RXT-6402 User Manual

Advanced Dual 400G Multi-service Test Module

P/N D07-00-157P Rev.B02

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General Information

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

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Customer Support

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

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

Support hours may vary depending on the product.

Product Technical Support Contact Information

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

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Warranty

For warranty information on VeEX Inc. products, go to www.veexinc.com.

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

Patent Information

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

Documentation Conventions

Icons used in this manual:

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

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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.

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.

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- 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.

Optical Connectors

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

1. Deactivate the laser before connecting or disconnecting optical cables or patchcords.
2. Never look directly into an optical patchcord or an optical connector interface (SFP+) while the laser is enabled. Even though optical transceivers are typically fitted with Class 1 or 2 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 chassis, 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).

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Electrical Connectors

Telephone lines may carry dangerous voltage. 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, 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.

Noise Disclaimer

CAUTION! Operating this product in high-speed Ethernet (HSE) applications (e.g., 1x800GE, 2x400GE, 2x200GE, etc.) for extended periods, in confined areas and/or environments with excessive noise levels (e.g., equipment room with HSE switches, servers), may result in users being exposed to high levels of noise. In those cases, it is recommended to use Hearing Protection Devices. Additionally, whenever feasible, operating the product remotely is also strongly recommended.

Check local regulations and ordinances related to Recommended noise Exposure Limits (REL).

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Getting Started

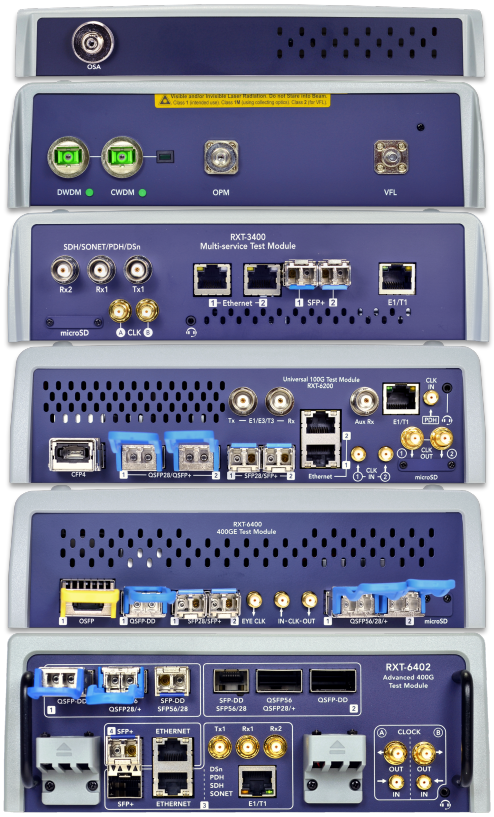
Introduction to RXT-1200 Modular Test Platform

RXT® represents the next-generation in integrated toolkits for field technicians, combining advanced multi-service testing capabilities, built around a single high-performance chassis, in a compact format.

RXT-1200 is a flexible Modular Platform for nodes and field applications. RXT-1200 offers a modern test platform architecture, with a broad range of available test modules covering Access (copper and fiber), Edge, Metro, Data Center, Transport and Core technologies.

The RXT® family of modules offer a full range of link and service testing capabilities, from Core to Access, from Lab to Field and from 64k to 400G, with a complete range of communication technologies, including eCPRI, CPRI/OBSAI, OTN, SDH/SONET, PDH/DSn, Carrier Ethernet, SyncE, 1588v2 PTP, Fibre Channel, OTDR, OSA. All supported by a single rugged hand-held test platform.

It uses field-replaceable self-contained modules, to offer a broad variety of modern and legacy test capabilities.



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Platform Highlights

- Modern test platform, with a broad range of available test modules covering Access (copper and fiber), Edge, Metro, Transport, Data Center and Core technologies, including DWDM
- Application-oriented GUI
- GUI familiarity across different test modules and other VeEX products reduces the learning curve
- View test results and create detailed reports by region, area, system, and technician
- Enables all jobs to be completed correctly the first time
- Multi-technology: Fiber Optics, xWDM, DSn/PDH, SONET/SDH, OTN, Ethernet, Fibre Channel, CPRI/OBSAI; from 64k to 400Gbps
- Expand test functions with a growing list of test modules
- Future-proof cost-effective platform
- Test set connectivity via Ethernet Management interface, Wi-Fi, Bluetooth®, or Data Card for back office applications and workflow optimization
- User defined test profiles and thresholds
- Fast and efficient test result transfer to USB memory stick
- Ultra-high capacity field-exchangeable Li-ion battery pack extends testing time
- Management Port (Ethernet LAN and remote access)
- Two USB 2.0 ports
    - Memory sticks, Wi-Fi, Bluetooth, Fiber Scope, Optical Power Meter, Wi-Fi Spectrum Analyzer, 3G/4G Data Card, External OTDR, etc.
- Built-in GPS/GNSS Receiver and Atomic Clock hardware (optional)
- VeExpress Client

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- Keeps Platform and Native Modules SW versions and licenses up-to-date

- R-Server Client option (Advanced Results Management)
  - Upload Test Results and Test Profiles to a centralized server

- QuickSwap™ Module Exchange (no tools required)

RXT-1200 Modules

RXT-6811: Advanced 800G Multi-service Testing

The RXT-6811 800G/Dual 400G offers the flexibility of testing current interfaces and supporting future expandability for applications including Transport, Aggregation, cross-connect, 5G x-haul, and NEMs field support.

RXT-6802: Advanced 800G Multi-service Testing

The RXT-6802 and RXT-6802 Lite offers the flexibility of testing current interfaces and supporting future expandability for applications including Transport, Aggregation, cross-connect, 5G x-haul, and NEMs field support

RXT-6402: Dual 400G Multi-service Testing

The RXT-6402 Dual 400G all-in-one offers the flexibility of testing all interfaces and rates and future expandability for applications including Transport, Metro, Aggregation, Datacenter inter/intra/cross-connect, Cloud computing, 5G backhaul, and NEMs.

