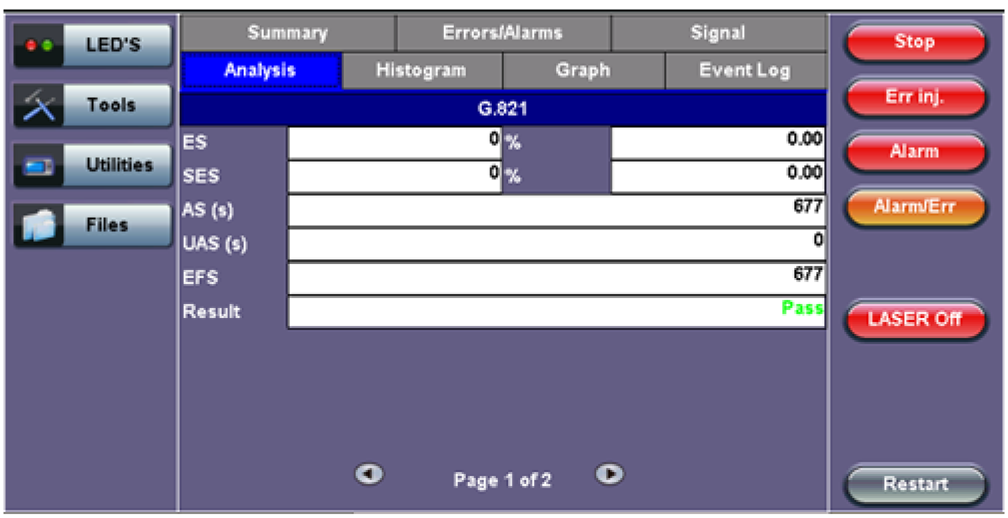
7.1.7 Performance Analysis

G.821 Analysis



The Analysis tab displays measured objectives from ITU-T performance tests selected from the Measurements tab (**Setup** > **Measurements**). For a brief description of supported G-Series and M-Series performance tests as well as setup instructions, please see Performance Analysis.

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.

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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.

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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.

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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)

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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.

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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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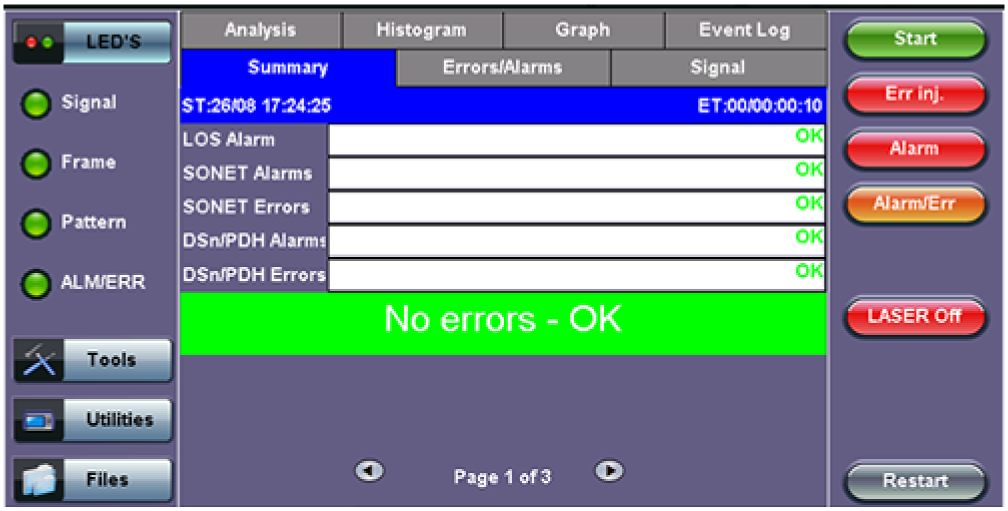
7.2 Results: SONET

7.2.1 Summary

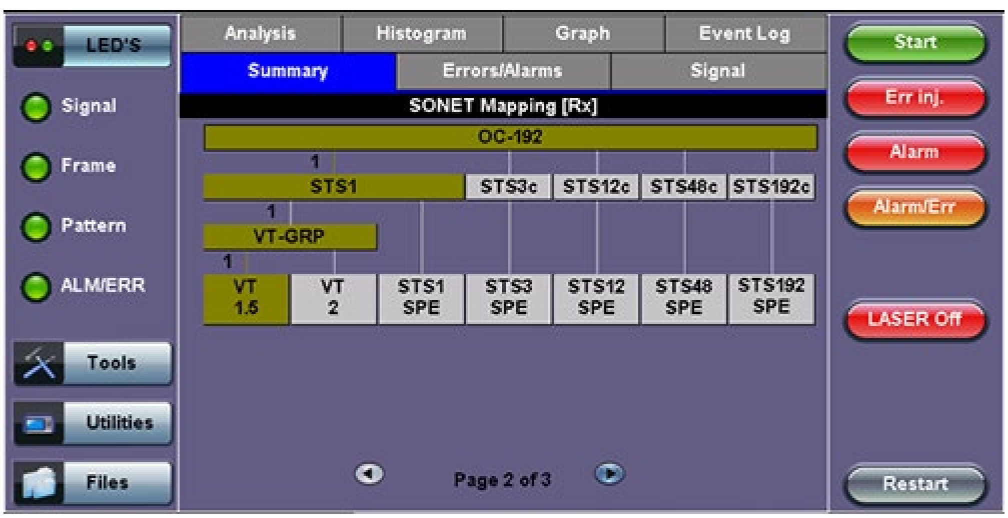
The Summary tab displays a summary of test results and parameters. At a glance, the user is able to see if there are any alarms, errors, or signal failure pertaining to the SONET signal and its payload.

Summary (Page 1)

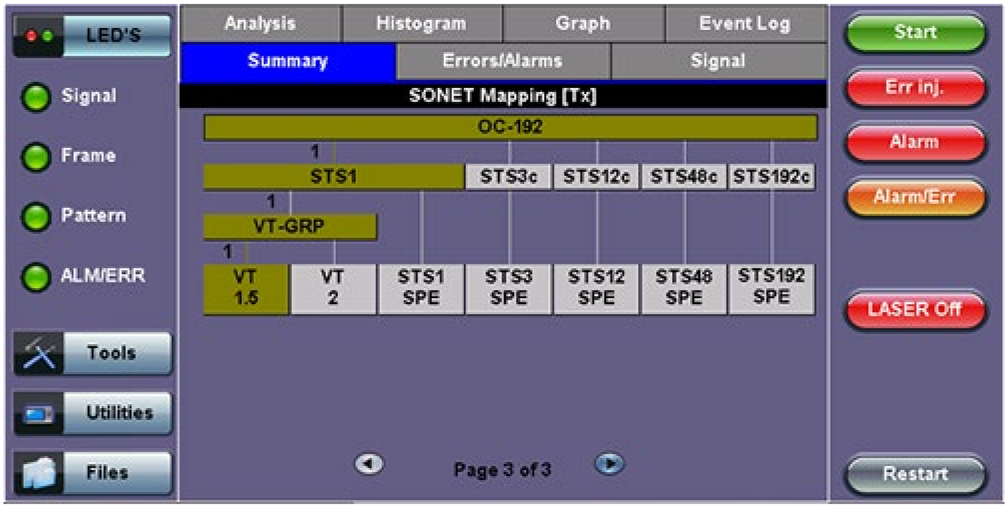


SONET mapping information is displayed on page 2 and 3.

Summary (Page 2)



Summary (Page 3)



7.2.2 Errors/Alarms

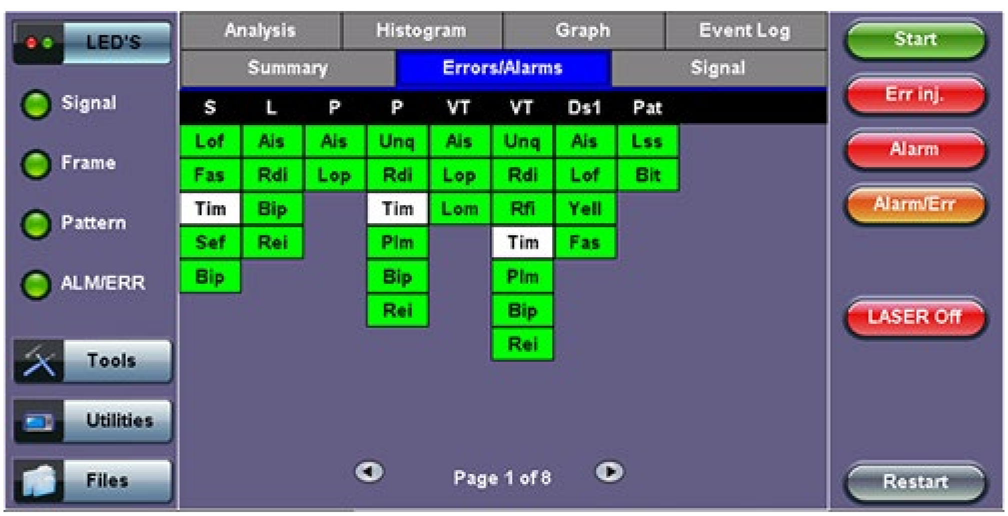
The Errors/Alarms tab brings up several pages showing error and alarm statuses.

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 you to the applicable result screen which provides detailed information.

The 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:

Abbreviation	Name	OH byte
LOS	Loss of Signal	
TSE	Test Sequence Error(bit error)	
LSS	Loss of Sequence Synchronizartion	
AIS	Alarm Indication Signal	
SECTION		
OOF	Out of Frame	A1,A2
LOF	Loss of Frame	A1,A2
B1(8bits)	Regenerator Section Error Monitoring	B1
TIM-S	Trace Identifier Mismatch	J0
LINE		
AIS-L	Line AIS	K2
RDI-L	Line Remote Defect Indication	K2
REI-L	Line Remote Error Indication	M1
B2(24bits)	Error Monitoring	B2
STS-PATH		
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(8bits)	Error Monitoring	B3
UNEQ-P	STS path Unequipped	C2
VIRTUAL TRIBURTARY PATH (VT)		
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 defection criteria per Bellcore GR.253 and ANSI T1.105/231:

	Anomalies/Defect	Detection Criteria	Bellcore ANSI
Section/Line Layer			
LOS	Loss of Signal	All-zero pattern for 2,3 us≤ T ≤ 100us	GR-253 T1.231
LOF	Loss of Frame	A1, A2 No valid framing pattern for 3 ms (24 frames)	GR-253 T1.231
B1	Section BIP error	Mismatch of the recovered and computed BIP-8 covers the whole STS-N frame	GR-253 T1.105
B2	Line BIP error	Mismatch of the recovered and computed NxBIP-8 covers the whole STS-N frame	GR-253 T1.105
AIS-L	Line-AIS	K2(bits 6, 7, 8) = 111 for 5 frame	GR-253 T1.231
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	GR-253 T1.105
RDI-L	Line Remote Defect Indication	K2(bits 6, 7, 8) = 110 for z frame (z= 5 – 10)	GR-253 T1.231

	Anomalies/Defect	Detection Criteria	Bellcore ANSI
STS Path Layer			
AIS-P	STS Path AIS	All "1" in the STS pointer bytes H1, H2 for ≥ 3 frames	GR-253 T1.231
LOP-P	STS Path Loss of Pointer	8 – 10 NDF enable, 8 – 10 invalid pointers	GR-253 T1.231
B3	STS Path BIP error	Mismatch of the recovered and computed BIP-8 covers the entire STS-SPE	GR-253 T1.105
UNEQ-P	STS Path Unequipped	C2 = "0" for ≥ 5 (≥ 3 as per T1.231) frames	GR-253 T1.231
TIM-P	STS Path Trace Identifier Mismatch	Mismatch of the accepted and expected Trace Identifier in byte J1 (64 bytes sequence)	GR-253 T1.105
REI-P	STS Path Remote Error Indication	Number of detected B3 errors in the sink side encoded in bye G1 (bits 1, 2, 3, 4) of the source side	GR-253 T1.105
RDI-P	STS Path Remote Defect Indication	G1 (bit 5) = 1 for 10 frames	GR-253 T1.231
PLM-P	STS Path Payload Label Mismatch	Mismatch of the accepted and expected Payload Label in bye C2 for ≥ 5 (≥ 3 as per T1.231) frames	GR-253 T1.231

	Anomalies/Defect	Detection Criteria	Bellcore ANSI
VT Path Layer			
LOM	Loss of Multiframe	Loss of synchronization on H4 (bits 7, 8) superframe sequence	GR-253 T1.105
AIS-V	VT Path AIS	All "1" in the VT pointer bytes V1, V2 for ≥ 3 frames	GR-253 T1.231
LOP-V	VT Path Loss of Pointer	8 – 10 NDF enable, 8 – 10 invalid pointers	GR-253 T1.231
BIP-2	VT Path BIP Error	Mismatch of the recovered and computed BIP-2 (V5 bits 1, 2) covers entire VT	GR-253 T1.105
UNEQ-V	VT Path Unequipped	V5 (bits 5, 6, 7) = 000 for ≥ 5 (≥ 3 as per T1.231) superframes	GR-253 T1.231
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	GR-253 T1.105
RDI-V	VT Path Remote Defect Indication	V5 (bit 5) = 1 for 10super frames	GR-253 T1.231
PLM-V	VT Path Payload Label Mismatch	Mismatch of the accepted and expected Payload Label in bye V5 (bits 5, 6, 7) for ≥ 5 (≥ 3 as per T1.231) superframes	GR-253 T1.231

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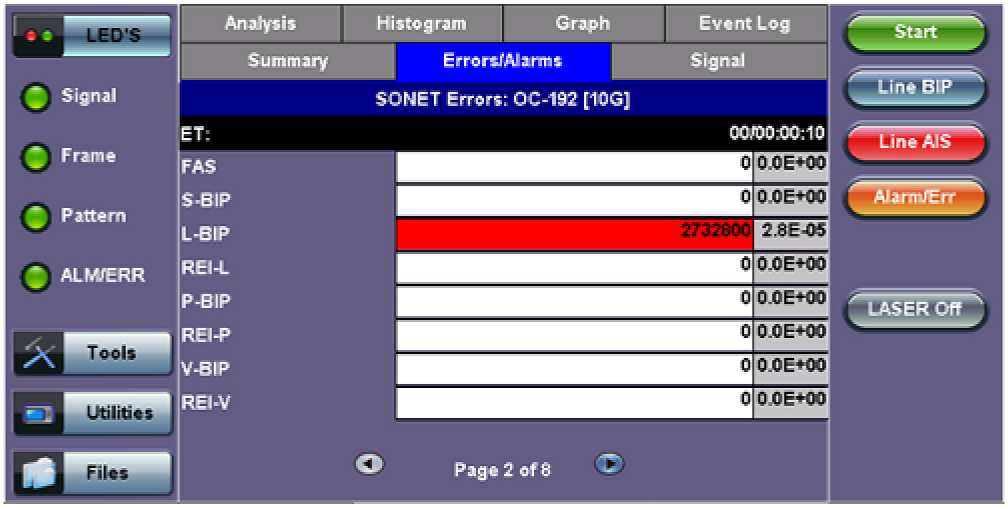
Errors/Alarms (Page 2)

Page 2 lists the SONET Errors in logical order that are associated with the signal under test. All errors are evaluated and stored. The Elapsed Time [ET] is shown in the right hand corner of the header. Error conditions are displayed in red including count and rate.

Errors/Alarms (Page 2)



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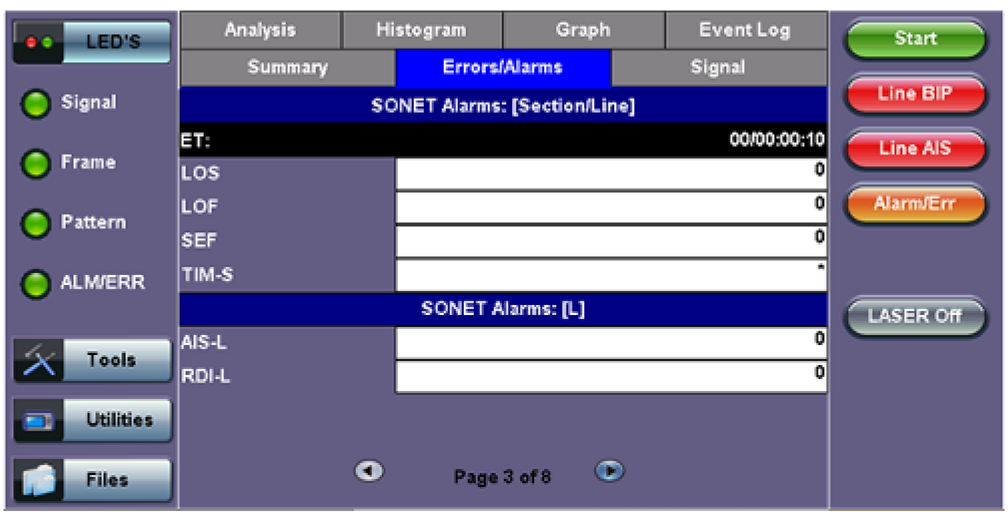
Errors/Alarms (Page 3)

Page 3 lists the Section and Line Overhead Alarms in logical order associated with the signal under test. All alarms are evaluated and stored. The Elapsed Time [ET] since the start of the test is shown in the upper right hand corner.

Errors/Alarms (Page 3)



The alarms associated with the Section and Line are displayed separately for ease of interpretation.

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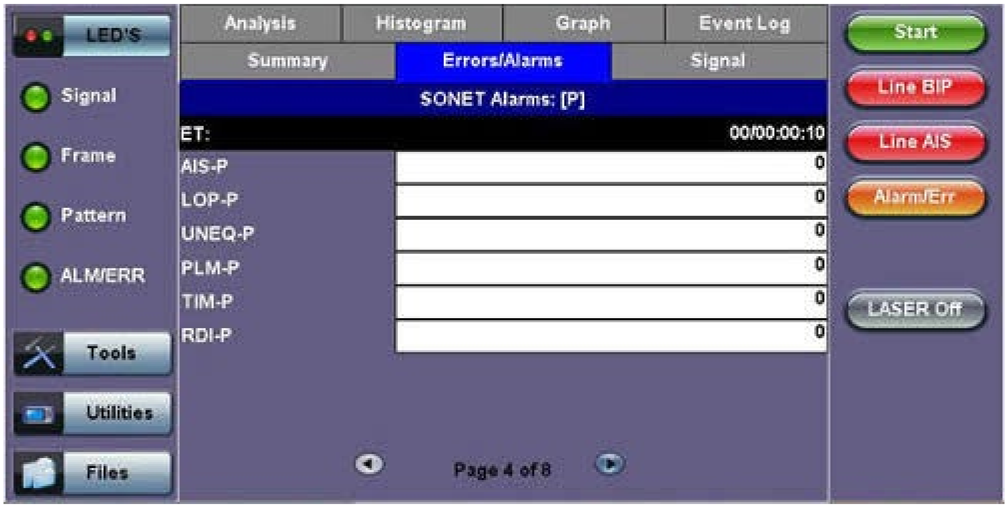
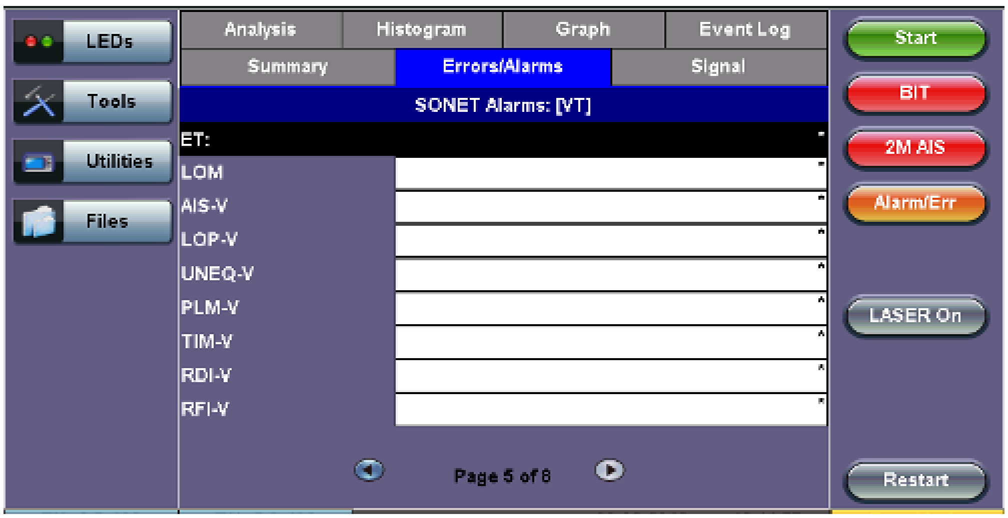
Errors/Alarms (Page 4 & 5)

Page 4 & 5 lists the STS Path and VT path in logical order that are associated with the signal under test. All alarms are evaluated and stored.

Errors/Alarms (Page 4)



Errors/Alarms (Page 5)



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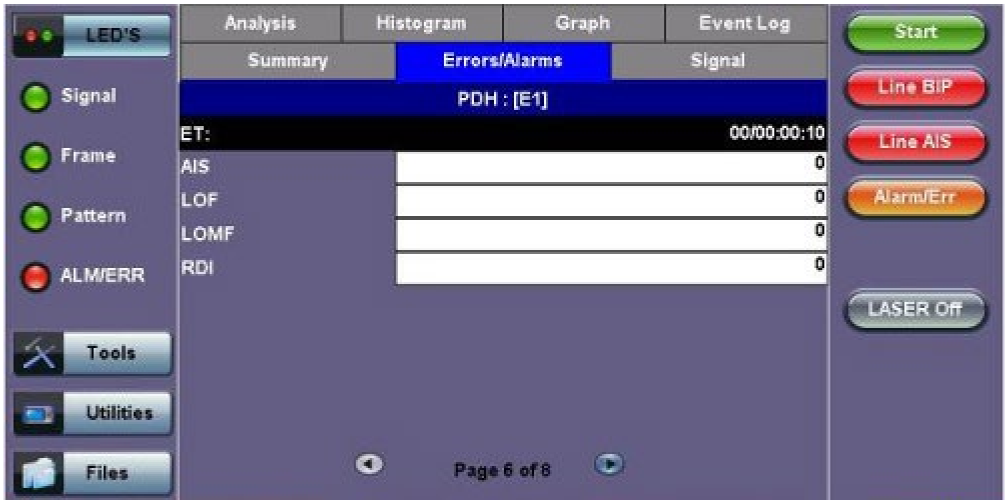
Errors/Alarms (Page 6)

Page 6 lists the **PDH/DSn Alarms** in logical order that are associated with the signal and payload under test. All alarms are evaluated and stored.

Errors/Alarms (Page 6)



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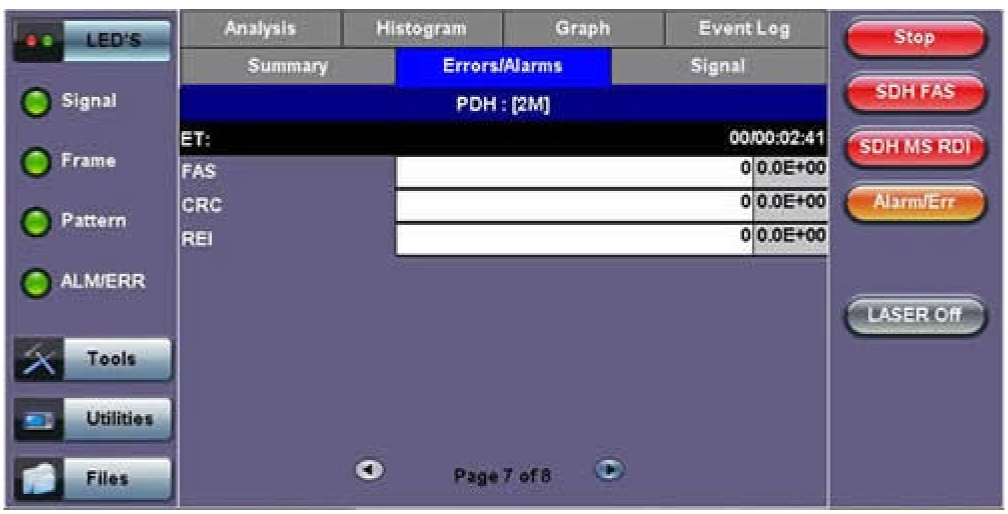
Errors/Alarms (Page 7)

Page 7 lists the **PDH/DSn Errors** in logical order that are associated with the signal and payload under test. All errors are evaluated and stored.

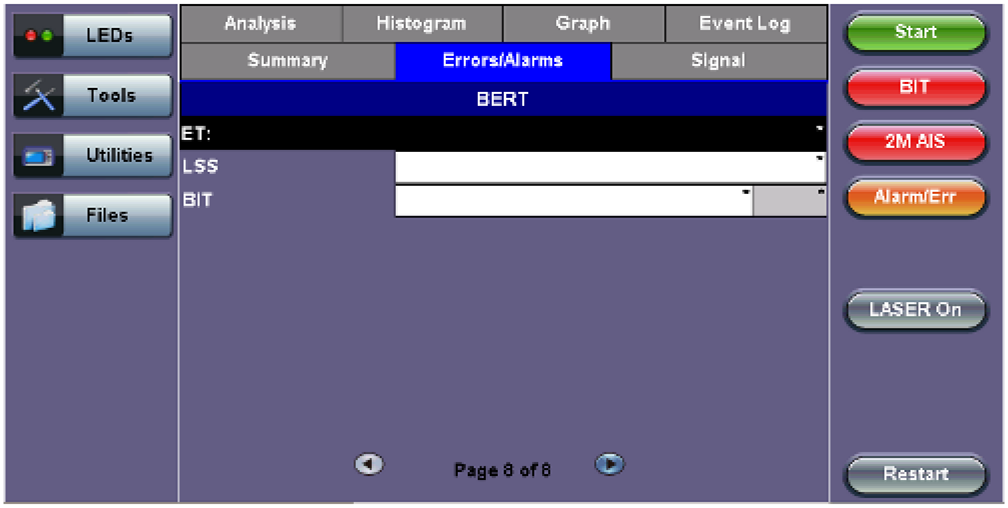
Errors/Alarms (Page 7)



Errors/Alarms (Page 8)

Page 8 lists the BERT Errors in logical order that are associated with the signal and payload under test. All errors are evaluated and stored.

Errors/Alarms (Page 8)



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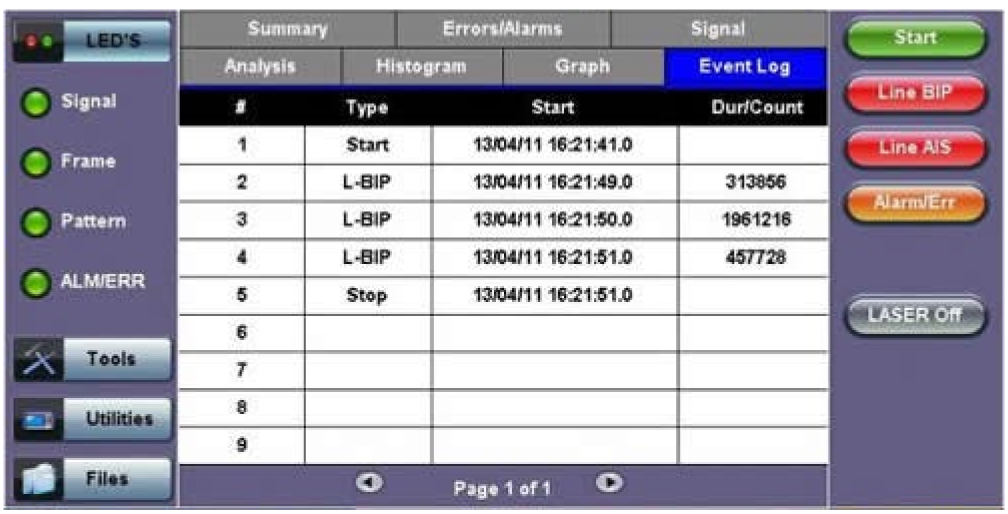
7.2.3 Event Log

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 and duration and duration (alarms) and ratio/count (errors) are displayed.

Event Log



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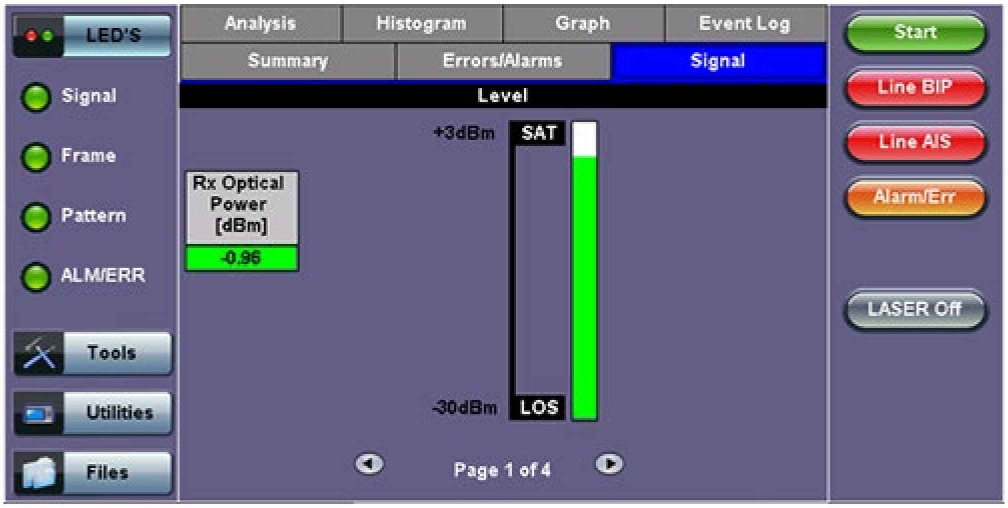
7.2.4 Signal

The Signal tab displays the Level and Frequency screen. Page 1 displays the level measurement in electrical units (volts) for OC-3, OC-12, OC-48 and OC-192 signals.

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

Signal (Page 1)



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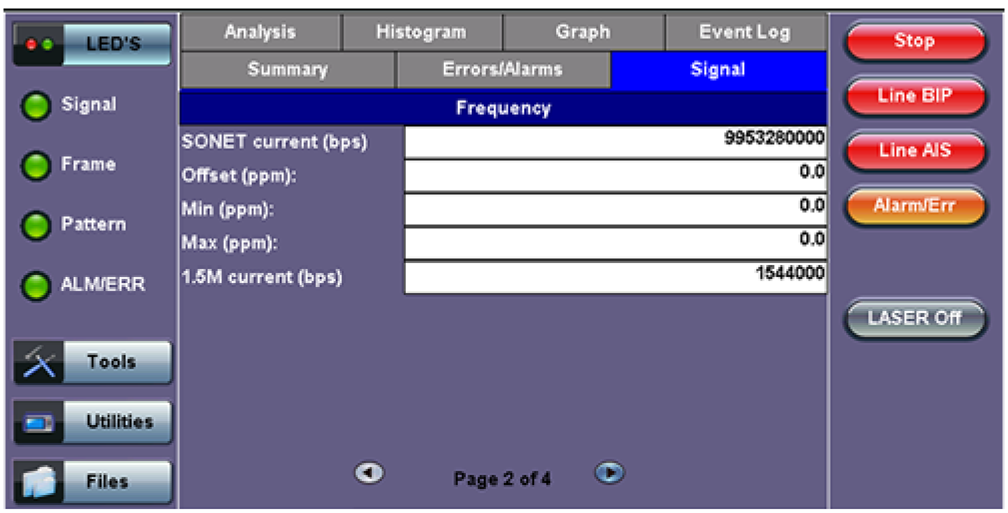
Signal > Frequency (Page 2)

The received signal frequency and offset is measured and displayed. For SONET signals, the measurement is performed on both electrical (BNC) and optical interfaces.

Frequency (Page 2)



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

- **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.
- **45M Current:** Indicates the frequency of the payload data. Options are 1.5M, 2M, 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.

Low quality clock sources that deviate from the nominal value cause problems in the operation of network elements. It is necessary and recommended to measure the signal frequency at all hierarchies to reduce synchronization risks. To measure line frequency in service, the test set must be connected to a Protected Monitoring Point (PMP). The frequency of the signal is normally reported in Hz, while the deviation is reported in ppm. Tolerances for the various clock frequencies of SONET hierarchies are presented in the table below

SONET/SDH Clock Frequencies and Tolerances	
Bit rate (Mbps)	**Tolerance (ppm)**
155,520	< 4.6ppm
622,080	< 4.6ppm
2,488,320	< 4.6ppm
9,953,280	< 4.6ppm

Level: Measures the Peak and Peak-Peak voltage values of the incoming signal. The levels for STS-3 electrical signal according to GR.253 recommendations are presented.

ITU-T/GR-253 Performance Analysis for PDH/DSn and SONET systems			
Analysis	**PDH/DSn**	**SONET**	**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, BIP-V, DS1/E1/DS3, E1 CRC
G.828 (In service)		✓	B1, B2, TSE
G.829 (In service)		✓	B1, B2, B3, BIP-V, TSE
M.2100	✓		DS1/E1/DS3 FAS, E1 CRC, TSE
M.2101		✓	B1, B2, B3, BIP-V, TSE

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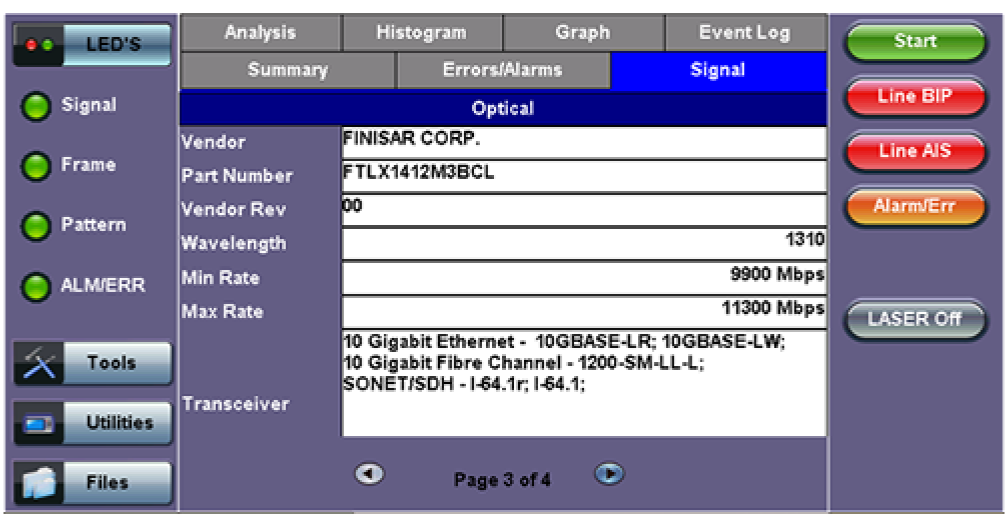
Optical Information (Page 3)

Page 3 displays the Optical module information which includes Vendor name, Part Number and Optical Wavelength.

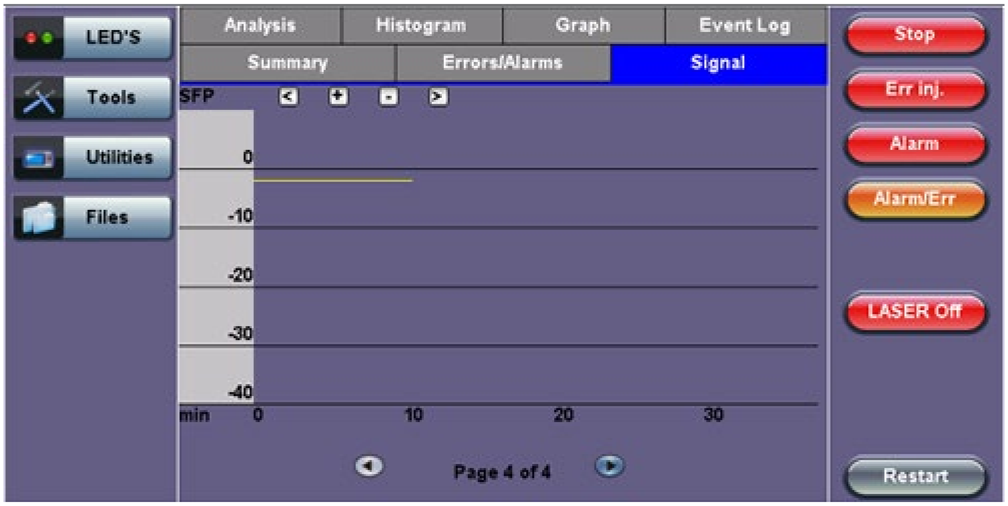
Signal - Optical (Page 3)



Signal > Optical Information (Page 4)

Page 4 displays the Optical module Power Measurement Graph.

Signal - Optical (Page 4)



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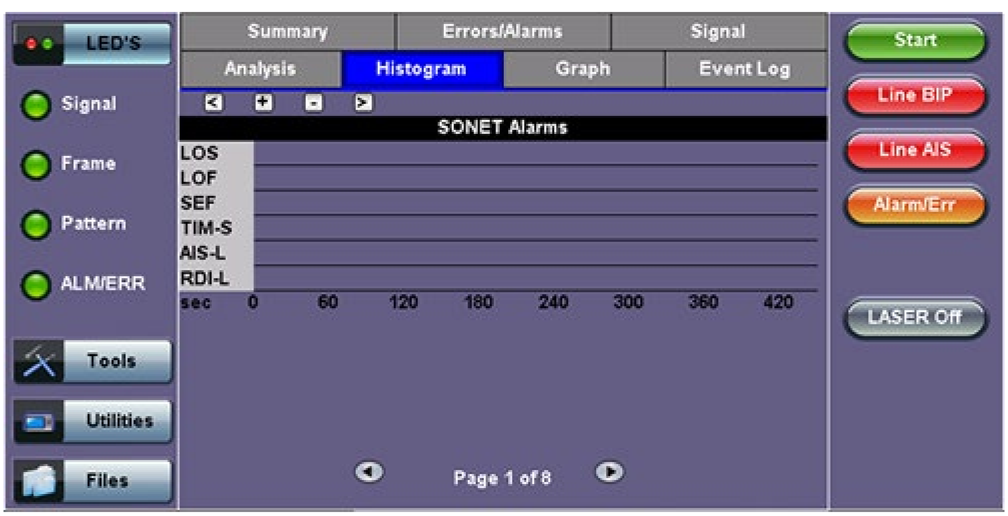
7.2.5 Histogram

The Histogram tab displays the screen showing a historical record of the Alarms and Errors recorded during the measurement interval. A dedicated page is available for errors and alarms including BER.

Page 1 displays the **Alarms** associated with the **SONET Alarm**.

Histogram - SONET Alarms (Page 1)



The alarms and errors presented depend on the signal type and structure selected. A graphical timeline on the horizontal axis indicates when the event occurred. The upper left and right arrows allow the user to scroll through the measurement period while the + and – keys allow zooming in/out of the time axis.

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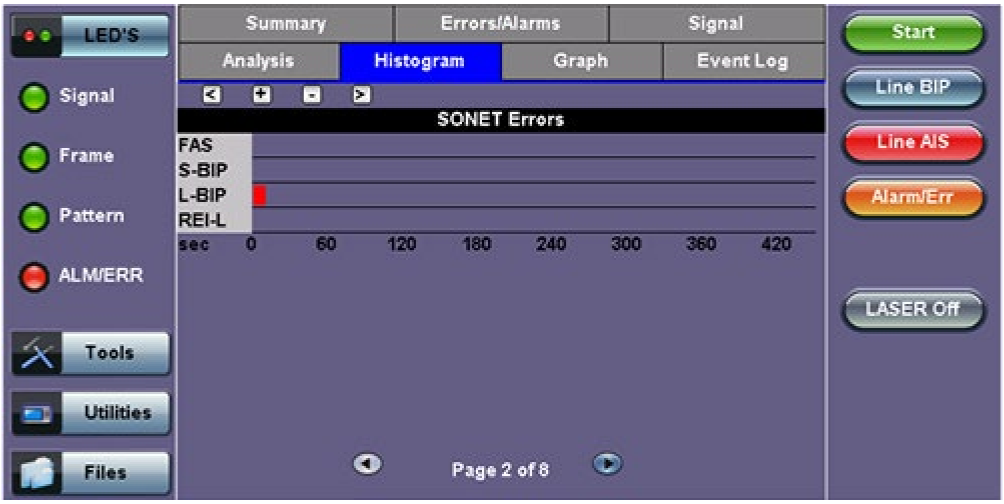
Histogram (Page 2)

Page 2 displays the Errors associated with the **SONET Errors**.

Histogram - SONET Errors (Page 2)



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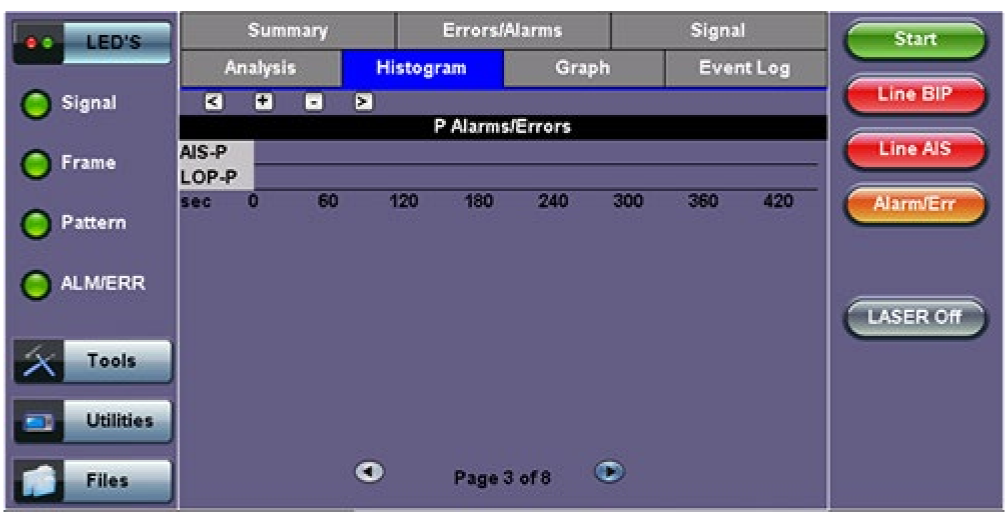
Histogram (Page 3)

Page 3 displays the **Alarms and Errors** associated with the **STS PATH**. The measured parameters are:

- AIS-P, STS Path AIS
- LOP-P, STS Path LOP

Histogram - P Alarms/Errors (Page 3)



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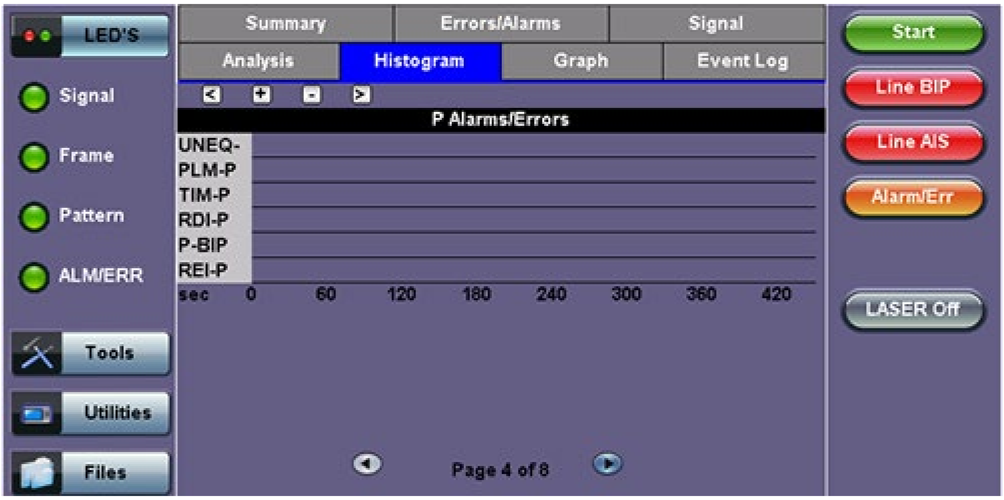
Histogram (Page 4)

Page 4 displays the **Alarms and Errors** associated with the **STS Path**. The measured parameters are:

- UNEQ-P (STS Path-Unequipped)
- PLM-P (STS Path-Payload Mismatch)
- TIM-P (STS Path-Trace Identifier Mismatch)
- RDI-P (STS Path-Remote Defect Indication)
- B3 errors
- REI-P (STS Path-Remote Error Indication)

Histogram - P Alarms/Errors (Page 4)



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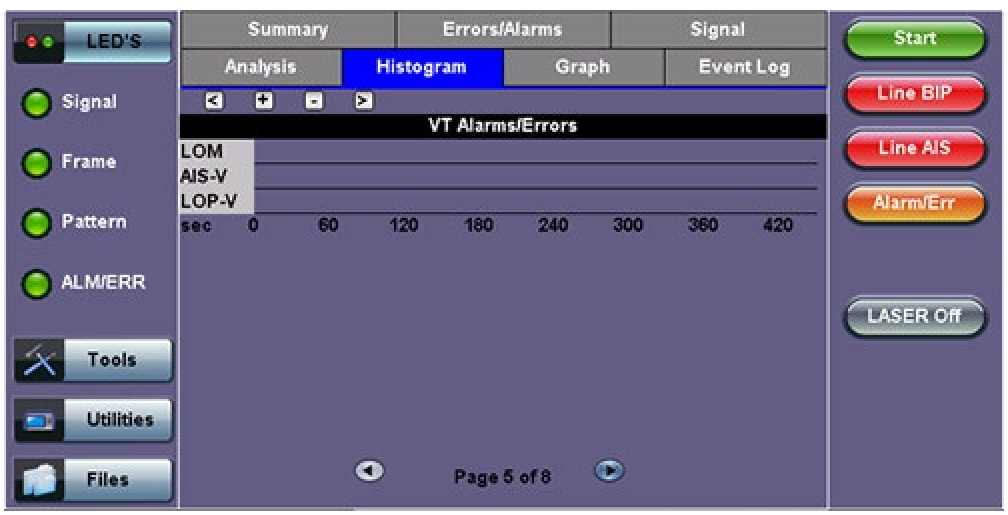
Histogram (Page 5)

Page 5 displays the **Alarms and Errors** associated with the **Virtual Tributary (VT)**.

- AIS-V (VT-Alarm Indication Signal)
- LO-VP (VT-Loss of Pointer)

Histogram - VT Alarms/Errors (Page 5)



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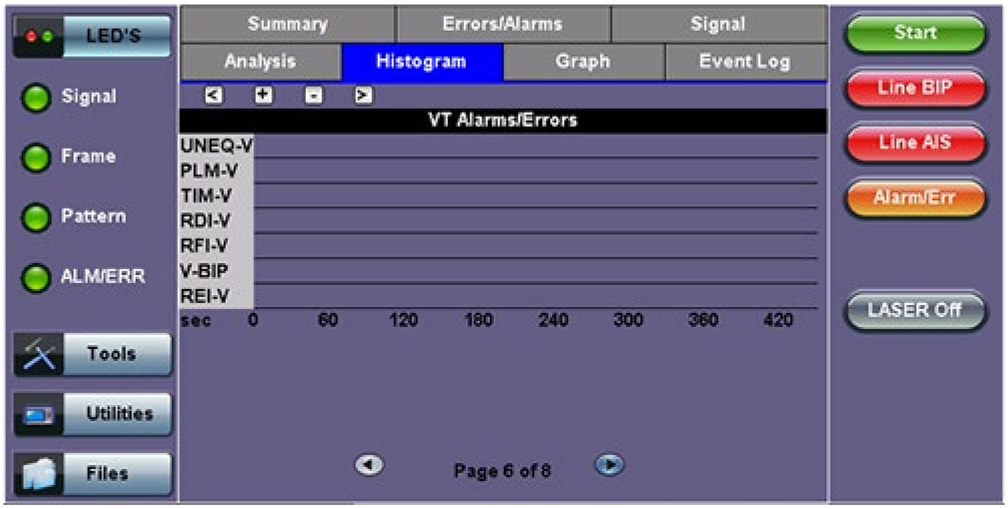
Histogram (Page 6)

Page 6 displays the **Alarms and Errors** associated with the **VT Path.** The measured parameters are:

- UNEQ-V (VT-Unequipped)
- PLM-V (VT-Payload Mismatch)
- TIM-V (VT-Trace Identifier Mismatch)
- RDI-V (VT-Remote Defect Indication)
- RFI-V (VT-Remote Fault Indication)
- BIP-V (VT-Bit Interleaved Parity)
- REI-V (VT-Remote Error Indication)

Histogram - VT Alarms/Errors (Page 6)



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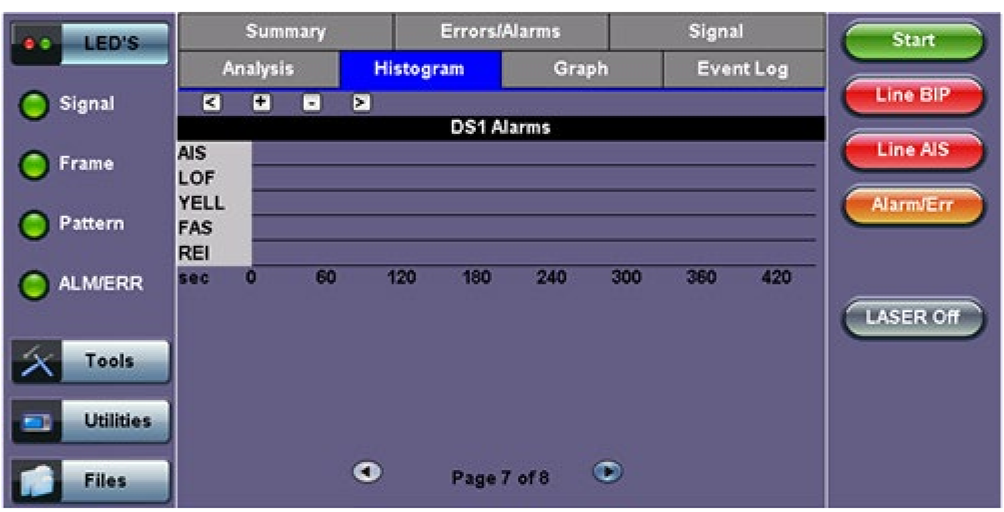
Histogram (Page 7)

Page 7 displays the **Alarms** and **Errors** associated with the payload. The measured parameters depend on the payload selected.

Histogram - DS1 Alarms (Page 7)



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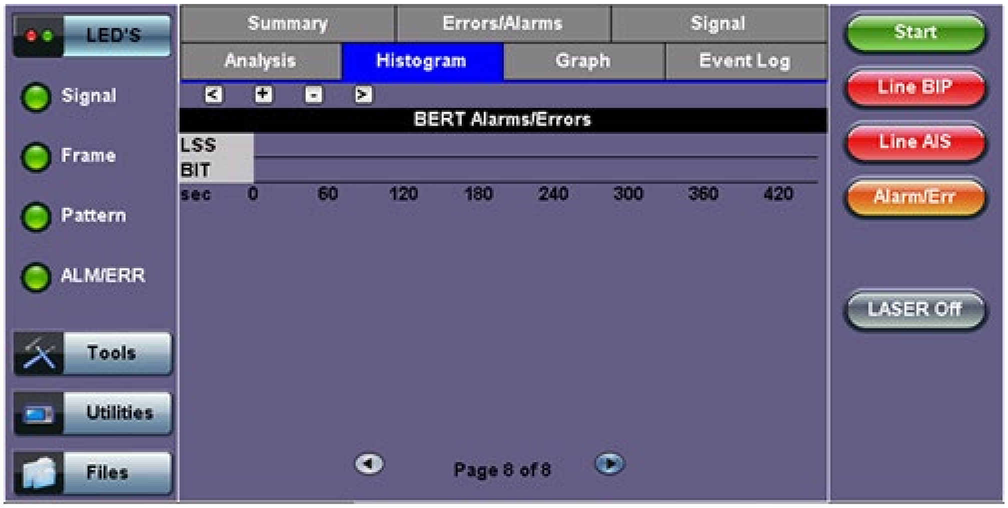
Histogram (Page 8)

Page 8 displays the **Bit Errors** associated with the test pattern.

Histogram - BERT Alarms/Errors (Page 8)



[Go back to top](#) [Go back to TOC](#)

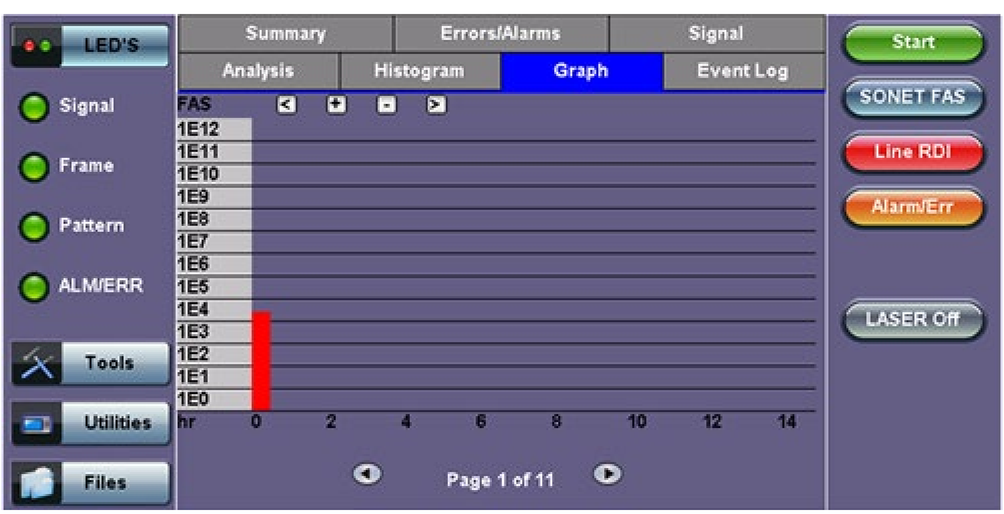
7.2.6 Graph

The Graph tab brings up the screen displaying a log of the Errors recorded during the measurement interval. A dedicated page is available for each of the following error types:

- FAS
- B1
- B2
- REI-S
- B3
- REI-P
- BIP-V
- REI-V
- PDH/DSn errors depending on payload

Scroll through the various pages to display the anomaly of interest. A status pop-up screen can be accessed by tapping on the graph area.

Graph (Page 1)



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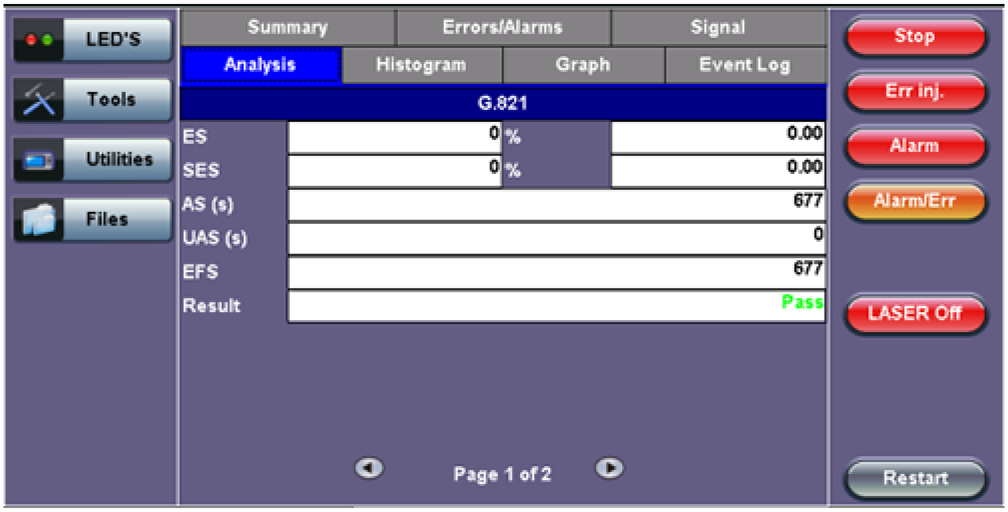
7.2.7 Performance Analysis

G.821 Analysis



The Analysis tab displays measured objectives from ITU-T performance tests selected from the Measurements tab (**Setup** > **Measurements**). Please see Analysis 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.

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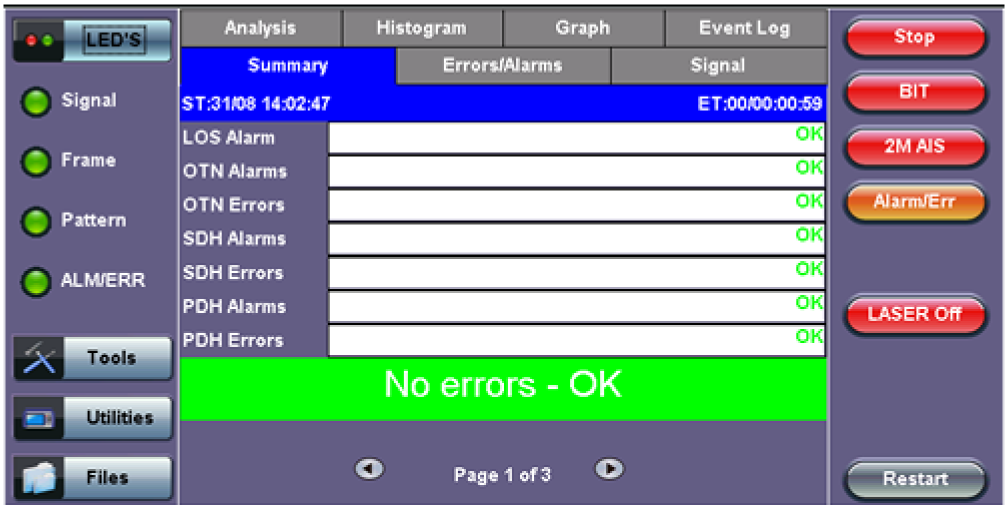
7.3 Results: OTN

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.

7.3.1 Summary

The Summary tab displays a summary page 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 OTN/SDH signal and its payload. And also shows OTN/SDH mapping information that can identify the setup in results.

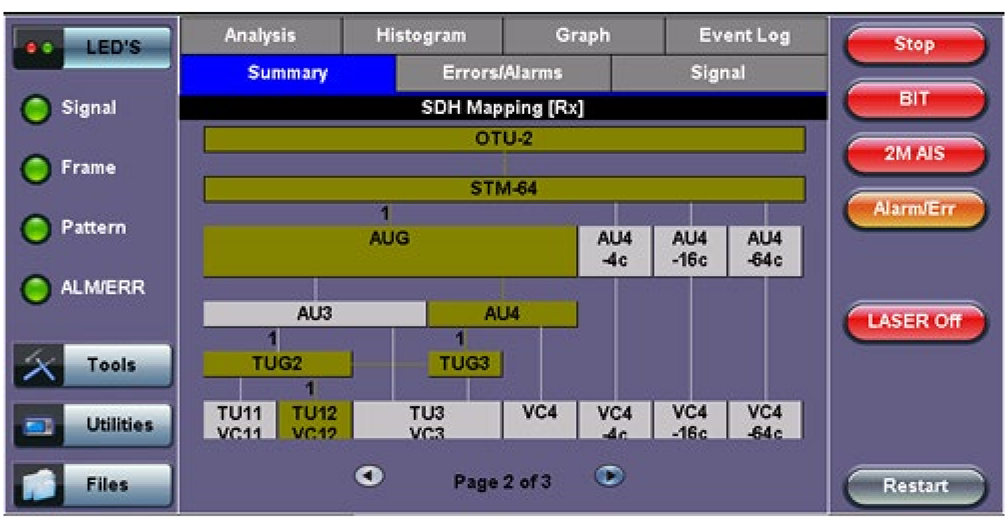
Summary (Page 1)



And also shows OTN/SDH (or OTN/SONET) mapping information that can identify the setup in results.

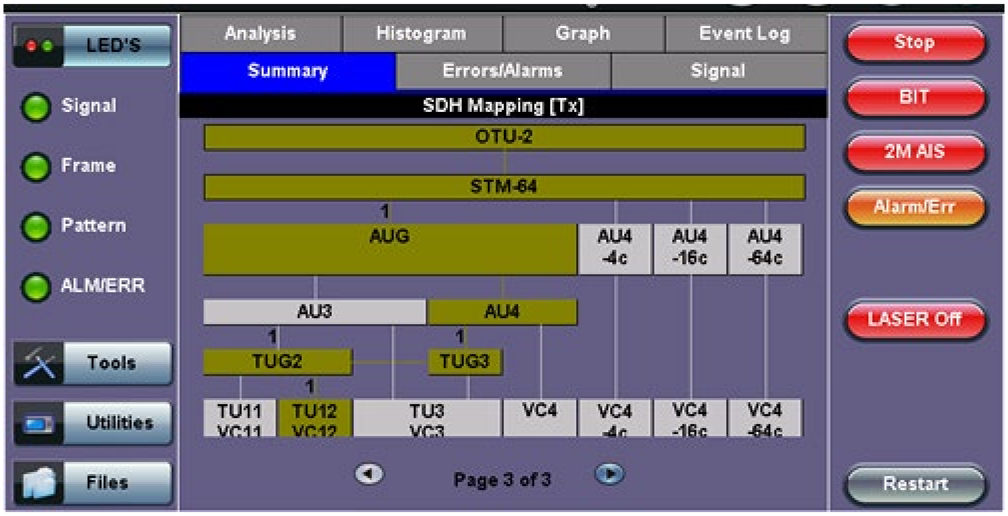
- **RX Mapping**

Summary (Page 2)



- **TX Mapping**

Summary (Page 3)



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7.3.2 Errors and Alarms

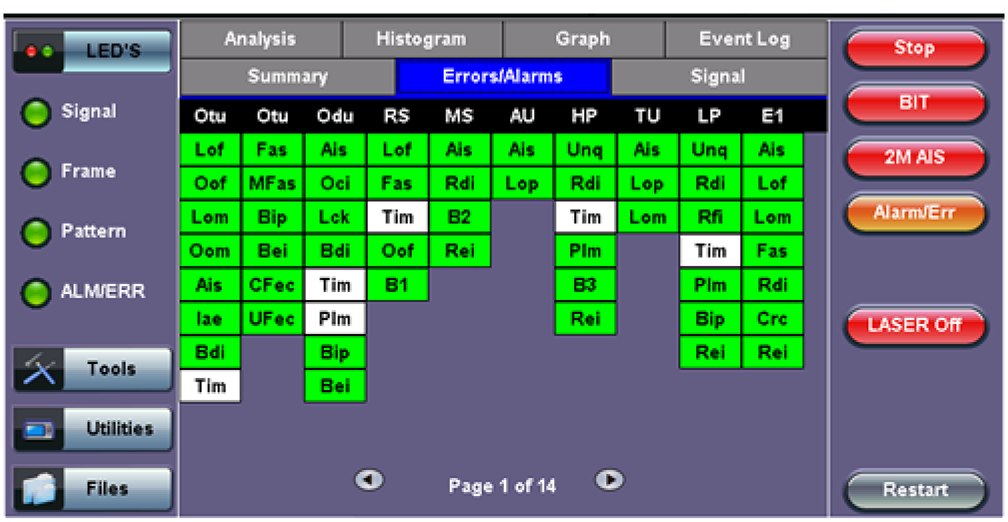
The Error/Alarm tab brings up several pages showing the errors and alarm status.

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 individual soft LED will automatically link directly to the applicable result screen which provides detailed information.

The LED headers are described in the table below:

Alarm Definitions and Descriptions	
OTU	Optical channel Transport Unit
ODU	Optical channel Data Unit
OPU	Optical channel Payload Unit
RS	Regenerator Section
MS	Multiplexer Section
AU	Administrative Unit
HP	High Order Path
TU	Tributary Unit
LP	Lower Order Path
E1	2Mbit/s signal (depend on payload selected)
PAT	Pattern detection (PRBS, User, fixed words)

OTN Error and Alarm definitions per ITU-T G.709 recommendations:

OTU Alarm Definitions Detection criteria according to G.709 and G.798	
LOF	Loss of Frame - Declared when the OOF states have been constantly observed for 3 ms respectively
OOF	Out of Frame - Declared if it fails to find an FAS sub-pattern (FAS bytes 3, 4, and 5) for five consecutive frames.
LOM	Loss of Multiframe - Declared when the OOF states have been constantly observed for 3 ms respectively
OOM	Out of Multiframe - Declared when the received MFAS is out of sequence for five consecutive frames
OTU-AIS	Alarm Indication Signal - PN-11 sequence (covers complete Och) ≥ 3 x 8192 bits
OTU-IAE	Incoming Alignment Error - This bit allows the ingress to inform the egress that an alignment error in the incoming signal has been detected. • IAE = 1 with error • IAE = 0 no error • Status (STAT) These three bits indicate the presence of maintenance signals (AIS, OCI, TCM, IAE)
OTU-BDI	Backward Defect Indication - This single bit conveys information regarding signal failure in the upstream direction • BDI = 1 indicates OTUk backward defect • BDI = 0 otherwise
OTU-TIM	Trail Trace Identifier Mismatch

OTU Error Definitions Detection criteria according to G.709 and G.798	
FAS	Frame alignment signal - Uses the first six bytes and , to provide framing for the entire signal
MFAS	Multiframe alignment signal - Used to extend command and management functions over several frames. The MFAS counts from 0 to 255, providing a 256 multiframe structure.
BIP-8	Bit interleaved parity-8 code
BEI	Backward error indication -SM byte 3, bit 1 to 4: value 0 to 8: SM BIP-8 error count value 9 to 15: no SM BIP-8 errors value 11: SM BIAE
BIAE	Backward incoming alignment error - SM byte 3, bit 1 to 4: " 1011" ≥ 3 frames
CFEC	Correctable FEC error
UFEC	Uncorrectable FEC error

ODU Alarm/Error Definitions Detection criteria according to G.709 and G.798	
ODU-BEI	Backward error indication -PM byte 3, bit 1 to 4: value 0 to 8: SM BIP-8 error count value 9 to 15: no SM BIP-8 errors
ODU-AIS	Alarm Indication Signal - PM byte 3, bit 6 to 8: " 111" ≥ 3 frames
ODU-OCI	Open connection indication - PM byte 3, bit 6 to 8: " 110" ≥ 3 frames
ODU-LCK	Locked - PM byte 3, bit 6 to 8: " 101" ≥ 3 frames
ODU-BDI	Backward Defect Indication - PM byte 3, bit 5 = 1 ≥ 5 frames
ODU-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.
ODU-TIM	Trail Trace Identifier Mismatch

SDH/PDH alarms are described previously

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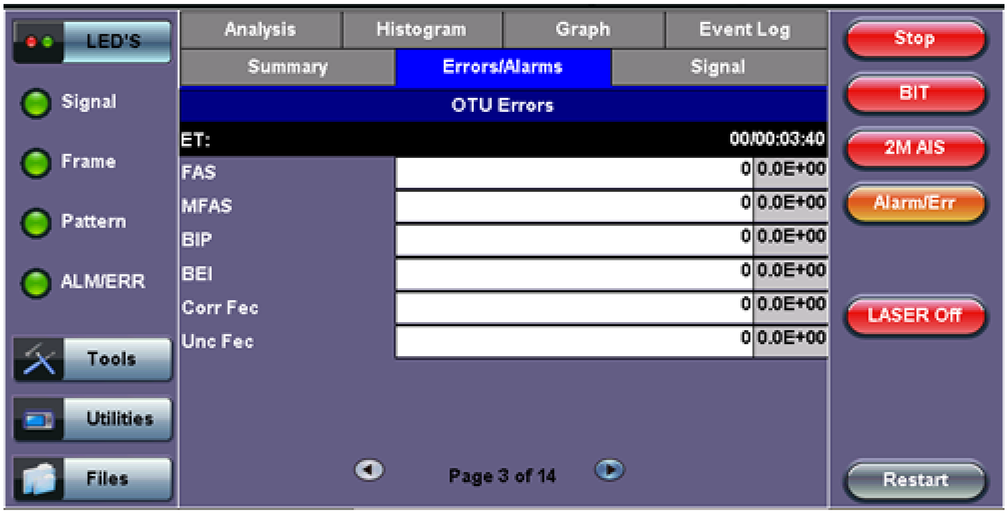
Errors/Alarms (Page 3)

Page 3 lists the **OTU Errors** in logical order that are associated with the signal under test. All errors are evaluated and stored. The Elapsed Time [ET] is shown in the right hand corner of the header. Error conditions are displayed in red including count and rate.

Errors/Alarms (Page 3)



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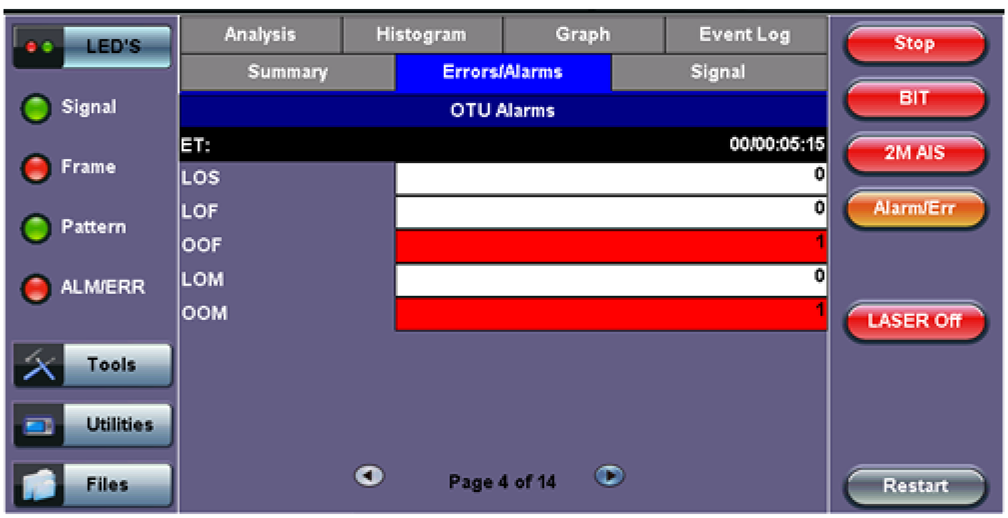
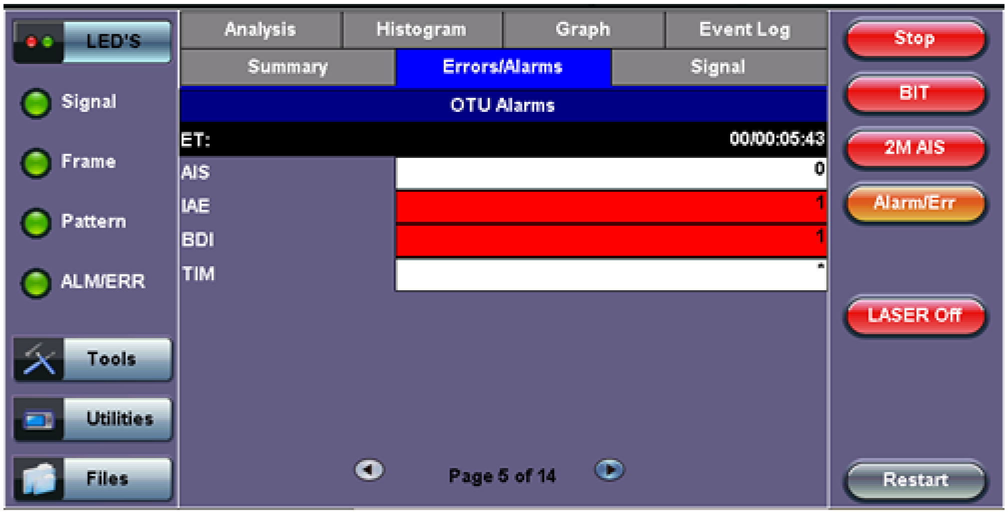
Errors/Alarms (Page 4 & 5)

Page 4 lists the **OTU Alarms** in logical order associated with the signal under test. All alarms are evaluated and stored. The Elapsed Time [ET] since the start of the test is shown in the upper right hand corner.

Errors/Alarms (Page 4)



Errors/Alarms (Page 5)



The alarms associated with the Section and Line are displayed separately for ease of interpretation.

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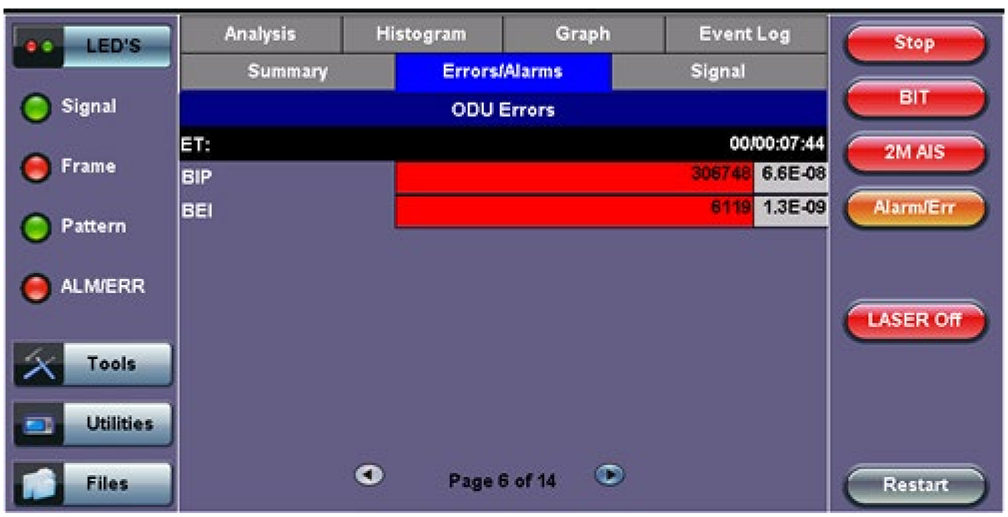
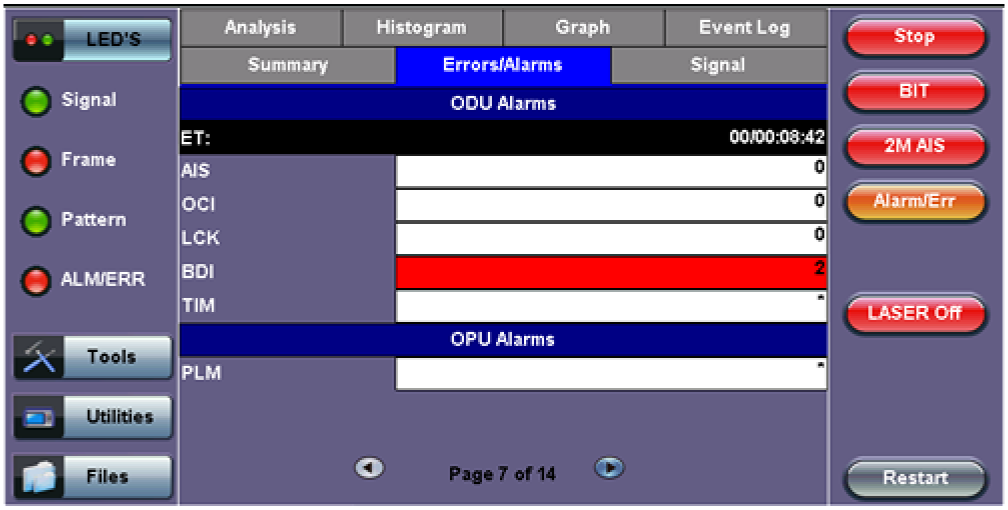
Errors/Alarms (Page 6 & 7)

Page 6 & 7 lists the **ODU/OPU errors and alarms** in logical order that are associated with the signal under test. All alarms are evaluated and stored.

Errors/Alarms (Page 6)



Errors/Alarms (Page 7)



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Errors/Alarms (Page 8 to 14)

Page 8 to 14 lists the **SDH/PDH Alarms** in logical order that are associated with the signal and payload under test. All alarms are evaluated and stored.

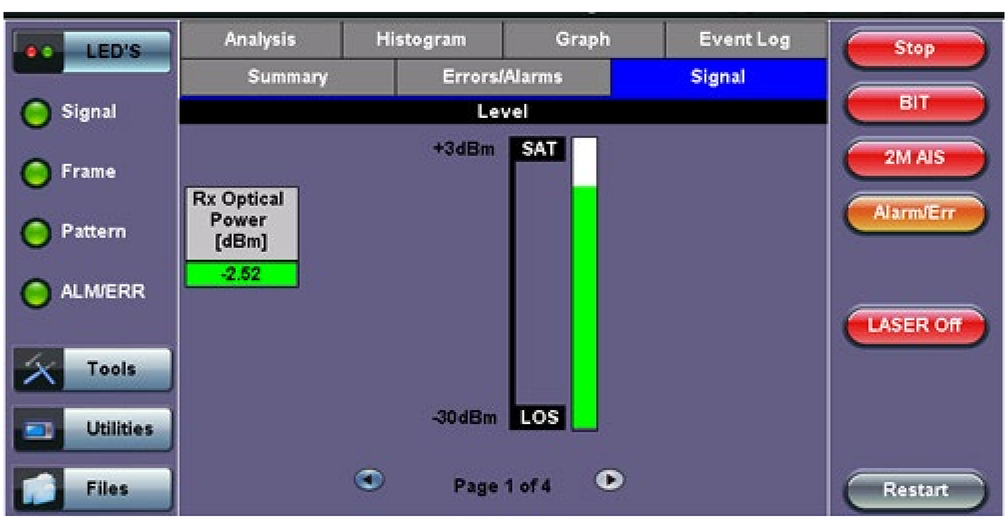
See SDH details in [Section 7.1](#)

Signal (Pages 1 to 4)

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

- **Optical Level (Page 1):**
  - The optical level measurement for OTU-1 and OTU-2 signals is displayed in dBm.
  - Loss of Signal (LOS) and the Saturation levels is shown both graphically and in dBm.

Signal (Page 1)



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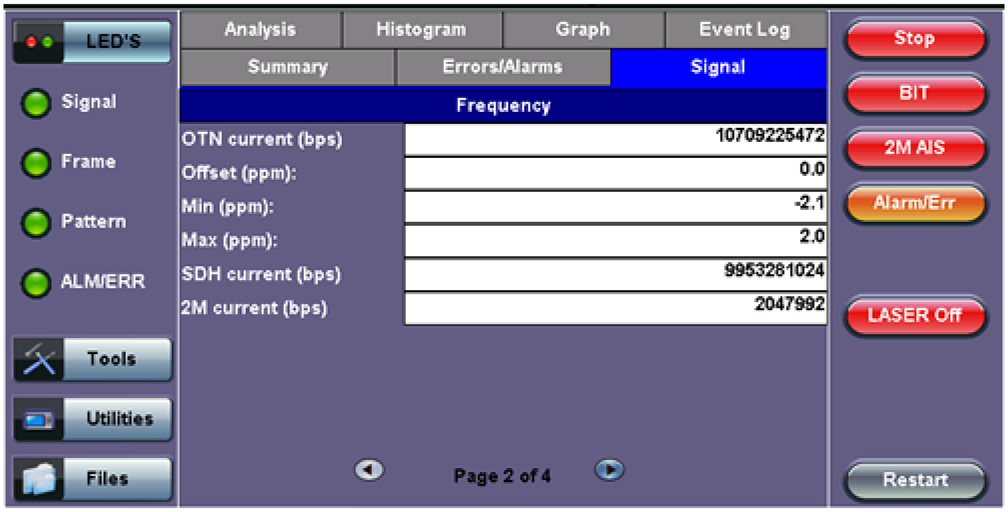
- **Frequency (Page 2)**
  - The received signal frequency and offset is measured and displayed.

- For OTN signals, the measurement is performed on the optical interfaces (SFP+ for OTU-1 and 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
- 2M Current: Indicates the frequency of the PDH or T-Carrier payload. Options 1.5Mbps, 45Mbps, 34Mbps, 139Mbps

Signal (Page 2)



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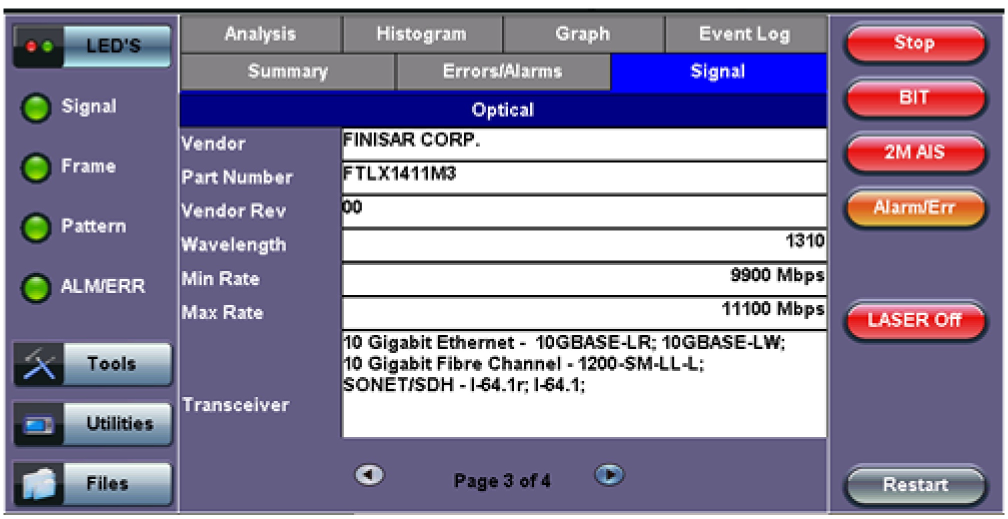
- **Optical Information (Page 3)**
  - The Optical Transceiver (SFP or XFP) information including Vendor name, Part #, Firmware revision #, Optical Wavelength, Min/Max bit rates supported and Dynamic Range

Signal (Page 3)



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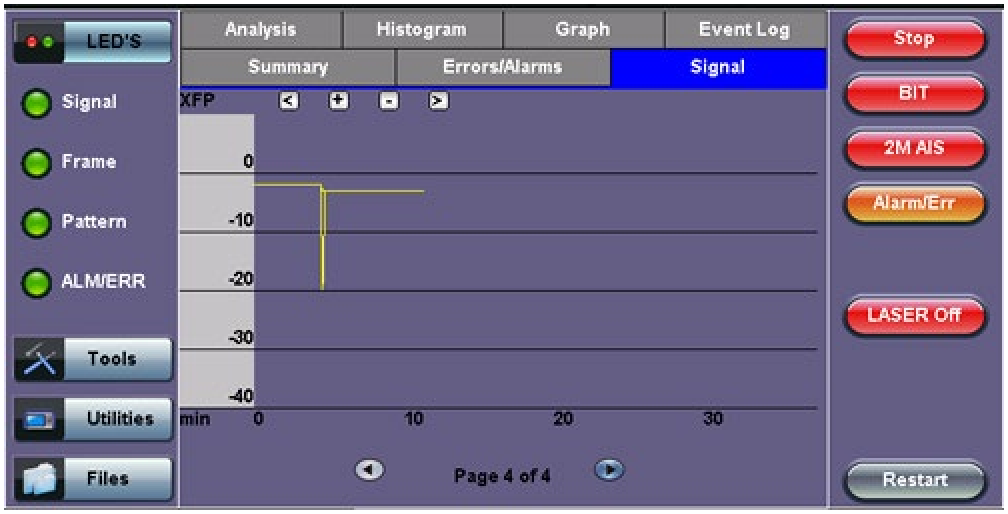
- **Optical Histogram (Page 4)**
  - Displays the Optical Transceiver Power Measurement Graph.

- This is useful for troubleshooting defective XFPs or for monitoring intermittent optical power fluctuations

Signal (Page 4)



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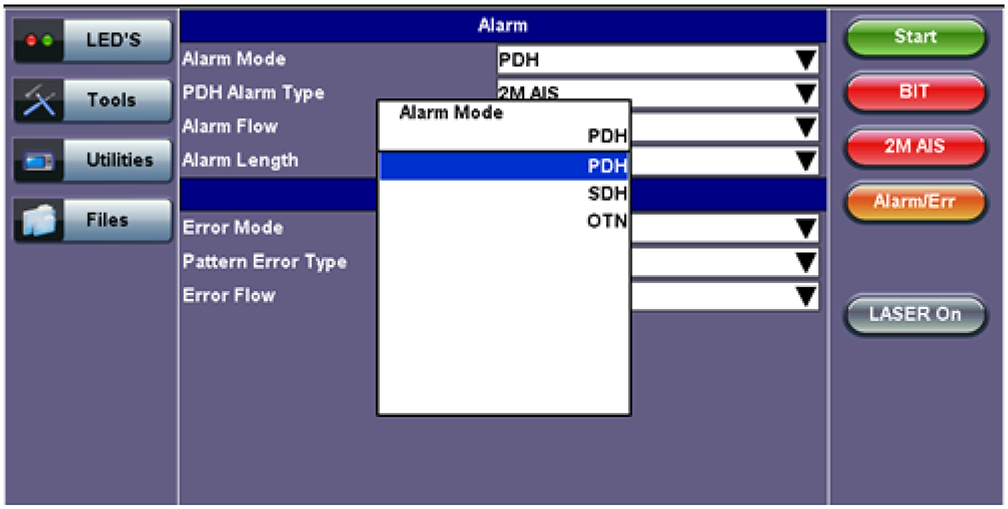
8.0 SDH/PDH Alarms

Accessing Alarm Generation and Error Insertion

Tap on Home (main menu) **>Advanced Mode> Alarm/Error**

The alarm and error functions are used in conjunction with the drop-down menu which has dedicated buttons for error injection and alarm generation. Alarm and error selections will depend on PDH, SDH, or OTN signal types.

Alarm Setup



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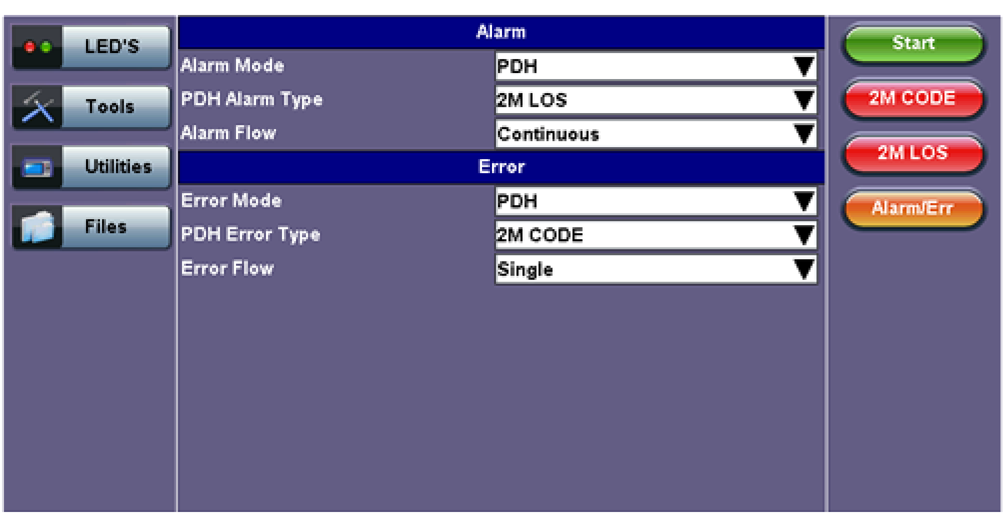
8.1 Alarm Generation

Generation range of different anomalies into the transmit signal. Alarm generation modes include:

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

Alarm/Error Generation



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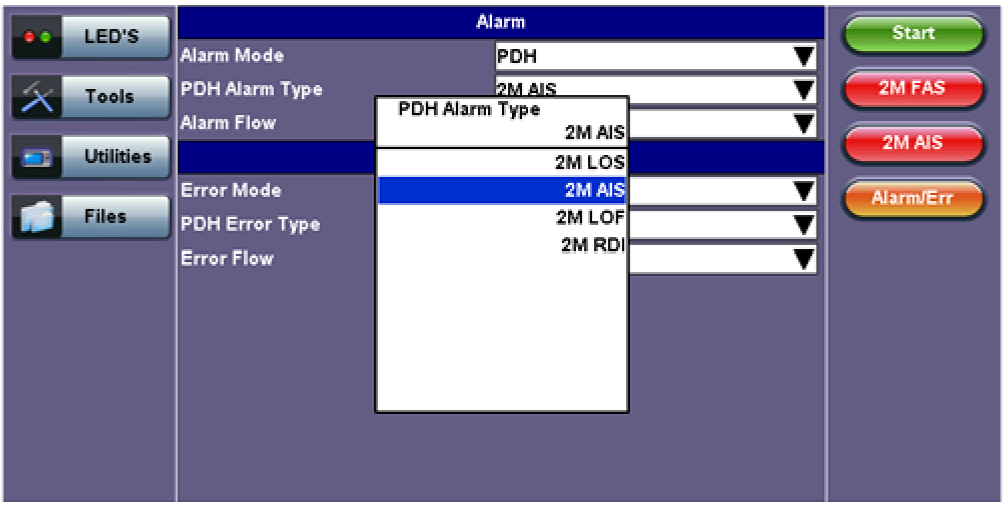
8.1.1 PDH Alarms

The following **PDH and T-Carrier alarms** can be generated:

- **E1 signals:** LOS, LOF, AIS, RDI
- **E3 signals:** LOS, LOF, AIS, RDI
- **E4 signals:** LOS, LOF, AIS, RDI
- **DS1 signals:** AIS, Yellow, idle, LOS, LOF
- **DS3 signals:** LOS, LOF, OOF, AIS, Parity

Mode: Static (enable/disable) using drop-down menu function.

PDH Alarm Type



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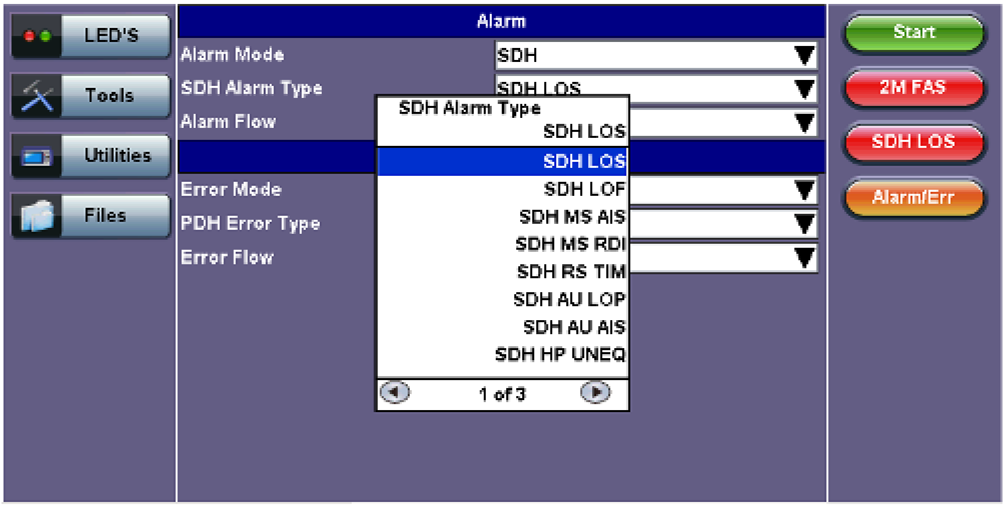
8.1.2 SDH Alarms

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

- **STM-1/4/16/64 (depends on signal structure):** 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 (depends on payload):** DS1-AIS, DS1-LOF, 2M-AIS, 2M-RDI, 2M-LOF, 34M-AIS, 34M-LOF, 34M-RDI, 45M-AIS

Mode: Static (enable/disable) using drop-down menu function.

SDH Alarm Type



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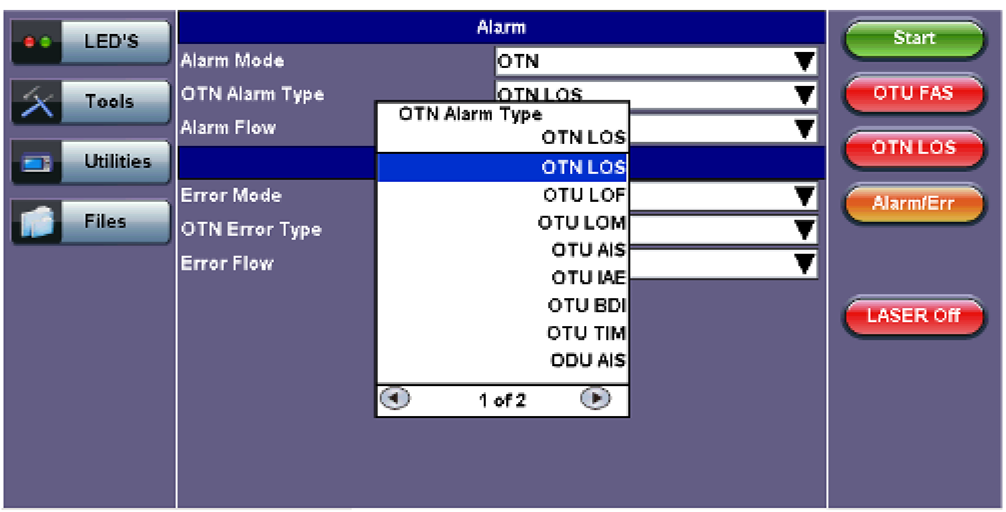
8.1.3 OTN Alarms

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

- **OTU-1/OTU-2:** LOS, LOF, OOF, OOM, LOM, AIS, IAE, BDI, TIM
- **ODU-1/OPU-2:**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 (depends on payload):** DS1-AIS, DS1-LOF, 2M-AIS, 2M-RDI, 2M-LOF, 34M-AIS, 34M-LOF, 34M-RDI, 45M-AIS

Mode: Static (enable/disable) using drop-down menu function.

OTN Alarm Type



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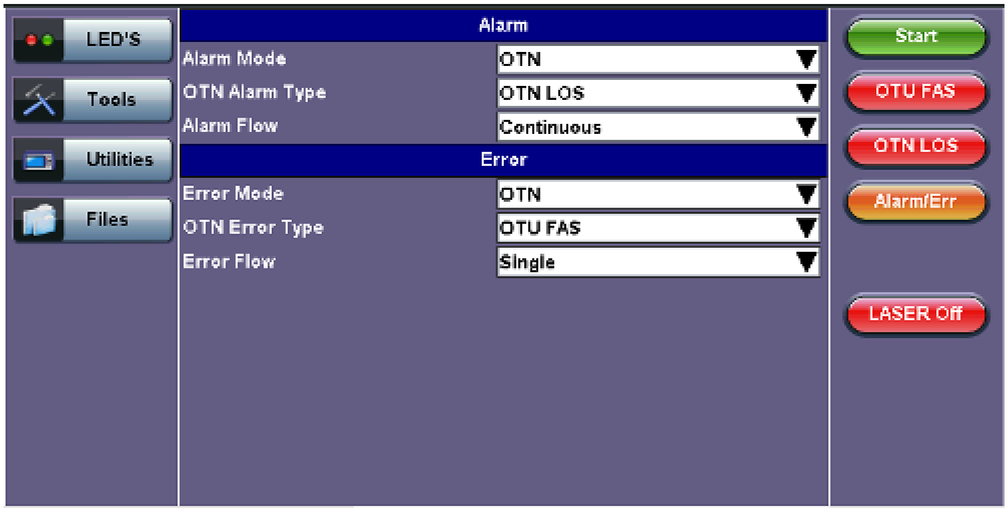
8.2 Error Insertion

OTN, SDH, PDH and T-Carrier errors can be generated.

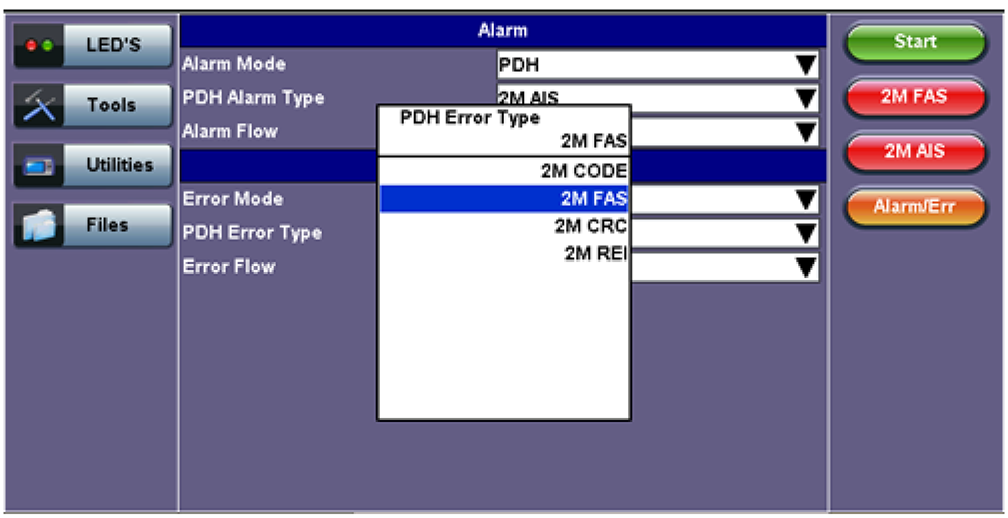


8.2.1 PDH & T-Carrier Errors

The following **PDH and T-Carrier errors** can be inserted:

- **E1 signals:** Code, FAS, CRC, REI, E-bit, Bit
- **E3 signals:** Code, FAS, Bit
- **E4 signals:** FAS, Bit
- **DS1 signals:** Code, FAS, Bit
- **DS3 signals:** Code, FAS, Bit

PDH Error Type



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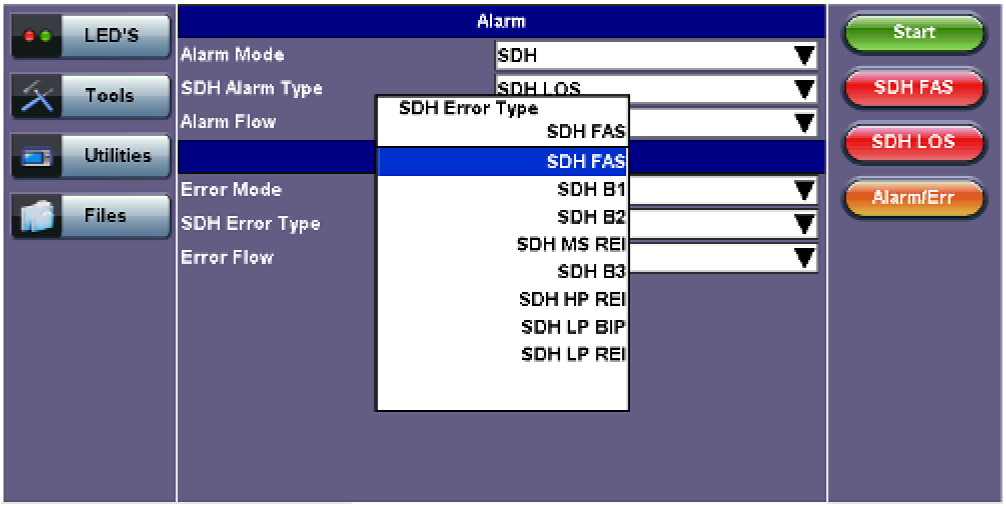
8.2.2 SDH Errors

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

- **STM-1/4/16/64 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

SDH Error Type



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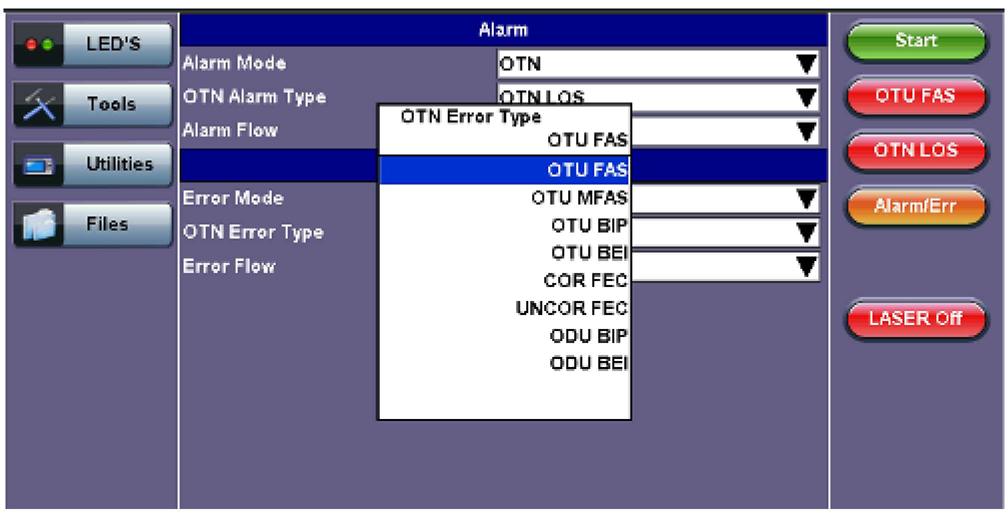
8.2.3 OTN Errors

- **OTU-1/2 signals**: FAS, MFAS, BIP, BEI, Corrected FEC errors, Uncorrectable FEC
- **ODU-1/2 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

OTN Error Type



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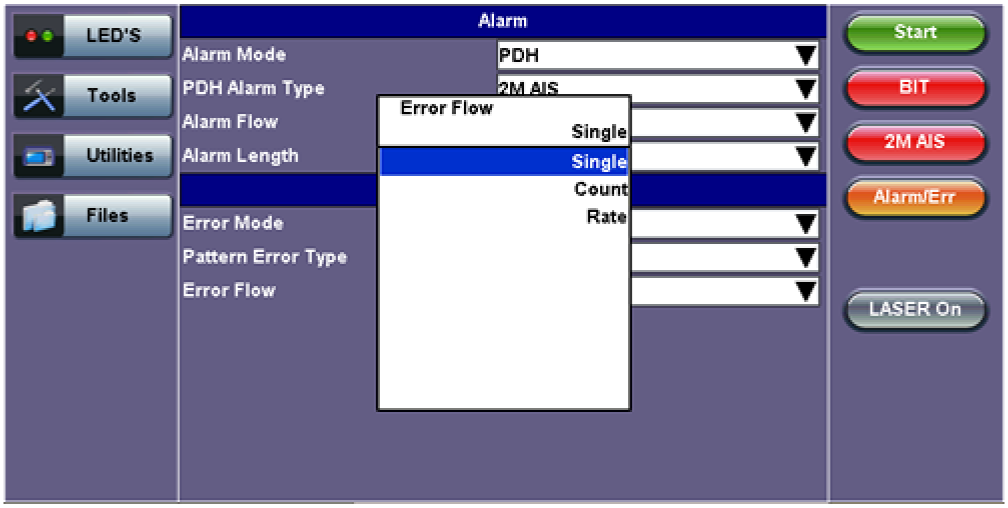
Error Flow: OTN, SDH, SONET, PDH signals

Injects different anomalies into the transmit signal. Error insertion flow modes 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
- **Rate:** Specific rate between $1x10^{-3}$ and $5x10^{-6}$

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

Error Flow



Alarm Generation/Error Insertion

At any time during the test process, tap the **Error Injection** or **Alarm Generation** buttons to inject errors or generate alarms.

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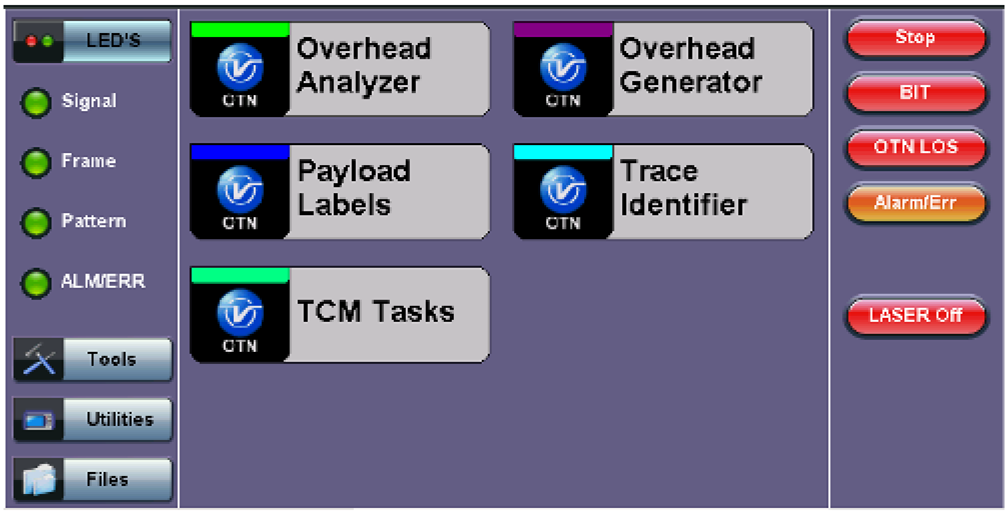
9.0 OTN Tools

9.1 Shortcuts

Accessing OTN Tools

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

OTN Tools Menu



- **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.