RXT-3400: Advanced Multi-Service Testing

The RXT-3400 add-on module for the versatile RXT® test platform offers state-of-the-art support for Access, Metro, Core, Transport, Carrier Ethernet, Backhaul, Fronthaul and SAN Technologies up to 16GFC. VeEX RXT is the industry's most flexible, compact, complete and future-proof hand-held test solution, from 64k to 400GE, including Fiber Optics and WDM.

RXT-6400: 400G Testing

This portable 400G test module, supporting native QSFP-DD PAM4, extends the RXT® testing range to 400 Gbps and offers a future upgrade path for all-in-one 10M-to-400GE testing. Addesses installation, verification, commissioning, monitoring, troubleshooting, and maintenance tasks, as well as advanced layer 1-4 features, such as FEC codeword Error distribution analysis, PAM4 pre-emphasis, skew, transceiver check and stress, Lane BERT, Throughput test, IPv4/IPv6 and much more.

RXT-6200: 100G Universal Testing

The RXT-6200 100G Universal Test Module adds Ethernet, Mobile Backhaul, Fronthaul, Storage Area Networks, OTN, SDH/SONET, PDH/T-Carrier links and services testing, from 1.5/2 Mbps up to 100 Gbps.

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RXT-6000e: 100G Multi-Service Testing

Enhanced Universal Test Module for Carrier Ethernet, Backhaul & Transport Technologies. The RXT-6000e module adds Ethernet, Mobile Backhaul, Storage Area Networks, OTN, SDH/SONET, PDH/T-Carrier links and services testing, from 1.5/2 Mbps up to 100 Gbps.

RXT-3000: Multi-service Testing

Full featured test solution for OTN, SDH, SONET, PDH, DSn networks with extensive support for Mobile Backhaul technologies with SyncE, 1588v2 PTP, Carrier Ethernet, Fibre Channel and CPRI/OBSAI testing.

RXT-4100+: OTDR Testing

Features a range of Optical test functions including OTDR, OPM, Light Source and VFL. Physical link for OTN, SDH/SONET, Ethernet, Fibre Channel and Synchronous Packet Networks utilizing optical fibers can easily be verified as well as OSA testing on CWDM/DWDM network with a single test platform ensuring maximum test productivity.

RXT-4111: DWDM OTDR Testing

Features a tunable DWDM OTDR for testing optical Mux/Demux to verify channel routing and end to end connectivity. Multi-service DWDM networks can be verified with a single test platform ensuring maximum test productivity.

RXT-4112: CWDM OTDR Testing

Features a range of Optical test functions including tunable CWDM OTDR, OPM, Light Source and VFL. Multi-protocol networks utilizing CWDM technology can easily be verified with a single test platform ensuring maximum test productivity.

RXT-4113+: xWDM OTDR Testing

The industry's first combined CWDM/DWDM OTDR in a single test module. CWDM and DWDM (C-band) wavelength tuning with up to 500,000 data point sampling resolution offers unprecedented network characterization.

RXT-4500/4510: OSA Modules

Optical Spectrum/Channel Analyzer for CWDM and DWDM networks. Using micro-optic design and MEMS tuning technology, the OSA modules measure key optical parameters such as wavelength, channel power, and OSNR.

Introduction to RXT-6402

Advanced Dual 400G Multi-service Test Module

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Advanced 2x400GE Multi-service handheld test set for Lab to Field Applications

VeEX® RXT is the industry's most flexible, compact, and future- proof handheld test solution for Core, Metro, Datacenter, and Access applications. The RXT-6402 Dual 400G offers the flexibility of testing current interfaces and supporting future expandability for applications including Transport, Aggregation, cross-connect, 5G x-haul, and NEMs field support.

- 400G Down to 10M Ethernet Testing
- OTN, SDH/SONET, PDH/DSn
- Fibre Channel

General

- 2x400GE concurrent testing capabilities
- Offers dual ports for all pluggable optics form factors, required for AOC/DAC, fan-out and wrap-around tests (from 10M to 400GE)
- Up to four concurrent and independent tests
- Native QSFP-DD, QSFP56, SFP-DD, and SFP56 PAM4 hardware for best-in-class signal integrity (no adapters required).
- Supports testing for all common form factors, including QSFP-DD, QSFP56, SFP-DD, and SFP56 transceivers, DACs,AOCs, network equipment and 400GE links.
- Advanced and flexible state-of-the-art FPGA-based design provides future-proof hardware support for emerging standards, test functions and applications.
- Wide range of supported 400GE interfaces, including 400GBASE-SR8, FR8, LR8, DR4, FR4, LR4, CR8, CR4 and 400ZR/ZR+.
- Complete industry-standard Ethernet link test feature set for Layers 2, 3 and 4.
- I2C/MDIO registers Read and Write.
- Per-lane PAM4 host pre-emphasis settings.
- Signal integrity check with FEC codeword symbol errors distribution and Skew.
- Transceivers power consumption monitoring (voltage, current) and variable voltage supply.

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- Dedicated QSFP-DD head cooling fans (field replaceable) to optimize operating temperature verification of high-power class transceivers, such as ZR/ZR+
- All-in-one solution with common legacy test interfaces.
- Internal and external (cage) QSFP-DD temperature monitoring with overheating protection.
- High-capacity power supply provides support for long range coherent line interface transceivers and 2x400GE applications
- Battery (backup) operation improves mobility and efficiency in large hyperscale data centers, nodes, COs, R&D, evaluation labs and other field applications.
- High-efficiency intelligent cooling system
- Full-feature portable hand-held test set form factor, without compromises.

Applications

- Bring-into-service, verification and troubleshooting of high- speed Ethernet links.
- Optical transceivers verification.
- DAC and AOC verification, requiring full dual port capabilities.
- Fan-out tests.
- Evaluation labs and field support.
- Comprehensive test applications for layers 1-4, from 10M to 400GE.
- Full rate 400GE Throughput and frame loss measurements.
- PCS & RS-FEC layer testing.
- PAM4 signal integrity testing with multi-lane unframed BERT.
- I2C/MDIO verification and programming.
- Advanced optical transceiver test.
- Portable for field testing, evaluations, demonstrations, interop check, benchmarking, troubleshooting, link verification, etc.

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- Maintenance and troubleshooting of legacy transmission equipment, interfaces and links.
- Robust construction and enhanced cooling for field applications.

Test Interfaces

- 2x QSFP-DD (PAM4)
- 2x QSFP56/QSFP28/QSFP+ (PAM4/NRZ)
- 2x SFP-DD/SFP56/SFP28 (PAM4/NRZ)
- 2x SFP+/SFP (NRZ)
- 2x RJ45
- 1x RJ48 and 3x SMA (legacy)
- 2x Clock Inputs and 2x Outputs
- Four independent test port groups

PAM4 Interfaces

- Native PAM4 support for 400G QSFP-DD, QSFP56, SFP-DD, SFP56, transceivers.
- 400GBASE-SR8, FR8, LR8, DR4, FR4, LR4, CR8, CR4, and 400ZR/ZR+.
- Supports IEEE 802.3bs and MSA compliant transceivers.
- 300W supply supporting power classes 1 through 8.
- Cage temperature monitoring.
- QSFP-DD high-temperature warning threshold, overheat protection and field-replaceable external QSFP-DD head cooling system.
- Per-lane post and pre-emphasis settings.
- Lane BERT with independent test patterns.

MDIO Read/Write

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- Complete MDIO I2C access.
- Raw read/write capability for all MDIO registers.
- Formal display of commonly used fields.
- Module hardware control pin read/write access.

Optical Power Measurement

- Global and per lane output enable/disable.
- Received per lane and composite optical power level monitoring.

Transmit Clock Sources

- Internal 2.5 ppm VCXO and optional GPS 1PPS.
- Recovered: from the incoming signal.
- External: 1.544 MHz, 2.048 MHz, 10 MHz, BITS/1.544 Mbps, SETS/2.048 Mbps, and 1PPS via 50 Ohm SMA Connector.

Line Frequency Offset Generation

- Line frequency offset generation ±100 ppm in steps of 0.1 ppm.

Line Frequency Measurement Capability

- Displays measured transmit line frequency in kHz.
- Displays measured transmit line frequency offset from reference clock in current, min, max ppm.
- Measures all lanes.

Stress Test: Pre and Post-FEC Test Suite

- Simple one button pass/fail test for verifying all transceiver properties.
- Advanced user defined thresholds.
- Simple test report includes settings, Pass/Fail, and detailed results.

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- Frequency pulling range stress test.
- Pre and Post FEC test.

Advanced Optical Transceiver Test Suite

- Pre-FEC BER validation on a per-lane basis, over operational voltage and frequency offset range to verify optical module integrity before FEC is applied to the PAM4 signal (400GE interfaces).
- Pre-Framed BER (Lane BERT) validation for non PAM4 interfaces.
- Voltage, temperature, and Pre-FEC BER are monitored and displayed for the duration of the test. A histogram function clearly displays all three measurements for easy correlation and tracking of any abnormal changes.
- Pre-FEC BER and Optical Power threshold settings for PASS/ FAIL indication.
- Pre-emphasis: Pre-taps, post-taps, and attenuation settings for PAM4 signal conditioning on the host side to help verify and stress transceiver tolerance and performance.
- Supply Voltage Tolerance Verification: Sweep range from 3.135V to 3.465V (3.300V +/- 5%) to verify compliance with optical transceiver MSA standard.
- Power Consumption Verification: Monitors the optical transceiver's power consumption (Watts), to verify conformance to its specified power class.
- Temperature Monitoring: QSFP-DD module and cage temperature monitoring with built-in shutdown protection of the optical module if the temperature increases beyond a certain high temperature.
- Frequency Tolerance Verification: Sweep range from -100 ppm to +100pm (in 0.1ppm/step), to verify compliance with the 400GE IEEE 802.3 +/- 20 ppm tolerance specification.
- I2C Baud Rate Sweep: QSFP-DD and OSFP sweep range 100K to 4000K. QSFP28 sweep range (20K to 1000K).

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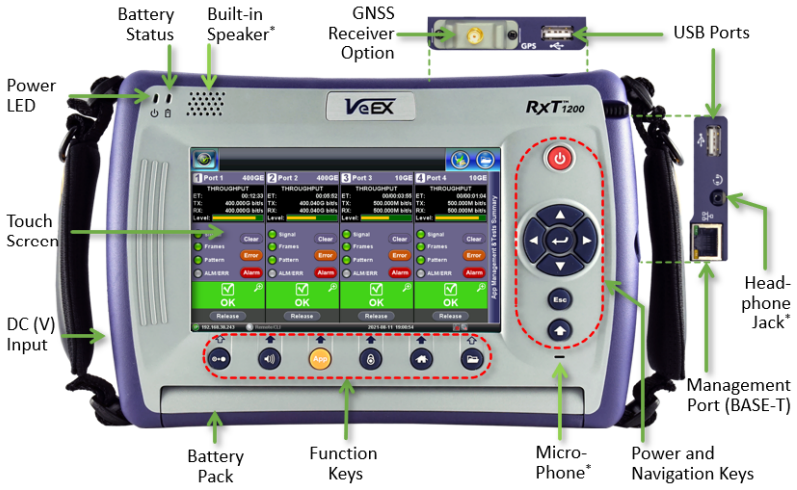
Hardware Configuration

Please refer to their individual datasheets and manuals for further details. For specifications and an up to date list of modules available for the RXT-1200 platform, go to www.veexinc.com/Products/RXTSeries.

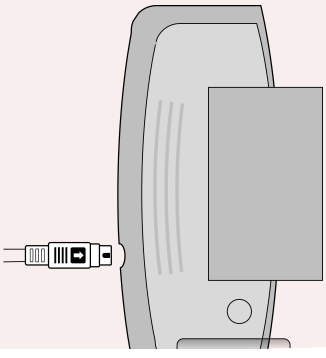


Depending on the test modules ordered, users receive one of the following three RXT test platform models. They are very similar, with just a few differences, such as their power capacity, DC port types, and required AC/DC adapter (non-interchangeable).