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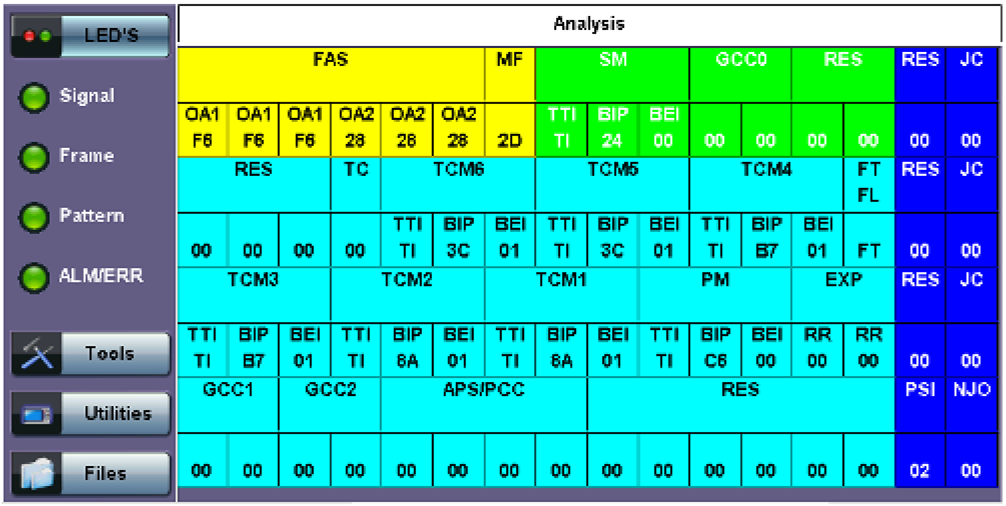
9.2 Overhead Analyzer & Generator

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

Overhead Analyzer Menu

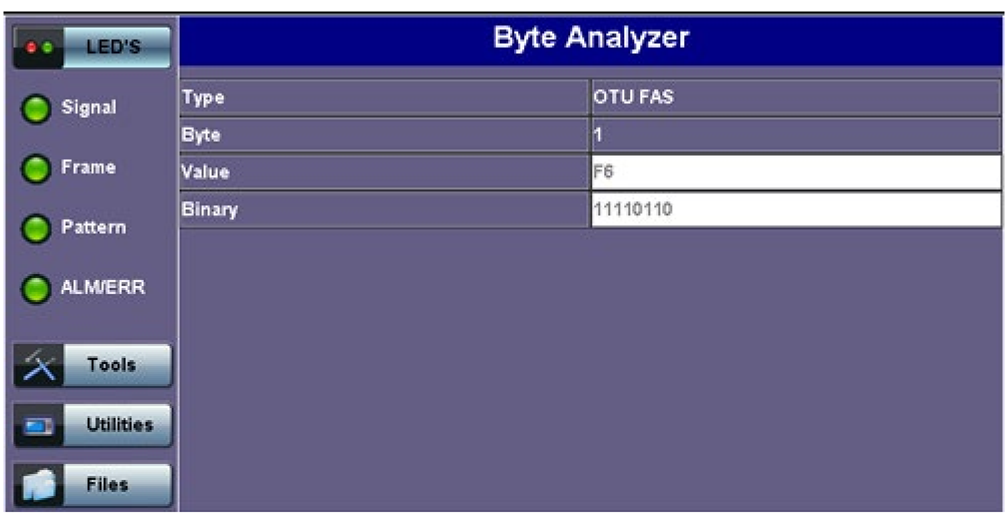


The Overhead is color coded for simplified viewing.

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



9.2.1 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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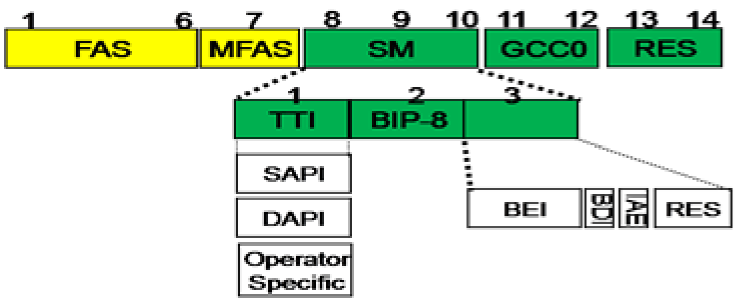
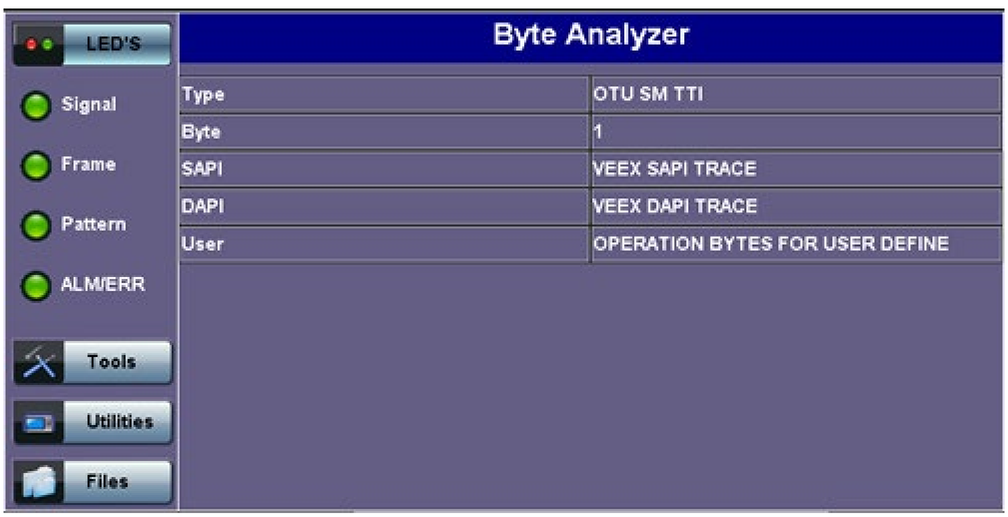
9.2.2 Optical Transport Unit (OTU) Analysis

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



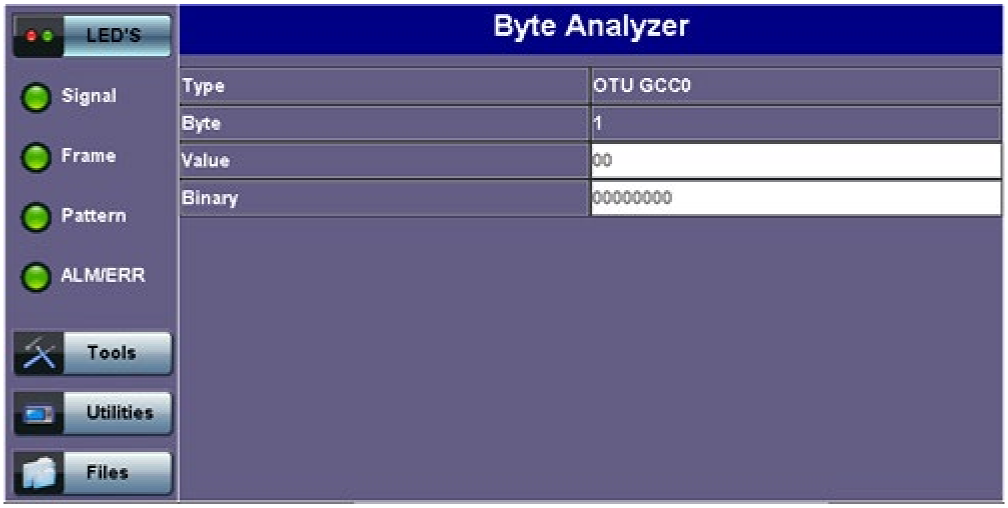
- **Section Monitoring (SM)**
  - Bytes are used for the Trail Trace Identifier (TTI), Parity (BIP-8) and the Backward Error Indicator (BEI) (also known as the Backward Incoming Alignment Error [BIAE]), Backward Defect Indicator (BDI), and Incoming Alignment Error (IAE).
  - The TTI is distributed over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

GCCO Type



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

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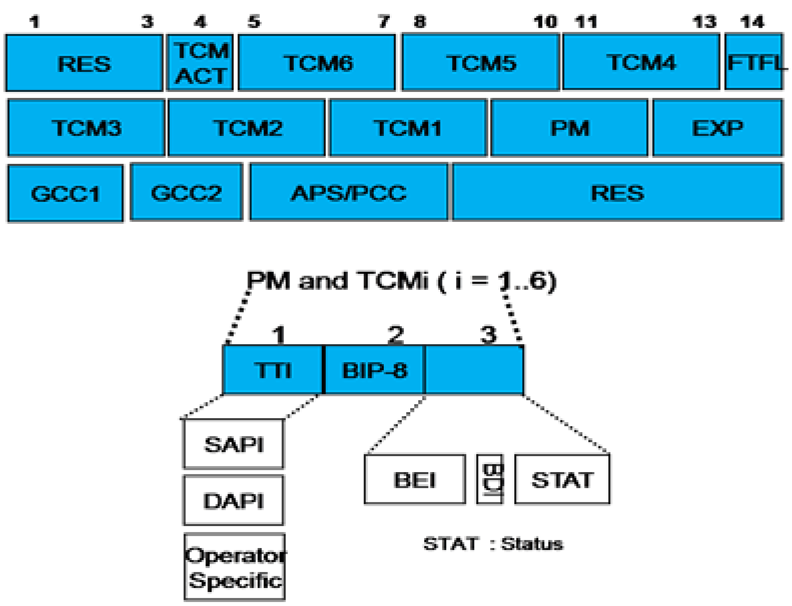
9.2.3 Optical Data Unit (ODU) Analysis

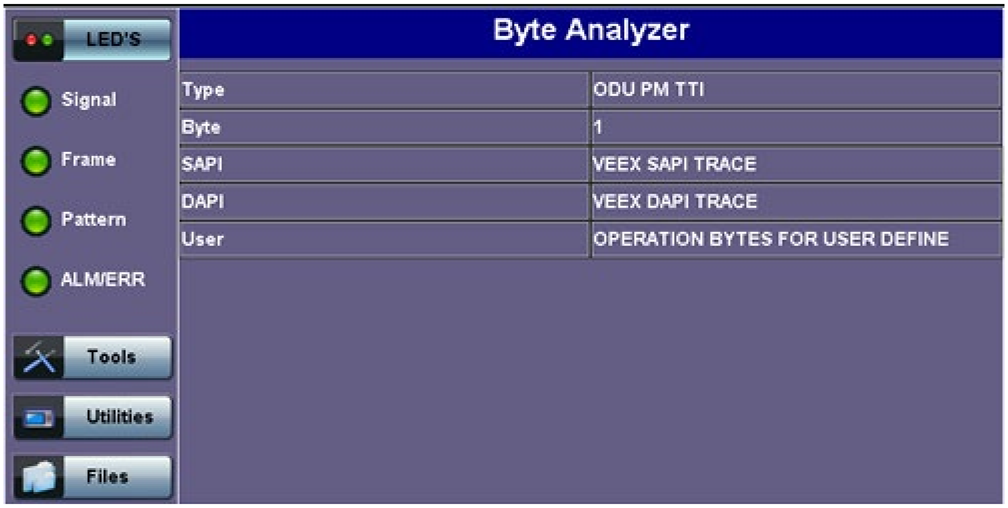
The ODU overhead is divided into several fields: RES, PM, TCMi, TCM ACT, FTFL, EXP, GCC1/GCC2 and APS/PCC.



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.

PM TTI Type



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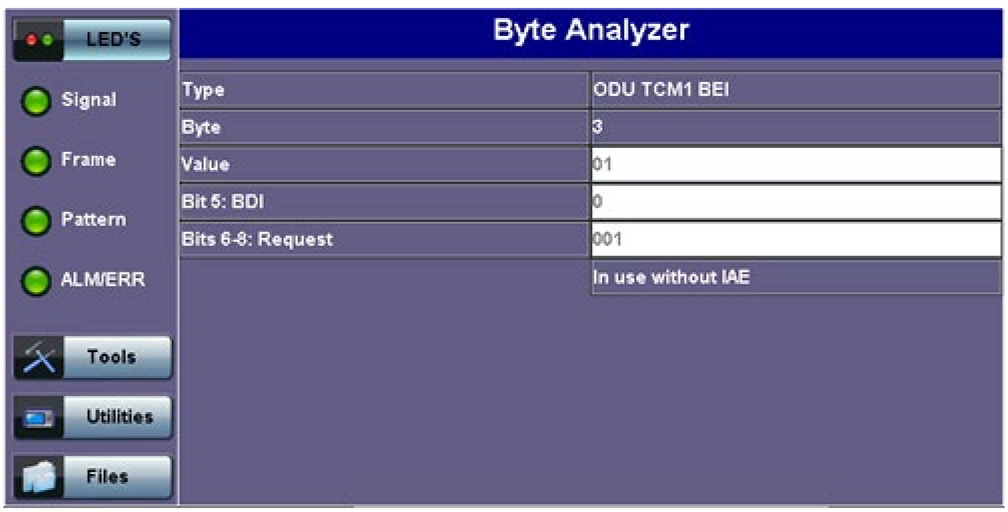
- **TCMi:**
  - There are six Tandem Connection Monitoring (TCMi) fields that define the ODU TCM sub-layer, each containing TTI, BIP-8, BEI/BIAE, BDI, and STAT subfields associated to each TCM level (i=1 to 6).
  - The STAT subfield is used in the PM and TCMi fields to provide an indication of the presence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

TCM1 BEI Type



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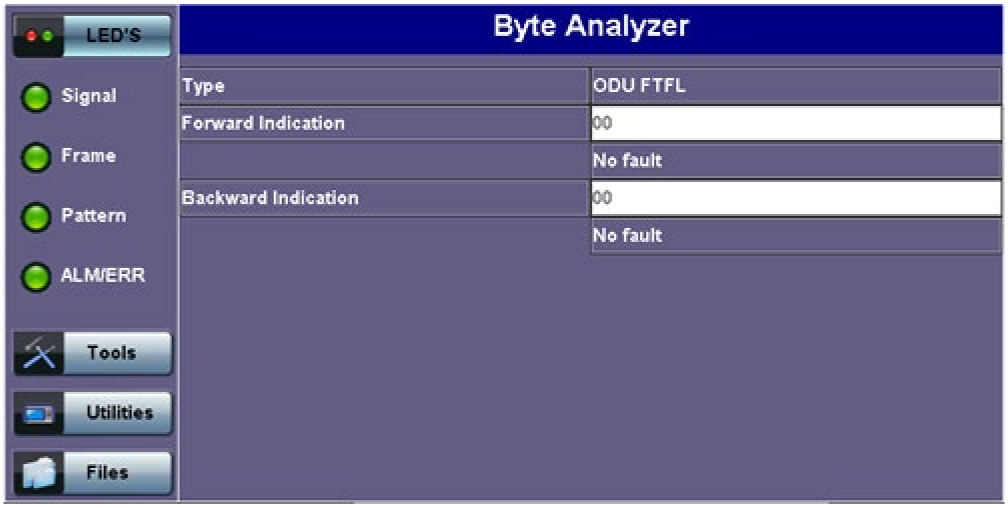
- **Fault Type and Fault Location (FTFL)**
  - Reporting communication channel field used to create a message spread over a 256-byte multiframe
  - Provides the ability to send forward and backward path-level fault indications

FTFL Type



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

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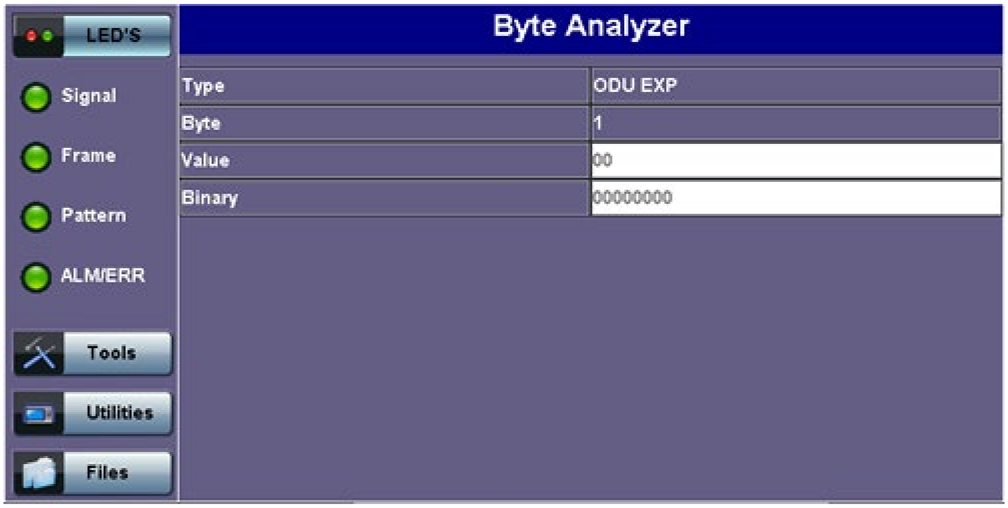
- **Experimental (EXP)**
  - Field not subject to standards and is available for network operator applications

EXP Type



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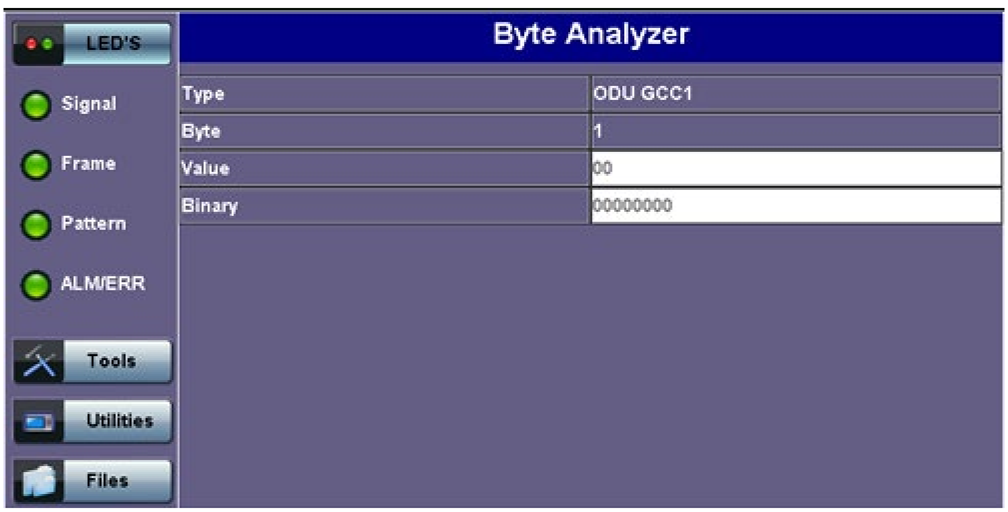
- **General Communication Channels 1 and 2 (GCC1/GCC2)**
  - Fields are very similar to the GCC0 field, except that each channel is available in the ODU

GCC1 Type



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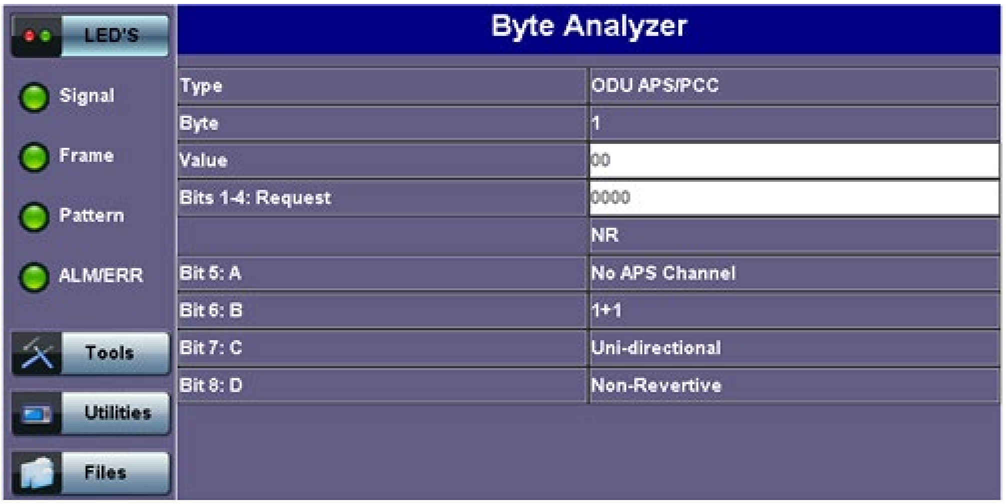
- **Automatic Protection Switching and Protection Communication Channel (APS/PCC)**
  - Supports up to eight levels of nested APS/PCC signals associated to a dedicated-connection monitoring level depending on the value of the multiframe

APS/PCC Type



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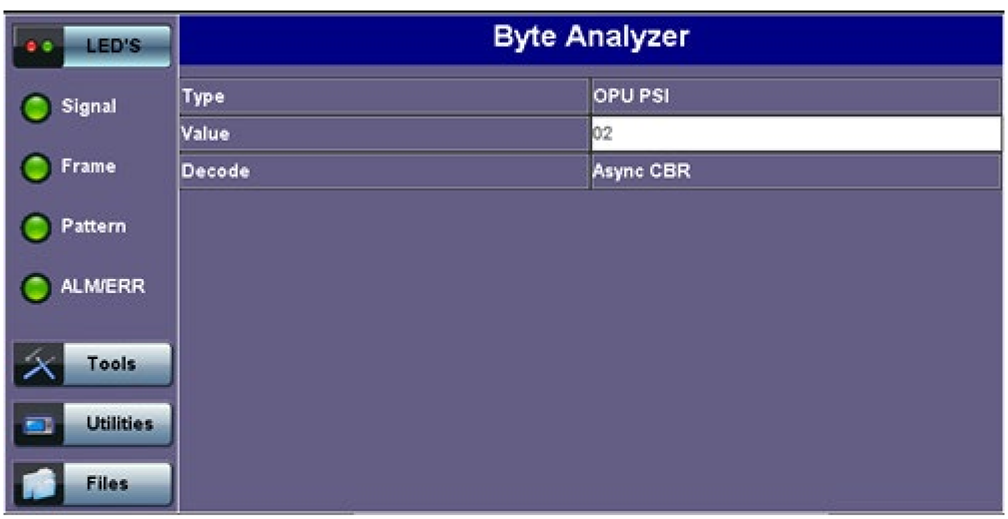
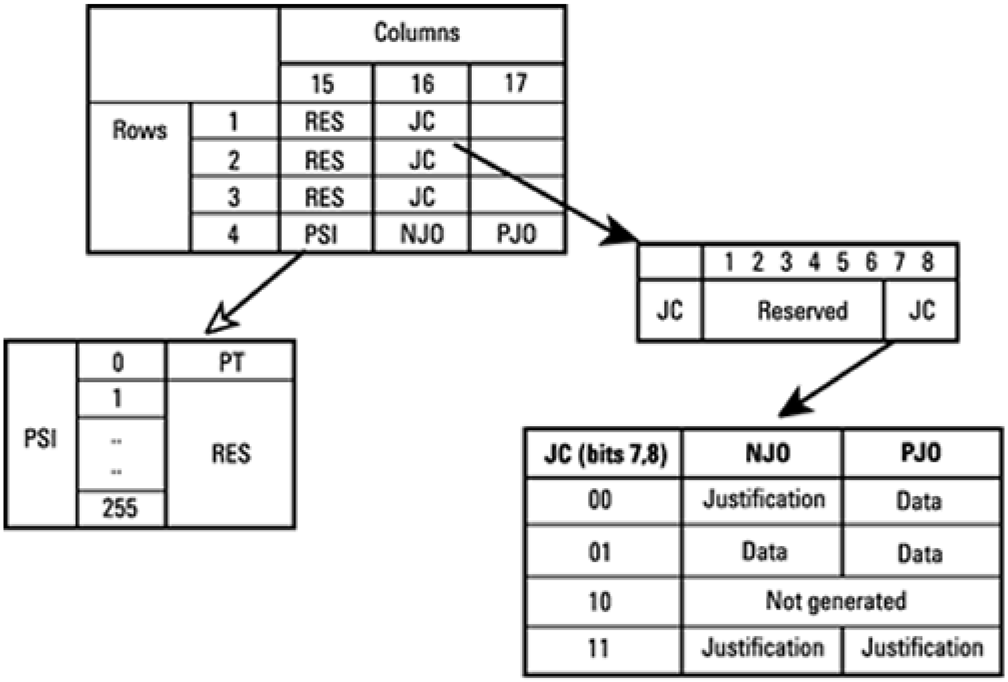
9.2.4 Optical Payload Unit (OPU) Analysis

- **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.



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

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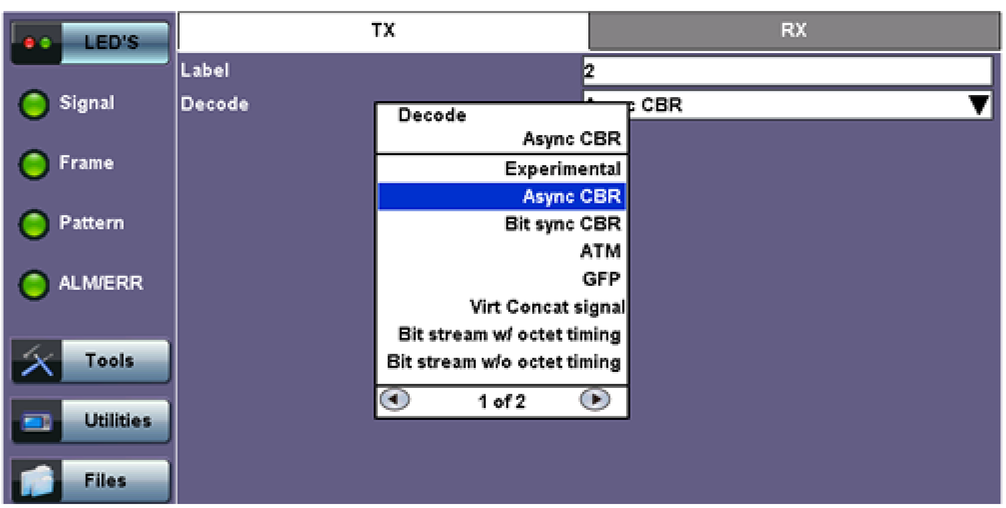
9.3 Payload Label (Payload Structure Identifier)

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.

MSB 1 2 3 4	LSB 5 6 7 8	Hex code (Note 1)	Interpretation
0 0 0 0	0 0 0 1	01	Experimental mapping
0 0 0 0	0 0 1 0	02	Asynchronous CBR mapping
0 0 0 0	0 0 1 1	03	Bit synchronous CBR mapping
0 0 0 0	0 1 0 0	04	ATM mapping
0 0 0 0	0 1 0 1	05	GFP mapping
0 0 0 0	0 1 1 0	06	Virtual Concatenated signal
0 0 0 1	0 0 0 0	10	Bit stream with octet timing mapping
0 0 0 1	0 0 0 1	11	Bit stream without octet timing mapping
0 0 1 0	0 1 1 0	20	ODU multiplex structure
0 1 0 1	0 1 0 1	55	Not available
0 1 1 0	0 1 1 0	66	Not available
1 0 0 0	x x x x	80-8F	Reserved codes for proprietary use
1 1 1 1	1 1 0 1	FD	NULL test signal mapping
1 1 1 1	1 1 1 0	FE	PRBS test signal mapping
1 1 1 1	1 1 1 1	FF	Not available

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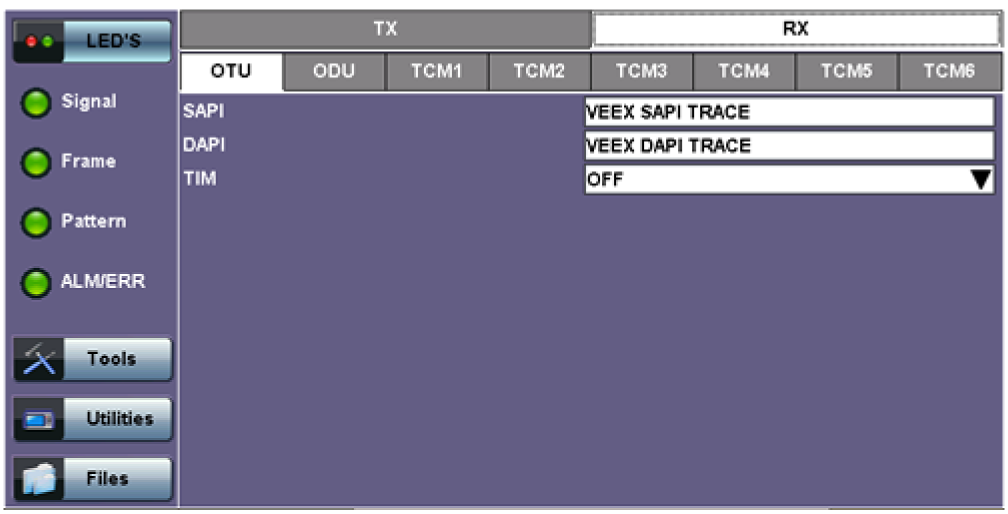
9.4 Trace Identifier (Trail Trace Identifier)

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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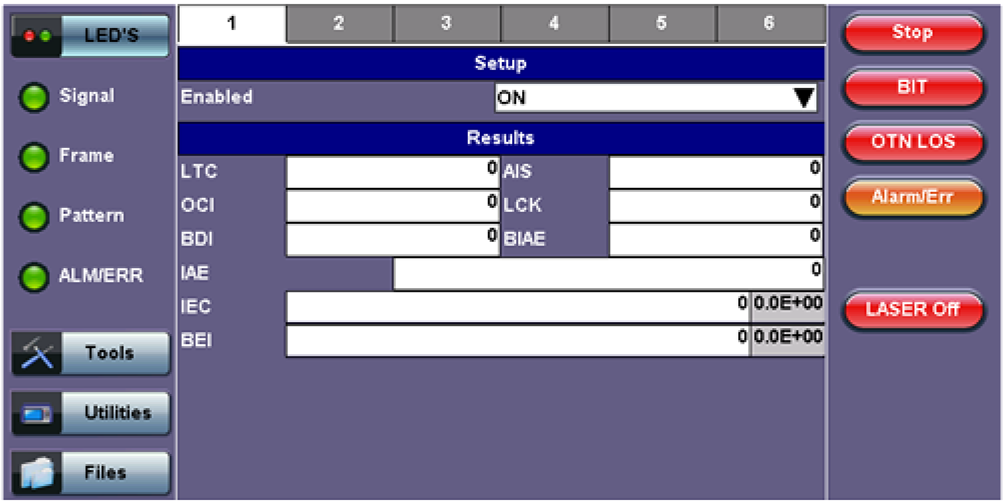
9.5 TCM Tasks (Tandem Connection Monitoring)

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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10.0 SDH/SONET Tools

10.1 SDH Tools

Accessing SDH Tools

Tap on **Home** (main menu) >**SONET/SDH Tools**

10.1.1 Shortcuts

SDH/SONET Tools Menu

- **Overhead Analyzer:** Displays the Section Overhead (SOH) and Path Overhead (POH) bytes of the received channel.
- **Overhead Generator:** SDH mode. Used to edit Section Overhead (SOH) and Path Overhead (POH) bytes of the transmitted channel.
- **Pointer Tasks:** Displays both AU and TU pointer values and generates AU and TU pointer movements.
  - Pointer sequences according to ITU-T G.783 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-11mode
- **TCM Tasks:** Used to analyze or edit the sequence of N1 and N2 TCM 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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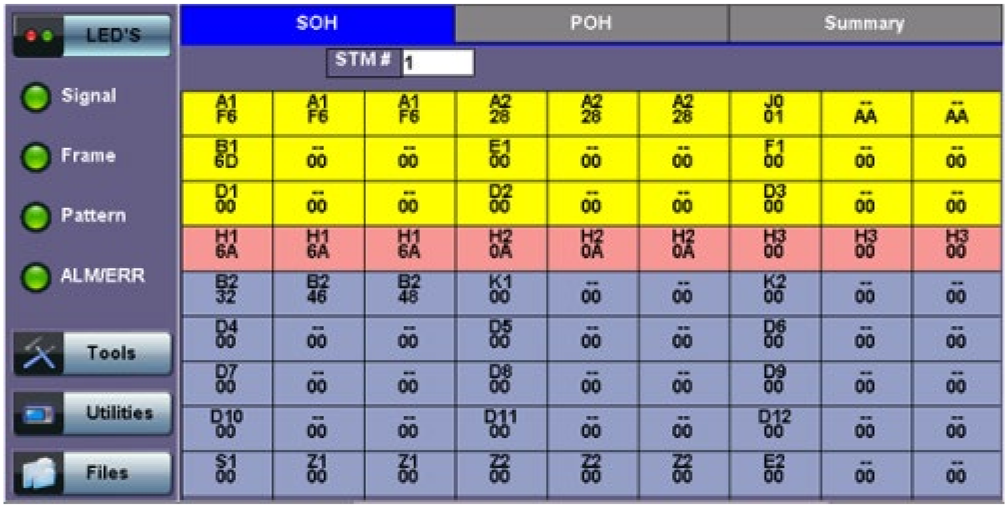
10.1.2 Overhead Analyzer

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.

Section Overhead

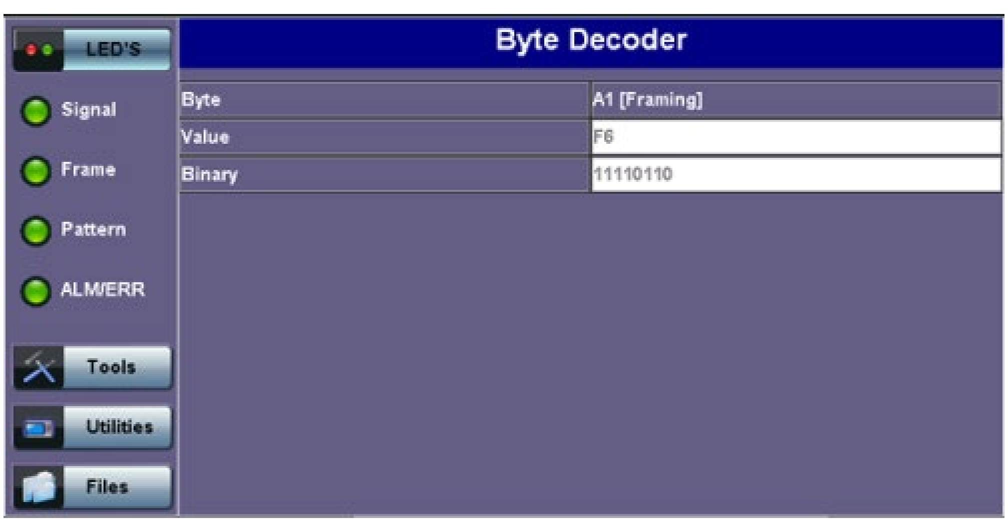
The following is a partial list of SOH bytes and their corresponding functions:

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

A1 [Framing] Byte



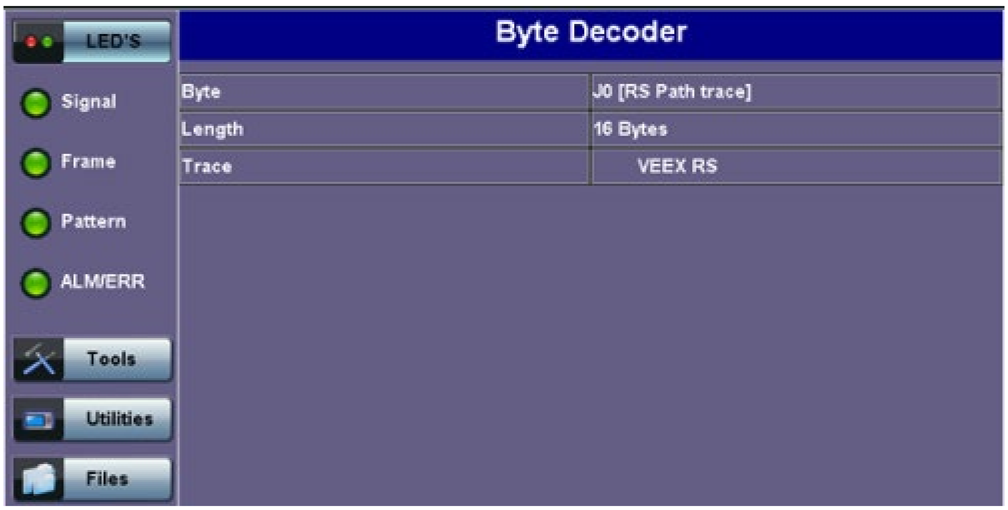
Path Trace Byte (J0)

- 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

Path Trace Byte (J0)



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)

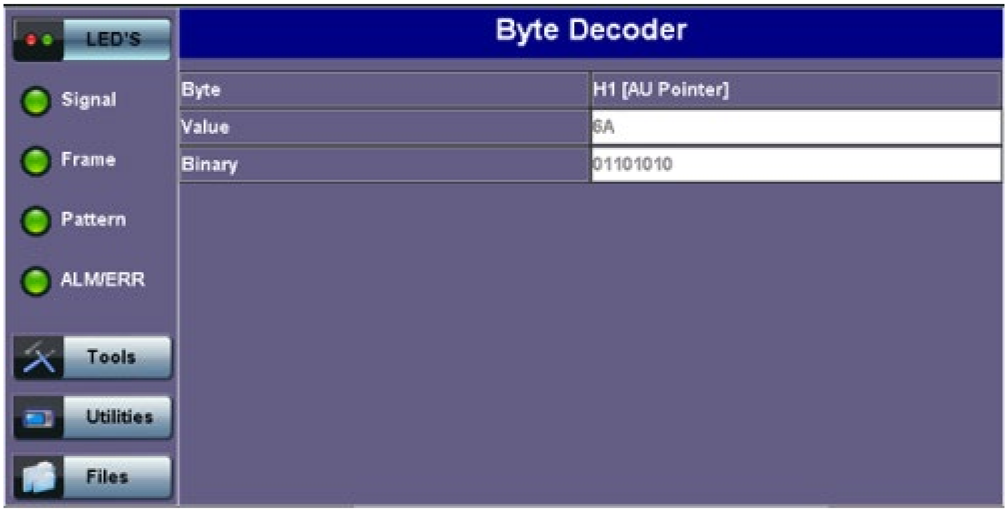
- Data Communications Channel (DCC)
- D1, D2 and D3 together form a 192kbps message channel for OAM purposes
- It can generate internal or external messages
- It can also be used as a BER function

Pointers

AU Pointers Bytes (H1/H2/H3)

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

AU Pointer Byte



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Line Layer / Multiplexer Section

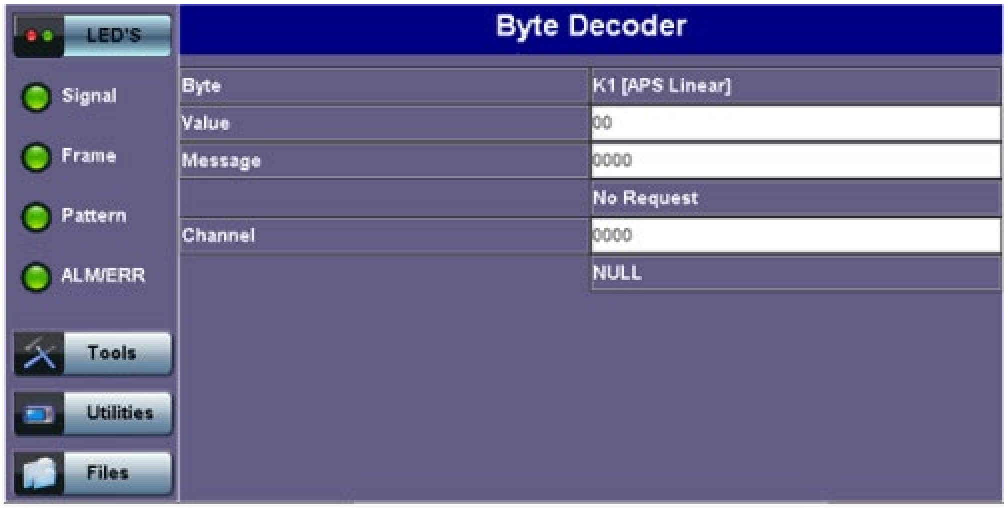
B2 Byte (MS-BIP)

- 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 except those in the Regenerator Section overhead
- The computed checksum is placed in the MSOH of the following STM-1 frame

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)

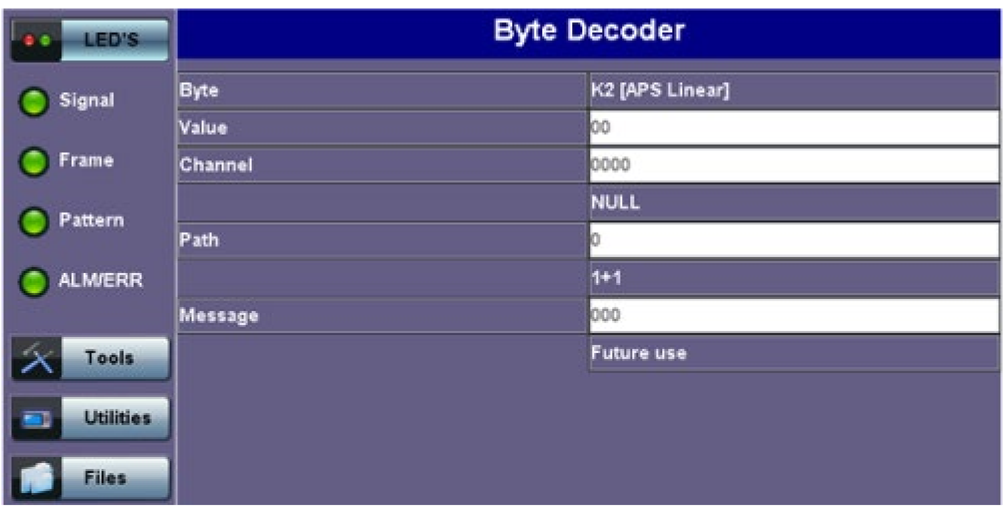
- Conforms to ITU-T G.783 and Bellcore GR.253
- Used to activate and deactivate the switching between the main and protection paths on a multiplexer section
- Used to communicate Alarm Indication Signal (AIS) and Remote Defect Indication (RDI) conditions
  - Bits 1-4 selects bridged channel used
  - 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)

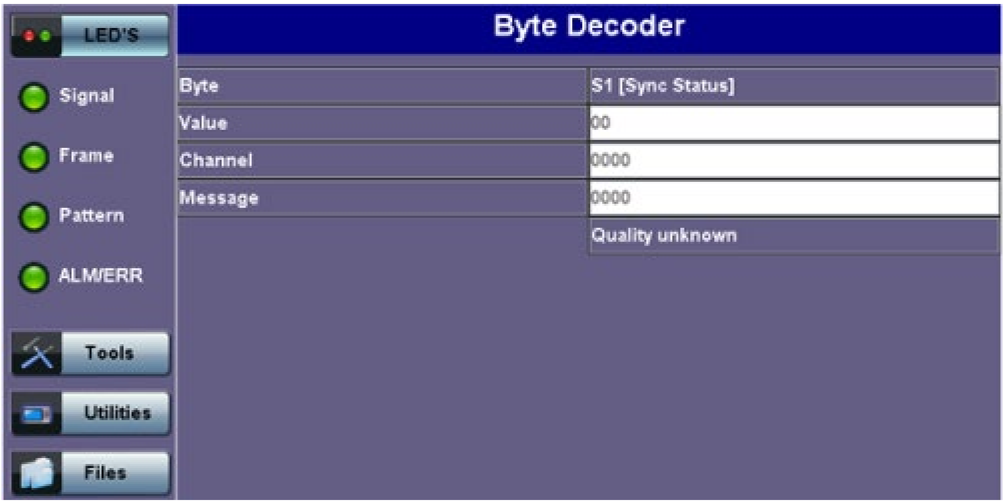
- DCC – together these nine bytes form a 576kbps message channel for OAM purposes.
- They can be used for internally or externally generated messages or BER function.

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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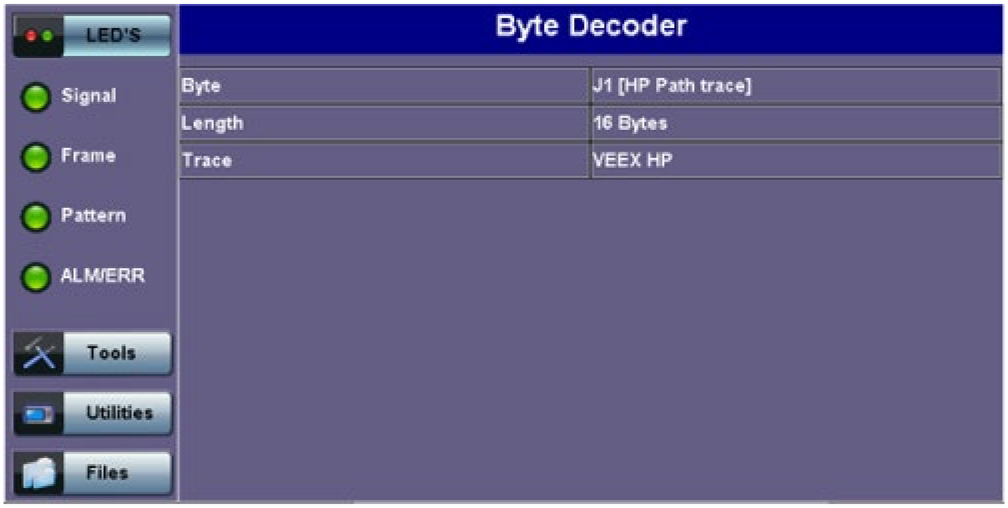
Path Overhead Layer

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 a SDH 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

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
  - The computed checksum is placed in the B3 byte before scrambling

- **C2 byte (HP signal label) for SDH mode**
  - Indicates mapping of the VC-n.
  - The table below indicates the standard C2 binary values:

C2 Byte (HP signal label)

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 34Mbit/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)

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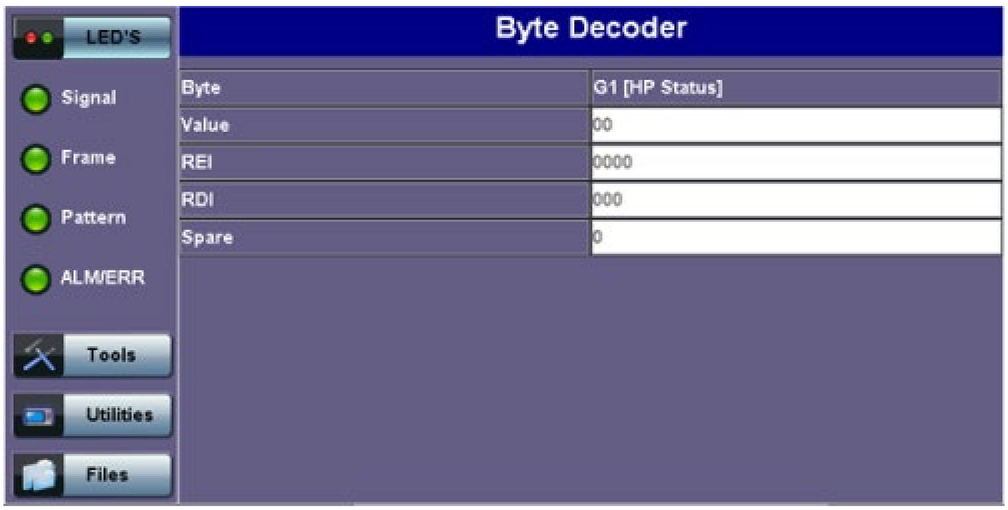
- **G1 byte (Path status)**
  - High Order path status byte
  - Used to convey the path terminating status back to the originating path, thus allowing bidirectional monitoring of the complete path
  - Bits 1-4: Remote Error Indication (HP-REI) indicates number of bit errors detected by B3
  - Bit 5: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

G1 Byte (HP Status)



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- **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.

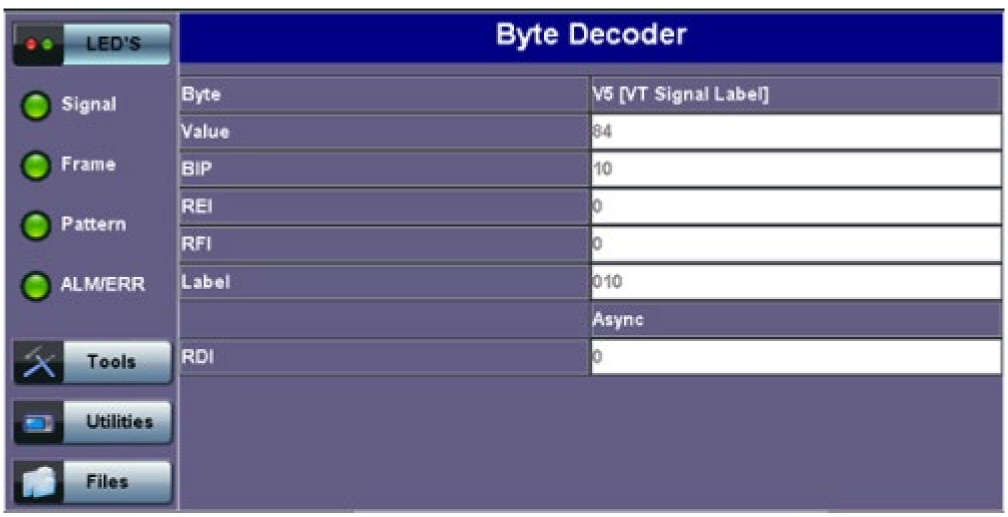
- **K3 byte (HP APS)**
  - Bits 1-4 are used for protection switching of VC-3 & 4 paths.
  - Bits 5-8 are a currently not used

- **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

<table>
<tr><th colspan="32">K4 multiframe structure per ITU-T G.707 recommendations</th></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td><td>24</td><td>25</td><td>26</td><td>27</td><td>28</td><td>29</td><td>30</td><td>31</td><td>32</td></tr>
<tr><td colspan="11">Multiframe Alignment Signal</td><td colspan="8" rowspan="2">Extended Signal Label</td><td rowspan="2">0</td><td rowspan="2">R</td><td rowspan="2">R</td><td rowspan="2">R</td><td rowspan="2">R</td><td rowspan="2">R</td><td rowspan="2">R</td><td rowspan="2">R</td><td rowspan="2">R</td><td rowspan="2">R</td><td rowspan="2">R</td><td rowspan="2">R</td><td rowspan="2">R</td></tr>
<tr><td colspan="5">Frame count</td><td colspan="6">Seq. Indicator</td></tr>
</table>

K4 byte structure per ITU-T G.707 recommendations							
Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
Extended Signal Label	Virtual concatenation Overhead	Unassigned		Optional Use			Unassigned

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- **Summary**
  - The Summary tab displays the summary screen listing the major bytes of the received SDH 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)

Summary

	Path Traces (SP) indicates a space between the message characters. The message is displayed in red when an alarm condition is detected.

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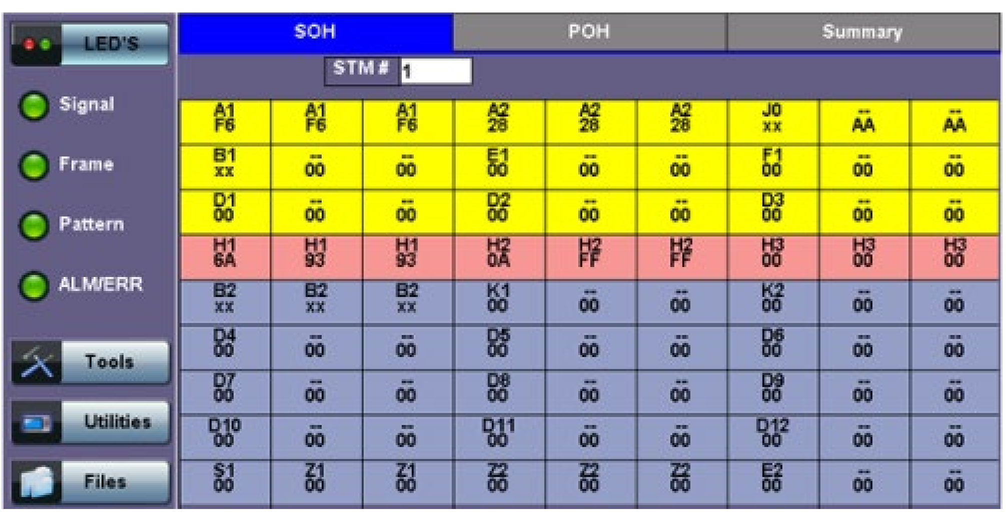
10.1.3 Overhead Generator

SOH



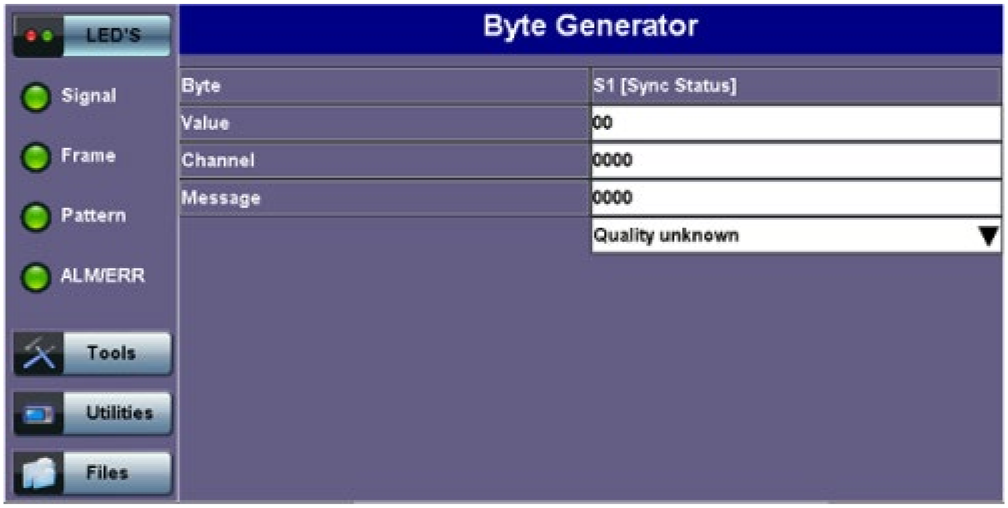
Tap the Overhead Generator icon to display the OH screens shown below. There are three tabs:

- **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.

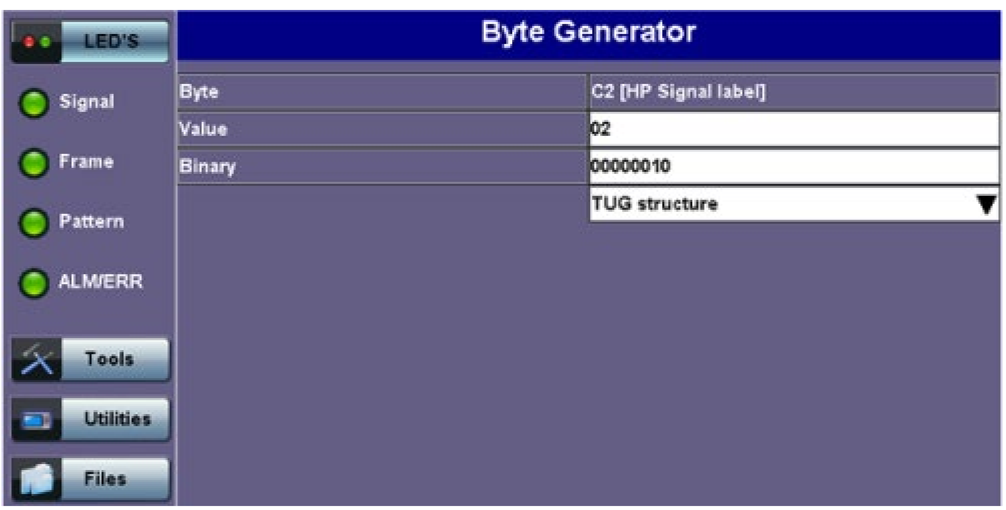
While programming of most overhead bytes is possible using the OH Generator feature, dedicated functions are available for Pointer Tasks, Payload Labels, Trace Identifier, APS Testing, TCM testing. In some instances, more advanced editing is possible using the dedicated functions.

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.

C2 Byte from POH



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.

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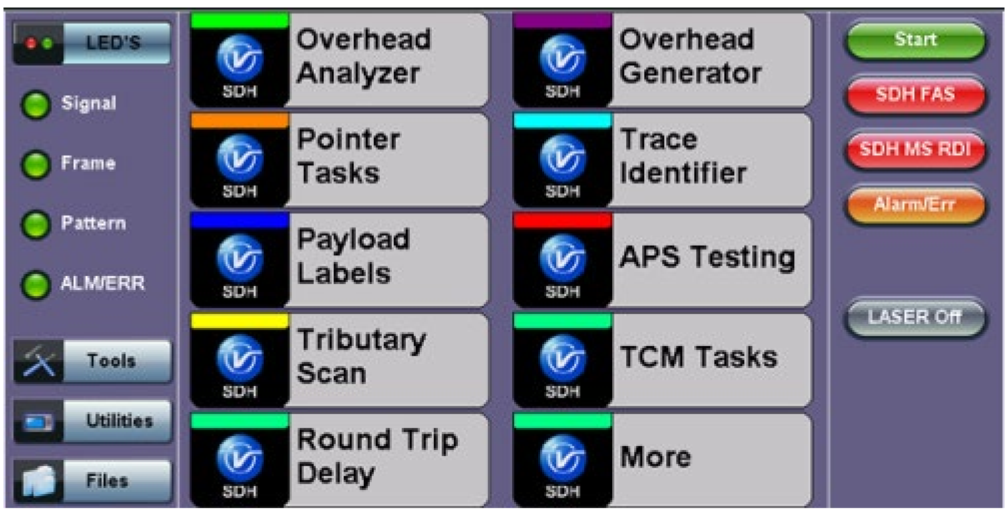
10.1.4 Pointer Tasks

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

SDH/SONET Tools Menu

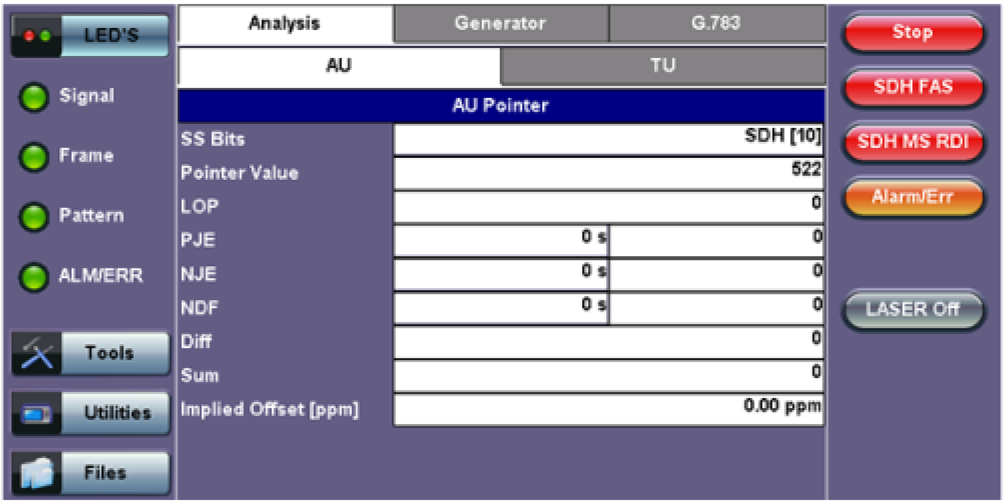


10.1.4.1 Pointer Analysis

Pointers keep SDH 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.

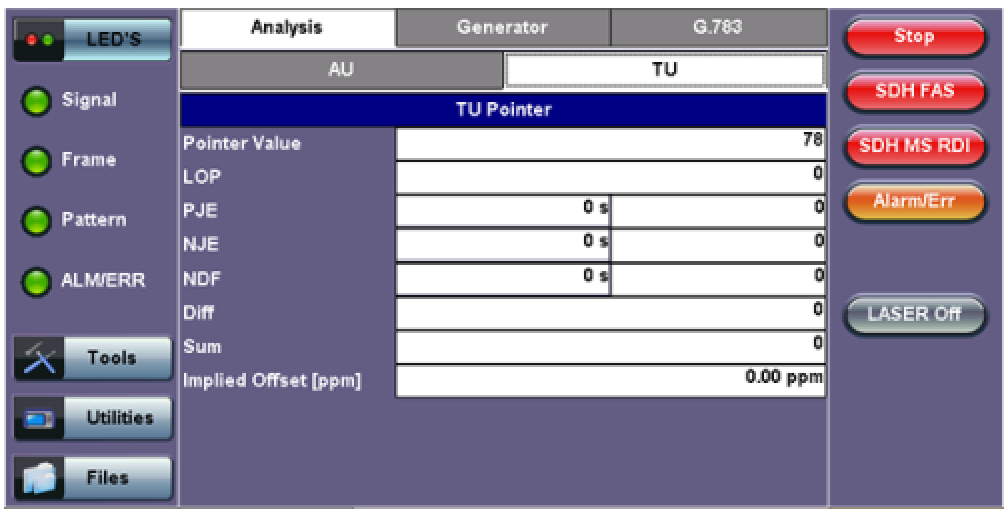
- **For AU pointers:**
  - SS bits – Displays bits 5 and 6 of the H1 byte to indicate SDH [10], SONET [00], Unknown [01] and [11] signal type
  - Pointer value – Displays the H1 and H2 values (addresses) indicating the offset in bytes between the pointer and first byte of the AU-n
  - LOP (Loss of Pointer)
  - 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

Analysis > AU tab



- **For TU 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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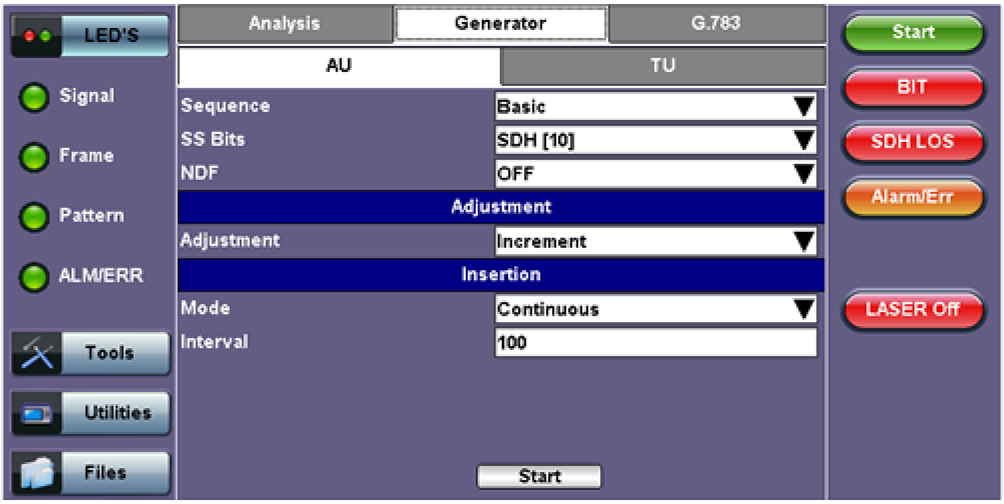
10.1.4.2 Pointer Generation

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

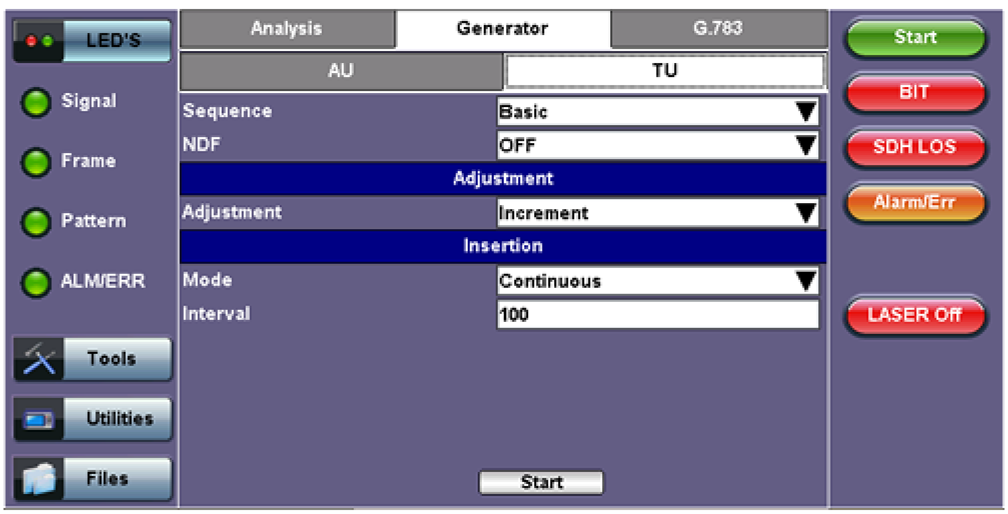
- **For AU pointers:**
  - SS bits: Program bits 5 and 6 of the H1 byte to be either SDH [10], SONET [00], Unknown [01] or [11].
  - Pointer value: Transmits a new pointer address or value with or without a new data flag (NDF). Configurable in a range of 0 to 782 pointers.
  - Increment (INC) or Decrement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

Generator > AU tab



- **For TU pointers**
  - 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



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10.1.4.3 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:

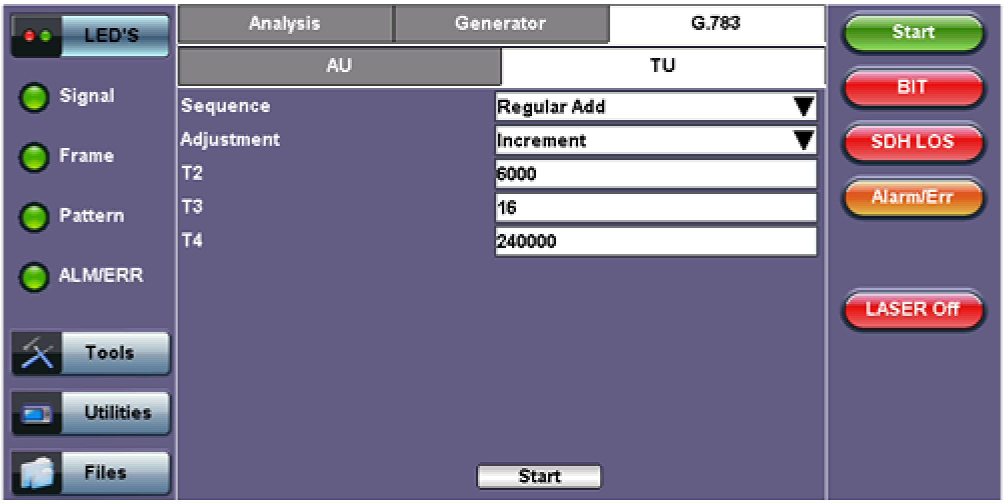
- **Sequence:** Decide how to affect the pointer sequence
- **Basic:** Specify whether the pointer is increasing or decreasing
  - Select Inc to increase the pointer value
  - Select Dec to decrease the pointer value
  - Select New Value to set new pointer value
- **Single Alternating:** Increase or 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

G.873 > TU tab



	**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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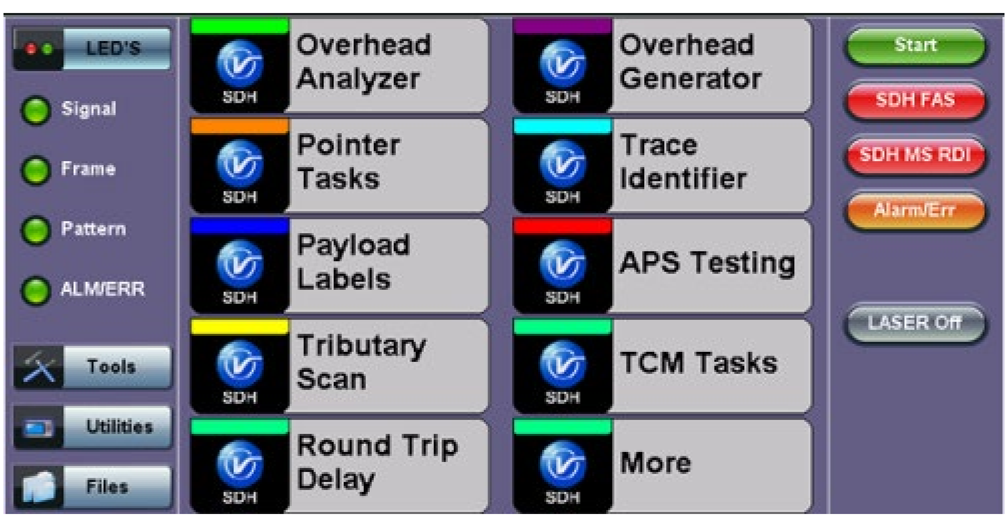
10.1.5 Trace Identifier

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

SDH/SONET Tools Menu



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

10.1.5.1 Transmitted Traces (TX)

- J0 [RS]: Regenerator section trace
  - Program a 1 or 16-byte identifier to check the connection between regenerators
- J1 [HP]: High order path section trace
  - Program a 16 or 64-byte identifier to check the high order transmission path
- J2 [LP]: 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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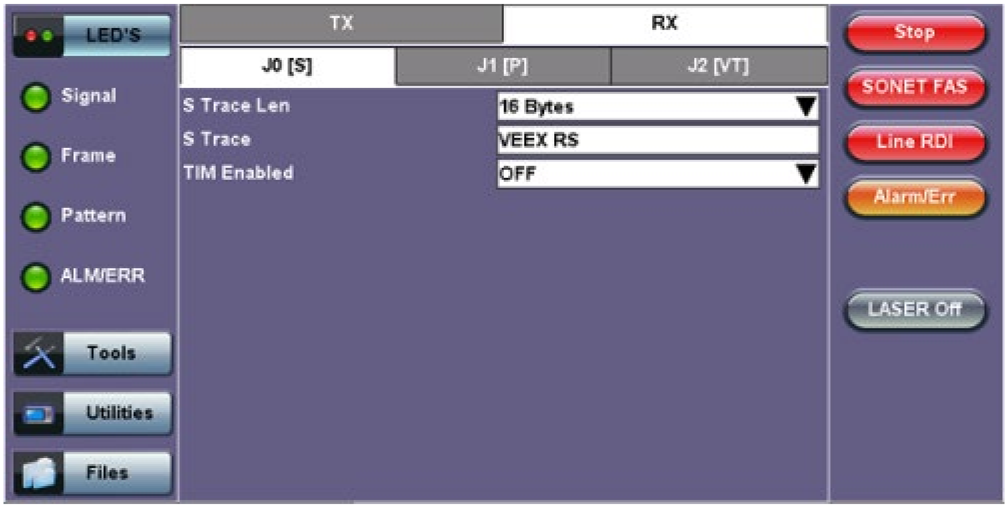
10.1.5.2 Received Traces (RX)

- J0 [RS]: Regenerator section 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]: High 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
- J2 [LP 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

RX - JO [S]



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10.1.6 Payload Labels

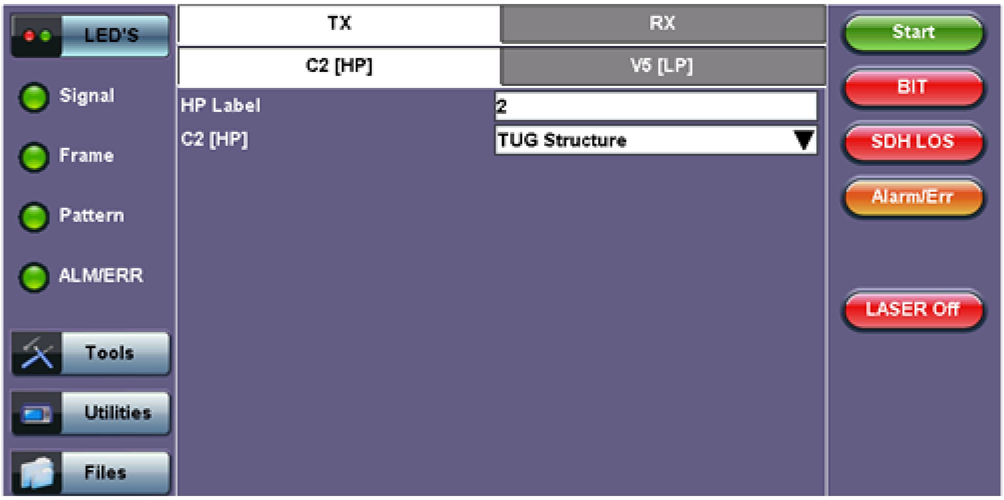
This function is used to set the C2 and V5 Path Signal Labels which indicate the content of the High order and Low order VCs.

SDH/SONET Tools Menu

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]: Path signal label**
    - Specifies the mapping type in the VC-n
    - 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

TX C2 [HP]



- **V5 [LP 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

TX V5 [LP]

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10.1.7 APS Tasks

10.1.7.1 APS Timing

This function measures the Automatic Protection Switching (APS) limits of the network. APS applies only to the Multiplex sections of a SDH 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.

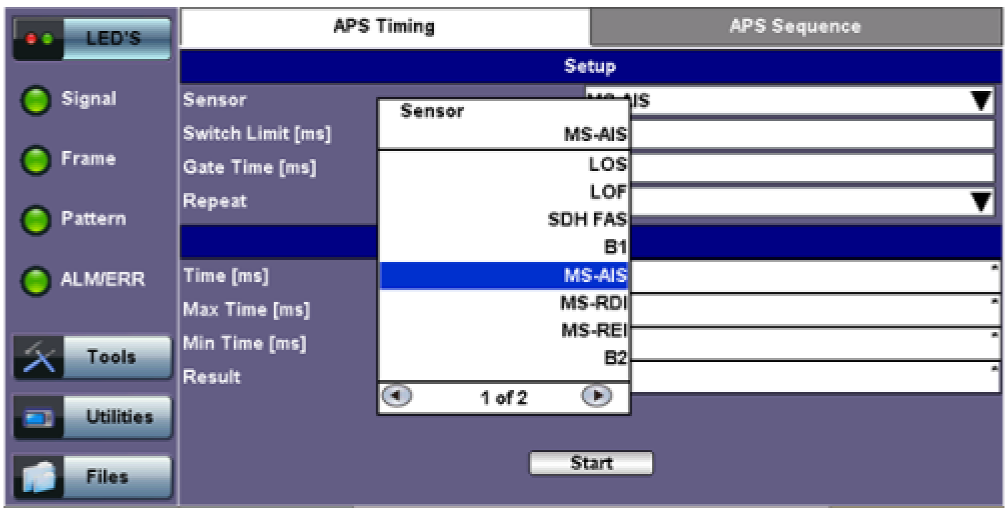
- **APS Standards**
  The principles and protocols of APS in SDH networks are defined in ITU-T G.783 and G.841 and Bellcore GR-253 recommendations for Linear and Ring network architectures respectively. According to recommendations, the re-routing of the signal has to occur within 50ms. Protection switching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

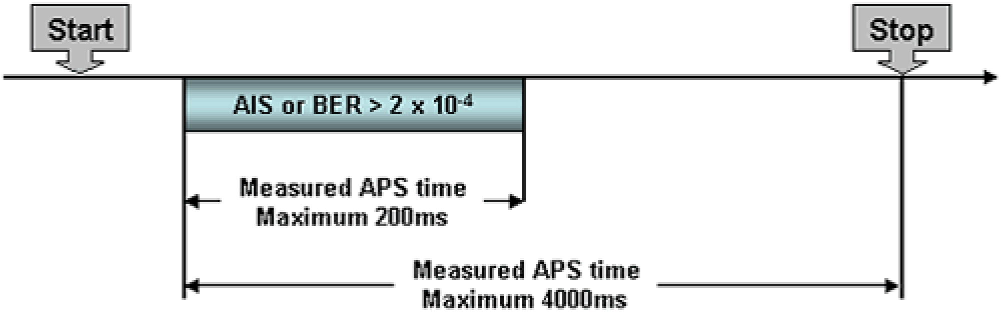


Figure 1: Perfect service disruption

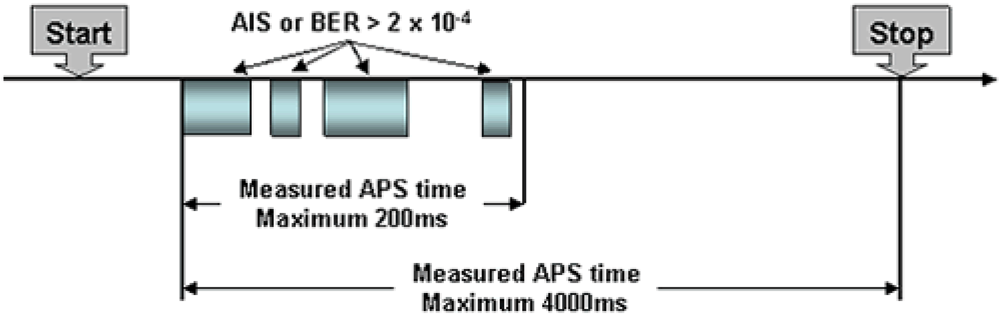
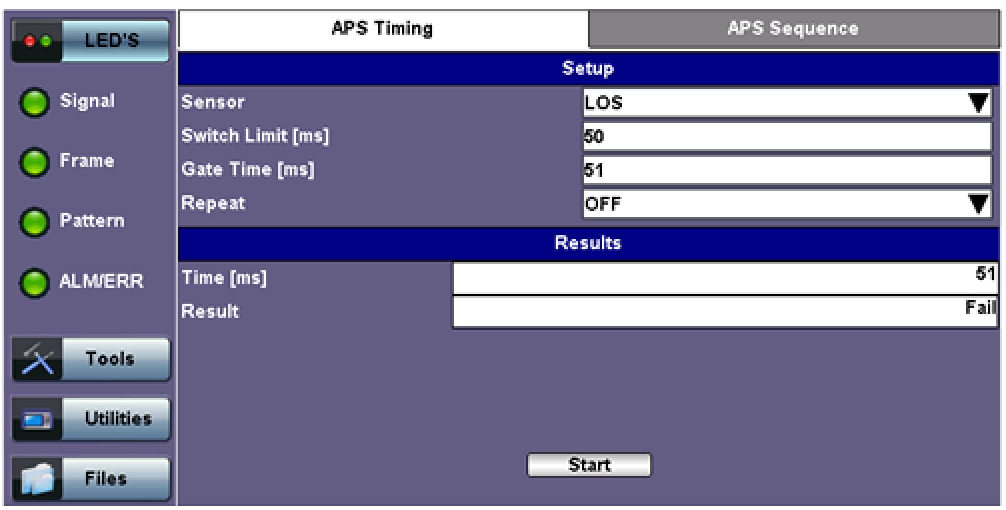


Figure 2: Multiple service disruption or micro interrupts



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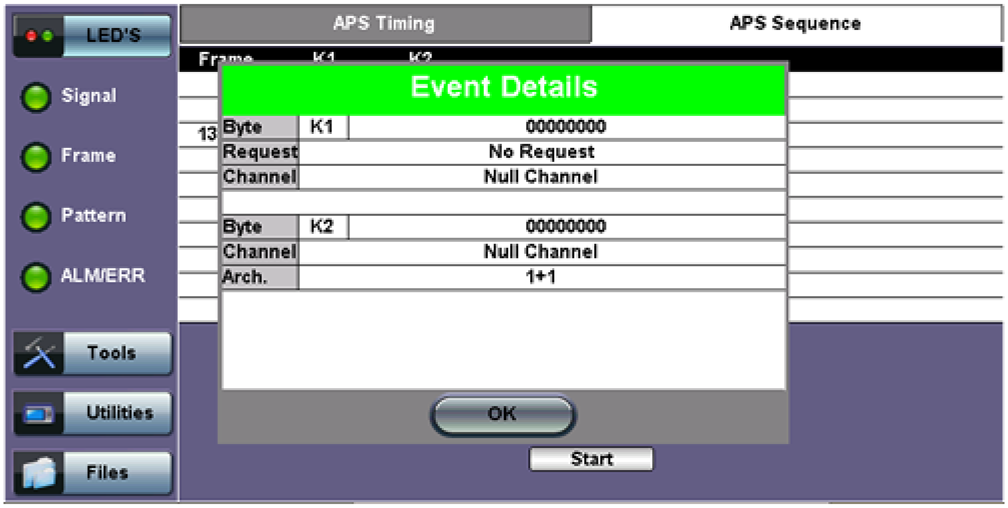
10.1.7.2 APS Sequence

The associated K1/K2 sequence and received K1/K2 bytes may be captured.

Event Details



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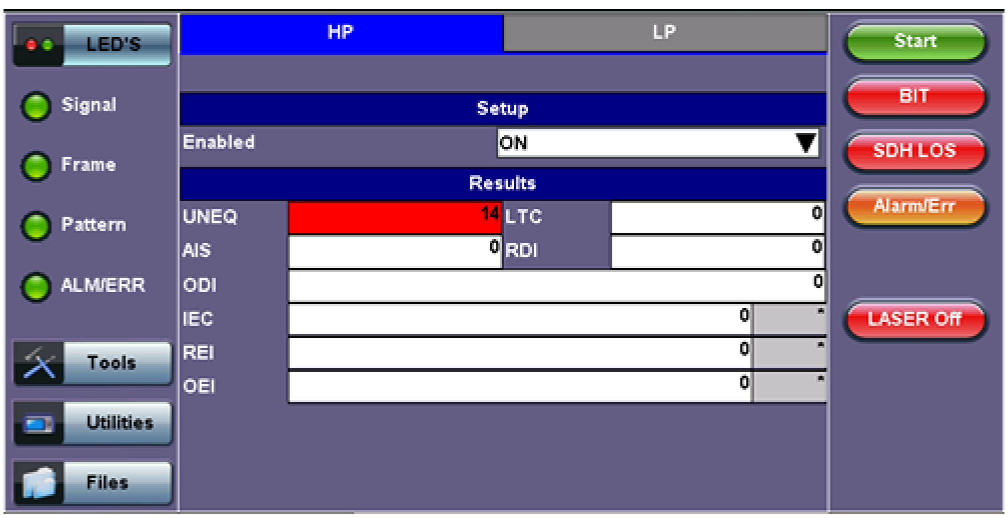
10.1.8 Tandem Connection Monitoring (TCM)

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
    - 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-B1P		"1"	IAIS	TC-REI	OEI	TC-APId, TC-RDI,ODI, reserved	

IEC:	Incoming Error Count. Indicates IAIS when set to '1110' (seebelow)
IAIS:	Incoming AIS alarm
TC-REI:	Tandem Connection Remote Error Indication
OEI:	Outgoing Error Indication
TC-APId:	Tandem Connection Access Point Identifier (16-byte message)
TC-RDI:	Tandem Connection Remote Defect Indication
ODI:	Outgoing Defect Indication
TC-BIP:	2-bit Bit Interleaved Parity for Tandem Connection

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10.1.9 Tributary Scan

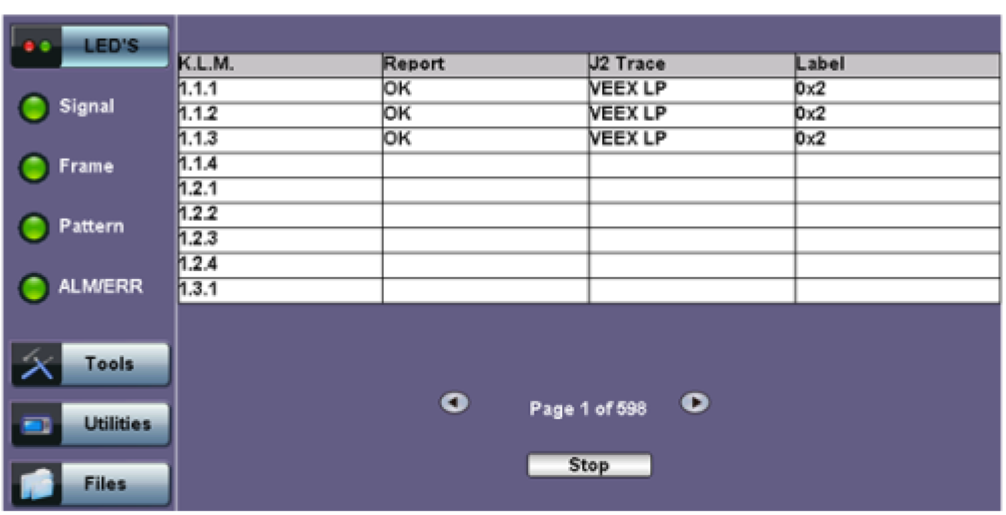
This function requires VC12 or VT-1.5 mapping and allows for a quick check of the signal structure, trace identifier, and the payload.

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 a STM-4 contains 252 x VC-12's checking each path manually can be very time consuming.

The unit automatically performs a sequential BER test on each SDH tributary (C12 channel) - mapping can be either via AU-4 or AU-3. The unit checks for alarms in the received signal, the SDH 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

Tributary Scan



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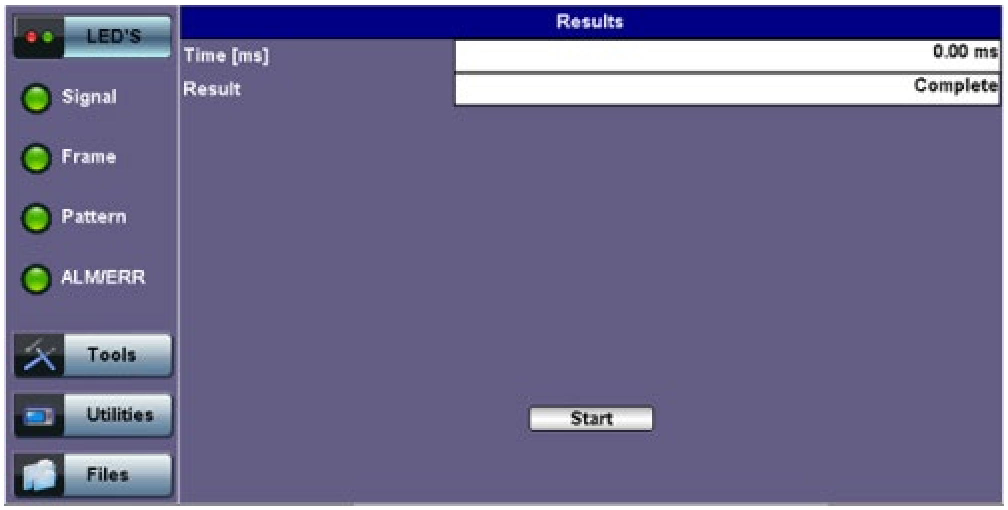
10.1.10 Round Trip Delay

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 SDH as TX/RX standard.
- View the Round Trip Delay of a looped back signal.
- Set check box on Setup RX pattern to Out-of-Service.

Round Trip Delay Results



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10.1.11 Jitter and Wander

For more information on Jitter and Wander, please see Jitter and Wander Application.

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10.2 SONET Tools

Accessing SDH/SONET Tools

Tap on **Home** (main menu) >**SONET/SDH Tools**

10.2.1 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 received channel.
- **Pointer Tasks:** Displays both STS and VT pointer values and generates STS and VT pointer movements. Pointer sequences 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 STS path and 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.
- **TCM Tasks:** Used to analyze or edit the sequence of Z5 and Z6 TCM bytes by generating alarms and errors in the Tandem connection sub-layer.
- **Tributary Scan:** Used to scan individual or multiple tributaries to verify routing and error free operation. Available in VT-1.5 or VT-2 mode
- **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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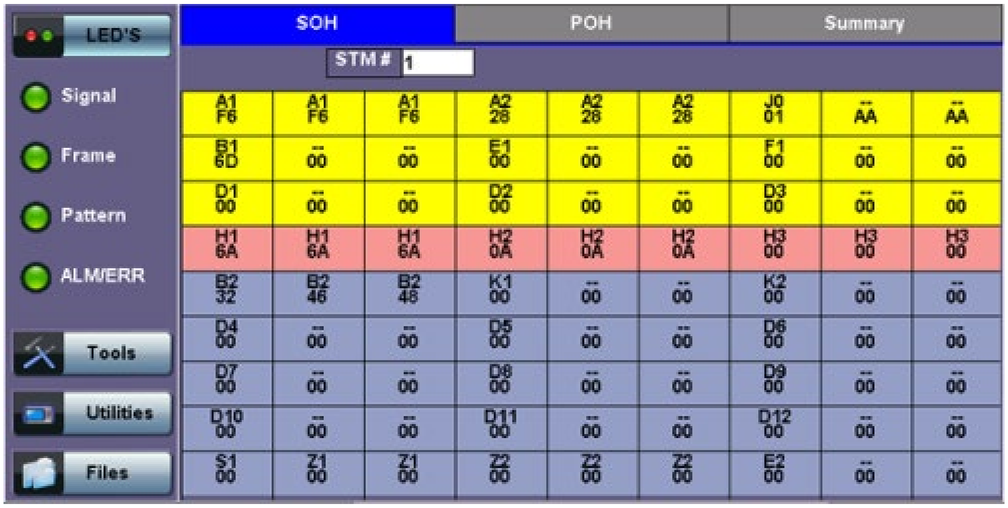
10.2.2 Overhead Analyzer

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.

Section Overhead

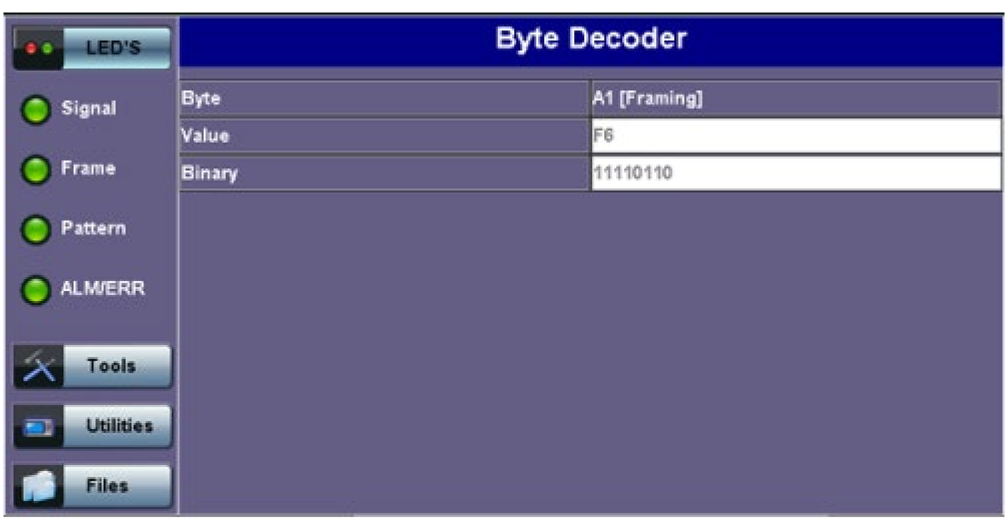
The following is a partial list of SOH bytes and their corresponding functions:

Section Layer

Framing Bytes (A1/A2)

- The A1/A2 bytes indicate the beginning of the STS-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 STS-N frame is composed of (3 x N) A1 bytes followed by (3 x N) A2 bytes

A1 (Framing) Byte



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 STS-N frame before scrambling
- The checksum value is placed in the SECTION overhead of the following STS-N before scrambling

B1 (Section-BIP) Byte

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

D1 Byte

Pointers

H1/H2/H3 Bytes (STS Pointers)

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

H1 Pointer Byte

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Line Layer

B2 Byte

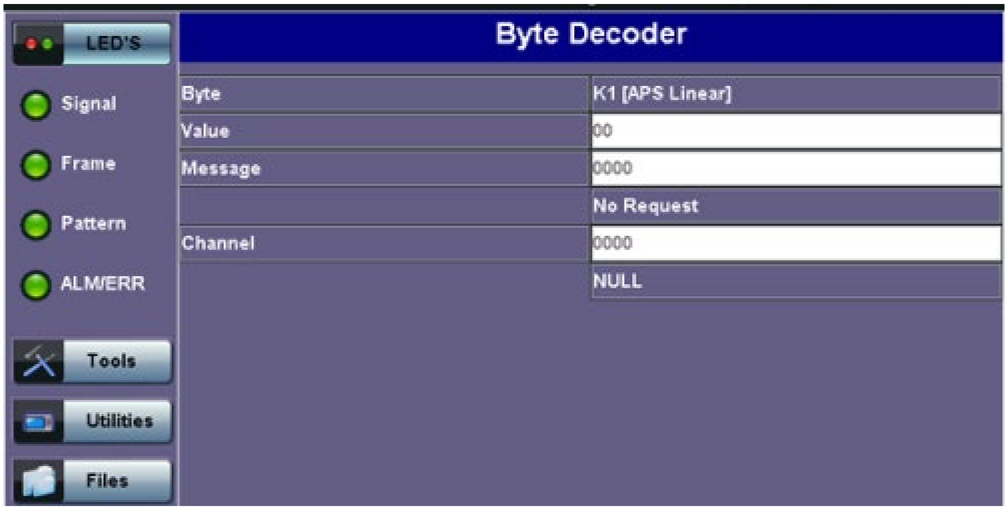
- A 24-bit interleaved even parity code used to determine if transmission errors have occurred over the Section Layer
- Its calculated over all the bits of the STS-3 frame except those in the Section overhead
- The computed checksum is placed in the TOH of the following STS-N frame

B2 Byte

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 channels

K1 Byte (APS-Linear)



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)

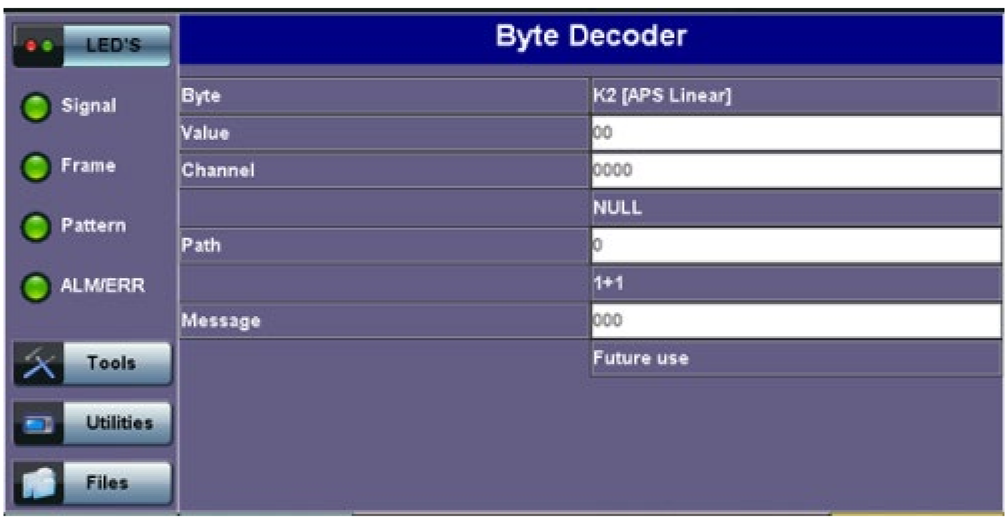
- Conforms to ITU-T G.783 Bellcore GR.253
- Used to activate and deactivate the switching between the main and protection paths on a multiplexer section
- Used to communicate Alarm Indication Signal (AIS) and Remote Defect Indication (RDI) conditions
  - Bits 1-4 selects bridged channel used
  - Bit 5 determines APS architecture
    - 1+1
    - 1:N
  - Bits 6-8
    - 110 RDI-L
    - 111 AIS-L

        ▪ 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 RDI-L
        - 111 AIS-L
        - Others Not used

K2 Byte (APS-Linear)



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

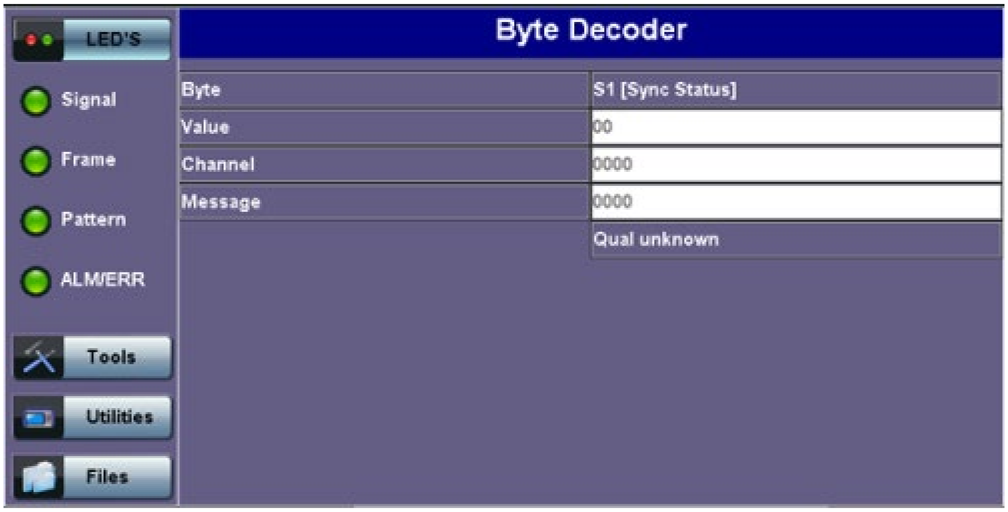
- Data Communications Channel (DCC) – together these nine bytes form a 576kbps message channel for OAM purposes.
- They can be used for internally or externally generated messages or BER function.

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 SONET Minimum Clock
        - 1101 Stratum 3e

- 1110 Provisionable by the Network Operator
- 1111 Not used for synchronization
- Other bytes are reserved

S1 Byte (Synchronization Status)



Order Wire Byte (E2)

- A 64 kbps 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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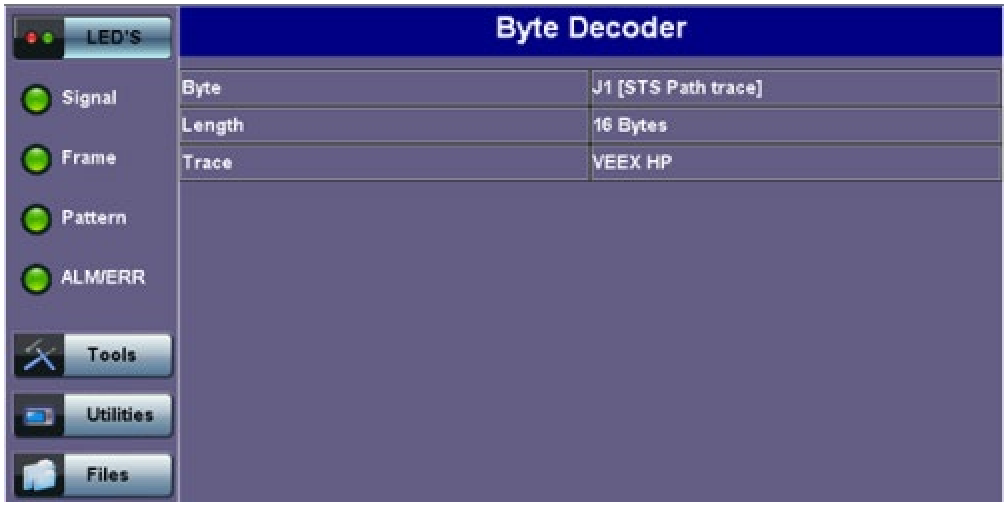
Path Overhead Layer

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

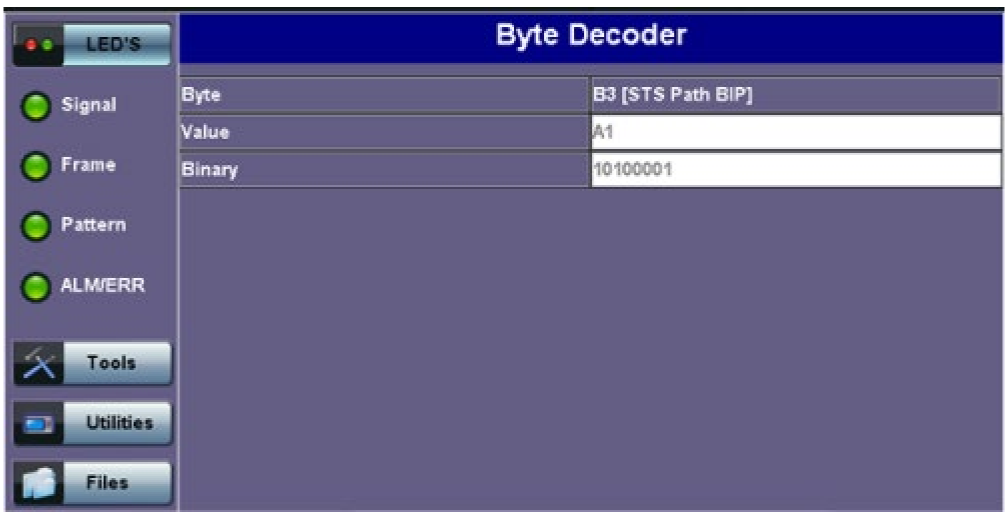
- **J1 byte (STS Path Trace)**
  - High Order STS-N path trace byte
  - An unique message is assigned to each path in a SONET network – therefore the path trace can be used to check continuity between any location on a transmission path and the path source
  - This user programmable byte repeatedly transmits 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 STS-3 frame

J1 Byte (STS 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 STS-3
  - The computed checksum is placed in the B3 byte before scrambling

B3 Byte (STS Path BIP)



- **C2 byte (STS path signal label)**
  - 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:

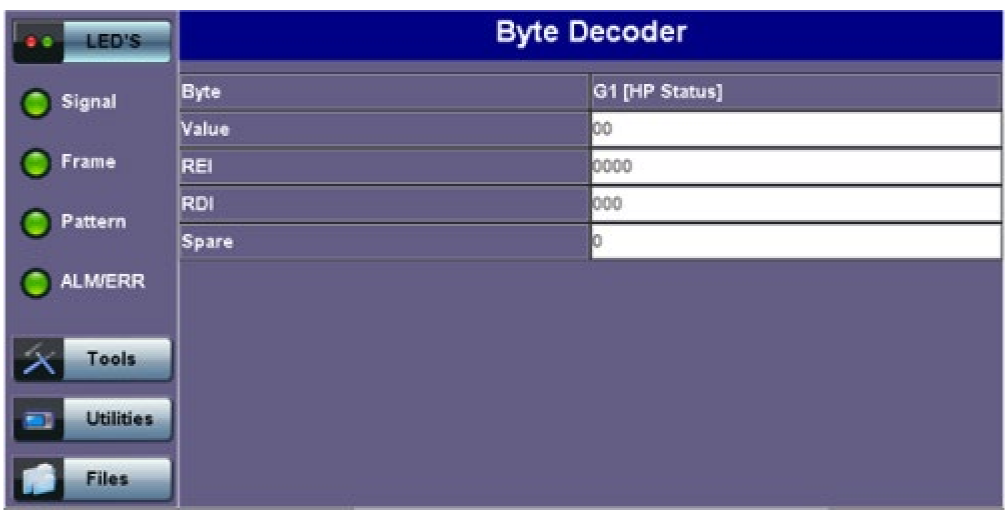
C2 Byte (STS Path signal label)

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.)

- **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 (REI-P) indicates number of bit errors detected by B3
  - Bit 5: Remote Defect indication (RDI-P) set to 1 if signal failure is detected
  - Bits 6-7: Enhanced RDI information to differentiate between payload defects (PLM-P), connectivity defects (TIM-P, UNQ-P) and server defects (AIS-P, LOP-P)

G1 Byte (HP Status)



- **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

H4 Byte (VT Indicator)

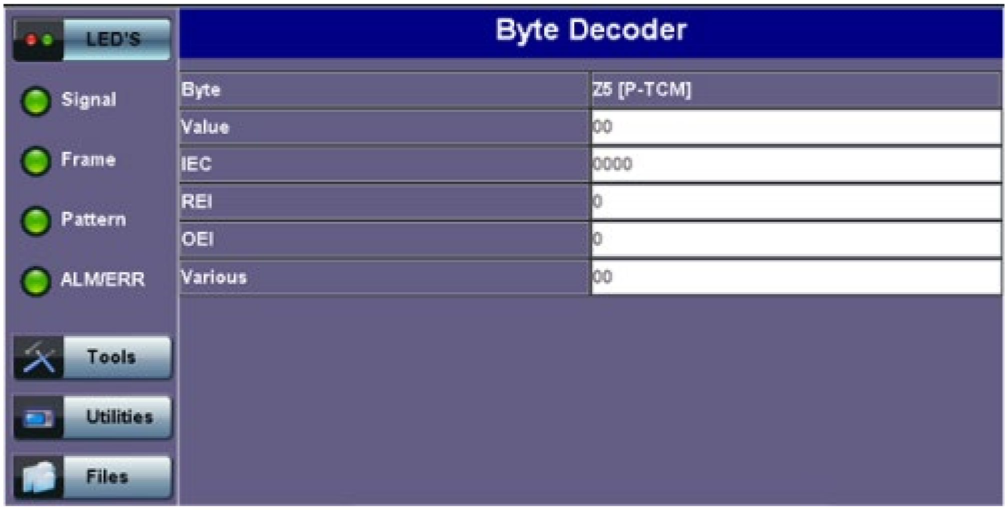
- **Z3/Z4 byte (STS Path)**
  - Allocated for future use. Have no defined value. The receiver is required to ignore their content.

- **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

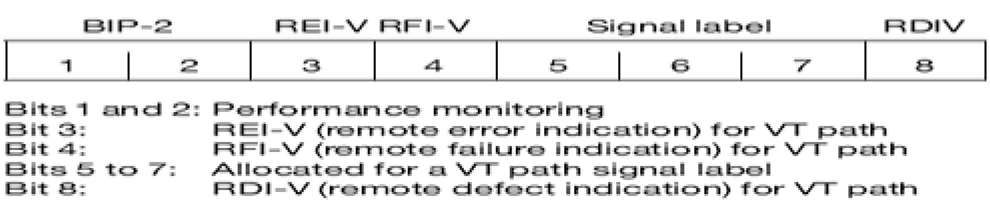
Z5 byte structure

b1	b2	b3	b4	b5	b6	b7	b8
IEC (IAIS)				TC-REI	OEI	TC-APId, TC-DI,ODI, reserved	

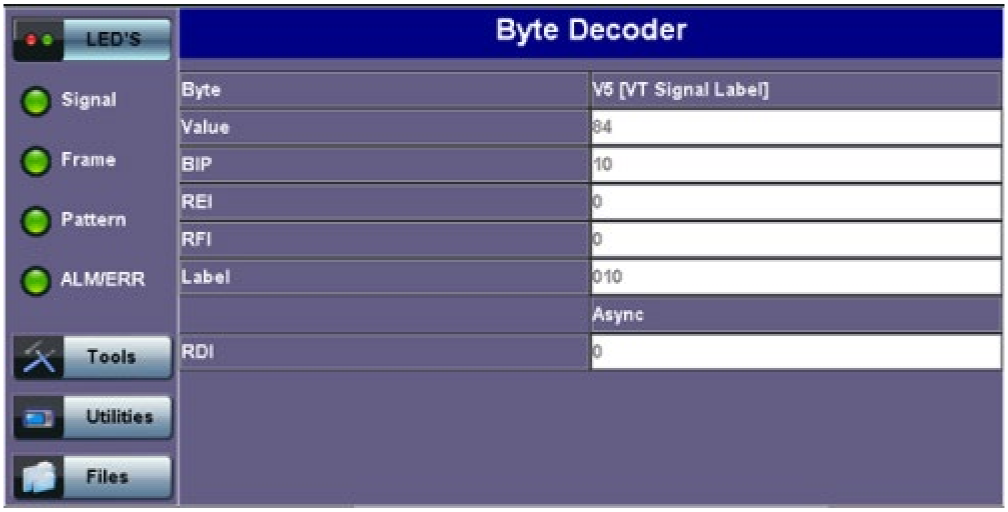
Z5 Byte (Path TCM)



- **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 (VT signal label)



- **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

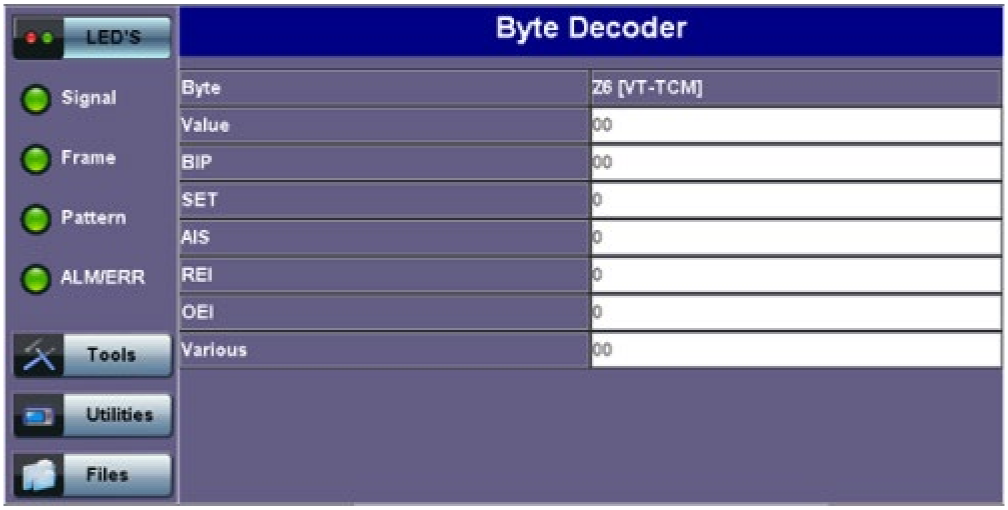
- **Z6 byte (VT-TCM)**
  - Provides VT tandem connection monitoring function (TCM-V) for the VT-1.5, VT-2 levels.
    - Bits 1-2: even parity error checking BIP-2 for the tandem connection
    - Bit 3: Set to “1”
    - Bit 4: Incoming AIS indicator (0 = no defect; 1 = defect occurred before tandem connection)
    - 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

b1	b2	b3	b4	b5	b6	b7	b8
TC-B1P		"1"	IAIS	TC-REI	OEI	TC-APId, TC-RDI,ODI, reserved	

Z6 Byte (VT-TCM)



- **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

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- **Summary**
    - The Summary tab displays the summary screen listing the major bytes of the received SONET signal.
        - 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. In the example below, the C2 byte has a PLM alarm (Payload Mismatch) (i.e., the received signal label does not match the transmitted signal label).

Summary

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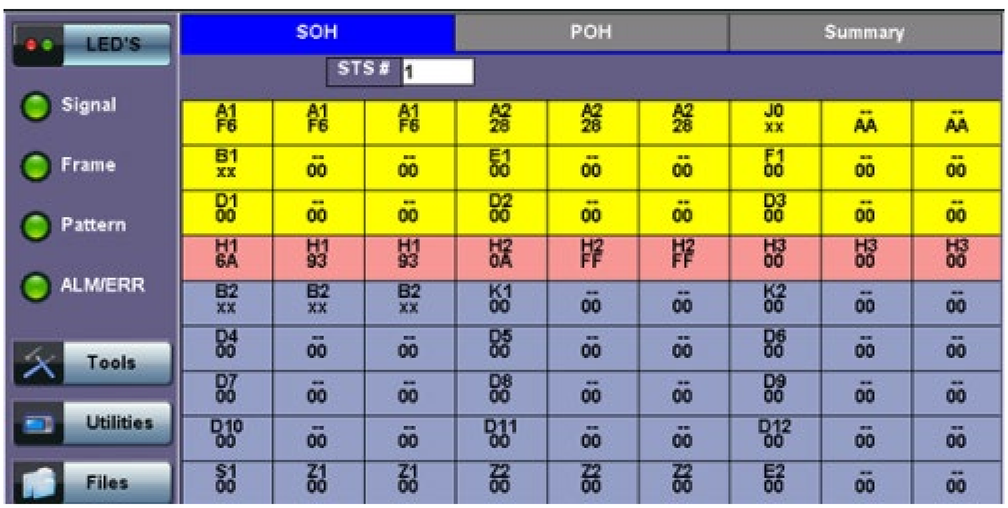
10.2.3 Overhead Generator

SOH

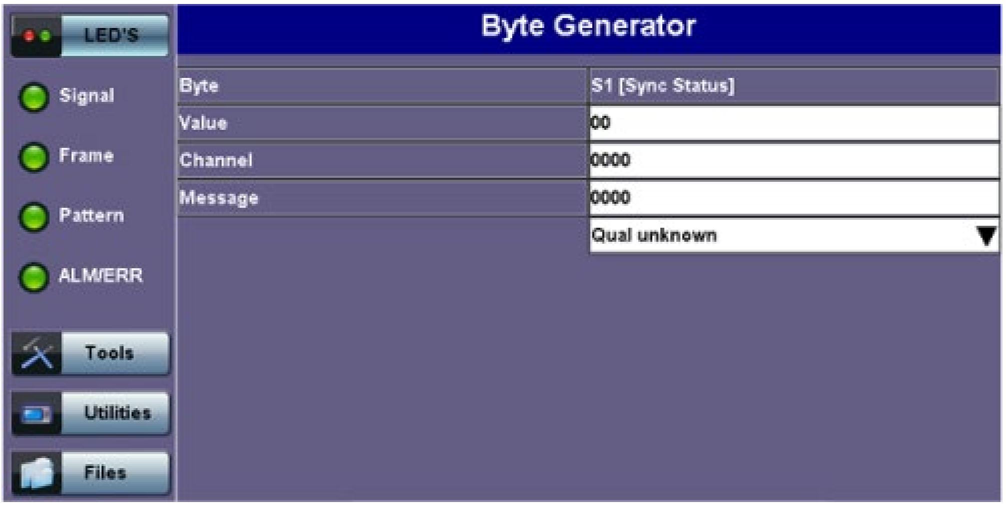


Tap the Overhead Generator icon to display the OH screens shown below. There are three tabs:

- **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

C2 Byte from POH

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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10.2.4 Pointer Tasks

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

SDH/SONET Tools Menu

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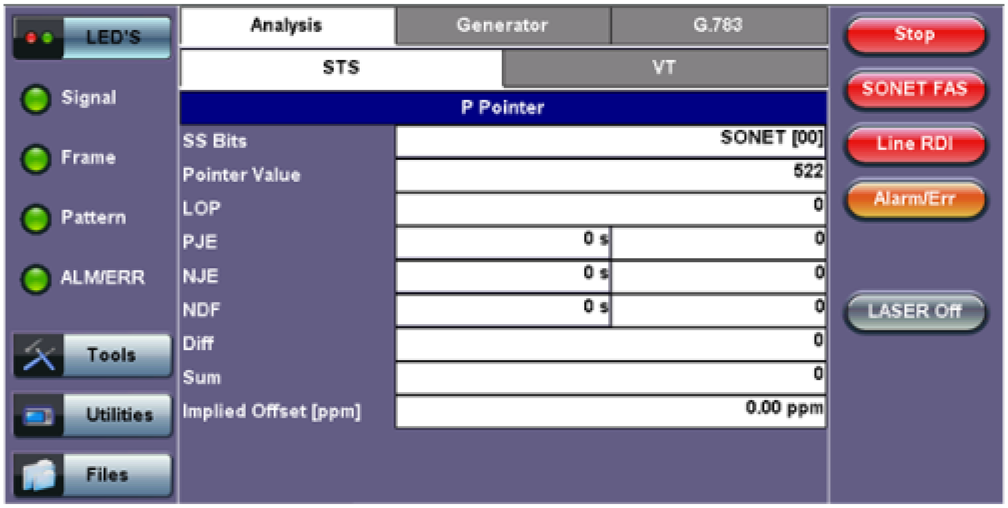
10.2.4.1 Pointer Analysis

Pointers keep SONET 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.

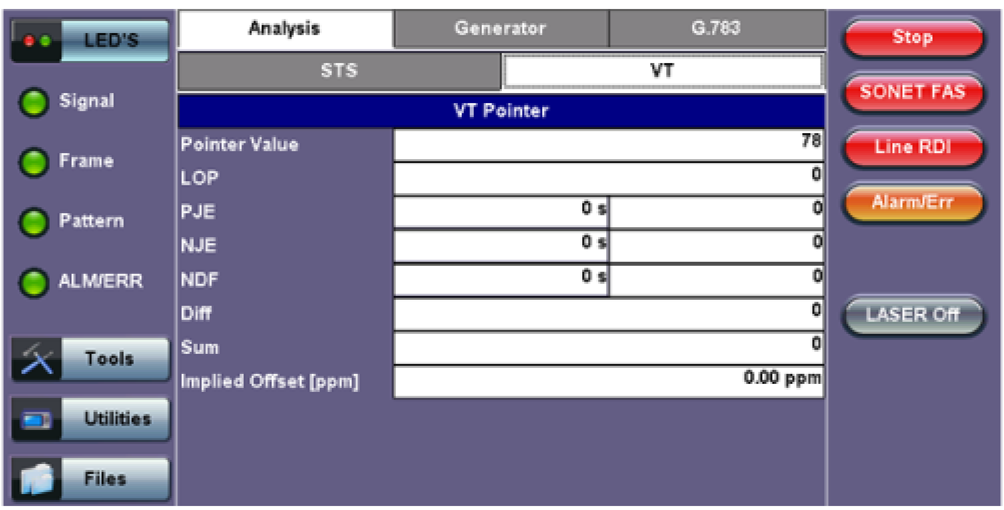
- **For STS pointers:**
  - SS bits – displays bits 5 and 6 of the H1 byte to indicate SONET [10], SONET [00], Unknown [01] and [11] signal type
  - Pointer value – displays the H1 and H2 values (addresses) indicating the offset in bytes between the pointer and first byte of the STS-n
  - LOP (Loss of 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

Analysis > P Pointer



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

Analysis > VT tab



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10.2.4.2 Point Generator

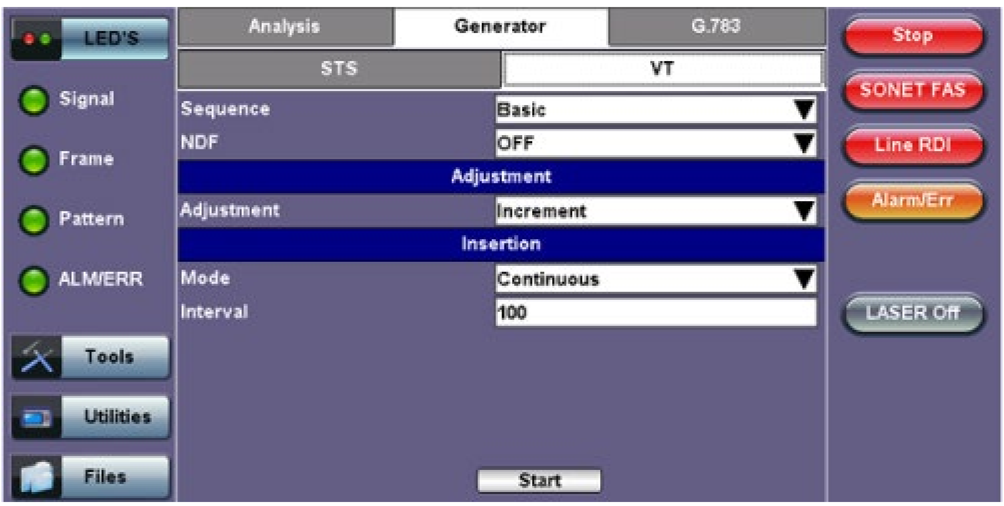
The Pointer generator is able to generate individual pointer movements as follows:

- **For STS pointers:**
  - SS bits: Program bits 5 and 6 of the H1 byte to be either 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.

Generator > STS tab

- **For VT pointers**
  - 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 steps

Generator > VT tab



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10.2.4.3 Pointer Sequences

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

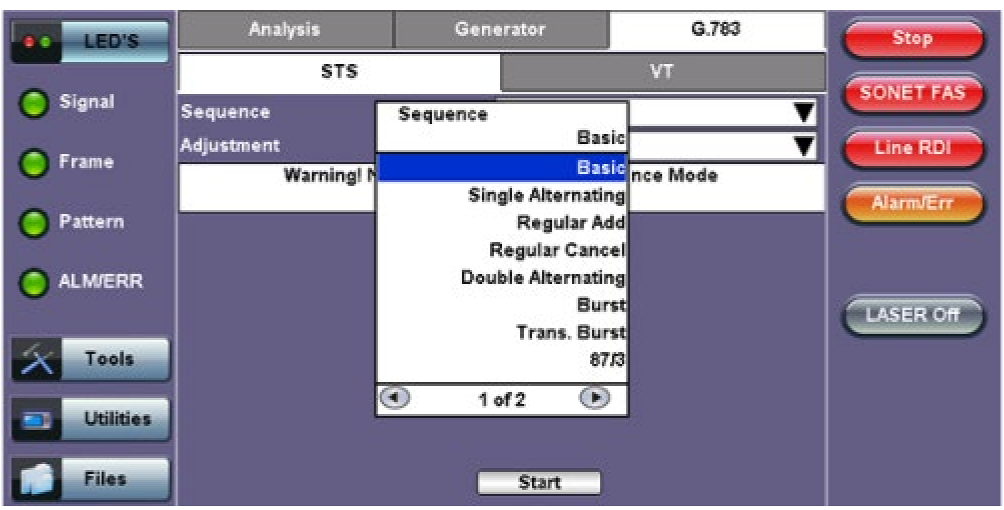
- **Sequence:** Decide how to affect the pointer sequence
  - **Basic:** Specify whether the pointer is increasing or decreasing
  - Select Inc to increase the pointer value
    - Select Dec to decrease the pointer value
    - Select New Value to set new pointer value
- **Single Alternating:** Increase 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, with added to have an additional pointer value)
- **87-3 Cancel**: Generate an 87-3 pattern (87 consecutive pointer adjustments, 3 consecutive pointer value, with reduce 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.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

G.873 > STS tab



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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10.2.5 Trace Identifier

Tap the **Trace Identifier** icon to display the path trace testing screens shown below. There are dedicated tabs for Transmitted and Received (expected) path traces and setups.

SDH/SONET Tools Menu

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10.2.5.1 Transmitted Traces (TX)

- J0 [Section]: Regenerator section trace
  - Program a 1 or 16-byte identifier to check the connection between regenerators
- J1 [STS Path]: High order path section trace
  - Program a 16 or 64-byte identifier to check the high order transmission path
  - The message is transmitted one byte per STS-3 frame
- J2 [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.

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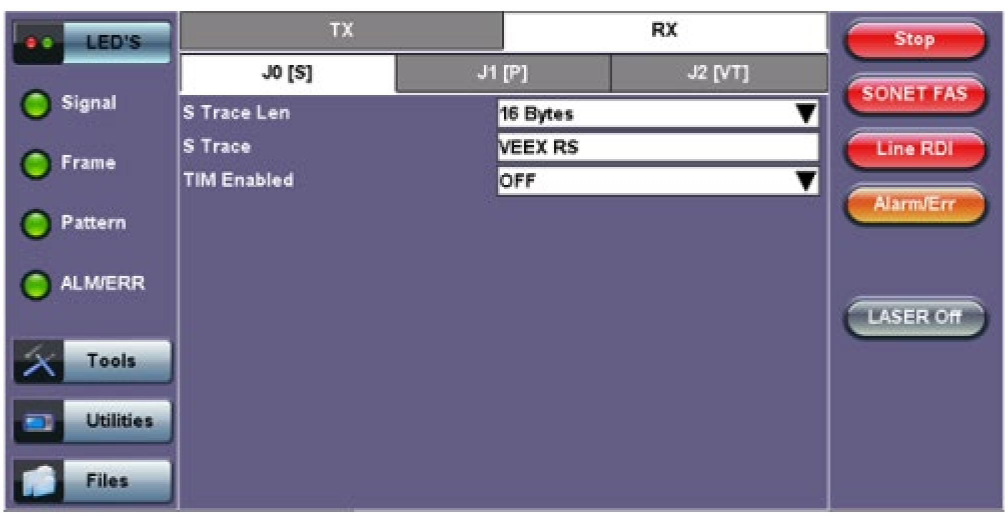
10.2.5.2 Received Traces (RX)

- J0 [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 [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 [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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10.2.6 Payload Labels

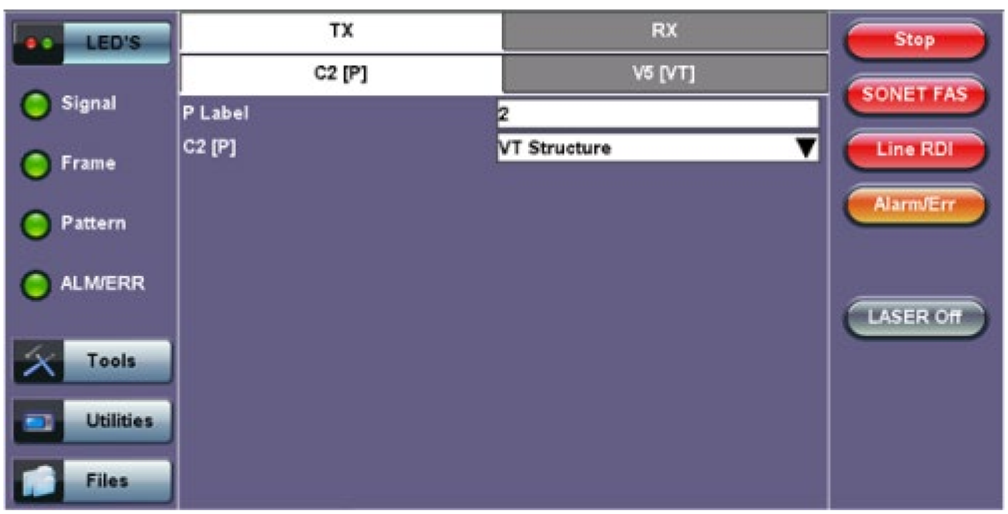
This function is used to set the C2 and V5 Path Signal Labels which indicate the content of the High order and Low order VCs.

SDH/SONET Tools Menu

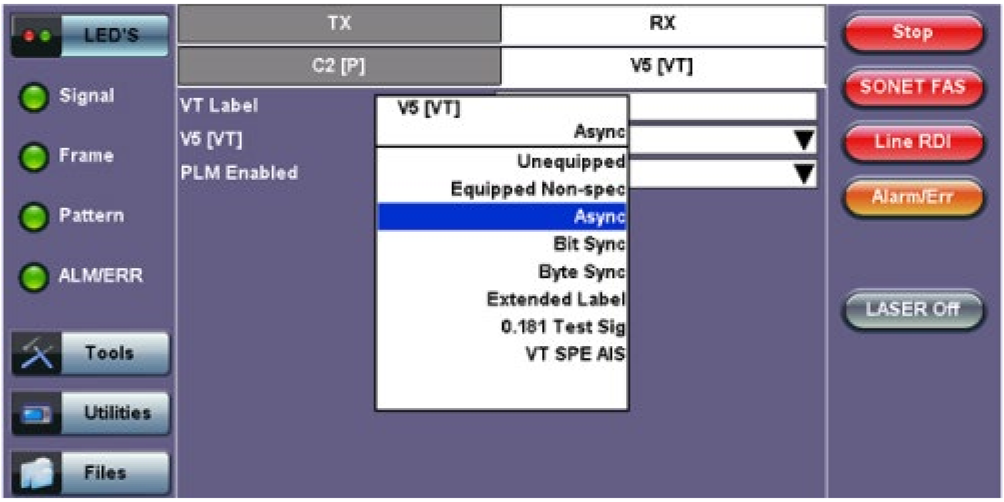
Tap the **Payload Label** icon to display the payload label screens. There are dedicated tabs for Transmitted and Received payload labels and setups:

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

TX C2 [P]



- **V5 [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, you can enable or disable the Payload Mismatch (PLM) Alarm



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10.2.7 APS Tasks

10.2.7.1 APS Timing

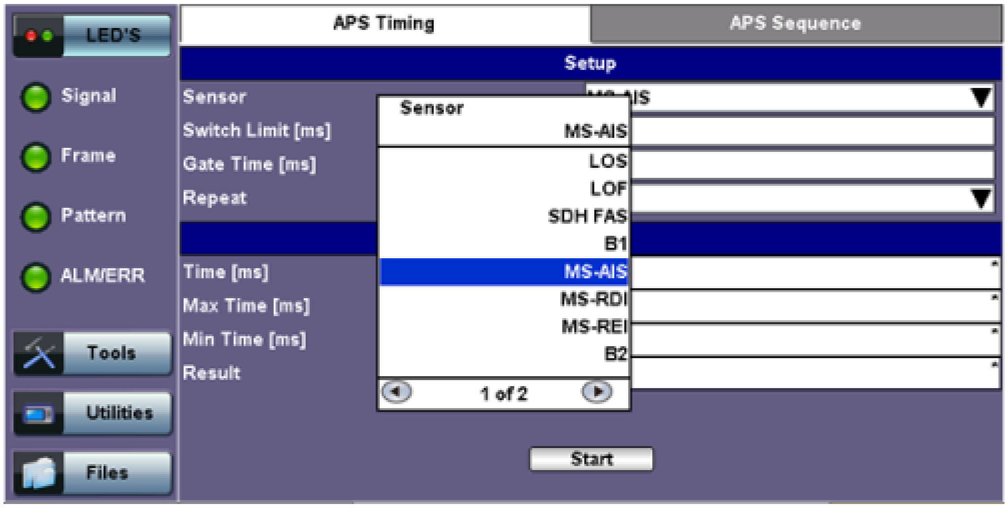
This function measures the Automatic Protection Switching (APS) limits of the network. APS applies only to the Multiplex sections of a SONET network and enables network elements to re-route traffic to a backup circuit in the event of network failure or problems. The protection mechanism is coordinated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

- **APS Standards**
  The principles and protocols of APS in 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 these 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 screens shown below.

- **Sensor:** Select the trigger that will initiate the APS measurement.
  - The selections are: LOS, LOF, SONET FAS, B1, B2, B3, AIS-L, RDI-L, REI-L, AIS-P, LOP-P, RDI-P, REI-P, AIS-V, 2M-LOF, 2M-AIS, 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.
- **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 SONET network.
- Ensure that no errors or alarms are present on the transmission system because this will impact the measurement.
- The measurement will be triggered by an Alarm Indication Signal (AIS)
- 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.

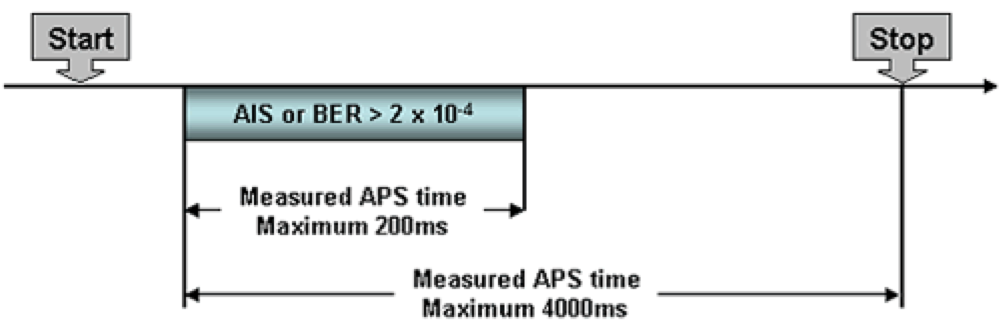


Figure 1: Perfect service disruption

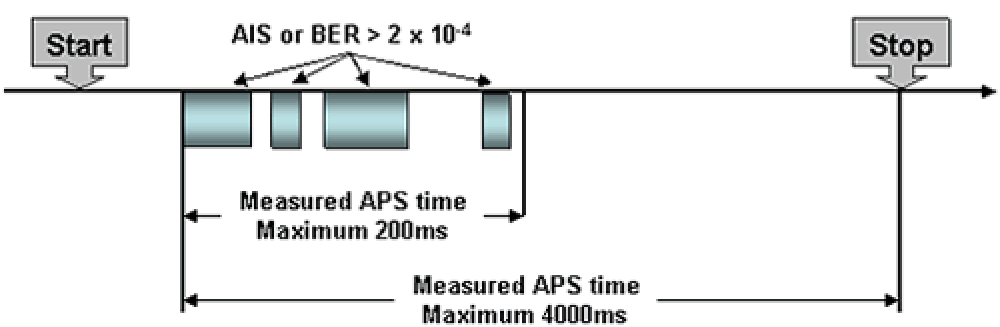


Figure 2: Multiple service disruption or micro interrupts

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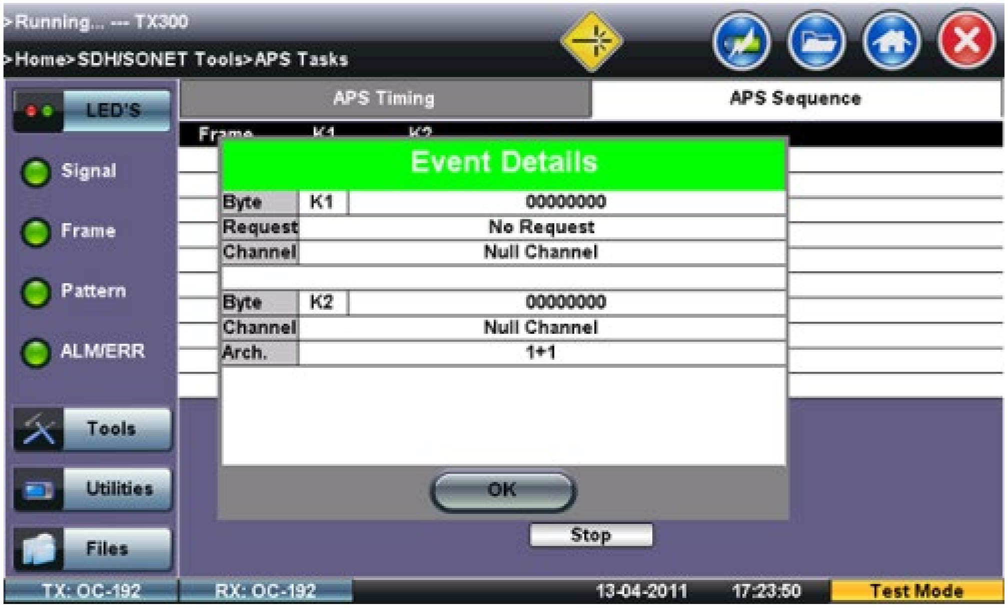
10.2.7.2 APS Sequence

The associated K1/K2 sequence and received K1/K2 bytes may be captured.

Event Details



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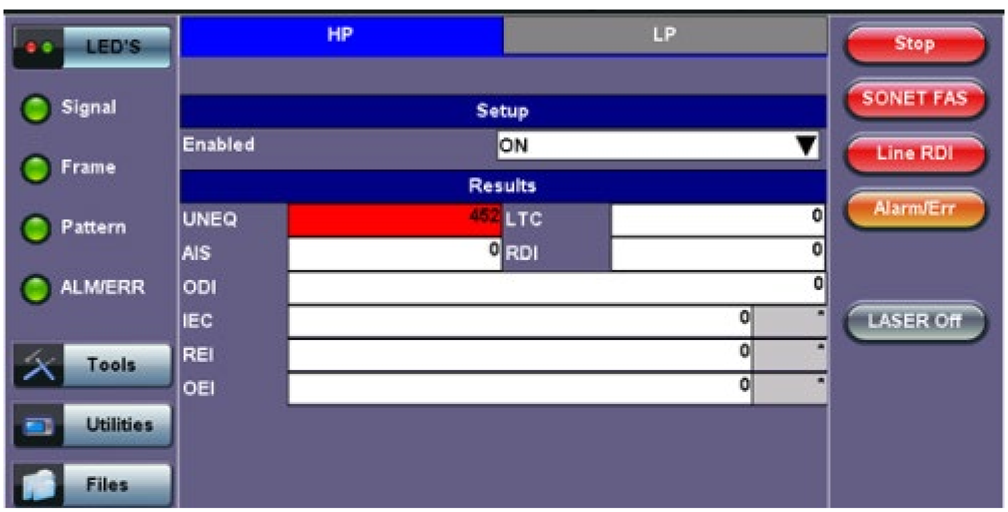
10.2.8 Tandem Connection Monitoring (TCM)

HP Setup



TCM Standards
The Tandem paths are defined in ITU recommendation G.707 Annex D and Annex E. ITU-T recommendation 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 the Z5 byte for STS-N and in the Z6 byte for VT's. 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-B1P		"1"	IAIS	TC-REI	OEI	TC-APId, TC-RDI,ODI, reserved	

IEC: Incoming Error Count. Indicates IAIS when set to '1110' (seebelow)
IAIS: Incoming AIS alarm
TC-REI: Tandem Connection Remote Error Indication
OEI: Outgoing Error Indication
TC-APId: Tandem Connection Access Point Identifier (16-byte message)
TC-RDI: Tandem Connection Remote Defect Indication
ODI: Outgoing Defect Indication
TC-BIP: 2-bit Bit Interleaved Parity for Tandem Connection

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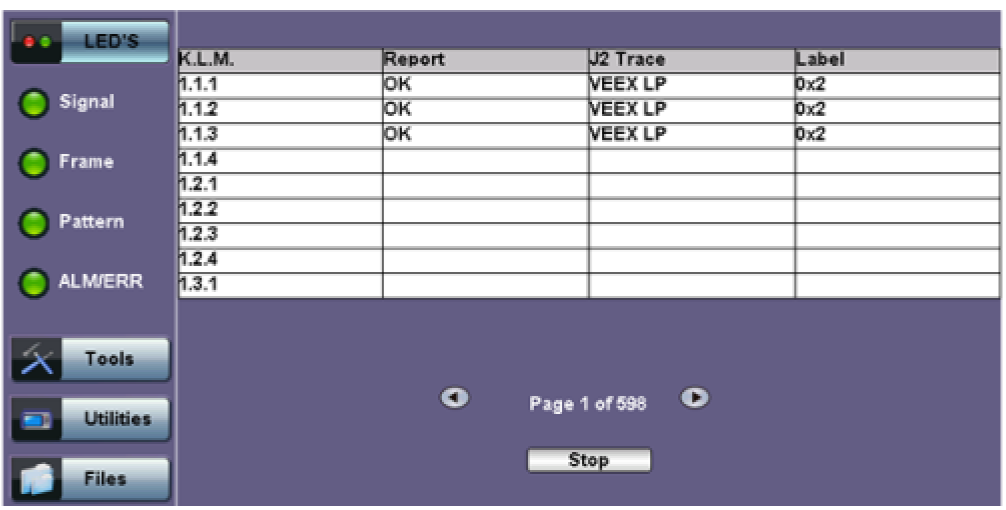
10.2.9 Tributary Scan

This function requires VC12 or VT-1.5 mapping and allows you to quickly check the signal structure, trace identifier and the payload.

Tributary Scan



An important part of any Add Drop Multiplexer (ADM) installation process is the verification of the path routing. Considering that an STS-3 contains 84 x VT-1.5's and a STS-12 contains 336 x VT-1.5's checking each path manually can be very time consuming.

The test set automatically performs a sequential BER test on each SONET tributary (VT channel) - mapping can be via STS-N. The unit checks for any alarms in the received signal, the SONET 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

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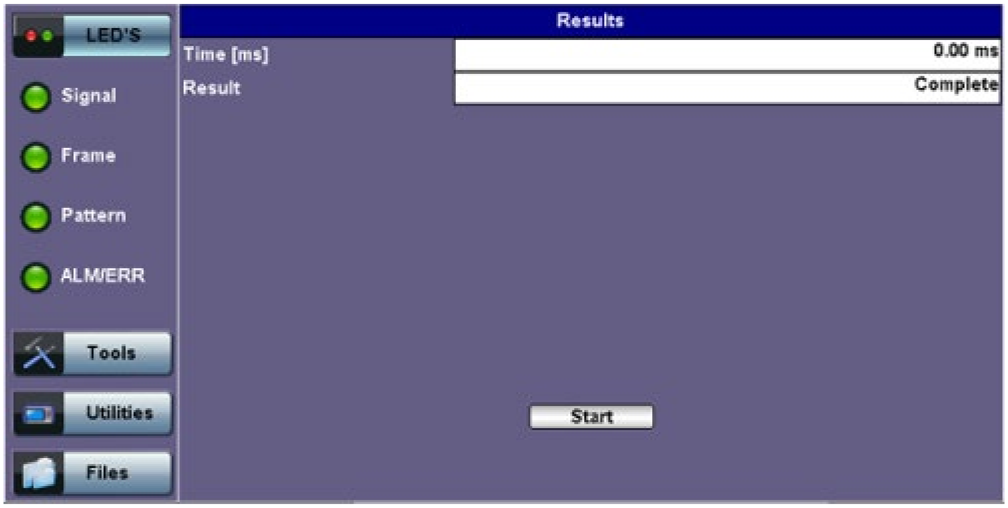
10.2.10 Round Trip Delay

Round Trip Delay Results



The Round Trip Delay (Propagation Delay) measurement works by sending a test pattern. A errors is transmitted in the pattern. The time it takes for the error to reach the receiver is the propagation time through the network.

- Select SONET as TX/RX standard.
- View the Round Trip Delay of a looped back signal.
- Set check box on Setup RX pattern to Out-of-Service.

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10.2.11 Jitter and Wander

For more information on Jitter and Wander, please see Jitter and Wander Application.

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11.0 Jitter and Wander

Accessing Jitter and Wander

Go to **OTN/SDH/SONET Testing** from the **Test Mode Selection**, then select the following:

- For **SONET** or **SDH signals**: **Home** (Main Menu) **> SONET/SDH Tools > More > Jitter & Wander**

Jitter & Wander displays the Jitter Measurements showing measurements and analysis of jitter in received signal.

Jitter and Wander are usually described as the phase noise in digital signals. This is a natural occurrence in telecommunication networks.

Excessive jitter can lead to transmission errors and deterioration in network quality. ITU defines jitter as follows: "The short-term variations of the significant instances of a digital signal from their ideal positions in time (where short-term implies these variations are of frequency greater than or equal to 10 Hz)." The long-term variation (less than 10 Hz) of a digital signal is called wander.

In simple terms, jitter is an unwanted phase modulation of the digital signal that may cause errors or bit slips in a digital circuit and deteriorate the performance of a transmission network.

In lower-rate digital systems, systematic jitter is dominant. In higher-rate systems, random jitter may become more important. Test environment parameters that affect jitter performance are test sequences, bit rate, pulse shape, cable characteristics, temperature, cross-talk, and noise.

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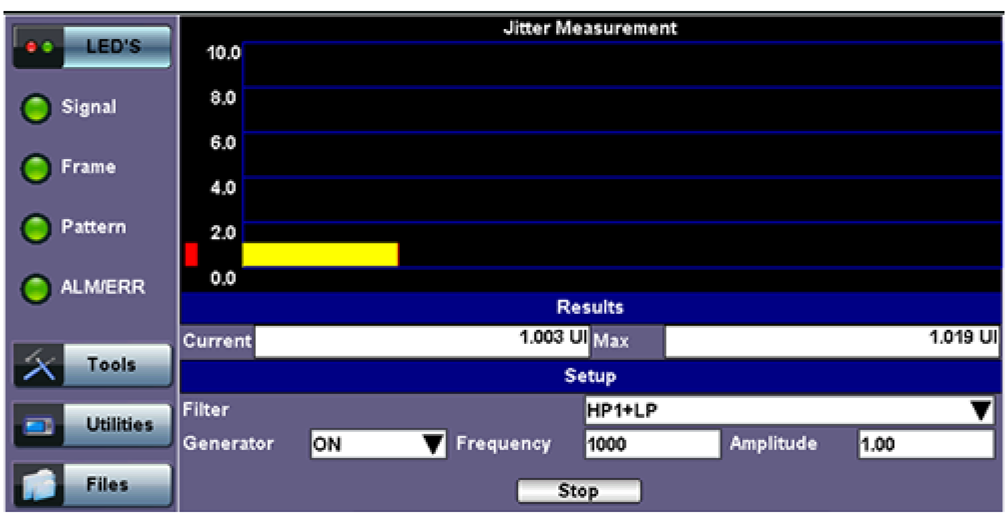
11.1 Jitter Measurement & Generation (Jitter icon)

Tapping the **Jitter** icon brings up the **Jitter Measurement and Generation** screen.

Jitter Measurement and Generation Menu



The Jitter measurements menu allows the user to measure and analyze received signal jitter. The measurement example is shown above (the vertical grid spacing is 2.0 UIpp). The red bar indicates Max. peak jitter during testing and the yellow bar indicates the current peak jitter.

Setup

Configure the following settings before starting the test:

- **Filter:** HP1+LP or HP2+LP. The frequency for each filter varies depending on the setup mode (E1/E3, DS1/DS3). Frequency ranges for each filter and setup mode are listed as follows:
    - E1: HP1+LP (20Hz to 100KHz); HP2+LP (18 Hz to 100KHz)
    - E3: HP1+LP (100Hz to 800KHz); HP2+LP (10KHz to 800KHz)
    - DS1: HP1+LP (10Hz to 40kHz); HP2+LP (8kHz to 40kHz)
    - DS3: HP1+LP (10Hz to 400kHz); HP2+LP (30kHz to 400kHz)

- **Generator:** ON or OFF

- **Frequency:** 2 Hz to 10,000 Hz for E1(2M) options, 2 Hz to 800,000 Hz for E3 (34M) options. 2 Hz to 40,000 Hz for DS1 (1.5M) options, 2 Hz to 400,000 Hz for DS3(45M) options.

- **Amplitude:** Enter the amplitude at which peak to peak jitter generation occurs. See O.172 for the ITU recommendation on minimum jitter generation.

Press **Start** to start measurements.

Results

Results are displayed for the current jitter value and maximum jitter value during measurement.

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11.2 Max Jitter Tolerance (MTJ)

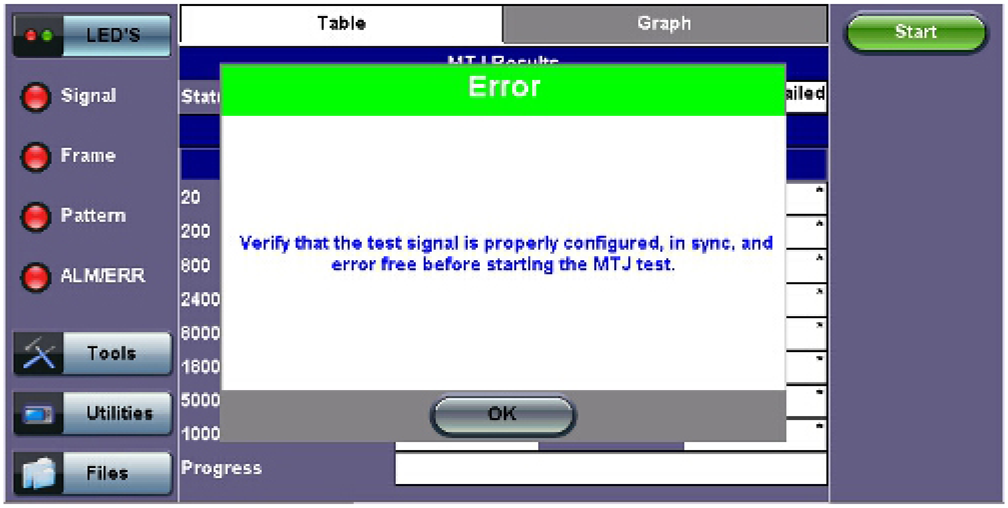
Jitter Tolerance or jitter accommodation is defined in terms of the sinusoidal jitter amplitude which causes a designated error when applied to digital equipment input. Jitter tolerance is a function of applied jitter's amplitude and frequency. Equipment must pass the lower limit of maximum jitter tolerance, which is specified in ITU-T G.823, G.824, and G.825 standards.

The unit will transmit jitter from point-to-point or low to high frequency at different amplitudes to determine where errors occur. This is known as maximum jitter tolerance (MTJ).

Defects and Anomalies Check

The Max Jitter Tolerance feature checks the health of the incoming signal prior to starting the test. If any alarms or errors are detected, the test set will notify the user that the test cannot be performed and present configuration suggestions to correct the problem.

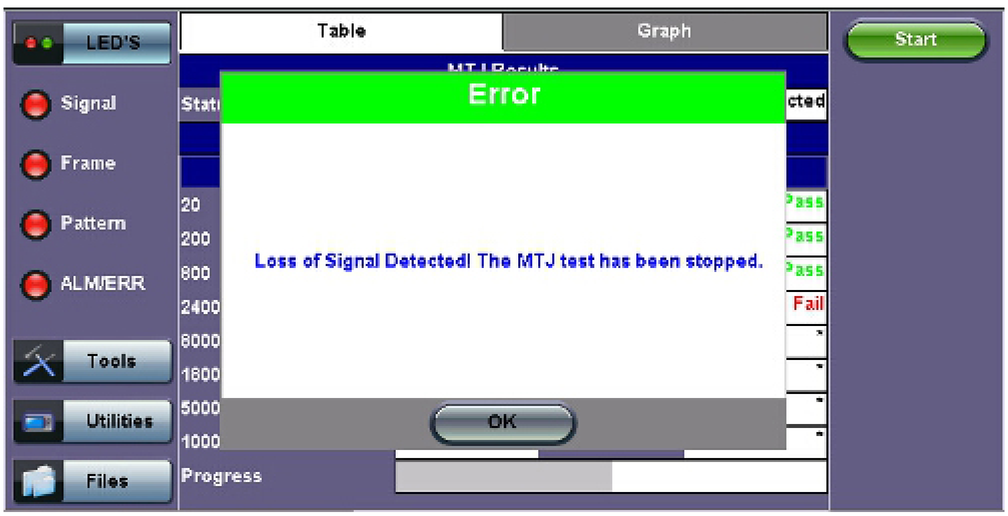
Error Message: Configuration Suggestions



Loss of Signal (LOS) Check

If the LOS condition is detected at any time during the MTJ test, the data will become invalid and the test will stop automatically. An error message will appear to notify the user to correct the condition before running the test again.

LOS Error Message

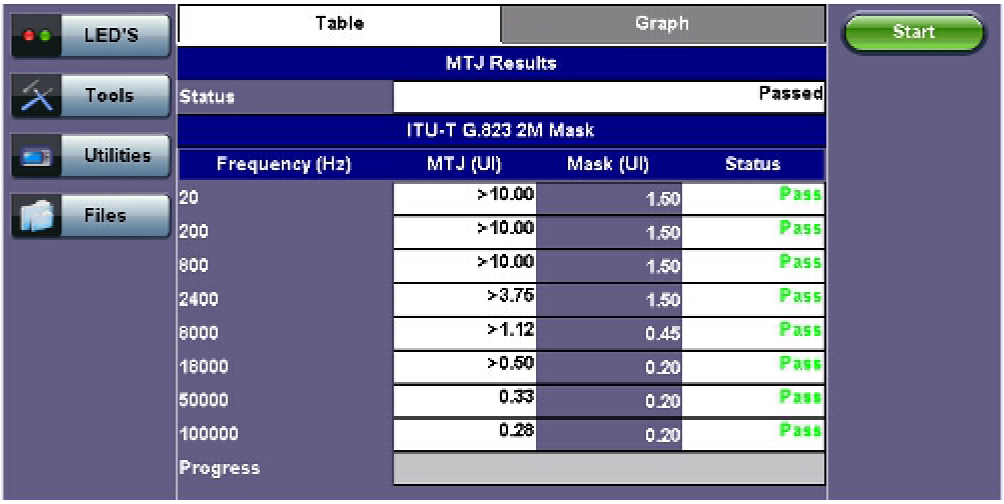


Table

Table values include:

- Frequency tested (Hz)
- **MTJ (UI):** Maximum Tolerable Jitter (in Unit Intervals).
- **Mask (UI):** Peak-to-Peak jitter limit (in UI) as defined by ITU standard. This is the minimum jitter value to pass (i.e., the MTJ value must exceed the Mask value for the data point to pass).
- **Status:** Pass/Fail status.
- **Start/Stop:** Starts or stops the test.
- **Progress:** A green bar at the bottom of the graph shows the test progress.

MTJ Table

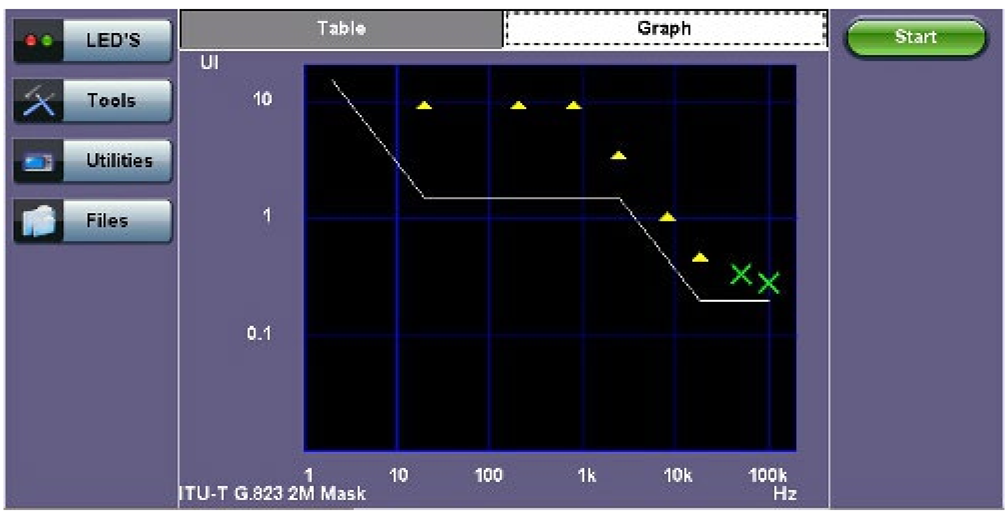


Frequency (Hz)	MTJ (UI)	Mask (UI)	Status
20	>10.00	1.50	Pass
200	>10.00	1.50	Pass
800	>10.00	1.50	Pass
2400	>3.76	1.50	Pass
6000	>1.12	0.45	Pass
16000	>0.50	0.20	Pass
50000	0.33	0.20	Pass
100000	0.28	0.20	Pass

Graph

A cross (x) indicates the maximum jitter value tolerated at the frequency.
Yellow triangles (▲) indicate that the data point is greater than, while the green "X" symbols represent actual measured values. Greater than implies that the jitter tolerance of the DUT (device under test) is much better than the value measured by the test set. Users should expect all data points above the mask (curve) to pass. For this example, the table results and graphical example confirm that all points have passed.

Graph



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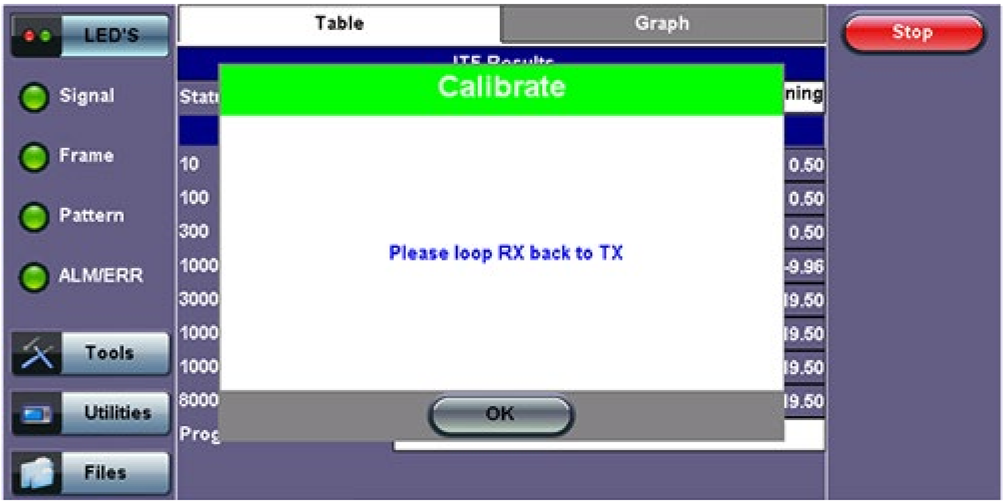
11.3 Jitter Transfer Function (JTF)

Jitter Transfer defines the ratio of output jitter to input jitter amplitude versus jitter frequency for a given bit rate. Often, a portion of received jitter is transmitted at a piece of the equipment's output. If LOS is detected during the JTF test, the test will be stopped.

1. Calibration

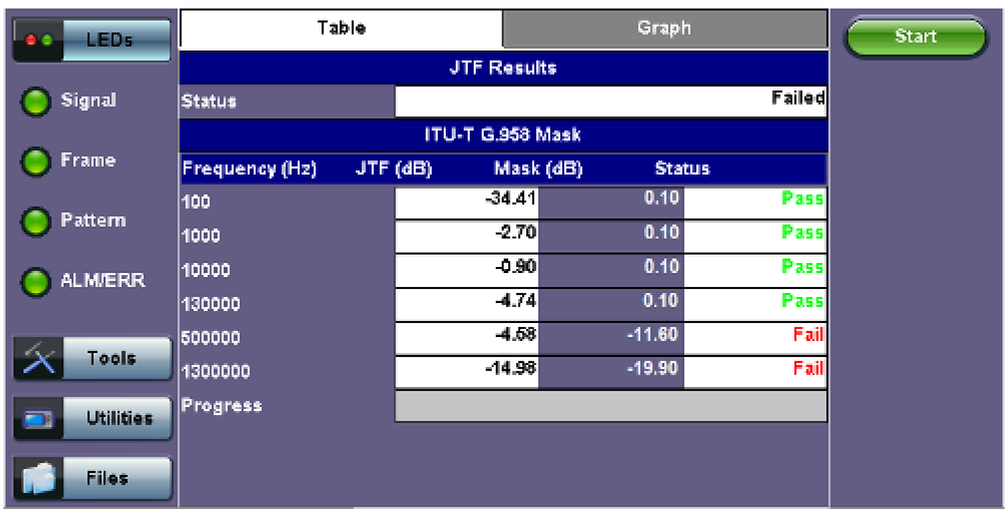
Using a short and clean patch cord, connect the test set's TX back to the RX to form a local reference loop.

Loop Message

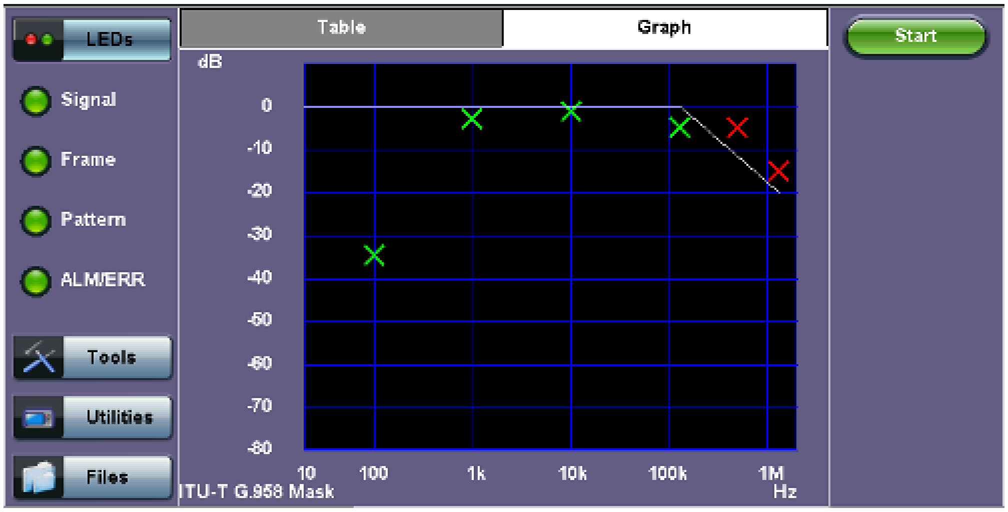


2. Device Under Test (DUT)

Before starting the test, "Connect Device Under Test" will appear. Connect the test set to the DUT then press **Start** to begin testing.



- **Frequency (Hz):** Frequency measured
- **JTF (Jitter Transfer Function) (dB):** Jitter in divided by jitter out value (in dB)
- **Mask (dB):** Jitter output in relationship to the input
- **Progress:** The bar at the bottom of the graph shows the test progress



A green cross (x) indicates the the jitter transfer value has passed.

A red cross (x) indicates that the jitter transfer value has failed.

Yellow triangles (▲) indicate that the jitter transfer value is greater than the value measured by the test set.

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11.4 Wander Measurements and Analysis

The test set may be equipped with wander measurement options (or licenses) that add verification of stability (wander) and accuracy for different types of data interfaces. Those signals under test could be physical clocks (1.544, 2.048, 10 MHz or 1PPS), SDH/SONET, PDH/DSn, SyncE slave or 1588v2 precision timing protocol.

Three main wander measurement and analysis applications may be offered by the test set (all optional), along with an off-line MTIE/TDEV analysis software for PC

- Recovered Clock Wander Measurements
- Advanced Clock Wander & Phase Measurements
- Built-in MTIE/TDEV Wander Analysis
- VeEX MTIE/TDEV Wander Analysis PC software

Individual screens, fields and selections may vary among products or technologies, and depend on the options/licenses loaded or available for each test set. Nonetheless, the concepts and procedure flow are very similar.

11.4.1 Recovered Clock Wander Measurements

The test set may offer wander measurement options (or licenses) that add verification of stability (wander) and accuracy for different types of data interfaces. Those signals under test could be SDH/SONET, PDH/DSn, SyncE slave interfaces, or the clock recovered by the 1588v2 PTP. Each individual transmission technology may require its own wander measurement license.
The Recovered Clock Wander Measurements features can usually be found within the test options that the intended technology offers.

- In 1GE and 10GE test modes, the Wander Measurement function may be found under the Advanced Tools menu, provided that SyncE or 1588v2 slave modes have been enabled.
- In PDH test modes, the wander measurement function may be found in >PDH Tools >Jitter & Wander >Wander
- In SDH/SONET test modes, the wander measurement function may be found in >SONET/SDH Tools >Jitter & Wander >Wander
- In DSn test modes, the wander measurement function may be found in >DS1/DS3 Tools >DS1/3 Jitter &

Wander >Wander

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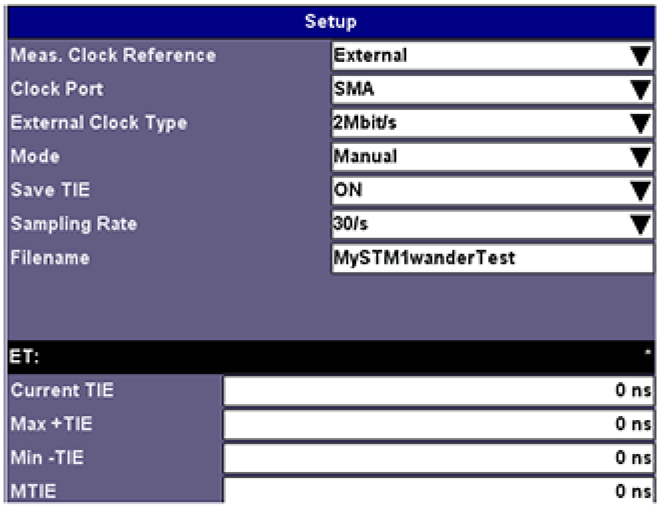
11.4.1.1 Test Setup

Setup



1. Measurement Clock Reference or Reference Clock Source offers a selection of external or internal (optional) frequency references. Internal or built-in reference options could be “Atomic 10 MHz” or “Atomic 1PPS”, disciplined by GPS or free running.
2. Clock Port indicates the connector in which the traceable external clock reference source shall be connected. (Avoid using rigid BNC-to-SMA adapters to prevent any stress on the test set’s connector. Flexible adapters or cables are recommended.)
3. External Clock Type allows users to select from a list of supported clock signals (e.g. 1.544 MHz, 2.048 MHz, 1544 Mbps, 10 MHz, 2.048 Mbps, 1PPS)
4. Test Mode lets user 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.
5. 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.
6. The Sampling Rate (samples per second) can be set to 1/s, 5/s, 10/s or 30/s, depending on the application.
7. 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.
8. Tap on the **Start** button to initiate the measurements and data logging.
9. 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.
10. 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.

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11.4.1.2 Test Result

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

1. **Current TIE:** Shows the current time interval error measurement.

2. **Max TIE:** Maximum positive TIE value that has been recorder since the beginning of the test
3. **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.
4. **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

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11.4.2 Advanced Clock Wander & Phase Measurements

The test set may offer clock wander and phase error measurement options (or licenses) that add verification of stability (wander) and accuracy (absolute phase error) on external (physical) clock signals. Those signals could be from reference clocks or recovered clock outputs from remote or slave terminals (SDH/SONET, PDH/DSn, SyncE, PTP, GNSS/GPS, Rb clocks, etc.)

The results are the similar to the ones obtained by measuring wander on data interface ports (SDH/SONET, PDH/DSn, SyncE or PTP). The main difference is that the advanced clock wander measurements are performed on a physical (not internally recovered) clock signal.

This feature is usually an independent Test Mode and not linked to any particular data transmission interface.

11.4.2.1 Clock Wander and Phase Measurements (Optional)

The “Clock Wander & Phase Measurements” option offers short and long term Wander measurements for frequency sources (e.g. 1.544, 2.048Mbps or 1.544, 2.048, 10MHz or 1PPS) and Phase Error measurements for timing sources (i.e. 1PPS) and can save the TIE or TE measurements to a FAT32 USB Memory stick for further analysis. The test set itself may also offer a built-in MTIE/TDEV Wander Analysis option to analyze the data or it can also be done by using the free VeEX Wander Analysis PC Software that can be downloaded from www.veexinc.com

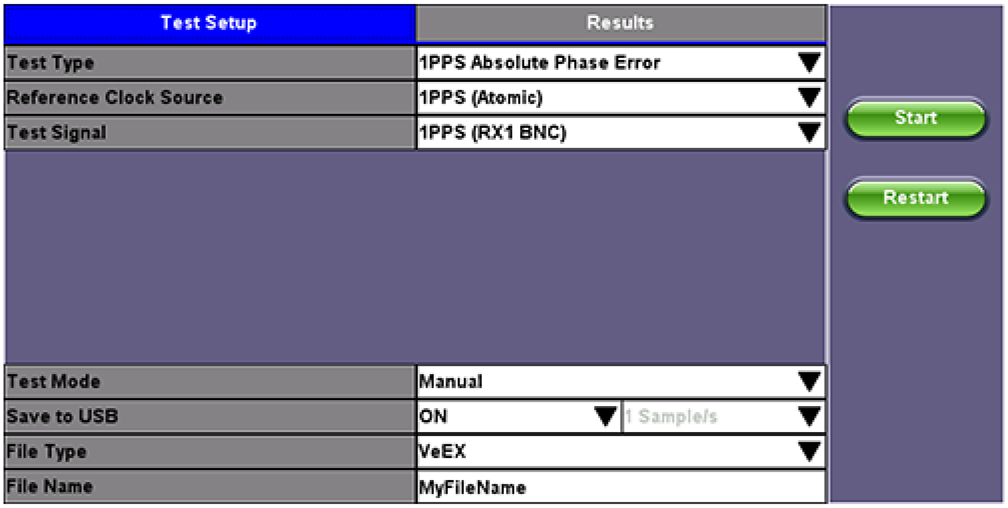
Both, Wander and Phase Error, measurements require a stable and accurate reference clock source, which can be an external source connected to the CLK (SMA) input port or optional optional built-in GPS and Chip-scale Atomic Clock references.

- The built-in GPS hardware option provides a (raw) 1PPS timing signal (clock), aligned to the standard second, and can be used to discipline the built-in atomic clock. The direct use of this raw “GPS 1PPS” alone is not recommended for wander or phase measurements. It should be combined with the Atomic Clock to filter and stabilize the timing signal
- The built-in Atomic Clock hardware option can provide highly stable frequency references on its own (Atomic 1PPS and Atomic 10 MHz), suitable for wander measurements
- When disciplined by the internal GPS receiver, the Atomic Clock 1PPS can also be used as a very stable and accurate absolute timing reference aligned to the standard second (1PPS) or very accurate and stable frequency reference (10 MHz)
- External clock signals, directly traceable to PRC or PRTC, can also be used as a reference for even more accurate results (e.g. high-quality GPS-disciplined OCXO, Rb or Cs clock sources)

While wander (stability) measurements use high precision frequency references, the absolute phase error (also known as Time Error ot TE) requires an accurate 1PPS timing signal, aligned to the standard second (UTC). The 1PPS can be sourced from a high precision GPS-disciplined clock (built-in option or external).
The Wander (TIE) and Phase (TE) data logs can be saved in real time to a USB Memory using VeEX proprietary format (to be analyzed by the built-in or PC-based MTIE/TDEV Analysis software) or exported to an open CSV format.

Test Setup

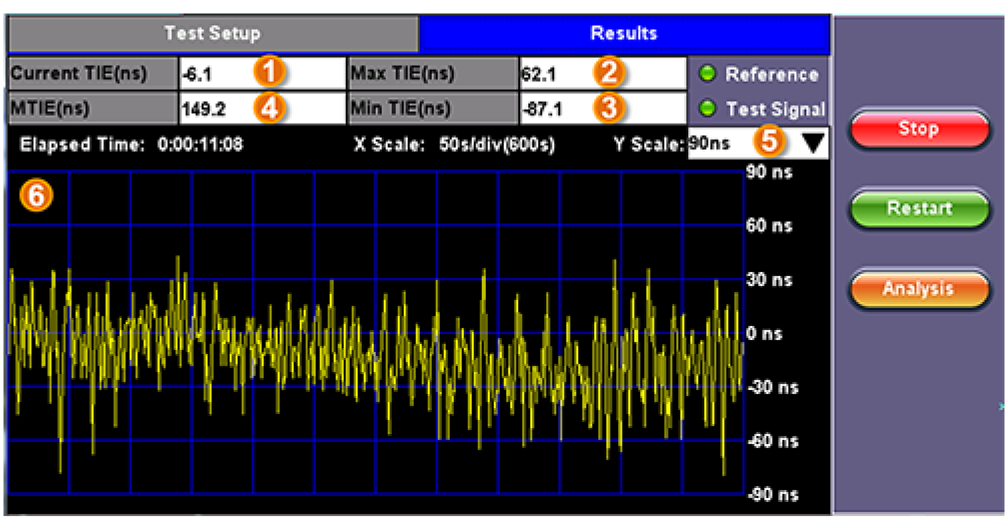
Setup



1. Test Type offers a selection of "1PPS Absolute Phase Error" for timing error measurements or "Clock Wander Measurement" for frequency stability measurements
2. Reference Clock Source offers a selection of external or internal (optional) frequency or timing references
3. The Test Signal is the clock that needs to be measured for stability and/or accuracy
4. Test Mode lets user 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.
5. Save to USB can be turned ON to write all wander or phase measurements to a FAT32 USB Memory stick in real time, to be analyzed later on. User can also set the sampling rate (samples per second).
6. File Types available are the proprietary "VeEX" format (compatible with VeEX Wander Analysis PC software" and an open CSV format that can be analyzed or formatted with a spreadsheet program (e.g. Excel or Numbers) or could be imported to other analysis software.
7. 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.
8. Tap on the **Start** button to initiate the measurements and data logging.
9. 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.

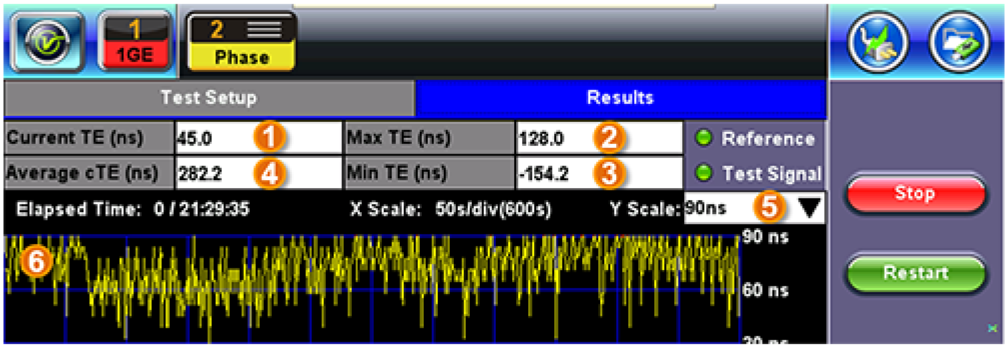
Results

Results



Wander results are presented in nanoseconds and include: (1) Current TIE, (2) Highest TIE recorded, (3) Lowest or negative TIE recorded, (4) MTIE for the whole test data, (5) Y scale zoom level, (6) the last 600s of TIE values, Start/Stop/Restart buttons, and Analysis button (if the built-in MTIE & TDEV Analysis option is loaded in the test set)

Results



Phase results are also presented as the difference in nanoseconds between the rise of the reference timing pulse and the signal under test. It includes (1) Current timing or phase error (TE), Maximum time error recorded, (3) Minimum or negative time error recorded, (4) Average time error (cTE) for the whole test.
The 600s graph is provided as a tool to confirm the settings and signals stability before running a long term test, so time is not wasted in testing an unstable signal or with frequency offset. It also gives users a glance of the current status of long term tests.

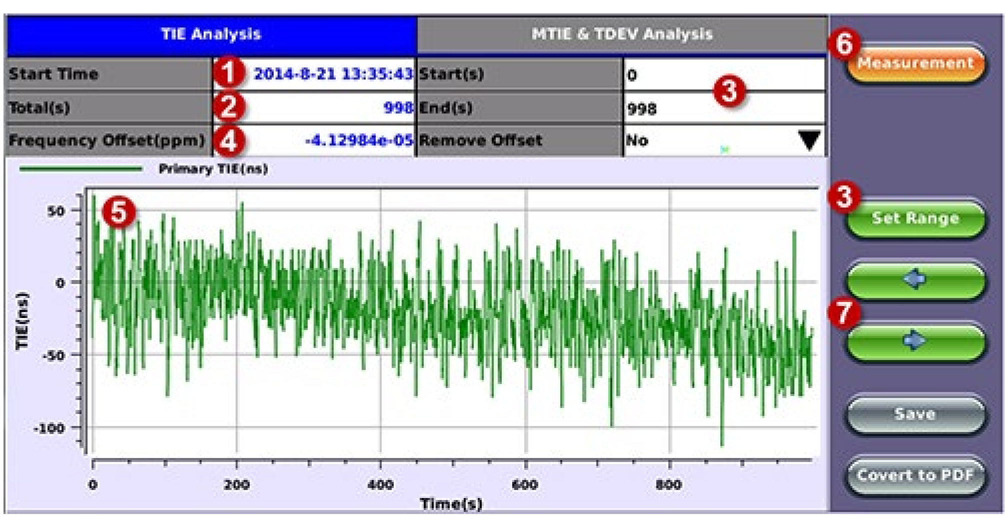
11.4.2.2 Built-in MTIE & TDEV Analysis (Optional)

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 still recommended for tests longer than 24 hours.

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

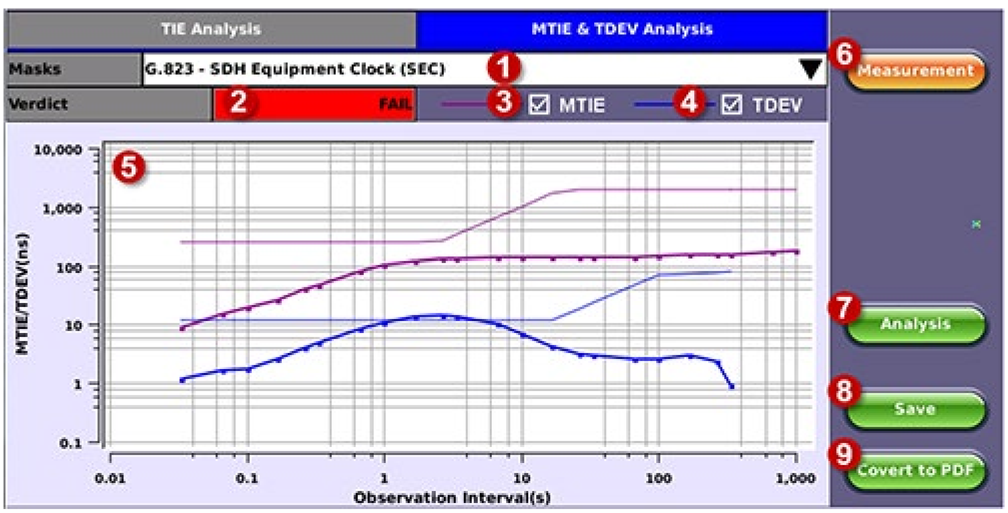
TIE Results



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.

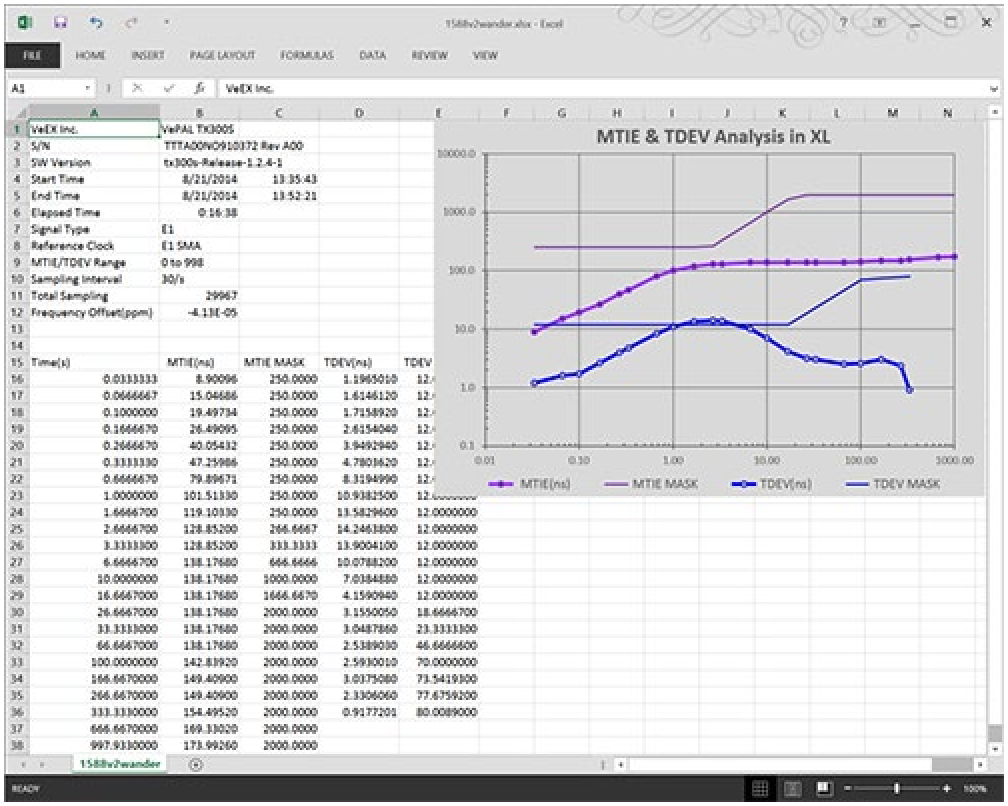
MTIE & TDEV Pass/Fail Analysis

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



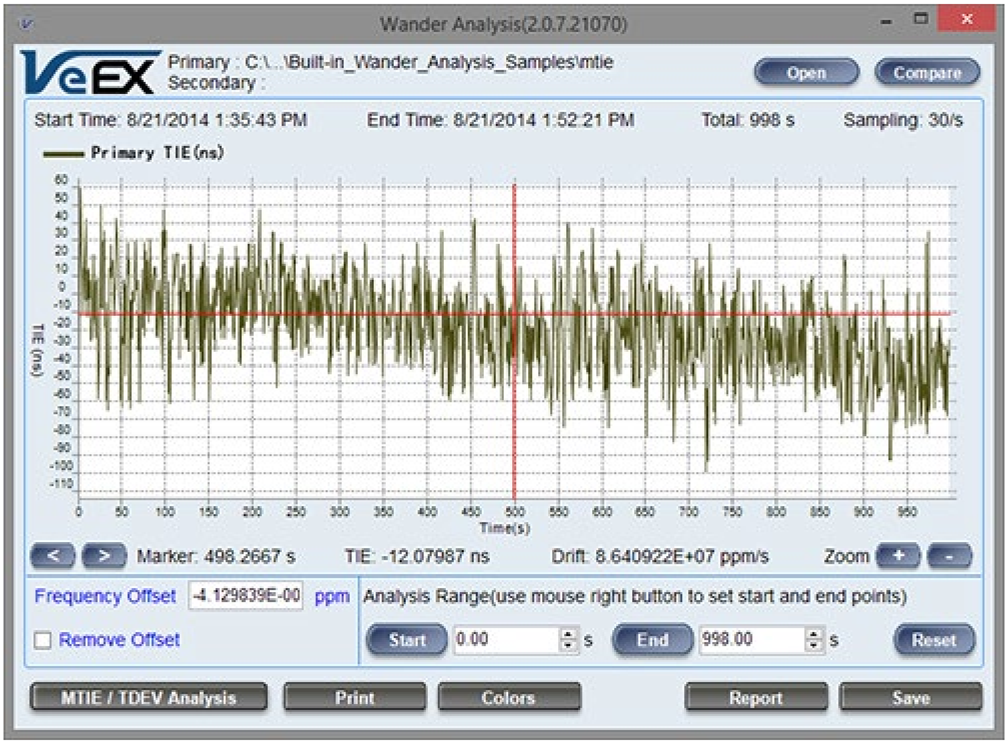
11.4.3 VeEX MTIE/TDEV Wander Analysis PC software

- 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
- 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.

11.4.3.1 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.



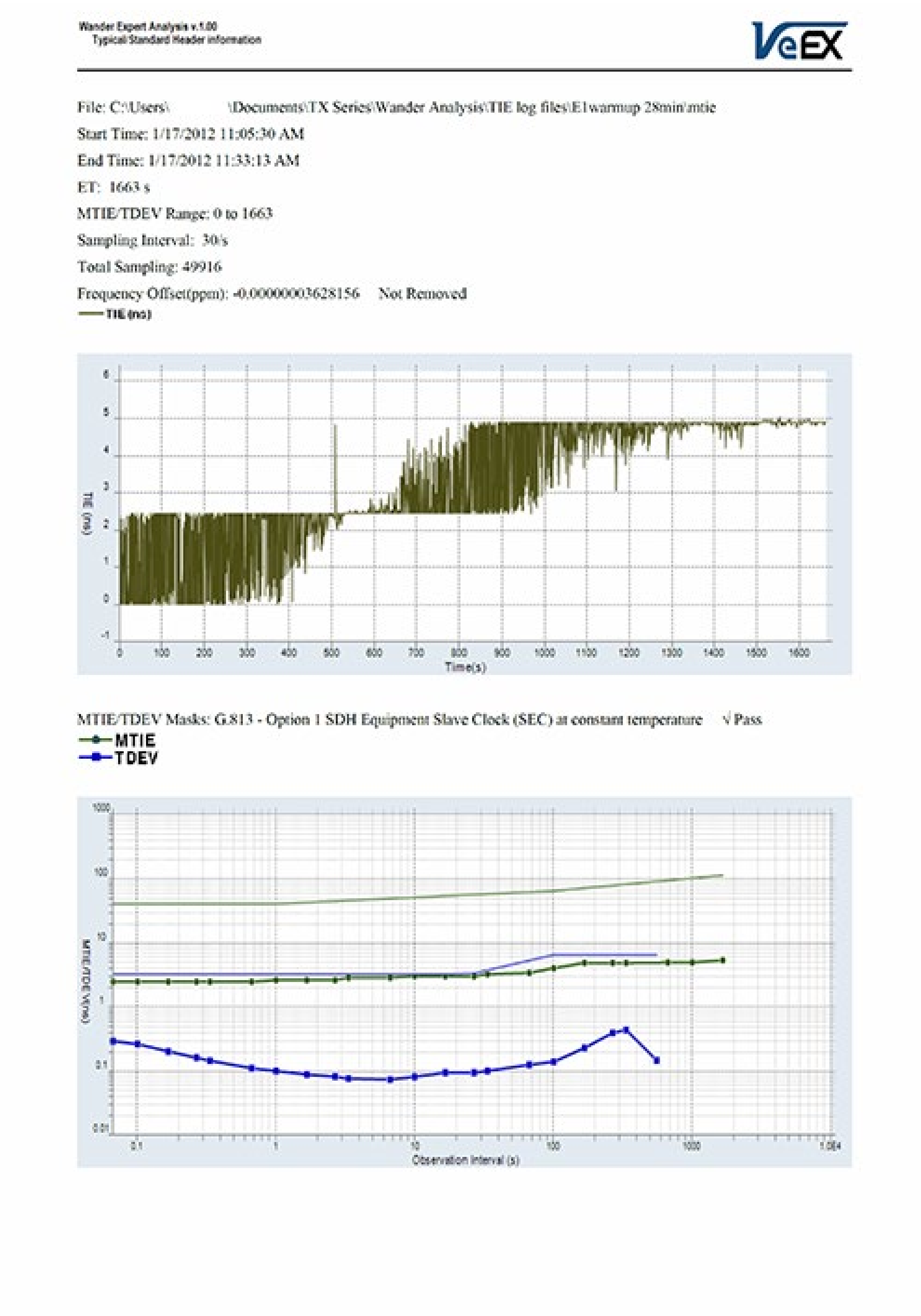
Click on the MTIE/TDEV Analysis button to go to the wander analysis function

11.4.3.2 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.

11.4.3.3 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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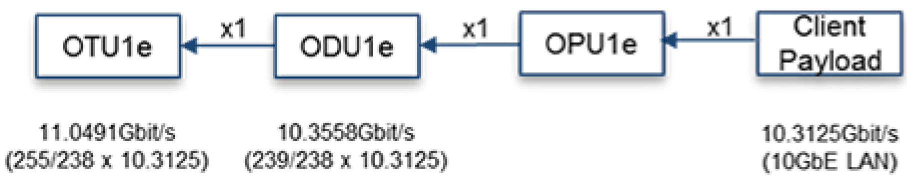
12.0 OTU-Xe

12.1 OTU-Xe Overview

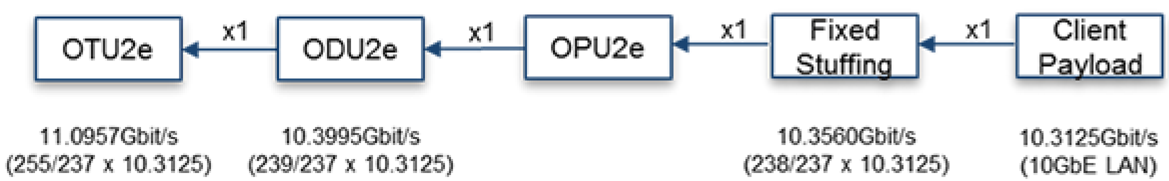
Overclocked OTN Testing

An Overclocked option verifies extended bit rates to ITU-T series G supplement 43 standards. Overclocked OTN compensates for the rate mismatch between 10 GbE LAN and OPU2 payload by raising the overall OTU2 data rate from the standard 10.709 Gbps to fit the 10GbE LAN client signal.

OTU1e (11.0491Gbps) bit rate support (without fixed stuffing)



OTU2e (11.0957Gbps) bit rate support (with fixed stuffing)



Overclocked OTN supports the following two optical line rates for mapping 10GbE LAN signals.

G.709 Interface	Line Rate	SONET/SDH and Ethernet rate	Line Rate
OTU-1	2.666 Gbit/s	STM-16/OC-48	2.488 Gbit/s
OTU-2	10.709 Gbit/s	STM-64/OC-192	9.953 Gbit/s
OTU-1e	11.0491 Gbit/s	10GbE LAN	10.3125 Gbit/s
OTU-2e	11.0957 Gbit/s	10GbE LAN	10.3125 Gbit/s

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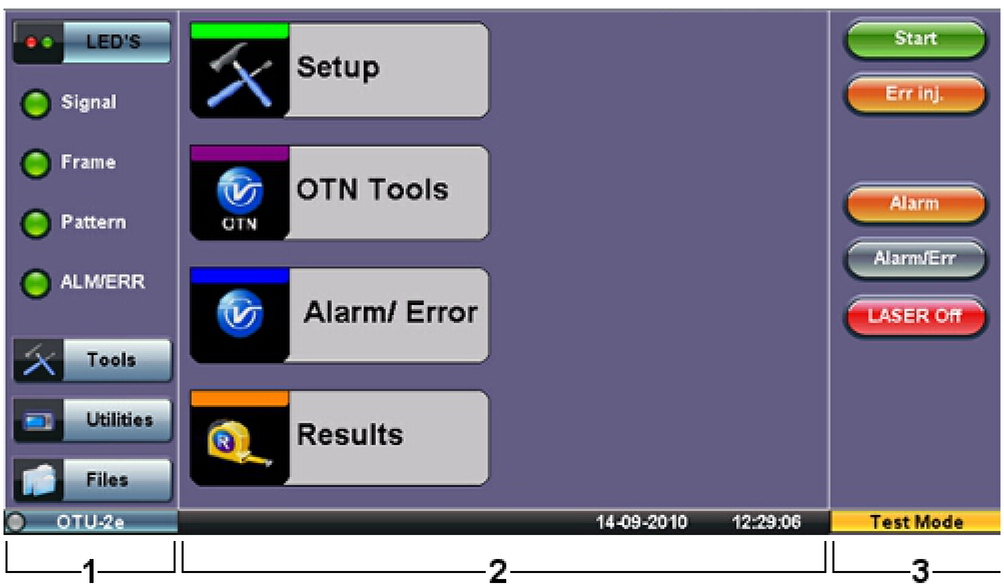
12.2 Home Menu and Switch Test Mode

The Home menu can be accessed at anytime during operation by pressing the **Home** key on the rubber keypad. The screen is divided into three presentation areas:

- **1 - Left:**
  - **LEDs:** Displays soft LEDs associated with Errors and Alarms
  - **Tools:** IP connection status, Advanced IP features (Net Wiz, WiFi Wiz, VoIP, and IPTV applications)
  - **Utilities:** Applications (Help, Settings, Files) which are common to all VePAL handheld test sets
- **2 - Middle:**
  - Test Applications specific to the test set (Setup, Alarm/Error, OTN Tools, RFC 2544, BERT, Throughput)
  - Setup to configure test interfaces
- **3 - Right:**
  - **Test mode:** Selects to the test interface(s)
  - **Laser On/Off:** Enables/Disables the Laser transmitter on optical ports

OTUx Home Menu



OTUx Home Menu with Ethernet Options

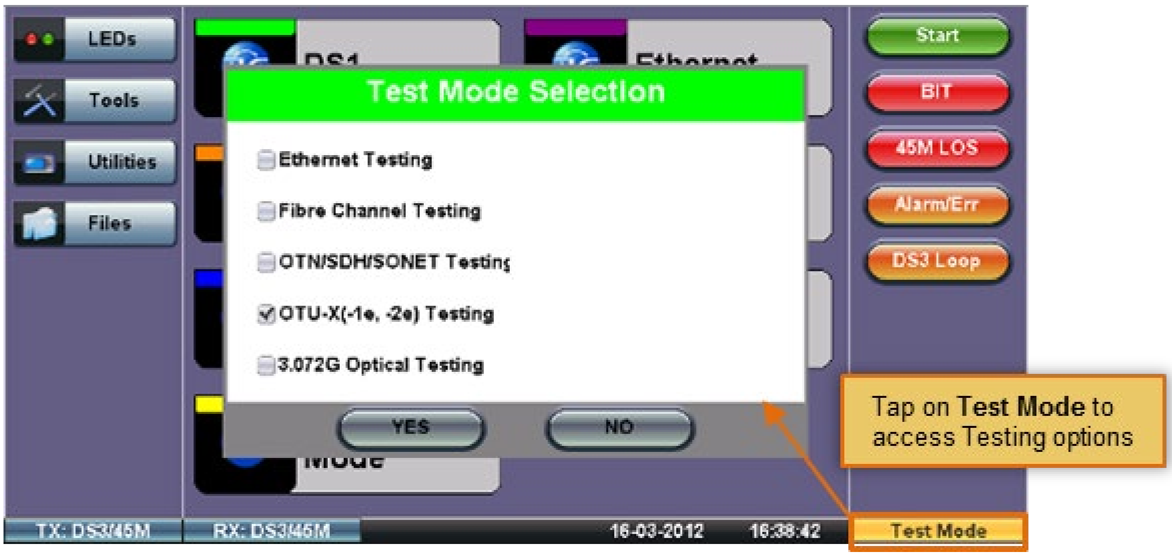
Enabling Ethernet Options on the OTUx Home Menu

The Home menu features different test applications depending on Setup configuration. To enable Ethernet options (BERT, RFC 2544, Throughput) and access them from the Home menu, select 10GE SYNC or 10GE ASYNC for the OTN Mapping. For more information on configuring the OTN mapping, please see Hierarchy.

From the menu, select one of the following test modes: **Ethernet Testing, Fibre Channel Testing**, **SONET/SDH Testing**, or **OTU-x (-1e, -2e) Testing**.

OTU-x (-1e, -2e) Testing appears in the Home menu when OTU-1e or OTU-2e options are Enabled or Ordered.

Test Mode Selection



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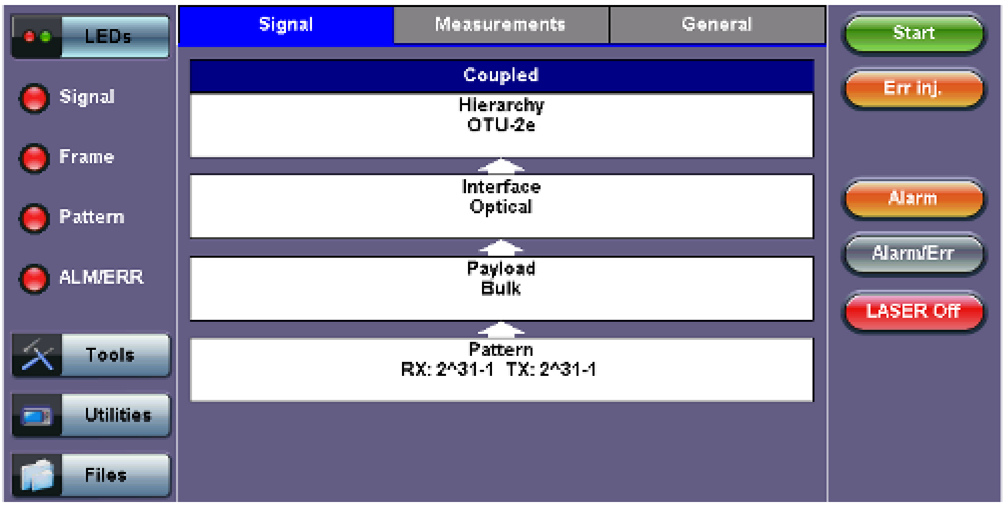
12.3 OTN Setup

Tap on the Setup icon to access the tabs featured in this section.

12.3.1 Signal Setup

Signal Setup



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

12.3.1.1 Hierarchy

To access the Hierarchy setting, tap on the **Hierarchy** box from the Signal tab.

Hierarchy Setup

- **Test Rate:** Options are OTU-1e and OTU-2e (referring to 11.049G and 11.095G respectively).
- **OTN Mapping:** 10GE SYNC, 10GE ASYNC, and Test pattern. Overclocked OTN is technology that enables the transparent transportation of 10GbE LAN signals over OTN networks as per ITU-T series G supplement 43 are supported. The multiplexing structure is shown below.
- **Scrambler:** ON/OFF.
- **FEC:** FEC encoder can be ON/OFF (activated/deactivated).

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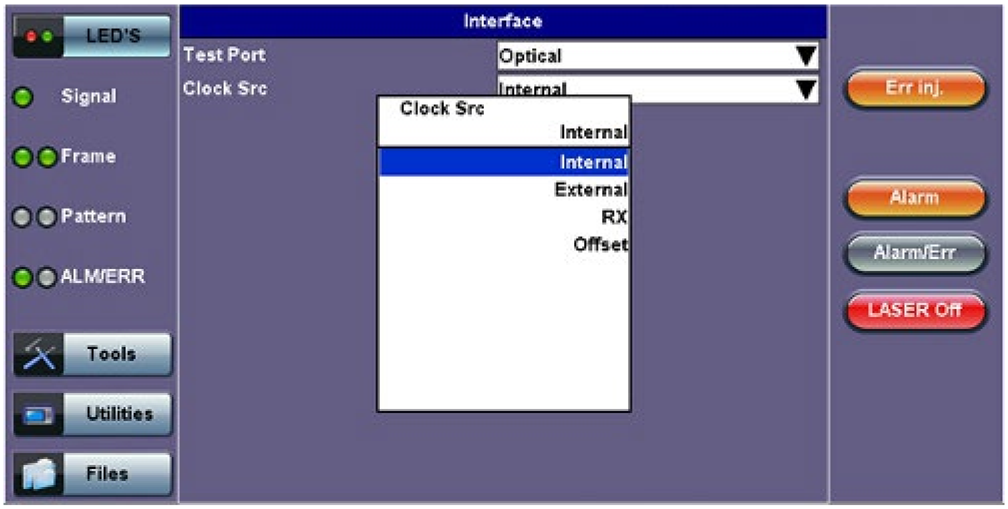
12.3.1.2 Interface

Tapping the **Interface** box opens the Interface Setup screen.

Interface Setup



- **Test Port:** Optical interface is available for OTU-1e, OTU-2e 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
    - 2Mbps (or 1.5Mbps) signal
    - 2MHz (or 1.5MHz) BITS clock
    - 64Kbps (co-directional) present on the SMA connector
    - 2Mbps signal present on the RX2 balanced or RX2 BNC unbalanced

    These options can be selected from them **Clock External** box.
  - **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.
- **Aux Line Code** (1.5 Mbps, 2 Mbps only): HDB3, B8ZS, AMI

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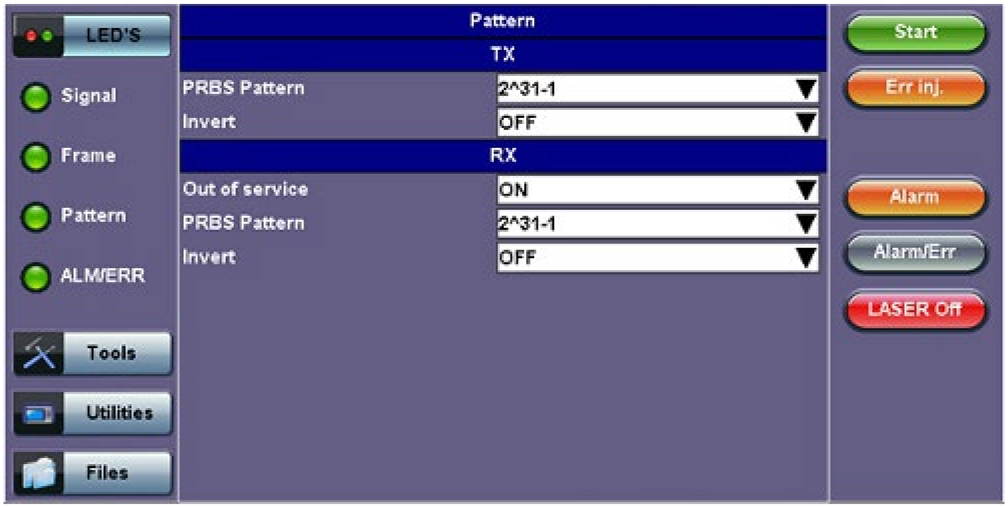
12.3.1.3 Pattern

Tapping the Pattern box opens the Pattern Setup screen. The pattern setup will show when OTN Mapping is set to Test Pattern.

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 PRBS polarity is also available. Inversion of fixed words is not permitted.

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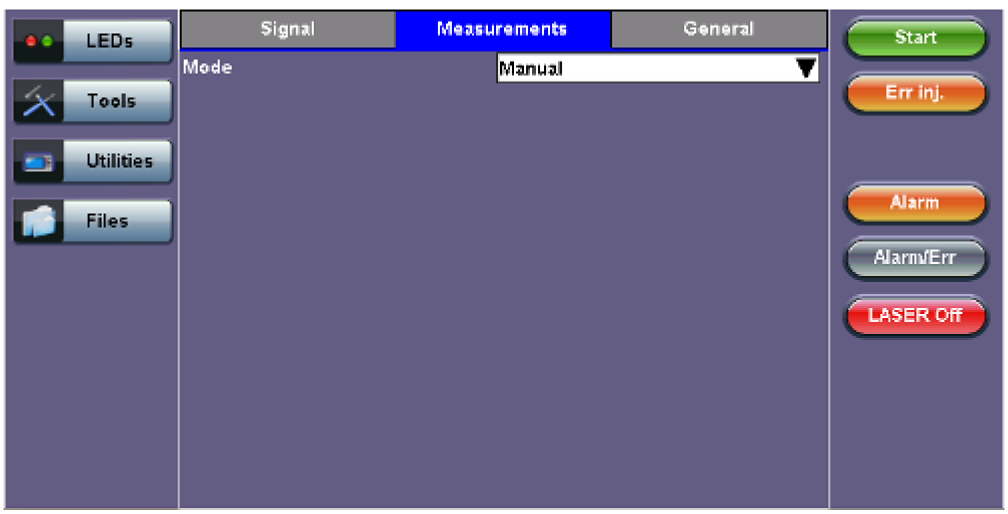
12.3.2 Measurements

Measurements tab



Manual mode is chosen as the default configuration for starting/stopping the test.

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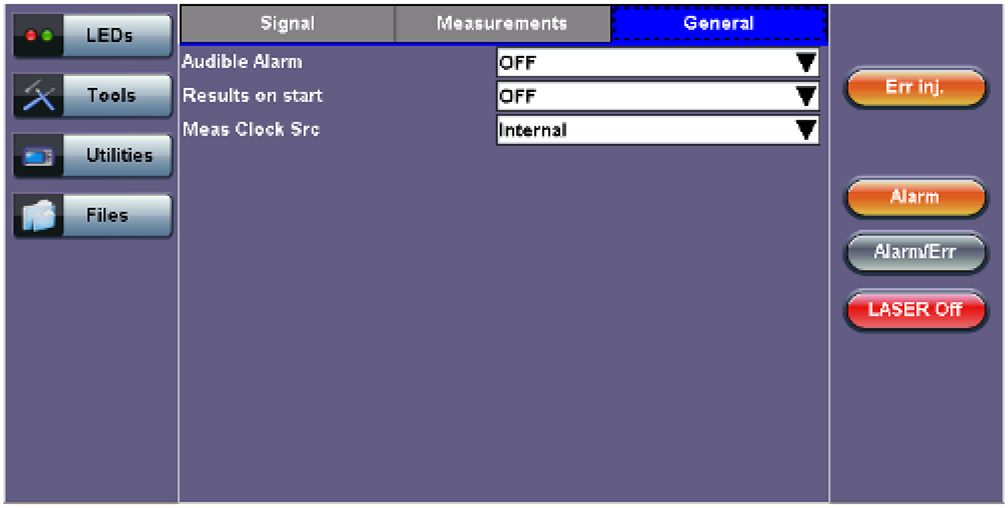
12.3.3 General

General tab



- **Audible Alarm:** OFF, ON.
- **Results on start:** On or Off. Provides an automatic move to Result screen when it starts.
- **Measurement Clock Source:** Internal Clock or Tx Clock Source; the measurement is synchronized to the Transmitted (Tx) Clock.

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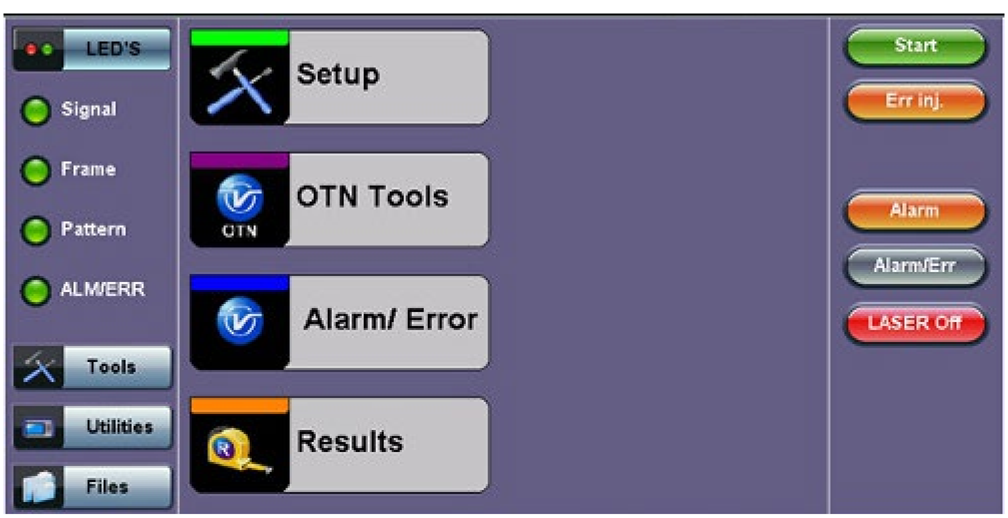
12.4 OTN Results

Accessing OTN Results

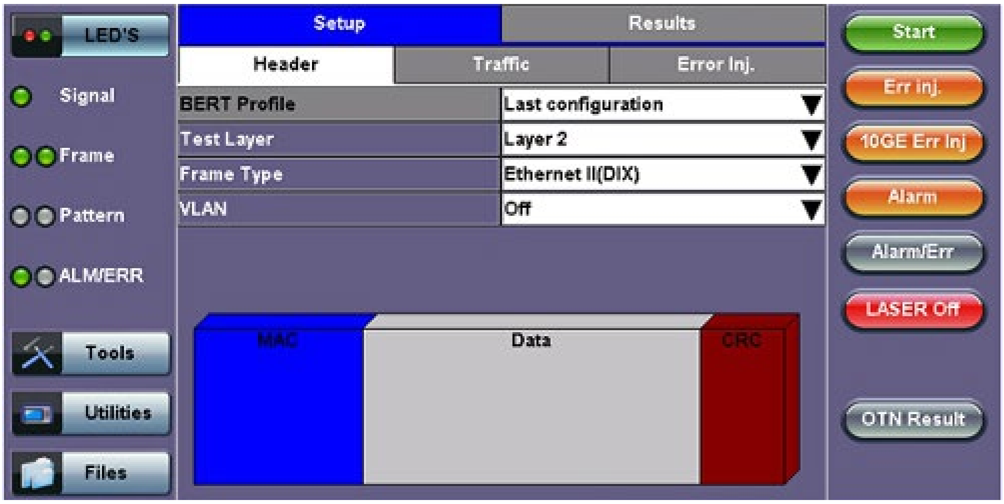
Measurements are accessed by tapping the **Results** icon in the main menu. The results comprise of a range of tabbed pages, similar to the setup pages. If Ethernet options are enabled, the Results icon will not be available on the Home menu. To access results, press the **OTN Results** button 

from the selected Ethernet application.

OTN Menu



OTN Menu (Ethernet BERT application)



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12.4.1 Summary

The Summary tab displays a summary page 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 OTN signal and its payload.

Summary tab

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12.4.2 Errors/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 individual soft LED will automatically link to the applicable result screen which provides detailed information.

The LED headers are described in the table below:

Alarm Definitions and Descriptions	
OTU	Optical channel Transport Unit
ODU	Optical channel Data Unit
OPU	Optical channel Payload Unit
PAT	Pattern detection (PRBS, User, fixed words)

OTN Error and Alarm definitions per ITU-T G.709 recommendations:

OTU Alarm Definitions Detection criteria according to G.709 and G.798	
LOF	Loss of Frame - Declared when the OOF states have been constantly observed for 3 ms respectively
OOF	Out of Frame - Declared if it fails to find an FAS sub-pattern (FAS bytes 3, 4, and 5) for five consecutive frames.
LOM	Loss of Multiframe - Declared when the OOF states have been constantly observed for 3 ms respectively
OOM	Out of Multiframe - Declared when the received MFAS is out of sequence for five consecutive frames
OTU-AIS	Alarm Indication Signal - PN-11 sequence (covers complete Och) ≥ 3 x 8192 bits
OTU-IAE	Incoming Alignment Error - This bit allows the ingress to inform the egress that an alignment error in the incoming signal has been detected. • IAE = 1 with error • IAE = 0 no error • Status (STAT) These three bits indicate the presence of maintenance signals (AIS, OCI, TCM, IAE)
OTU-BDI	Backward Defect Indication - This single bit conveys information regarding signal failure in the upstream direction • BDI = 1 indicates OTUk backward defect • BDI = 0 otherwise
OTU-TIM	Trail Trace Identifier Mismatch

OTU Error Definitions Detection criteria according to G.709 and G.798	
FAS	Frame alignment signal - Uses the first six bytes and , to provide framing for the entire signal
MFAS	Multiframe alignment signal - Used to extend command and management functions over several frames. The MFAS counts from 0 to 255, providing a 256 multiframe structure.
BIP-8	Bit interleaved parity-8 code
BEI	Backward error indication -SM byte 3, bit 1 to 4: value 0 to 8: SM BIP-8 error count value 9 to 15: no SM BIP-8 errors value 11: SM BIAE
BIAE	Backward incoming alignment error - SM byte 3, bit 1 to 4: " 1011" ≥ 3 frames
CFEC	Correctable FEC error
UFEC	Uncorrectable FEC error

ODU Alarm/Error Definitions Detection criteria according to G.709 and G.798	
ODU-BEI	Backward error indication -PM byte 3, bit 1 to 4: value 0 to 8: SM BIP-8 error count value 9 to 15: no SM BIP-8 errors
ODU-AIS	Alarm Indication Signal - PM byte 3, bit 6 to 8: " 111" ≥ 3 frames
ODU-OCI	Open connection indication - PM byte 3, bit 6 to 8: " 110" ≥ 3 frames
ODU-LCK	Locked - PM byte 3, bit 6 to 8: " 101" ≥ 3 frames
ODU-BDI	Backward Defect Indication - PM byte 3, bit 5 = 1 ≥ 5 frames
ODU-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.
ODU-TIM	Trail Trace Identifier Mismatch

BERT	Description
LSS	Loss of Sequence Synchronization
Bit	Bit error

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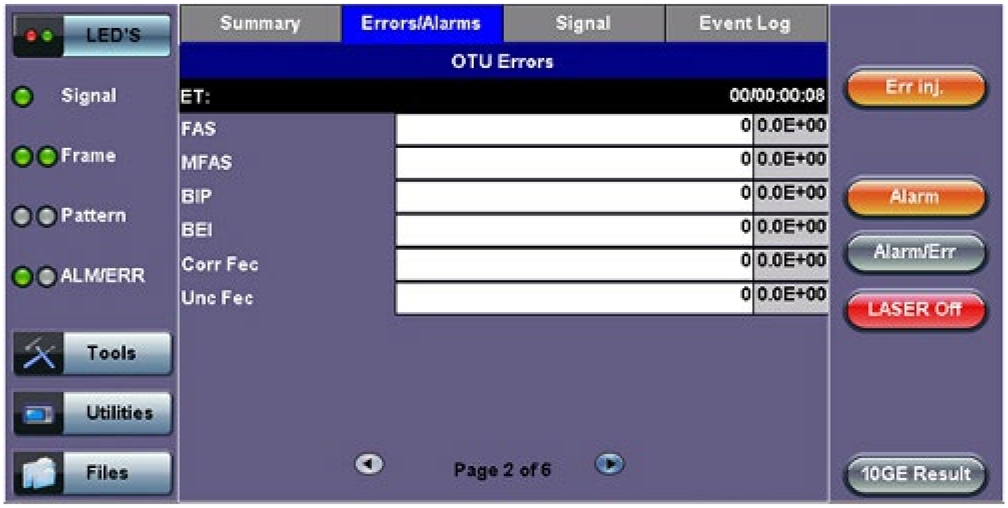
Errors/Alarms (Page 2)

Page 2 lists the **OTU Errors** in logical order that are associated with the signal under test. All errors are evaluated and stored. The Elapsed Time [ET] is shown in the right hand corner of the header. Error conditions are displayed in red including count and rate.