Chassis	Voltage	Power	DC Plug Style	DC Jack	Use With
RXT-1200	15 VDC	140W			RXT-6200 RXT-3400 RXT-4xxx
RXT-1200+	15 VDC	180W			RXT-6400
RXT-1202	24 VDC	300W			RXT-6402 RXT-6802 RXT-6811

***Attention:** For the **RXT-1202**, the flat part of the DC plug must be facing towards the front of the test set (as shown in the diagram), before plugging it in. Refer to the diagram embossed on the connector cover and the label on the power cord.*

Forcing it in any other orientation would trigger its protection circuit and disable it for several minutes (in some cases could cause permanent damage). If it happens by accident, disconnect the DC plug from the test set and wait for about one hour before trying again.



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RXT-1200 Test Platform (a.k.a. Chassis)

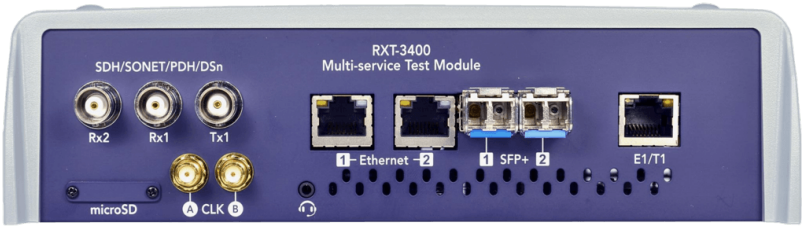
The RXT® is the industry's most flexible, compact, and future-proof hand-held test solution for core, data-center, metro, access and fiber optics applications. The forward-looking RXT-1200™ family of test platforms address the challenges of communication service providers to increase efficiency and productivity.

Test Modules/Hardware Options

RXT-3000

- All-in-One test module reduces CAPEX
- Optimized for engineers or technicians installing and maintaining OTN, SDH/SONET, and Carrier Ethernet networks transporting legacy and next generation Mobile Backhaul networks
- Flexible software platform allows for multiple test applications running simultaneously
- User defined test profiles and thresholds

RXT-3400



- Flexible, all-in-one multi-service test solution, from 64 kbps to 14 Gbps (can be combined with 400G, 100G/40G, OTDR, and OSA modules)

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- Offers two fully independent test port groups
- Support for Access, Metro, Core, Transport, Carrier Ethernet, Backhaul, Fronthaul and SAN technologies up to 16GFC.

RXT-4100/4100+

- Multimode and Singlemode Wavelength options - 850, 1300, 1310, 1490, 1550, 1625 & 1650 nm
- Filtered 1625 or 1650 nm OTDR port for in-service measurements
- OTDR ports feature live fiber detection
- High dynamic range for long haul fibers
- Sampling points up to 500,000 (RXT-4100+)
- FTTx/PON optimized test parameters for best in class dead zones
- Event dead zone < 1m, Attenuation dead zone < 4m
- Telcordia GR-196 and SR-4731.sor file formats
- Optional V-Scout Multi-pulse test mode
- Smart link mapping using intuitive icons derived from multiple test acquisitions
- Optional Built-in Visual Fault Locator
- Optional Optical Power Meter with WaveID detection
- Optional Light Sources with WaveID and Loop mode
- Optional Fiber Inspection Scope (USB)
- Upload OTDR traces, OLTS results and Fiberscope images directly to Fiberizer Cloud

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- Built-in G.657 launch fiber
- Universal 2.5 mm optical interfaces with inter-changeable optical adaptors (SC/FC/ST/LC)

RXT-4111

- Test DWDM Mux/Demux at ITU-T G.694.1 wavelengths
- C-band tuning (standard 89 channels at 50 GHz spacing)
- Optional extended band tuning to Channel 62 with 50 GHz spacing
- Integrated wavelength locker stable to within ± 2.5 GHz
- High dynamic range for long haul fibers and testing through DWDM multiplexers/OADMs/de-multiplexers Sampling points up to 128,000
- Advanced TEC laser stabilization for hot and cold weather operating conditions
- Optimized test parameters for best in class dead zones
- Event dead zone < 1m, Attenuation dead zone < 4m
- Telcordia GR-196 and SR-4731.sor file formats
- Optional V-Scout mode – displays intuitive icons derived from multiple test acquisitions
- Optional DWDM Light Source via OTDR port
- Push/Pull OTDR traces and Fiberscope images directly to Fiberizer Cloud via wired or wireless internet connection
- Built-in launch fiber to characterize OTDR connections and short fiber spans
- Universal 2.5 mm optical interfaces with inter-changeable optical adaptors (SC/FC/ST/LC)

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RXT-4112

- Characterize CWDM networks at ITU-T G.694.2 wavelengths
- End-to-end continuity testing using stabilized CWDM light source (via OTDR port)
- OTDR port features live fiber detection
- High dynamic range (up to 42 dB) for long haul fibers and testing through CWDM multiplexers/OADMs/de-multiplexers Sampling points up to 256,000
- Optimized test parameters for best in class dead zones
- Event dead zone < 1m, Attenuation dead zone < 4m
- Telcordia GR-196 and SR-4731.sor file formats
- Optional V-Scout mode – displays intuitive icons derived from multiple test acquisitions
- Optional Built-in Visual Fault Locator
- Optional Optical Power Meter
- Optional CWDM Light Source via OTDR port
- Upload OTDR traces and Fiberscope images directly to Fiberizer Cloud via wired or wireless internet connection Universal 2.5 mm optical interfaces with inter-changeable optical adaptors (SC/FC/ST/LC)

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RXT-4113+

- CWDM wavelengths per ITU-T G.694.2 (8, 10, or 18 Channels)
- DWDM wavelengths per ITU-T G.694.1 (C-band, 1529.55 to 1563.86 nm, Channel #s 17-60) in 50, 100 or 200 GHz steps
    - Optional extended channel 14-62 available
    - TEC laser stabilization for hot and cold weather conditions
    - Built-in DWDM wavelength locker with ±2.5 GHz stability
- Sampling resolution up to 5000,000 points
- Event dead zone <0.85 m, attenuation dead zone <3.5 m
- High dynamic range for long haul fibers and testing through xWDM Mux/demux
- Telcordia GR-196 and SR-4731.sor file formats
- Optional V-Scout mode – displays intuitive icons derived from multiple test acquisitions
- Optional CWDM/DWDM/Legacy Light Source via OTDR port
- Optional broadband Optical Power Meter
- Optional VFL 650 nm light source
- Built-in G.657A2 launch fiber to characterize OTDR connections and short fiber spans
- Fixed connector or universal 2.5 mm optical interface with inter-changeable optical adaptors (SC/FC/LC)