Errors/Alarms (Page 2)



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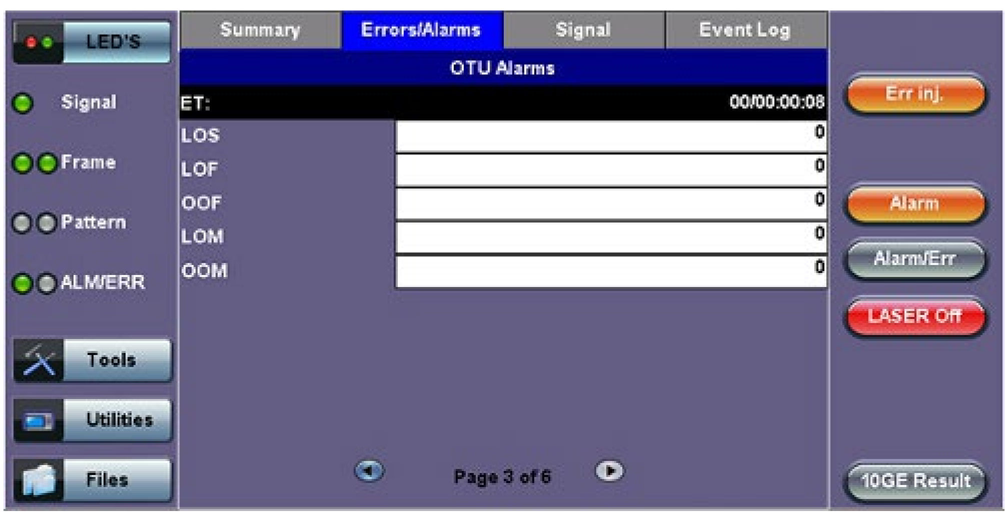
Errors/Alarms (Page 3 & 4)

Page 3 & 4 lists the **OTU Alarms** in logical order associated with the signal under test. All alarms are evaluated and stored. The Elapsed Time [ET] since the start of the test is shown in the upper right hand corner.

Errors/Alarms (Page 3)



The alarms associated with the Section and Line are displayed separately for ease of interpretation.

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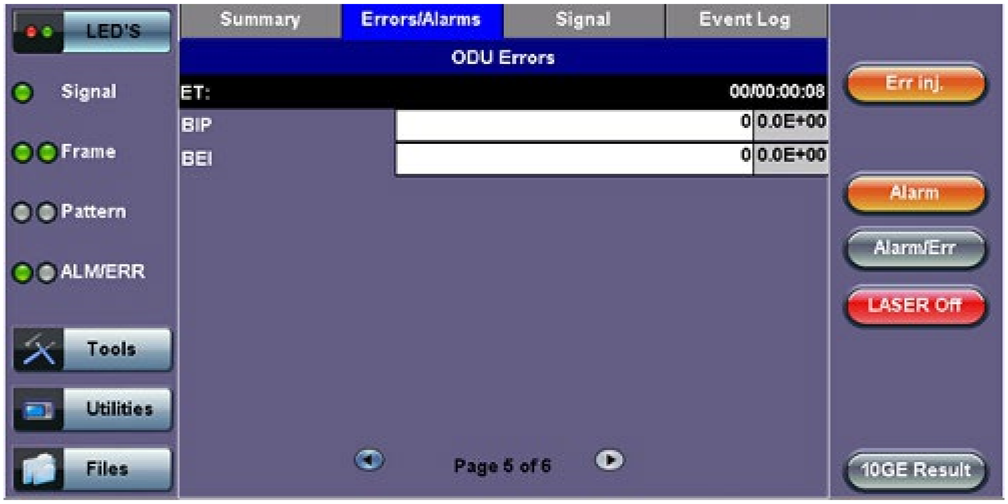
Errors/Alarms (Page 5 & 6)

Page 5 & 6 lists the **ODU/OPU Errors and Alarms** in logical order that are associated with the signal under test. All alarms are evaluated and stored.

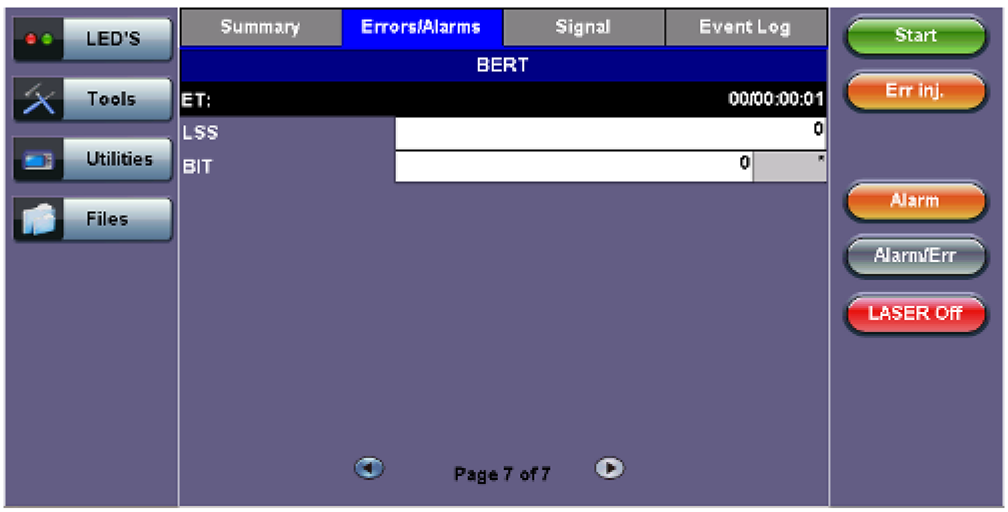
Errors/Alarms (Page 5)



Errors/Alarms (Page 7)

Page 7 lists the **BERT Errors/Alarms** in logical order that are associated with the signal under test. All alarms are evaluated and stored.

Errors/Alarms (Page 7)



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12.4.3 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.

- **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.

Event Log

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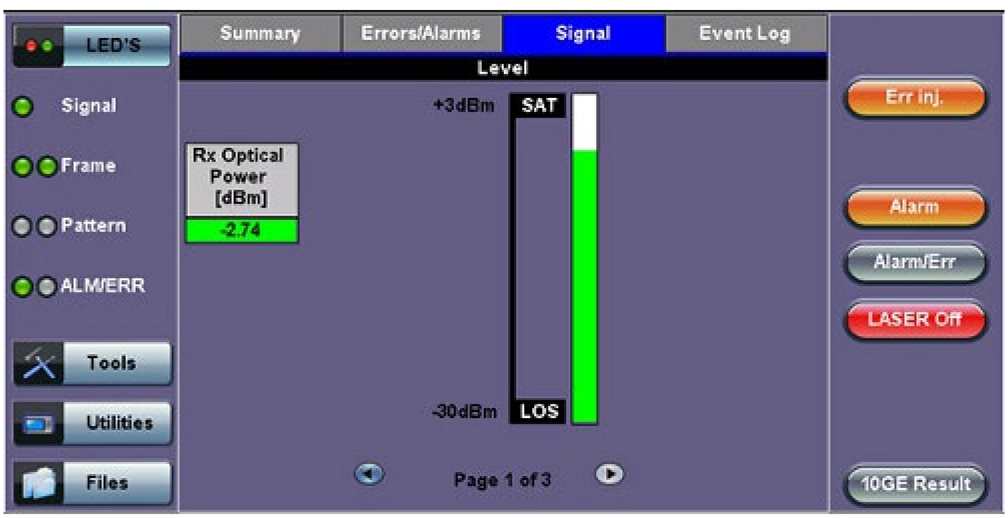
12.4.4 Signal

Level (Page 1)

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

Signal (Page 1)



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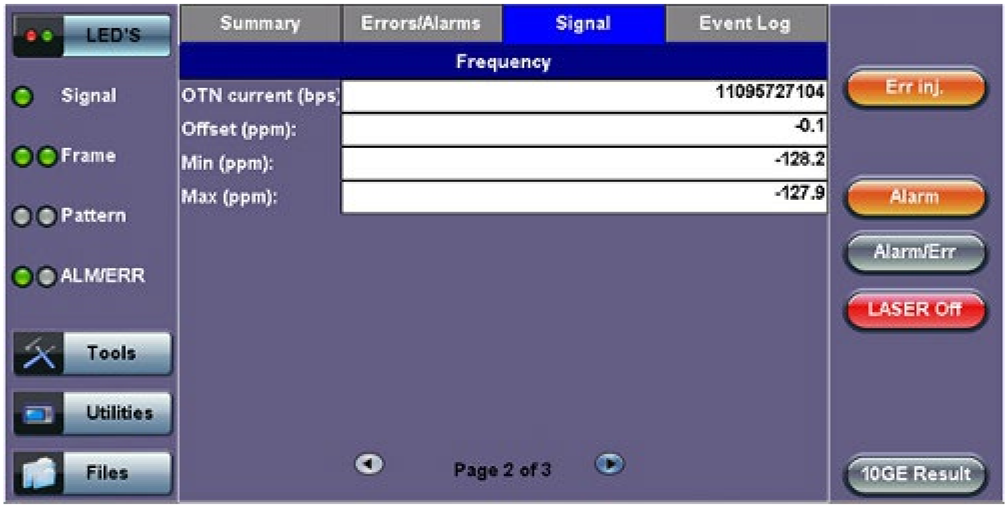
Frequency (Page 2)

The received signal frequency and offset is measured and displayed. For OTN signals, the measurement is performed on optical interfaces.

Signal (Page 2)



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

- **OTN Current (bps):** Indicates the frequency of the input signal
- **Offset (ppm):** 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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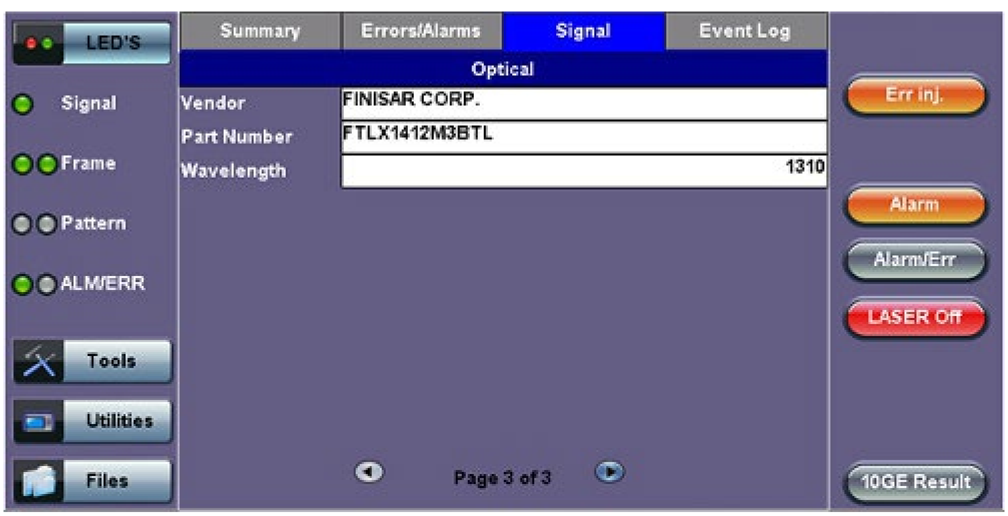
Optical Information (Page 3)

Page 3 displays the Optical module information which includes Vendor name, Part number and Optical Wavelength.

Signal (Page 3)



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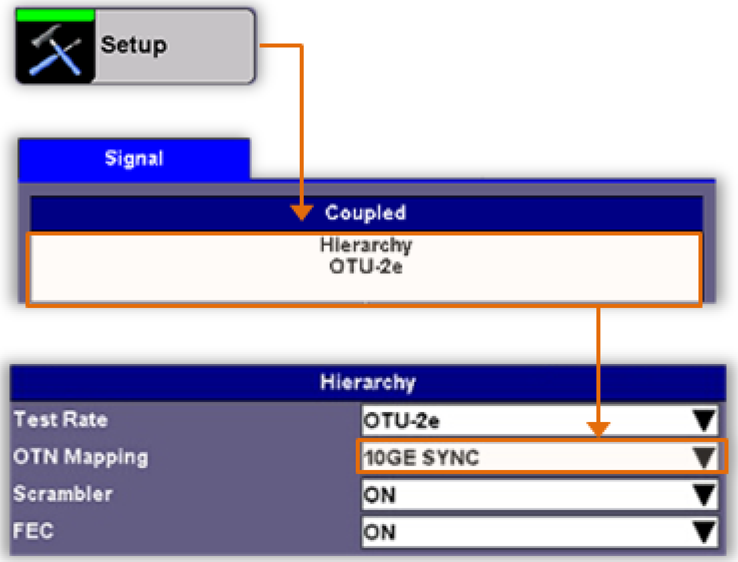
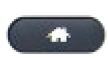
12.5 OTU-Xe Ethernet Applications

Accessing Ethernet Applications from OTU-Xe

To enable and access Ethernet applications from the Home menu (RFC 2544, BERT, Throughput), tap on **Setup** [Home menu] > **Hierarchy** > **OTN Mapping** and select 10GE SYNC or 10GE ASYNC from the drop-down menu.



Hierarchy Setup

After configuring the OTU-Xe signal, press the **Home Key**  on the keypad and tap on the desired Ethernet test.

OTN Home Menu with Ethernet Options

Setup and results for Ethernet applications featured in OTU-x (-1e, -2e) are the same as those featured in Ethernet Testing mode. Please refer to the corresponding Ethernet testing section for more information on the following applications:

- **12.5.1 OTU-Xe with 10GE BERT** redirects to BERT
- **12.5.2 OTN/10GE RFC 2544 Conformance Testing** redirects to RFC 2544 Conformance Testing
- **12.5.3 OTN/10GE Throughput Testing (Multiple Streams)** redirects to Throughput Testing

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13.0 Ethernet

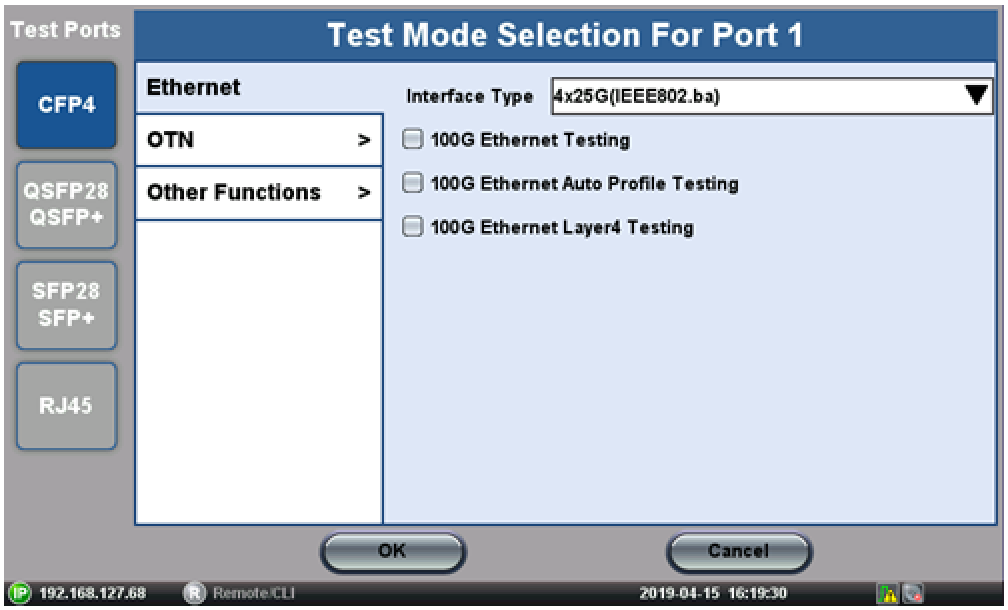
Test mode, test port(s), and network settings are required prior to performing any measurements or applications.

13.1 Ethernet Setup

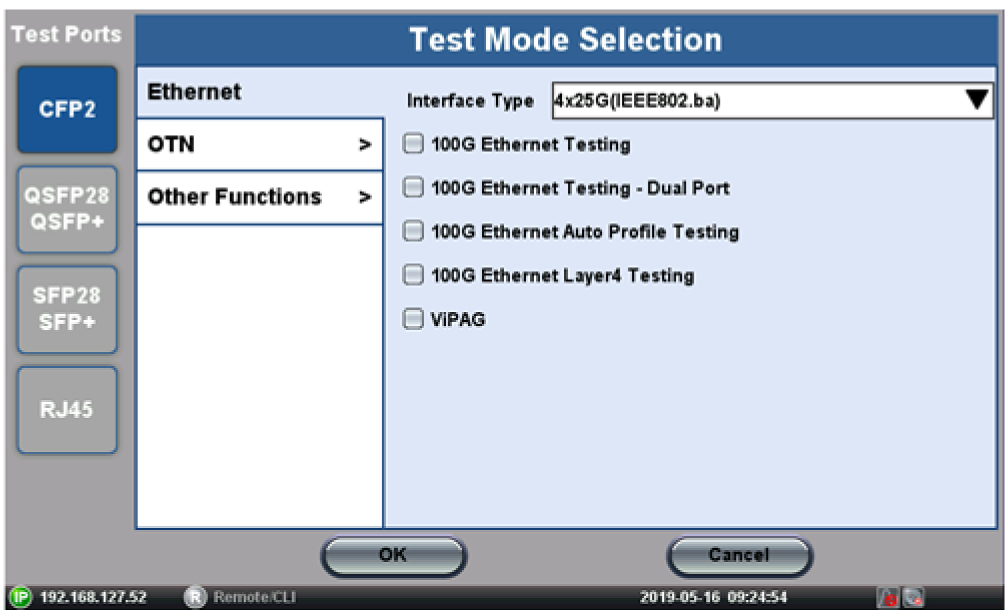
13.1.1 Test Port Selection

This menu is accessed via the Test Port button located at the top left hand side of the screen. Click on the Test Port (CFP4, CFP2, QSFP+, SFP+, RJ45) to select the test mode. Depending on interface options purchased, the following selections are possible:

Test Mode Seelction RXT-6200



Test Mode Seelction RXT-6000e



Shared single/dual port combinations between RXT-6200 and RXT-6000e:

- Single port 100G (CFP2 or CFP4)
- Single port 100G, 50G (QSFP28/QSFP+)

- Single port 40G (QSFP+)
- Single port 25G, 10G, 1G (SFP28/SFP+)
- Single Copper port 1G (1G Copper)
- Dual port 100G, 50G (QSFP28/QSFP+)
- Dual port 40G (QSFP+)
- Dual port 25G, 10G, 1G (SFP28/SFP+)
- Dual Copper port 1G (1G Copper)

Single/dual port combinations present only in RXT-6000e:

- Single port 100G (CFP2)
- Single port 100G, 50G (QSFP28/QSFP+)
- Single port 40G (QSFP+)
- Single port 25G, 10G, 1G (SFP28/SFP+)
- Single Copper port 1G (1G Copper)
- Dual port 100G, 50G (QSFP28/QSFP+)
- Dual port 40G (QSFP+)
- Dual port 25G, 10G, 1G (SFP28/SFP+)
- Dual Copper port 1G (1G Copper)
- ViPAG
- Pass Through Monitor 10G (SFP28/SFP+)
- Pass Through Monitor 10/100Base-X (SFP28/SFP+)
- Pass Through Monitor 10/100/1000Base-T (1G Copper)

After selecting the test interface click **OK**.

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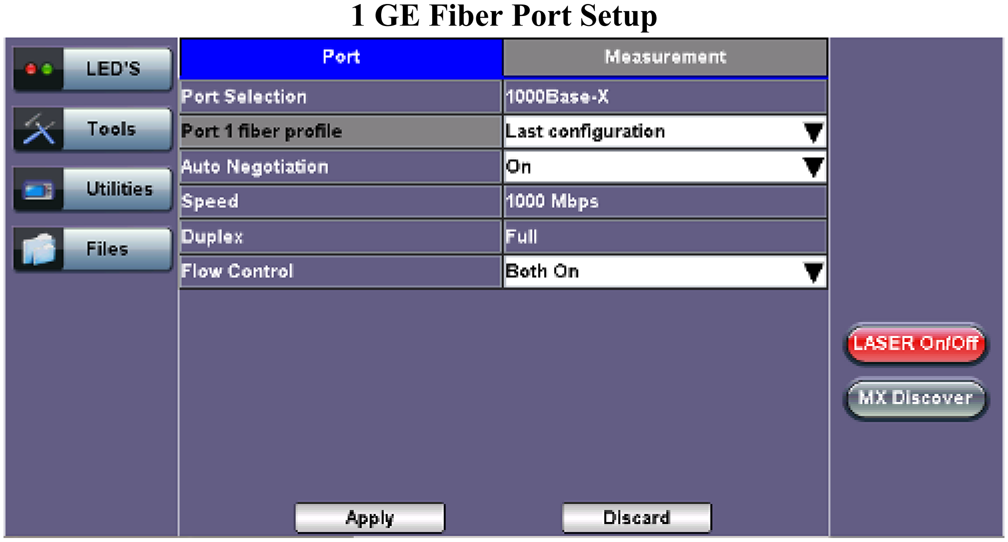
13.1.2 Port Setup

Port setup or test interface configuration 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.

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

1 GE Fiber Port Setup



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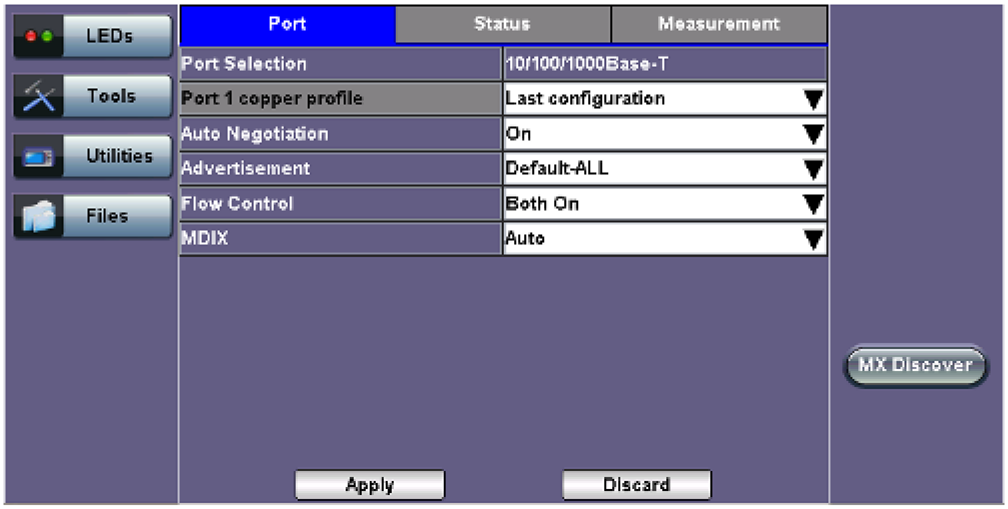
1 GE Fiber Port

- **Auto Negotiation:** On or Off. Matches the test set's negotiation settings to those of the link partner
- **Speed:** Default set to 1000 Mbps
- **Duplex:** Default set to Full
- **Flow Control:** TX On, RX On, Both On, or Off
  - When flow control is enabled, the test set will respond to pause frames received by the link partner by adjusting the transmit rate
  - When flow control is disabled, the test set ignores all incoming pause frames from the link partner and continues transmitting at the configured transmit rate

1 GE Copper Port Setup



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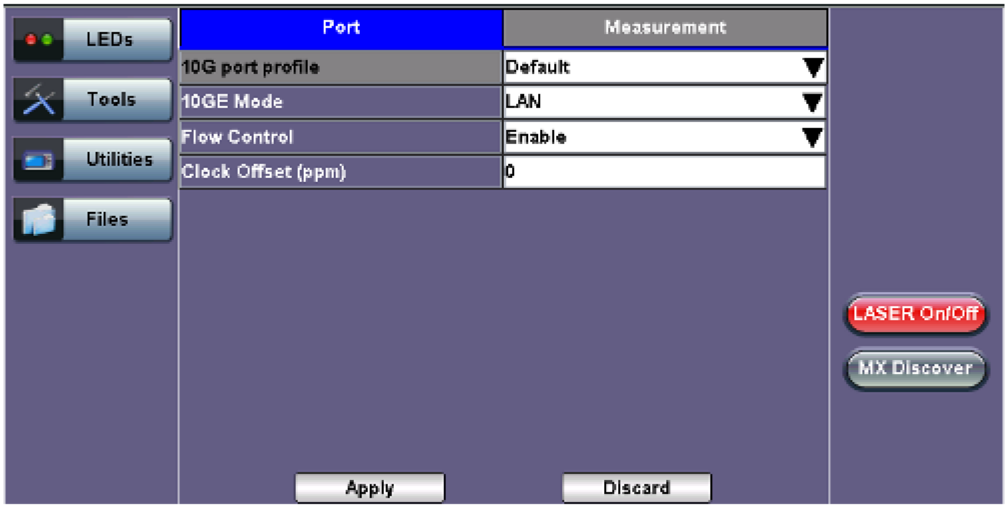
1 GE Copper Port

- **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): 10 Mbps, 100 Mbps, 1000 Mbps.
  - **Duplex** (only when Auto Negotiation is Off): Half or Full.
  - **Advertisement** (only when Auto Negotiation is On): 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.
- **MDIX:** 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.

10GE Port Setup



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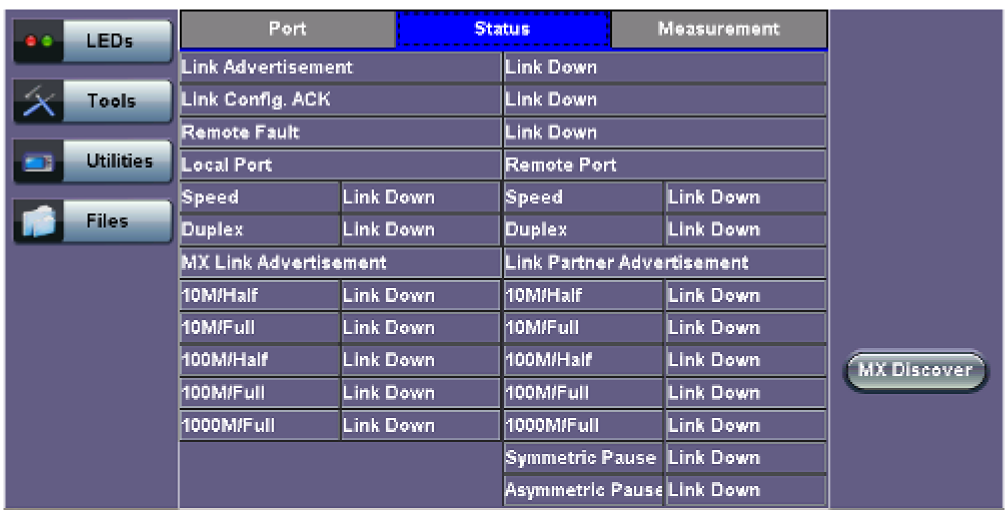
10 GE Port

- **10GE Mode:** LAN or WAN
- **WIS Mode** (only available in WAN mode): SDH or SONET
- **Flow Control:** Enable chosen as default option
- **Clock Offset (ppm):** The frequency may be offset in parts per million

Status

Status tab



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

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

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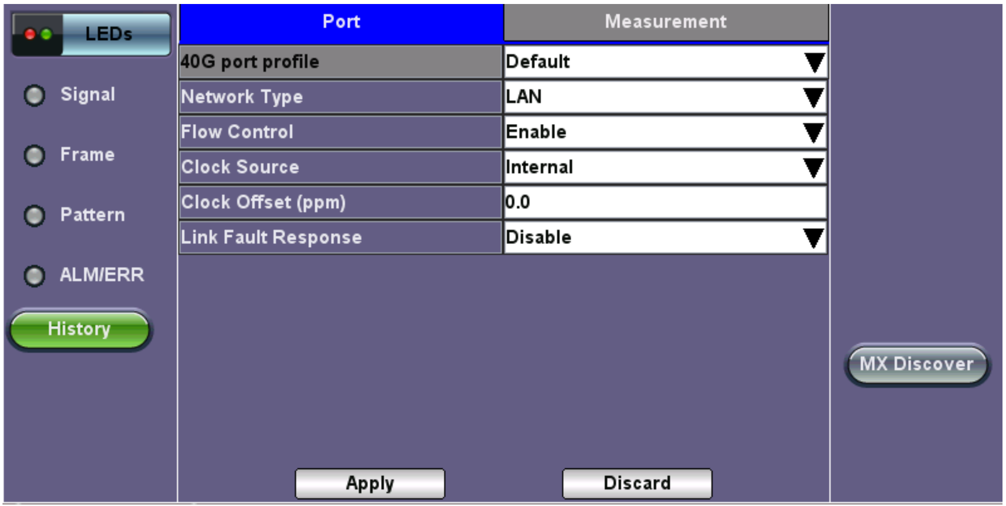
40 GE Port Setup

40 GE Port Setup



- **40G port profile:** Default
- **Network Type:** LAN
- **Flow Control:** Enable/Disable
- **Clock Source:** Internal, External (2Mbps, 2MHz, 1.5Mbps, 1.5MHz, 10MHz, 1PPS), RxCLK, GPS1PPS
- **Clock Offset (ppm):** Can be configured; range is +/- 150ppm
- **Link Fault Response:** Enable/Disable

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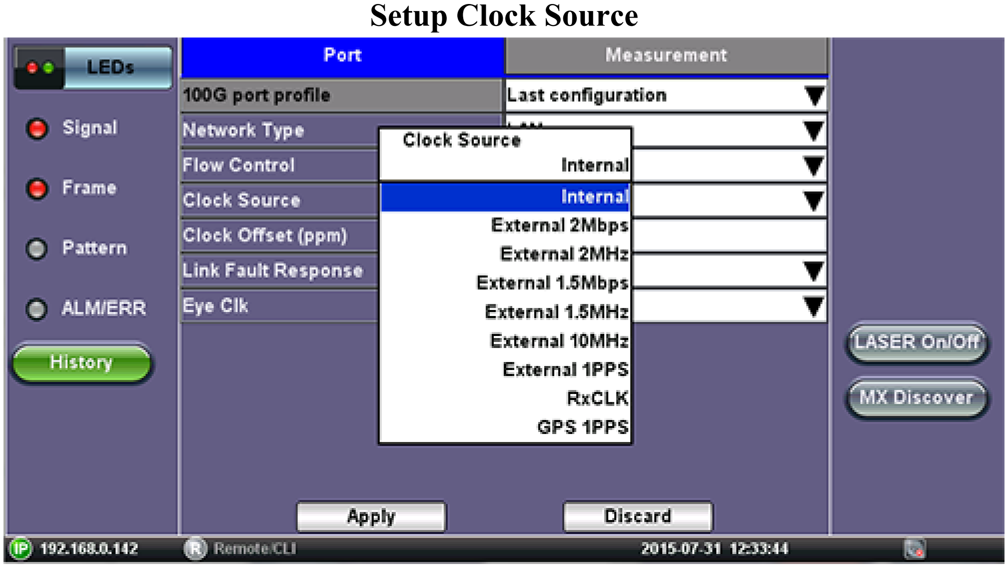
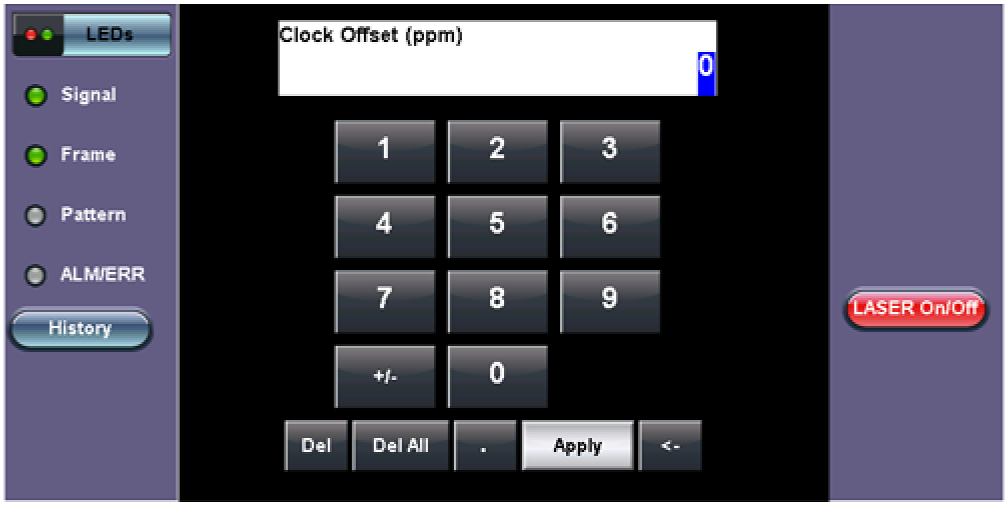
100 GE Port

- **100G port profile**: Default
- **Network Type**: LAN
- **Flow Control**: Enable/Disable
- **Clock Source**: Internal, External (2Mbps, 2MHz, 1.5Mbps, 1.5MHz, 10MHz, 1PPS), RxCLK, GPS1PPS
- **Clock Offset (ppm)**: Can be configured; range is +/- 150ppm

Setup Clock Source

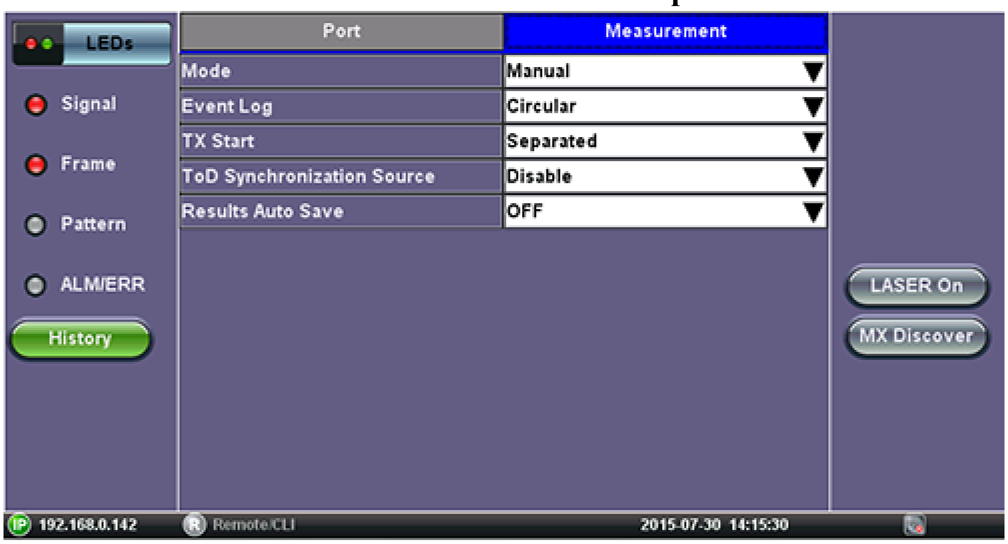


Setup Clock Offset



13.1.3 Measurement Settings

10 GE Measurement Setup



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

- **Profile:** Last configuration, Delete, Save, Save as..., Default.

- **Mode:** Manual, timed, or auto mode are available.
  - **Manual mode:** User starts and stops the measurements manually.
  - **Timed mode:** User defines the duration of the test; after the test is started, the test will run for the configured duration and stop automatically.

- **TX Start:** Tx & Rx, or Tx Separate. Configure how the measurements are started when in BERT and Multiple Streams test modes.
  - **Tx & Rx:** 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.
  - **Tx 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.
  - **Tx 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.

- **ToD Synchronization Source:** Disable, GPS 1PPS

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

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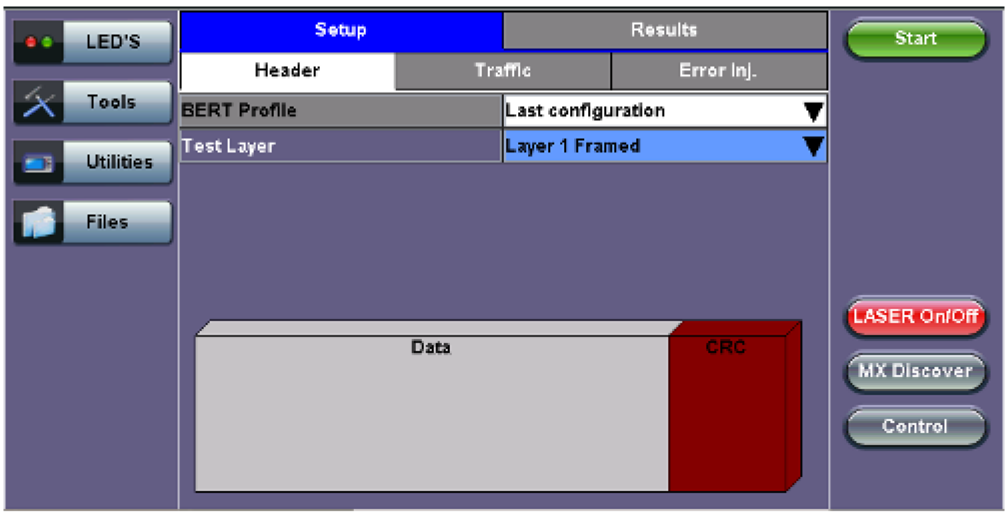
13.2 BERT

13.2.1 BERT Setup

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.

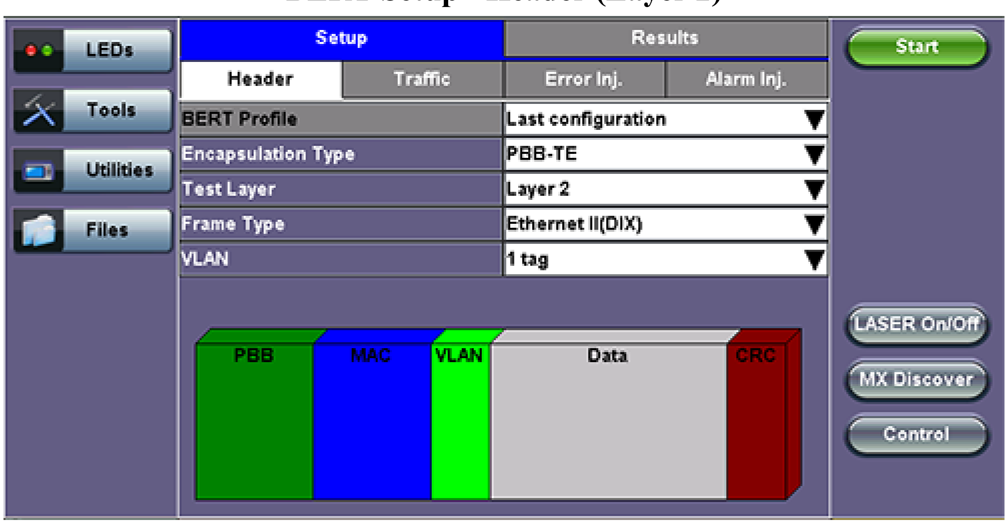
- **Layer 1:** Unframed mode (fiber ports only) or Framed mode
  - **Unframed mode:** Test traffic consists of a bit stream of the selected test pattern
  - **Framed mode:** Test pattern is encapsulated into a valid Ethernet frame with SOF, Preamble, and CRC field

BERT Setup - Header (Layer 1)



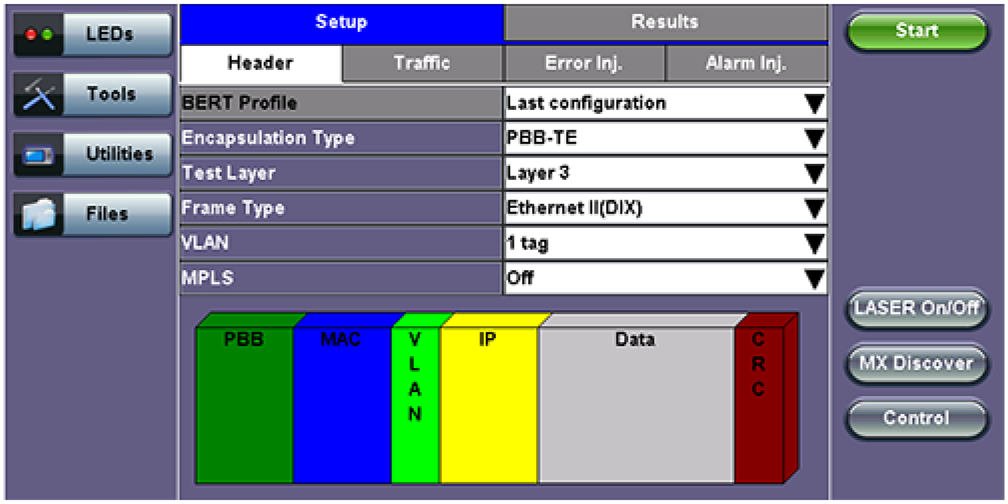
- **Layer 2:** Framed BERT (same as Layer 1 Framed)
  - **MAC Address:** A default or user configured Media Access Control (MAC) address is added to the frame

BERT Setup - Header (Layer 2)



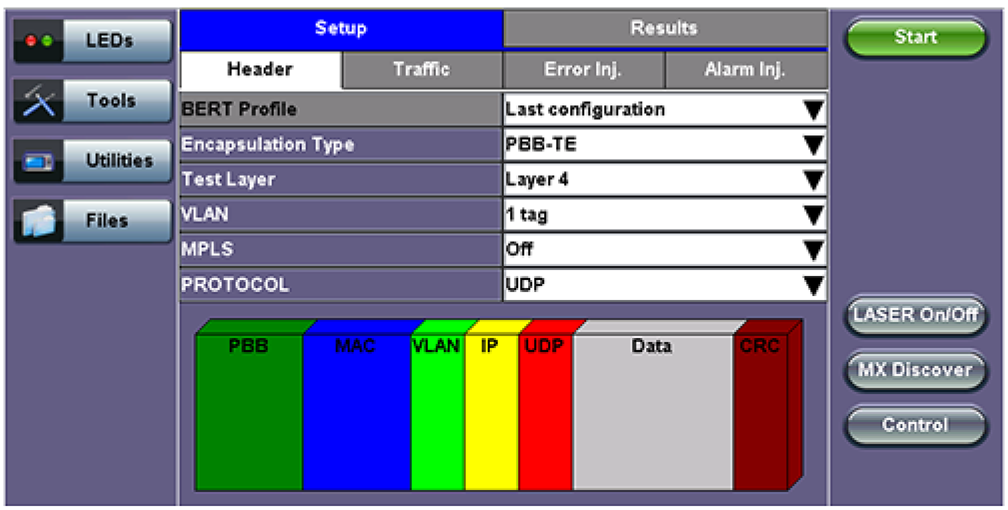
- **Layer 3:** Framed BERT (same as Layer 1 & 2 Framed)
  - **MAC Address:** A default or user configured Media Access Control (MAC) address is added to the frame
  - **IP Address:** A default or user configured IP address is added to the frame

BERT Setup - Header (Layer 3)



- **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 Address:** A user defined source and destination port address is added to the frame

BERT Setup - Header (Layer 4)



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13.2.1.1 Header Settings

- **BERT Profile:** Load a previously configured test profile or create a new profile from existing settings. Please see **6.0 Profiles** in the **ReVeal MTX300 manual** for more details on how to create new profiles using ReVeal software.

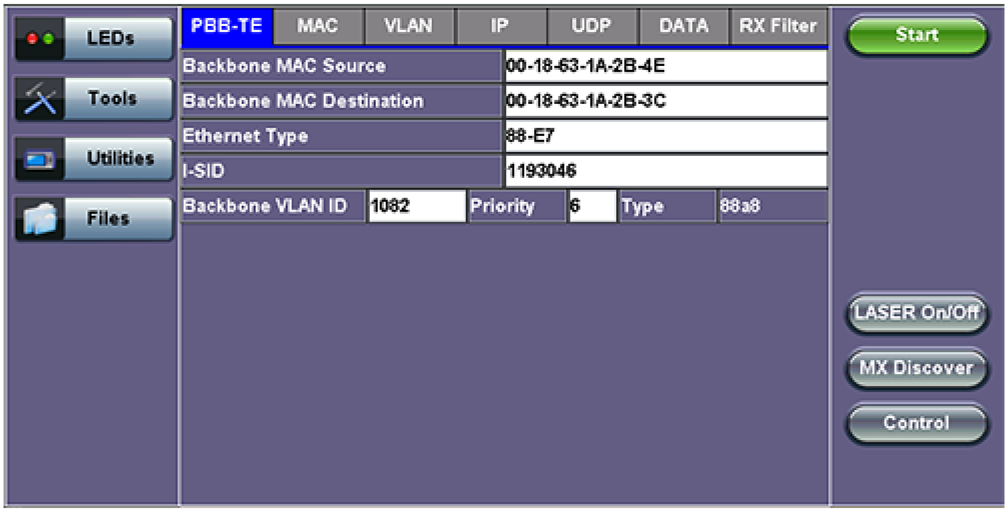
- **Encapsulation Type:** None or **Provider Backbone Bridge (PBB-TE):** Provider Backbone Bridge MAC-in-MAC (IEEE 802.1ah) encapsulation are configured trunks that add resiliency and configurable performance levels in the provider backbone network. Available for 1GE Copper/Fiber and 10GE port. PBB encapsulation is available for all Ethernet tests (Layer 2,3 and 4) - BERT, RFC2544, Throughput, V-SAM.

  Tap the PBB block to configure the settings. All PBB fields are configurable.

  - Backbone MAC Source
  - Backbone MAC Destination

- Ethernet Type
- I-SID
- Backbone VLAN ID, Priority, Type

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

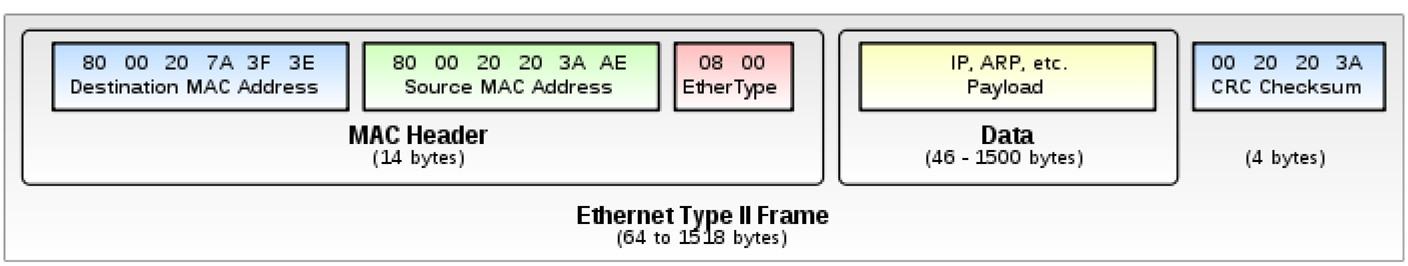
- **VLAN:** Off, 1 tag, 2 tags, 3 tags
  - The user is able to configure up to 3 VLAN tags (VLAN stacking, for Q-in-Q applications)

    VLAN stacking is an option

- **MPLS:** Off, 1 tag, 2 tags, 3 tags
  - The user is able to configure up to 3 MPLS tags

    MPLS tag configuration is only available when the MPLS option is purchased

The most common Ethernet Frame format, Type II



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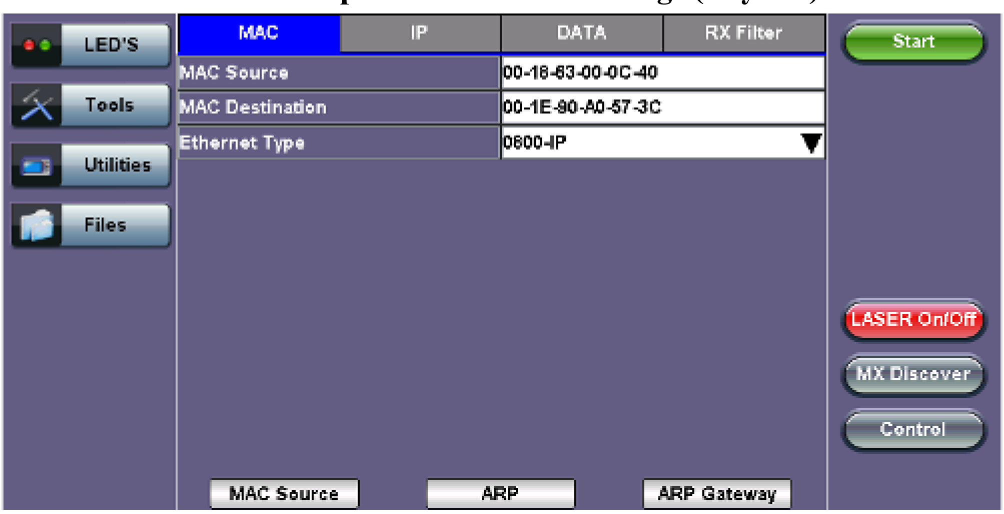
MAC, VLAN, MPLS, IP, and Test Pattern Configurations:

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 that a valid IP connection needs to be up to use these functions. Refer to **9.1 IP** in the **V300 Common Functions manual** for details on IP connection.
  - **Ethernet Type:** For Layer 3 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

BERT Setup - MAC address settings (Layer 3)



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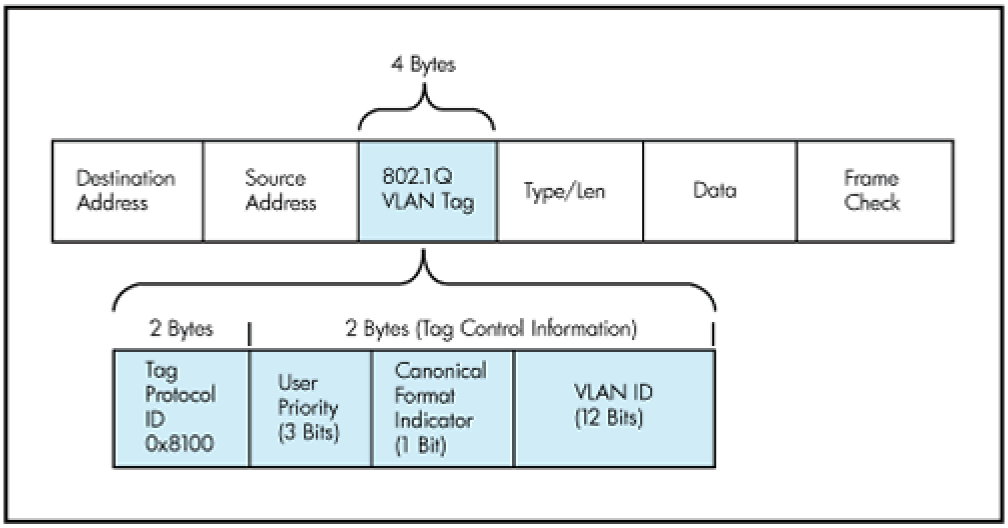
- **VLAN Tab:** In the VLAN tab the following parameters are configured:

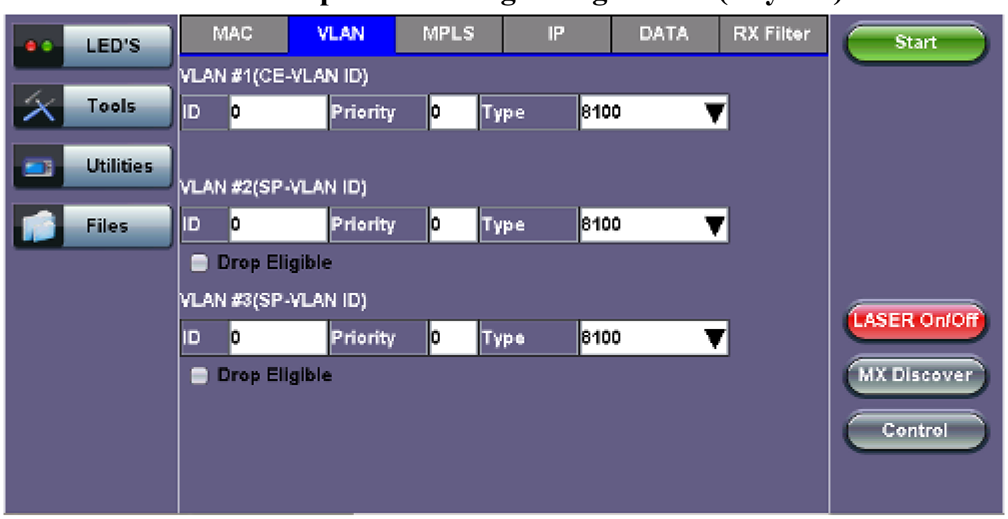
  - **VLAN ID:** Configurable in the range 1 to 4094.
    - VLAN ID is the identification of the VLAN, which is basically used by the standard 802.1Q.
    - It has 12 bits which allows the identification of 4096 (2^12) VLANs.
    - Of the 4096 possible VIDs, a VID of 0 is used to identify priority frames 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 15 are reserved).

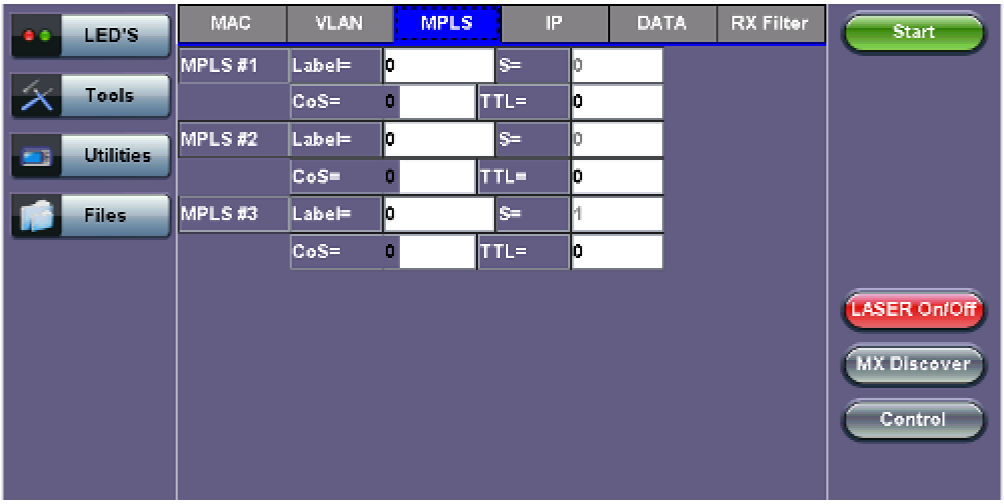
      Composed of 20 bits which allows for the creation of over one million labels.
    - **CoS:** Configurable in the range 0 to 6.

      This field is three bits in length and maps directly to IP Precedence TOS bits to provide Class of Service (COS).
    - **S-bit:** Configurable 0 or 1.

      The S field is one bit in length and is used for stacking labels. This is important as it is used to indicate the last label in the label stack.

- **TTL:** Configurable in the range 0 to 255. The default setting is 128 hops.
  Used to decrement the time-to-live counter.

BERT Setup - MPLS label configuration



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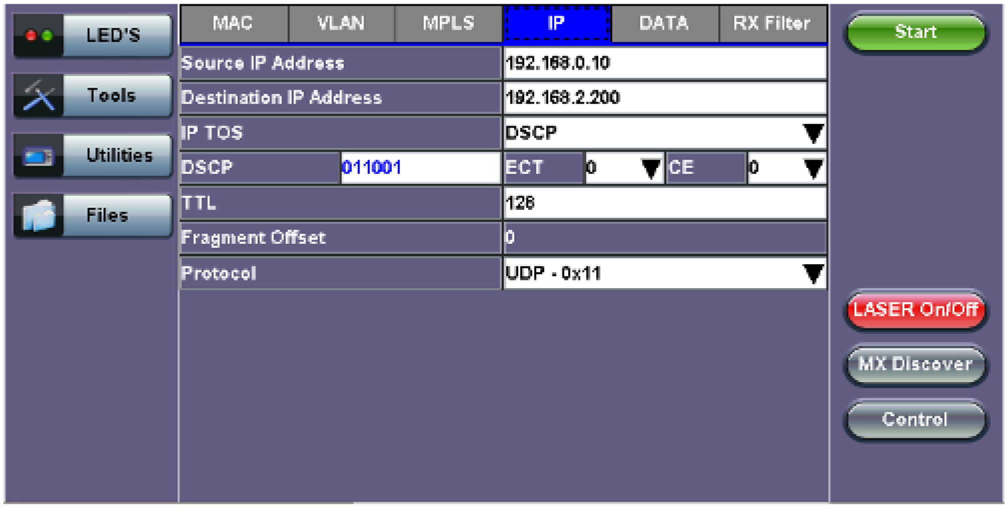
- **IP Tab:** In the IP tab the user must configure the destination IP address and source address. The user may also configure the following IP header fields:
  - **IP Type:** IPv4
  - **IP Src and IP Dest:** For IP Src, if the IP connection is up, refer to section **9.1 IP** in the **V300 Common Functions manual**. 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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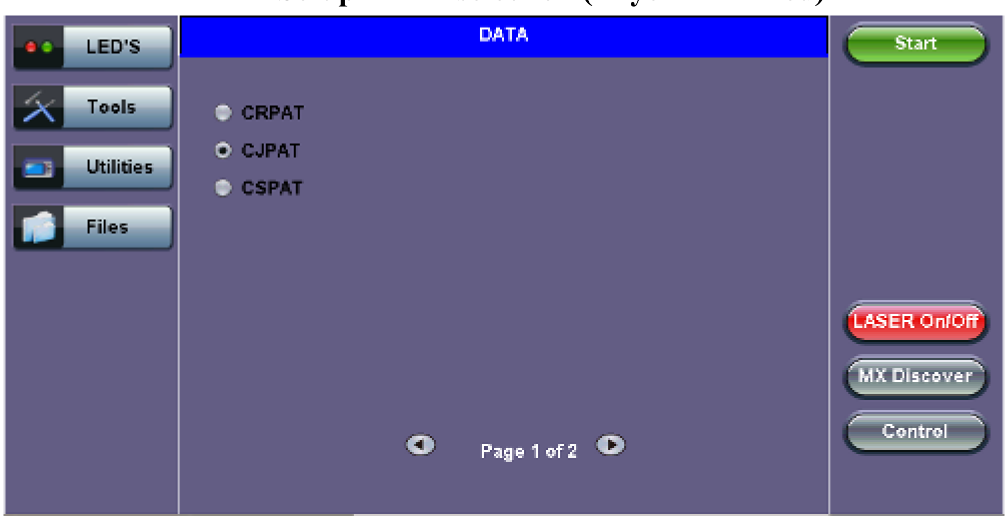
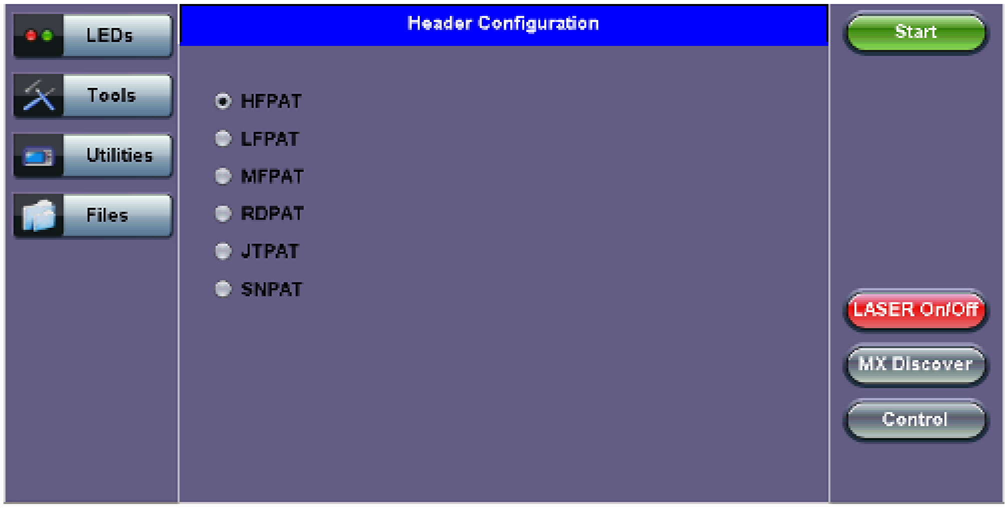
- **Data Tab:** User selects a test pattern that will be encapsulated in the Ethernet frame payload (for framed mode). Depending on the test layer, different test pattern options are available.
  - **Layer 1 Framed Test Patterns**
    - **CRPAT:** Compliant Random Pattern provides broad spectral content and minimal peaking for the measurement of jitter at component or system level.
    - **CJTPAT:** Compliant Jitter Test Pattern is a 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.
    - **CSPAT:** Compliant Supply Noise Pattern. Represents worst case power supply noise.

BERT Setup - Data selection (Layer 1 Framed)



BERT Setup - Data selection - (Layer 1 Unframed)



- **Layer 1 Unframed Test Patterns**
  - **HFPAT (High Frequency Pattern):** This test pattern is to test random jitter (RJ) at a BER of 10-12, and also to test the asymmetry of transition times. This high frequency test pattern generates a one, or light on, for a duration of 1 bit time, followed by a zero, or light off, for a duration of 1 bit time. This pattern can be generated by the repeated transmission of the D21.5 code-group. Disparity rules are followed.
  - **LFPAT (Low Frequency Pattern):** The intent of this test pattern is to test low frequency RJ and also to test PLL tracking error. This low frequency test pattern generates a one, or light on, for a duration of 5 bit times, followed by a zero, or light off, for a duration of 5 bit times. This pattern can be generated by the repeated transmission of the K28.7 code-group. Disparity rules are followed.
  - **MFPAT (Mixed Frequency Pattern):** The intent of this test pattern is to test the combination of RJ and deterministic jitter (DJ). This mixed frequency test pattern generates a one, or light on, for a duration of 5 bit times, followed by a zero, or light off, for a duration of 1 bit times, followed by a one for 1 bit time followed by a zero for 1 bit time followed by a one for 2 bit times followed by a zero for 5 bit times followed by a one for 1 bit time followed by a zero for 1 bit time followed by a one for 1 bit time followed by a zero for 2 bit times. This pattern can be generated by the repeated transmission of the K28.5 code-group. Disparity rules are followed.
  - **RDPAT (Random Data Pattern):** Designed to provide energy across the entire frequency spectrum providing good simple BER testing.
  - **JTPAT (Jitter Tolerance Pattern):** Designed to verify jitter tolerance on the receivers by exposing a receiver's CDR to large instantaneous phase jumps. The pattern alternates repeating low transition density patterns with repeating high transition density patterns.
  - **SNPAT (Supply Noise Pattern):** Designed to simulate the worst case power supply noise that could be introduced by a transceiver.

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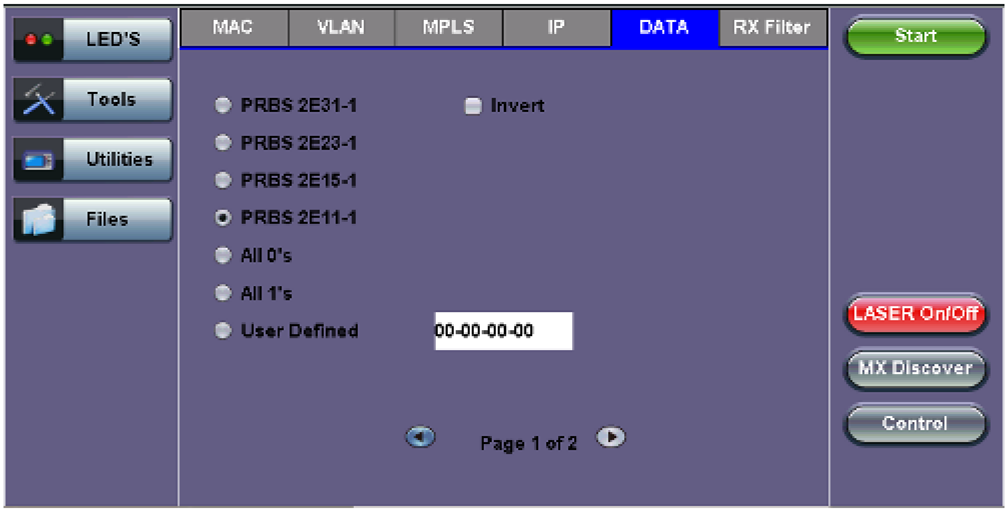
- **Layer 2, 3, & 4 test patterns (40GE and 100GE only support up to Layer 3)**
  - **PRBS:**
    - 2^31 -1 (147 483 647-bit pattern used for special measurement tasks, [e.g., delay measurements at higher bit rates])
    - 2^23 -1 (8 388 607 bit pattern primarily intended for error and jitter measurements at bit rates of 34 368 and 139 264 kbps)
    - 2^15 -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)
    - 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)

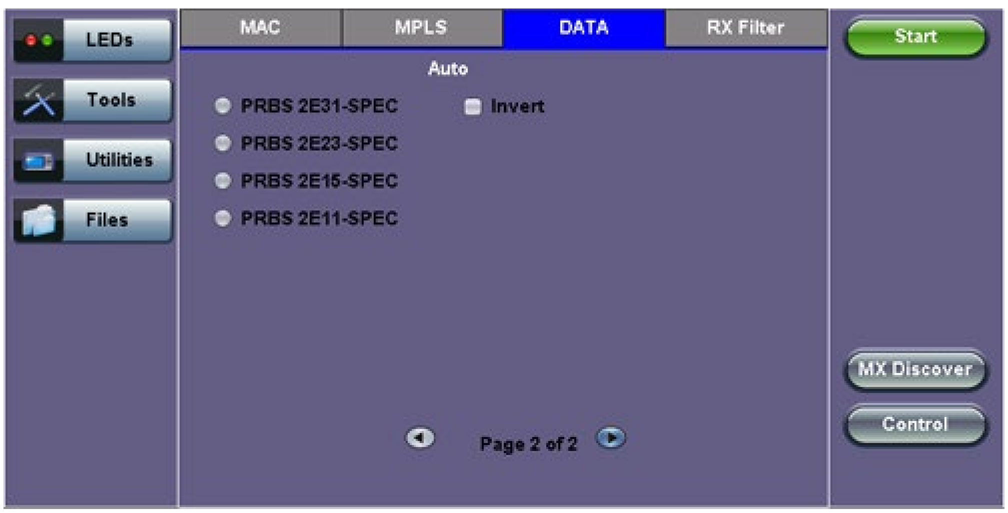
- **Fixed:** All 0s or All 1s
- **User Defined pattern:** Length depends on size of frame
- **Inversion:** Normal or inverted

BERT Setup - Data selection - PRBS Patterns (Page 1)



- **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.

BERT Setup - Data selection - Special Patterns (Page 2)



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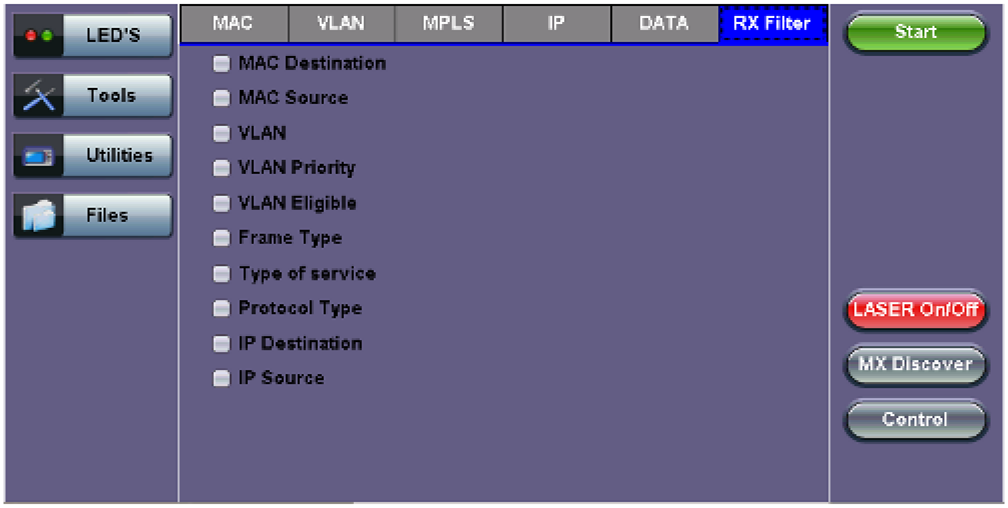
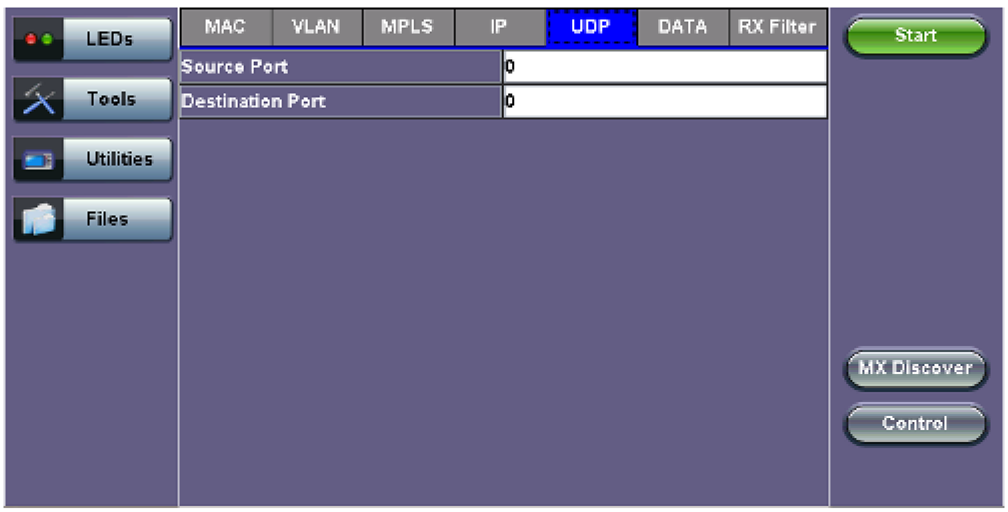
- **RX Filter Tab:** Allows the user to filter incoming streams. When checked, the incoming traffic flows not matching these criteria will not be considered for these results.
  - MAC Destination address
  - MAC Source address
  - VLAN
  - VLAN Priority
  - VLAN Eligible
  - Frame Type
  - Type of Service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

Traffic Tab

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

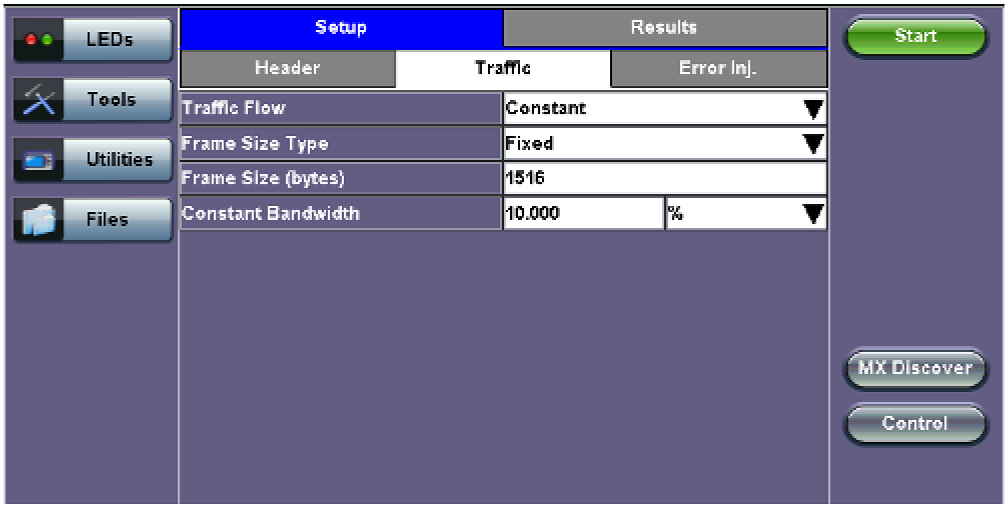
- **Traffic Flow:** Select from the following traffic flows:
  - **Constant:** The selected frame is transmitted continuously according to the selected bandwidth %.
  - **Ramp:** The selected frame is transmitted at maximum bandwidth according to the selected duty cycle and burst period.
  - **Burst:** 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 1518 bytes, in addition to jumbo frames up to 10000 bytes

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

BERT Setup - Constant Traffic



Note: Frame Size Limitations

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

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13.2.1.3 Error Injection

( This description is for 10GE only)

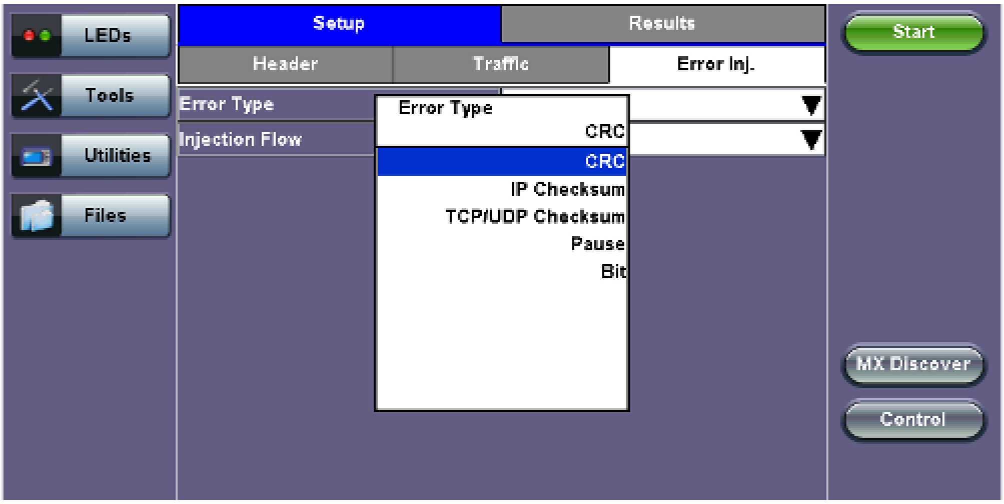
Error injection can be performed during testing. The error type and injection rate are configured in the Error Injection tab.

- **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 - Injection Error



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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13.2.1.4 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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13.2.2 BERT Results

13.2.2.1 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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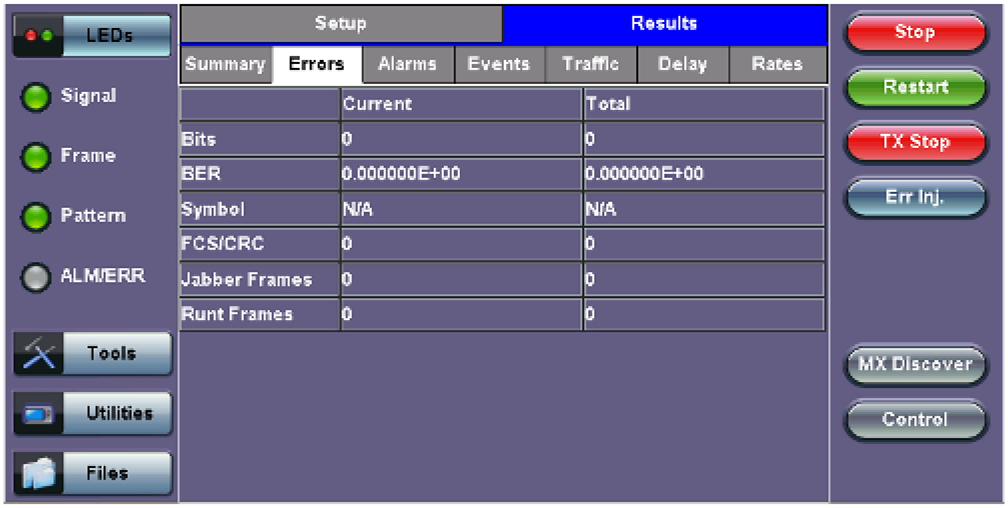
13.2.2.2 Errors

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 1518 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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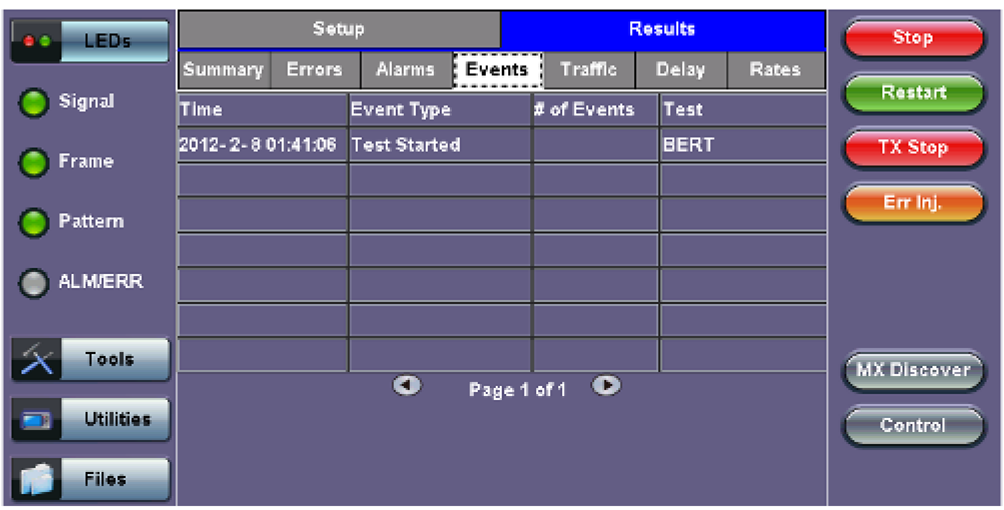
13.2.2.3 Events

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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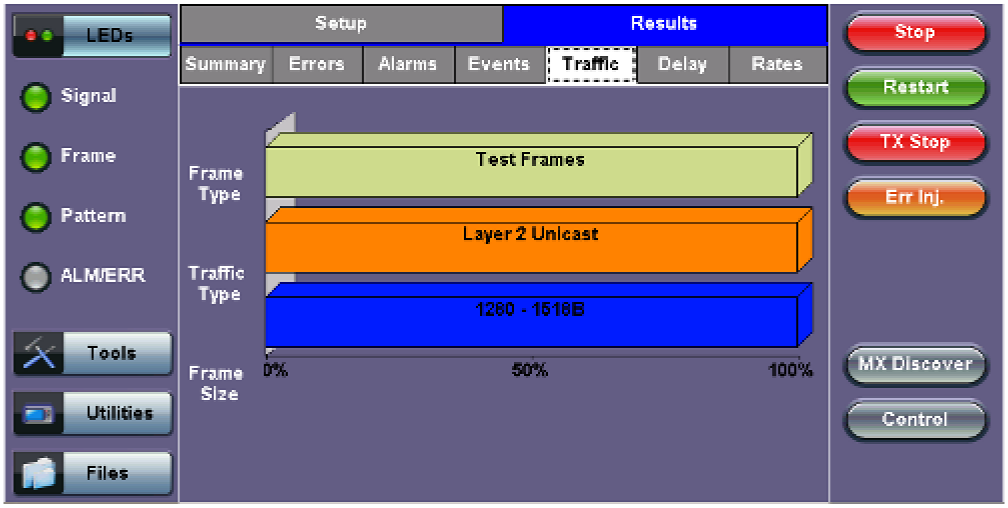
13.2.2.4 Traffic

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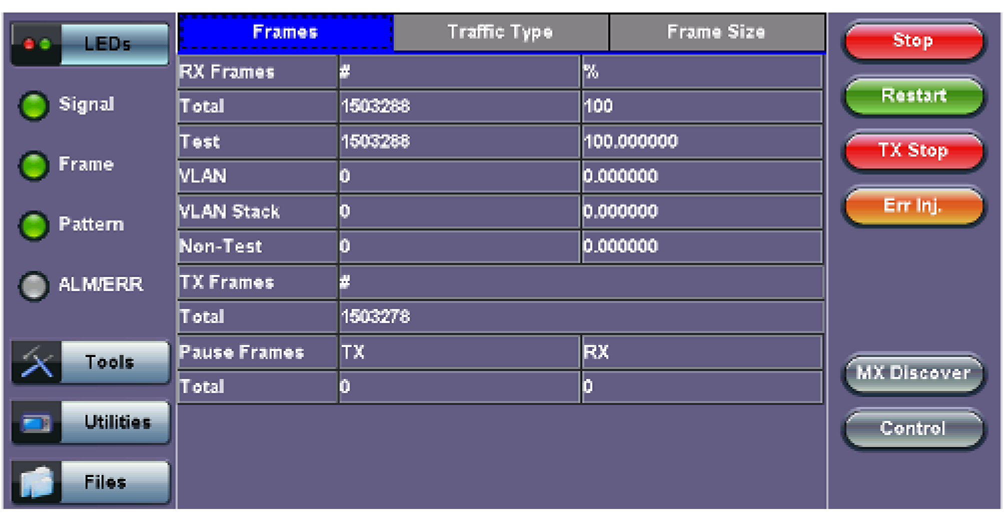
Frames tab: The following Frame distribution statistics are displayed in Count (#) and Percentage (%):

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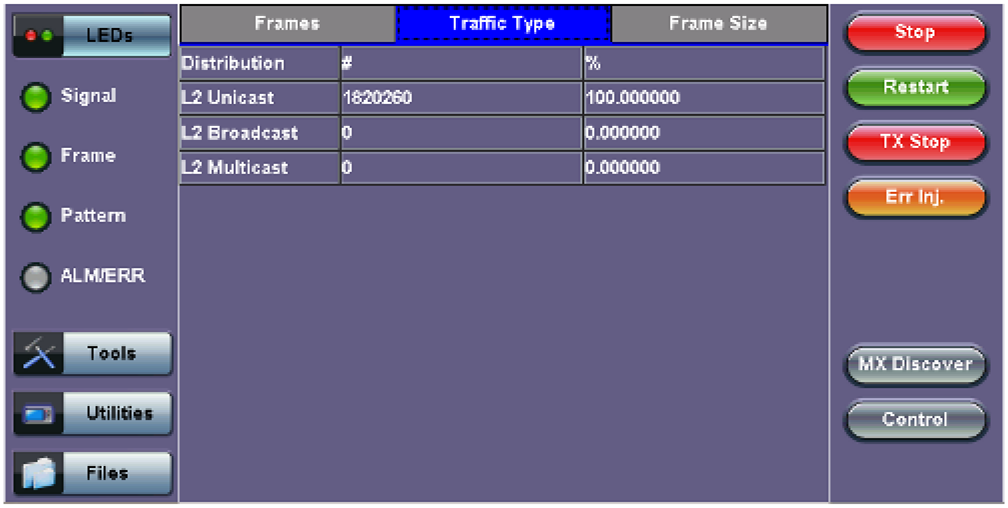
Traffic Type tab: The following Traffic distribution statistics are displayed in Count (#) and Percentage (%):

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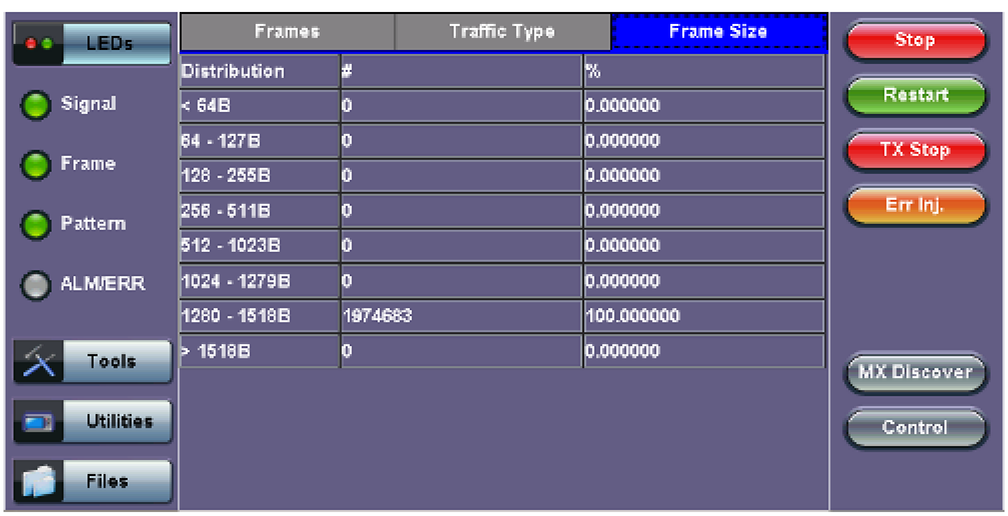
Frame Size tab: The following Frame distribution statistics are displayed in Count (#) and Percentage (%):

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

BERT Results - Frame Size



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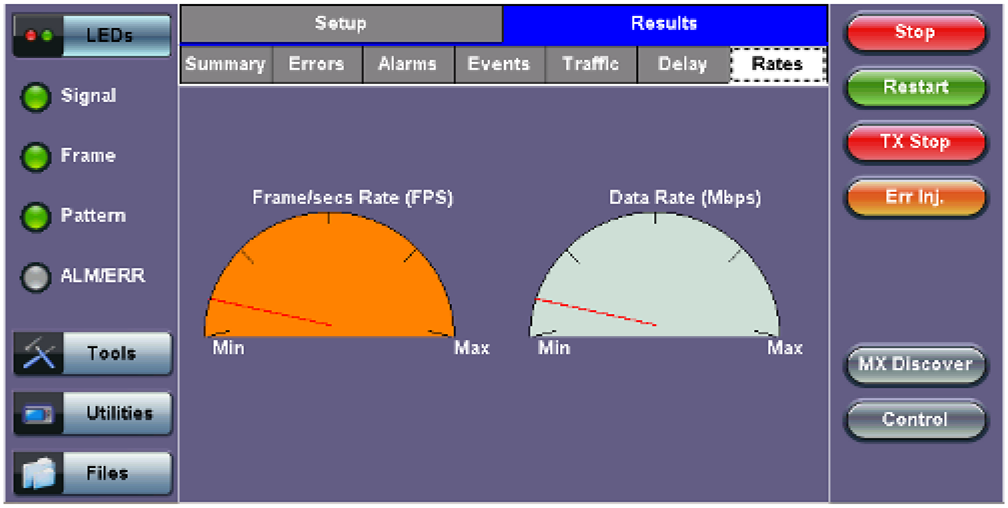
13.2.2.5 Rates

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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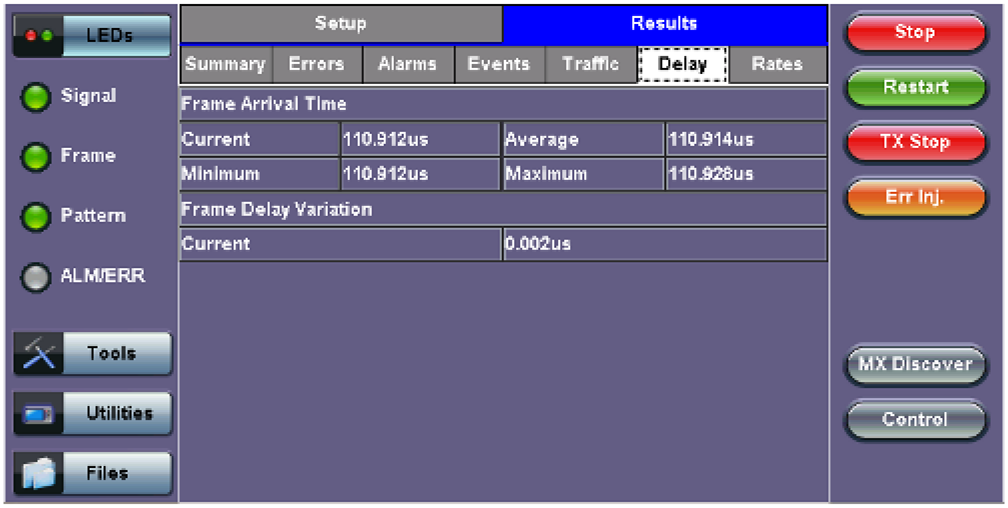
13.2.2.6 Delay

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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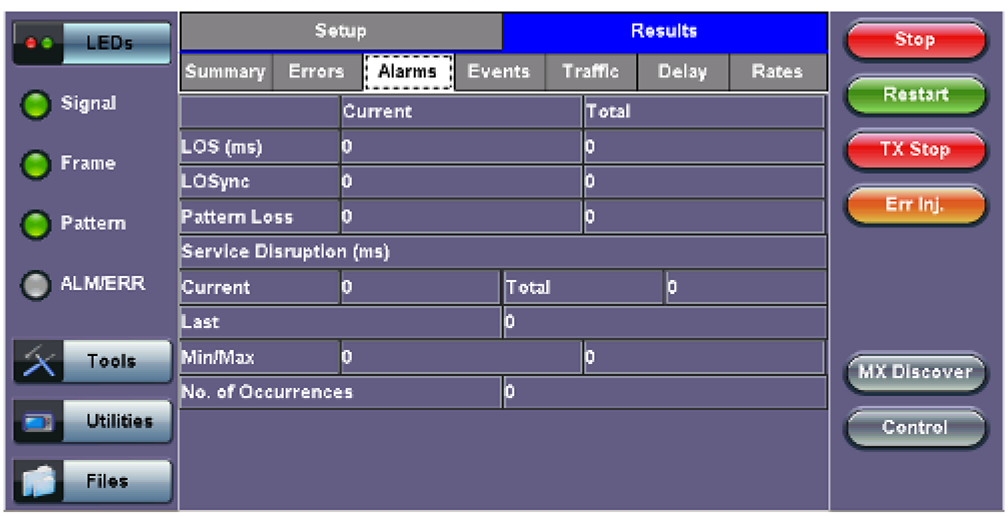
13.2.2.7 Alarms

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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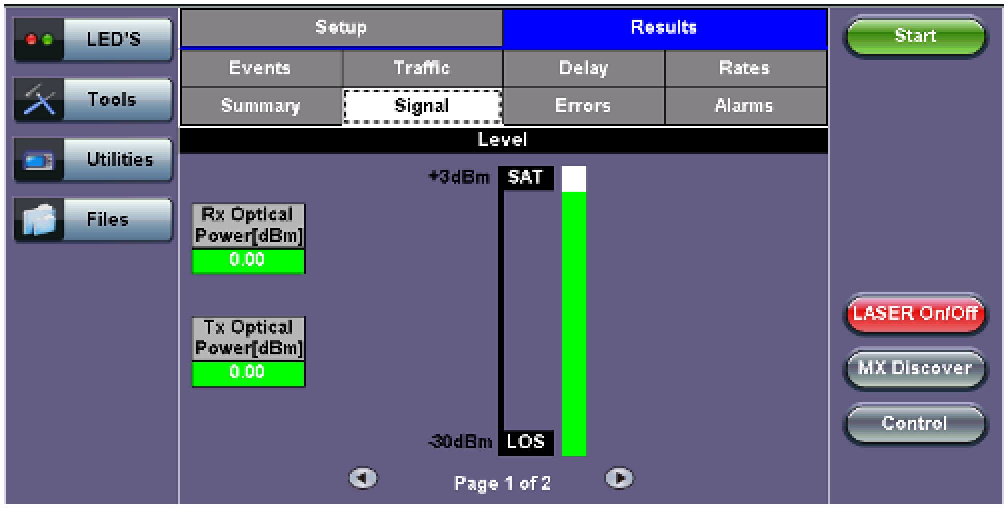
13.2.2.8 Signal

The Signal tab (fiber ports only) displays the optical level measured by the SFP or XFP transceiver.

BERT Results - Signal



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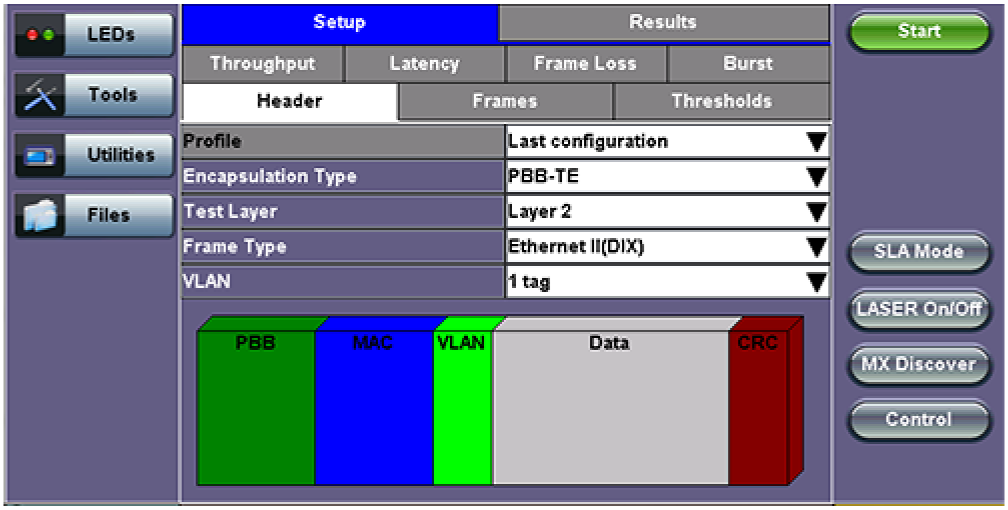
13.3 RFC 2544 Conformance Testing

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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13.3.1 Setup - Standard Mode

Unless otherwise noted, the Frame Header and related setups are identical to the setups described in the BERT Application above. A summary of the RFC 2544 setup options are outlined below.

13.3.1.1 Header Settings

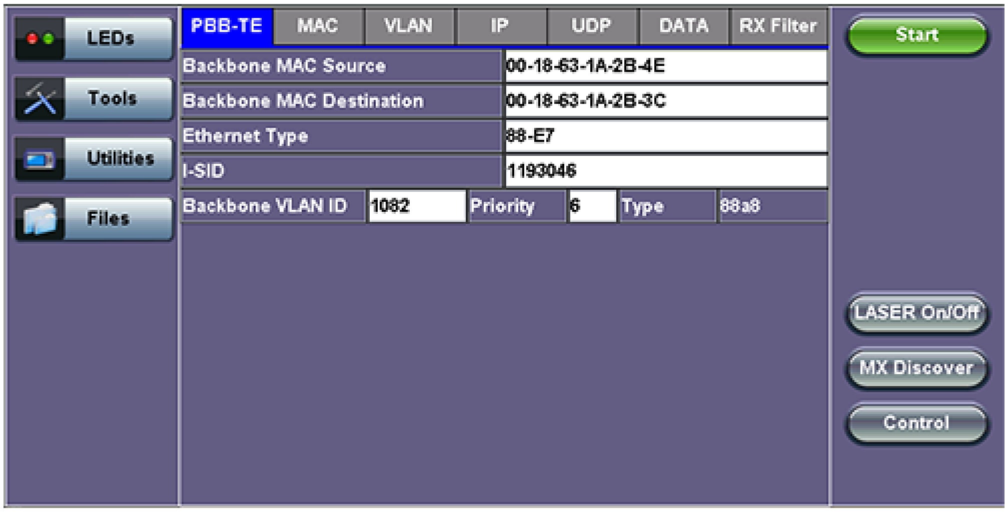
- **RFC 2544 Profile:** Load a previously configured test profile or create a new profile from existing settings. Please see **6.0 Profiles** in the **ReVeal MTX300 manual** for more details on how to create new profiles using ReVeal software.

- **Encapsulation Type:** None or **Provider Backbone Bridge (PBB-TE):** 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. Available for 1GE Copper/Fiber and 10GE port. PBB encapsulation is available for all Ethernet tests (Layer 2, 3 and 4) - BERT, RFC2544, Throughput, V-SAM.

  Tap the PBB block to configure the settings. All PBB fields are configurable.

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

PBB



- **Test:** Select the test layer to perform the test.
  - Options are Layer 2, Layer 3, and Layer 4.

- **Frame Type:** Select the Ethernet frame type for Layer 2, Layer 3 or Layer 4.
  - 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.

- **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).

    VLAN stacking is an option.

- **MPLS:** Off, 1 tag, 2 tags, 3 tags.
  - The user is able to configure up to 3 MPLS tags.

    MPLS tag configuration is only available when the MPLS option is purchased.

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

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

  For more information on header configuration please see 13.2.1.1 Header Settings in the BERT section.

- **MAC Header Tab:**
  - **MAC Source:** Use the default source address of the test set or configure a new or different address. See MAC address editing screen shot below.
  - **MAC Destination**: Configure the destination MAC address of the far-end partner test set. See MAC address editing screen shot below.
  - **Ethernet Type:** For Layer 3 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

RFC 2544 Setup - MAC address editing

- **Data Tab:** No payload selection is possible.
  The payload area is populated with a VeEX signature field and other proprietary data.

- **RX Filter Tab:** Depending on test layer, allows the user to filter streams by:
  - MAC Destination address
  - MAC Source address
  - VLAN ID
  - IP Destination address
  - IP Source address

- **VLAN Tab:** VLAN ID, priority, and Tag Type (Ethernet Type) can be configured. Please refer to the BERT application for more details.

- **MPLS Tab:** MPLS label, CoS priority settings, TTL, and S-bit fields are configured for available MPLS tags. Please refer to the BERT application for more details.

- **IP Tab:** User configures the source and destination IP addresses.
  The user can also configure the following IP header fields; IP TOS (for quality of service testing), TTL, fragment offset byte, and the protocol field. Please refer to the BERT application for more details.

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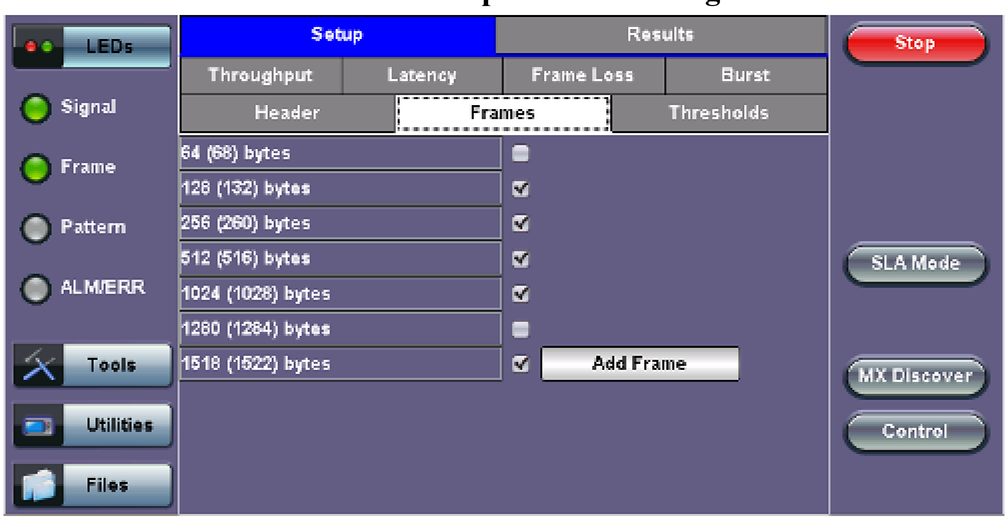
13.3.1.2 Frames Settings

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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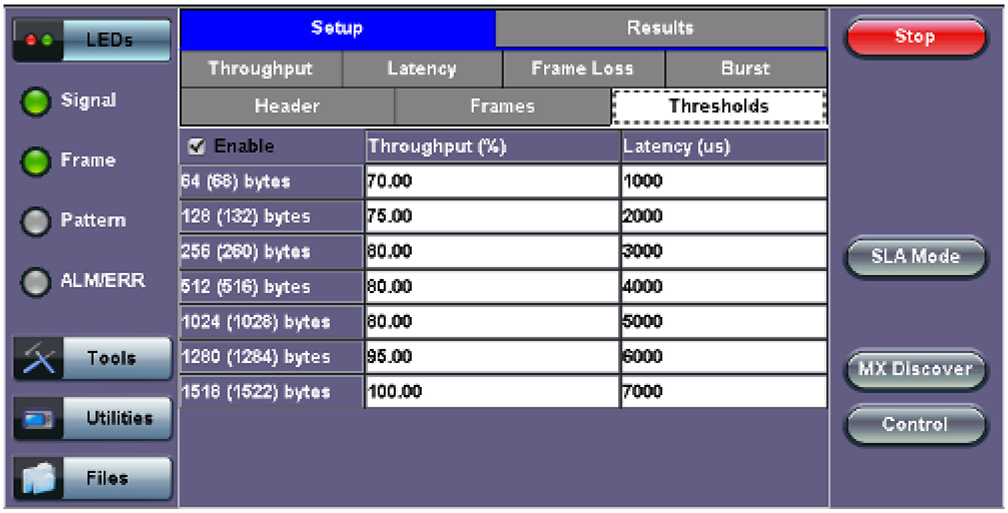
13.3.1.3 Threshold Settings

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.
  - 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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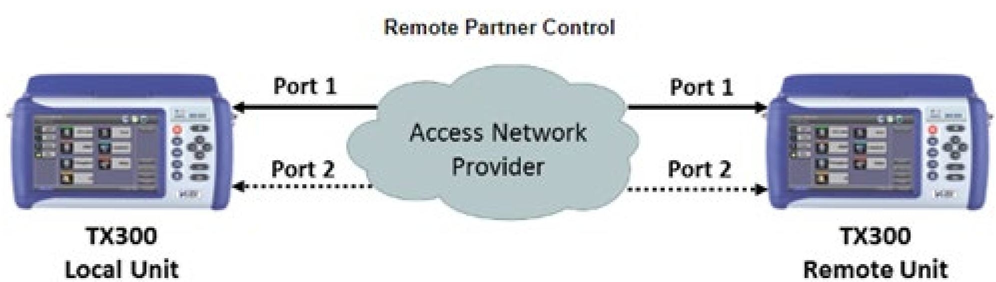
13.3.1.4 Peer-to-Peer Asymmetric Testing

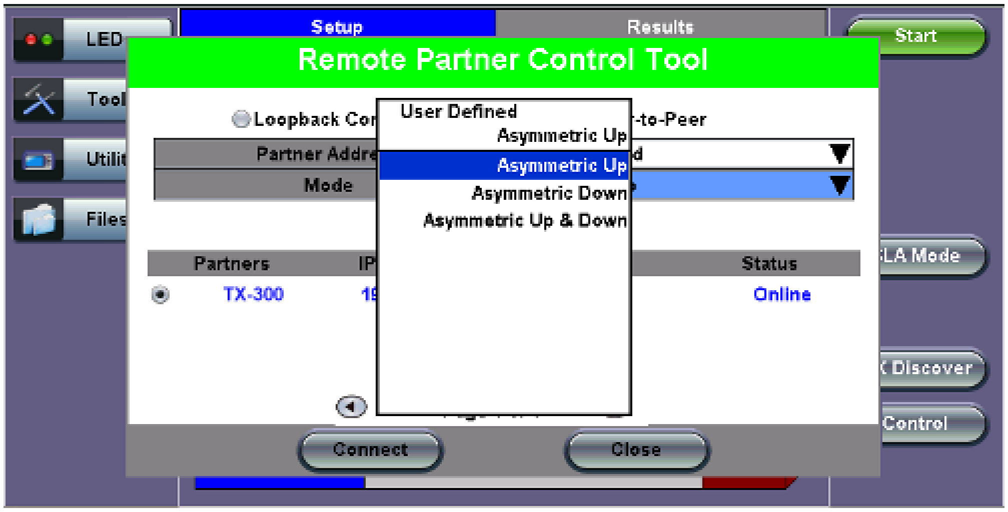


When the local unit connects to the remote (peer) partner, it loads the same configuration profile (header, traffic, and frame size) to the remote partner, with the MAC and IP addresses inverted. From the peer-to-peer menu, asymmetric testing becomes available.

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 Control

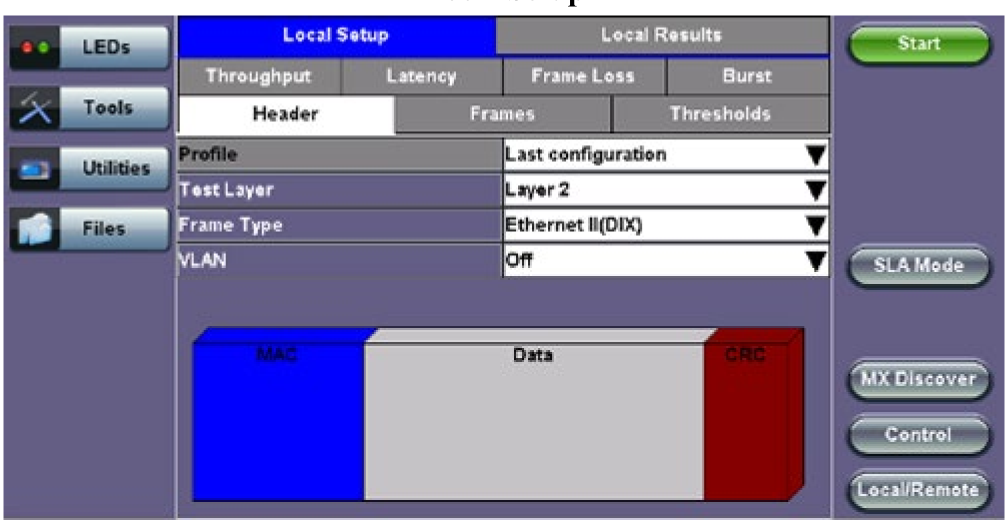


Asymmetric Testing Setup

- **Partner Address:** Select MX Discovered or User Defined. For instructions and further information on the MX Discovered and User Defined options, please see [13.5.1.2 MX Discover and Control.]
- **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 directions.
- Press **Connect**.

The user is able to configure and view the local/remote unit's setup and results. Tap on the **Local/Remote** button on the right side menu to toggle between the two settings.

Local Setup



13.3.1.5 Throughput, Latency, Frame Loss, and Burst Settings

The RFC 2544 test suite allows the user to run all four tests, one of the four tests, or a combination of any of the four tests. The user simply has to enable/disable which tests to perform by checking/unchecking a selection box in the respective tab for each test. By default all four tests are enabled.

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

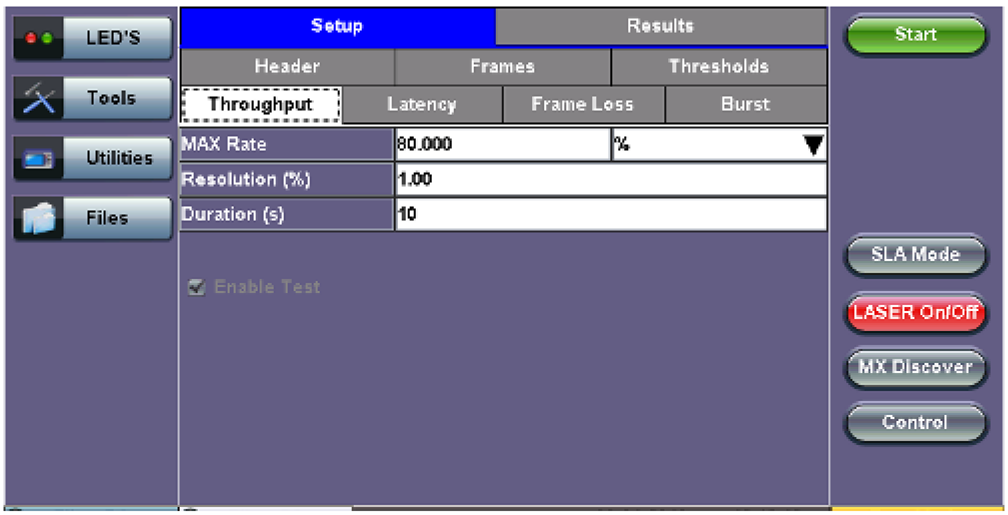
Throughput tab:

- **Max Rate:** Up to 100% of the negotiated line rate. The default value is 100%.
  - This is the maximum transmit rate to perform the 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.

- **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.

RFC 2544 Setup - Throughput Settings



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Latency tab:

User configures the following:

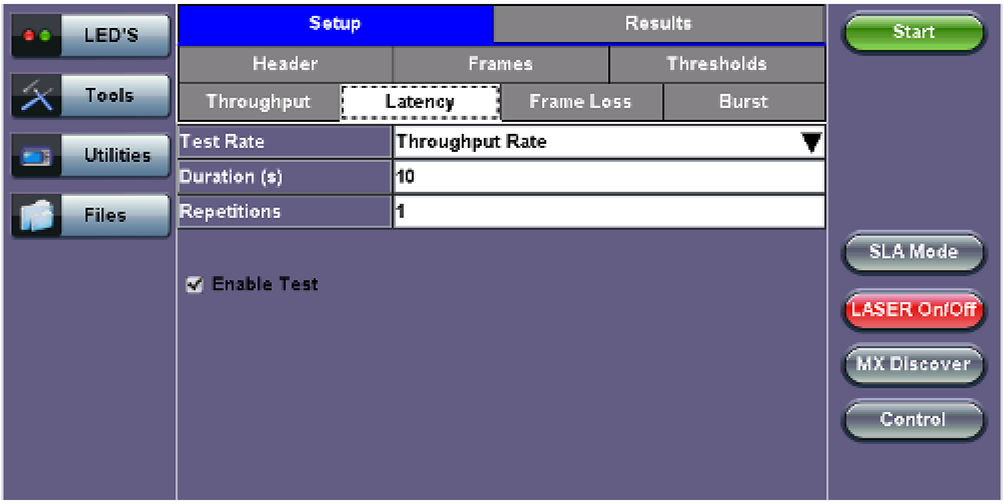
- **Test:** Throughput Rate or Custom Rate. The default value is throughput.
  - **Throughput rate**: Latency test will be performed at the throughput rate found for each of the tested frame sizes.
  - **Custom rate:** User configures a custom rate in % or Mbps.

- **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.

RFC 2544 Setup - Latency Settings



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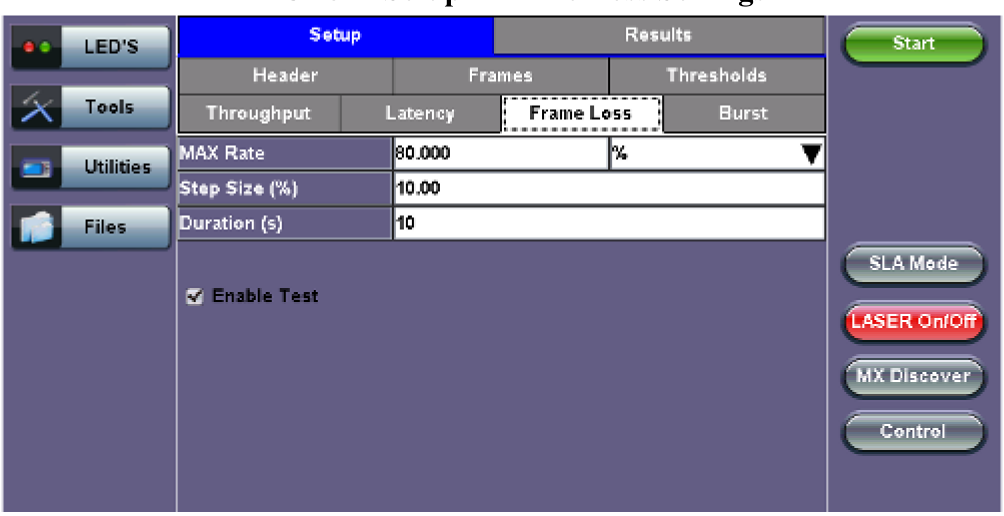
Frame Loss tab:

- **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.

- **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:

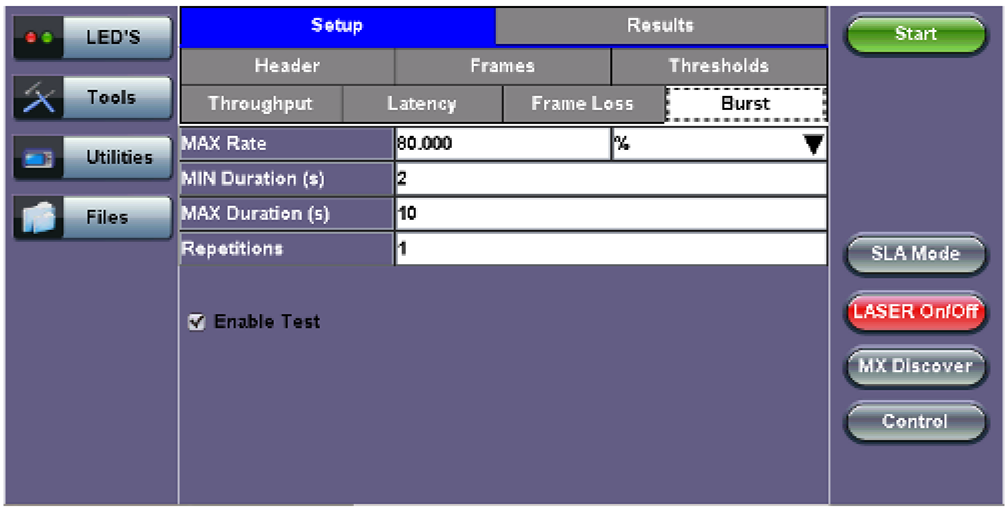
- **Max Rate:** The default value is 100%.
  In the burst test, frames are always transmitted at the maximum rate for a given minimum and maximum burst duration.

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

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

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

RFC 2544 Setup - Burst Settings



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13.3.1.6 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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13.3.2 Results - Standard Mode

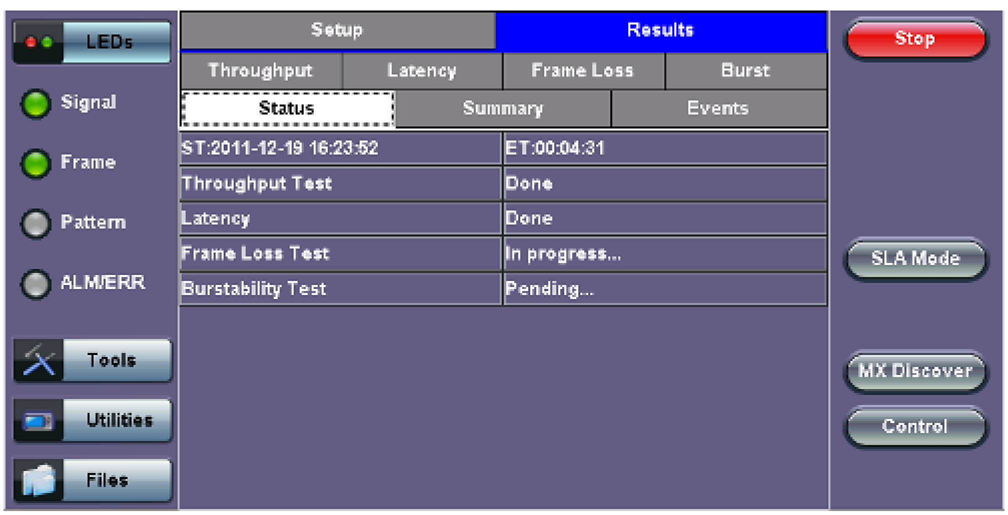
The progress and current result of the RFC 2544 can be viewed as the test is in progress.

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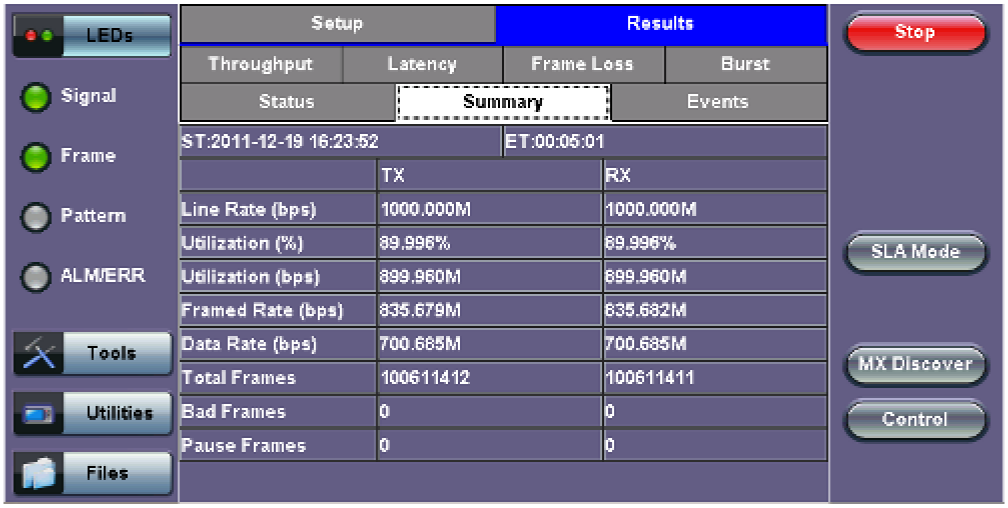
Summary tab: The following results including the Start (ST) and Elapsed (ET) times are displayed:

- **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).

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

RFC 2544 Results - Summary



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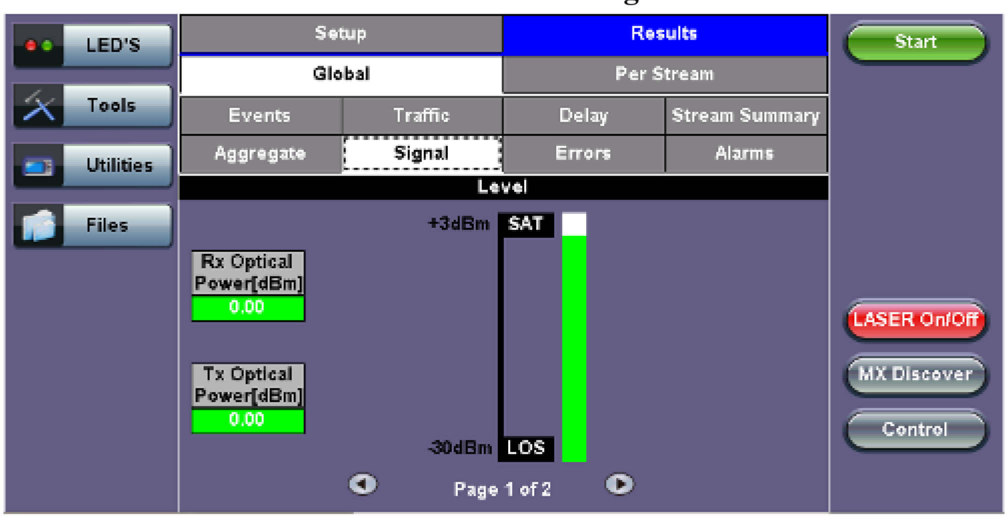
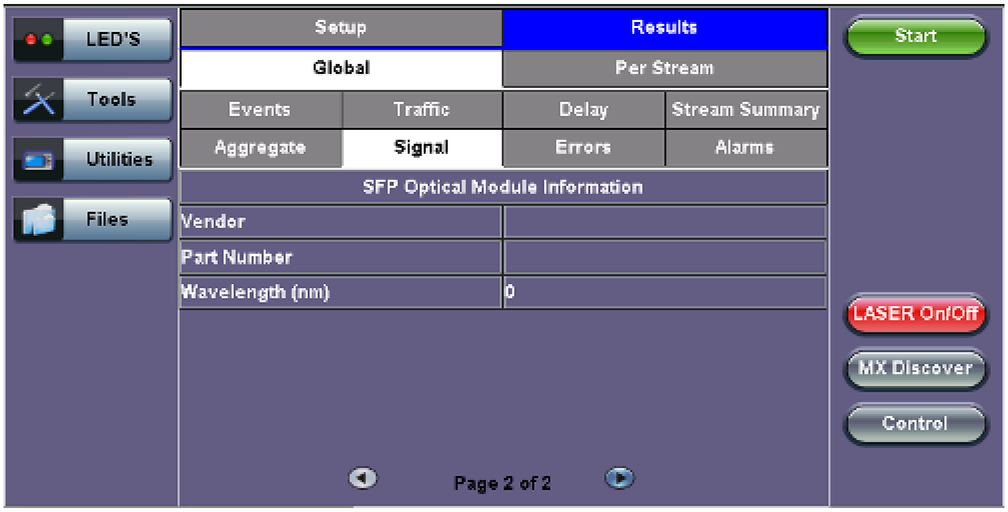
Signal tab:

The Signal tab (fiber ports only) displays the optical level measured by the SFP or XFP transceiver.

RFC 2544 Results - Signal



RFC 2544 Results - Signal (page 2)



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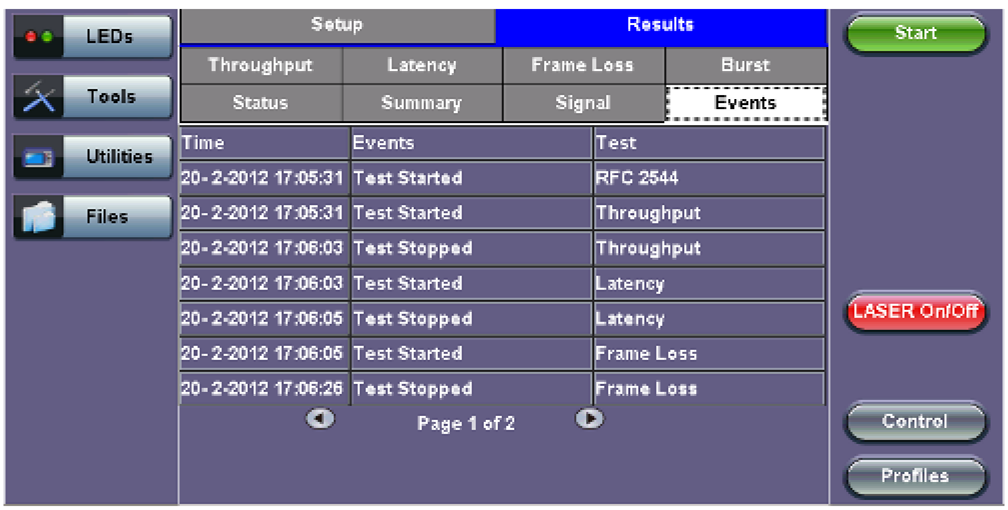
Events tab:

A time stamped log of each test is displayed.

RFC 2544 Results - Events



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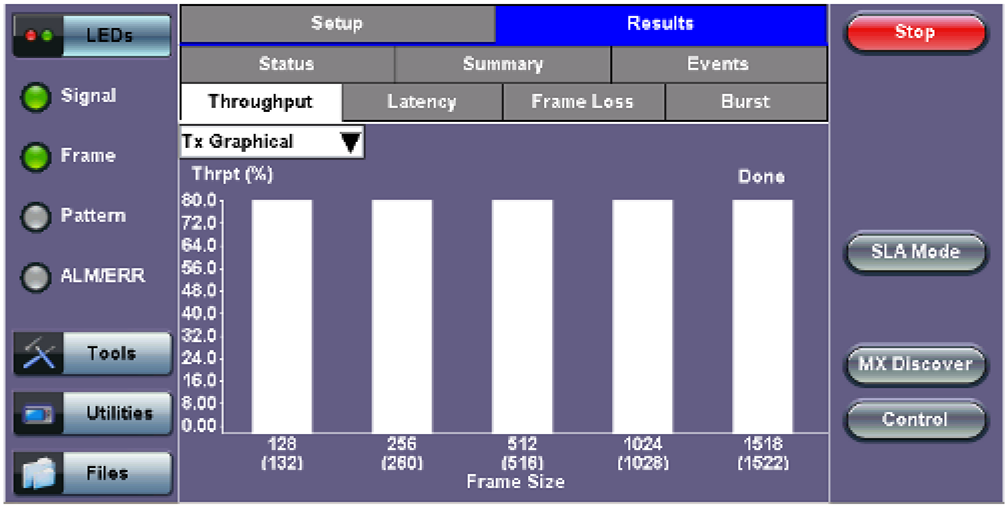
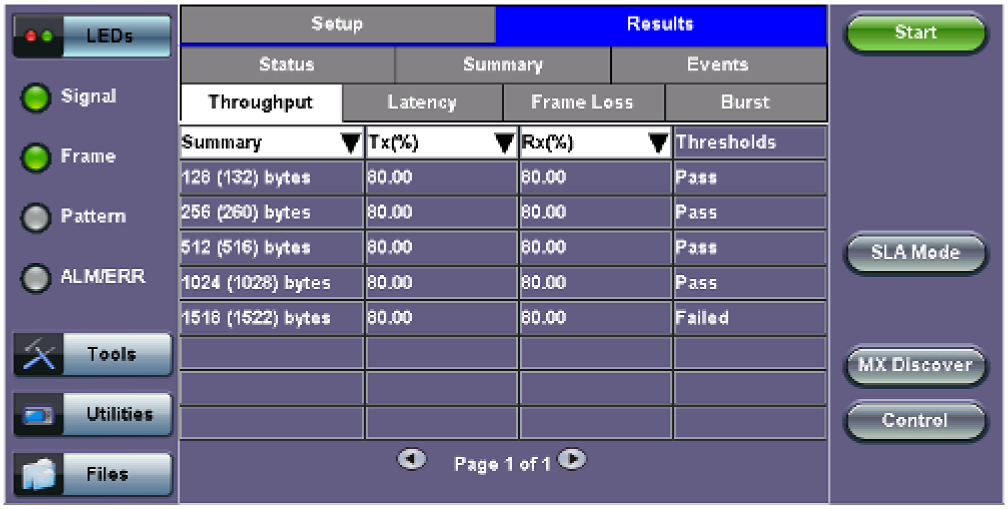
The Throughput tab displays the maximum throughput rate of the link under test. Results are displayed in graphical and table formats. Use the drop-down menu to change the display format.

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

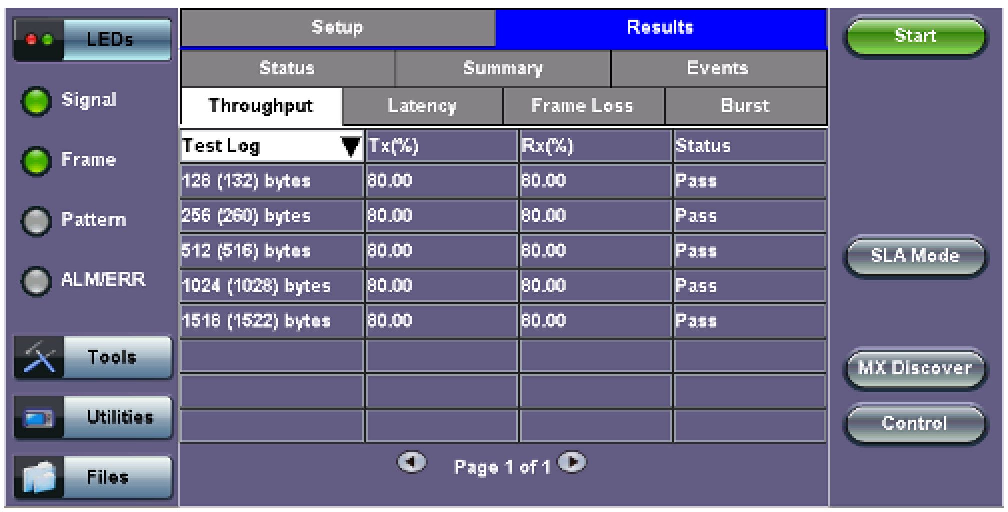
RFC 2544 Results - Throughput (Tx Graphical)



RFC 2544 Results - Throughput (Summary Table)



RFC 2544 Results - Throughput (Test Log Table)



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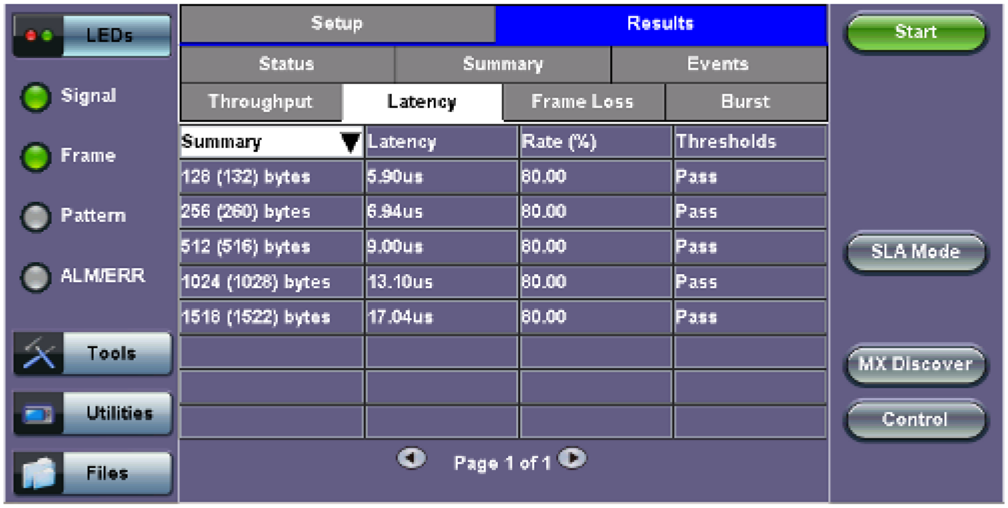
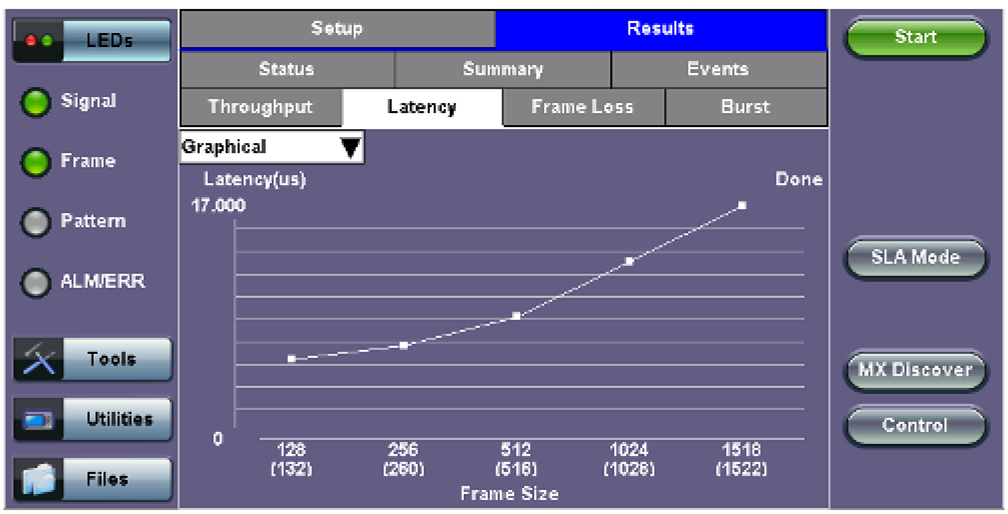
Latency and frame jitter measurements results are displayed in the following formats. Use the drop-down menu to select the Latency format:

- **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.

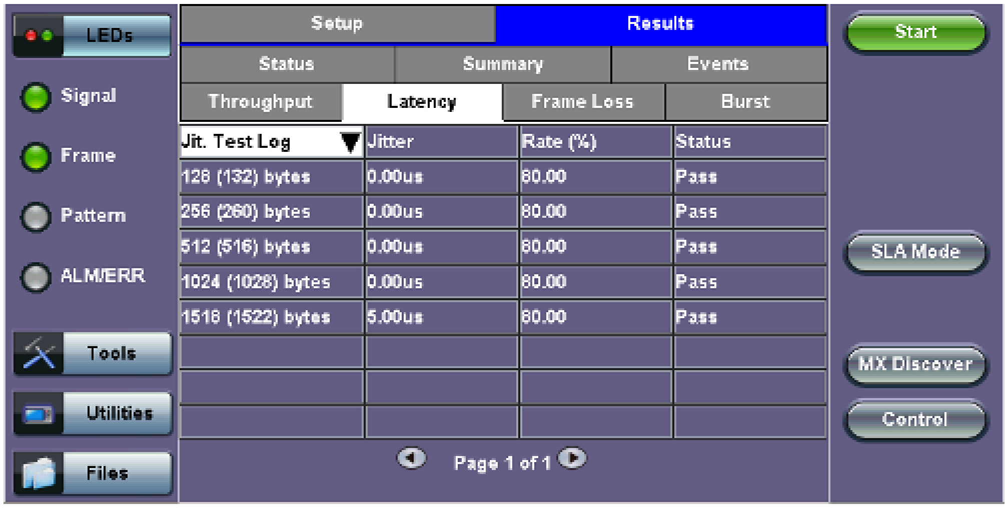
RFC 2544 Results - Latency (Summary)



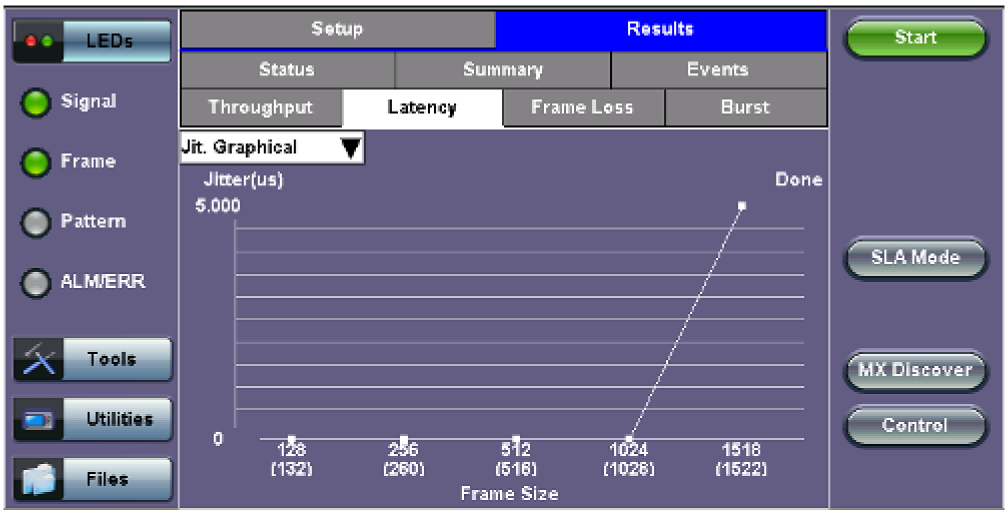
RFC 2544 Results - Latency (Graphical)



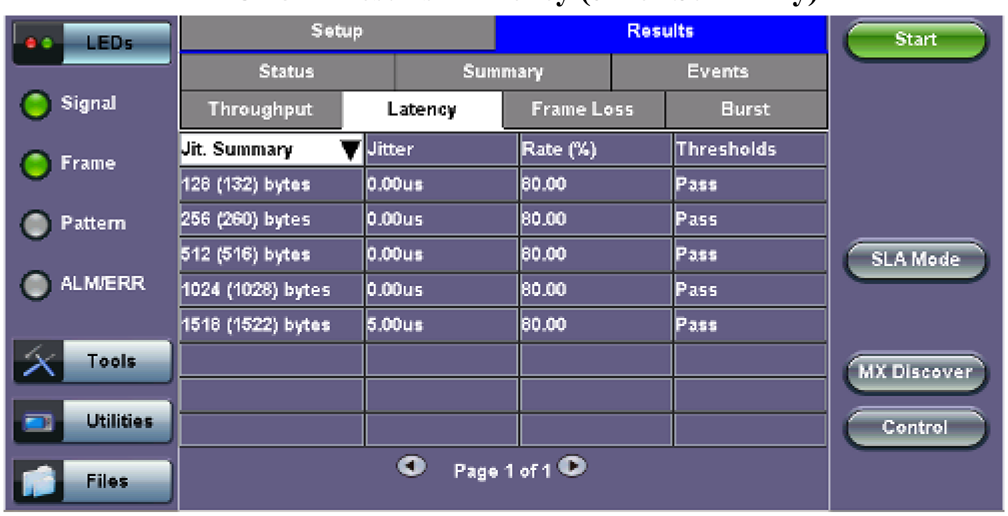
RFC 2544 Results - Latency (Test Log)



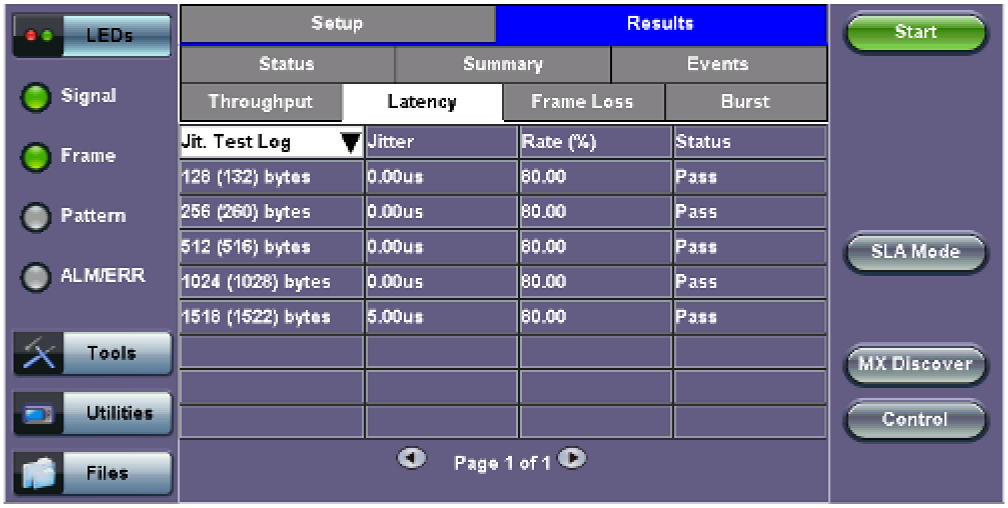
RFC 2544 Results - Latency (Jitter Graphical)



RFC 2544 Results - Latency (Jitter Summary)



RFC 2544 Results - Latency (Jitter Test log)



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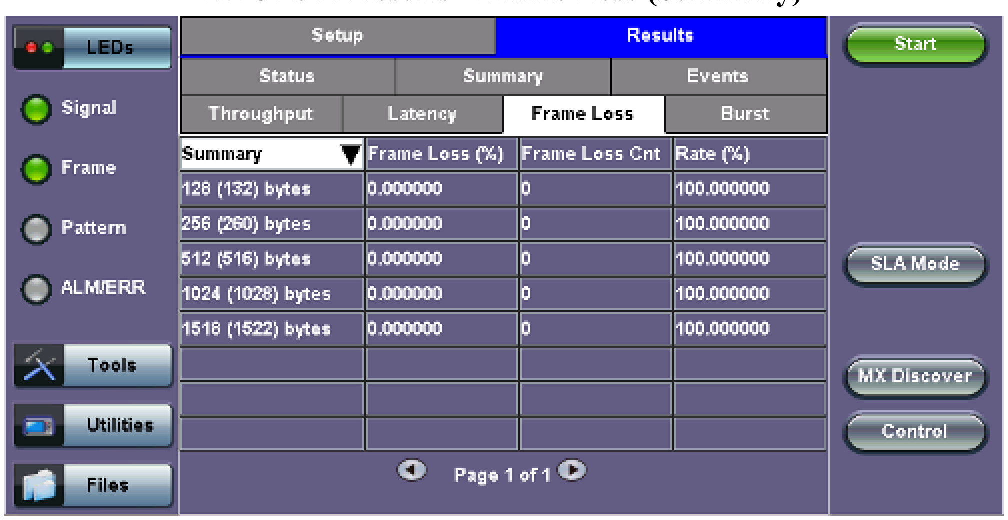
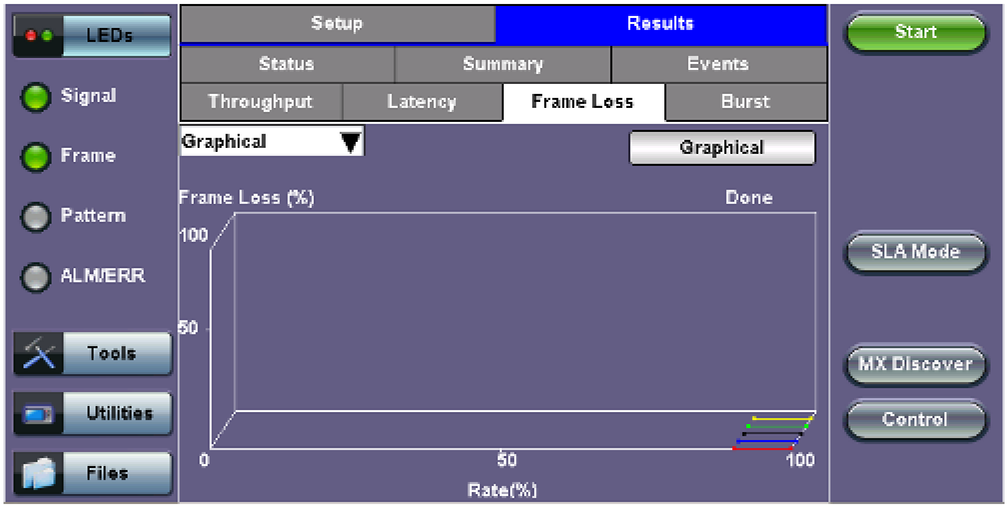
Frame Loss tab: Frame loss displays the percentage of frames not received. Use the drop-down menu to select the Frame Loss format:

- 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 magnifying glass to see the legend.

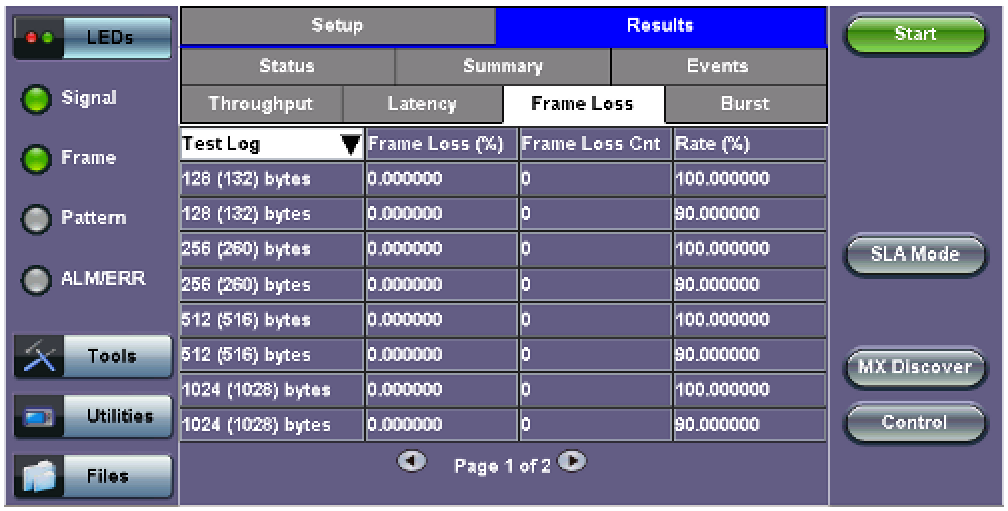
RFC 2544 Results - Frame Loss (Summary)



RFC 2544 Results - Frame Loss (Graphical)



RFC 2544 Results - Frame Loss (Test log)



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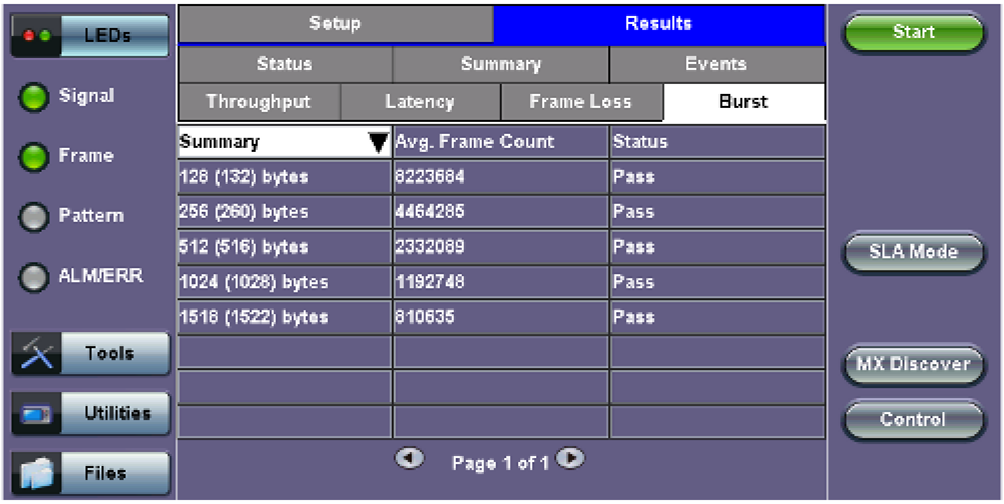
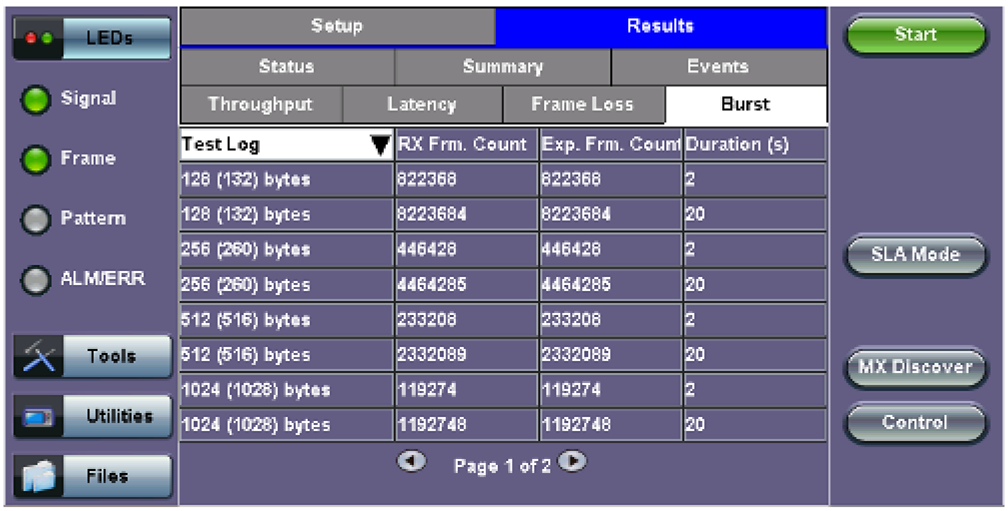
Burst tab: Burstability (back-back) results are the number of frames successfully transmitted/received at the line rate. It is displayed in the following formats:

- **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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13.3.3 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 **Home** > **Files** > **Saved**.

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13.3.4 Advanced SLA Mode

SLA Mode is not available for 40G and 100G.

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.

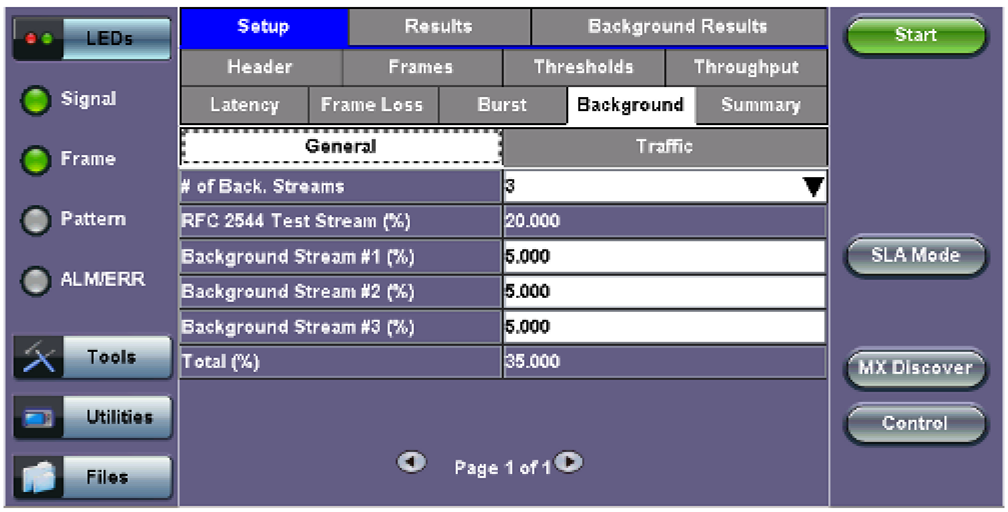
Setup

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

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

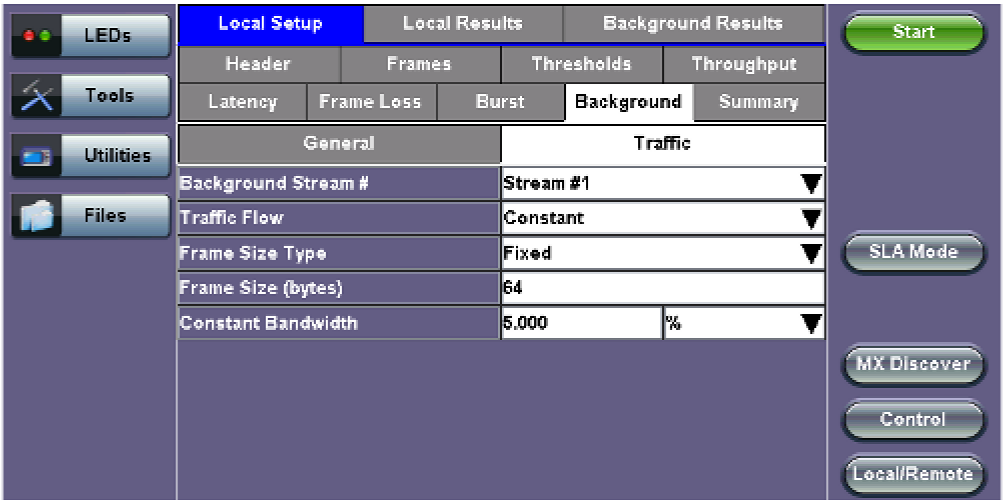


Background - Traffic

- **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 - 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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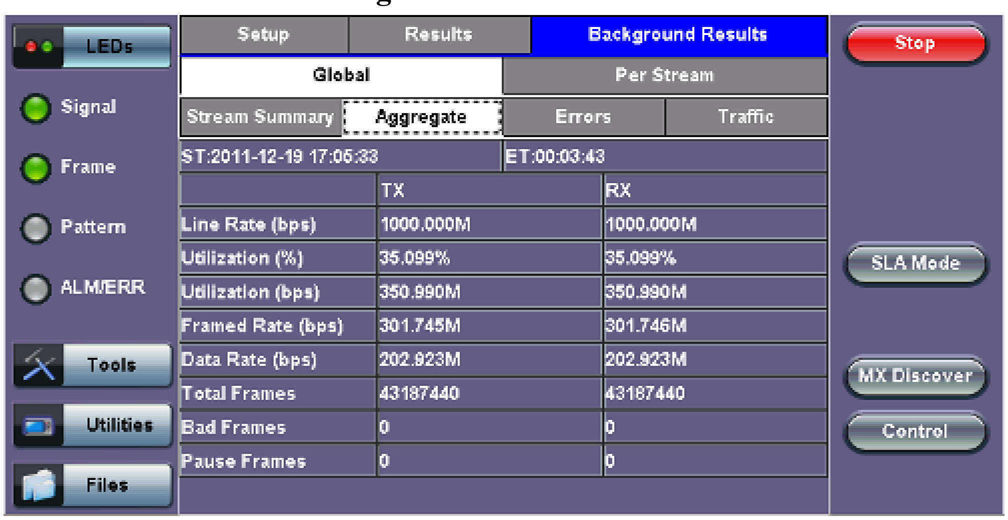
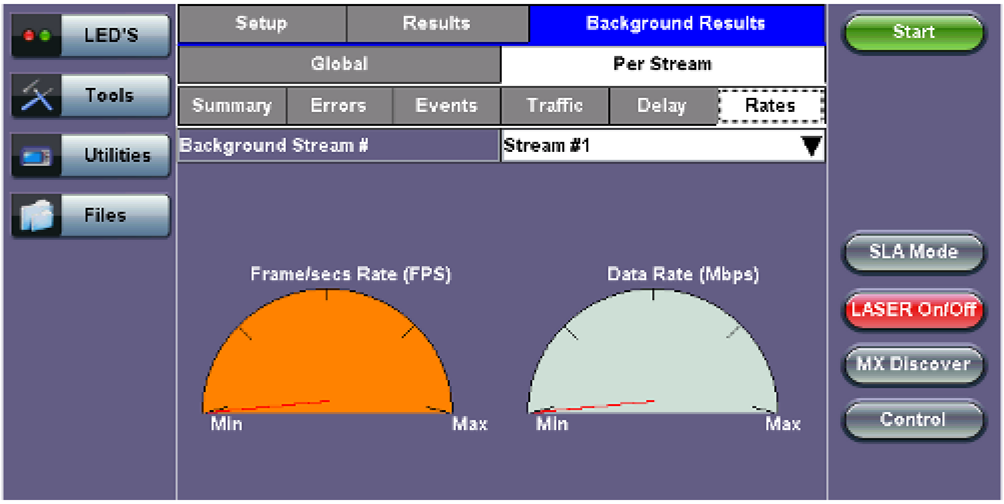
13.3.5 Background Results - Advanced SLA Mode

For information on Global and Per Stream Results in Advanced SLA Mode, please refer to 13.5.2 Throughput Results.

Background Results - Global



Background Results - Per Stream



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13.4 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

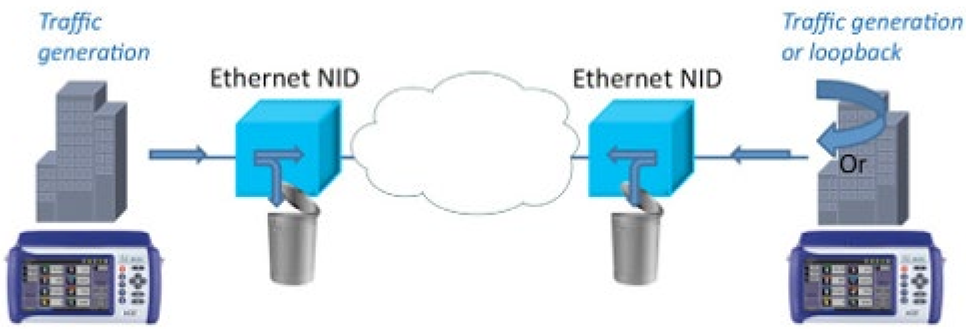
	RFC2544	Y.1564
Key Test Objective	Device performance	Network Service verification/activation
Service validation	One service at a time	Multiple services simultaneously
Throughput	Yes	Yes
Latency	Yes	Yes
Frame Loss	Yes	Yes
Burstability	Yes	Yes
Packet Jitter	No	Yes
Multiple Streams	No	Yes
Test Duration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



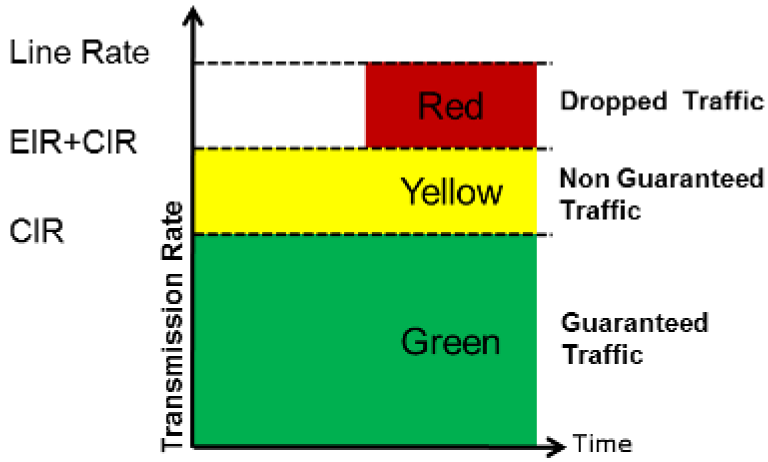
Phase 1: Service Configuration Test

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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13.4.1 V-SAM Setup

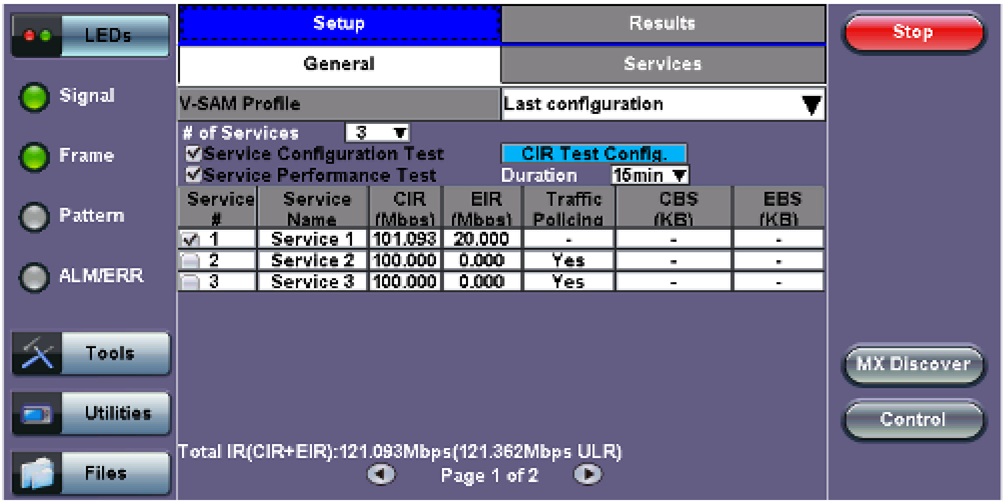
General (Page 1 and 2)

- **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, up to 10 services can be chosen for a 10 GE interface and up to 32 services for 40GE and 100GE interface.
- **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.

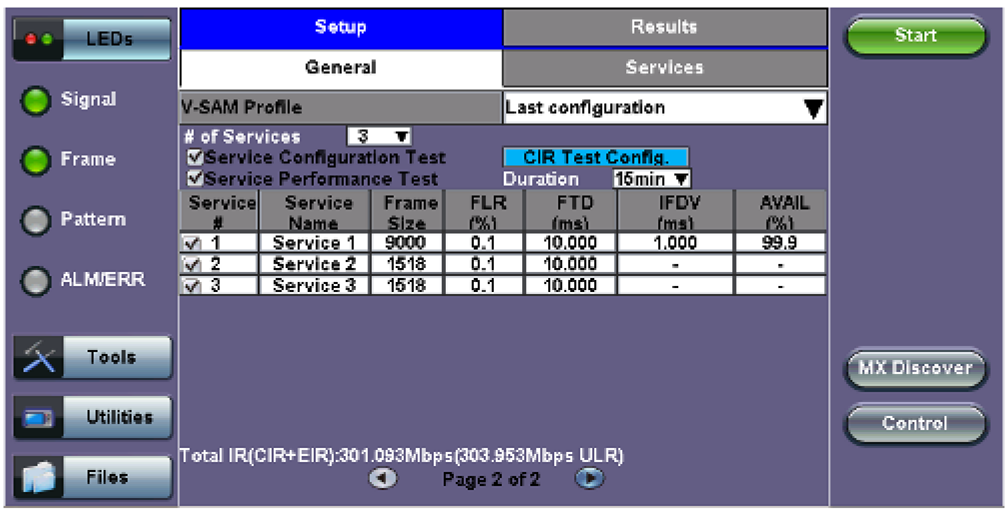
Enabling/Disabling Tests

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)



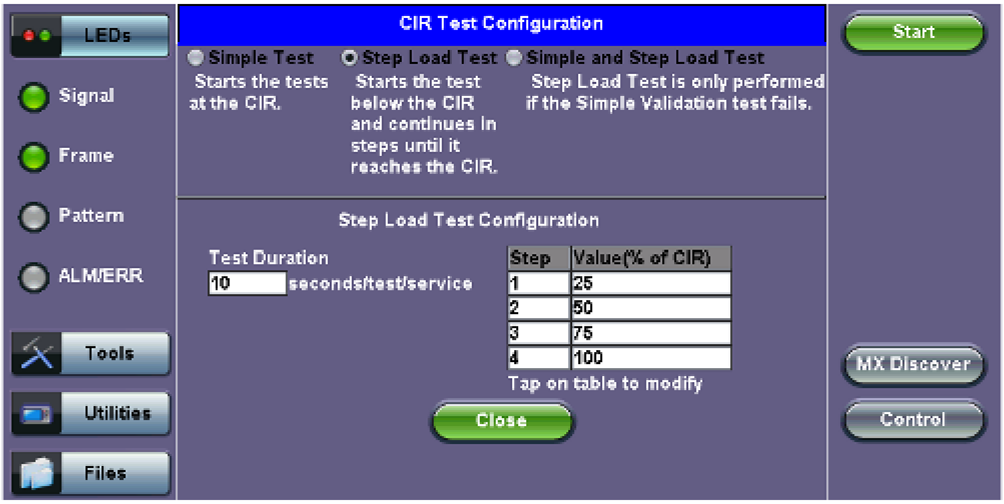
V-SAM - Setup - General (Page 2)



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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13.4.1.1 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.

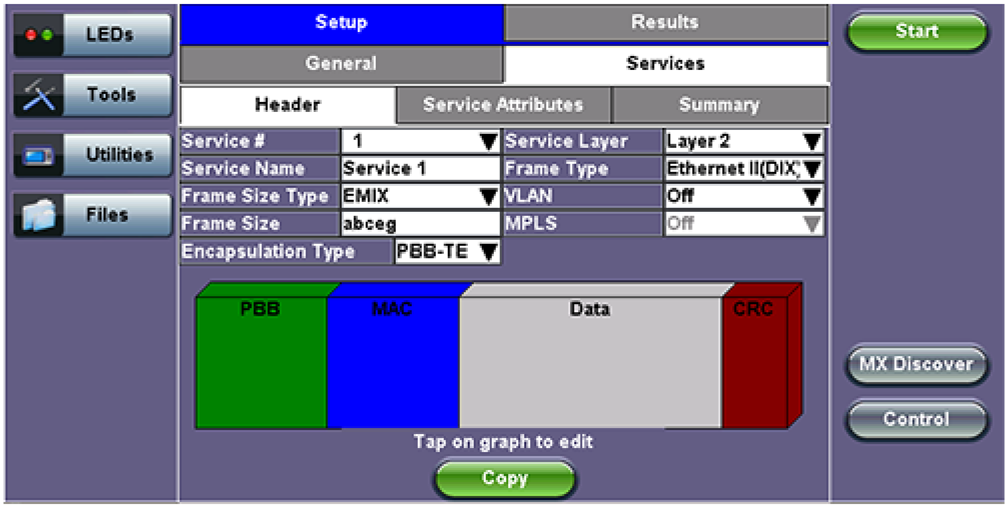
    Any EMIX configuration of 5 frames is allowed.
- **Encapsultaion Type:** None or **Provider Backbone Bridge (PBB-TE):** Provider Backbone Bridge MAC-in-MAC (IEEE 802.1ah) encapsulation are configured trunks that add resiliency and configurable performance levels in the provider backbone network. Available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

  Tap the PBB block to configure the settings. All PBB fields are configurable.

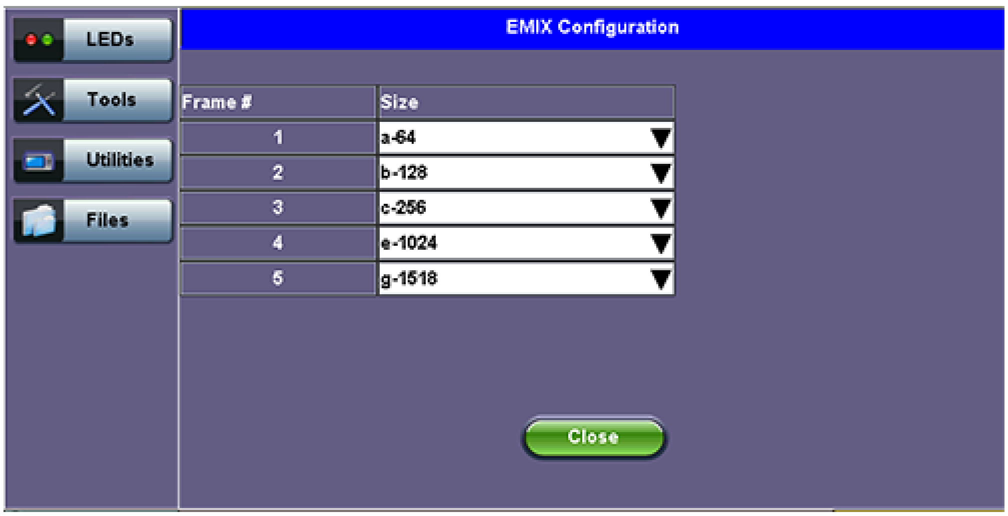
  - Backbone MAC Source
  - Backbone MAC Destination
  - Ethernet Type
  - I-SID
  - Backbone VLAN ID, Priority, Type

Please see [15.3 RFC 2544 Setup](#) and follow the setup procedure to configure the remaining Header Settings for V-SAM.

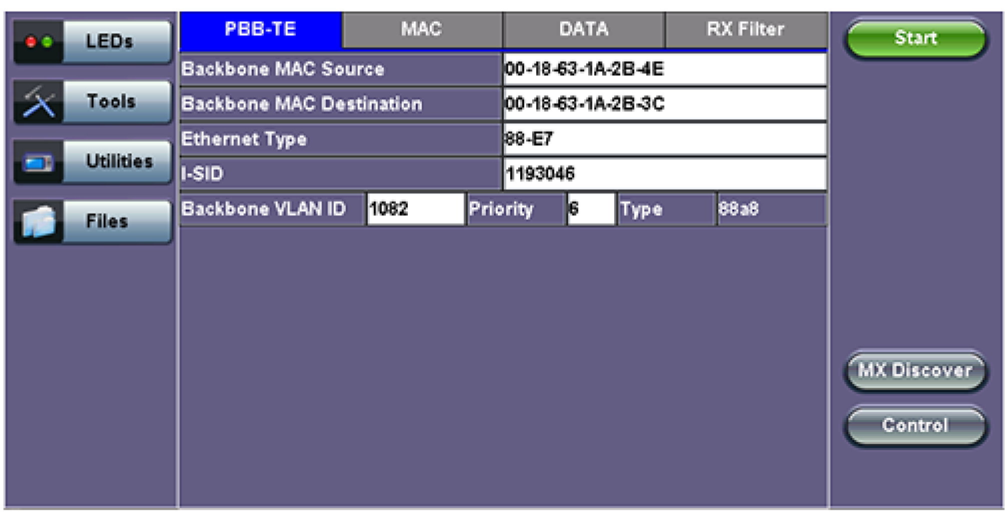
V-SAM Setup - Services - Header Settings



V-SAM Setup - Services - EMIX Frame Size Settings



V-SAM Setup - Services - PBB Settings



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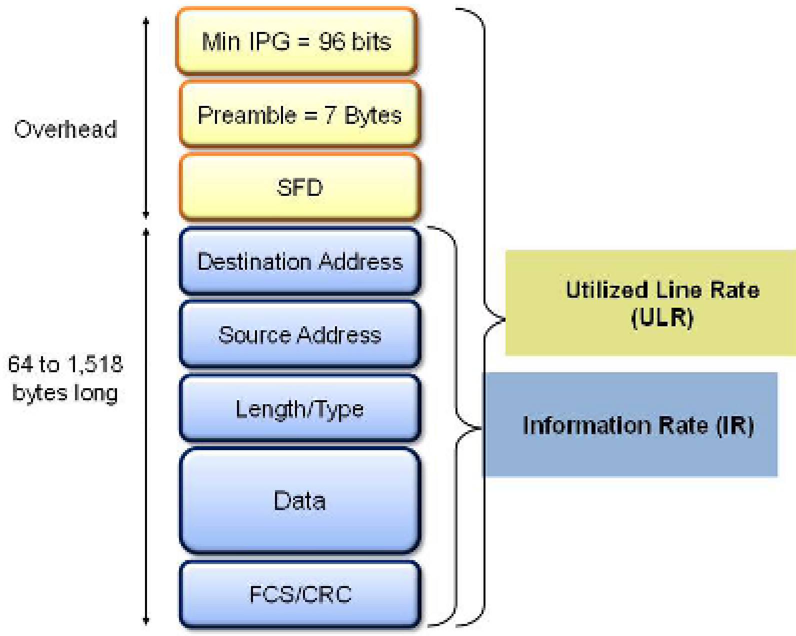
13.4.1.2 Service Attributes

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.

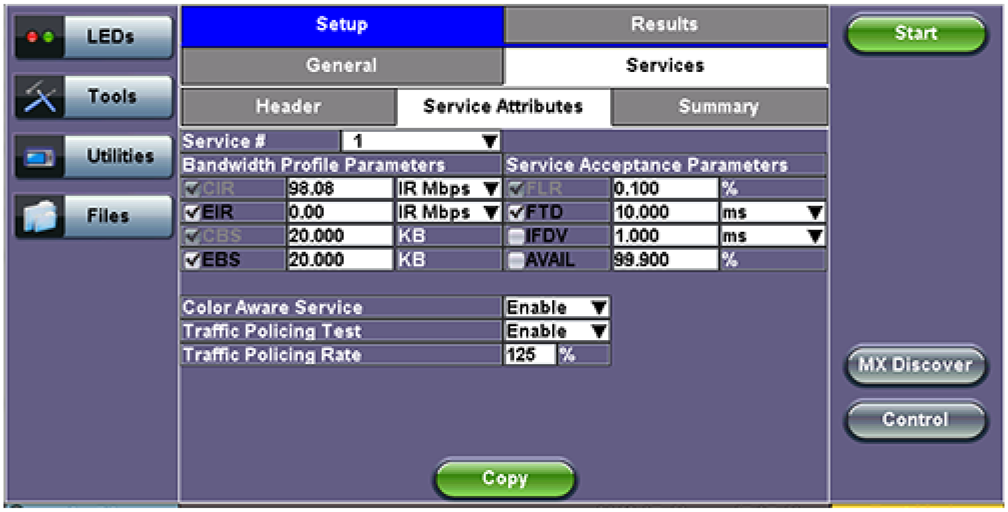
V-SAM Services - Header



- **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). ***Not supported on 10GE, 40GE and 100GE***.
  - 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

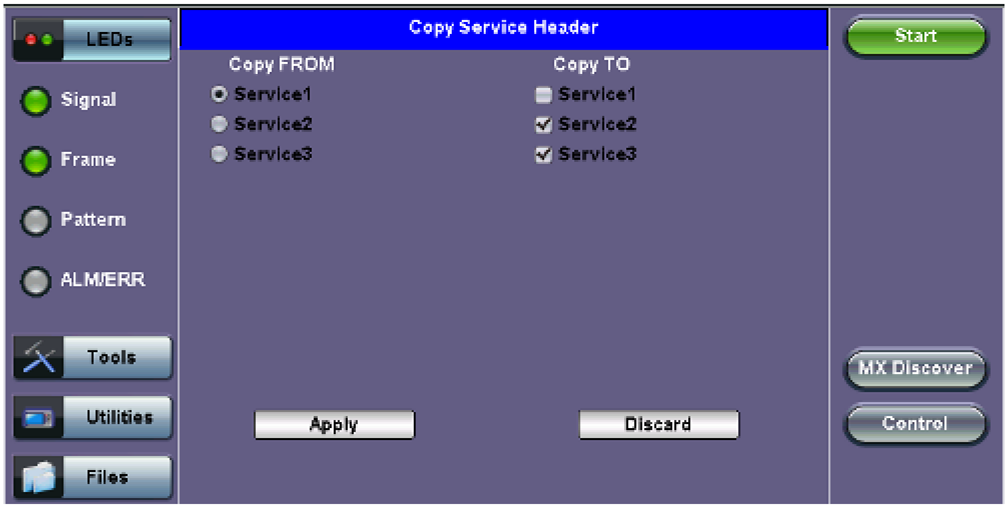
A check next to the parameters in the Service Attributes table indicates that the test for the corresponding service is set to run. Tap on the box to remove the check and cancel the test for that service.

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.

MX Discover and Control Settings

For instructions on how to loop up/down the test set with another test set or device, please refer to 13.5.1.2 MX Discover and Control.

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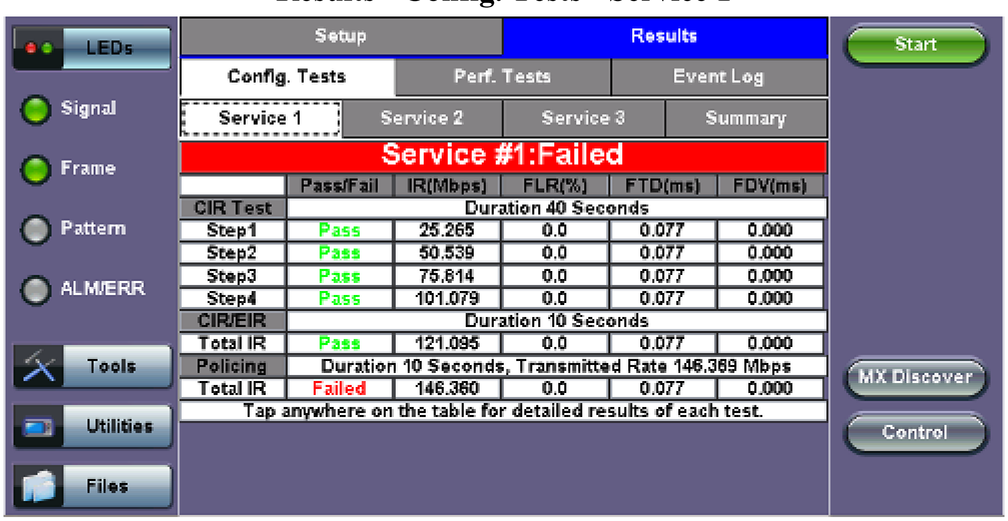
13.4.2 Results

Results - Config. Tests - Service 1



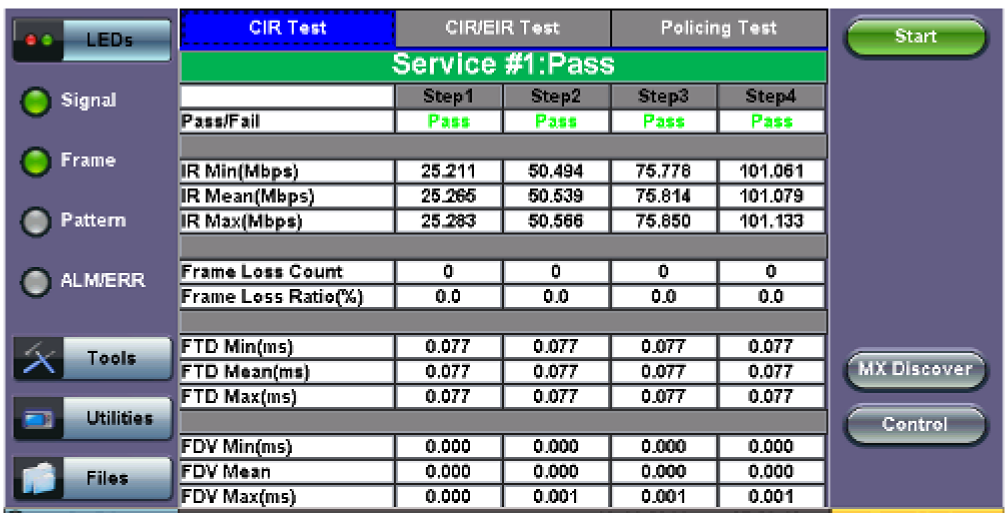
To run the test, make sure that traffic is being looped back at the far-end of the network under test.

Configuration Test

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

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

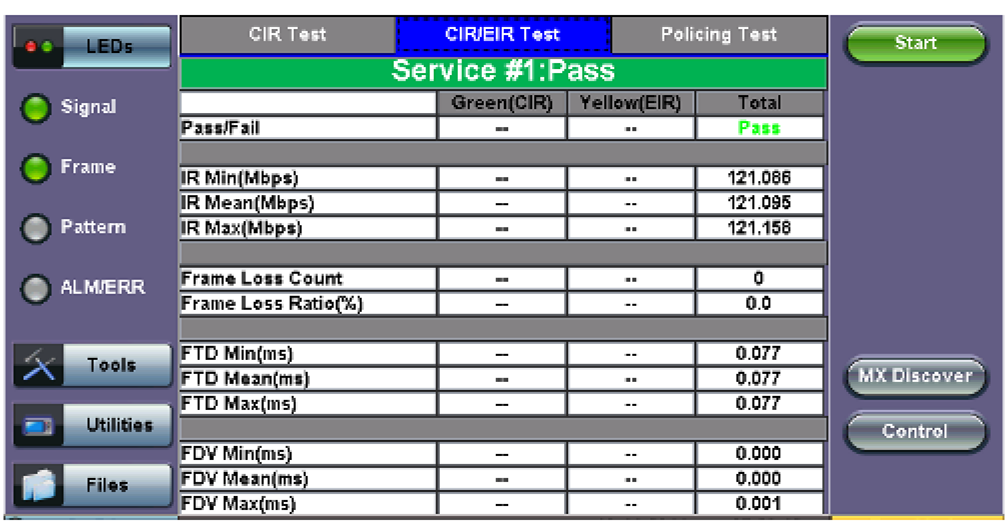
CIR Test - Service 1



	Step1	Step2	Step3	Step4
Pass/Fail	Pass	Pass	Pass	Pass
IR Min(Mbps)	25.211	50.494	75.778	101.061
IR Mean(Mbps)	25.265	50.539	75.814	101.079
IR Max(Mbps)	25.283	50.566	75.850	101.133
Frame Loss Count	0	0	0	0
Frame Loss Ratio(%)	0.0	0.0	0.0	0.0
FTD Min(ms)	0.077	0.077	0.077	0.077
FTD Mean(ms)	0.077	0.077	0.077	0.077
FTD Max(ms)	0.077	0.077	0.077	0.077
FDV Min(ms)	0.000	0.000	0.000	0.000
FDV Mean	0.000	0.000	0.000	0.000
FDV Max(ms)	0.000	0.001	0.001	0.001

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

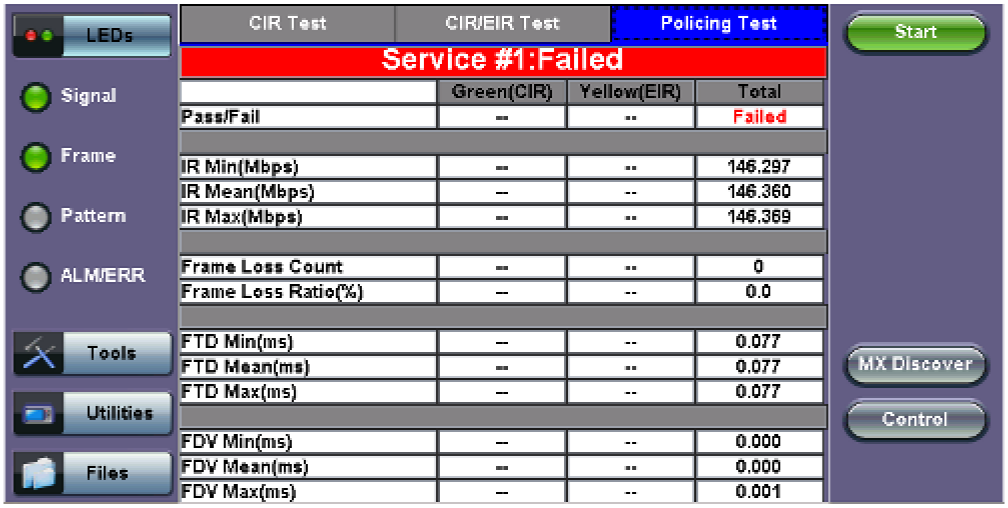
CIR/EIR Test - Service 1



	Green(CIR)	Yellow(EIR)	Total
Pass/Fail	--	--	Pass
IR Min(Mbps)	--	--	121.086
IR Mean(Mbps)	--	--	121.095
IR Max(Mbps)	--	--	121.158
Frame Loss Count	--	--	0
Frame Loss Ratio(%)	--	--	0.0
FTD Min(ms)	--	--	0.077
FTD Mean(ms)	--	--	0.077
FTD Max(ms)	--	--	0.077
FDV Min(ms)	--	--	0.000
FDV Mean(ms)	--	--	0.000
FDV Max(ms)	--	--	0.001

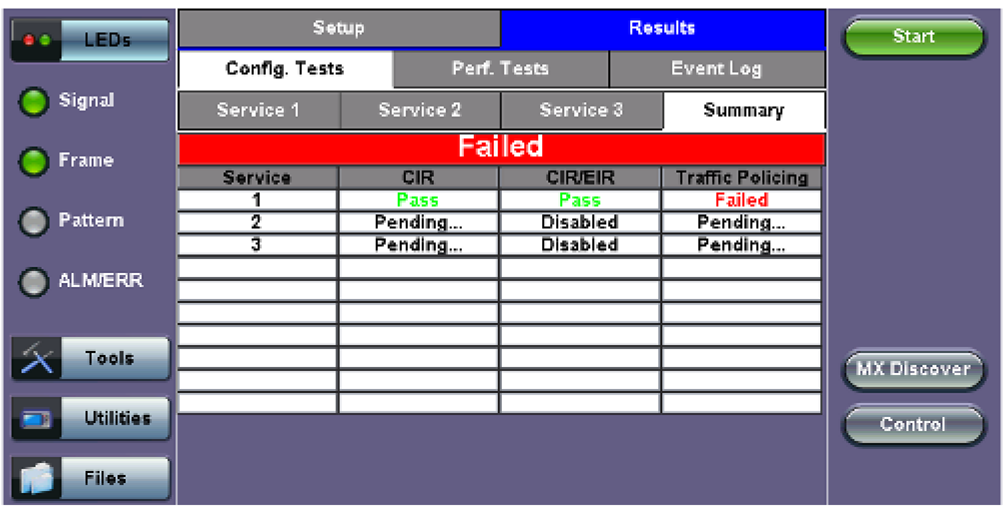
CIR/EIR test: The test passes if the received IR value is between the CIR (minus the margin allowed by the FLR) and CIR+EIR.

Policing Test - Service 1



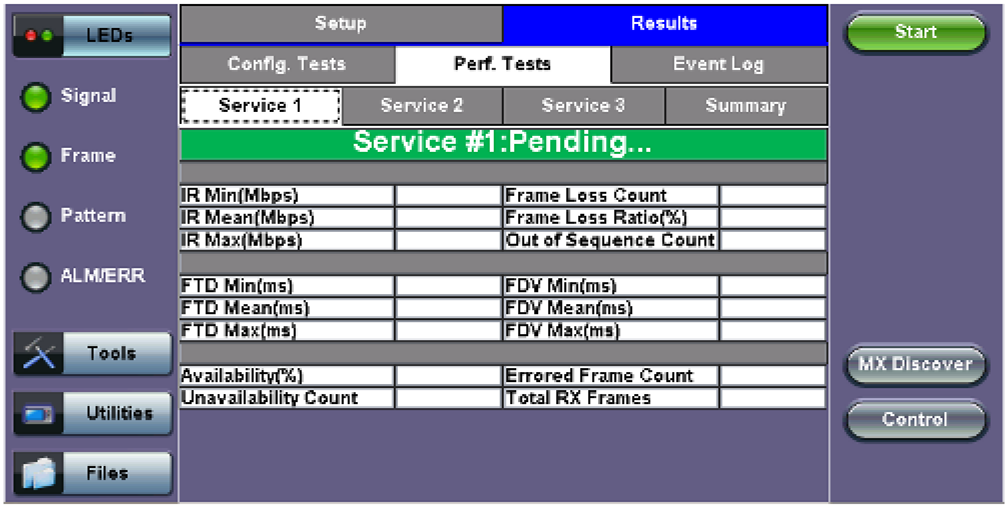
Policing test: The test passes if the received traffic rate is at least at the CIR (minus the margin allowed by the FLR) but does not exceed the allowed CIR+EIR.

Results - Config. Tests - Summary



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

Perf. Test - Service 1



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.

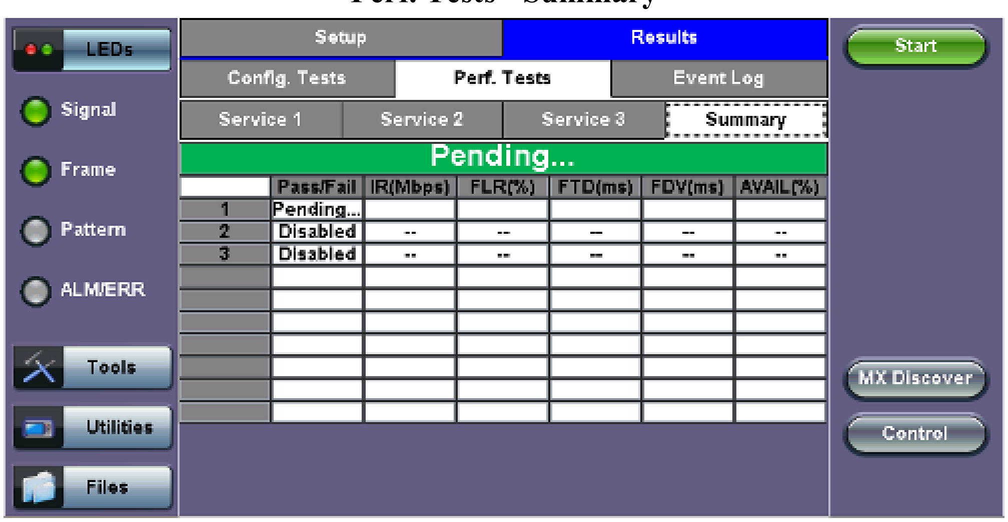
- **Total RX Frames:** Total number of frames received

- **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**.

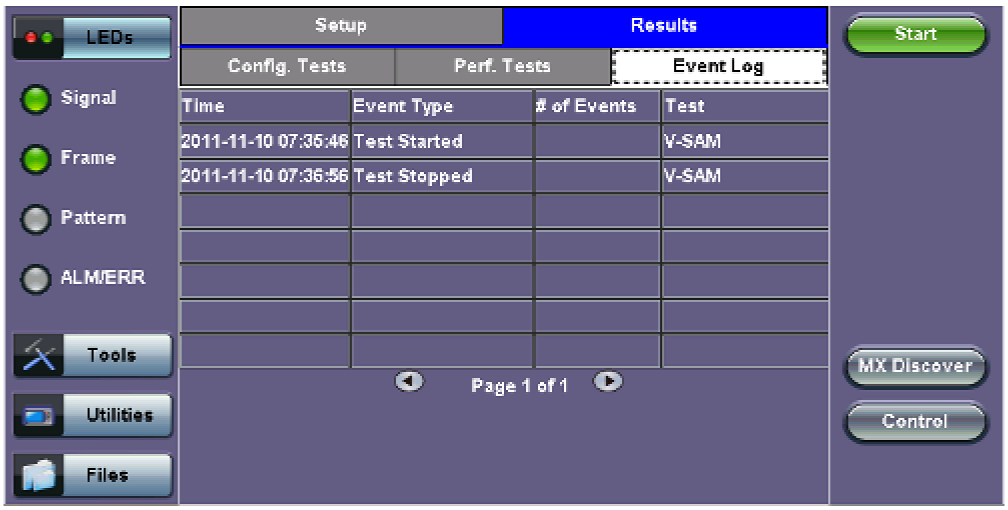
Perf. Tests - Summary



Event Log

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

Event Log



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13.5 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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13.5.1 Setup

Unless otherwise noted, the Frame Header and related setups are the same as the ones described in section 13.2 BERT and 13.3 RFC 2544. 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)

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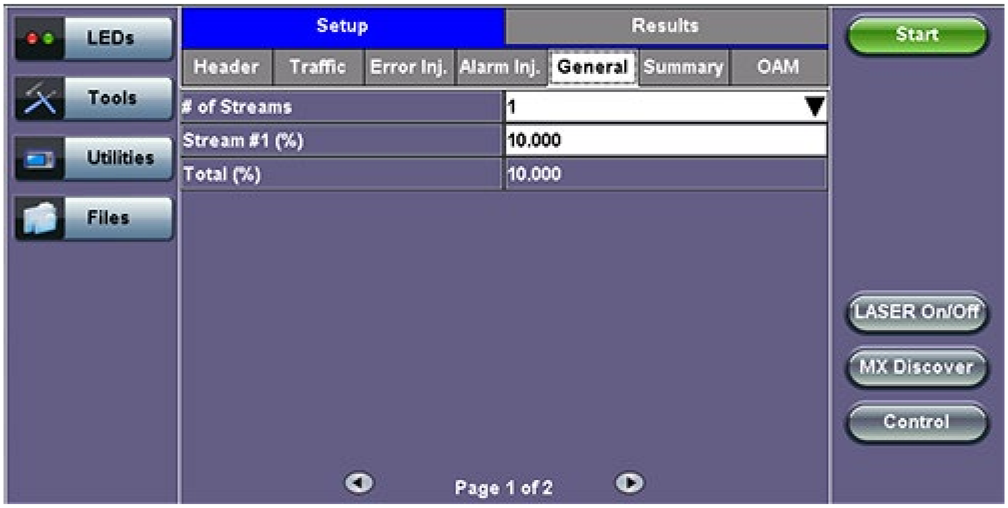
13.5.1.1 General Throughput Settings (Global Configuration)

Page 1:

- **# of Streams:** From 1 to 10 streams. 32 streams for 40GE and 100GE.

- **Stream #:** Allocated Bandwidth per Stream: The total bandwidth for all streams cannot exceed 100%.
- **Total (%):** Sum of all stream rates in %.

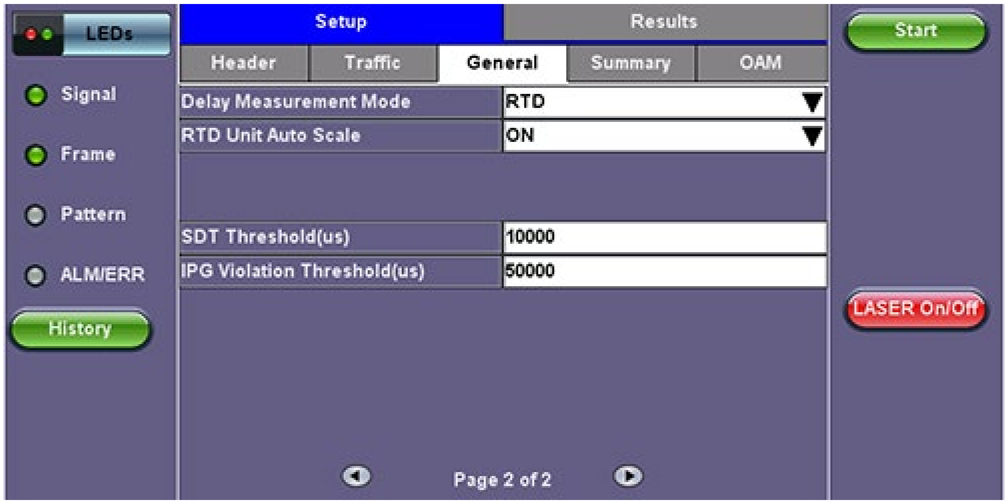
Throughput Setup - General Settings



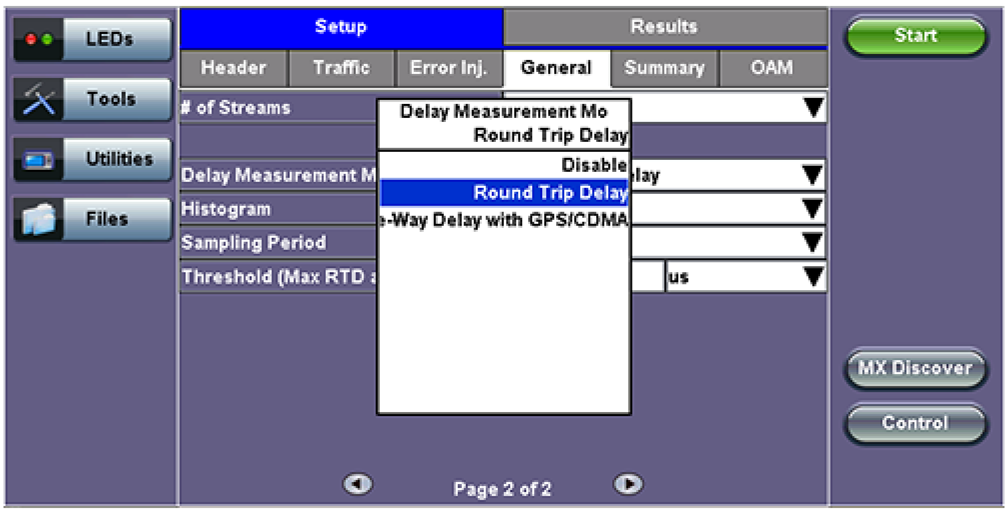
Page 2:

- **#of Streams:** From 1 to 10 streams. *# 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, One-Way Delay with GPS/CDMA or Local One-Way Delay (for Dual Port Mode).
  - **Round Trip Delay:** Round Trip Delay should only be enabled when running the test to a remote loopback.
  - **One-Way Delay with GPS/CDMA:** One Way Delay (OWD) measurements can be carried out between two units only when their clocks are synchronized. In order to achieve synchronization, both units must be synchronized to the same timing source and at the same time. See Chapter 13-1_Ethernet_Setup for a detailed description of the synchronization process.
- **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 Threshold and IPG Violation:**
  - SDT: Service Disruption Time
  - Measure SDT based on IPG (inter packet gap)
  - SDT Threshold: If the IPG is equal or greater than the threshold configured, the SDT measurement is triggered.
  - IPG Violation Threshold: If the IPG is equal to or greater than the configured threshold, a SDT Violation event is triggered in the Events tab and a SDT Violation is counted in the SDT measurement menu.

Throughput Setup - General Settings Page 2



Throughput - General Settings Delay Measurement Mode



	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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13.5.1.2 MX Discover and Control

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

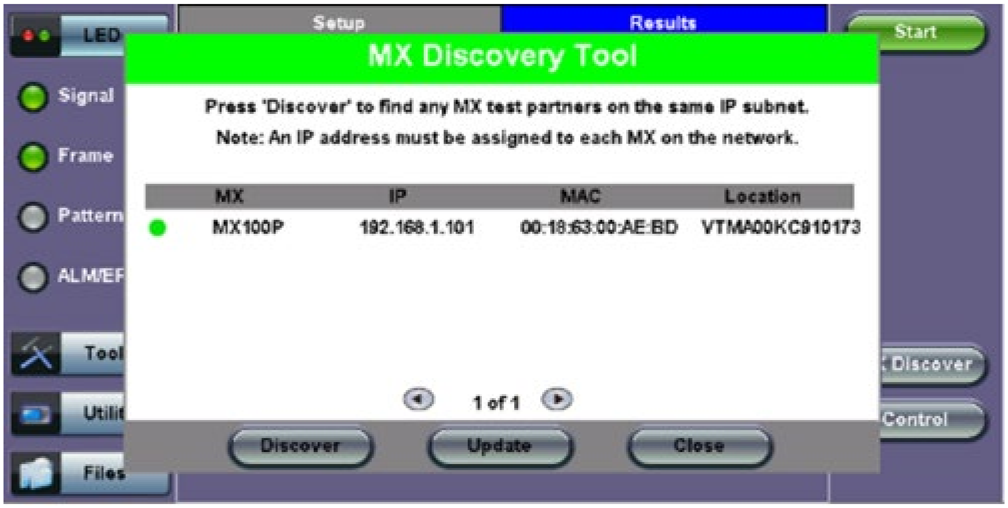
If using OAM Discover, it is unnecessary to assign an IP address to the local or remote unit.

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**:

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

MX Discovery Tool



Loop Control

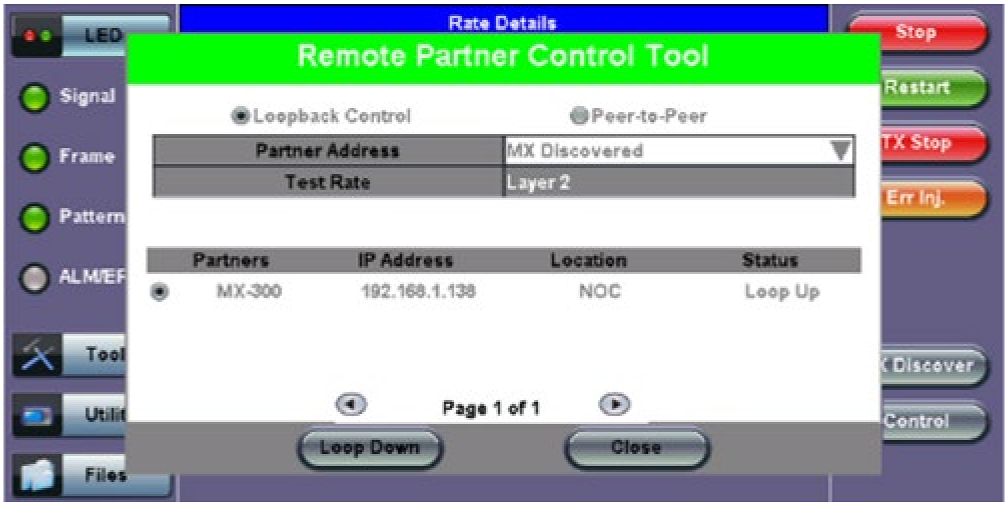
The **Loop Control** button becomes available on the right side menu when any Ethernet application (V-SAM, RFC 2544, Throughput, BERT) is selected. Press the **Control** button to configure loop up and loop down commands necessary to control a far-end unit. The loop up command contains information about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

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

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

- **MX Discovered:** Lists MX discovered devices. Select from the list of discovered devices to loop up/down
- **User Defined:** Input the destination IP address of the far-end device
- **OAM Discover**: Lists OAM discovered devices. Select from the list of discovered devices to loop up/down

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 15.3.1.4 Peer-to-Peer and Asymmetric Testing.

13.5.1.3 Per Stream Configurations

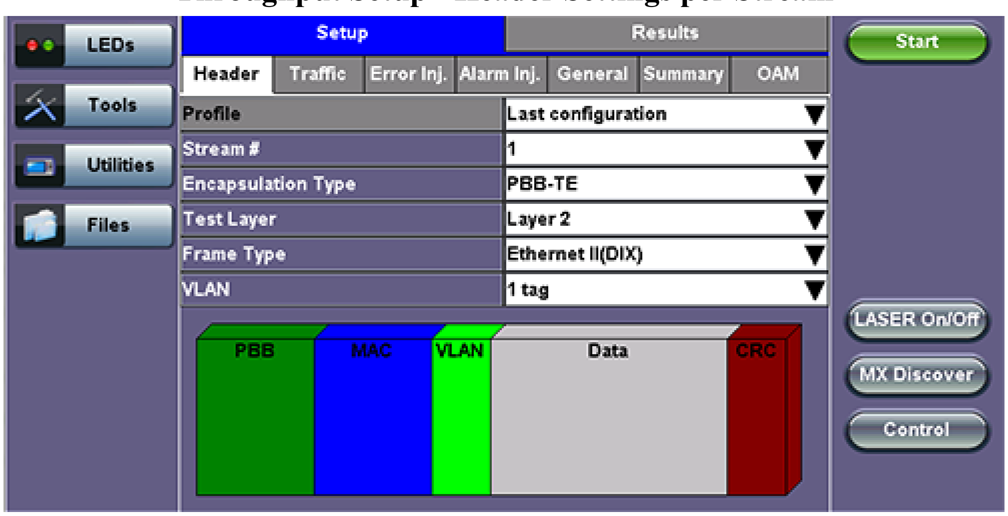
MAC Setup

MAC configuration in the Throughput section features MAC flooding for buffering verification and performance testing of Ethernet switches.

- **Source (SRC) and Destination (Dest) flooding:** Enable or Disable.
- **Flood Range:** Specifies the number of MAC source and/or destination addresses. Enter a number from 0-4095. The source and/or destination MAC addresses will be incremented by 1 until it reaches the number of times entered in the flood range.

For information on header configuration please see 13.2.1.1 BERT Header Settings in the BERT section.

Throughput Setup - Header Settings per Stream



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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13.5.1.4 Traffic Settings (Per Stream Configuration)

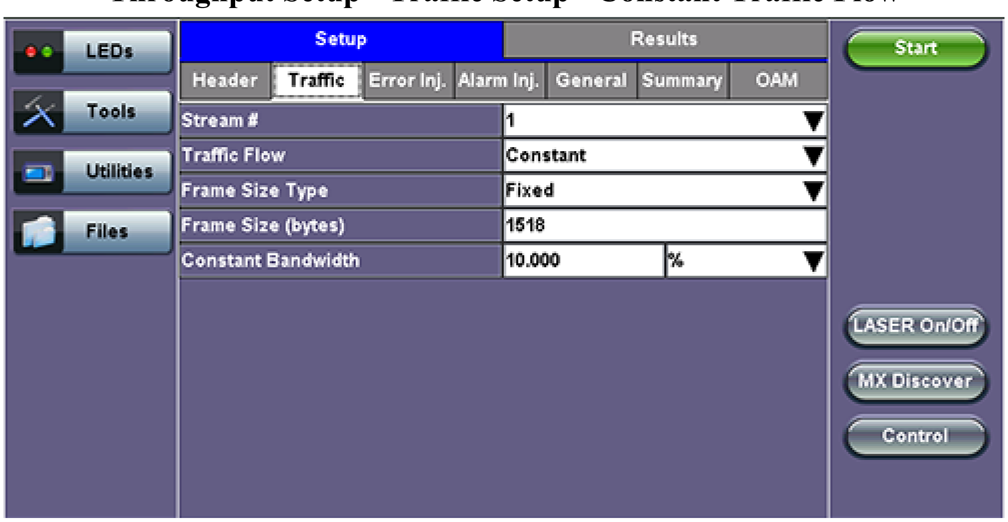
In the Traffic tab the user is able to configure the traffic profile per stream, including frame size selection, traffic type, and transmit rate.

- **Stream #:** Select a stream number to configure.
- **Traffic Flow:** Select from Constant, Ramp, Burst, or Single Burst traffic flow.
- **Frame Size (Type):** Fixed 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.

For more information on Traffic Settings, please see 13.2.1.2 BERT Traffic Settings.

Throughput Setup - Traffic Setup - Constant Traffic Flow



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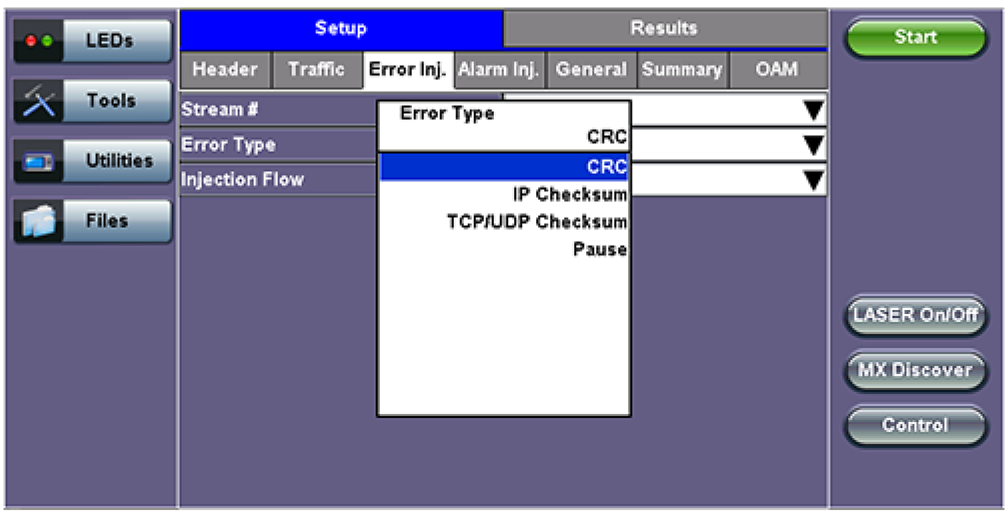
13.5.1.5 Error Injection Settings (Per Stream Configuration) - *(Only in 10GE)*

Error injection can be performed during test. The type of errors and error injection are configured in the Error Injection tab. Once the test is running, error injection can be performed by pressing the **Error Inject** button on the right side of the screen.

- **Stream #:** Select the stream to configure.
- **Error type:** Select from CRC, IP Checksum (Layer 3, 4 only), TCP/UDP Checksum (Layer 4 only), or Pause. With Pause selected, the unit will transmit a pause frame when the **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. The user can select a single error or a specific count.
- **Count:** The user will be able to configure the error count via numeric keypad.

Throughput Test - Error Injection Settings per Stream



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13.5.1.6 Alarm Injection Settings

(Only in 10GE)

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

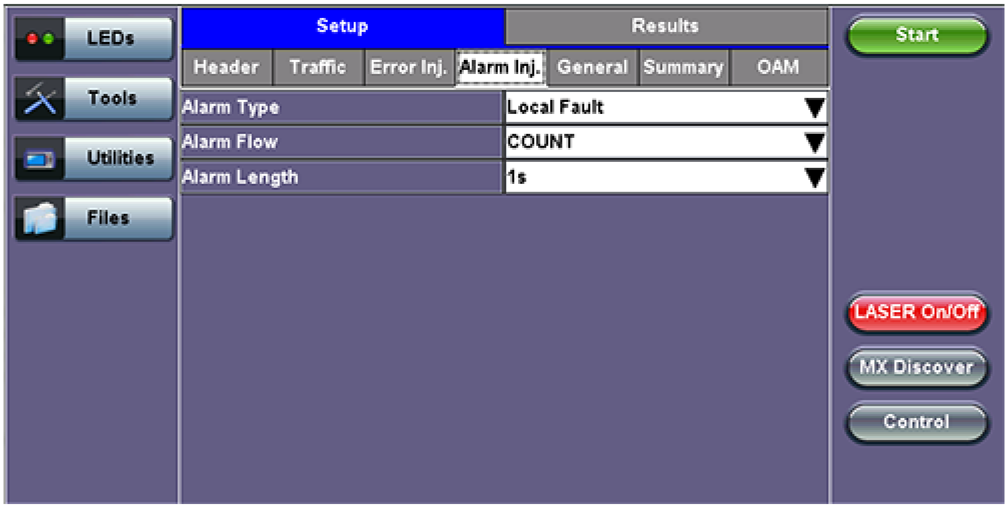
Alarm Injection is available only with 10GE Port Tests.

- **Alarm Type:** Local Fault, Remote Fault
- **Alarm Flow:** The alarm flow determines how the selected alarms will be injected. A specific Count or Continue

(continuous) can be selected.

- **Alarm Length:** 1s, 10s, or 100s.

Throughput Alarm Injection Setup



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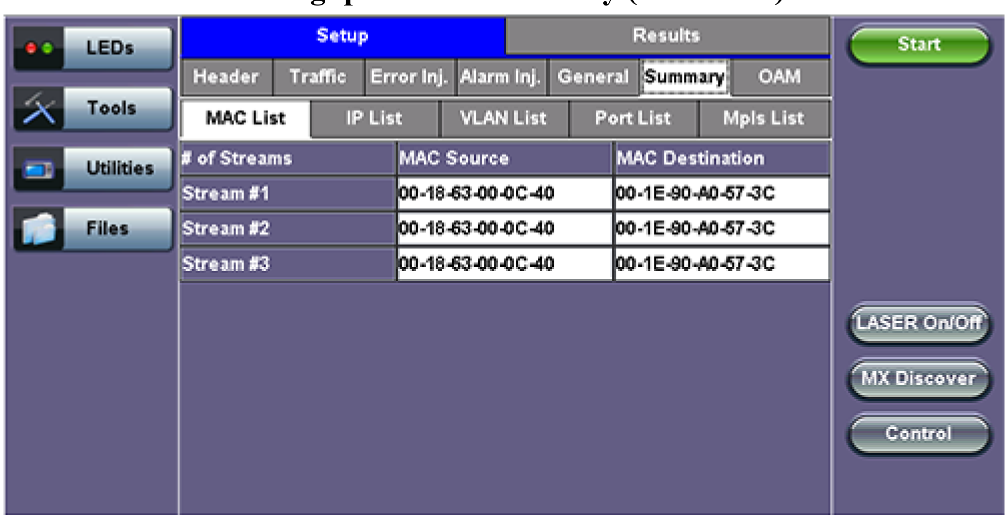
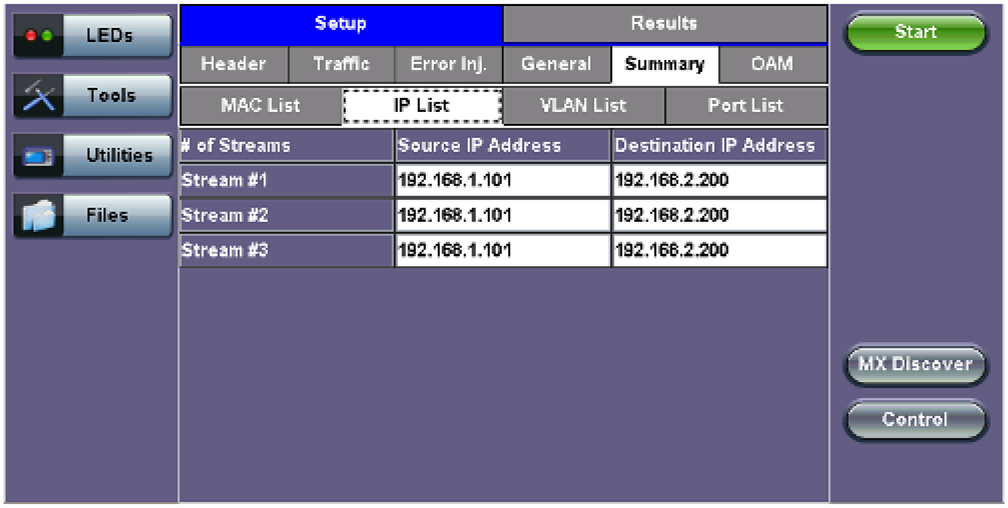
13.5.1.7 Summary

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)

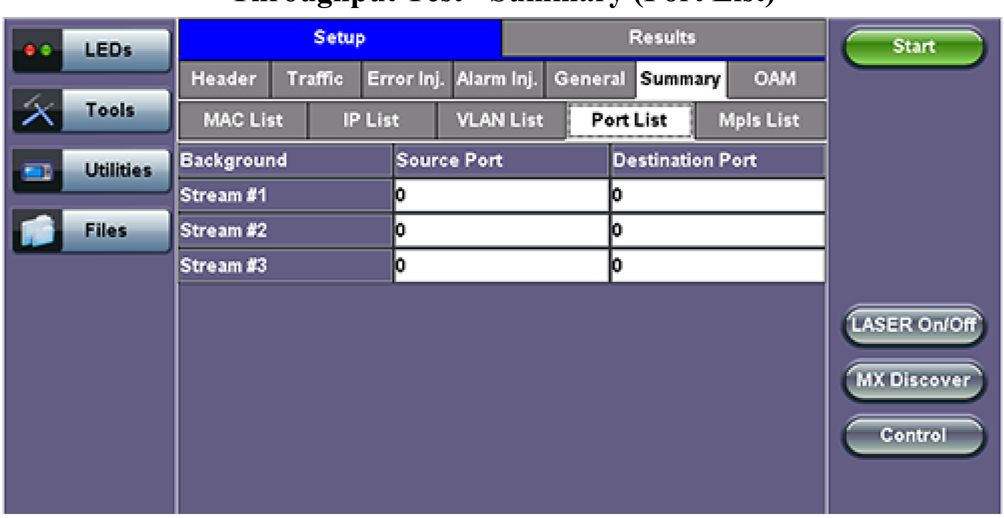


Throughput Test - Summary (IP List)



Throughput Test - Summary (VLAN List)

Throughput Test - Summary (Port List)



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13.5.1.8 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 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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13.5.2 Throughput Results

13.5.2.1 Viewing Throughput (Multiple Streams) Test Results

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

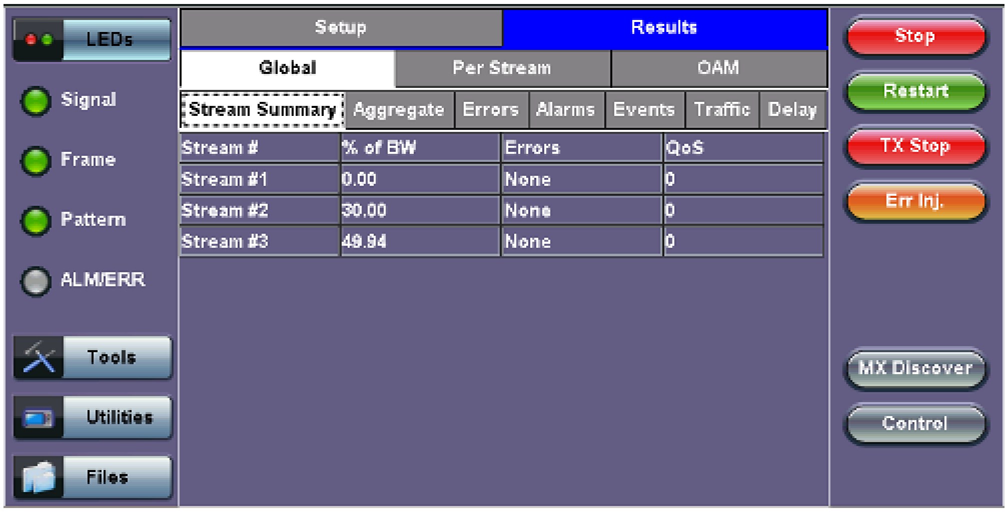
13.5.2.2 Global/Aggregate Results

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



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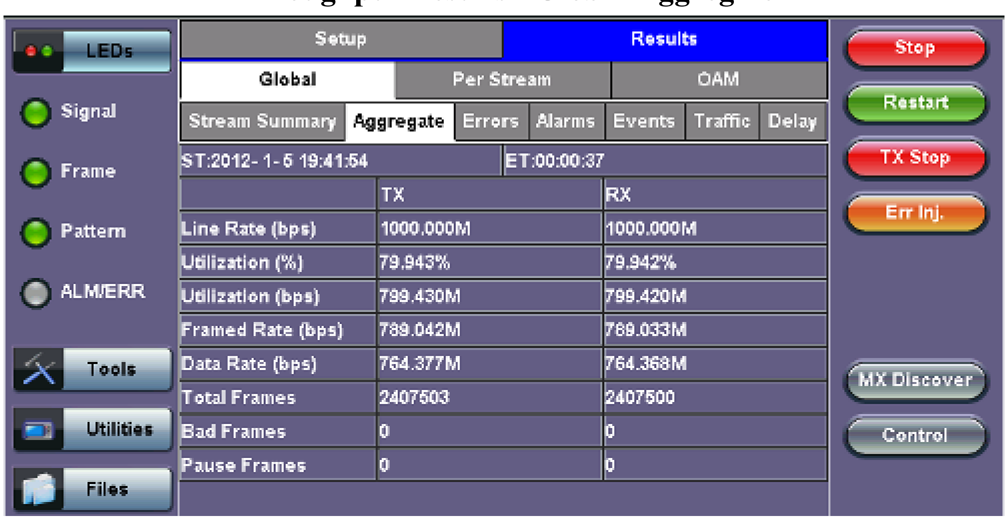
The Aggregate screen displays these parameters:

- **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.
- **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 # of frames, bad frames, and pause frames.