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RXT 4500/4510

- Wavelength range from 1260 to 1650 nm
- DWDM channel spacing down to 25 GHz, module dependent
- Resolution 0.1 nm C-band
- In-band OSNR measurement
- Fast continuous scanning at ≤ 5 sec
- Simultaneous measurements of up to 200 channels, module dependent
- Channel power measurement
- Channel threshold detection
- Span power measurement
- Continuous sweep with min/max hold
- Channel frequency and wavelength delta vs. ITU grid
- High wavelength accuracy: ± 50 pm
- High dynamic range: ≥ 65 dB
- OSNR measurement: up to 40 dB
- Low Polarization Dependent Loss (PDL): < 0.3 dB
- Universal optical interface with industry standard adaptors
- Supports 10/40/100 Gbps transmission modulation types
- DFB laser qualification
- DWDM channel monitoring per ITU G.694.1 grid for 25/33/37.5/100/200 GHz, module dependent

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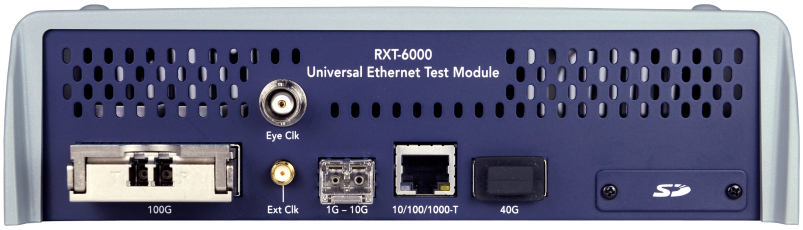
CWDM channel monitoring per ITU G.694.2 grid

- OSNR measurement compliant with IEC 61280-2-9

RXT-6000



- CFP2 interface for 100GE and OTU4 applications
- QSFP+ for 40GE, OTU3 and STL256.4
- SFP+ for 100Base-FX, 1000Base-X, 10GEBase-X, OTU2/2e/1e, STM-64/OC192, and Fibre Channel 1/2/4/8/10G applications RJ45 for 10/100/1000Base-T applications
- External clock interface
- 150ppm clock offset generation
- Eye diagram reference clock output
- Soft LED indicators

RXT-6000e

- 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

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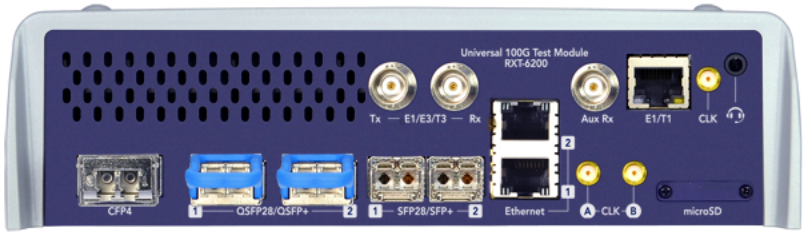
- CFP4 support via CFP2-to-CFP4 adapter
- QSFP+ for 40GE, OTU3
- SFP28 interface for 25GE, 32/16G FC, 24G CPRI 10 and 25G eCPRI Layer 4 with RS-FEC
- SFP+ for 100Base-FX, 1000Base-X, 10GEBase-X, OTU2/2e/1e/1, STM-64/16/4/1/0, OC192/48/12/3/1, and Fibre Channel 16/10/8/4/2/1G and CPRI up to 12G RJ45 for 10/100/1000Base-T applications
- Optional PDH/DSn with standard connectors

RXT-6200



- 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 Fibre Channel 16/10/8/4/2/1G and CPRI up to 12G RJ45 for 10/100/1000Base-T applications

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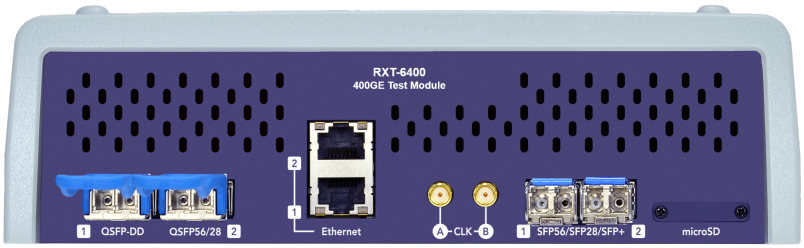
RXT-6400



- Native QSFP-DD PAM4 hardware for best-in-class signal integrity (no adapters required)
- 400G Ethernet testing per IEEE 802.3bs specification with KP4 Forward Error Correction (FEC)
- Provides all the necessary features to test QSFP-DD transceivers, networking equipment and 400GE links
- Advanced and flexible state-of-the-art FPGA-based design, with native PAM4 transceivers, provides future-proof hardware support for 400GE evolution, emerging standards, test functions, requirements and applications
- Wide range of supported 400GE interfaces, including 400GBASE-SR8, FR8, LR8, DR4, and FR4
- MDIO/I2C registers Read and Write
- Per-lane PAM4 pre-emphasis settings
- KP4 FEC codeword symbol errors distribution and Skew
- Ethernet Throughput performance test
- Hardware ready to support QSFP56, QSFP28, QSFP+, SFP56, SFP28, SFP+, SFP, RJ45 interfaces for lower rate applications
- Battery backup for efficient operation and mobility within large equipment rooms and datacenters (no need for constant rebooting)

RXT-6402

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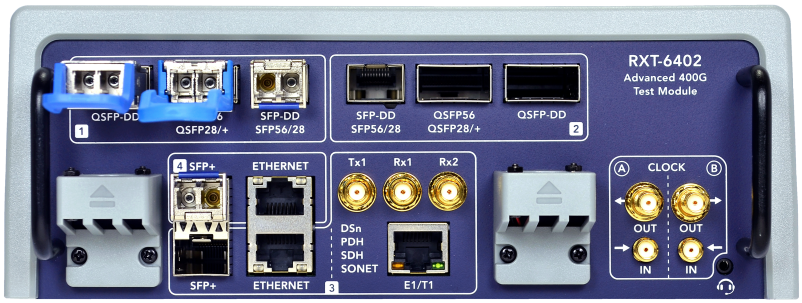