Throughput Results - Global Aggregate



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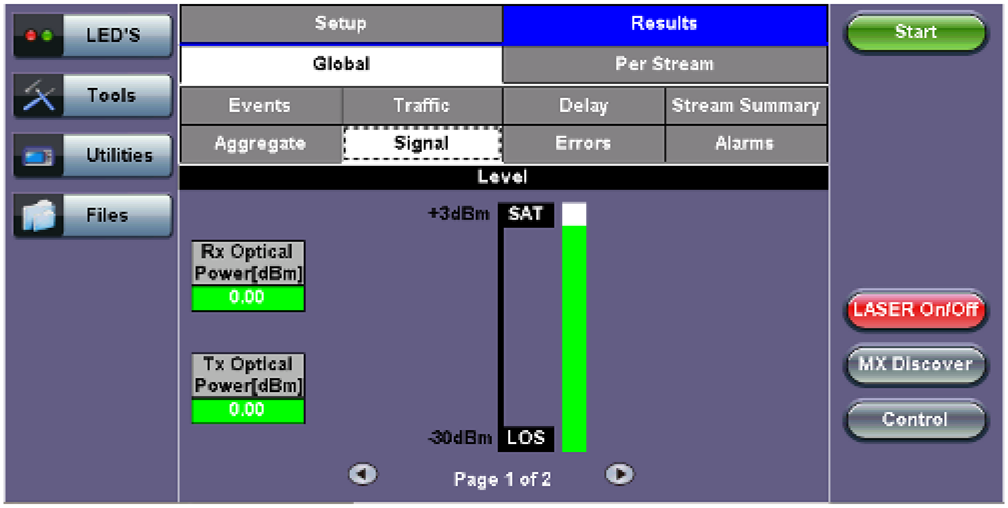
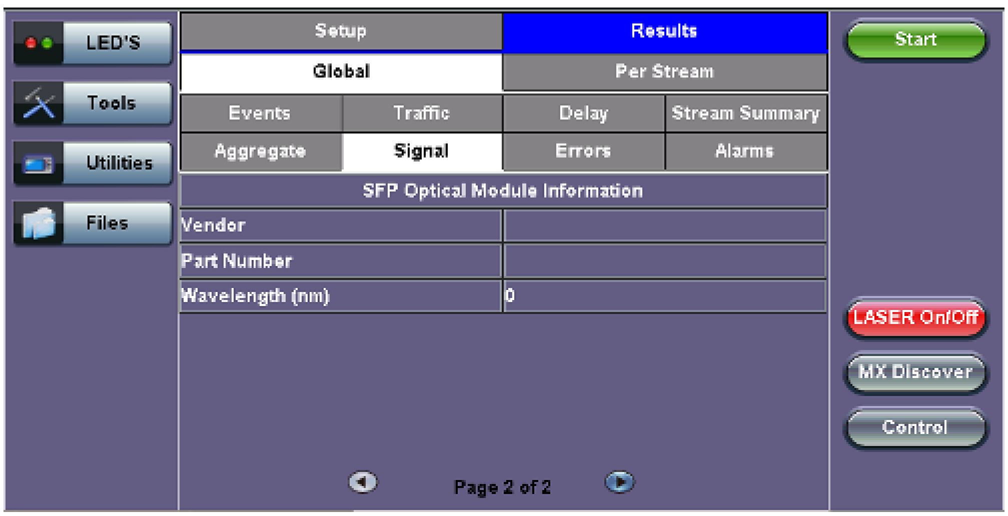
The **Global Signal** screen (fiber ports only) displays the optical level measured by the SFP or XFP transceiver.

Throughput Results - Global Signal



Throughput Results - Global Signal (page 2)



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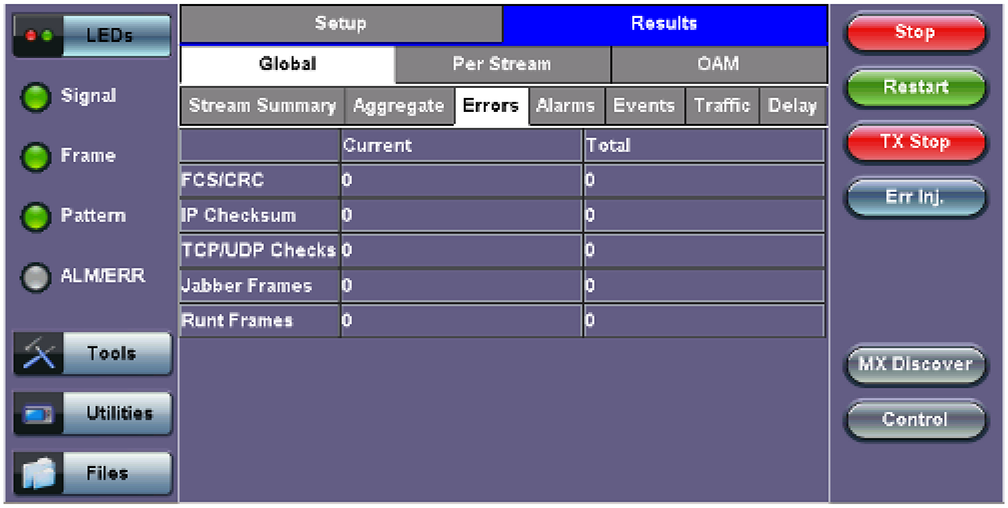
The **Global Errors** screen displays the Current and Total error count of all streams:

- **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

Throughput Results - Global Errors



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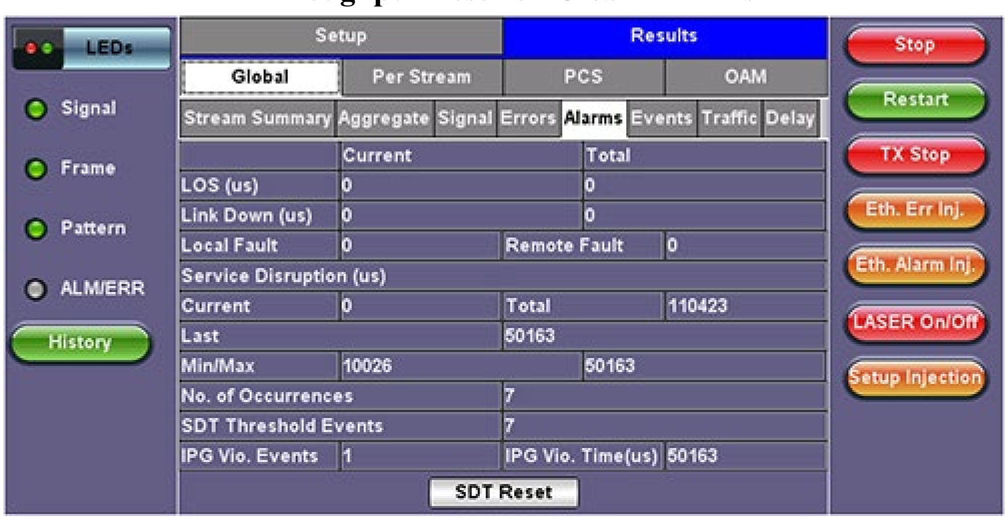
The **Global Alarms** screen displays the Current and Total alarm count of all streams:

- **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
  - **SDT Threshold Events:** Service Disruption Time
  - **IPG Violation Events:** If the IPG is equal to or greater than the configured threshold, a SDT Violation event is triggered in the Events tab and a SDT Violation is counted in the SDT measurement menu.

Throughput Results - Global Alarms



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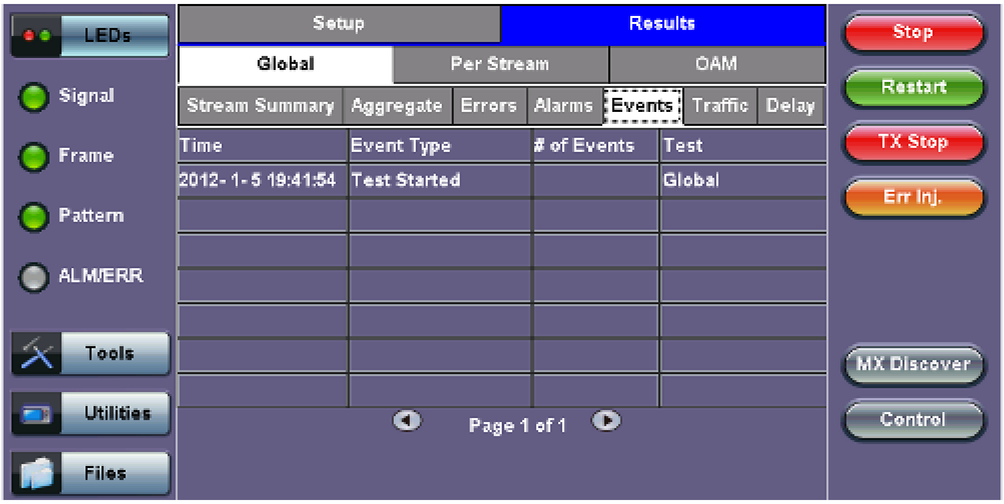
The **Global Events** screen displays the **Time**, **Event Type**, **Number of Events**, and **Test Type**.

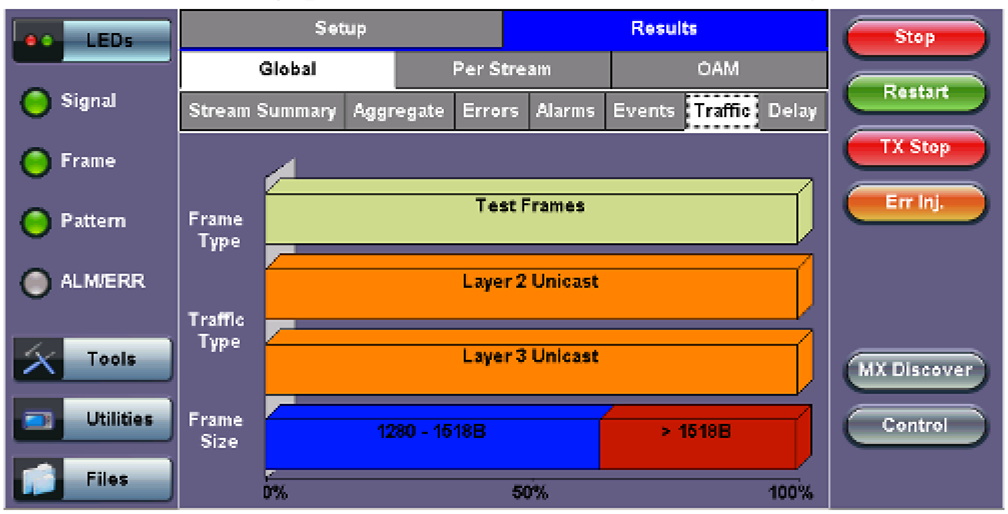
Throughput Results - Global Events



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



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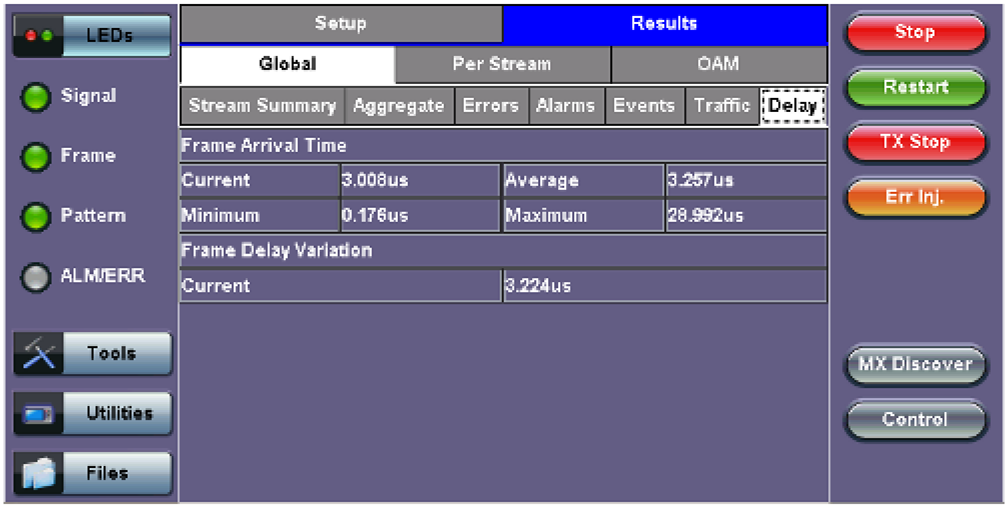
The **Global Delay** tab: Delay measures the interpacket gap, start of the frame, and preamble duration. Frame arrival statistics are displayed in tabular format:

- Current, minimum, average, and maximum frame arrival time
- Current Frame Delay Variation

Throughput Results - Global Delay



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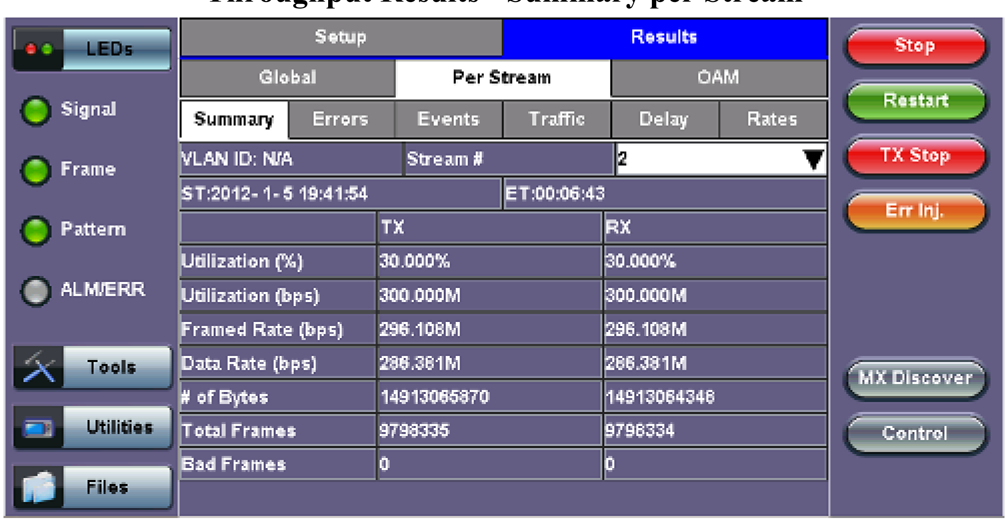
13.5.2.3 Per Stream Results

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 the corresponding section in 13.5.2.2 Global/Aggregate Results.

- **Summary:** Framed rate, data rate, # of bytes, total # of frames associated with each stream.
- **Errors:** Errors associated with each stream.
- **SDT:** Service Disruption Time
- **Events:** Events associated with each stream.
- **Traffic:** Traffic statistics associated with each stream.
- **Delay:** Delay associated with each stream. Note that 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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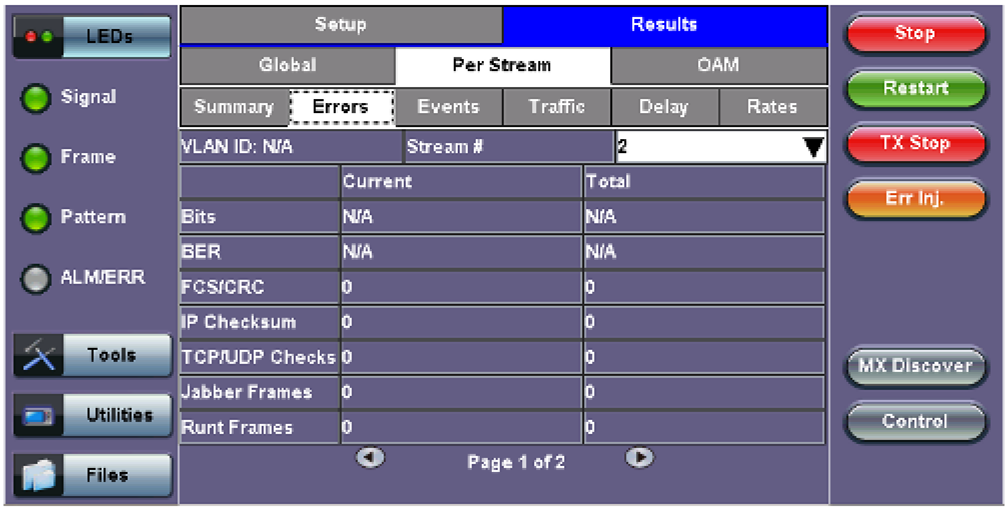
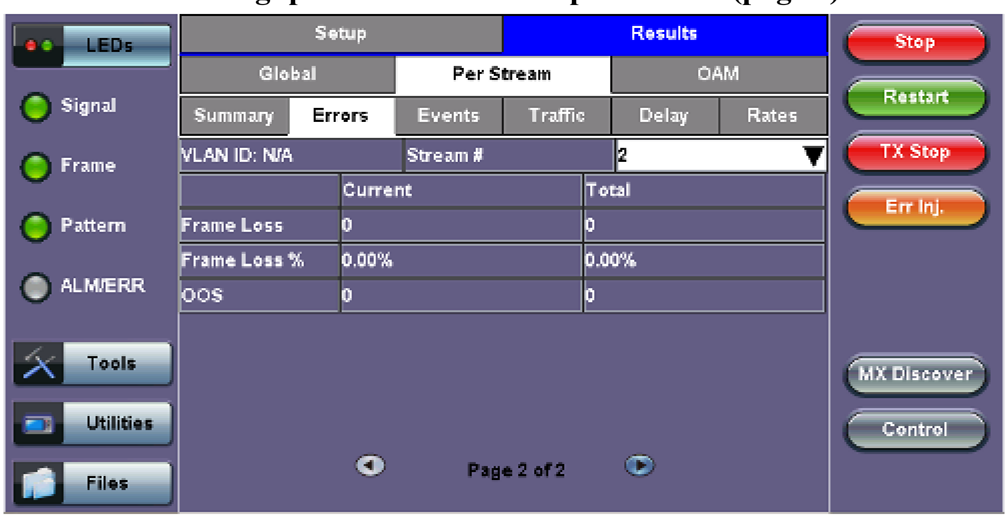
The **Per Stream Errors** screen displays the Current and Total error count of each stream.

- **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



Throughput Results - Errors per Stream (page 2)



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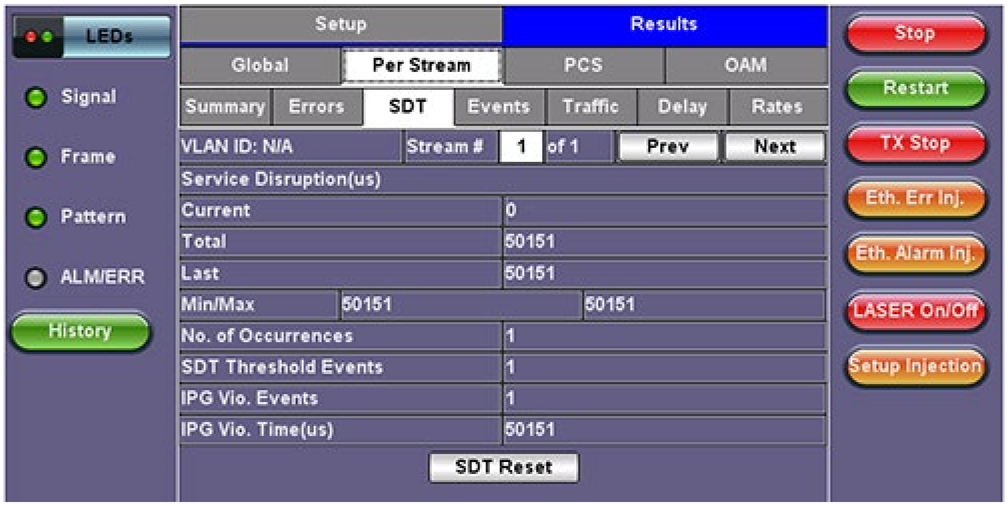
The **Per Stream SDT** screen displays a VLAN ID, Stream #, Service Distruption information - Current, Total, Last, Min/MA, No. of Occurrences, SDT Threshold Events, IPG Violation events, IPG Violation Time.

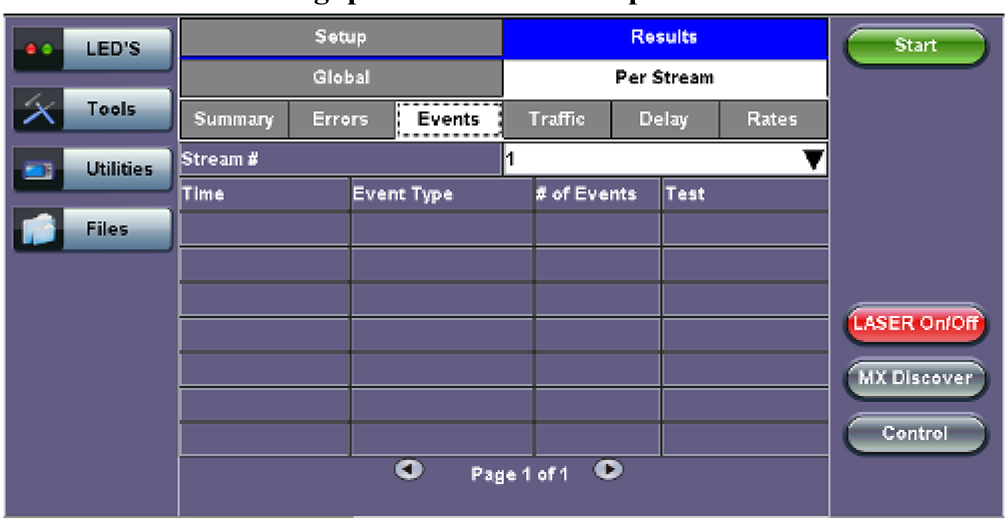
Throughput Results - Events per SDT



[Go back to top] [Go back to TOC]

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

Throughput Results - Events per Stream



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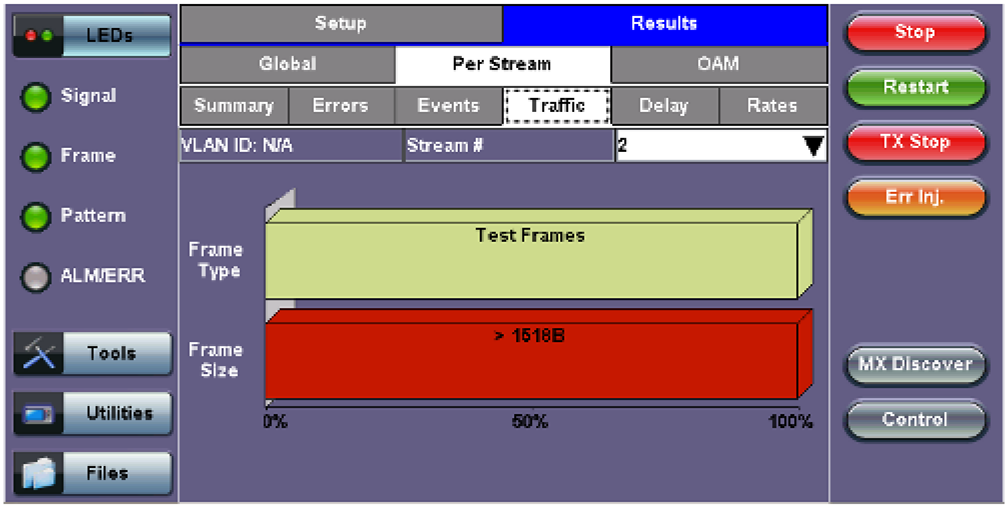
The **Per Stream Traffic** screen displays the frame type and frame size distribution pertaining to each stream.

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.

Round Trip Delay Results and Histogram:

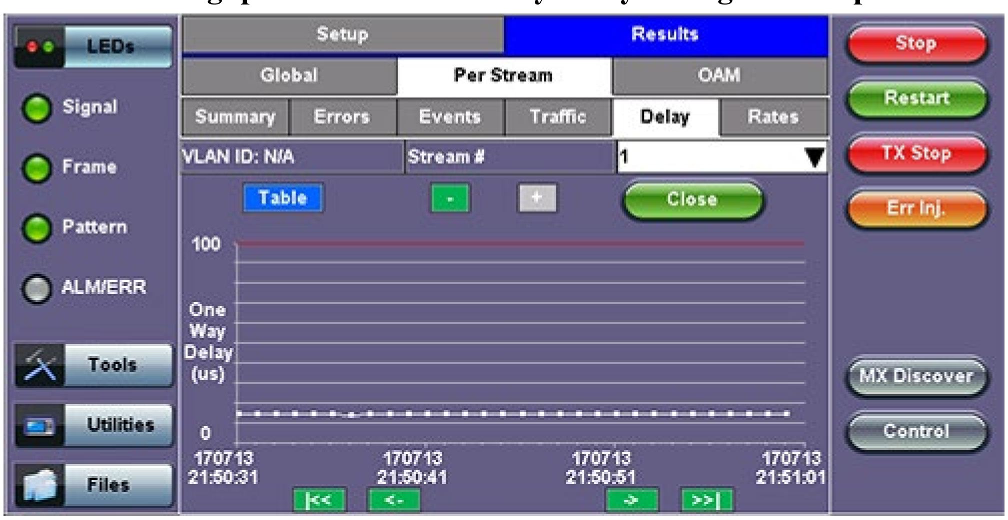
Throughput Results - Delay per Stream

Throughput Results - Round Trip Delay Histogram

One Way Delay Results and Histogram (Table and Graph):

Throughput Results - Delay per Stream (One Way Delay)

Throughput Results - One Way Delay Histogram Graph



Throughput Results - One Way Delay Histogram Table

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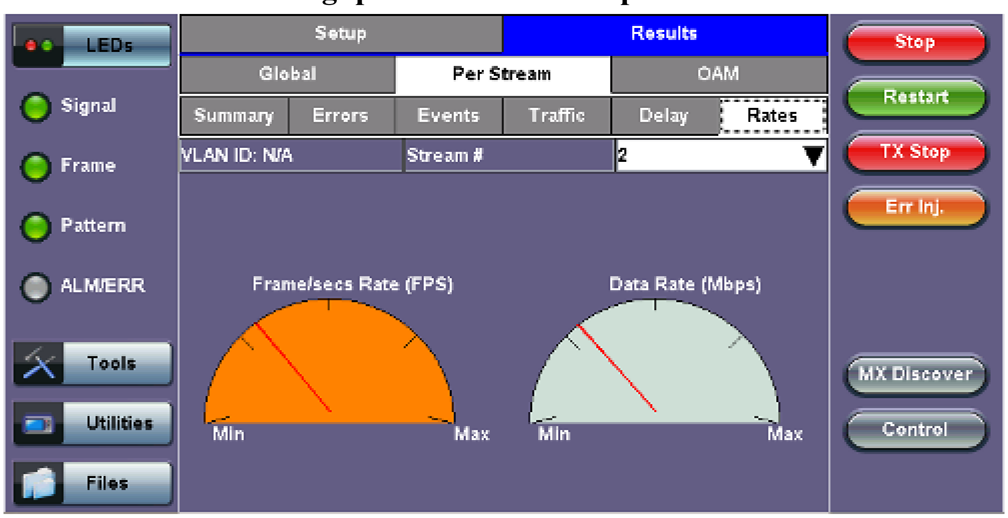
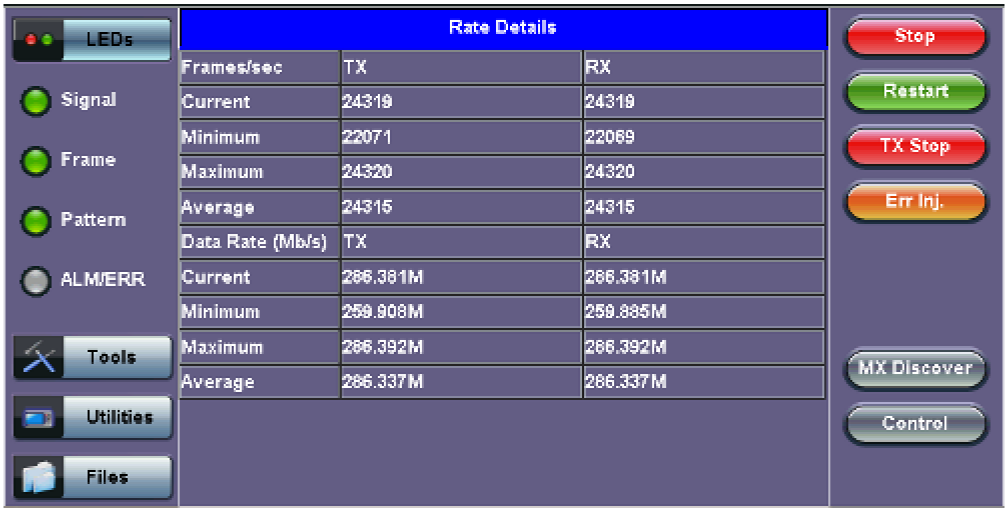
The **Per Stream Rate** screen displays the frame rate and data rate pertaining to each stream.

Throughput Results - Rates per Stream



Throughput Results - Rates per Stream (Rate Details)



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13.5.2.4 Saving Throughput (Multiple Streams) Results

Once the test has been stopped the results can be saved by pressing the **Save** key on the 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 **Home** > **Files** > **Saved**.

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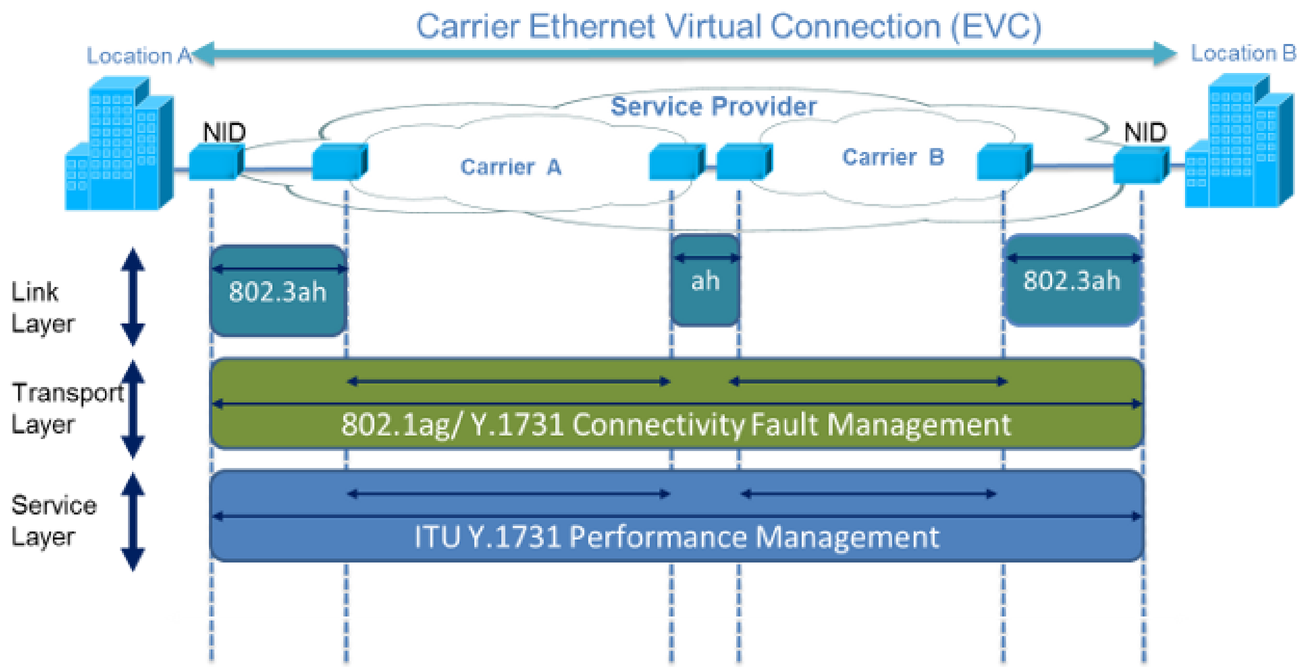
13.6 Ethernet OAM Testing



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

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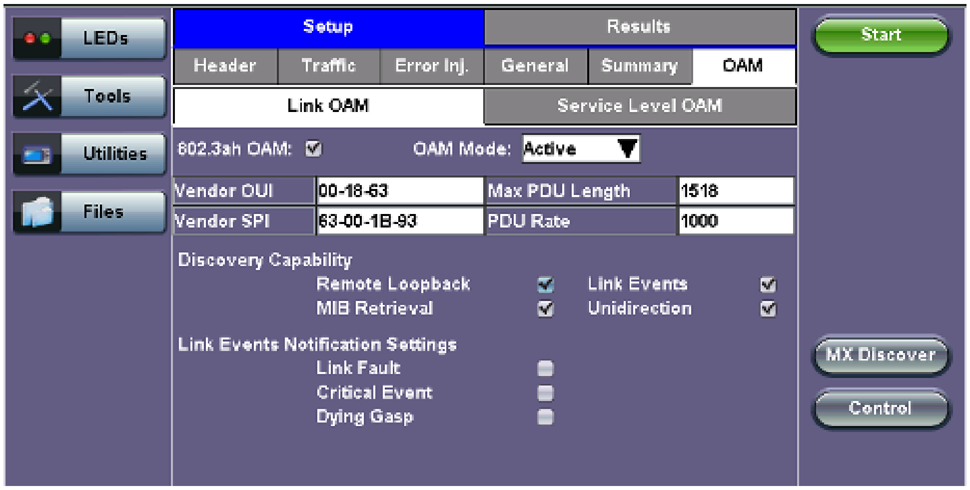
13.6.1 OAM Setup

13.6.1.1 Link Level 802.3ah OAM Setup

802.3ah functions include:

- Discovery
- Link Performance Monitoring
- Remote loopback
- Fault detection
- Collecting Performance Statistics (Function not supported in current software release)
- Organizational Specific Extensions (Function not supported in current software release)

Link OAM Setup



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

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

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

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

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

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

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802.3ah OAM Discovery

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

OAM Mode Active/Passive Actions

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

OAM Mode - Acceptable Active/Passive Combinations

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

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

Discovery Capabilities: Capabilities advertised during discovery process

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

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

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

MIB Retrieval: Retrieves information on network devices and interfaces.

Unidirection: Checks for unidirectional transmission.

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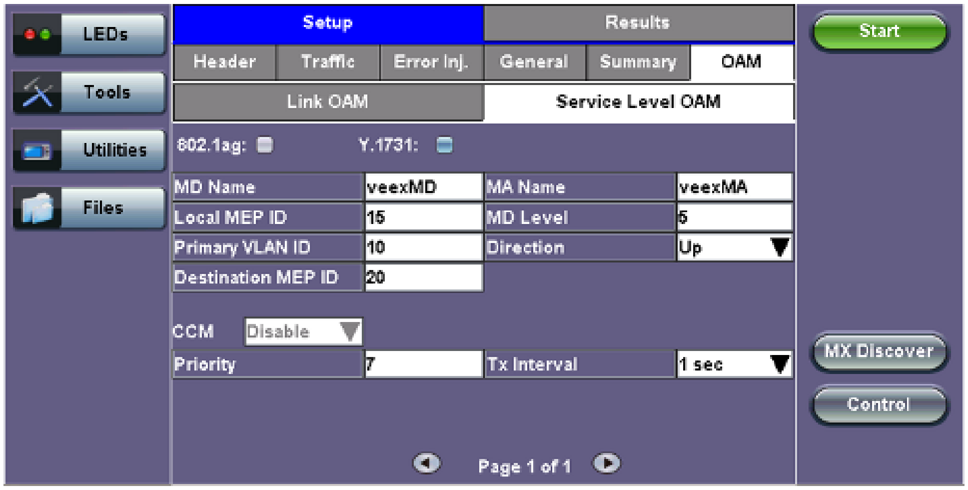
13.6.1.2 Service Level OAM: 802.1ag/Y.1731 Setup

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

- Fill out the given parameters. **MD Name**, **MA Name**, **VLAN**, and **MD Level** input values must match for both connected OAM devices in order for the test to work. The **Destination MEPID** and **Local MEP ID** must also be inverted for the tests to work.
- Tap the box next to 802.1ag or Y.1731 to start the selected test. The transmission of OAM PDUs become active as soon as the checkmark is added to the test.

OAM - Service Level OAM (Page 1)



Service Level OAM Configuration Parameters

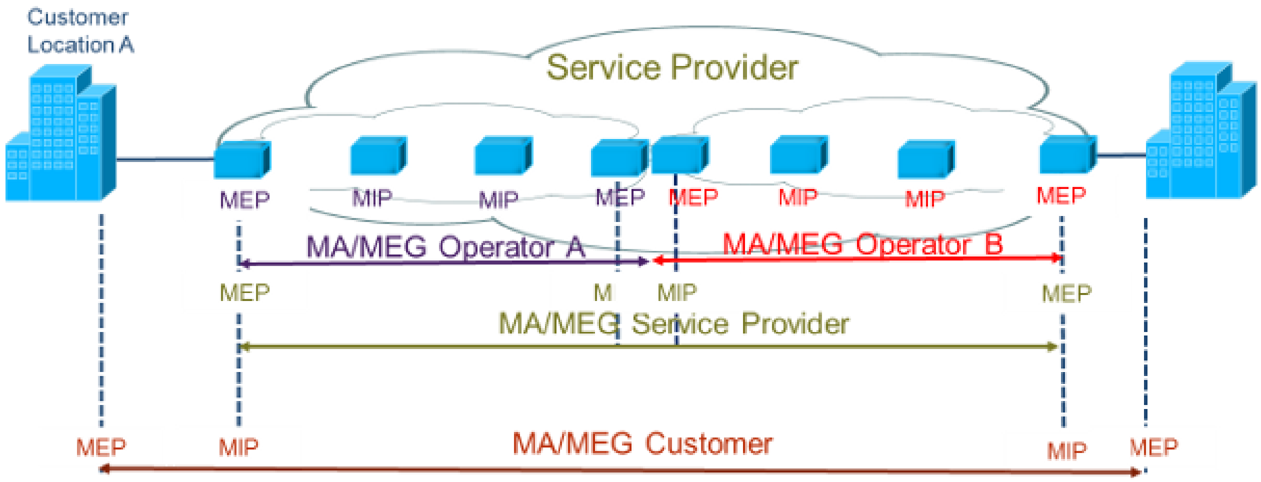
- **MD Name:** Name of the Maintenance Domain (only for 802.1ag)
- **MA Name:** Enter the name of the 802.1ag MA or Y.1731 MG
- **MD Level:** Maintenance domain level (0 to 7)
- **MEP ID:** End point identifier (1 to 8191)
- **Primary VLAN ID:** VLAN ID associated with the MA or MEG
- **Direction**
  - **Up:** Inward facing MEP used for MA/MEG with a wider reach (i.e., end-to-end, beyond a single link)
  - **Down:** Outward facing MEP used for MA/MEG spanning a single link
- **Destination MEP ID:** MEP ID of the MEP end point

Differences between 802.1ag and Y.1731

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

IEEE 802.1ag Definitions

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



Some terms differ between the two protocols. The chart below describes the differences.

Definition Equivalencies

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

Maintenance Point Roles

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

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OAM Services Setup

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

- Continuity Check (CCM)

- Loopback (LBM/LBR)
- Link Trace (LTM/LTR)
- Loss Measurement (LMM/LMR) (Y.1731 Only)
- Delay Measurement (DMM/DMR) (Y.1731 Only)

General Setup

To run any 802.1ag/Y.1731 Tests, fill out the listed parameters and press **Start**. In the case of **CCM**, select **Enable** from the drop-down menu to run that test. Details on individual test parameters will be listed in the specified section.

802.1ag/Y.1731 Connectivity Fault Management Functions

802.1ag/Y.1731 Connectivity Fault Management Functions supported by the test set are as listed:

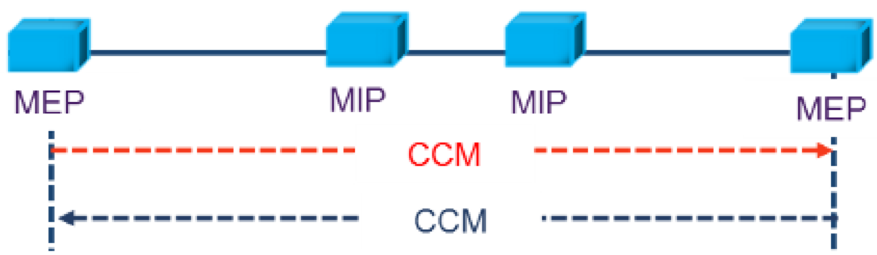
- Fault Detection – Continuity Check:
  - CCM "heartbeat" messages are transmitted at a configurable periodic interval by MEPs.
- Network/Path Discovery – Link trace message:
  - Equivalent to a traceroute test. MIPs and MEPs along the path send a response.
- Fault verification and isolation – Loopback: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

Continuity Check Messages (CCM)

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

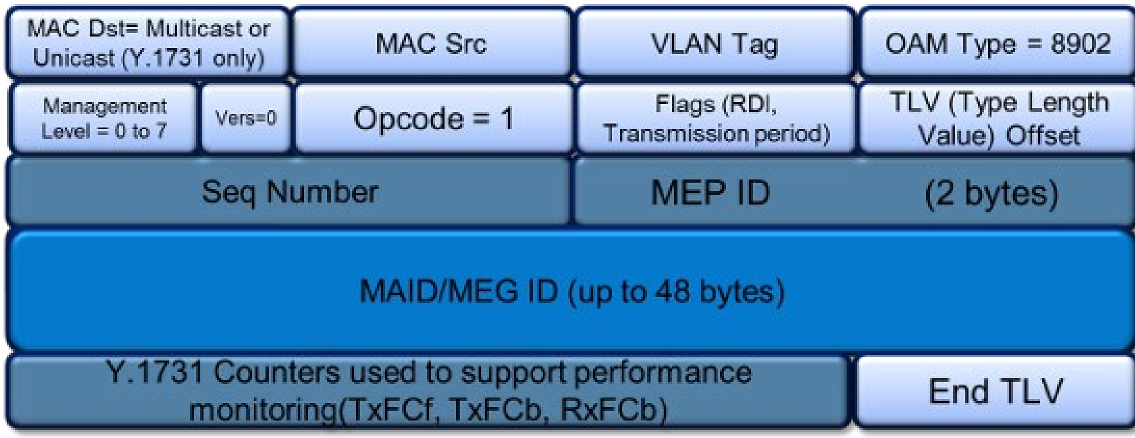
There can be 4,094 VLANs per port and up to eight maintenance levels. This yields a worst case CCM transmission rate of 9.8 million CCMs per second if 3.3ms interval is used.

Continuity Check Message (CCM)

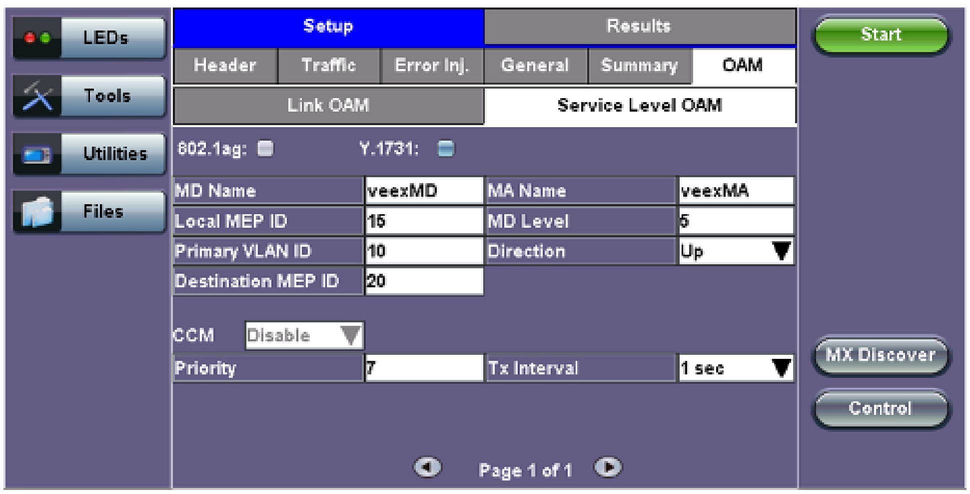


RDI Flags added in CCM Messages indicates loss of continuity in the remote direction.

CCM Message Format



Service Level OAM (Page 1)

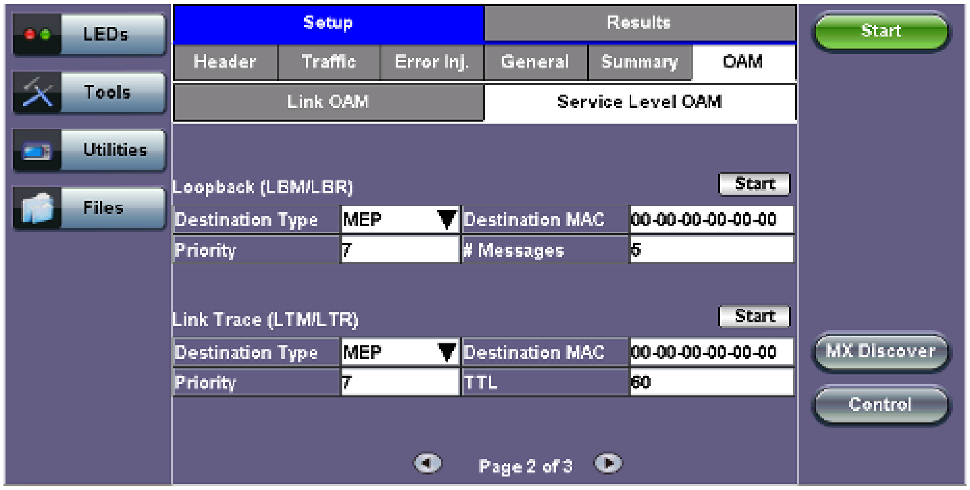


CCM Configuration Parameters

- **CCM**
  - **Enable**: Enable sending Continuity Check messages
  - **Disable**: Disable sending Continuity Check messages
- **Priority:** 802.1p priority in the CCM VLAN Tag
- **Tx Interval:** Choose from the supported CCM intervals: 1 s, 10 s, 1 min, 10 min.

Link Trace and Loopback Messages

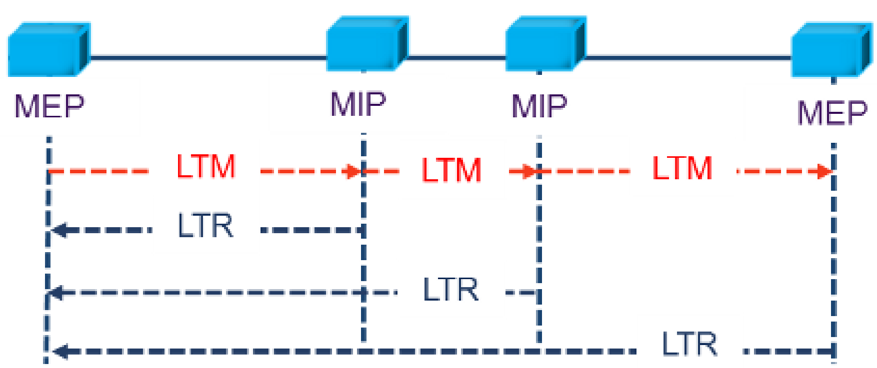
OAM - Service Level OAM (Page 2)



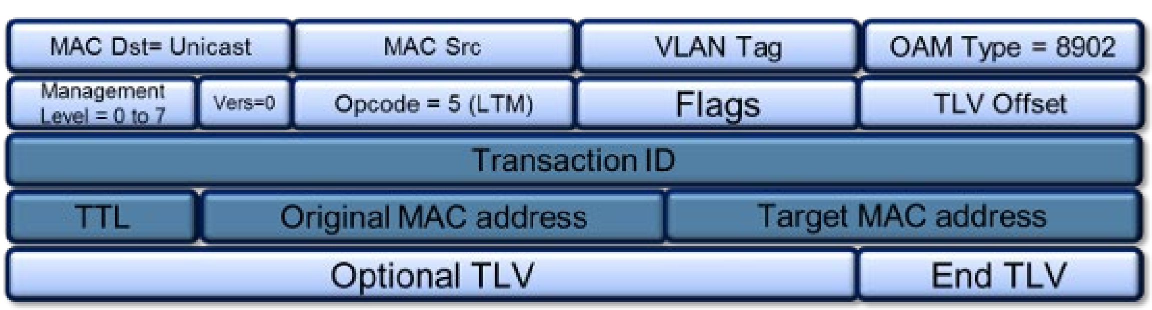
Link Trace Messages (LTM/LTR)

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

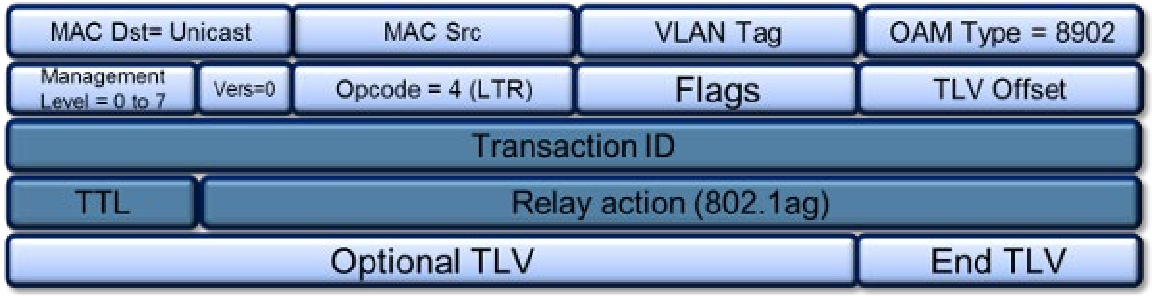
LTM Diagram



Link Trace Message Format



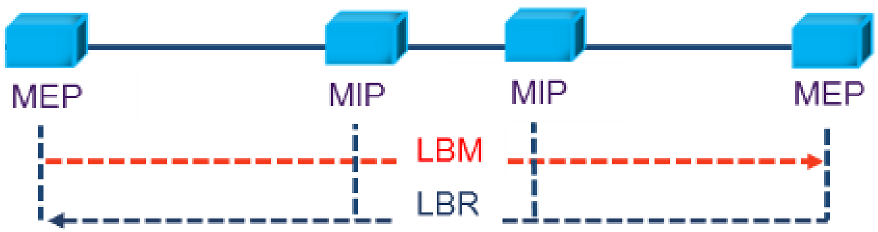
Link Trace Response Format



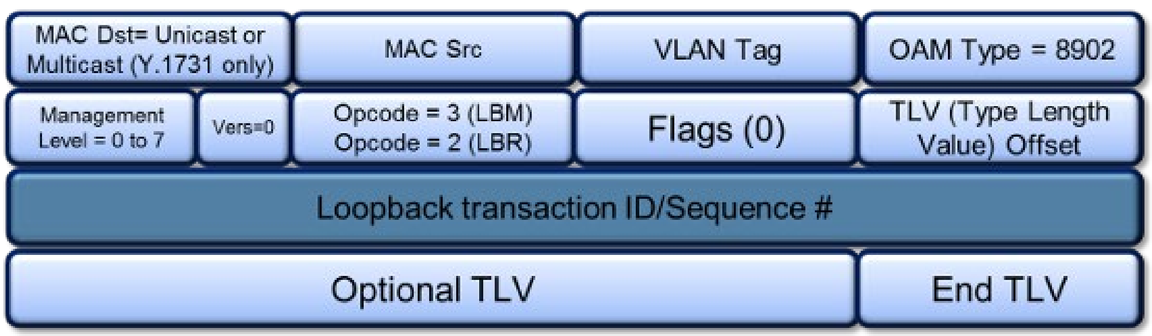
Loopback Message (LBM/LBR)

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

LBM Diagram



Loopback Message Format



Link Trace and Loopback Message Config. Parameters

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

Press **Start** to initiate testing.

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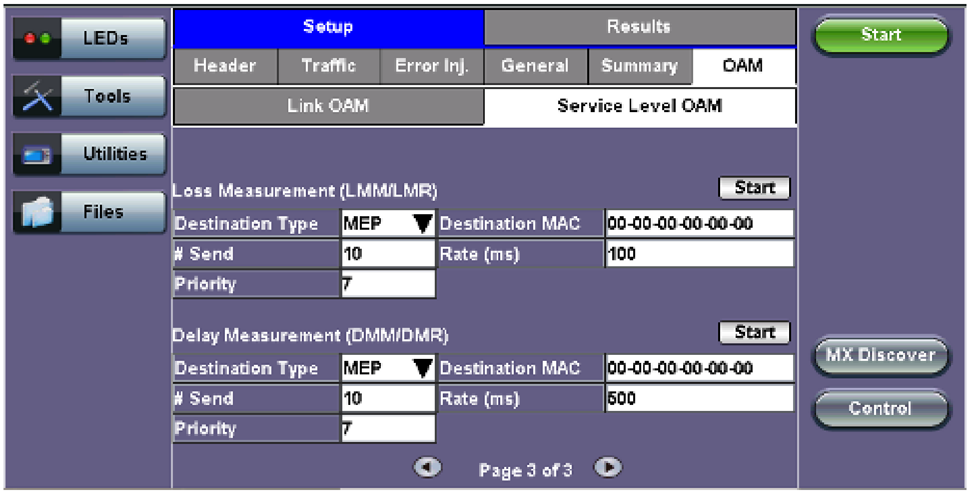
Y.1731 Performance Management Functions

OAM - Service Level OAM (Page 3)



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

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

Press **Start** to initiate testing.

Frame Loss Measurement

Two local counters for each peer MEP:

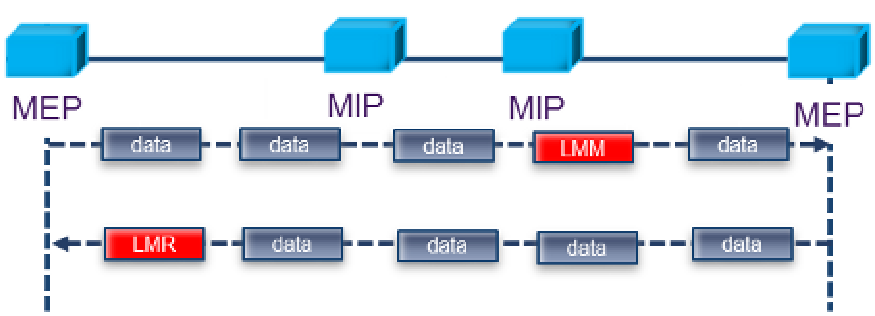
- TxFCf: Counter for in-profile data frames transmitted towards peer MEP
- RxFCf: Counter for in-profile data frames received from peer MEP

Single-ended ETH-LM:

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

CCM frames contain frame counters.

Single Ended Frame Delay Measurement



LMM frames contain frame counters.

Delay Measurement

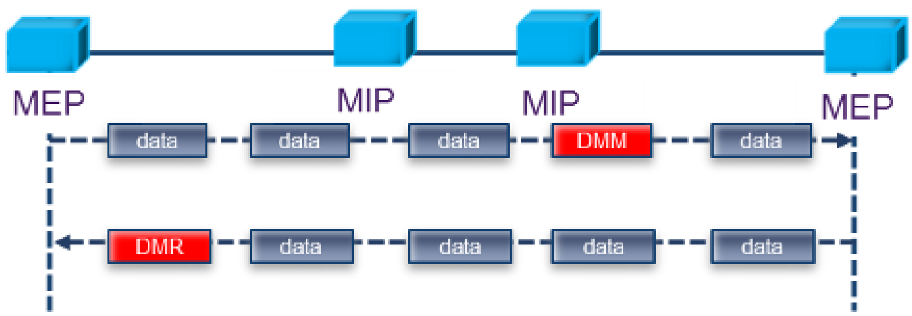
On demand OAM for measuring Frame Delay (FD) and Frame Delay Variation (FDV):

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

Two-way ETH-DM:

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

Dual Ended Frame Delay Measurement



DMM and DMR frames contain timestamp info.

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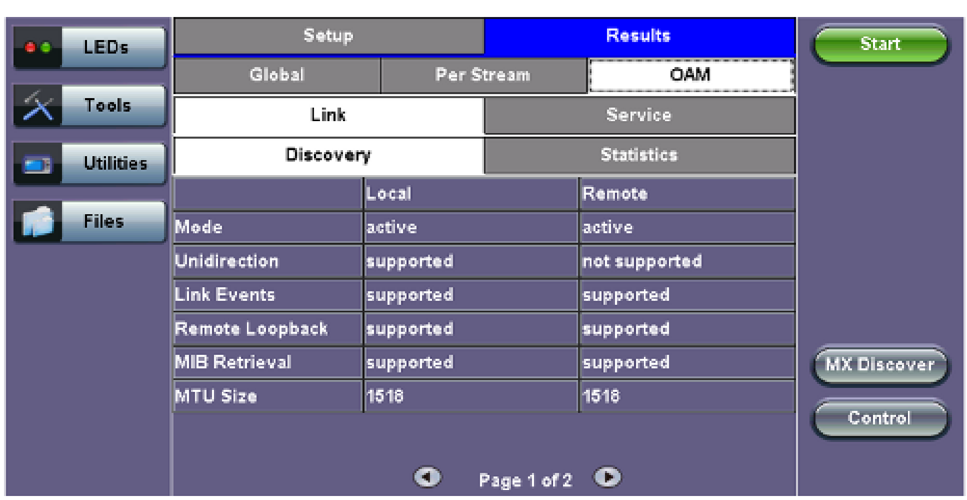
13.6.2 OAM Results

13.6.2.1 Link OAM Results

Link OAM Discovery

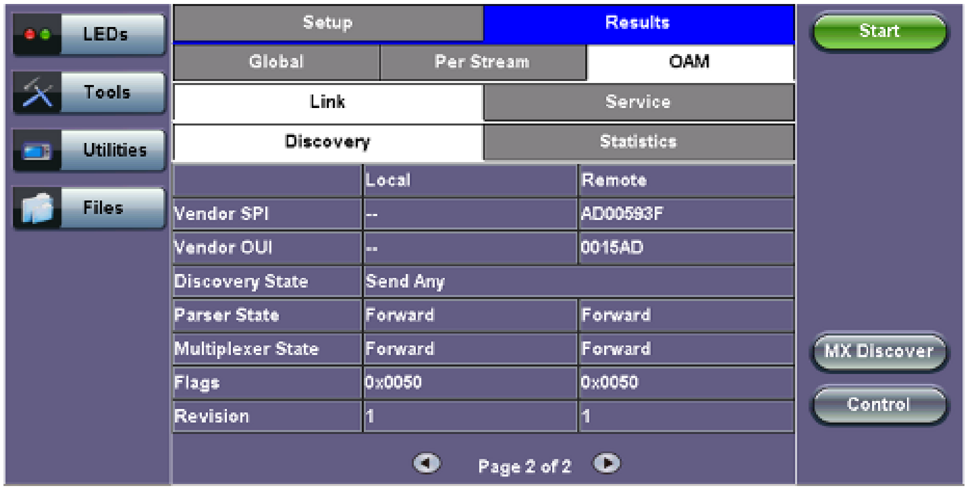
The discovery page lists **Local** (the current test unit) and **Remote** (far-end device) parameters.

OAM - Link - Discovery (Page 1)



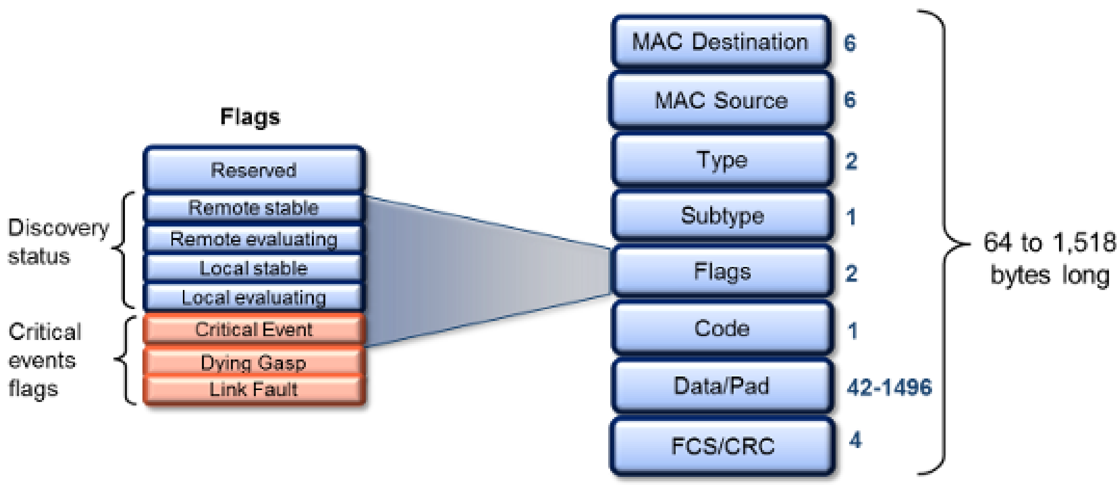
- **Mode:** Lists Active or Passive mode configuration.
- Supported and unsupported capabilities advertised during Discovery are listed, including: Unidirection, Link Events, Remote Loopback, MIB Retrieval, and MTU Size.

OAM - Link - Discovery (Page 2)

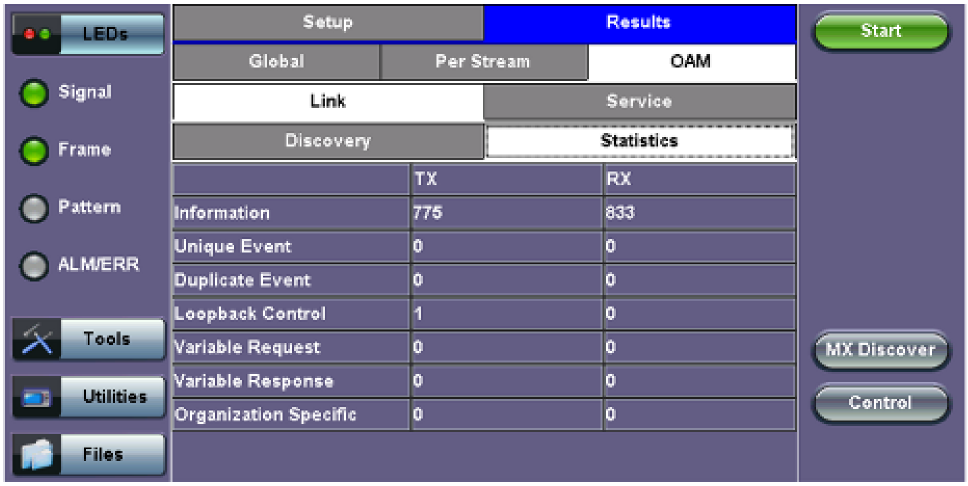


- **Vendor SPI and OUI:** Organization Unique identifier and Vendor specific information (similar to MAC address fields).
- **Discovery State:** Send Any indicates the device was successfully discovered.
- **Parser/Multiplexer state:** Forward indicates the device is forwarding regular traffic transmission.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

Flag Decode



OAM PDU



OAM PDU

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

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

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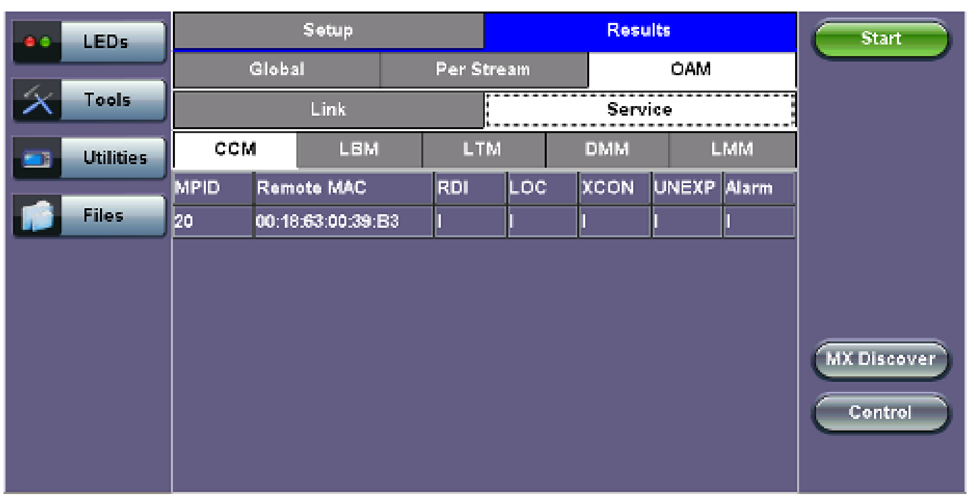
13.6.2.2 OAM Service Results

802.1ag/Y.1731 Connectivity Fault Management Functions Results

OAM - Service - CCM



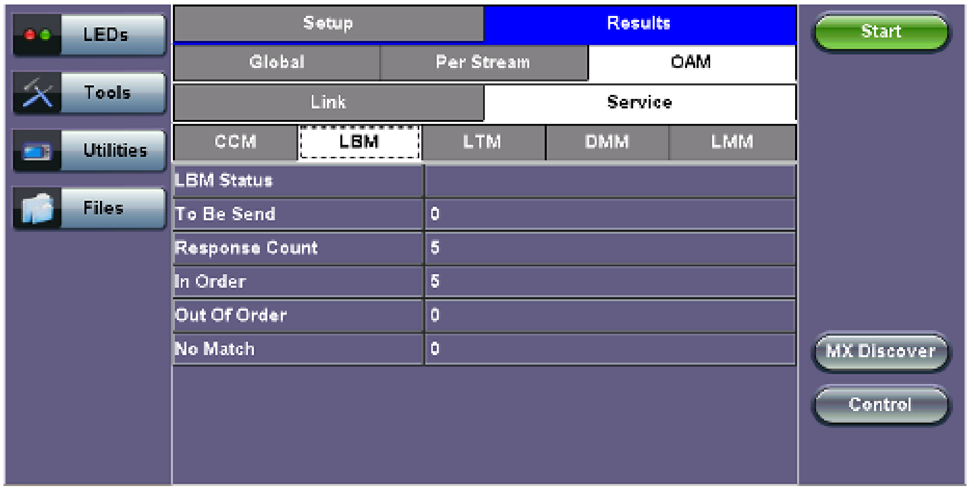
OAM CCM Results

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

- **MPID:** MEP ID of the remote MEP.

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

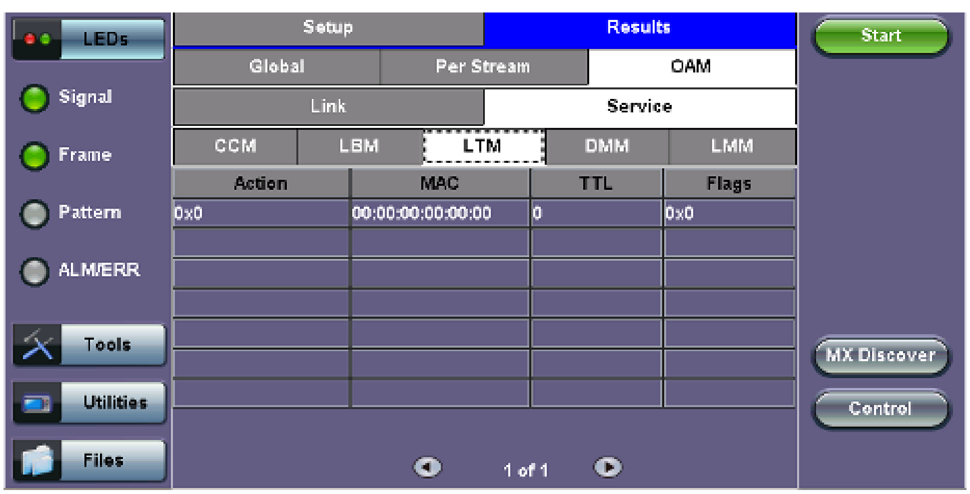
OAM - Service - LBM



OAM LBM Results

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

OAM - Service - LTM



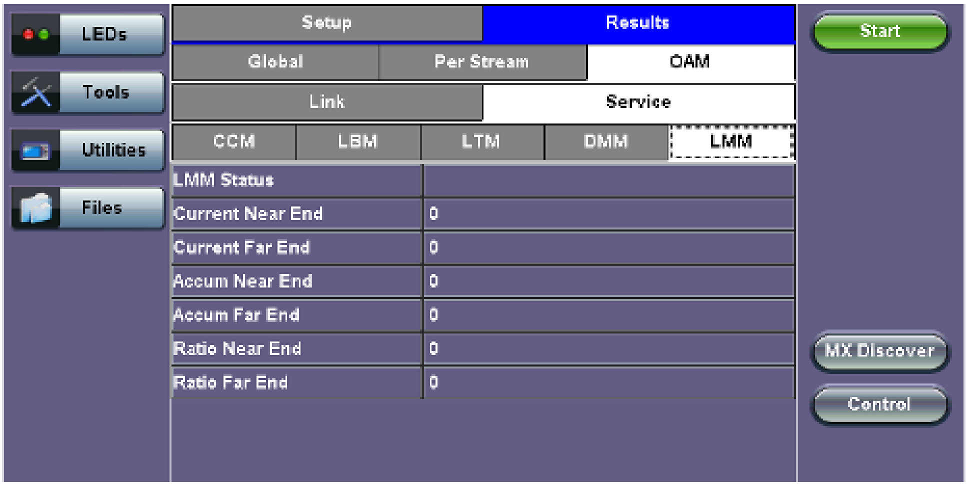
OAM LTM Results

- **Action:** RlyHit indicates that the LTM has reached the destination MAC/MEP (i.e., final point)

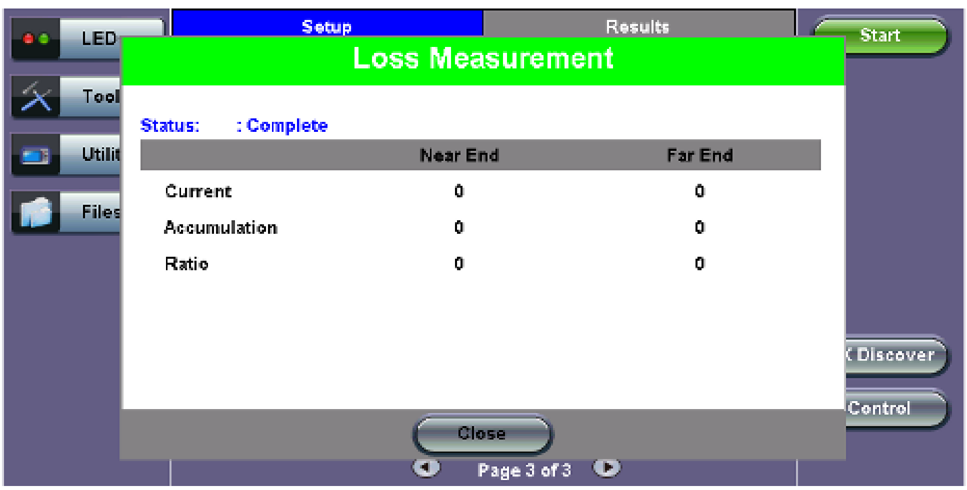
- **MAC:** MAC address of the responder
- **TTL:** TTL field on the response, indicated how many hops have been traversed
- **Flags:** If set, indicates that only MAC addresses learned in a Bridge's Filtering Database, and not information saved in the MIP CCM Database, is to be used to determine the Egress Port

Y.1731 Performance Management Functions Results

OAM - Service - LMM



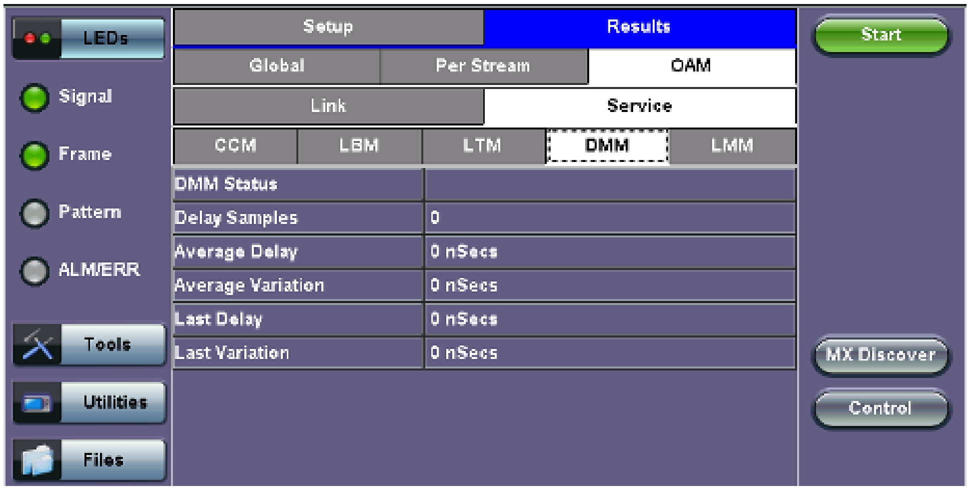
OAM - LMM Message



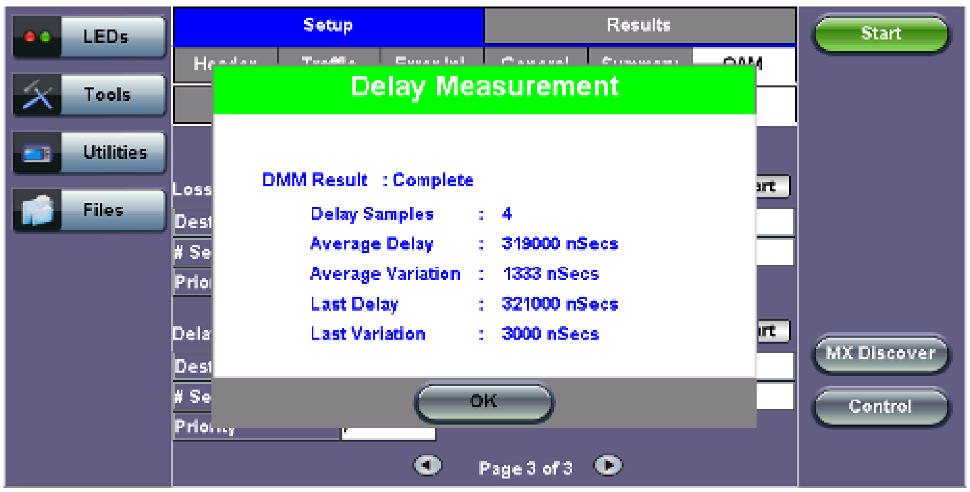
OAM LMM Parameters

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

OAM - Service - DMM



OAM - DMM Message



OAM DMM Parameters

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

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13.7 Auto Profile Scripting

The Auto Scripting application allows users to run tests with pre-configured 1GE/10GE/40GE/100GE Throughput or BERT profiles in sequence for a certain duration. This allows for a certain degree of automation for lab and field applications. The pre-configured profiles can be either created with ReVeal and loaded to the unit, or created on the unit itself.

The Auto Scripting application can be accessed in two different ways:

- Short cut from the application selection window (CFP4/QSFP28/QSFP+)
- Within the selected application (1GE/10GE/40GE/100GE) Home/Advanced Tools menu

Users can select up to 10 profiles in sequence. At the end of each profile test the results are saved automatically.

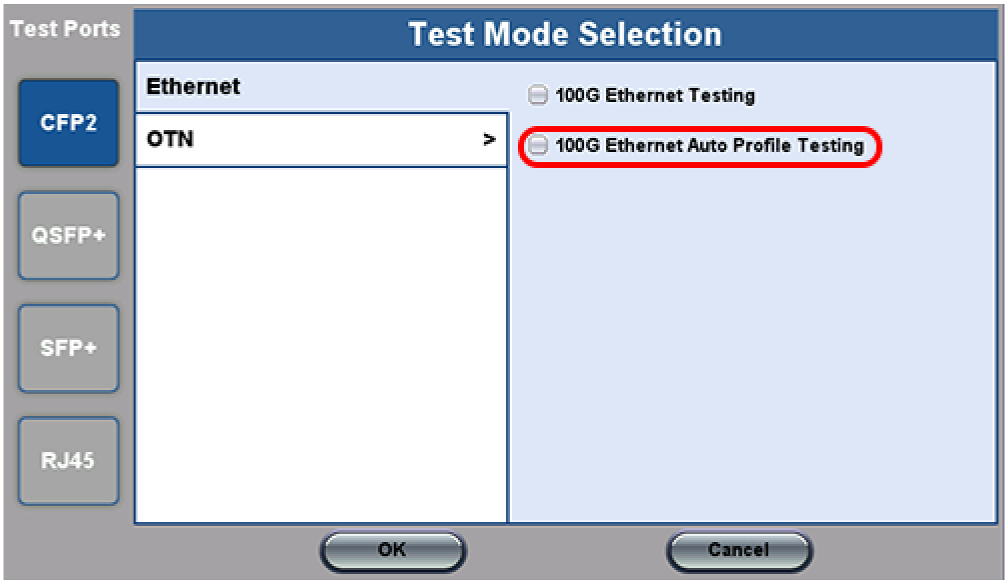
Starting from Boot-up:

1. On boot up, tap on the Application window

Boot-up Screen

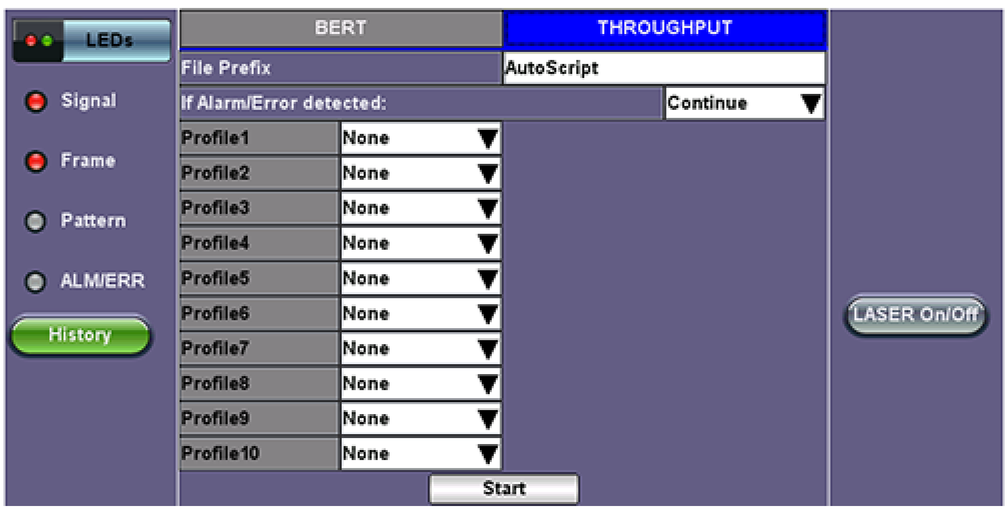
2. Test Mode Selection: The short cut to the Auto Profile Scripting application is found in each of the interface sub-menus for CFP2, QSFP+/SFP+, and RJ45.

Test Mode Selection



3. When the shortcut is selected from the Test Mode selection window, the Auto Script application is automatically launched.

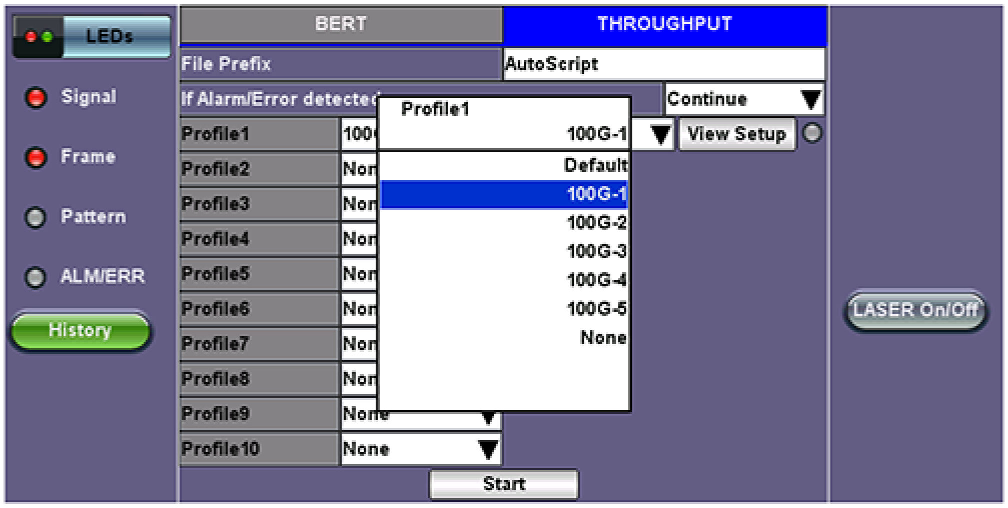
Auto Script Main Menu



Selecting Profiles

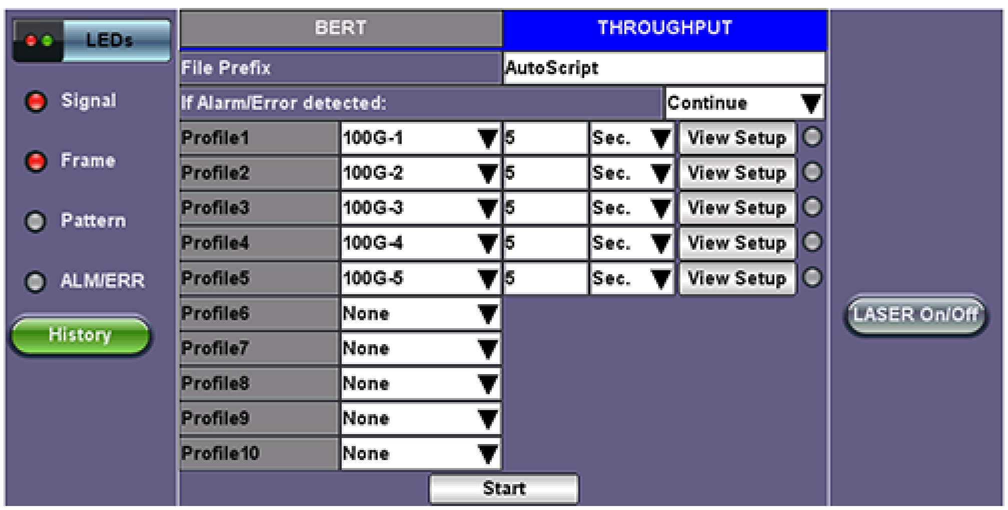
- Pre-configured profiles appear in each of the Profile pull down menus. The user can select any profile available one or more than one time.

Pre-configured Profiles



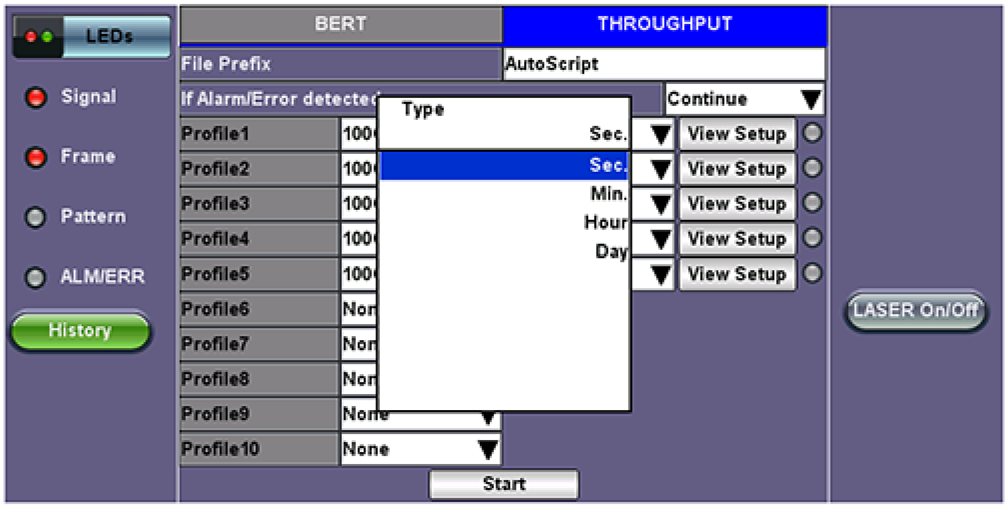
- User can select up to 10 profiles, each with a different test duration.

Selected Profiles



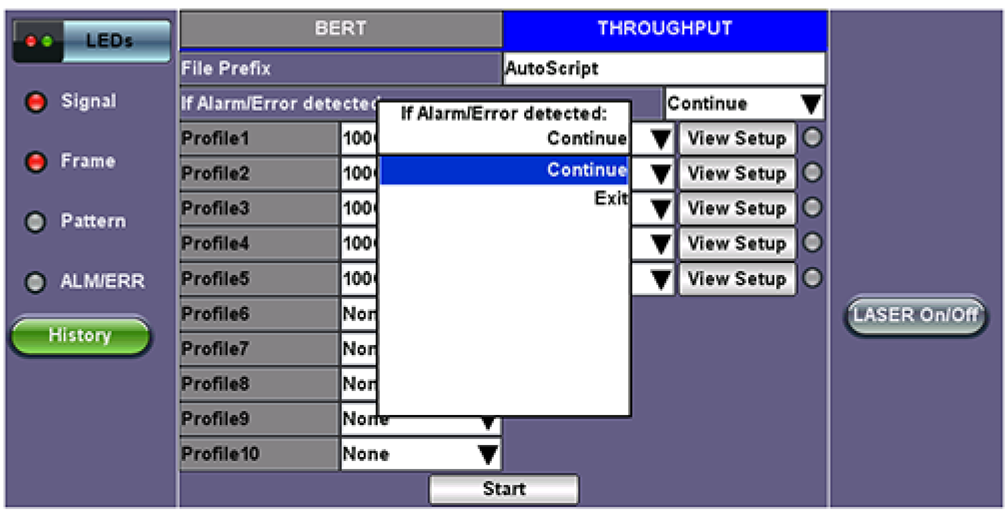
Profile Test Duration: The duration of each profile can be in seconds, minutes, hours, or days

Profile Test Duration



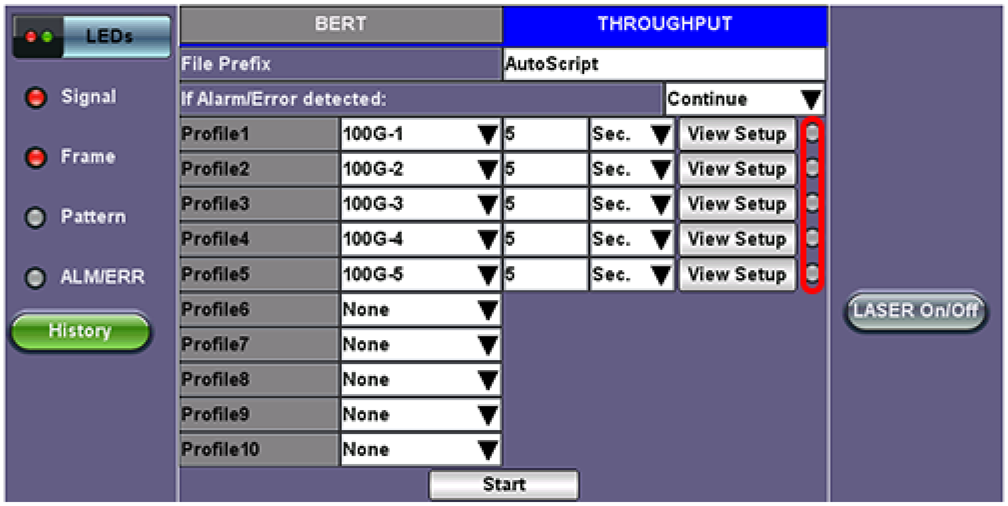
Error handling during Test: The user can choose to Continue the auto scripting test if errors occur in any of the profiles by selecting "Continue". Or they can choose to stop the auto script by selecting "Exit".

Error Handling



Status of Profile Test: At the end of each profile tests, the status will be indicated by the soft LEDs next to each profile. Green = the test ran error free. Red = errors occurred during the test.

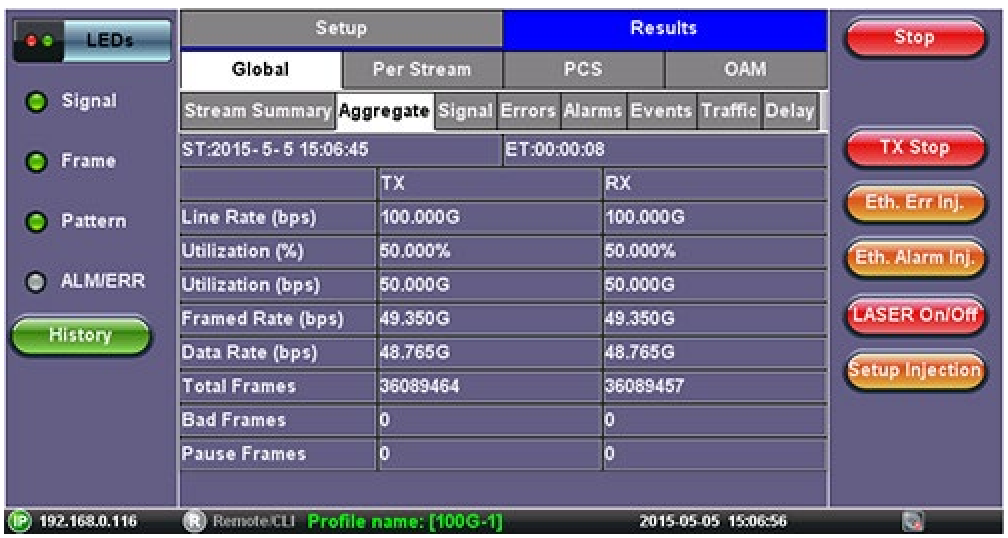
Status before testing



Test Running:

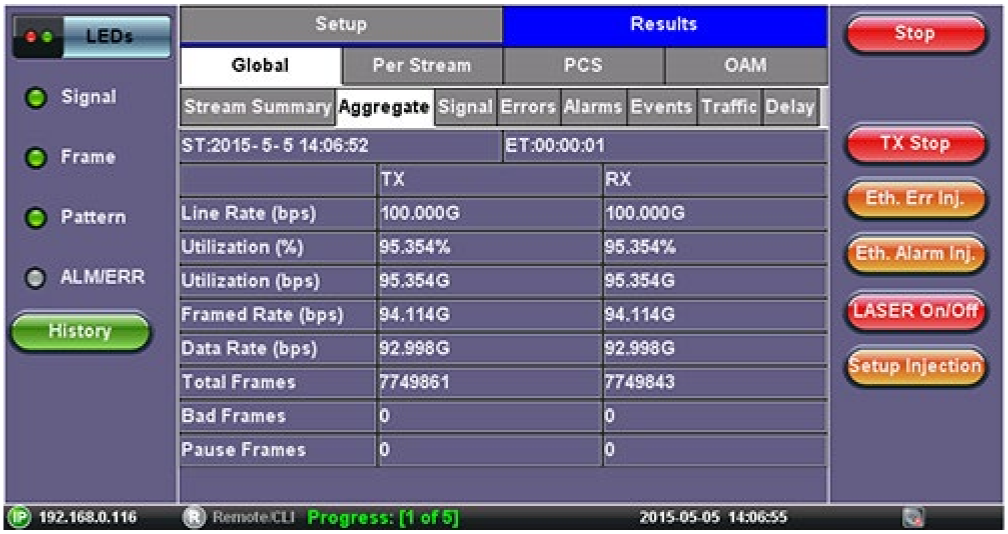
- To identify the profile being tested, progress of the test, and remaining time of each profile being tested, Profile Name, Progress and RT are scrolled on the bottom bar one after the other for a couple of seconds each time.

Bottom Bar - Profile Name



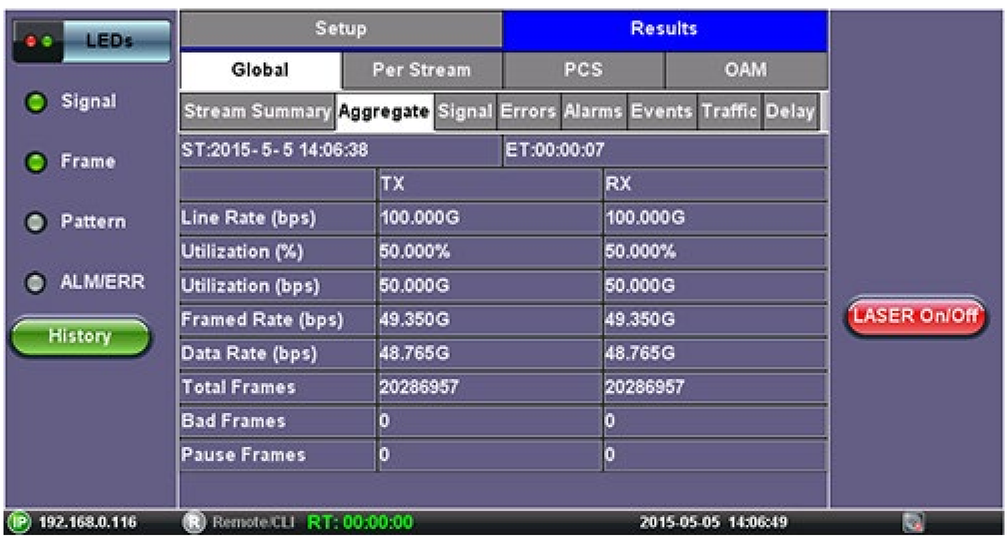
- **Progress:** Progress (1 of X) profiles being tested is displayed on the bottom bar.

Bottom Bar - Progress



- **Remaining Time** is displayed on the bottom bar.

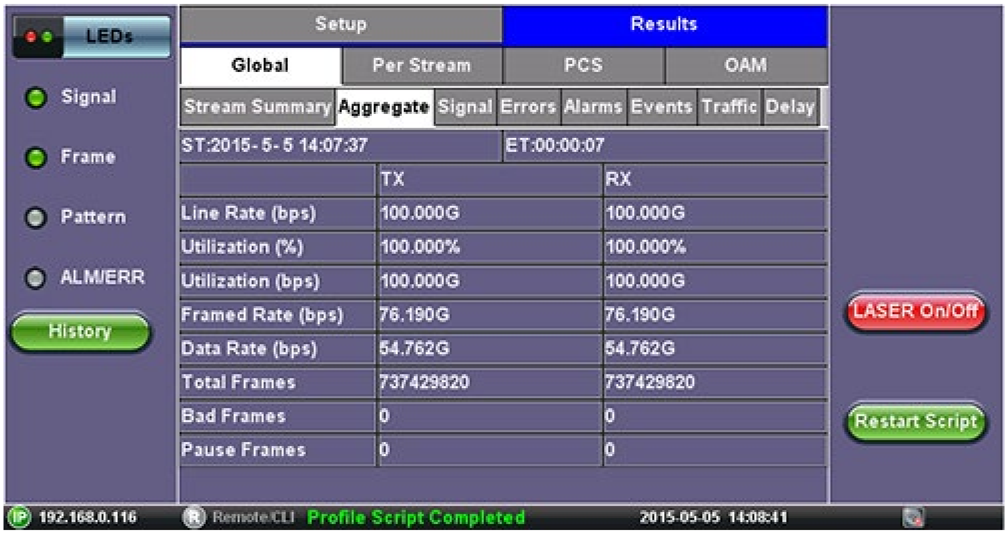
Bottom Bar - Remaining Time



End of Test

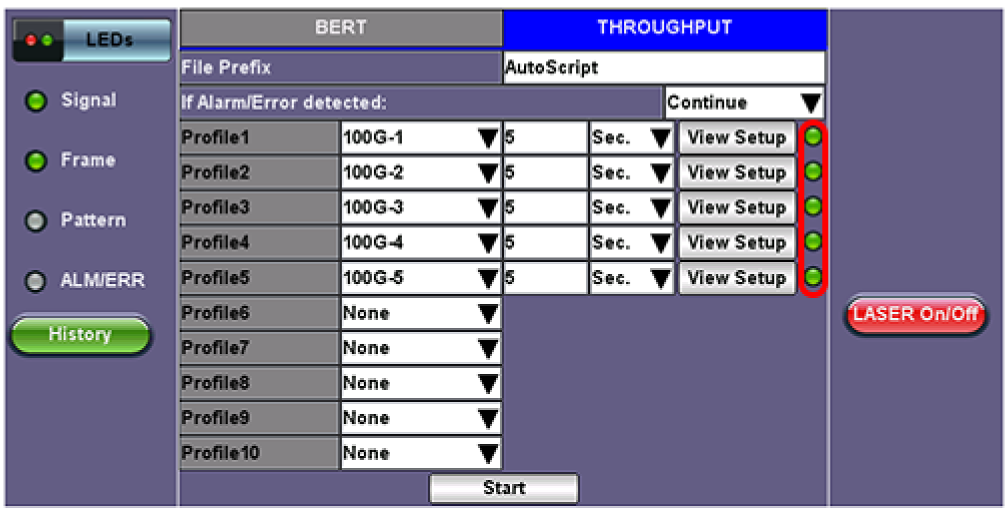
At the end of the auto scripting test a “Profile Script Completed” message is displayed on the bottom bar.

Bottom Bar - Profile Script Completed



At the end of the auto script test the soft LEDs will display the overall status of each profile test that was carried out.

Status at the end of the test



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13.8 Monitor (Pass Through)(RXT-6000e Only)

Pass through monitor mode enables the test set to be used for long term in-service testing. This allows for bi-directional monitoring of up to 10GE Ethernet line rate on the two 10GE SFP+ ports or the two 10/100/1000T RJ45 ports.

The Pass Through functionality allows:

- In-line traffic monitoring in both directions
- Long or short term network monitoring for troubleshooting network traffic problems
- Isolate network problems to the customer network or the service provider/operator network
- Monitor traffic between 10GE/1GE Fiber or 10/100/1000T links

- **Pass through monitor operation**
  - Pass Through Monitor Copper 1GE
  - Pass Through Monitor Fiber 1GE
  - Pass through monitor mode enables bidirectional monitoring between the two 10GE Fiber ports or the two 10/100/1000 Base-T ports

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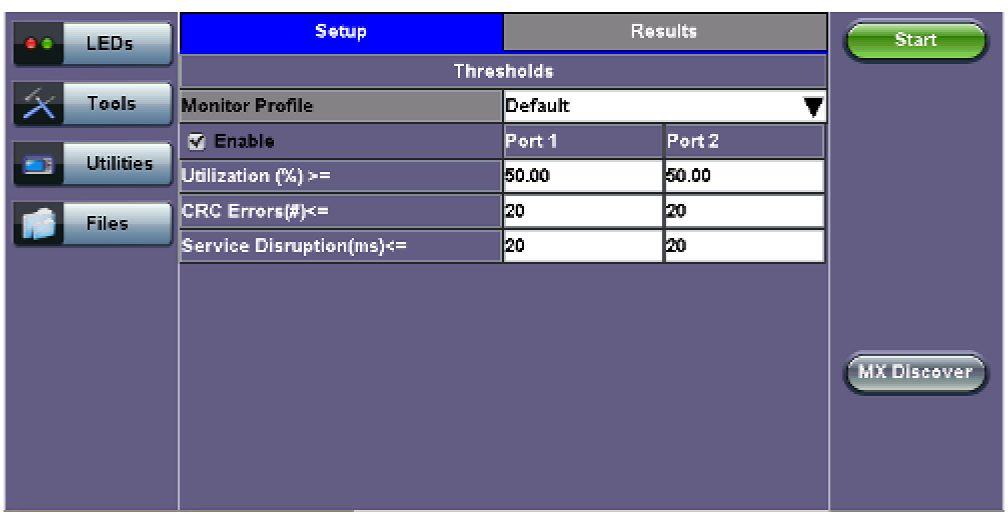
13.8.1 Setup

The pass through monitor setup and operation is straight forward and simple:

- Press the **Test Port** button on the right side of the screen and select a pass through mode option
- Connect to both 10GE Fiber ports, 1000Base-X fiber ports (port 1 and port 2) or both 10/100/1000T copper ports (port 1 and port 2), depending on the interfaces to be monitored
- Once the cable/interface connections are in place, press **Start**

Monitor Mode Setup



- Thresholds: Set values for Port 1 and Port 2. The thresholds can be enabled or disabled depending on test requirements. When enabled, the pass through will show a pass/fail status based on the configured threshold values.
  - Utilization in %
  - CRC error count
  - Service Disruption in ms
  - Optical Power level in dBm (1000Base-X connections only)
- Once the cable/interface 10GE Fiber ports connections are in place and the thresholds have been set, press **Start**.