- 2x400GE concurrent testing capabilities
- Offers dual ports for all pluggable optics form factors, required for AOC/DAC, fan-out and wrap-around tests (from 10M to 400GE)
- Up to four concurrent and independent tests
- Native QSFP-DD, QSFP56, SFP-DD, and SFP56 PAM4 hardware for best-in-class signal integrity (no adapters required).
- Supports testing for all common form factors, including QSFP-DD, QSFP56, SFP-DD, and SFP56 transceivers, DACs, AOCs, network equipment and 400GE links.
- Advanced and flexible state-of-the-art FPGA-based design provides future-proof hardware support for emerging standards, test functions and applications.
- Wide range of supported 400GE interfaces, including 400GBASE-SR8, FR8, LR8, DR4, FR4, LR4, CR8, CR4 and 400ZR/ZR+.
- Complete industry-standard Ethernet link test feature set for Layers 2, 3 and 4.
- I2C/MDIO registers Read and Write.
- Per-lane PAM4 host pre-emphasis settings.
- Signal integrity check with FEC codeword symbol errors distribution and Skew.
- Transceivers power consumption monitoring (voltage, current) and variable voltage supply.
- Dedicated QSFP-DD head cooling fans (field replaceable) to optimize operating temperature verification of high-power class transceivers, such as ZR/ZR+
- All-in-one solution with common legacy test interfaces.

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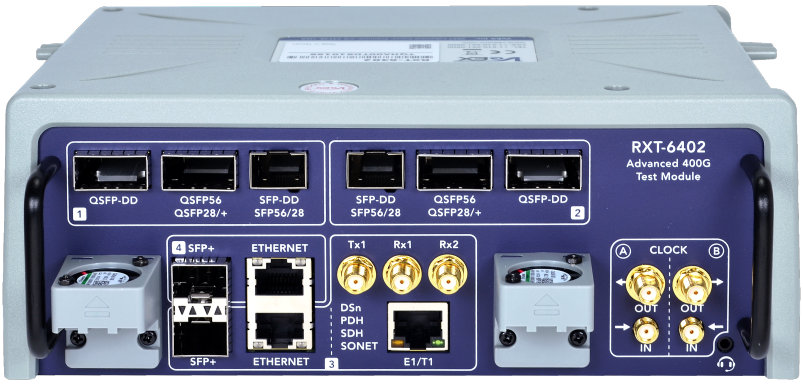
- Internal and external (cage) QSFP-DD temperature monitoring with overheating protection.
- High-capacity power supply provides support for long range coherent line interface transceivers and 2x400GE applications.
- Battery (backup) operation improves mobility and efficiency in large hyperscale data centers, nodes, COs, R&D, evaluation labs and other field applications.
- High-efficiency intelligent cooling system
- Full-feature portable hand-held test set form factor, without compromises.

RXT-6802



- 2x QSFP-DD800G test ports
- Supports pluggable client and line side DCO transceivers including QSFP-DD800, QSFP112, QSFP-DD, QSFP56 and QSFP28
- 800G to 100G Ethernet applications
- FEC and BER signal integrity testing
- PAM4 and NRZ SerDes up to 112G
- Independent port operation
- Comprehensive I2C capabilities for transceiver qualification
- Coherent ZR/ZR+ support

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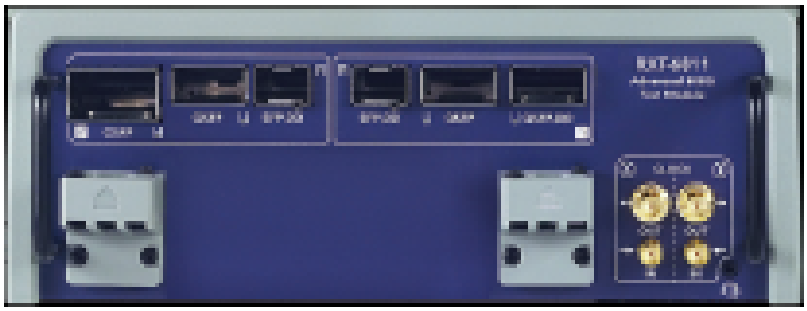
- PCS/FEC, Lane BERT, Throughput, RFC2544, Y.1564 V-SAM tests
- Compact handheld capable of generating up to 1.6 Tb/s of test traffic
- Field-proven performance and reliability
- Outstanding signal integrity
- Advanced cooling
- Forward-looking module design keeps evolving with fast- paced technology
- All-in-one hardware configuration, ready to meet leading- edge as well as legacy applications

RXT-6811



- Supports OSFP and QSFP-DD800 transceivers
- Supports pluggable client and line side DCO transceivers including OSFP, QSFP-DD800, QSFP112, QSFP-DD, QSFP56, and QSFP28
- 800G to 100G Ethernet applications
- FEC and BER signal integrity testing
- PAM4 and NRZ SerDes up to 112G
- Independent port operation
- Comprehensive I2C capabilities for transceiver qualification
- Coherent ZR/ZR+ support
- PCS/FEC, Lane BERT, Throughput, RFC2544, Y.1564 V-SAM tests

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- Compact handheld capable of generating up to 1.6 Tb/s of test traffic
- Field-proven performance and reliability
- Outstanding signal integrity
- Advanced cooling
- Forward-looking module design keeps evolving with fast- paced technology

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Inserting and Removing Test Modules

Turn the test set **OFF**.

- **Remove:** Press the black RELEASE button on the back and pull the module out.
- **Insert:** Align the module with the metal guides and push it slowly until you hear the locking "click".

If adding a new module, download the test module's software from its web page and install it using the **M.Upgrade** function, before using it. To find the Release Notes, go to the **Resources** tab of the module page on www.veexinc.com.

Change language and user interface style

Before using the platform, set the language and user interface style as needed. By default, the user interface style is set to USA if the unit is shipped to North America and to International if the unit is shipped to outside North America.

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To change the GUI language and user interface style:

1. Tap **Utilities** and then tap **Settings**.
2. Tap the **Global** option.
3. Select the language from the **Language** drop-down list box.
4. Select the user interface style from the User Interface drop-down list box.
    - **International:** Provides layer-based SDH/PDH configuration menus with access to detailed settings.
    - **USA:** Provides simplified application-based SONET/DSn menu with more automation. The **Advanced Mode** option displays the configuration menu for additional settings.

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To manually change the Date & Time:

Go to **System Tools >Utilities >Settings >Date & Time**, to manually set the date, time and time zone. Then, tap **Apply**.

To enable daylight saving time (DST), manually select a neighboring time zone with a +1:00 relative to the standard time zone of the current location. Set it back to the standard time zone offset when DST ends.

Get Standard Time from GPS/GNSS

If equipped with the GPS/GNSS receiver (hardware option), manually copy the GPS time into the system.

Go to **System Tools >Utilities >Settings >GPS/High Precision Clock**, to configure the GNSS Receiver and turn it ON. Once it recovers time (ToD UTC) from the satellites, click the **Sync ToD** button to apply the standard time to the RTU. The standard time will be applied at the start of the next second (rise of the internal 1PPS timing signal). The local UTC Offset (Time Zone) setting is used to apply the correction for local time. This manual Sync ToD time setting function should not be used when NTP is enabled.

For more information on the atomic clock and relative phase monitoring, see "High Precision Clock Sources" on page 573 and "GNSS/GPS & Sky View" on page 641.

Launching Test Applications

A Quick Guide is always presented in the Home screen after boot up.

This procedure can be started at any time, from any screen or menu.

1. Select an empty **Test App** button. The **Test Mode Selection** menu is displayed. If applicable, select a **Test Port**.

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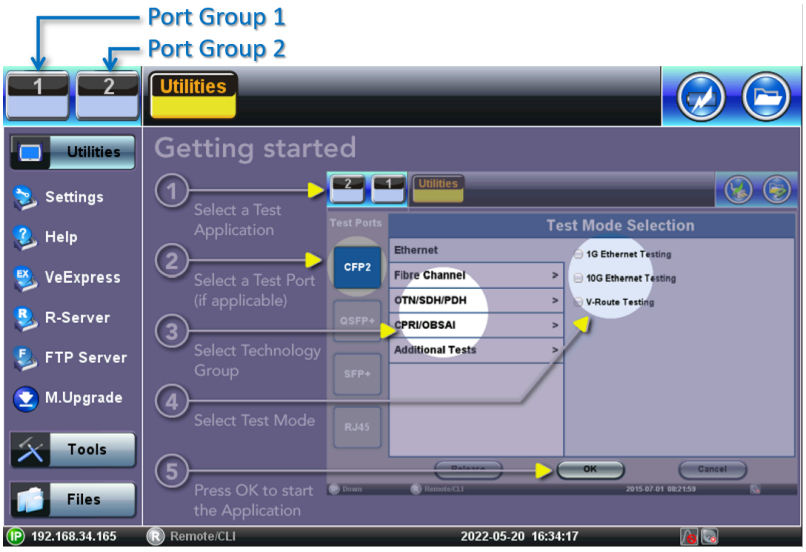
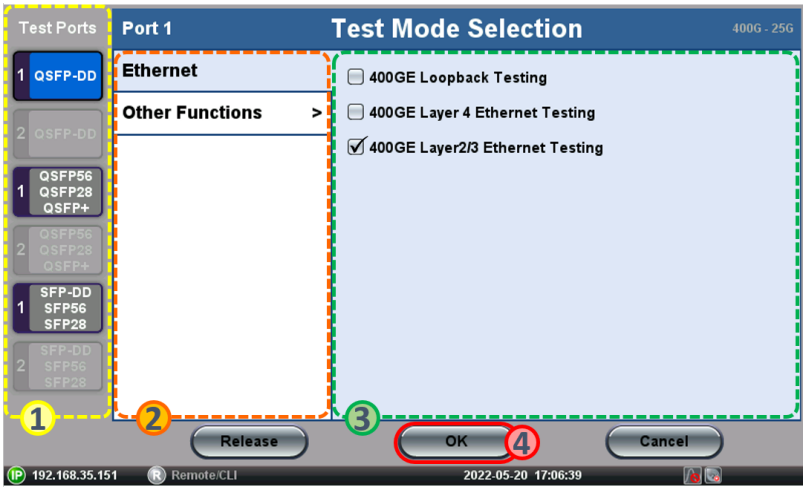


- Up to two independent tests can run simultaneously (test set or test module dependent).
- Some test applications may require two port groups (e.g., router wrap-around test) and may not be supported by all test modules or test sets configurations.



2. **Protocol** (technology group or link type), using the vertical tabs. (The available selection will depend on the capabilities of the selected port type.)
3. **Test Application/Mode**, using the check boxes. (The available test functions will depend on the of the selected protocol and purchased licenses.)

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If the Test Set shows a different Test Mode Selection menu, update its software to the latest version available using VeExpress or download the upgrade package from the product page on www.veexinc.com.

4. Press **OK** to launch the Test Application.

The test port is assigned to the selected test application and the required software/firmware is loaded.

Understanding Test Application GUI

A. **System Utilities Button:** Tap this button access RXT Utility functions Or press the orange App rubber button to toggle.

B. **Active Test Application GUI:** Shows the Test Port Group being used and the Test App ID (Rate/Technology).

- Tap this button to release the Test App or change its Test Mode.

C. **Test Application Menu**

- Lists all test Functions, Applications and Tools available for the selected test mode.
- Setup = Port and Test Signal configuration.

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D. **LEDs** - Test Signal Status.

E. **History** - Clears past events reminder (blinking).

F. **Current test interface line rates**

G. **Action buttons** section.

- This vertical section displays direct access functions applicable to each specific Test Mode, such as Start/Stop test, Laser control, Error and Alarm injection, Start protocol capture, etc.
- Most of these buttons offer immediate action. A few open a configuration menu.