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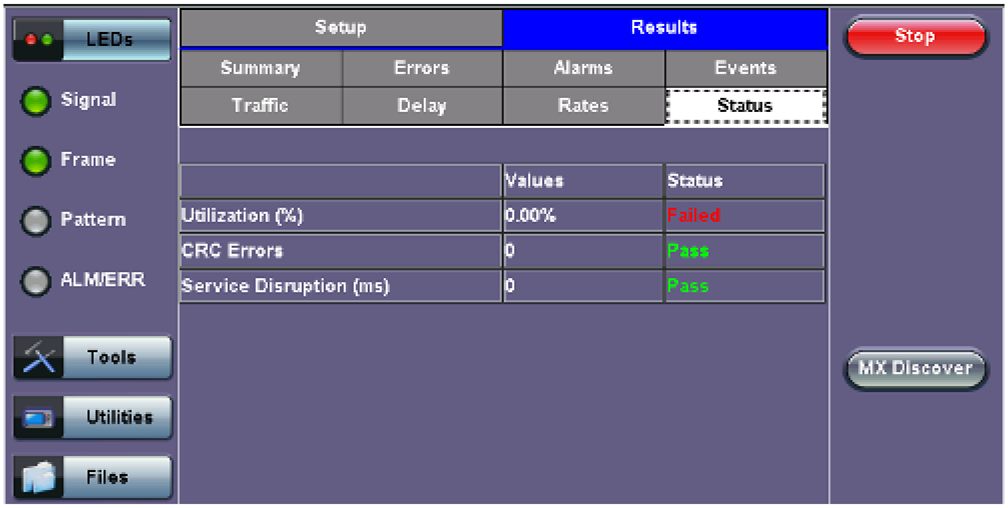
13.8.2 Results

Monitor Mode Results



Monitor Mode Results features the same statistics as BERT Results. Please see 15.2.2 BERT Results. The Status screen displays the following statistics:

- Utilization (%)
- CRC Errors
- Service Disruption (ms)

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13.9 Loopback Mode

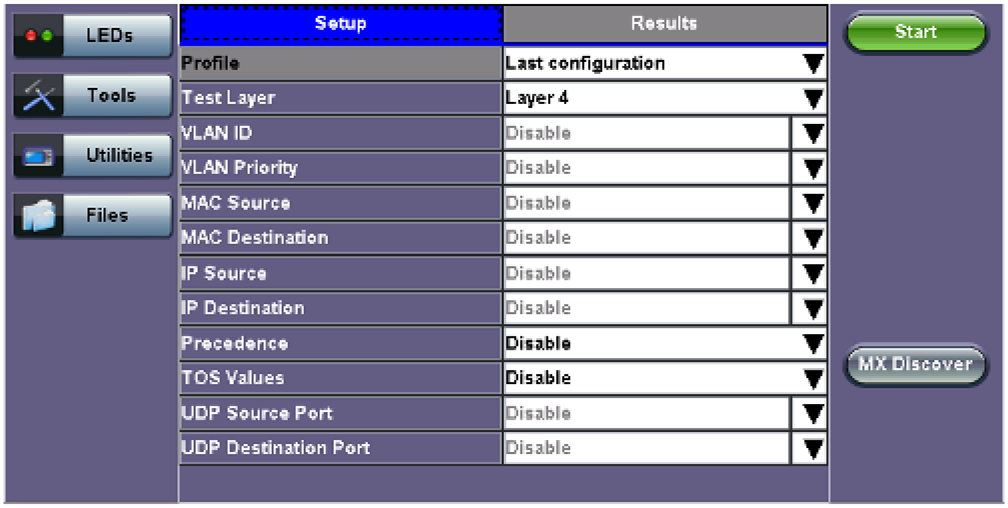
The Loopback application in the main menu allows the user to establish a manual loopback on the test set. The loopback function is used when an end-to-end test needs to be performed with one of the test partners in software loopback mode. The loopback function will loopback the incoming traffic to the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

The type of traffic that the loopback function loops back will depend on the type of test layer configured (Layer 1, 2, 3, or 4). Additional criteria can be set to allow only messages with specific criteria to be looped back. To specify loopback parameters, select the desired parameter and choose **Enable** from the drop-down menu. Tap on the box and input a value or select one of the drop-down menu choices:

- **Layer 1**: All incoming traffic to the Rx loopback interface will be sent out unaltered to the Tx loopback interface.
- **Layer 2, 3, & 4**: In a Layer 2 or 3 loopback all incoming test traffic will be looped back.
  - The loopback function will swap the MAC destination and MAC Source addresses (for Layer 2) or MAC and IP destination and source addresses (for Layer 3).
  - All incoming frames with CRC errors will be dropped, similar to what an Ethernet switch does.
  - All broadcast and multicast frames will be dropped including any incoming unicast frames that have the MAC Source address equal to the MAC Destination address.
  - **Loopback Parameters**: The following parameters are available on Layer 2, 3 and 4. For more information on the parameters, please see 13.2.1.1 BERT Header Settings in the BERT section. It is possible to enable any of these parameters to create a customer loopback filter. For example, enabling a filter with VLAN 64, Priority 7, will only loop back traffic corresponding to these values.
    - VLAN ID
    - VLAN Priority
    - MAC Source
    - MAC Destination
    - IP Source Address (Layer 3 & 4 only)
    - IP Destination (Layer 3 & 4 only)
    - Precedence (Layer 3 & 4 only)
    - TOS Value (Layer 3 & 4 only)
    - UDP SPort (Layer 4 only)
    - UDP DPort (Layer 4 only)

Press **Start** to begin loopback.  indicates that loopback is in progress. The **Results** tab displays current test results. Please see 13.2.2 BERT Results for information on the Results tabs.

Loopback Setup



Loopback In Progress

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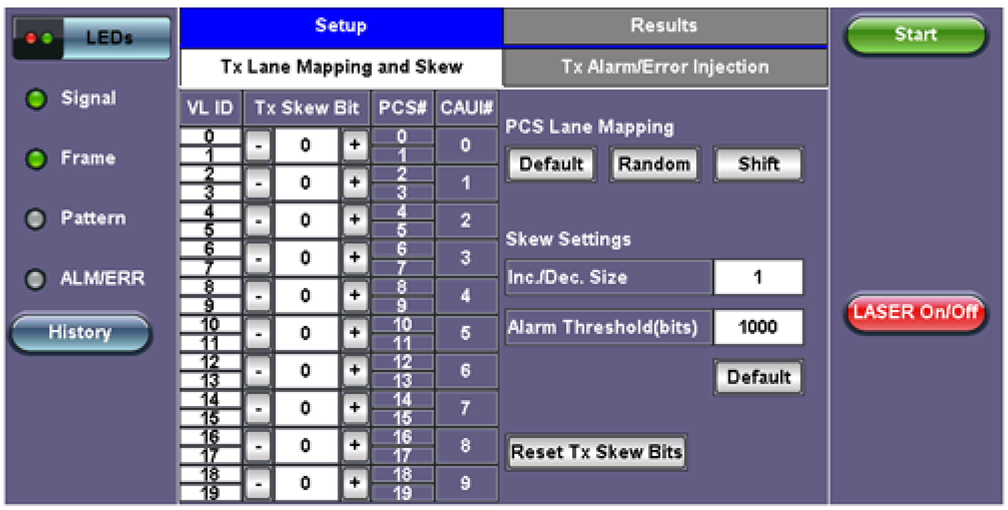
14.0 PCS

14.1 Setup

14.1.1 Tx Lane Mapping and Skew

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

PCS Setup - Tx Lane Mapping and Skew



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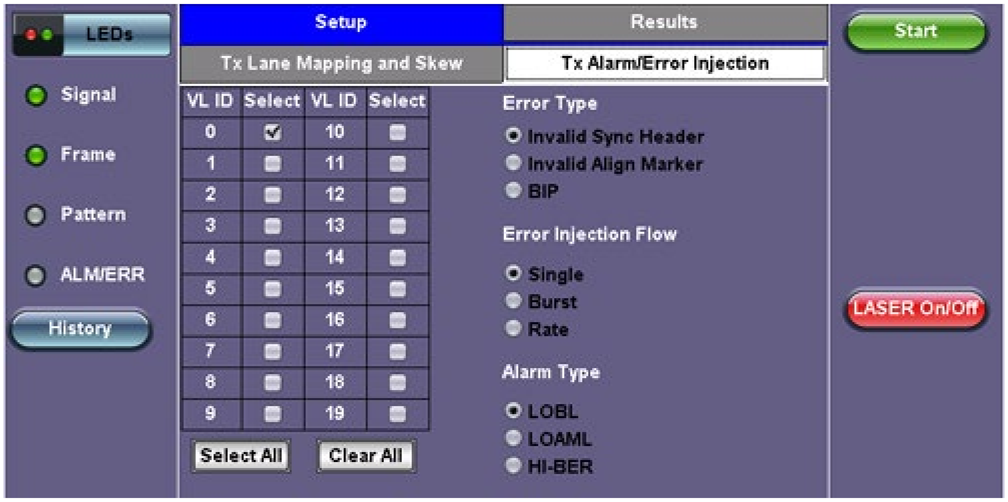
14.1.2 Tx Alarm/ Error Injection

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

PCS Setup - Tx Alarm/ Error Injection



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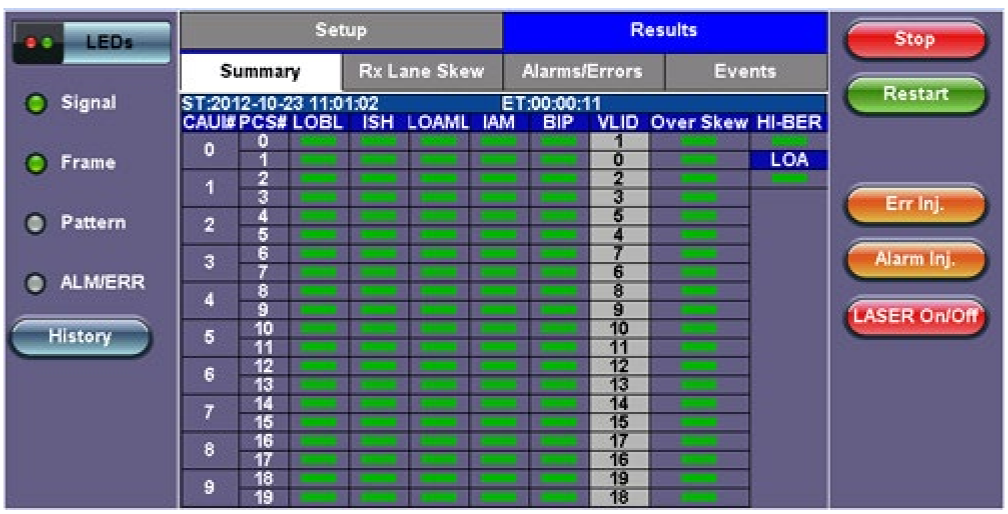
14.2 Results

14.2.1 Summary

PCS Results - Summary



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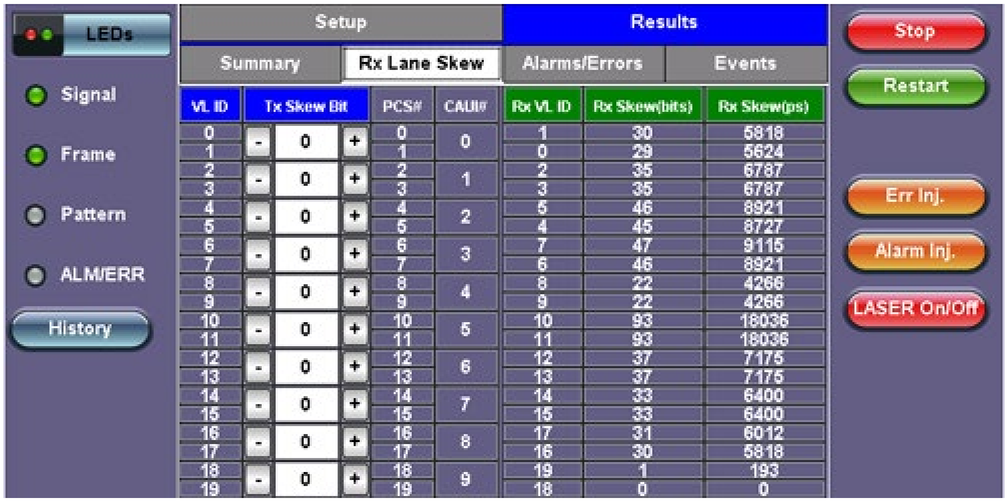
14.2.2 Rx Lane Skew

PCS Results - Rx Lane Skew



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14.2.3 Alarms/Errors

PCS Results - Alarms/Errors

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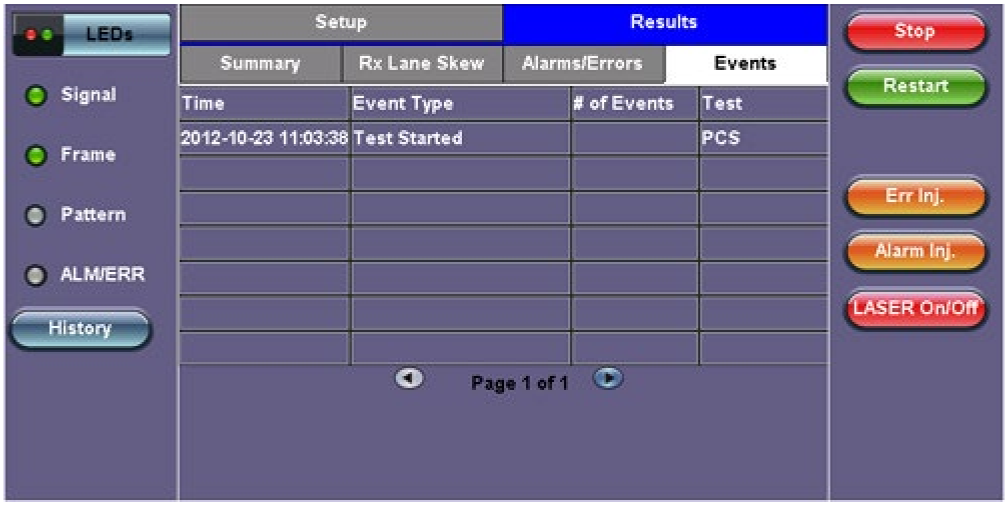
14.2.4 Events

PCS Results - Events



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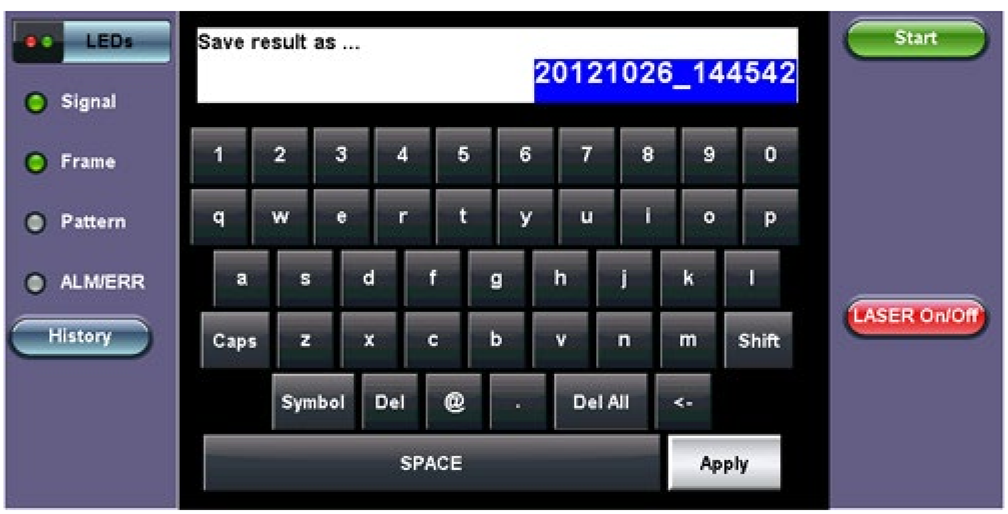
14.3 Saving PCS Results

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

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

PCS Results Save



Once the results are saved, they can be viewed or renamed by going to **Tools / System Settings screen> Files**.

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15.0 OTU3/ OTU4 Test App

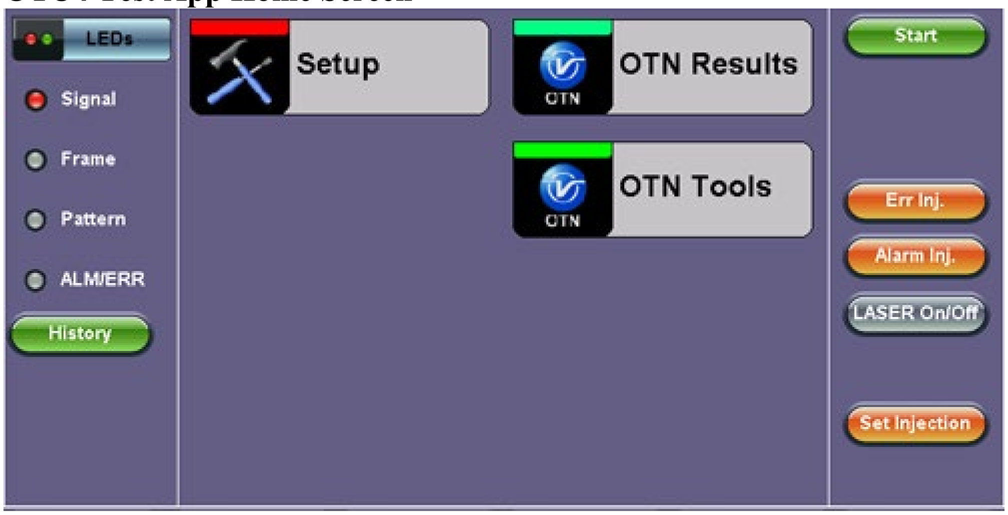
Follow the steps to assign the test module to a test tab as described in RXT-1200 Platform Manual of this manual.

Select the OTU4 Testing Application and press **Accept**.

The module will be configured and the progress will be displayed on the unit's screen.

The OTU4 home page will be displayed with links to Setup, OTN Results and OTN Tools. The Test Tab in the bottom of the screen will be red in color and so will be the soft LEDs for Signal and Frame on the left side of the screen.

OTU4 Test App Home Screen

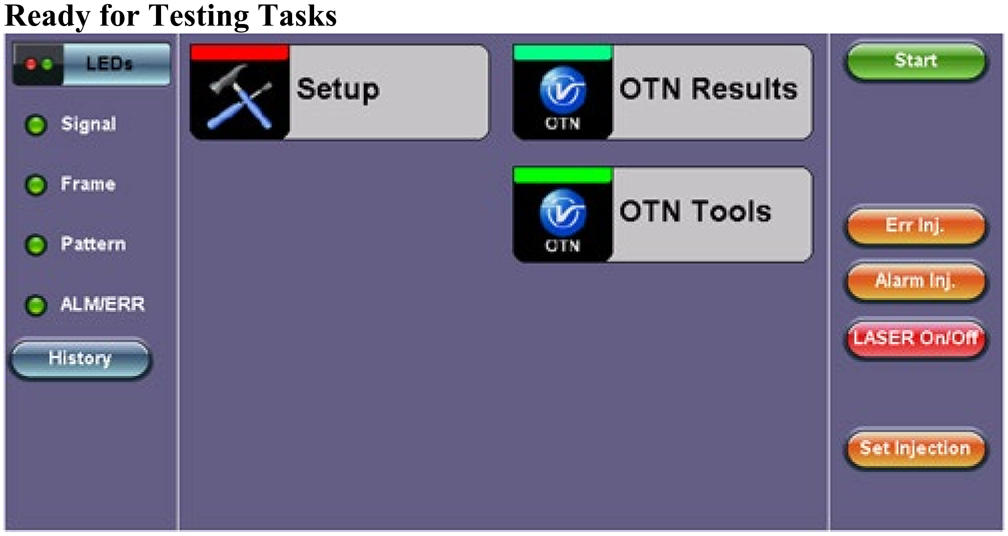


For safety reasons the transmitter laser is OFF by default. After making all the right connections, tap the **Laser On/Off** button on the right side of the screen.

The Laser On/Off button will turn Red, while the soft LEDs for Signal and Frame will start blinking, indicating the historical LOS condition.

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

Ready for Testing Tasks



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15.1 Setup

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

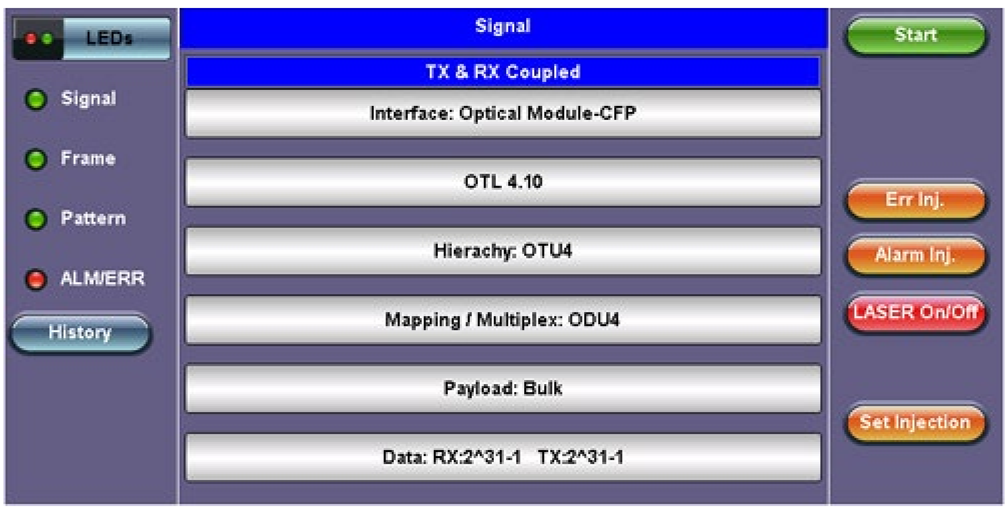
The parameters are for TX and RX Coupled - TX and RX configurations are grouped as one block; TX and RX will have identical configuration.

- **OTL**
- **Hierarchy:** Allows the user to configure OTN signal and network types, including the bit rate and higher order mapping, if applicable.
- **Data**

The following fields are pre defined:

- **Interface:** Optical Module-CFP - For OTN only optical interface is available.
- **Mapping / Multiplex:** ODU4
- **Payload:** Bulk

OTU4 Setup Home



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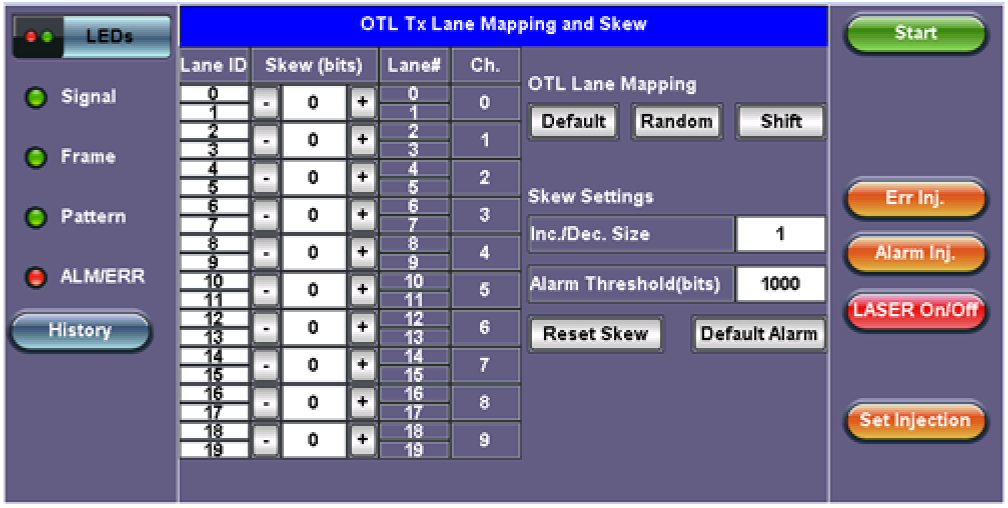
15.1.1 OTL

Tap the OTL tab on the Setup screen to configure the OTL Tx Lane Mapping and Skew.

OTL Tx Lane Mapping and Skew



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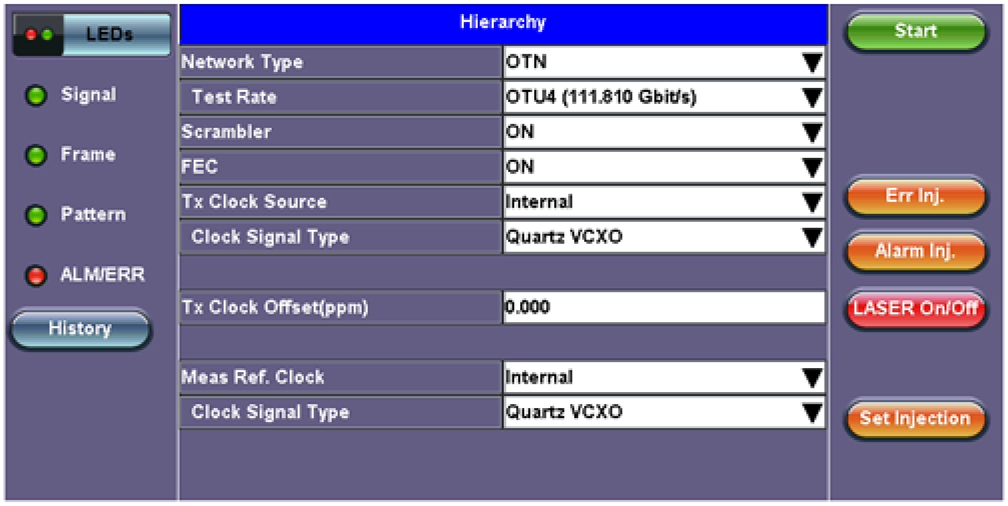
15.1.2 Heirarchy

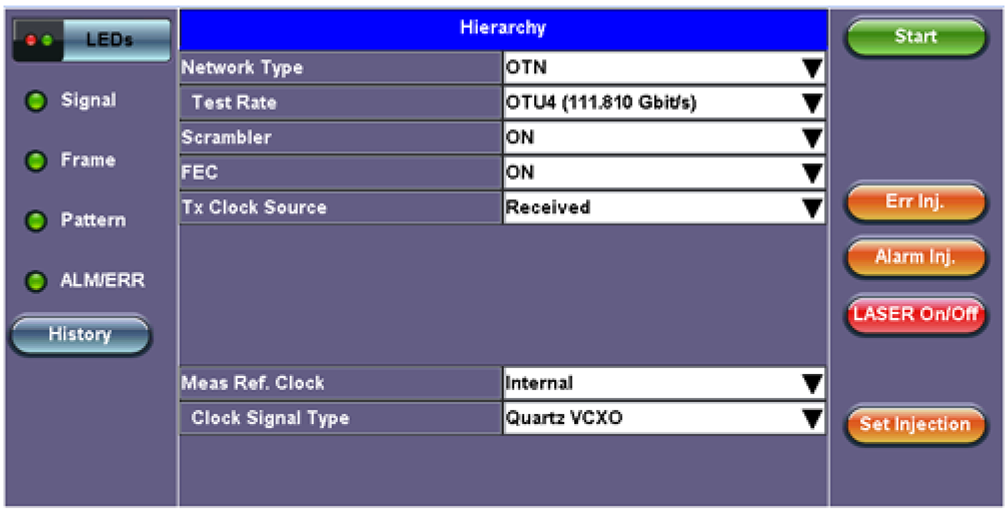
Tap the Heirarchy tab to enter the Heirarchy configuration screen. The following parameters are displayed:

- **Network Type:** OTN
- **Test Rate:** OTU4 (111.819 Gbits/s)
- **Scrambler:** On/Off
- **FEC:** On/Off
- **Tx Clock Source:**
  - **Internal:** The clock for the transmitter is derived from the internal clock. The internal clock has an accuracy of +/- 3.5ppm conforming to G.812 recommendations.
  - **Received:** The clock for the transmitter is derived from the received signal and the jitter of the incoming signal is suppressed.
  - **External (BNC):**
    - **Clock Signal Type:** 1PPS (BNC), 10MHz, 5MHz, 1544KHz, 2048KHz, 2048Kbit/s, 1544Kbit/s, 64 Kbit/s signals are present on the SMA connector.
    - **Line code:** HDB3, B8ZS, AMI
- **Measurement Reference Clock:** Internal
- **Clock Signal Type:** Quartz VCXO

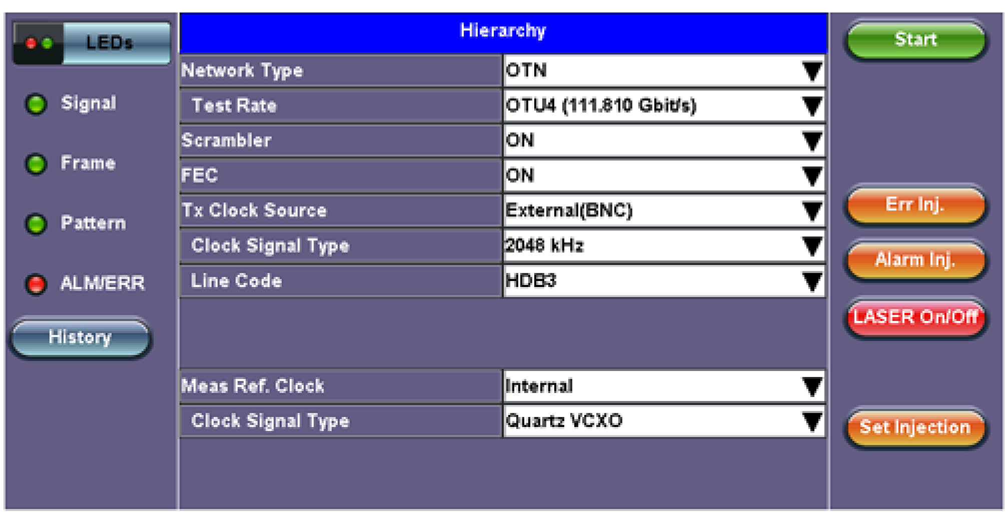
OTU4 Heirarchy Setup (Internal Clock)



OTU4 Heirarchy Setup (Received Clock)



OTU4 Heirarchy Setup (External Clock)



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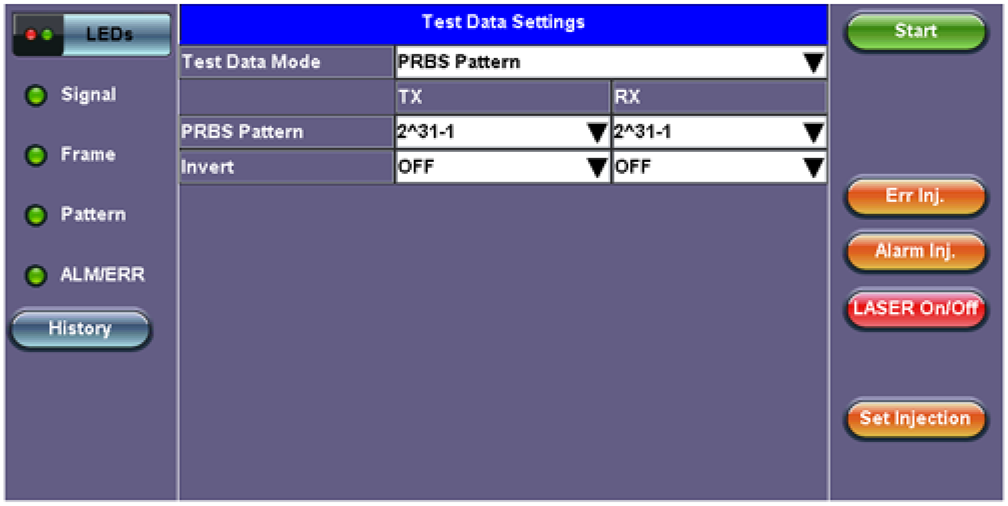
15.1.3 Data

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

- **Test Data Mode:** PRBS Pattern

- **PRBS Pattern (TX and RX):** Pseudo Random Bit Sequences (PRBS) defined by ITU-T 0.150 and 0.151 standards, fixed words and 24-bit or 32 bit user defined patterns are available.
  - Avaialble patterns: 2^31-1, 2^23-1, 2^9-1
- **Invert** (Logic pattern inversion)**:** On / Off

OTU4 Setup - Test Data Settings



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16.0 CPRI Testing

CPRI Overview

- CPRI stands for **Common Public Radio Interface**
- This protocol has been developed by Ericsson AB, Huawei Technologies Co. Ltd, NEC Corposration, Alcatel Lucent and Nokia Siemens
- It is an industry cooperation aimed at defining a publicly available specification for the key internal interface of radio base stations between the Radio Equipment Control (REC) and the Radio Equipment (RE)
- The standard is public and can be downloaded from http://www.cpri.info

OBSAI:

- OBSAI stands for **Open Base Station Architecture Initiative**
- This protocol has been developed by Hyundai, LGE, Nokia, Samsung and ZTE
- OBSAI Rates range from 728 Mbps to 6.8 Gbps

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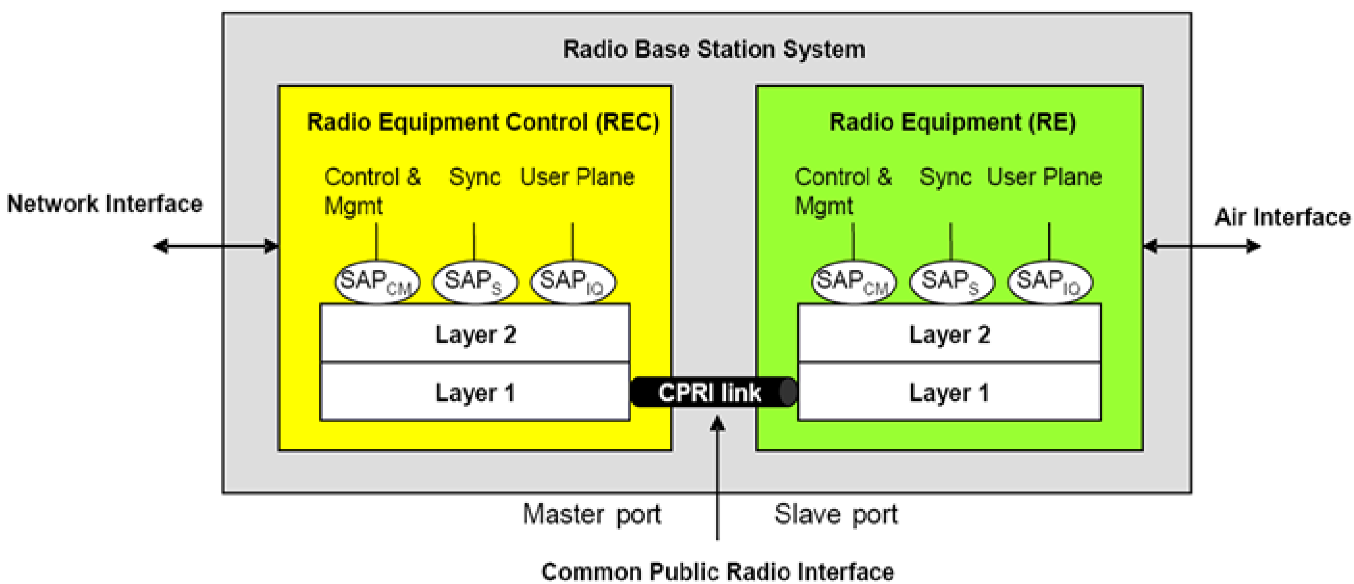
16.1 Interface Specifications



- CPRI specification defines only Layer 1 and Layer 2
- Specification written with the goal to be generic enough to support scalable rates, physical access medium type, and air interface technologies

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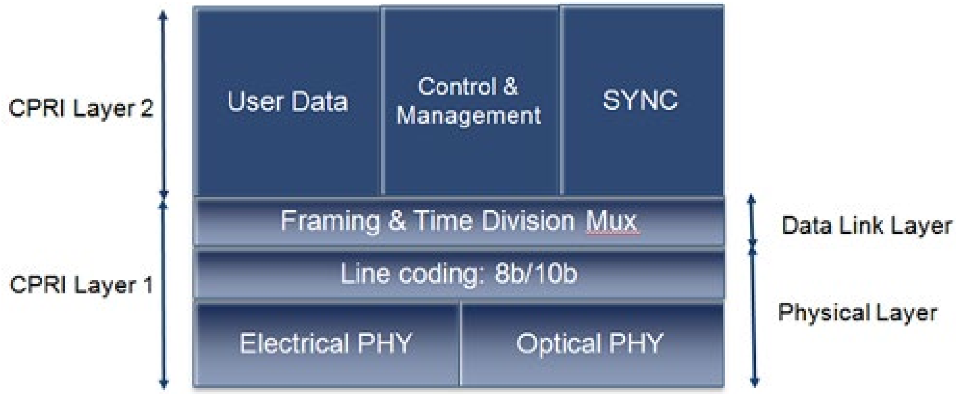
Protocol Stack



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Physical Layer

The following Line bit rates are defined from the standard:

- **Line Coding:**
  - 8B/10B line coding shall be used for serial transmission according to IEEE 802.3-2005, clause 36. (Same encoding as used for Gigabit Ethernet and Fibre Channel)
- **Bit Error Correction/Detection:**
  - The physical layer is designed in such a way that a very low bit error ratio can be achieved without expensive forward error correction schemes. Therefore, no general bit error correction is applied at Layer 1.
  - The RE and the REC shall support detection of 8b/10b code violations. Link failures shall be detected by means of 8b/10b code violations.

8B/10B Encoding - What is it and Why is it Used?

- 8b/10b is the line code used for Gigabit Ethernet and Fibre Channel.
- It maps 8 bits of data into a 10 bits symbol, each 8 bits can map into 2 possible 10 bit symbols. The symbols are chosen so that there is a limit of 5 consecutive equal bits and the difference of the count of 0s and 1s is no more than 2.
- The goal is to achieve DC balance by having a running disparity of 1s and 0s and to provide enough state changes to allow clock recovery.
- Clock recovery is particularly important because in the CPRI implementation, the RE must recover timing from the 8B/10Bencoded line rate and regenerate the original reference frequency to the required UMTS accuracy.
- In addition the 8b/10b has several error detection mechanisms: Validation of correct codes (only 268 of the possible 1024 10-bit codes are used)
  - Validation of correct running disparity
  - Validation that running number of 1s or 0s does not exceed 5

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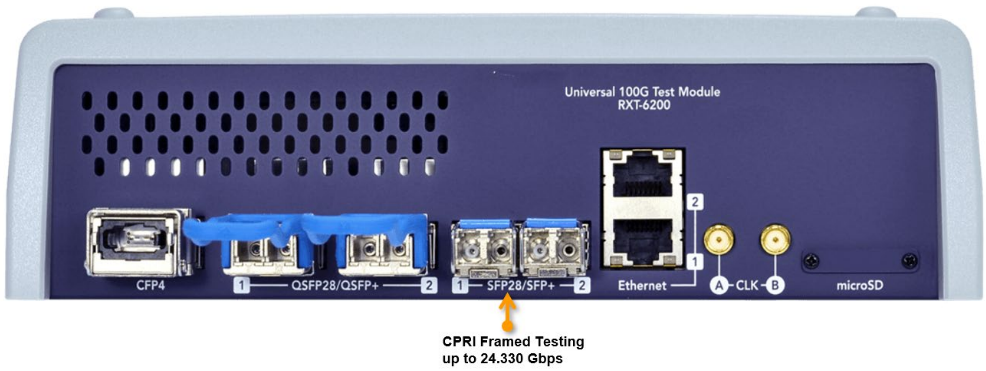
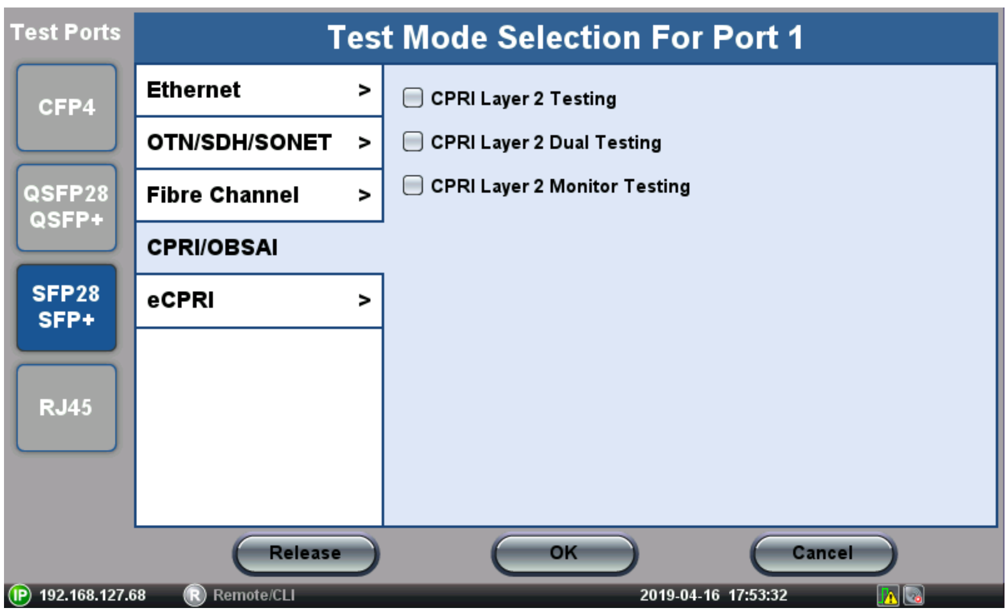
16.2 CPRI Testing

Test Ports and Modes

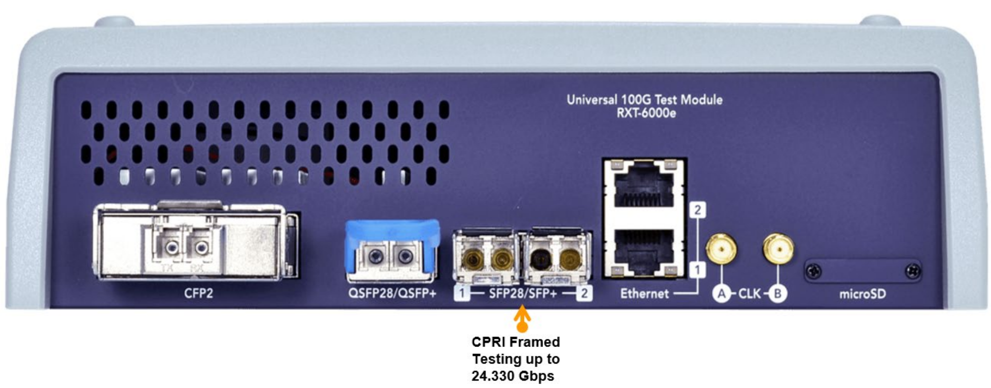
RXT-6200



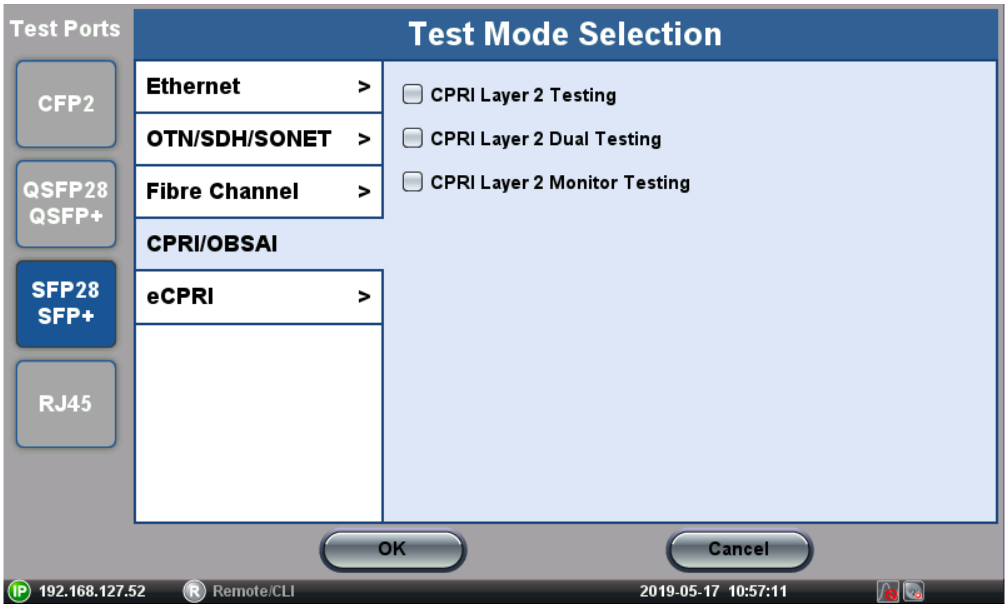
RXT-6200



RXT-6000e



RXT-6000e



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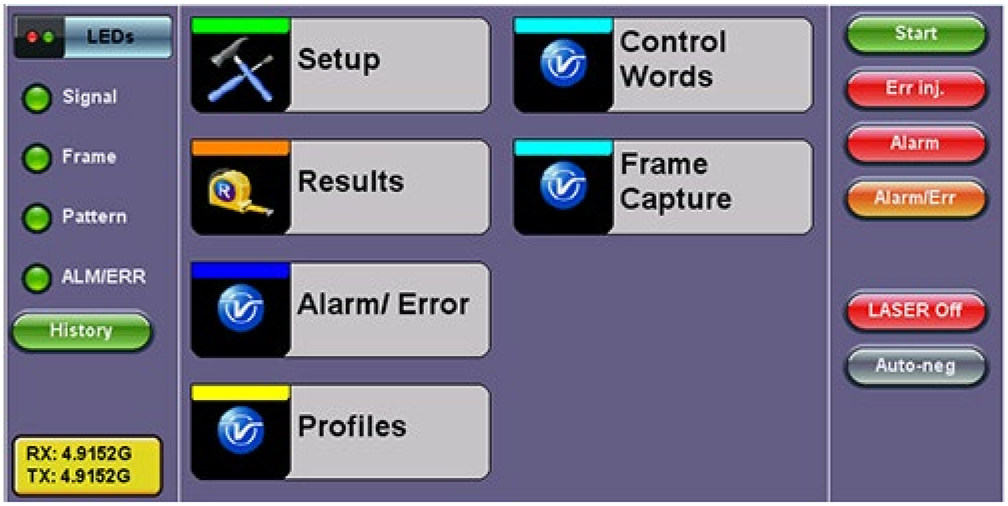
16.3 CPRI Layer 2 Framed Testing

CPRI Layer 2 Main Menu



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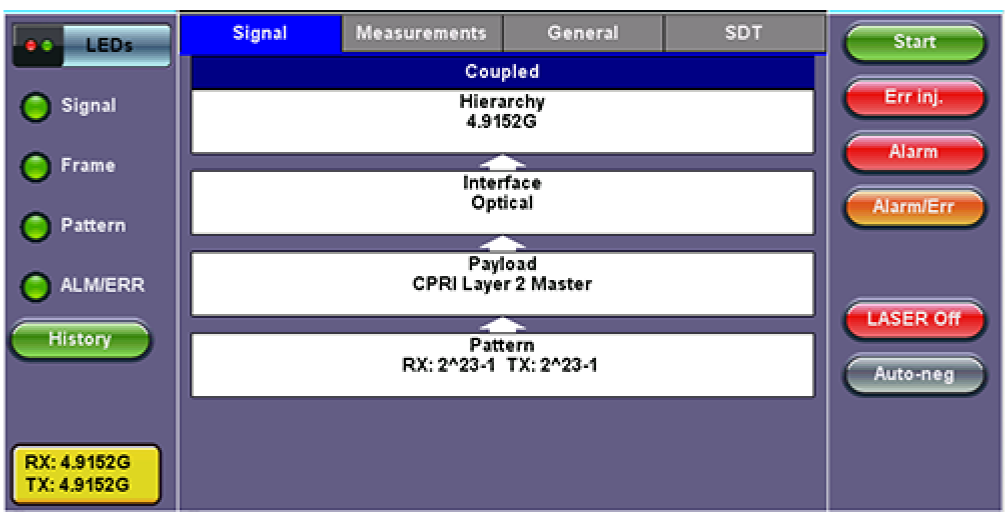
16.3.1 Setup

Setup Menu



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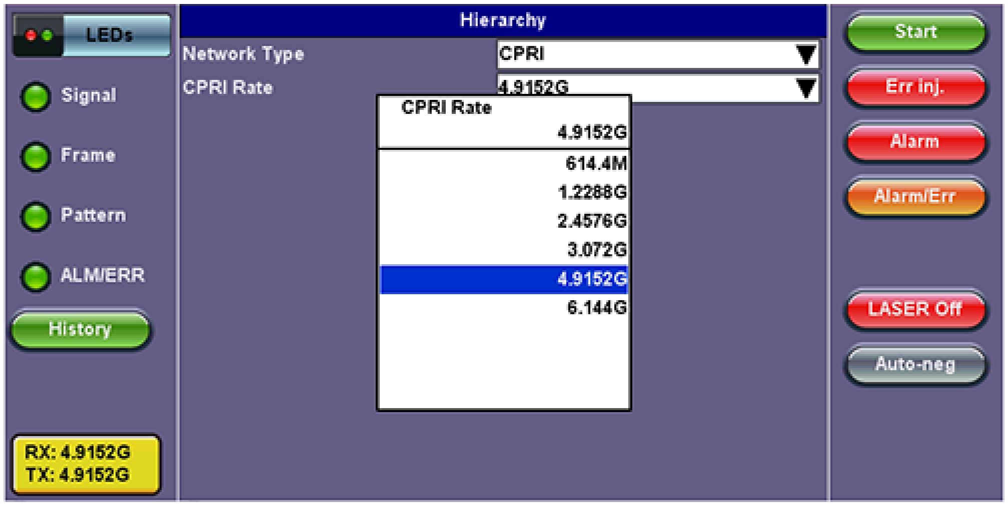
Configure the following:

Signal:

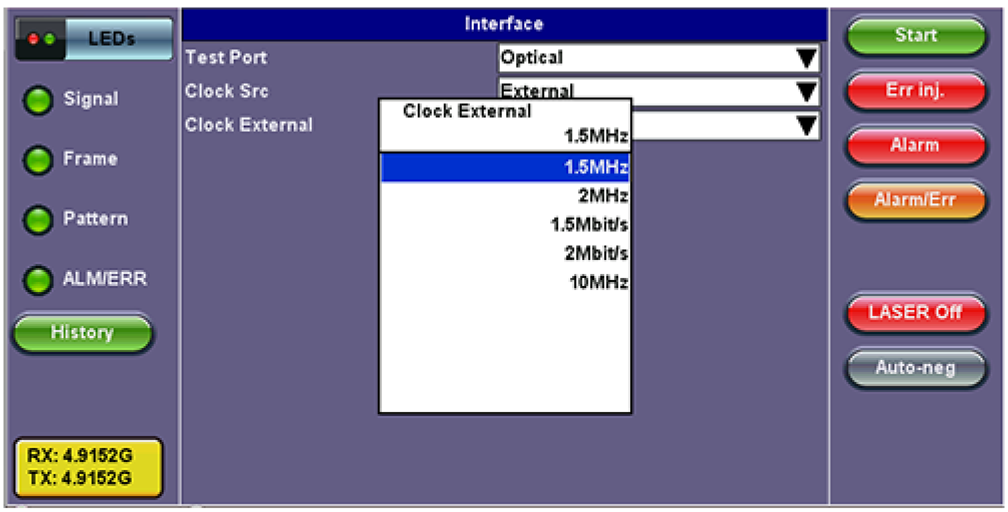
- **Hierarchy:** CPRI Rate selection from 614.4Mbps to 6.144Gbps. 4.9 and 6.1 Gbps rate requires compatible SFP+.

Hierarchy



- **Interface:** CPRI Clock Selection Internal/External (Master mode only). Slave uses RX signal recovered clock.
  - **Master:** Internal, External (1.5MHz, 2MHz, 1.5 Mbps, 2Mbps, 10MHz), Or Atomic 10MHz (Atomic clock option required)
    For External clock connection use the unit's SMA CLK port.

Interface



- **Payload:** CPRI Layer 2 configuration
  - **CPRI Emulation Type:** CPRI Master emulation (Radio Equipment Controller Emulation)
    CPRI Slave emulation (Remote Radio Unit). Slave = RE. Master is responsible for CPRI Start up sequence and Synchronization
  - **CPRI Protocol:** Version 1 supported
  - **#Z.0.1 Byte:** Sync Control Word Z.0.1 set to D16.2 or D5.6
  - **Channels:**
    - **Single:** PRBS test pattern transmitted on one AxC
    - **All:** PRBS test pattern transmitted on all AxC

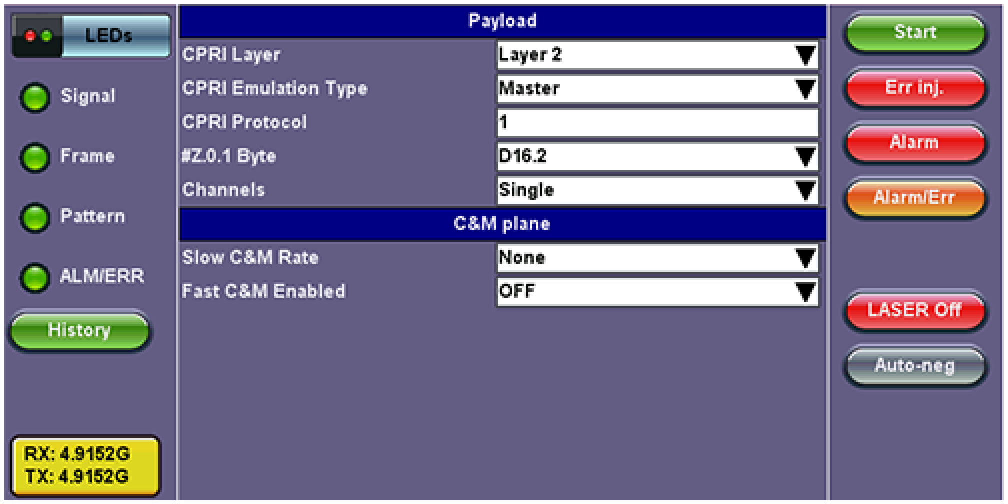
Control and Management (C&M) channel configuration:

  - **Slow C&M Rate:**
    - **None:** HDLC channel disabled
    - **Configurable rate:** 240kb/s to 2400 kb/s HDLC channel data rate depending on CPRI Link speed
  - **Fast C&M Enabled:** Ethernet channel, configurable start of Ethernet channel pointer in Control word or channel disabled.
    - **OFF:** Ethernet Channel disabled
    - **ON:** Ethernet Channel enabled, configure Ethernet pointer location from 20 to 63

Auto-negotiation can be used for Master/Slave to negotiate their maximum C&M channels

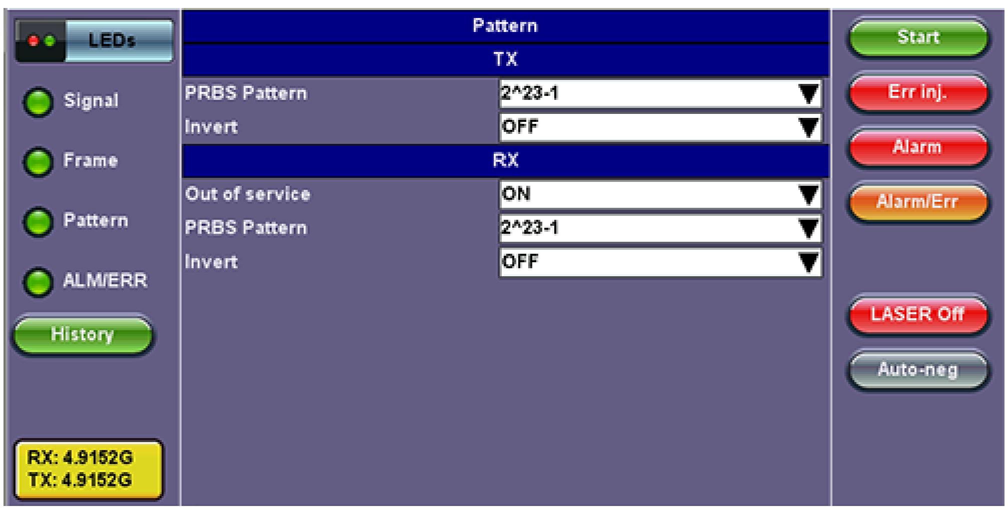
capabilities

Payload



- **Pattern**: Independent TX/RX test Pattern selection. PRBS 2^23-1 (normal or inverted) or PRBS 2^31-1 (normal or inverted)

Pattern



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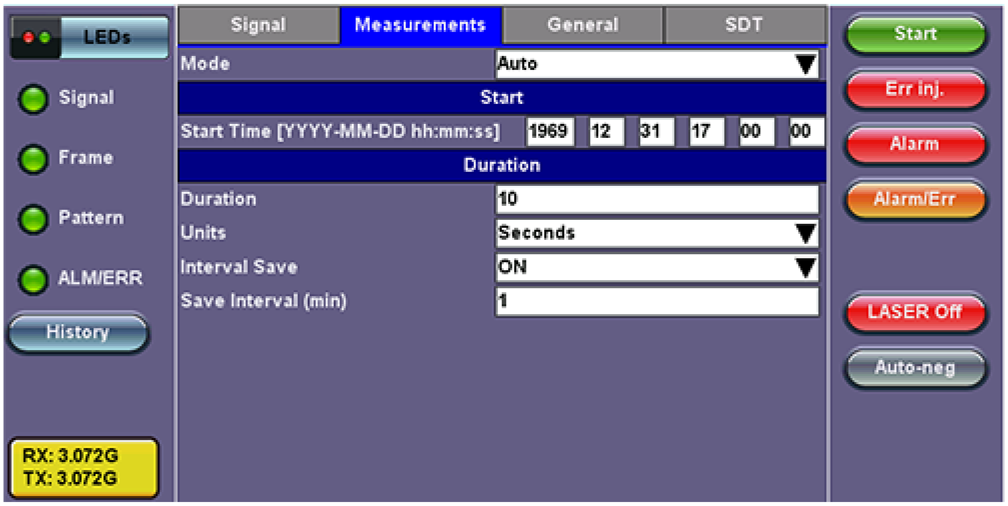
Measurements:

Measurements Setup



- **Mode:** Manual, Timed, Auto
    - **Timed:**
        - Duration: Enter the time
        - Units: Select seconds, minutes, hours, days
    - **Auto:** Start time, and Duration
- **Interval Save:** Test result automatically saved at configurable interval
    - **ON:** Set the Save Interval (in minutes). Tap the box to enter the value.
    - **OFF:** To opt to not save

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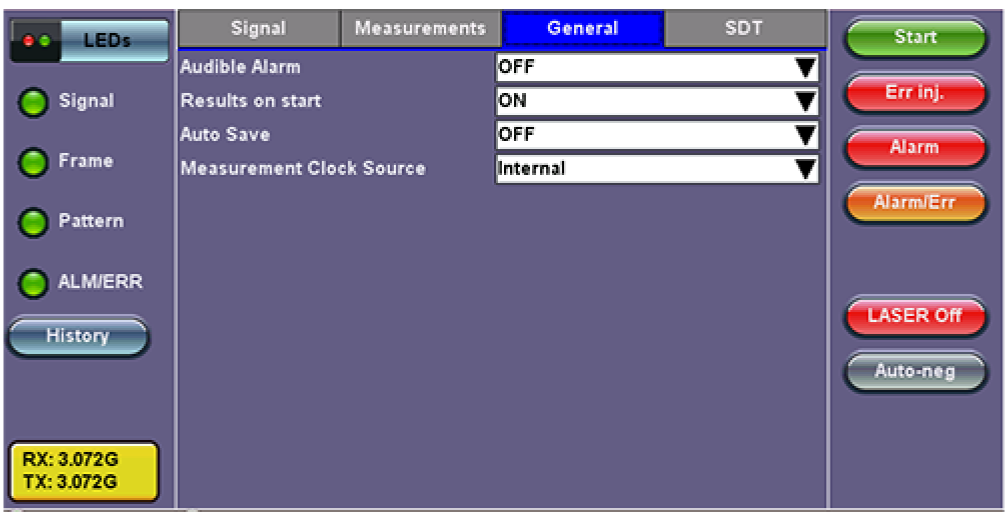
General:

General Setup



- **Audible Alarm:** OFF / ON. A sound will be generated every time there is an alarm.
- **Results on start:** OFF / ON. Shows the results screen on pressing Start.
- **Auto Save:** OFF / ON. Automatically Save the test results.
- **Measurement Clock Source:** Select the Measurement clock source used for Frequency measurement.
  For Master: Internal or TX clock source (if external clock source is used)
  For Slave: Internal

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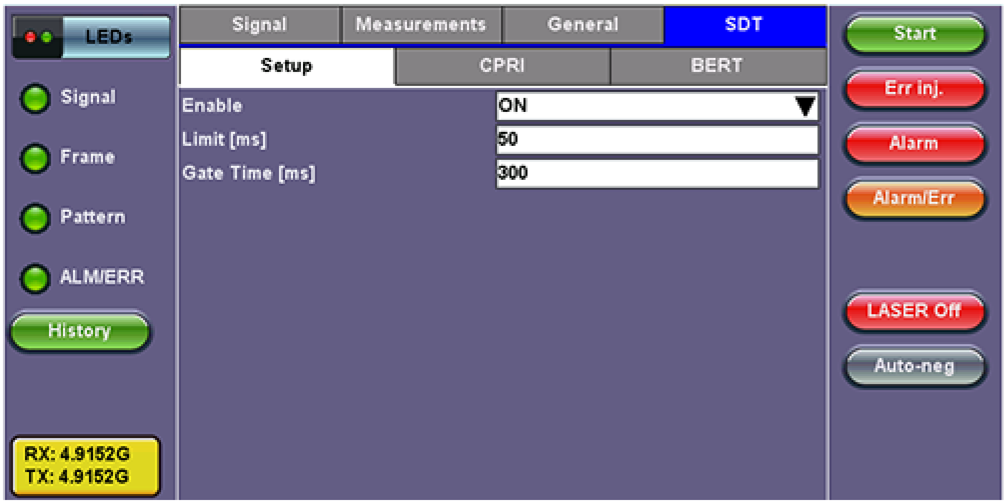
SDT: The Service Disruption Test can be disabled or enabled. If enabled the SDT Test is triggered by a qualifying error or alarm.

If enabled, select:

- **Limit Time:** Limit time determines qualifying events total time pass/fail criteria. Configurable from 20 to 1000 ms.

Gate Time: Gate time setting determines the duration of the measurement. Configurable from 20 to 10000 ms.

SDT Setup



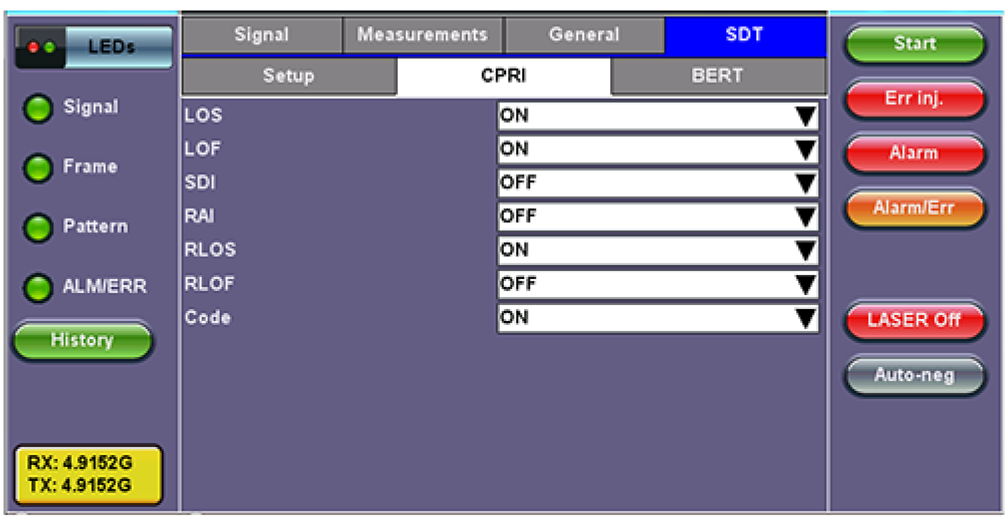
Enable CPRI and/or BERT trigger events

In the CPRI and BERT Tab enable (ON) or disable (OFF) the Alarms and Errors used to determine Service Disruption events. At least one error or alarm must be enabled for SDT to trigger.

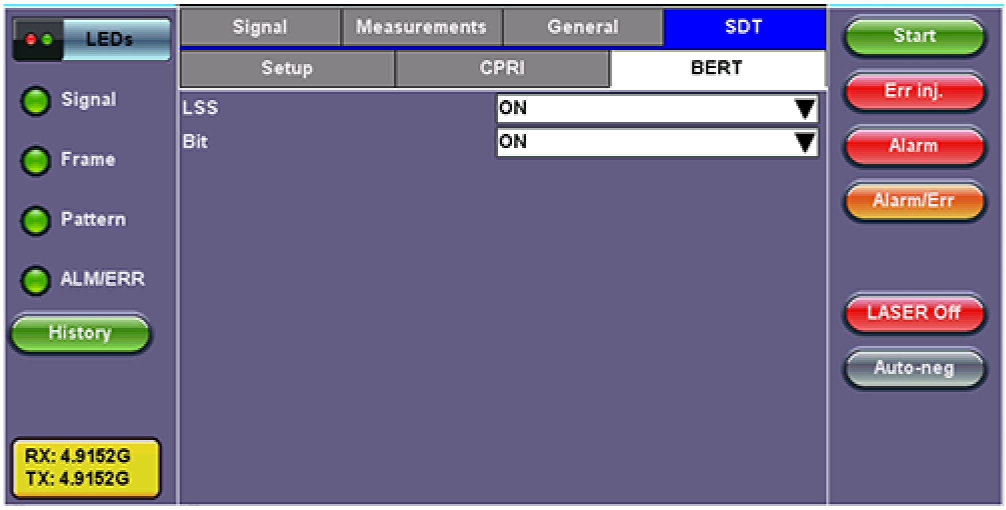
CPRI: LOS, LOF, SDI, RAI, RLOS, RLOF, Code

BERT: LSS, Bit

CPRI Event Setup



BERT Event Setup



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Alarm and Error Injection

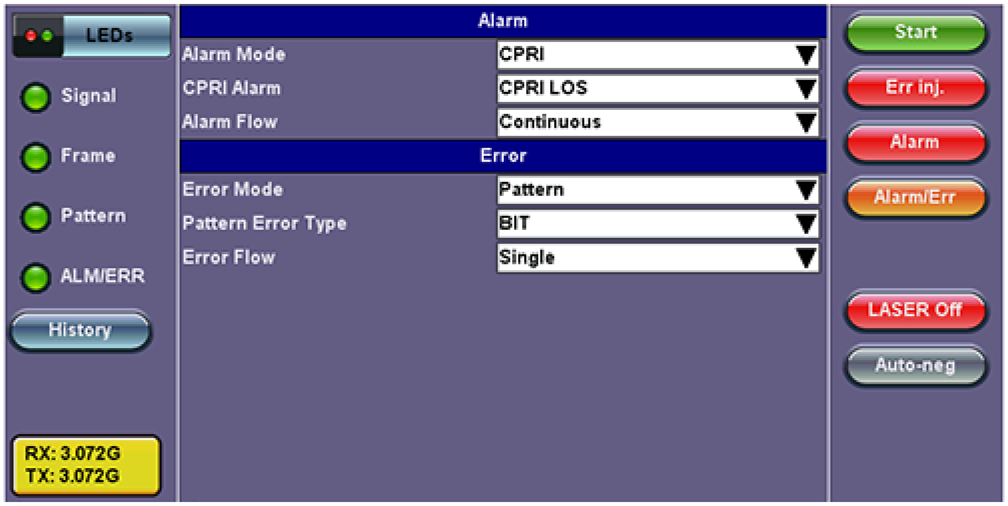
Alarm Injection: Each alarm can be set to Continuous or Count

- **CPRI Alarms:**
    - **LOS:** Trigger a Loss of Signal event (Laser OFF)
    - **LOF:** Trigger a Loss of Framing event. The Z.0.0 control byte is modified to send an invalid byte of value 0xff
    - **SDI:** Service Defect Indication is transmitted in the Control bytes for L1 inband protocol
    - **RAI:** Remote Alarm Indication is transmitted in the Control bytes for L1 inband protocol
    - **RLOS:** Remote Loss of Signal is transmitted in the Control bytes for L1 inband protocol
    - **RLOF:** Remote Loss of Framing is transmitted in the Control bytes for L1 inband protocol
- **Alarm Flow:**
    - **Continuous**
    - **Count:** 0.1s, 1s, 10s, 100s

Error Injection:

- **Error Mode:**
    - **Pattern:** BIT - Bit error injection in test pattern
    - **CPRI:** Code: 8B/10B Code violation error injection
- **Error Flow:**
    - **Single**
    - **Count:** Enter the value
    - **Rate:** 1E-3, 5E-4, 2E-4, 1E-4, 5E-5, 2E-5, 1E-5, 5E-6, 2E-6, 1E-6, 5E-7, 2E-7, 1E-7, 5E-8, 2E-8, 1E-8, 5E-9, 2E-9, 1E-9

Alarm and Error Injection



Press **Start** to start the test.

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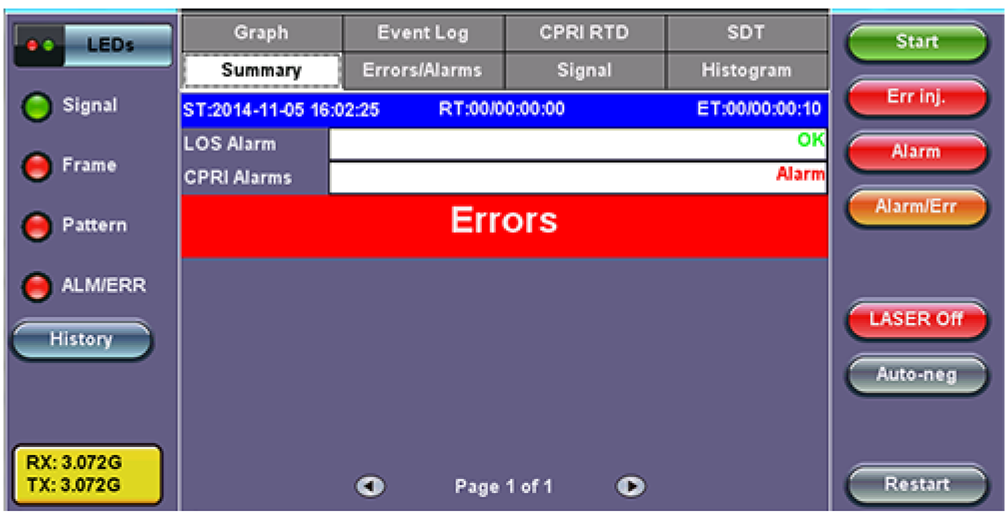
16.3.2 Results

Results Summary



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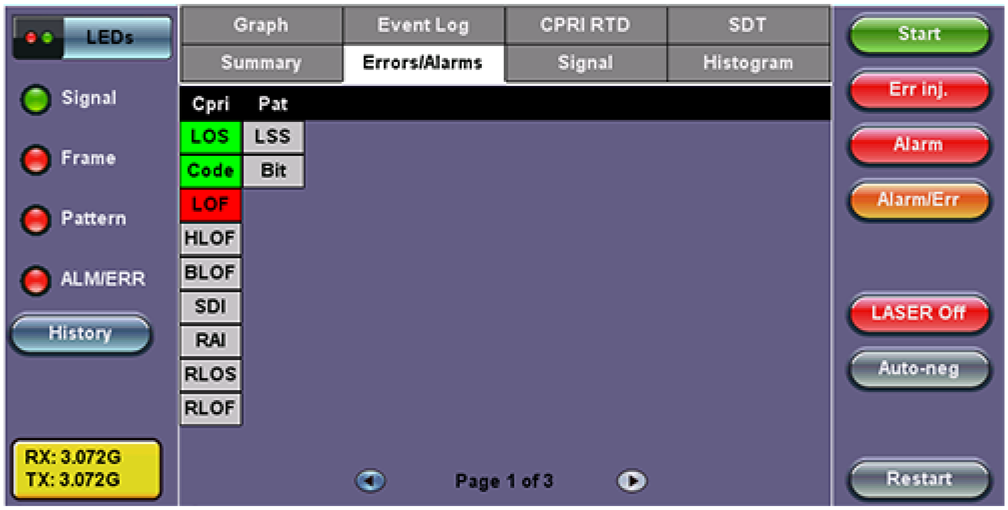
Alarms and Errors

These include Hyperframe Synchronization indication and BFN (NodeB Radio Frame) Synchronization indication.

- Green indicates no alarm
- Red indicates current alarm
- Grayed out indicates that the measurements are masked by an higher layer alarm or error

Alarms and Errors Page 1



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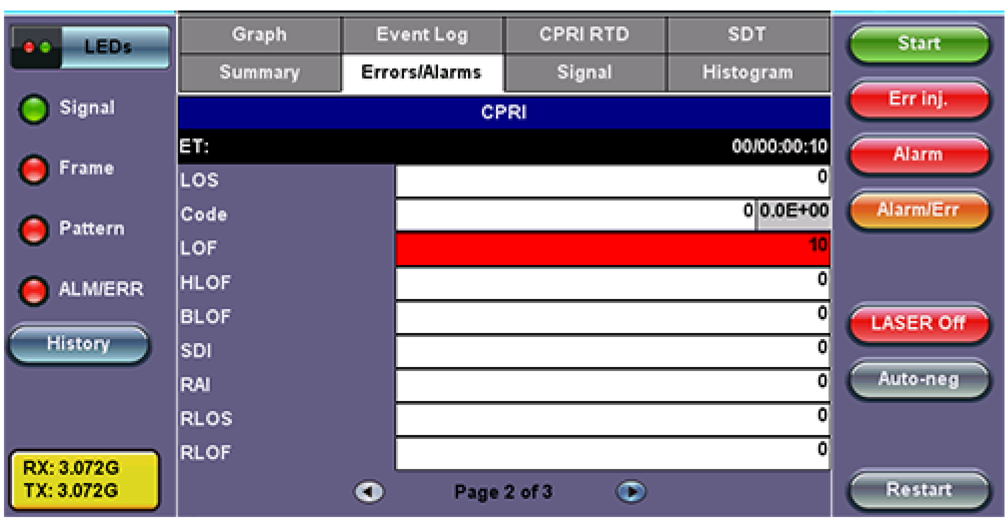
CPRI:

- **LOS:** Loss of Signal detection in seconds
- **Code:** 8b/10b code violation detected count and rate
- **LOF:** Loss of framing seconds detected if invalid Z.0.0 sync byte is received
- **HLOF:** Loss of Hyperframe synchronization seconds
- **BLOF:** Loss for Basic Frame (NodeB) frame synchronization seconds
- **SDI:** Service Defect Indication is detected in the Control bytes for L1 inband protocol
- **RAI:** Remote Alarm Indication is detected in the Control bytes for L1 inband protocol
- **RLOS:** Remote Loss of Signal is detected in the Control bytes for L1 inband protocol
- **RLOF:** Remote Loss of Framing is detected in the Control bytes for L1 inband protocol

Alarms and Errors Page 2



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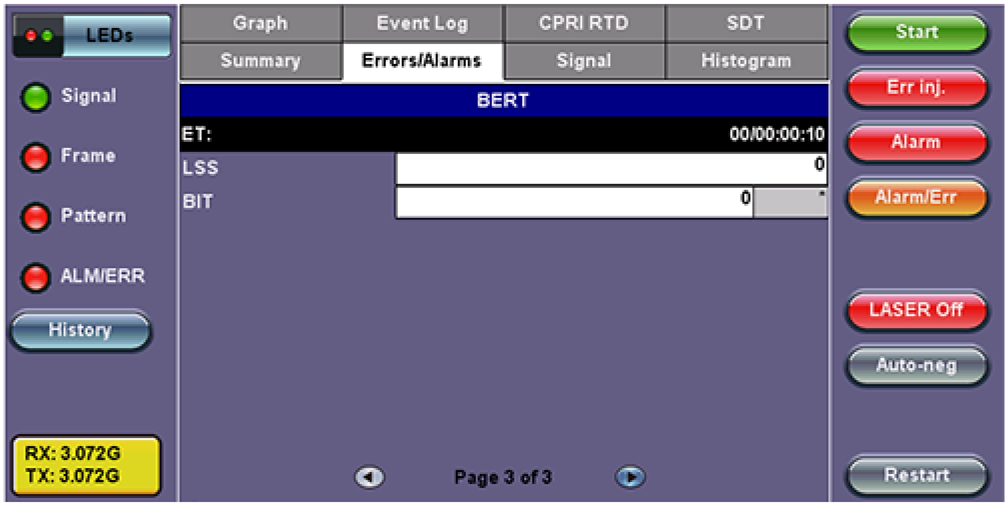
BERT:

- **LSS:** Loss of test pattern seconds
- **Bit:** Number of test pattern bit errors detected count and rate

Alarms and Errors Page 3



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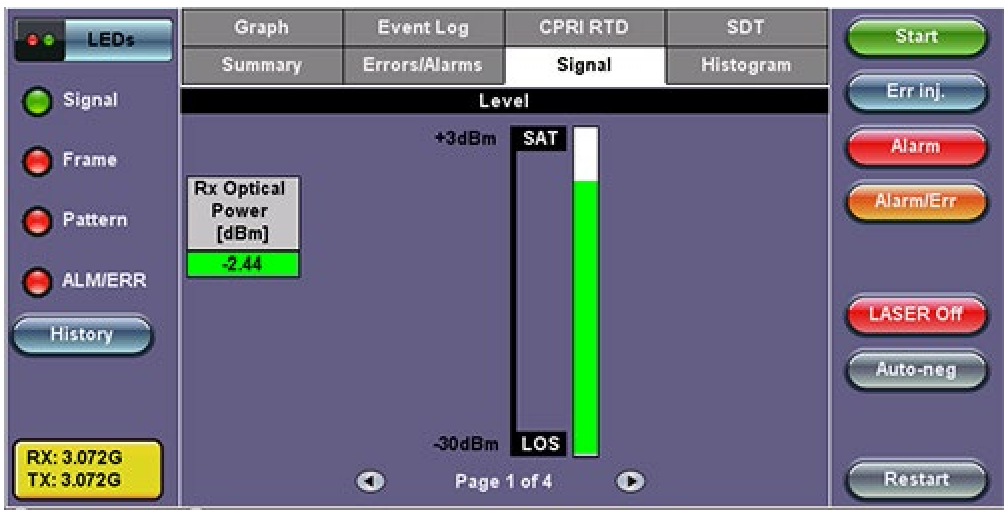
Signal

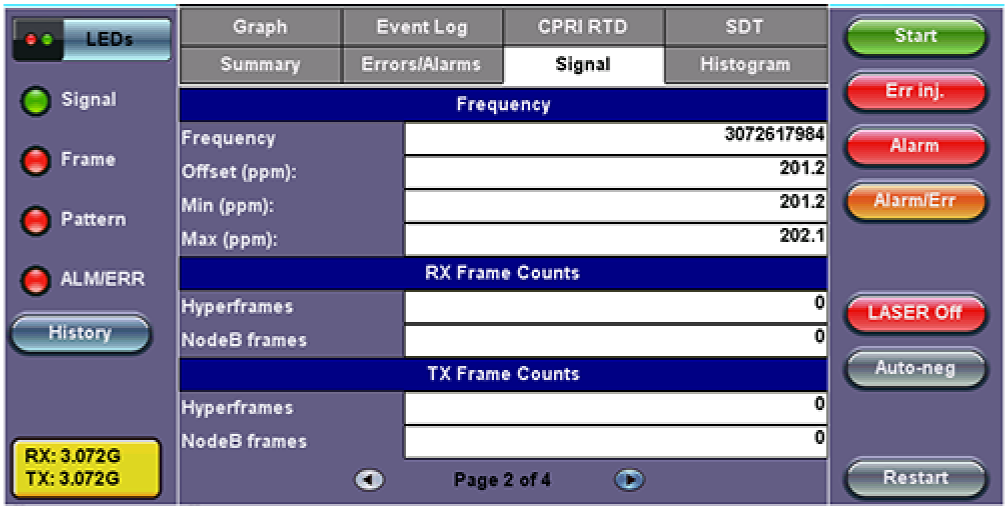
Signal Page 1



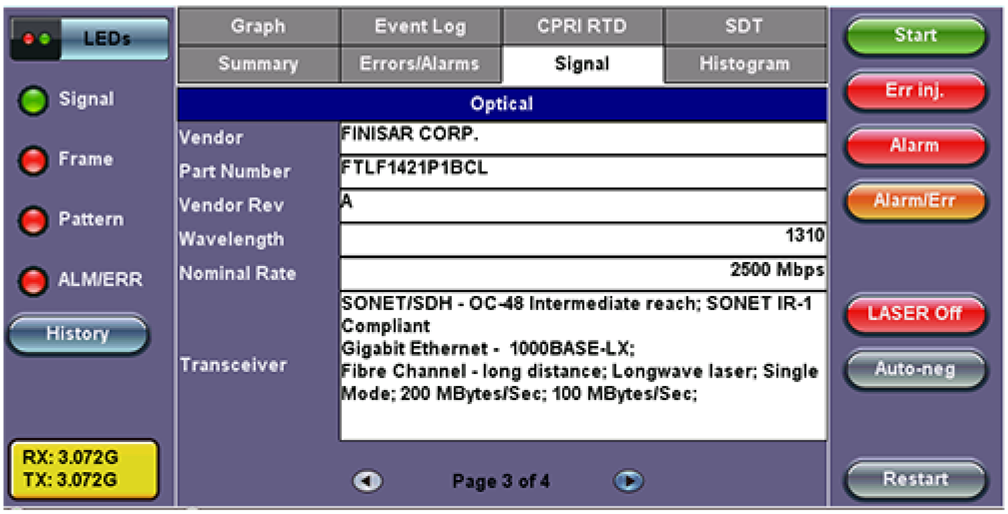
Page 2 includes:

- **Frequency:** Measured RX signal frequency
  - **Offset:** current frequency offset from the frequency measurement clock (internal or external)
  - **Min:** minimum frequency offset
  - **Max:** maximum frequency offset
- **Hyperframes TX/RX:** counters of Transmitted/Received Hyperframes
- **NodeB frames TX/RX:** counters of Transmitted/Received NodeB (Radio) framed

Signal Page 2

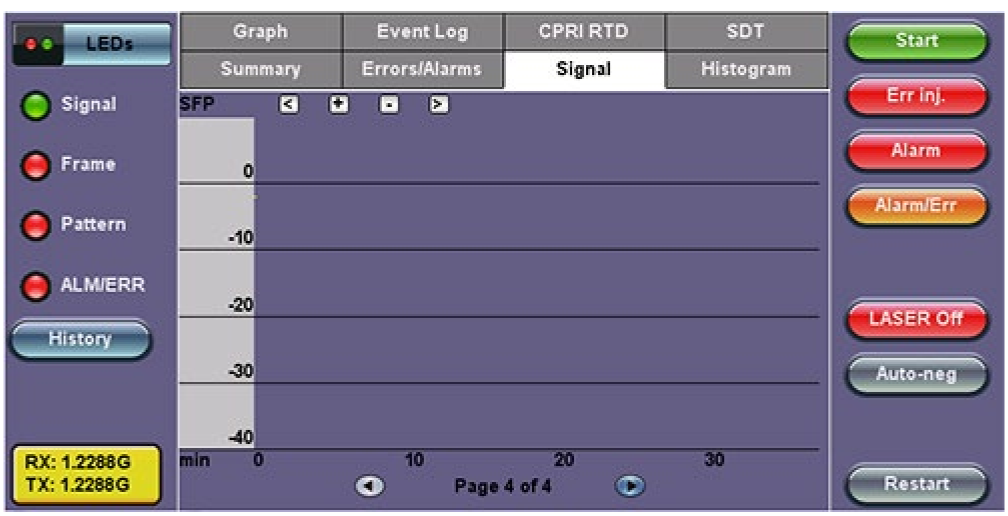


Signal Page 3



Histogram showing the fluctuation in RX optical signal level.

Signal Page 4



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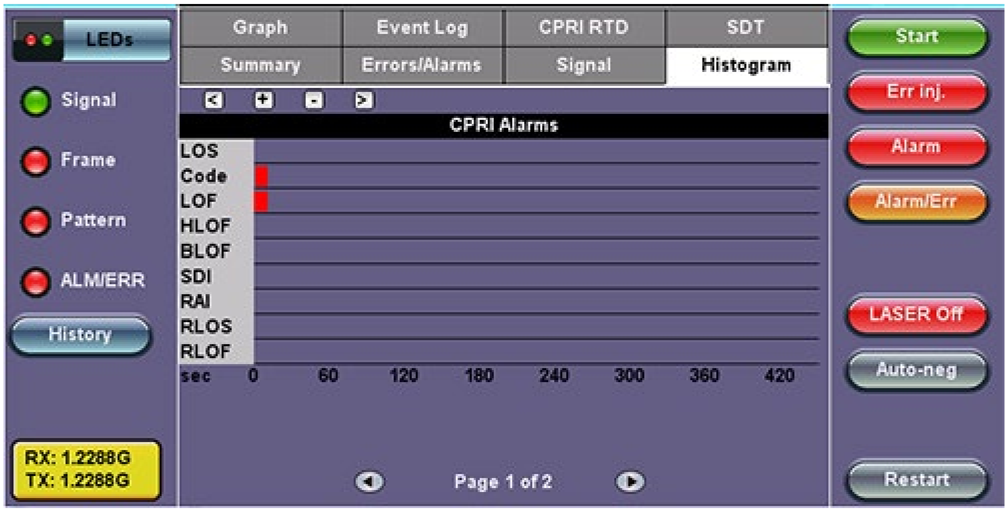
Histogram

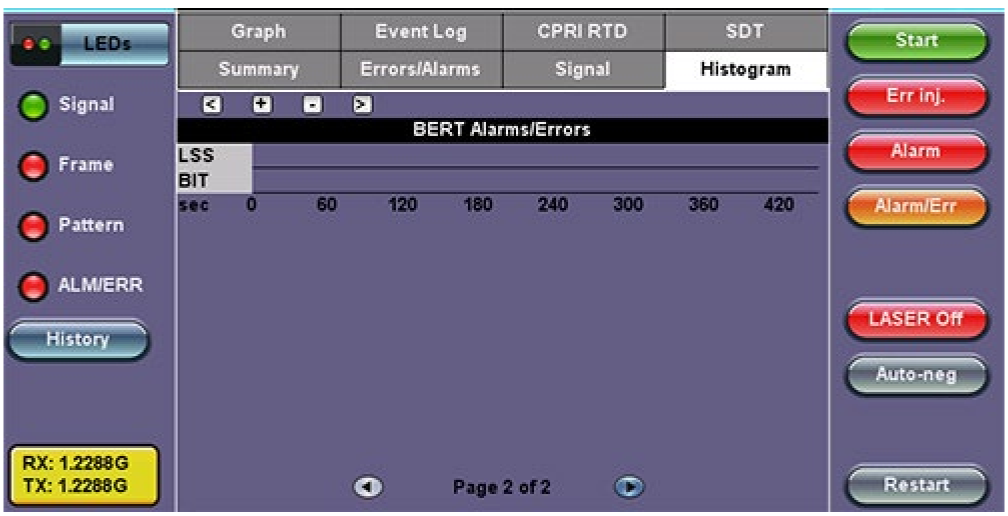
Histogram showing CPRI alarms and errors events.

Histogram



Histogram showing BERT alarms and errors events.

Histogram Page 2



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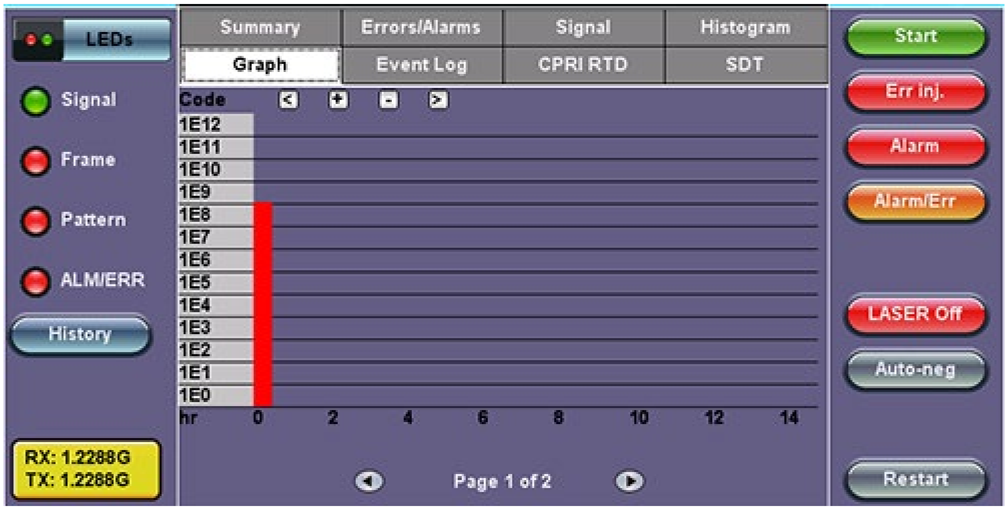
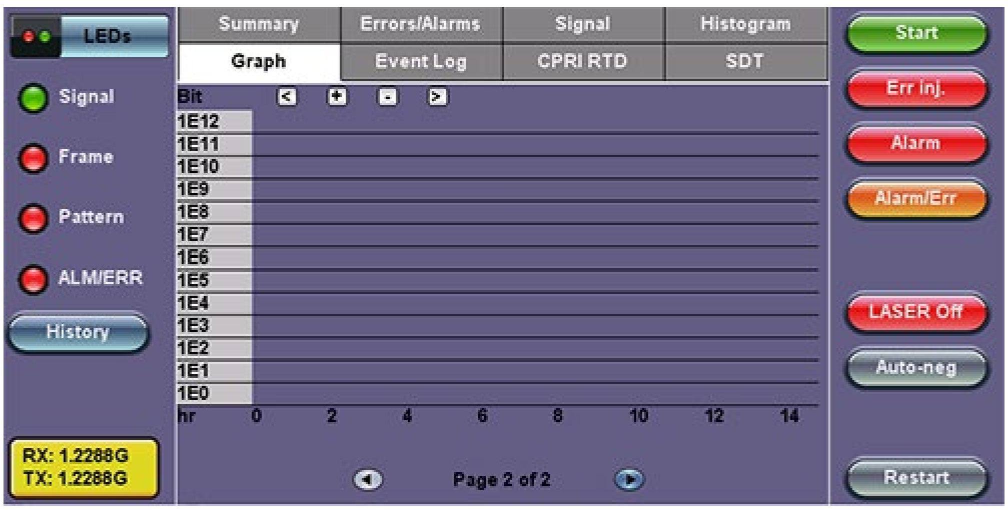
Graph

Graph showing CPRI Code and Bit error rate over time.

Graph



Graph Page 2



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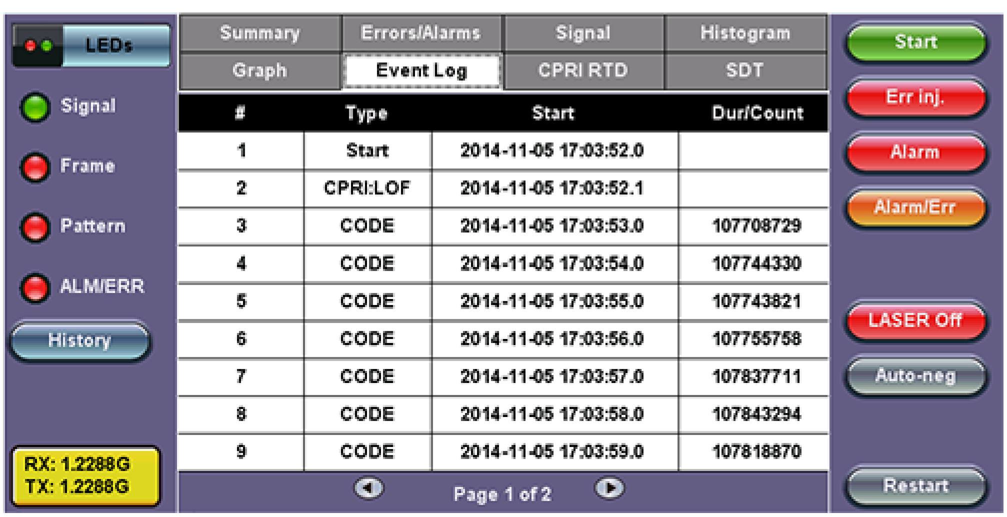
Event Log

Logs CPRI Alarms and Errors events along with corresponding count and duration for each event.

Event Log



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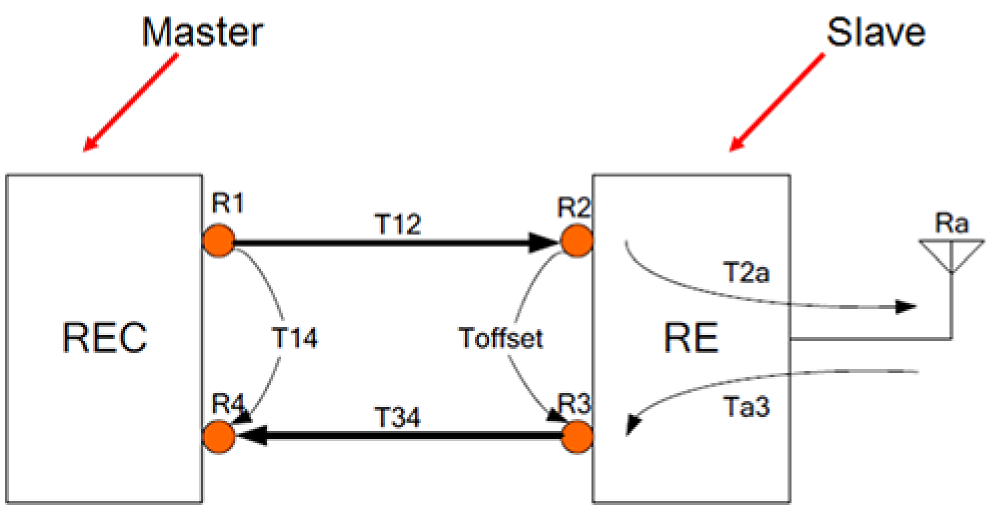
16.3.3 CPRI Round Trip Delay

CPRI Standard Cable Delay Measurement reference points:

- Toffset = Frame offset delay between Slave RX and Slave TX
- T 1,4 = Frame delay between Master TX and Master RX
- Cable Delay (round trip) = T 1,4 – Toffset

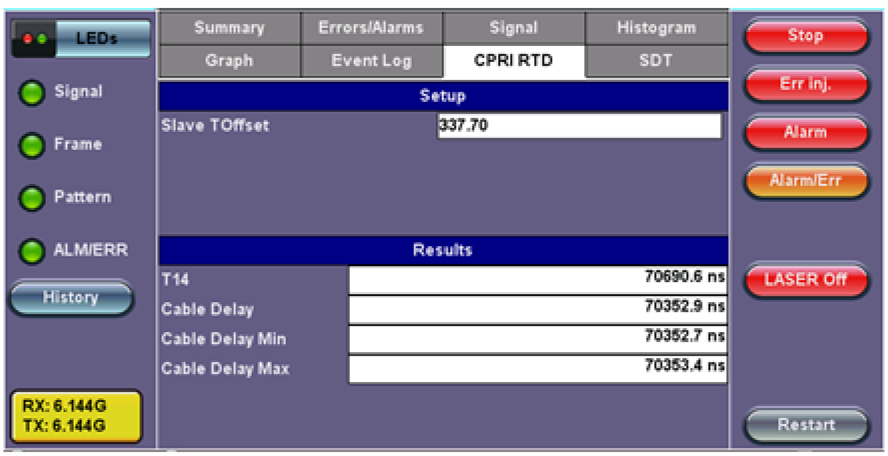
The figure below shows the definition of reference points for delay calibration (single-hop configuration):



Round trip delay Measurement procedure:

1. Slave Side: Start the test and note Toffset value
2. Master Side: Enter the Slave Toffset value using keypad
3. Master Side: Start the Test
4. Master Side: Note Cable Delay measurement min, max and current values

CPRI RTD



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16.3.4 SDT

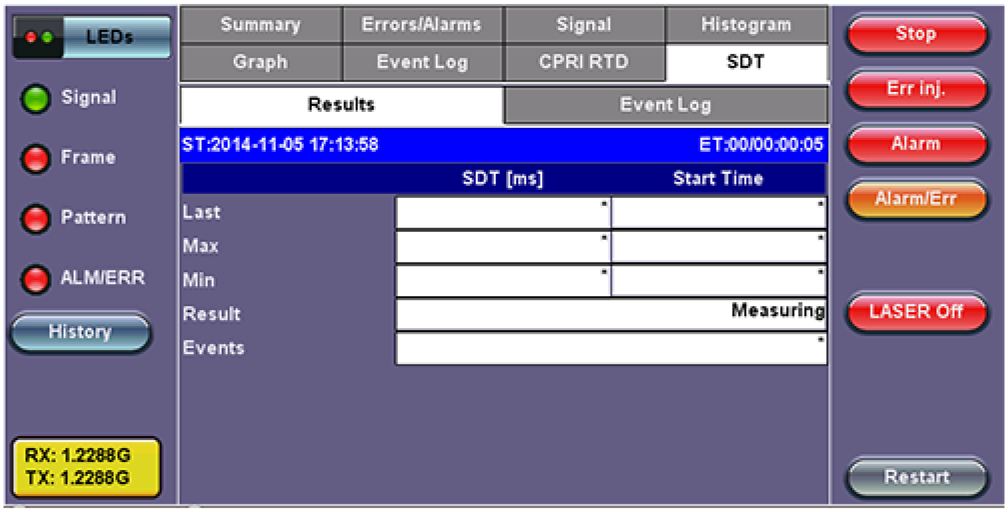
Limit and Gate Time counters begin at the onset of the first valid event.

SDT Measurement ends after the Gate time is elapsed, to allow the capture of multiple smaller events.

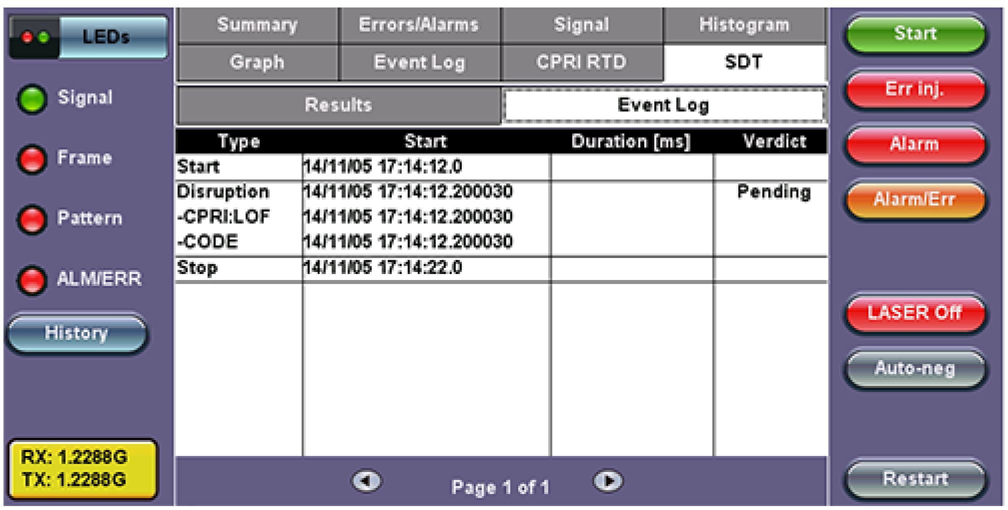
The total time from the beginning of the first event to the end of the last event (within the Gate Time) is the reported SD time.

The measurement process is immediately restarted in search for the next trigger. Results are presented in tabular form (Events table) indicating SD start time (1 ms resolution or better), disruption time, and Pass/Fail evaluation. This table gets populated as new disruptions are detected and measured.

SDT Results



SDT Event Log



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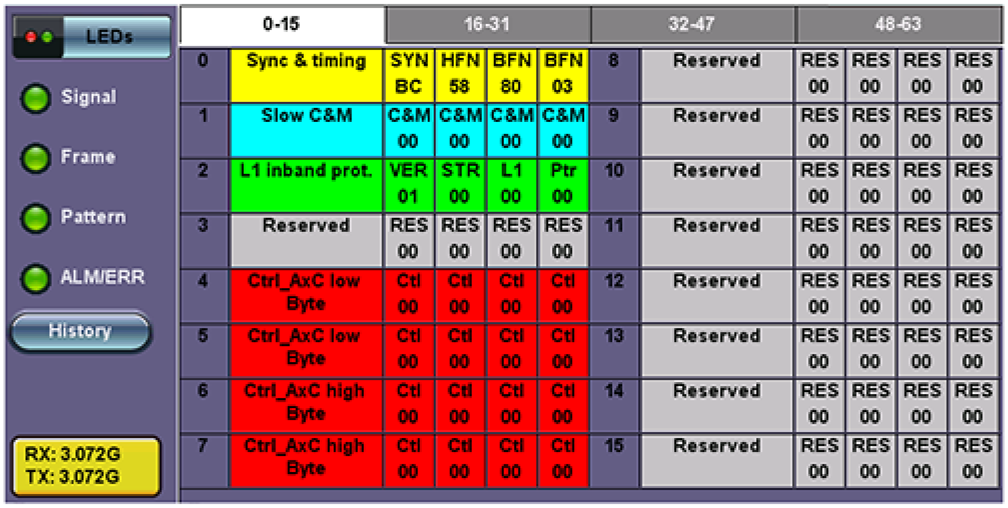
16.3.5 Control Words

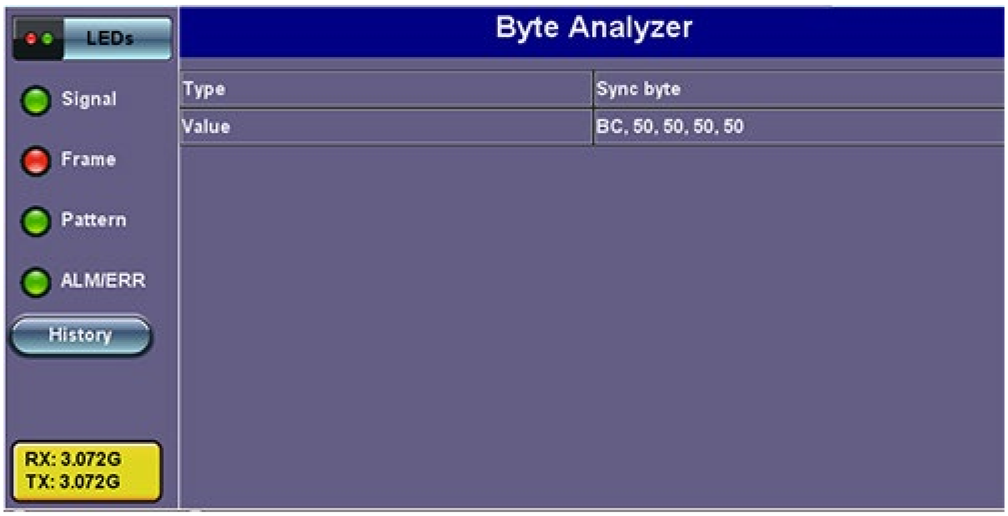
Display of Control words content in the 64 Subchannels.

Tap on any subchannel to display Hex and Binary value of the contents.

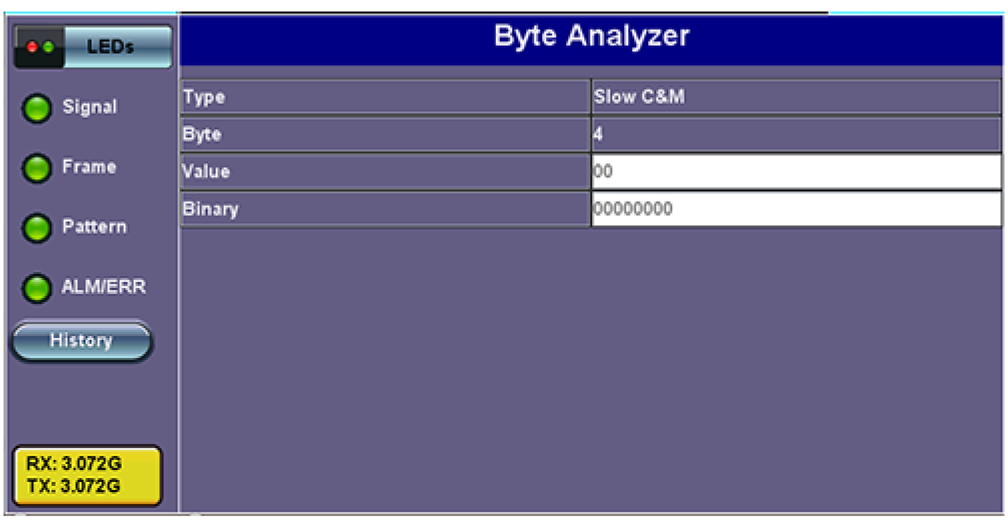
Control Words Display



Byte Analyzer



Byte Analyzer



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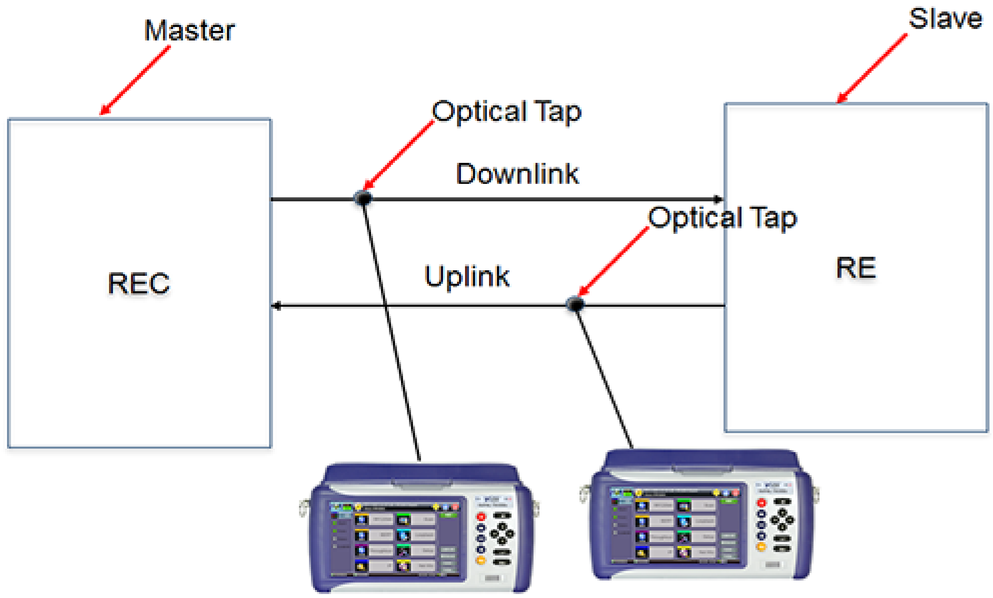
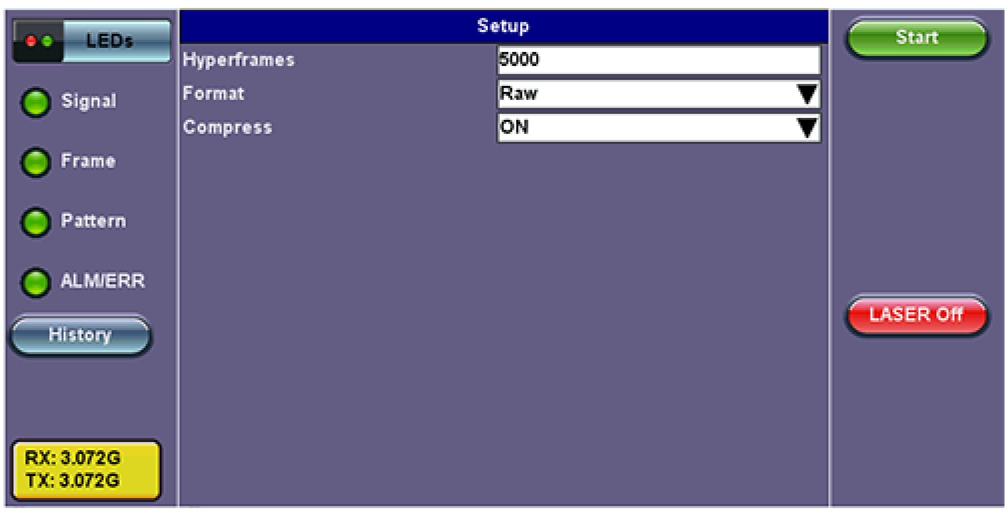
Frame Capture

The test set must be set to Slave mode or use the Master's ref. Clock.



- Capture up to 5000 Hyperframes
- CSV or raw frame format
- Compression (gzip format)
- Capture file written directly to USB drive

Frame Capture Setup



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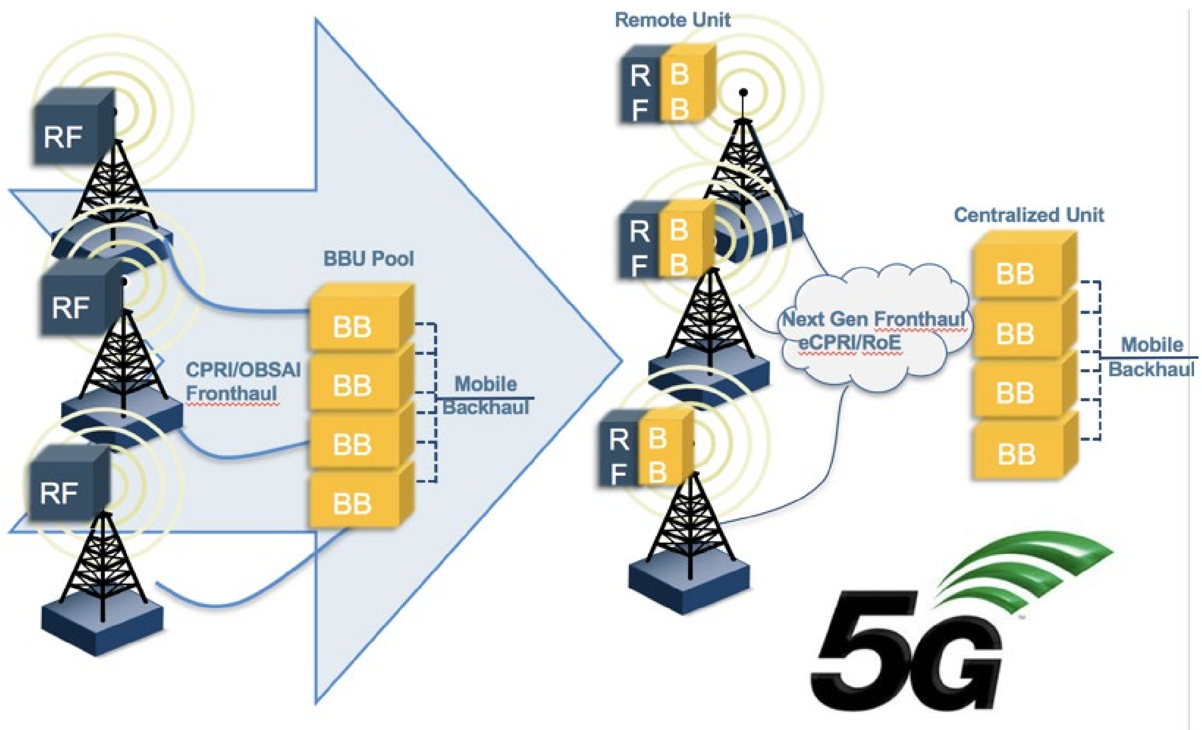
17.0 eCPRI

17.1 eCPRI Testing Overview

The Common Public Radio Interface (CPRI) forum introduced a new more stringent Ethernet packet based fronthaul interface, **eCPRI**, due to limitations for 5G deployments based on traditional CPRI or OBSAI.

To ensure that 5G network's strict requirements are met in the fronthaul, the eCPRI Transport Network requirement document establishes classes of service for data and C&M traffic. With full line rate eCPRI traffic generation capabilities and high accuracy one-way latency measurements, the eCPRI test application provides the tools necessary to ensure that the eCPRI transport network is ready for 5G deployments.

CPRI Mobile Fronthaul Evolution



This protocol has been developed by Ericsson AB, Huawei Technologies Co. Ltd, NEC Corporation, Alcatel Lucent and Nokia Siemens. The standard is public and can be downloaded from http://www.cpri.info.

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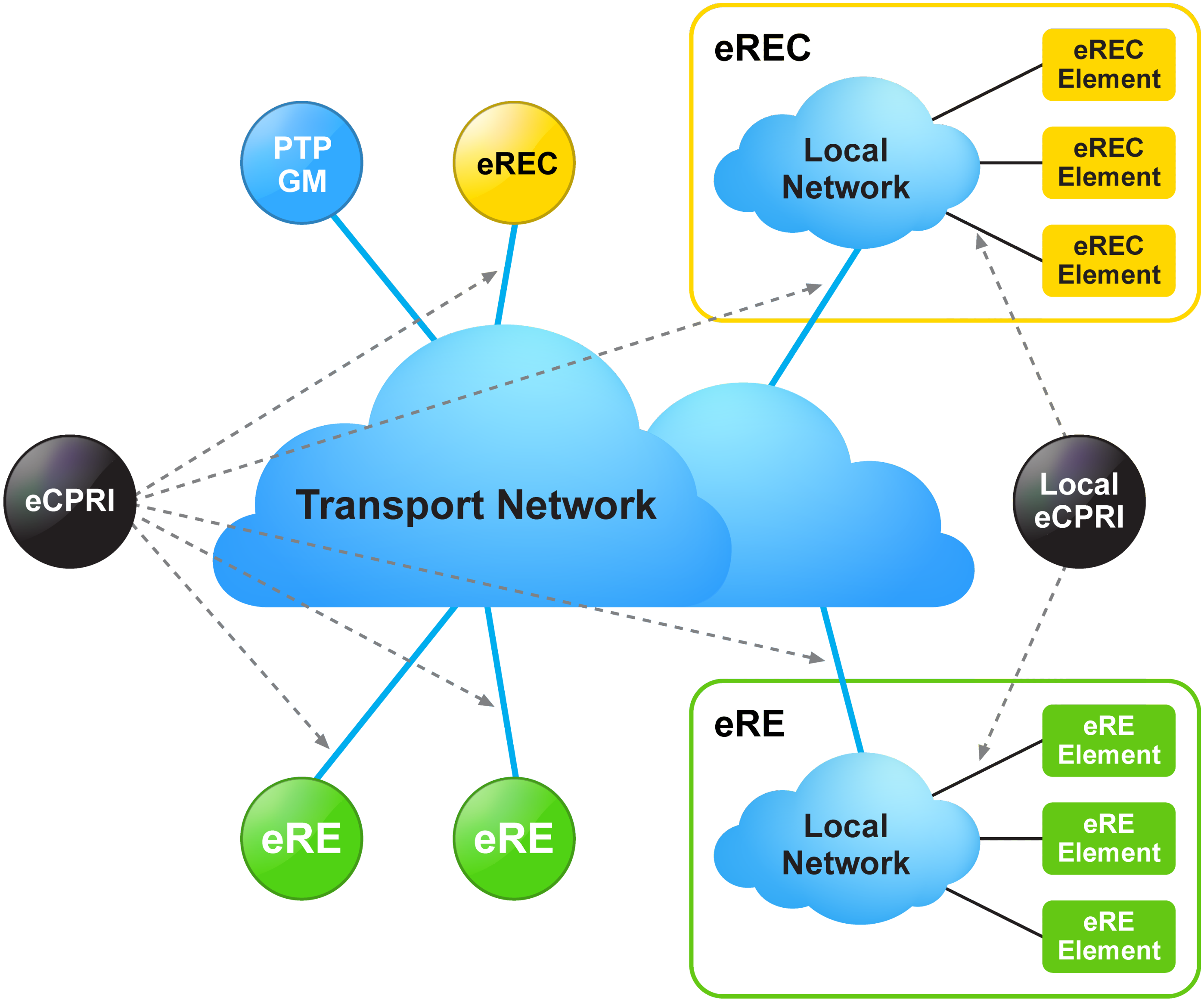
17.2 Interface Specifications

eCPRI System Architecture Example*
(*eCPRI Interface Specifications ver 1.1)



- CPRI Specification was written with the goal to be generic enough to support scalable rates, physical access medium type, and air interface technologies.
- eCPRI relies on existing standards for Ethernet/IP networking, synchronization, and security.

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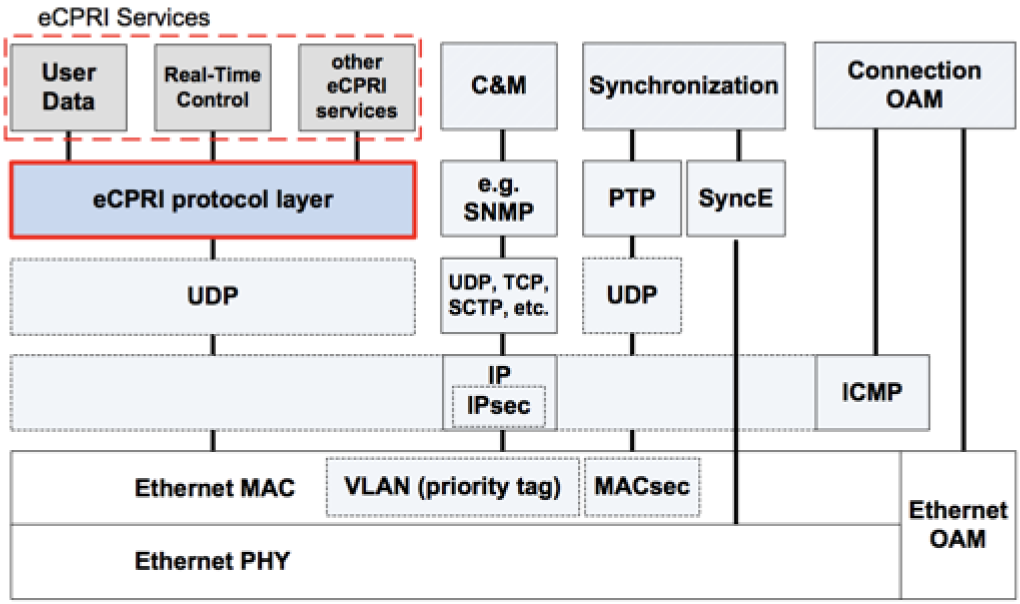
17.2.1 Protocol Stack

eCPRI Protocol Stack*
(*eCPRI Interface Specifications ver 1.2)



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17.2.2 eCPRI Key Features

Key features of eCPRI include:

- 25G/10G eCPRI (Protocol ver.1)
- Ethernet Type: AE-FE (eCPRI)
- Configurable C field and message type
- Dual-port testing capabilities
- RS-FEC support
- Multi-stream testing up to 32 independent streams
    - Each stream can be set with independent frame size, bandwidth, traffic profile, and QoS levels
- Throughput testing at Layer 2 and Layer 4
- Frame sizes from 64 to 1518 bytes and jumbo frames up to 16000 bytes (Layer 2 only)
- Configurable Source and Destination MAC
- Fully configurable IPv4 or IPv6 header
    - UDP Header configurable Source and Destination ports
- Q in Q (VLAN stacking up to 3 VLAN tags with configurable priority and type)
- MPLS up to 3 labels with configurable Label/S/CoS and TTL
- Test Patterns:
    - PRBS pattern: 231-1, 223-1, 215-1, 211-1
    - PRBS normal and inverted patterns
    - All 0s, All 1s, and User Defined
- High accuracy One-Way-Delay latency measurement
- Line rate packet capture

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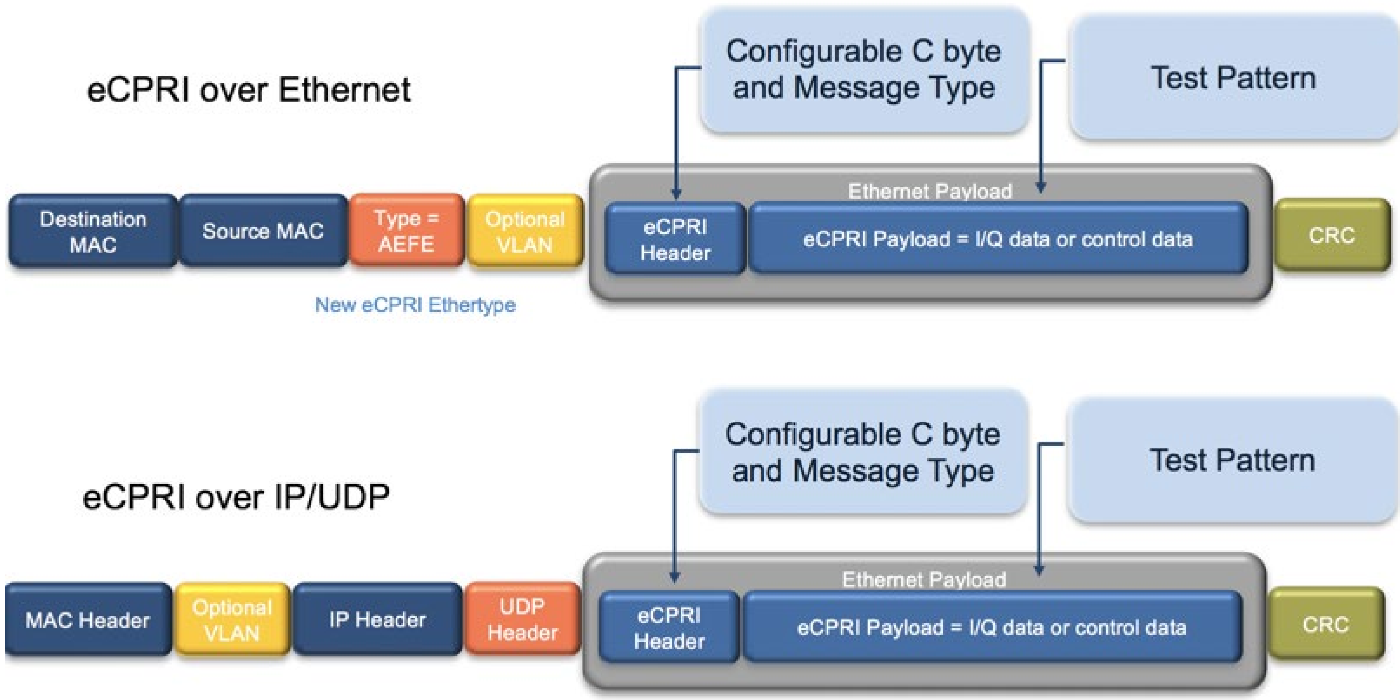
17.2.3 eCPRI Data Framing

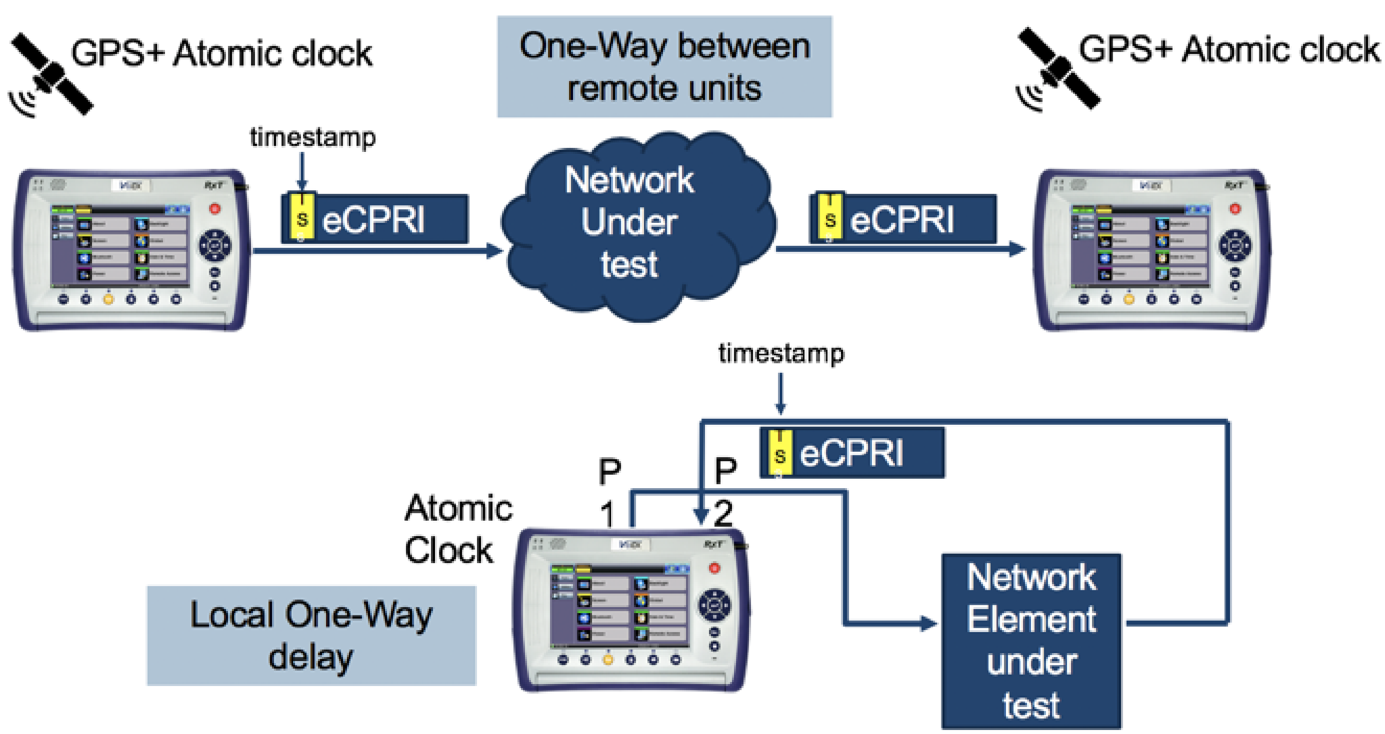
eCPRI Data Framing



17.2.4 eCPRI One Way Latency Measurement

The diagram below shows how eCPRI works with RXT-6000e and RXT-6200 test modules.

eCPRI One Way Latency Measurement



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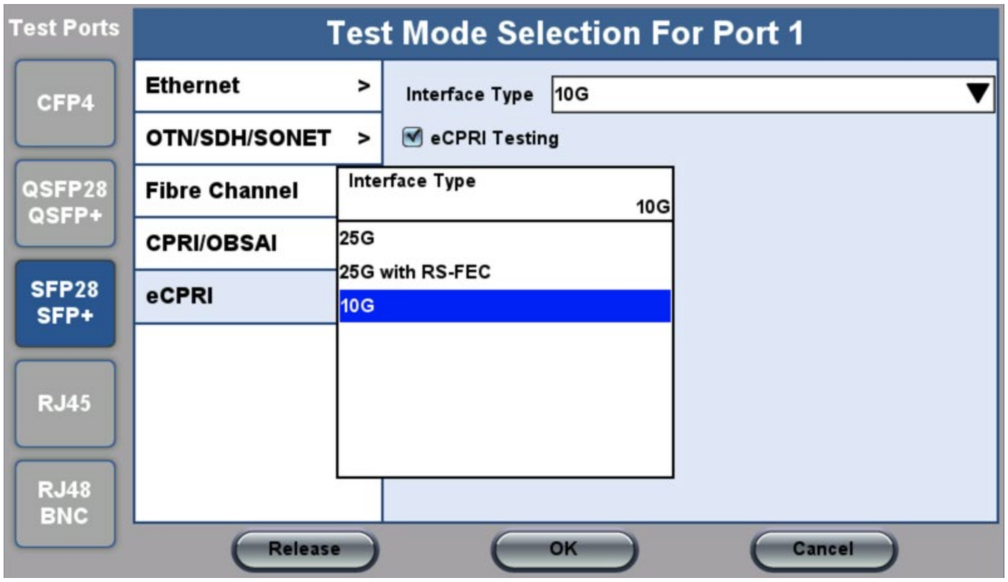
17.3 eCPRI Setup

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

17.3.1 Test Port Selection

Test Mode Selection



This menu is accessed via the Test Port button located at the top left hand side of the screen.

To select the eCPRI test:

1. Click the **SFP28/SFP+** Test Port, and then select the **eCPRI** test mode.
2. Select the test interface type (10G, 25G, or 25G with RS-FEC), and then click **OK**.

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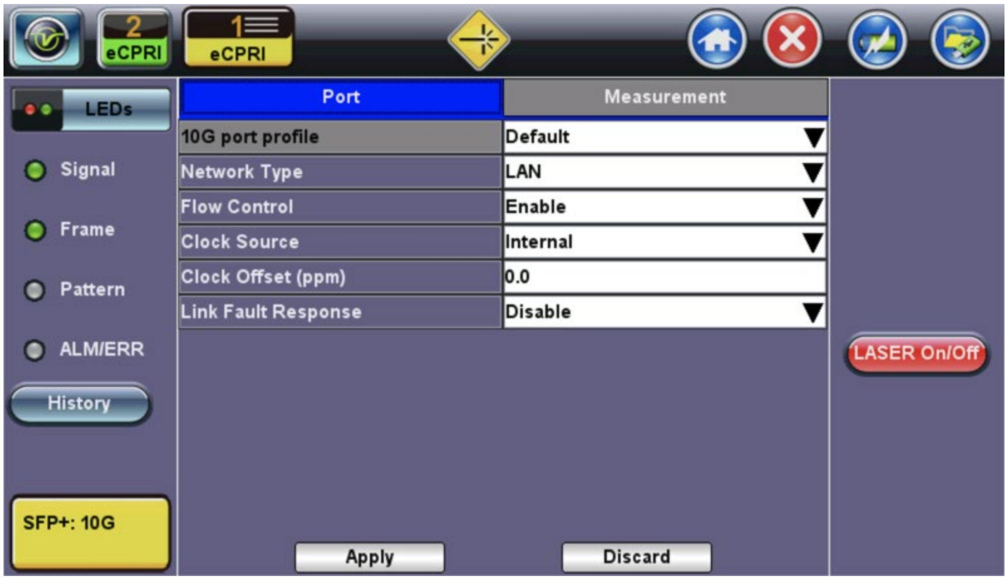
17.3.2 Port Setup

Configure the Test Ports and/or Test Interfaces using the Setup menu on the Home page. The available configuration settings depend on the interface selected.

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

The figure below shows a 10G Port Setup.

10G Fiber Port Setup



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Port Setup

- **Port Profile**: Lock, Delete, Save, Save as..., Default, Last configuration
- **Network Type**: LAN
- **Flow Control:** Enable/Disable
  - When flow control is enabled, the test set will respond to pause frames received by the link partner by adjusting the transmit rate.
  - When flow control is disabled, the test set ignores all incoming pause frames from the link partner and continues transmitting at the configured transmit rate.
- **Clock Source**:

  For one-way delay measurements between remote test units, the clock source should be set to 1PPS external, GPS 1PPS or Atomic 1PPS.
  - **Internal**: The internal clock has an accuracy of +/- 3.5ppm conforming to G.812 recommendations.
  - **External**: 2Mbps, 2MHz, 1.5Mbps, 1.5MHz, 10MHz, 1PPS
  - **RxCLK**: The clock is derived from the received signal and the jitter of the incoming signal is suppressed.
  - **GPS 1PPS**: The optional built-in GPS provides a (raw) 1PPS timing signal (clock) and is aligned to the standard second.
  - **Atomic 1PPS**: The optional built-in Atomic Clock provides a stable 1PPS timing signal.
- **Clock Offset (ppm)**: The clock for the transmitter is derived from the internal clock generator.
  Frequency offset: +/- 150 ppm with 0.1 ppm resolution.
- **Link Fault Response**: Enable/Disable

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17.3.3 Measurement Settings

10G Measurement Setup

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

- **Profile:** Last configuration, Delete, Save, Save as..., Default.
- **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.
- **TX Start:** Separated or Coupled. Configure how the measurements are started by separating or coupling the transmitter and receiver.
    - **Separated:** Independent control (Start/Stop) of the transmitter is enabled. At the start of the test only the receiver is turned on; the transmitter must be turned on manually.
    - **Coupled:** Transmitter and receiver are turned on at the same time, and the measurements start at the same time at the start of the test.
- **Results Auto Save**: ON/OFF. When ON is selected, results are saved automatically.
- **Maximum Number of Saved Events:** 128, 256, 512, 1024. Maximum number of error and alarm events recorded during a test.

17.3.4 eCPRI Tests

After setting up test ports and configuring the measurements, tests are available from the **Throughput** and **Packet Capture** options on the **Home** page.

Actual screens my differ depending on the installed module.

eCPRI Home page

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17.4 Throughput Testing

17.4.1 Setup

To access Throughput testing features, tap **Throughput** from the **Home** menu.

Overview:

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.

The Throughput application performs the following measurements:

- Throughput performance
- Frame Loss analysis
- Delay analysis
- Frame/Packet arrival analysis
- Received Traffic Type analysis
- Received Traffic Frame Size analysis.

On the transmit side, the Throughput application currently allows up to 32 streams with its MAC and IP address, VLAN tags (up to 3), bandwidth/rate, frame size, and L2 and/or L4 quality of service (QoS) parameters. On the receiver end, the traffic is analyzed on a per stream basis as well as a global or aggregate measurement.

eCPRI Throughput testing at Layer 2 and 4 is supported. Throughput can be configured to use either stress patterns 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.

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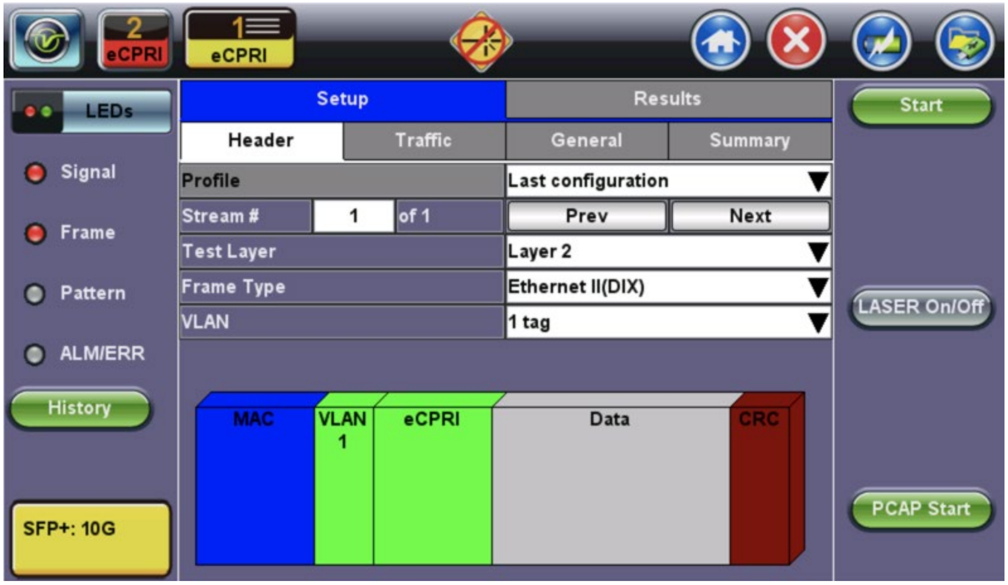
17.4.1.1 Frame Header Settings

The following parameters must be configured prior to performing a Throughput test:

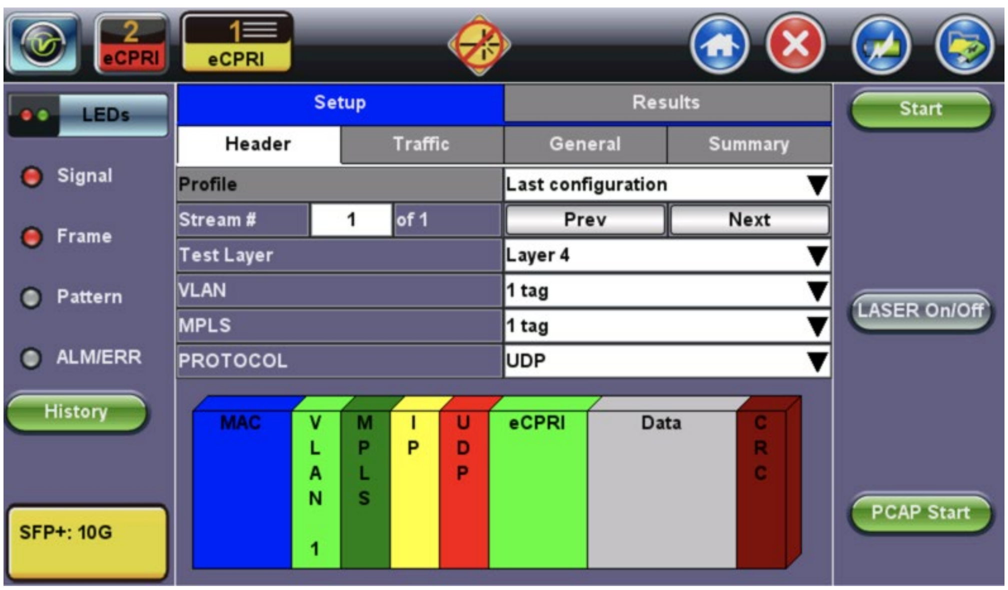
- **Layer 2:**
  - Test pattern is encapsulated into a valid Ethernet frame with SOF, Preamble, and CRC field
  - A default or user configured Media Access Control (MAC) address is added to the frame
- **Layer 4:**
  - A default or user configured Media Access Control (MAC) address is added to the frame.
  - A default or user configured IP address is added to the frame.

Header Settings

Throughput Header Settings: Layer 2



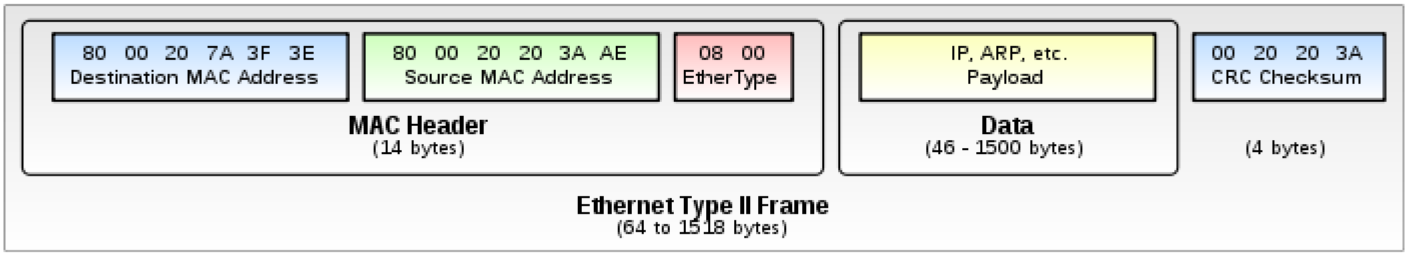
Throughput Header Settings: Layer 4



- **Profile**: Load a previously configured test profile or create a new profile from existing settings.
- **Stream #**: Number of stream for which to configure the profile. Use the **Prev** and **Next** buttons to change streams.

  Use the General tab to configure the total number of streams. See General Throughput Settings (Global Configuration) for more details.
- **Test Layer**: Select layer to perform the test. Layer 2 or 4.
- **Frame Type**: (**Layer 2 only)** Ethernet II (DIX); named after DEC, Intel, and Xerox, this is the most common frame type today.
- **VLAN**: Off, 1 tag, 2 tags, 3 tags (VLAN stacking is an option for Q-in-Q applications)
- **MPLS (Layer 4 only):** Off, 1 tag, 2 tags, 3 tags
- **Protocol (Layer 4 only)**: UDP
- **eCPRI**, **DATA,** and **CRC** are selected automatically for Layers 2 and 4. **IP** is selected automatically for Layer 4 only.

The most common Ethernet Frame format, Type II



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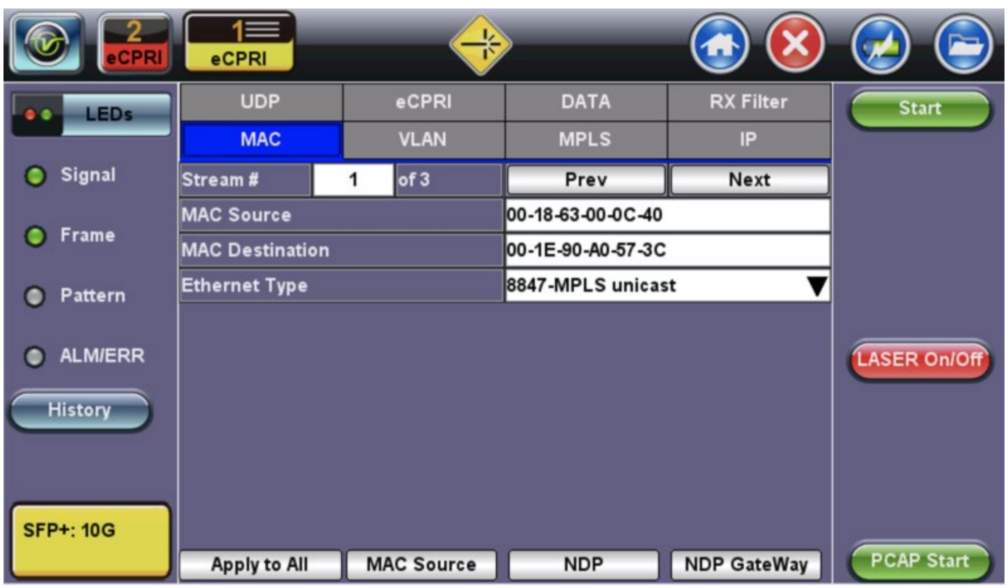
MAC, VLAN, MPLS, IP, UDP, eCPRI, DATA, and RX Filter Test Pattern Configurations:

To configure the MAC addresses, IP addresses, VLAN 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.

Tap the **Apply** button at the bottom to save your selections to the current stream or **Apply to All** to save your selections to all streams.

- **MAC Header Tab:**
  - **MAC Source:** Use the default source address of the test set or configure a new or different address.
    Tap the **Mac Source** button at the bottom to populate the fields with default test port settings.
    For Layer 4 (IPv6) only: *Tap the* ***NDP Gateway*** *and* ***NDP*** *buttons at the bottom to locate MAC addresses on the local network for the network address designated in the gateway.*
  - **MAC Destination**: Configure the destination MAC address of the far-end partner test set.
  - **Ethernet Type:**
    - **Layer 2:** AE-FE (fixed)
    - **Layer 4**: Set to 0800-IP (fixed), or
      select 8847-MPLS unicast or 8848-MPLS multicast if MPLS tagging is enabled.

Throughput Setup - MAC Layer 4



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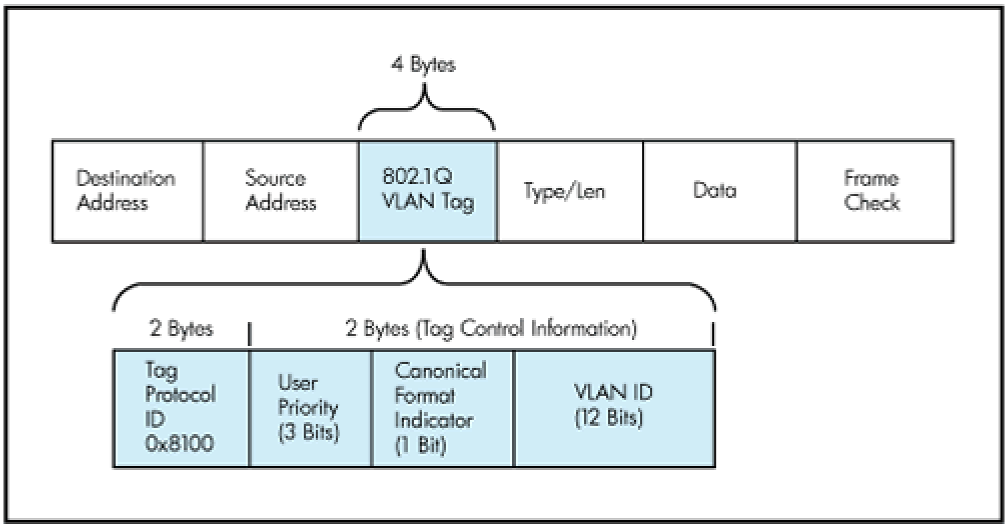
- **VLAN Tab:**
  - **VLAN ID:** Configurable in the range 1 to 4094.
    - Identifies the VLAN; used by standard 802.1Q.
    - It has 12 bits which allows the identification of 4096 (2^12) VLANs.
    - Of the 4096 possible VIDs, a VID of 0 is used to identify priority frames and value 4095 (FFF) is 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 referring to the IEEE 802.1p priority.
        - Indicates the frame priority level from 0 (lowest) to 7 (highest); used to prioritize different classes of traffic (voice, video, data, etc.).
    - **Type:** The following selections are possible:
        - 8100 (IEEE 802.1Q tagged frame)
        - 88a8 (IEEE 802.1ad Provider Bridging)
        - User Defined
    - **Drop Eligible:** If enabled, a drop eligibility flag will be set.

IEEE 802.1Q VLAN Tag in an Ethernet Frame



Throughput Setup - VLAN Tag configuration (Layer 4)

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- **MPLS Tab (Layer 4 only):**
    - **MPLS label:** Configurable in the range 16 through 1,048,575 (labels 0 to 15 are reserved).

      Composed of 20 bits which allows for the creation of over one million labels.
    - **CoS:** Configurable in the range 0 to 6.

      This field is three bits in length and maps directly to IP Precedence TOS bits to provide Class of Service (COS).
    - **S-bit:** Configurable 0 or 1.

      The S field is one bit in length and is used for stacking labels. This is important as it is used to indicate the last label *in the label stack.*

- **TTL:** Configurable in the range 0 to 255. The default setting is 128 hops.

  Used to decrement the time-to-live counter.

Throughput Setup - MPLS configuration (Layer 4)

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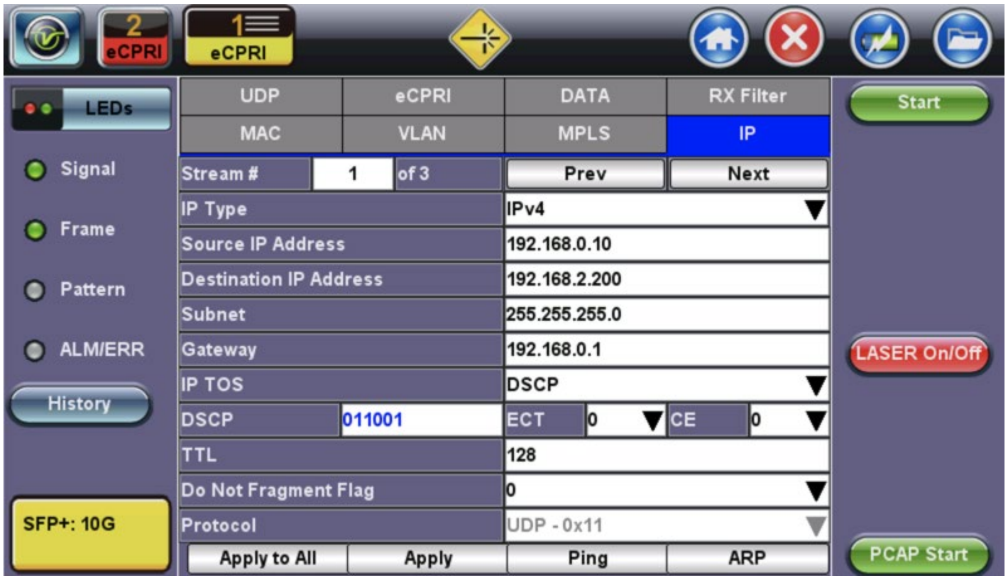
- **IP Tab:** Configures the destination IP address, source address and header fields.
  - **IPv4**
    - **IP Type:** IPv4, IPv6
    - **Source and Destination IP Address:** The source address is fixed to the IP address from the IP setup menu.
    - **Subnet**: Subnet mask
    - **Gateway**: Address of the network gateway
    - **IP TOS (for Quality of Service testing):** Legacy TOS or DSCP
      - **Legacy TOS :** The first three bits of the IP TOS field can be edited:
        - **Precedence:**
          - 000 - Routine
          - 001 - Priority
          - 010 - Immediate
          - 011 - Flash
          - 100 - Flash Override
          - 101 - Critical
          - 110 - Internetwork Control
          - 111 - Network Control
        - **TOS Values:**
          - 1000 - Minimize Delay
          - 0100 - Maximize Throughput
          - 0010 - Maximize Reliability
          - 001 - Minimize Monetary Cost
          - 0000 - Normal Service
      - **DSCP (Differentiated Services Code Point):** The first six bits of the IP TOS can be edited to provide more granular service classification.
      - **Time To Live (TTL):** Configurable in the range 0 to 255. Indicates how many hops have been traversed. It will be decremented by 1 each time it crosses a hop.
      - **Do Not Fragment Flag:** Fragment offset byte configurable in the range 0 to 65.528.

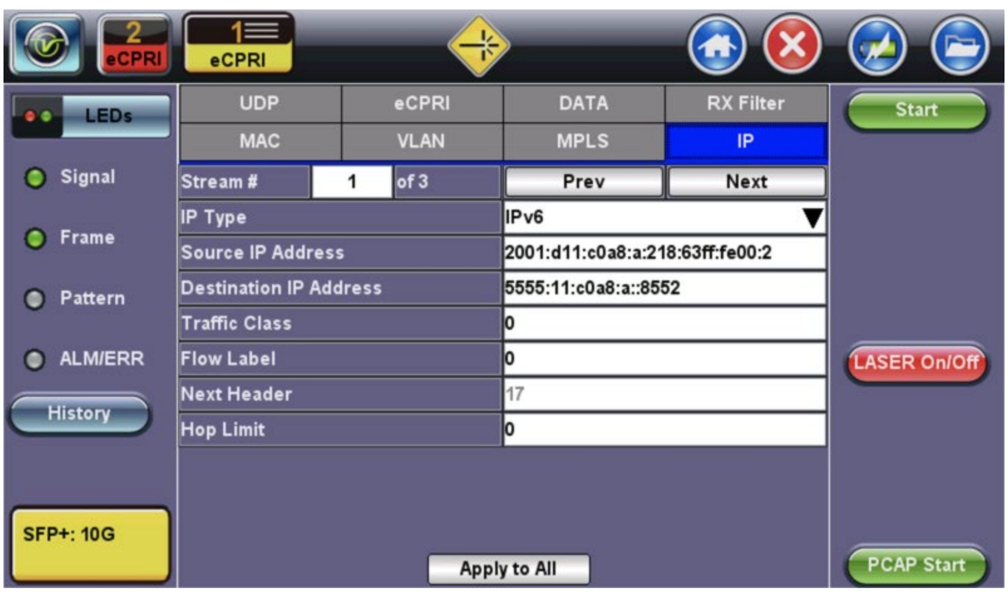
        The fragment offset field, measured in units of eight-byte blocks, is 13 bits long and specifies the offset of a particular fragment relative to the beginning of the original unfragmented IP datagram.
      - **Protocol:** UDP (0x11), TCP (0x06), User Defined.

Throughput Setup - IP Address Settings Layer 4 (IPv4 Legacy TOS)



- **IPv6**
  - **IP Type:** IPv6
  - **Source and Destination IP Address:** 128-bit fields. The source address is fixed to the IP address from the IP setup menu.
  - **Traffic Class**: 8-bit level used to designate priority handling of packets.
  - **Flow Label**: 20-bit label used to identify packets for special handling.
  - **Next Header**: 8-bit field to identify the type of header that immediately follows.
  - **Hop Limit:** 8-bit field to designate the maximum number of hops from source to destination. Packet is discarded once number is decremented to zero.

Throughput Setup - IP Address Settings Layer 4 (IPv6)



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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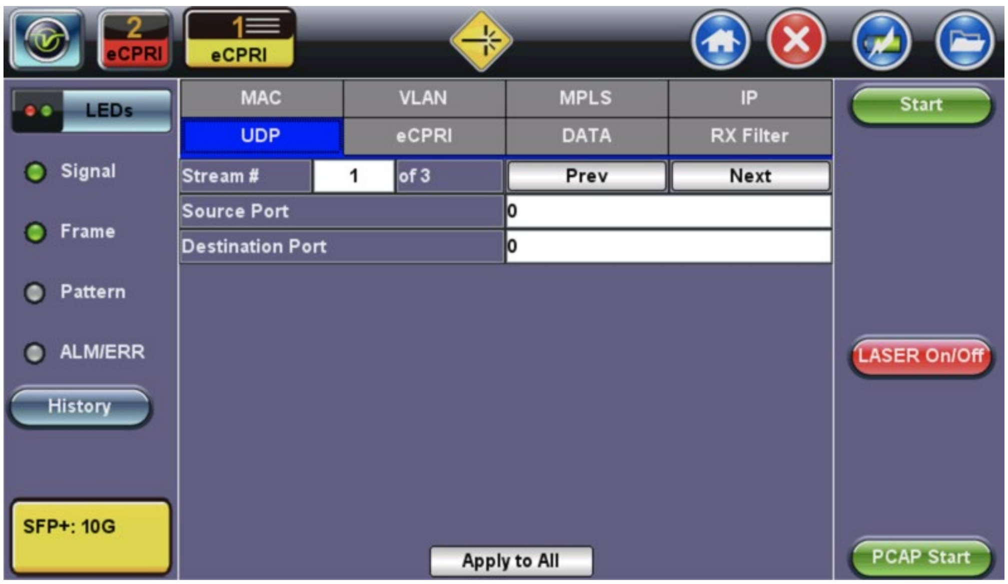
- **UDP Header Tab:**
  - **Source Port:** 16-bit fields used to identify the transmitter's and receiver's ports. Field has limit of 65,535.

Throughput Setup - UDP Settings Layer 4



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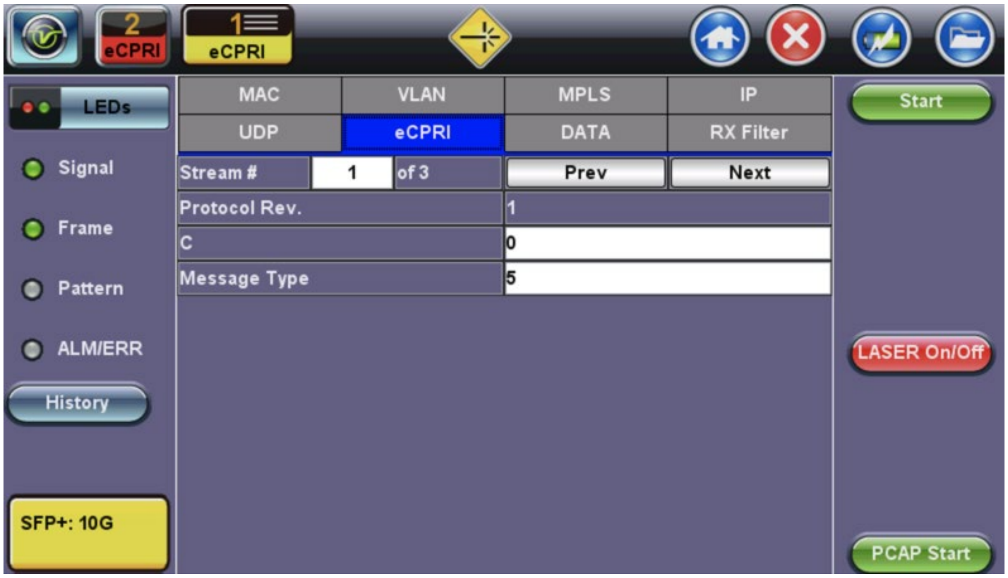
- **eCPRI Header Tab:**
  - **Protocol Rev.:** eCPRI Interface Specification version used (version 1 is default).
  - **C**:
    - 0 = indicates last message
    - 1 = indicates another eCPRI message follows
  - **Message Type**: The following types of messages are allowable in eCPRI specifications ver. 1. The default is set to 5 for One-way latency measurements.
    - 0 = IQ Data
    - 1 = Bit Sequence
    - 2 = Real-Time Control Data
    - 3 = Generic Data Transfer
    - 4 = Remote Memory Access
    - 5 = One-way Delay Measurement
    - 6 = Remote Reset
    - 7 = Event Indication
    - 8 - 63 = Reserved
    - 64 - 255 = Custom

Throughput Setup - eCPRI Settings Layer 4



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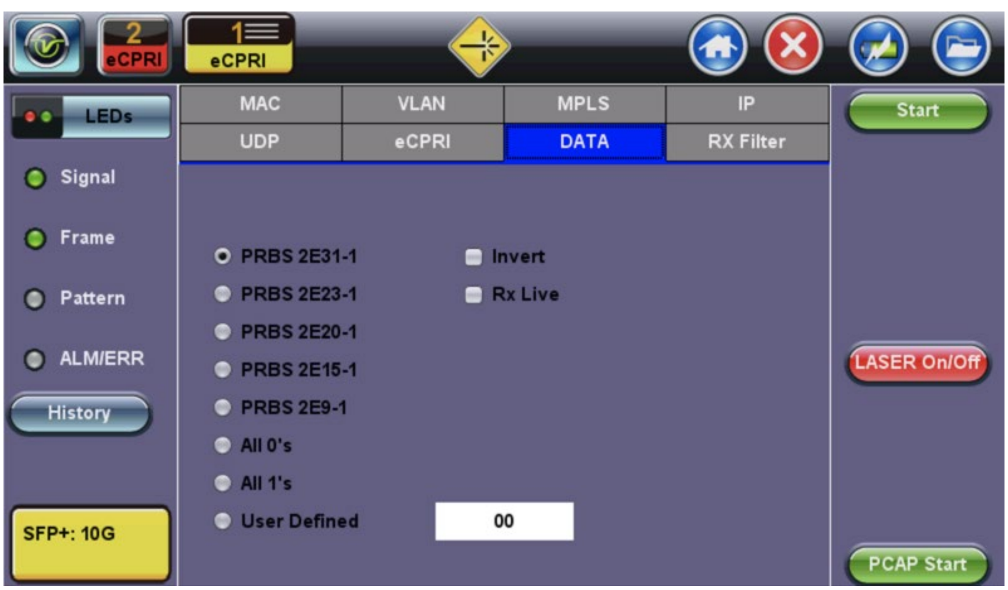
- **Data Tab:** Select a test pattern that will be encapsulated in the Ethernet frame payload (for framed mode). For both Layer 2 and 4 the following pattern is available:
  - **PRBS:**
    - 2E31 -1 (147 483 647-bit pattern used for special measurement tasks, [e.g., delay measurements at higher bit 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)
    - 2^15 -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)
  - **All 0's**: Set to all zeros
  - **All 1's**: Set to all ones
  - **User Defined**: 2 bit field
  - **Invert:** Normal or inverted
  - **Rx Live**: Select checkbox to check that receiver is active and ready to receive data.

Throughput Setup - DATA Settings Layer 4



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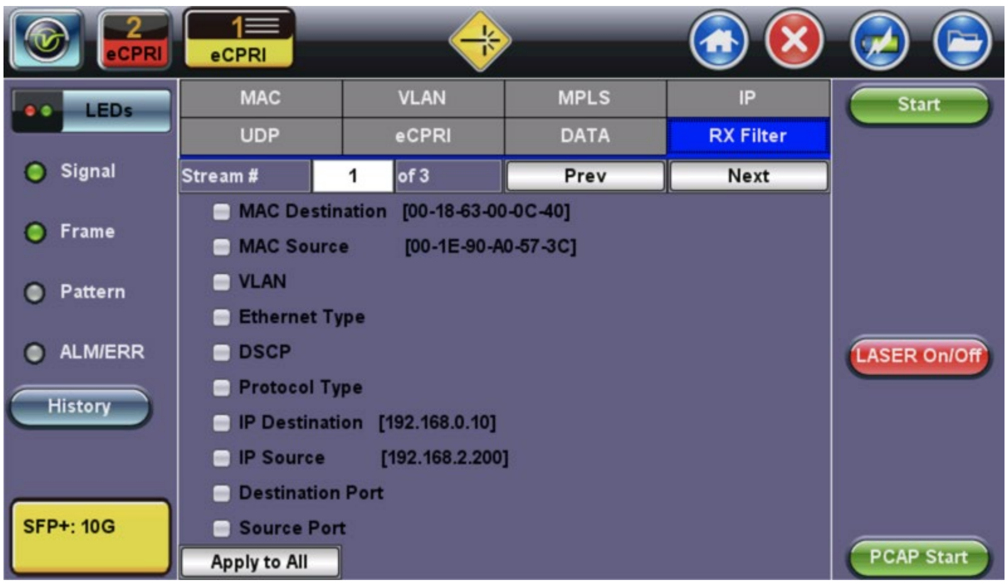
- **RX Filter Tab:** Filters incoming streams. When checked, the incoming traffic flows that do not match these criterion will not be considered for test results.
    - **MAC Destination**
    - **MAC Source**
    - **VLAN**
    - **Ethernet Type**
    - **DSCP (Layer 4 only)**
    - **Protocol Type (Layer 4 only)**
    - **IP Destination (Layer 4 only)**
    - **IP Source (Layer 4 only)**
    - **Destination Port (Layer 4 only)**
    - **Source Port (Layer 4 only)**
    - **VLAN Eligible (Layer 4 only)**

Throughput Setup - RX Filter Header Setup Settings Layer 4



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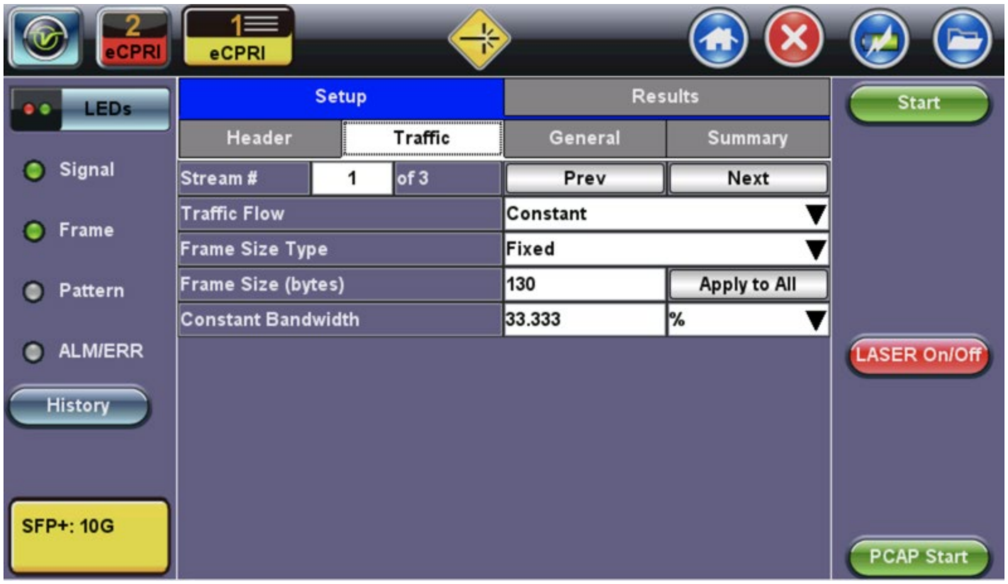
17.4.1.2 Traffic Settings (Per Stream Configuration)

Use the Traffic tab to configure the traffic profile per stream, including frame size selection, traffic type, and transmit rate.

- **Stream #:** Select a stream number to configure.
- **Traffic Flow:**
    - Multiple Streams: Constant
    - Single Stream: Ramp, Burst, or Single Burst
- **Frame Size (Type):** Fixed
- **Frame Size (bytes):** If a fixed frame size is chosen, this option is enabled to enter the frame size. Frame sizes can be from 64 bytes to 1518 bytes, in addition to jumbo frames up to 9k bytes.
- **Constant Bandwidth:** Configure the transmit rate for the stream. The parameters depend on the Traffic Flow selected.
    - Constant Traffic Flow: Constant Bandwidth
    - Ramp: Start BW, Stop BW, Step BW, Ramp Time, Repetitions
    - Burst: Burst 1 Bandwidth, Burst 1 Time, Burst 2 Bandwidth, Burst 2 Times
    - Single Burst: Single Burst Bandwidth

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

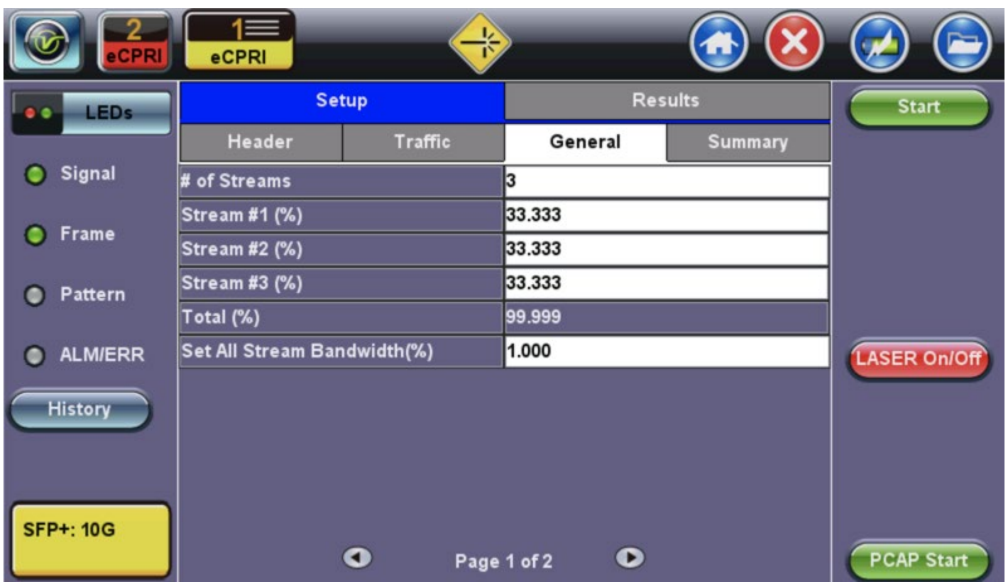
Throughput Traffic Settings



17.4.1.3 General Throughput Settings (Global Configuration)

- **# of Streams:** Up to 32 streams.
- **Stream #:** Allocated Bandwidth per Stream: The total bandwidth for all streams cannot exceed 100%.
- **Total (%):** Sum of all stream rates in %.

Throughput General Setup



Page 2 features One Way Delay measurement and Service Disruption Test (SDT) measurement settings.

- **Delay Measurement Mode:** Enable/disable the round trip delay measurement. It should only be enabled when running the test to a remote loopback.
- **RTD Unit Auto Scale:** ON/OFF
- **Histogram:** Enable / Disable
- **Sampling Period:** 1sec, 10secs, 30secs, 1min, 10min, 30min, 1hr. Defines how often the RTD (round trip delay) measurement is evaluated against the RTD threshold.
- **Threshold (Max RTD allowed):** Input the value in us, ms or sec. Defines the maximum allowed round trip delay value. If the RTD value exceeds the threshold, an event is logged with corresponding time stamp.
- **Save Histogram:** Enable/Disable
- **SDT Measurement**: Enable/Disable. The Service Disruption Test is triggered based on user established thresholds.
  - ***SDT Violation Threshold (us)***:Triggers an SDT Violation event in the event log. This is helpful for historical purposes during any given test. If the measured SDT is equivalent or greater than the configured threshold an SDT Violation event is counted.

SDT Measurement Trigger (>us): Any inter-frame gap that is equivalent or greater than the configured threshold will trigger the SDT measurement. This is useful if a known threshold is expected from a given network under test. For example, if the known switchover time is 50ms, the trigger can be set to a value slightly below 50ms to assure that the SDT is measured.

Throughput General Setup - One Way Delay Service

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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17.4.1.4 Error/Alarm Injection Settings (Per Stream Configuration)

Error injection and Alarm Injection can be performed during testing by tapping the **Setup Injection** button. The type of errors and error injection are configured in the Error Injection tab.

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

Error Injection Settings

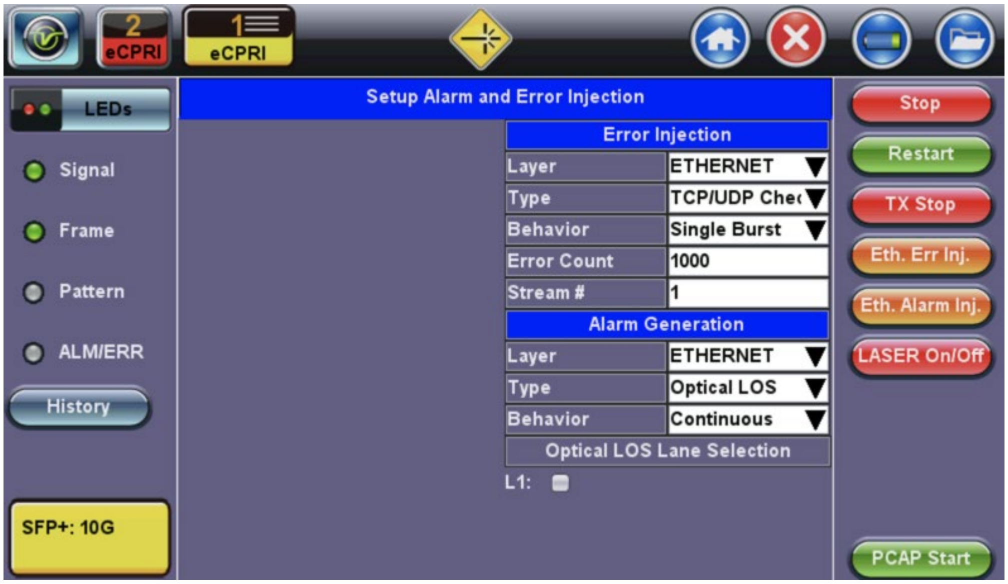
- **Layer**: ETHERNET
- **Type:** Type of error: CRC, TCP/UDP Checksum, Pause, OOS, Missing Sequence, or Dup. Sequence.
  When Pause is selected, the unit will transmit a pause frame when the **Error Inj.** button is pressed.
- **Behavior**: How the errors will be injected: Single, Single Burst, or Rate.
- **Pause Quanta**: Field appears when **Type** is set to Pause. 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.
- **Error Count**: Field appears when **Behavior** is set to Single Burst.
- **Error Rate**: Field appears when **Behavior** is set to Rate.
- **Stream #:** The stream to configure.

Alarm Injection Settings

- **Layer**: ETHERNET
- **Type:** Type of alarm: Local Fault, Remote Fault, or Optical LOS.
  Alarm Inj. Button is pressed.

- **Behavior**: How the alarms will be injected: Continuous or Single Burst
- **Optical LOS Lane Selection**: Checkbox appears when **Type** is set to Optical LOS.

Throughput Error/Alarm Injection Setup



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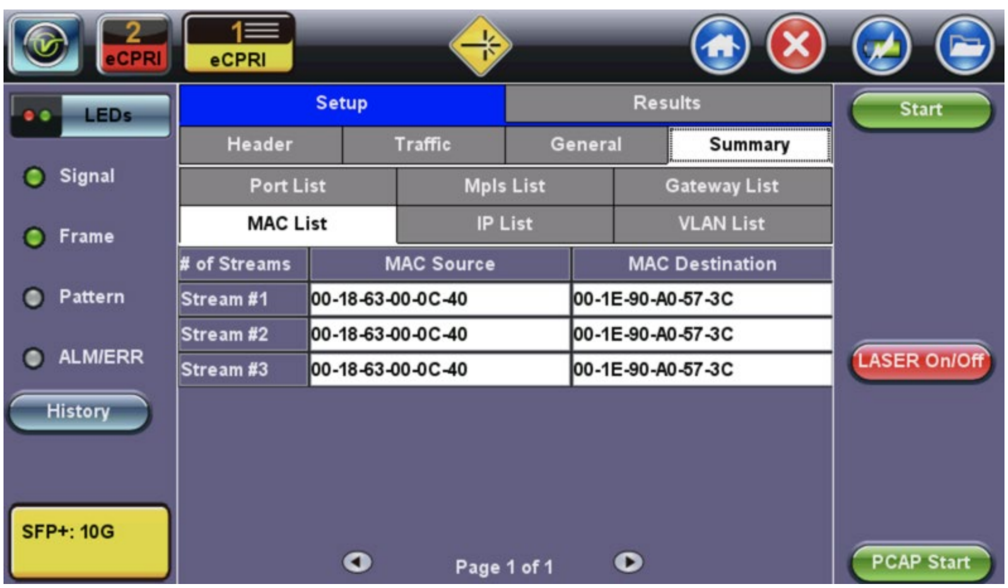
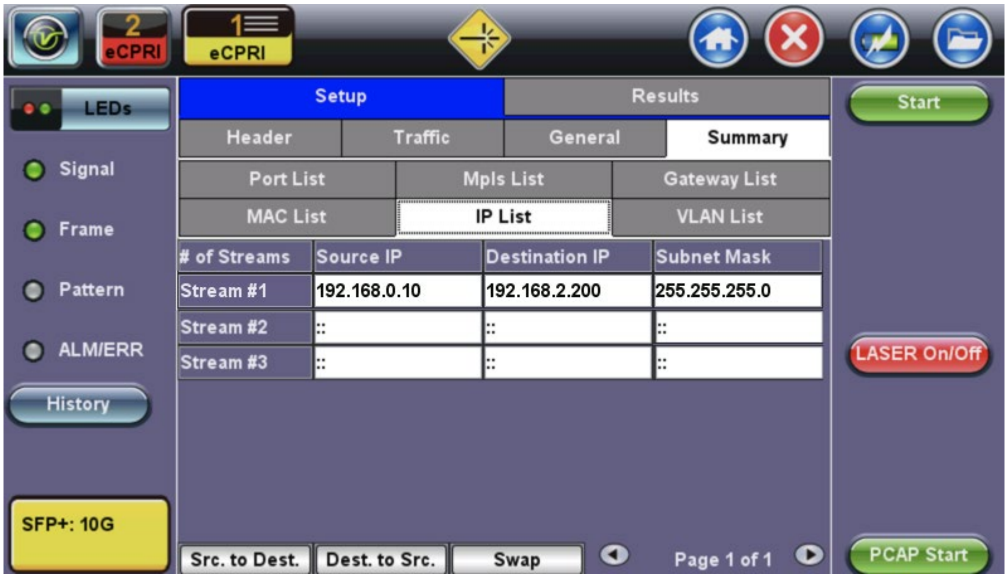
17.4.1.5 Summary

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

Throughput Summary MAC List - Level 4



Throughput Summary IP List - Level 4



Throughput Summary VLAN List - Level 4

Throughput Summary MPLS List - Level 4

Throughput Summary Gateway List - Level 4

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17.4.1.6 Starting/Stopping a Throughput (Multiple Streams) Test

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

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 eCPRI testing.
  - After configuring test settings on both units, start the tests.

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17.4.2 Throughput Results

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

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17.4.2.1 Global/Aggregate Results

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

The **Global Stream Summary** screen displays:

- Stream number (#)
- Transmit and Receiver rate (bps)
- Events (errors/alarms) associated with the stream

Throughput Results - Global Stream Summary

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The **Aggregate** screen displays these parameters:

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

Throughput Results - Global Aggregate

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The **Global Signal** screen (fiber ports only) displays the optical level measured by the CFP2 or QSFP+ transceiver.

Throughput Results - Global Signal Page 1

Throughput Results - Global Signal Page 2

Throughput Results - Global Signal Page 3

Throughput Results - Global Signal Page 4

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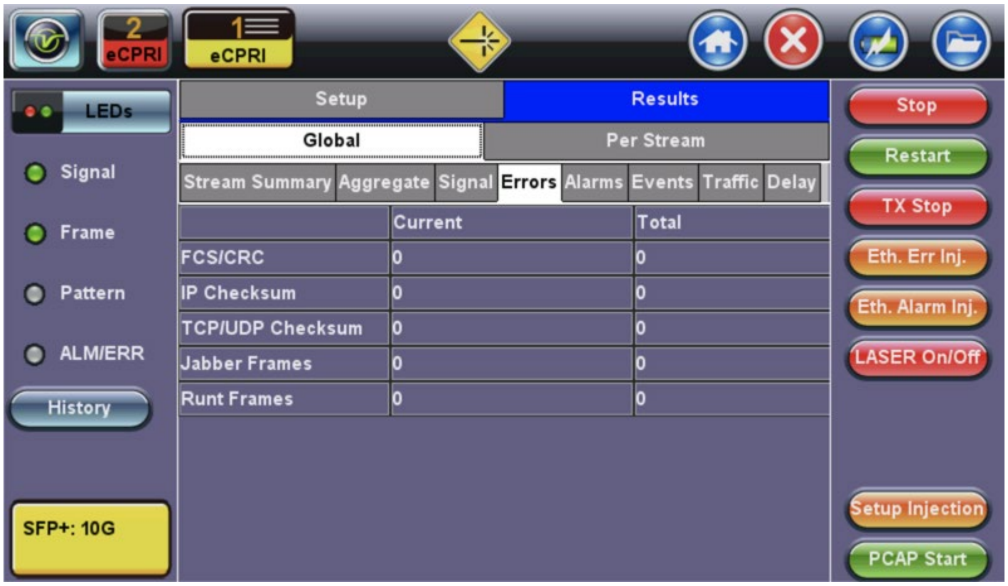
The **Global Errors** screen displays the Current and Total error count of all streams:

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

Throughput Results - Global Alarms

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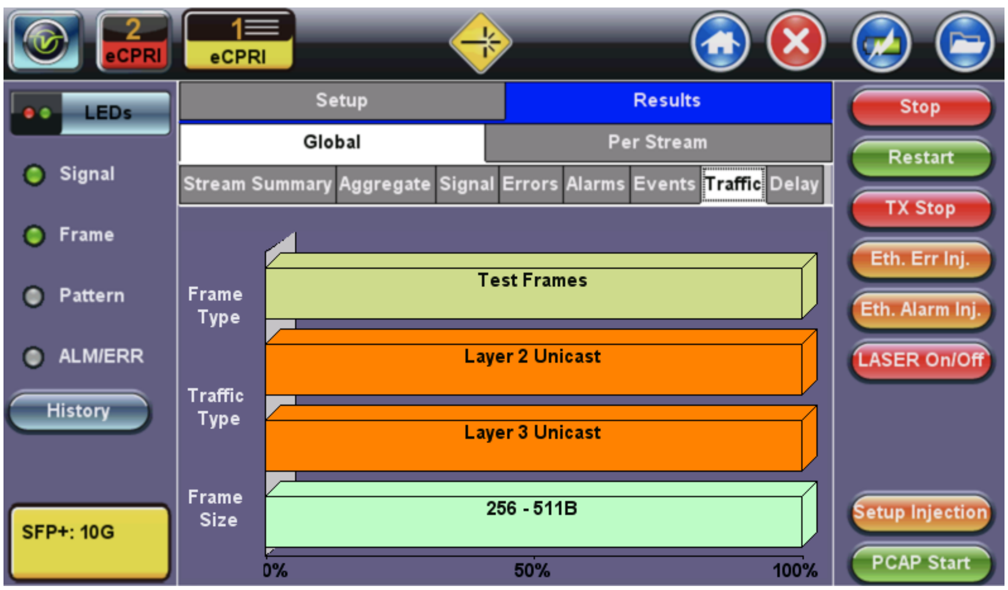
The **Global Events** screen displays the **Time**, **Event Type**, **Number of Events**, and **Test Type.**

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



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

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

Throughput Results - Global Traffic Details

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

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

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

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

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

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

Throughtput Results - Global Delay

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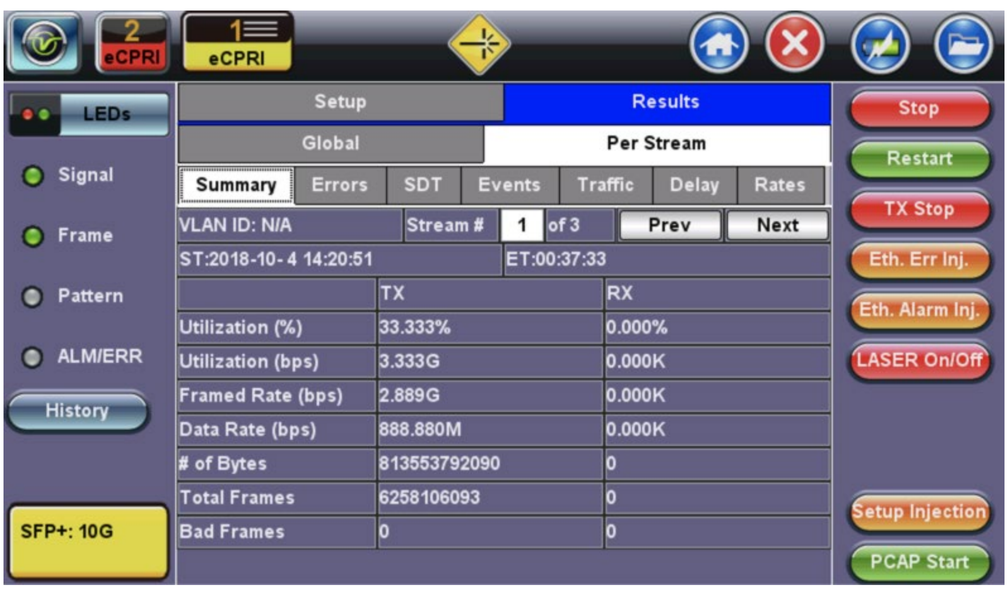
17.4.2.2 Per Stream Results

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

- **Summary:** Framed rate, data rate, # of bytes, total # of frames associated with each stream.
- **Errors:** Errors associated with each stream.
- Service Disruption Test results for each stream.
- **Events:** Events associated with each stream.
- **Traffic:** Traffic statistics associated with each stream.
- **Delay:** Delay associated with each stream. *One Way Delay measurements are only available in the per-stream results screen.*
- **Rates:** Rate information associated with each stream.

Throughput Results - Per Stream Summary



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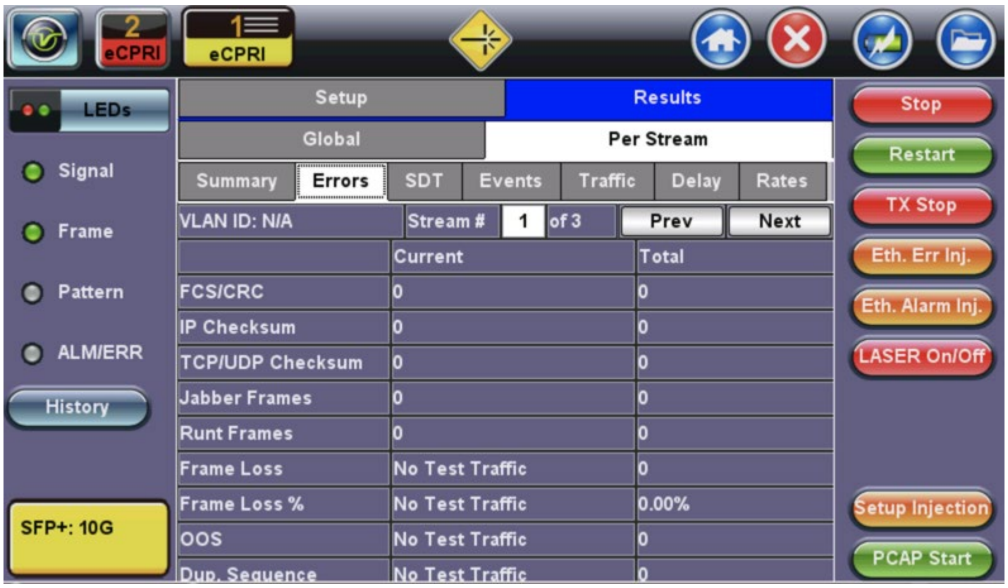
The **Per Stream Errors** screen displays the Current and Total error count of each stream.

- **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**: Number of frames lost from receiver
- **Frame Loss %**: Percentage of total frames that were lost
- **OOS**: Out of Service errors
- **Duplicate Sequence**

Throughput Results - Per Stream Errors Page 1



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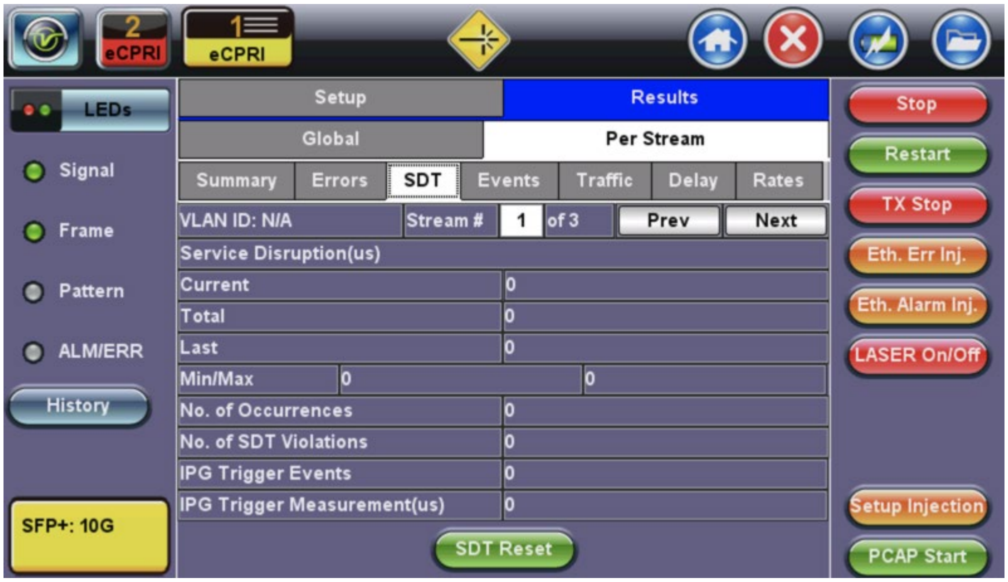
Service Disruption Test

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

Throughput Results - Per Stream SDT



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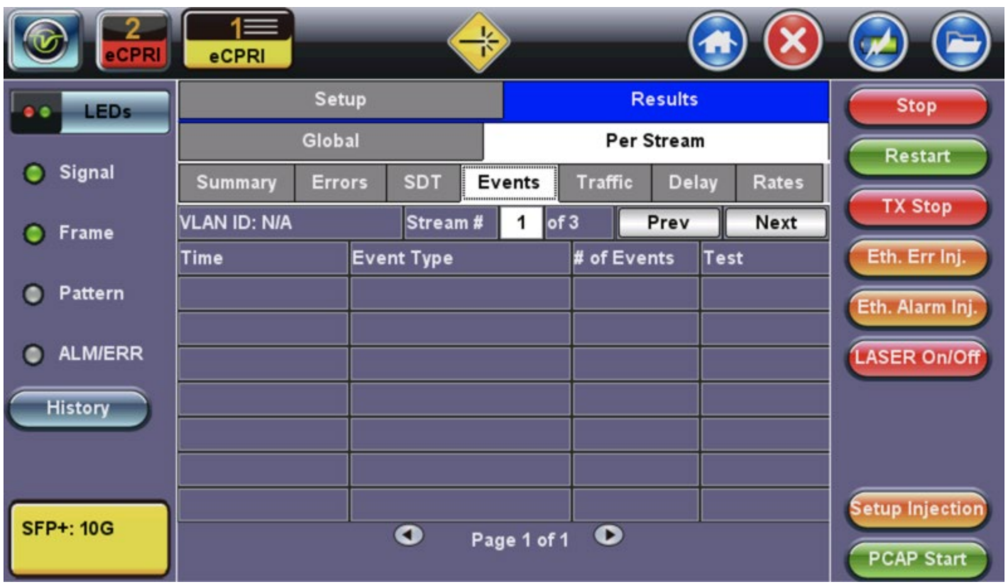
The **Per Stream Events** screen displays a Date and Time stamped record of bit errors, alarms and other anomalies pertaining to each stream.

Throughput Results - Per Stream Events



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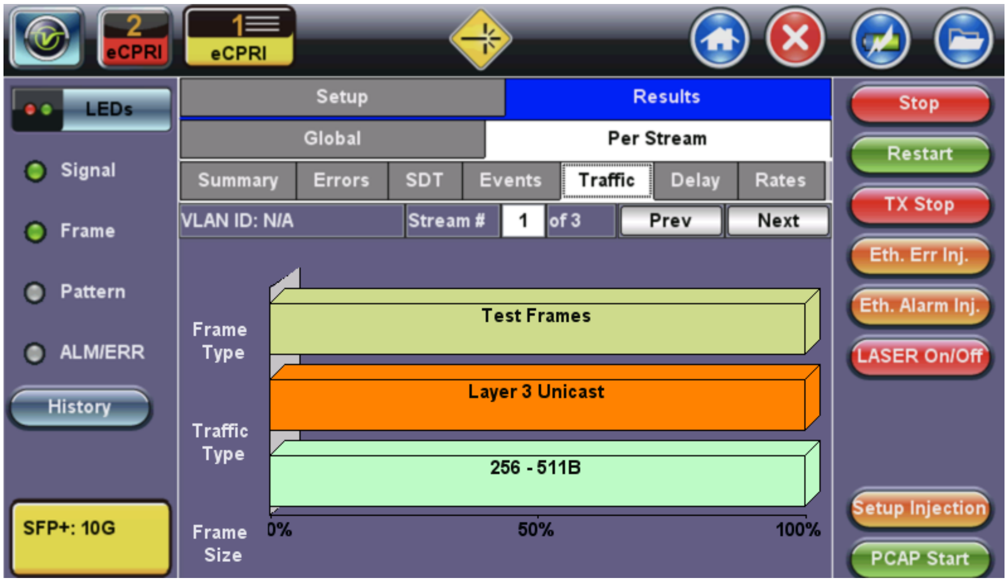
The **Per Stream Traffic** screen displays the frame type and frame size distribution pertaining to each stream.

Throughput Results - Per Stream Traffic



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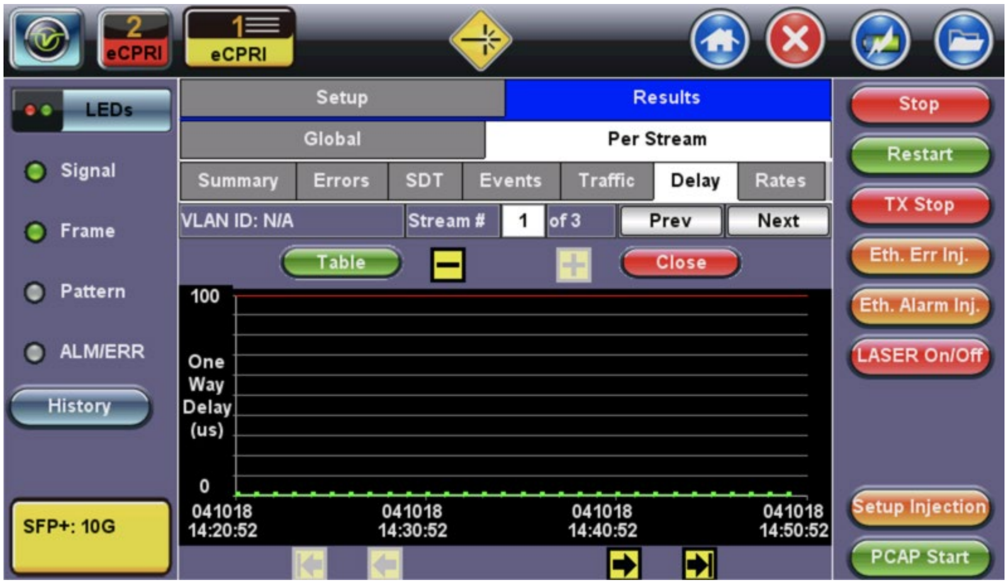
The **Per Stream Delay** screen displays the frame delay information pertaining to each stream.

The Histogram shows the sampling points for the delay.

Throughput Results - Per Stream Delay

Throughput Results - Per Stream Delay - Histogram



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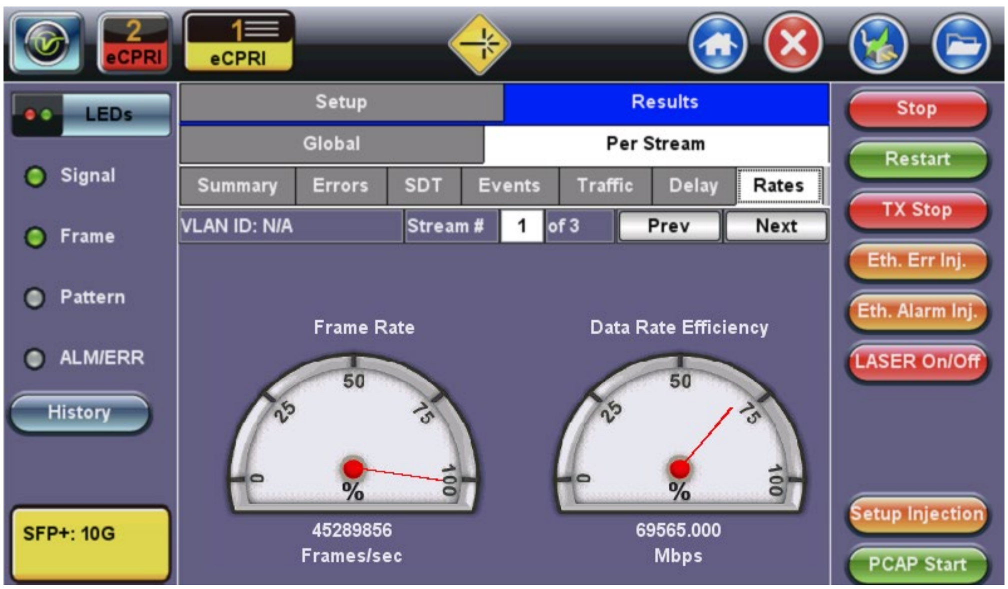
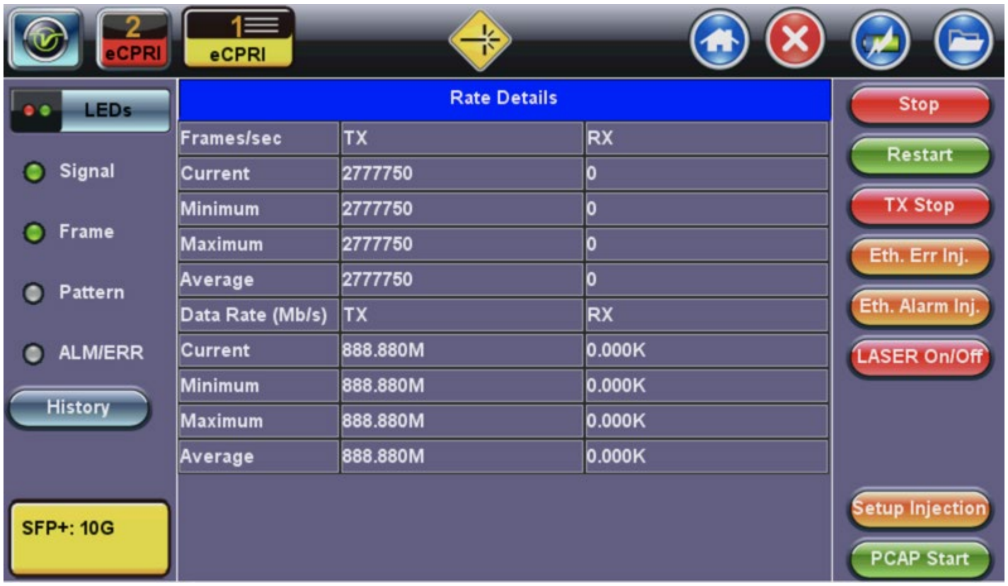
The **Per Stream Rates** screen displays the frame rate and data rate pertaining to each stream. Tap on either dial to see rate details.

Throughput Results - Per Stream Rates



Throughput Results - Per Stream Rate Details



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17.4.3 Saving Throughput Results

After stopping the test, save the results by pressing the **Save** button on the platform's keypad.

A window will open giving the option of namingx the results file. Enter the desired name for the file and tap apply. The results will be saved. For more information on retrieving saved test results, refer to test unit's platform manual for more information.

Throughput Results Save

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17.5 Packet Capture

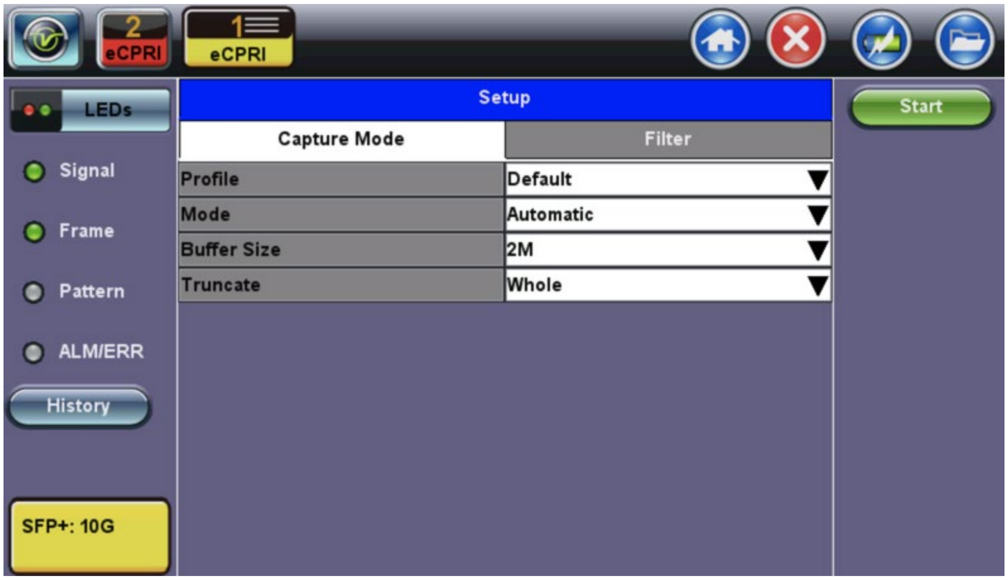
17.5.1 Packet Capture Setup

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

Configure the following **Capture Mode** parameters:

- **Profile:** Drop-down selections are Default, Delete, Save, Save As...
- **Mode:** Automatic. Packet capture is automatically started when pressing the **CAP ON** function key.
- **Buffer Size:** Defines the size of the storage allocated to packet capture.
- **Truncate:** Captures the whole frame or first number of bytes of that frame (64, 128, 192, 256).

Capture Mode Setup



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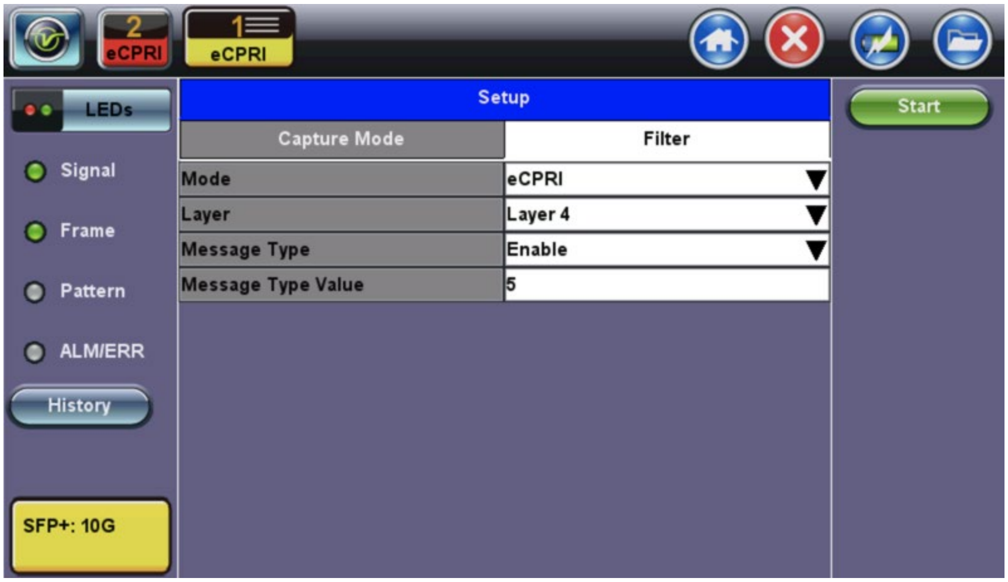
Select from the following Filter options:

eCPRI Mode

- **Mode:** eCPRI. Only traffic frames matching the source and destination addresses are captured.
- **Layer:** Layer 2 or Layer 4
- **Message Type**: Enable or Disable
- **Message Type Value**: (Field appears when Message Type is set to Enable.) The default is set to 5 for One-way latency measurements.
  The following types of messages are allowable in eCPRI specifications ver. 1.
  - 0 = IQ Data
  - 1 = Bit Sequence
  - 2 = Real-Time Control Data
  - 3 = Generic Data Transfer
  - 4 = Remote Memory Access
  - 5 = One-way Delay Measurement
  - 6 = Remote Reset
  - 7 = Event Indication
  - 8 - 63 = Reserved
  - 64 - 255 = Custom

Filter



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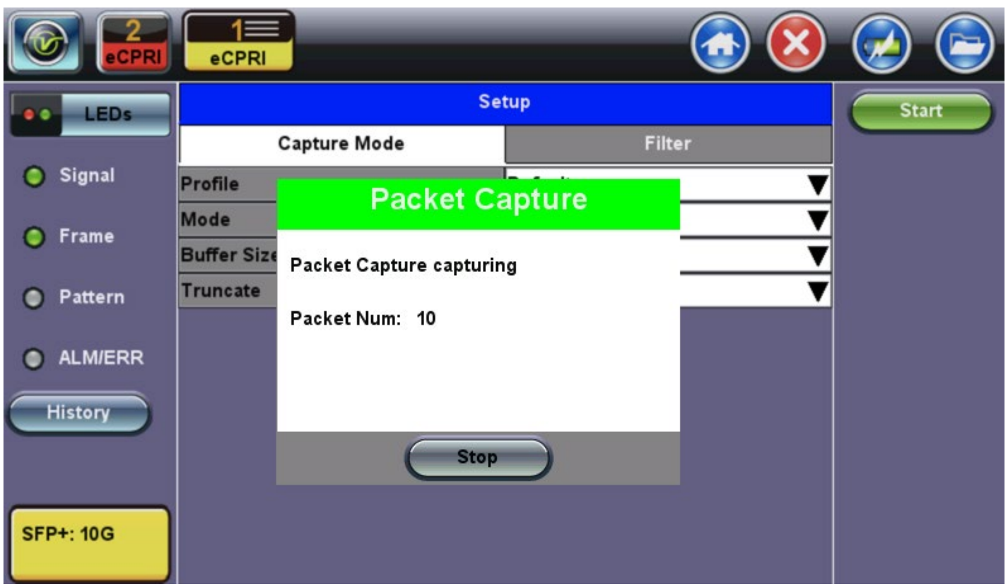
Tap the **Start** button to begin packet capture. A message appears showing the number of packets being captured.

Packet Capture In Progress



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17.5.2 Packet Capture Results

To finish packet capture and manage packet capture results, press **Stop**. A message appears showing the number of packets captured and the filename to which the results were saved on the test unit. Results are saved in PCAP format and are automatically named.

Packet Capture Save

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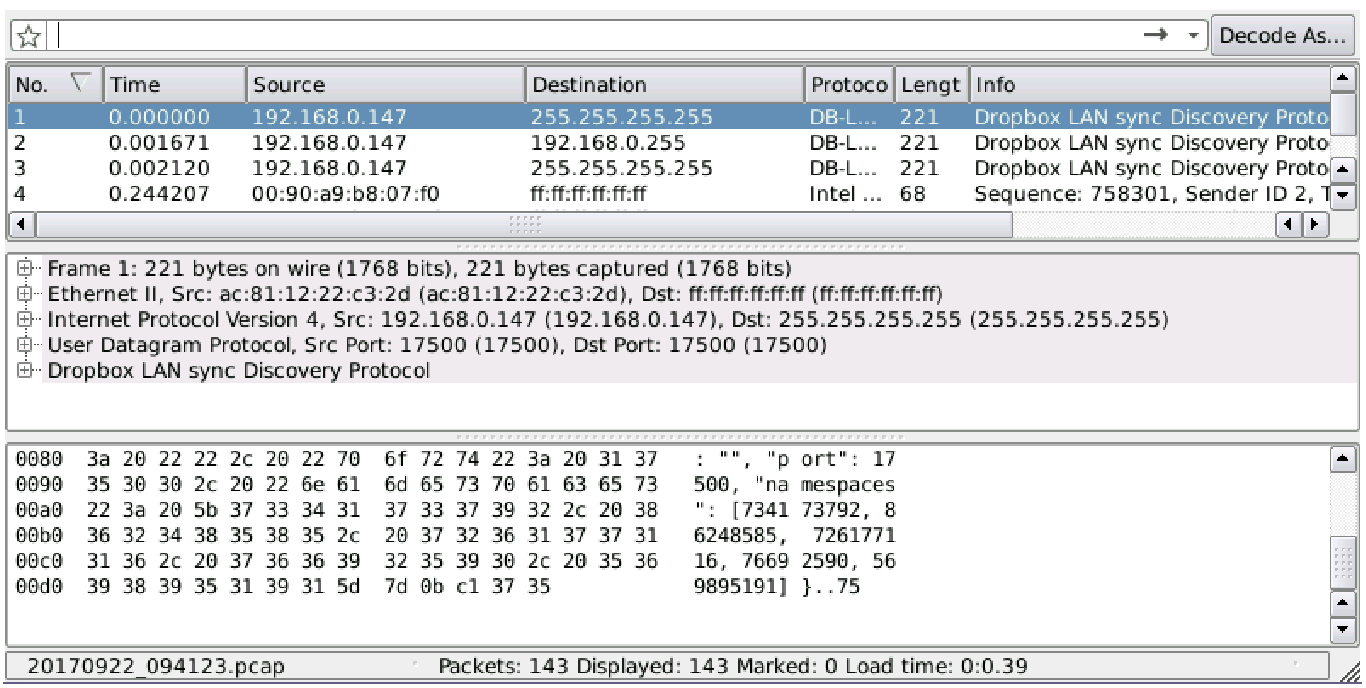
Viewing Packet Capture Results

When viewing results, Wire shark will launch and display the results.

The file is stored in the Files folder. It can be viewed on the test set or exported and analyzed on PC Wireshark. For more information on viewing and exporting files, see the RXT-1200 User Manual on www.veexinc.com.

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

Packet Capture Results on Wireshark



Top section:

- Time
- Source
- Destination
- Protocol

Length
- Info

Middle and Lower Sections:

- Frame details
- Ethernet frame details

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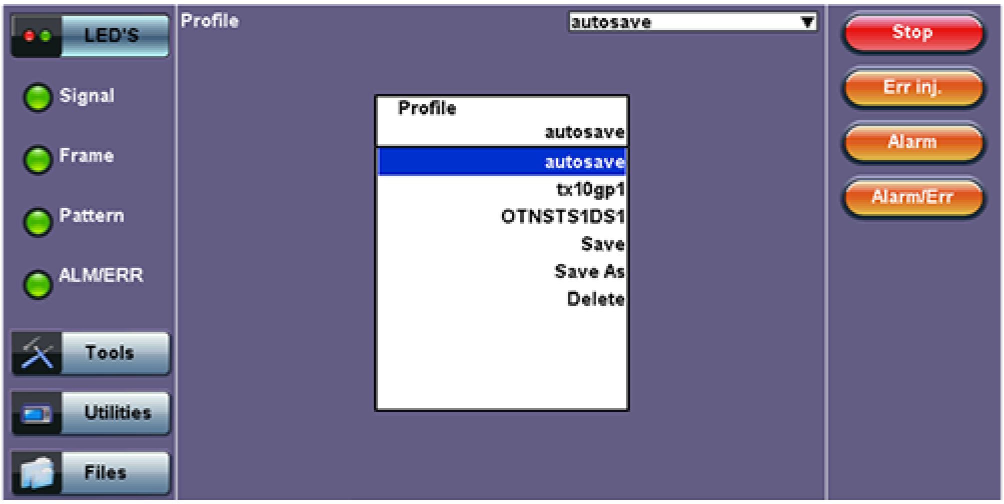
18.0 Profiles

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

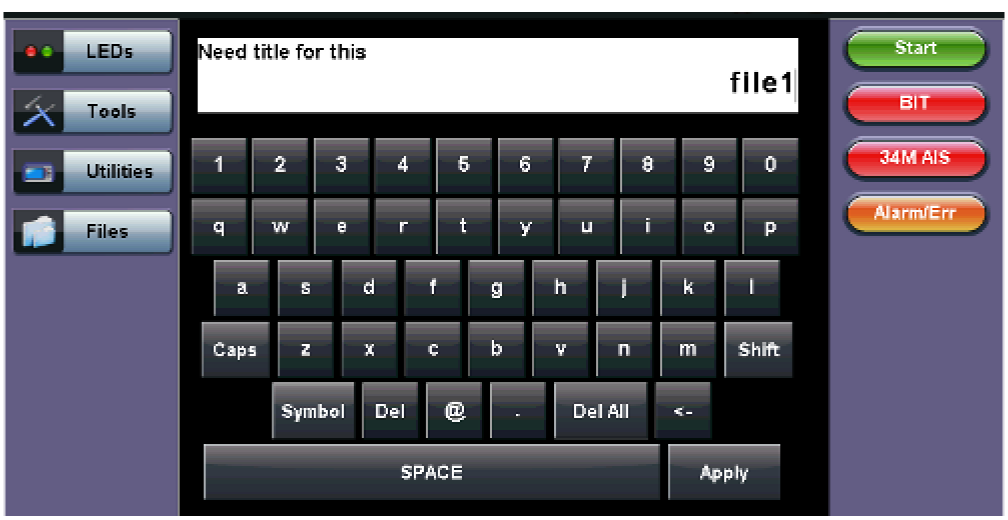
Profiles can be viewed and loaded in the Profiles folder located in the Files folder structure.



Accessing and Configuring Profiles

To access the Profiles menu from the **OTN/SDH/SONET** Testing main menu, tap on the following icons: **Advanced Mode** > **Profiles**. To save a new profile from the PDH or SDH applications mentioned above, select the **Save as** drop-down option. 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.

Alphanumeric keypad



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19.0 Common Functions

Please refer to the RXT-1200 Platform Manual for the following functions:

- IP Tools: Ping, Trace Route
- Net Wiz
- WiFi Wiz
- Advanced Tools
- Utilities
- Files
- R-Server
- Backlight
- VeExpress
- M.Upgrade

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20.0 Warranty and Software

Warranty Period: The warranty period for hardware, software and firmware is three (3) years from the date of shipment to the customer. The warranty period for battery pack, LCD, LCD touch panel, LCD protective cover, and accessories (including but not limited to patch cords, AC adaptor, SFP, USB adaptors, carrying case, carrying pouch) is limited to one (1) year.

Hardware Coverage: VeEX Inc. warrants hardware products against defects in materials and workmanship. During the warranty period, VeEX will, at its sole discretion, either

- Repair the products
- Replace hardware which proves to be defective

provided that the products that the customer elects to replace is returned to VeEX Inc. by the customer along with proof of purchase within thirty (30) days of the request by the customer, freight prepaid.

Software Coverage: VeEX Inc. warrants software and firmware materials against defects in materials and workmanship. During the warranty period, VeEX will, at its sole discretion, either

- Repair the products
- Replace the software and/or firmware which prove to be defective

provided that the products that the customer elects to replace is returned to VeEX Inc. by the customer along with proof of purchase within thirty (30) days of the request by the customer, freight prepaid.

Additionally, during the warranty period, VeEX Inc. will provide, without charge to the customer, all fixes, patches and enhancements to the purchased software, firmware and software options. VeEX Inc. does not warrant that all software or firmware defects will be corrected. New enhancements attached to a software option require the option to be purchased (at the time of order or the time of upgrade) in order to benefit from such enhancements.

Limitations: The warranty is only for the benefit of the customer and not for the benefit of any subsequent purchaser or licensee of any merchandise (hardware, software, firmware and/or accessories).

Revoking the warranty: VeEX Inc. does not guarantee or warrant that the operation of the hardware, software or firmware will be uninterrupted or error-free. The warranty will not apply in any of the following cases:

- Improper or inadequate maintenance by the customer
- Damage due to software installed by the customer on the unit without prior authorization (written) from VeEX Inc.
- Unauthorized alteration or misuse
- Damage occurred from operating the unit from outside of the environmental specifications for the product
- Improper installation by the customer

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21.0 Product Specifications

The most recent product specifications can be found on the VeEX web site at www.veexinc.com.

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22.0 Certifications and Declarations

Declaration of Conformity

What is CE?

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

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

ROHS Statement

What is RoHS?

RoHS is the acronym for Restriction of Hazardous Substances. Also known as Directive 2002/95/EC, it originated in the European Union and restricts the use of specific hazardous materials found in electrical and electronic products. All applicable products imported into the EU market after **July 1, 2006** must pass RoHS compliance.

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

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23.0 About VeEX

VeEX Inc., the Verification EXperts, is an innovative designer and manufacturer of test and measurement solutions addressing numerous technologies. Global presence through a worldwide distribution channel provides uncompromised product support.

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

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