Chassis Overview

To power on the test set, press for approximately two seconds, until the test set beeps once. See "Key Pad" on page 51 for more information on the test set's buttons.

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LEDs

Power LED

A single LED indicates the power state of the unit.

- **OFF** : The LED is off when the unit is powered off.
- **GREEN**: The LED is green when the unit is powered on and fully charged.
- **ORANGE**: The AC/DC adapter is plugged in and the battery is charging.

Audible Beeps

Low Battery status is indicated by a periodic beeping sound, every four seconds, and displaying a warning pop-up message on the screen.

When working on battery power, once the charge capacity reaches about 10%, the test set will start beeping to notify users to plug in the AC/DC adapter. A pop-up message may also be presented on the screen. When the charge level reaches 5%, the test set automatically initiates the shutdown process, to protect the battery.

To get information about the amount of battery charge and autonomy estimate (under current usage condition) tap the battery icon displayed on the top-right corner of the screen.

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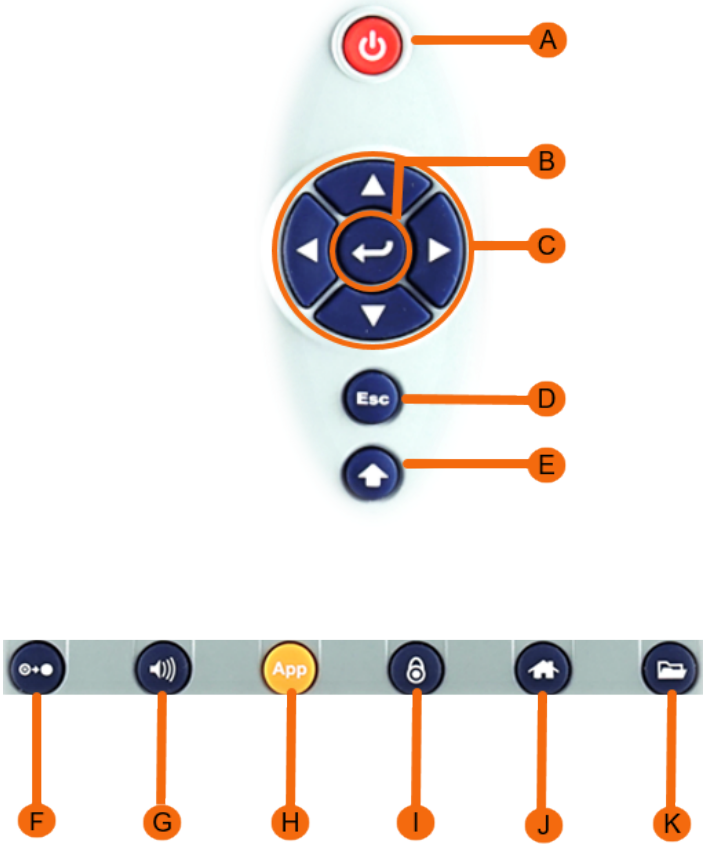
Key Pad



RXT-1200 Keypad

A. Power: Press for 3-5 seconds to turn the test set ON or OFF (prevents accidental ON/OFF). FORCE OFF by pressing more than 10 seconds.

B. Enter: Application dependent. Enter menus/functions.

C. Cursor Keys: Application dependent. Offers alternative Navigation to touch screen (e.g. while wearing gloves in cold weather). Moves the cursor in any of the four supported directions (left, right, up, down).

D. Escape: Application dependent. Returns to previous screen/function.

E. Alt Alternate function - Links the buttons to the GUI soft Function Keys (MTT Emulation Mode only).

F. Clear History: Resets blinking LED reminders of past Errors or Alarms. Test results are not affected (not used in OTDR). The **F2** key on standard keyboards can be used when controlled via VNC.

G. Volume and Brightness Control: Brings up the Sound and screen Brightness controls; Use cursor buttons to adjust the levels. Speaker and microphone may be optional or no longer available in certain test sets.

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H. Test Application Selector: Quickly switches back-and-forth between the active Test Application and RXT platform Utilities functions; Active test is not affected.

I. Lock/Unlock Touch Screen: Can also be programmed to capture Screen Shots (**>Utilities >Settings >Global >Save Settings**). Use the **F3** in standard keyboards.

J. Home: Returns to the Main Menu.

K. Save Test Results: Saves the current Test Results with customized or auto naming (yyyymmdd-hhmmss format). The **F1** key on standard keyboards can be used when controlled via VNC. Refer to File Manager for details on saving files.

Touch-Screen Display

The LCD supports touch-screen operation. To operate the touch-screen, use the stylus located in the top cover to navigate the menus and tabs. Please observe the following precautions:

- Never use excessive pressure on the touch-screen as this may damage its functionality.
- Never use sharp objects such as a pen, screwdriver etc. as this may damage the surface.
- Clean the surface of the touch screen using a soft cloth and mild detergent only. Do not use alcohol.

See "Touch Screen Calibration" on page 549 for instructions on how to recalibrate the touch-screen.

Battery

The test set platform is equipped with a smart Li-ion rechargeable battery pack, which is located on the rear of the unit. The battery will be partially charged upon delivery, so it is recommended to fully charge the battery before use. Please charge the battery at room temperature to preserve its life and to obtain maximum charge. The battery is charged during operation, provided the unit is connected to the AC Mains using the supplied AC/DC adapter. Removing the battery while the unit is powered on is not recommended - this may result in damage. Remove the rubber cover on the right side to connect the AC/DC adapter to the unit.

On the RXT-1202, make sure that the key is aligned while plugging in the AC adapter to the unit. If it is not aligned, the plug will not connect to the unit. Using force will damage the connector.

When battery capacity declines to 10%, an audible alarm and pop-up warning displays a notification to plug in the A/C adapter or shut down the unit. If this warning is ignored and the battery capacity is allowed to decline to under 5%, the unit will initiate a shutdown to protect the battery from damage and for safety.

If an event, such as the AC/DC adapter being unplugged, a power interruption occurs or some other event triggers the power load to exceed the 95W battery limit, the unit will initiate an emergency shutdown to protect the battery from damage and for safety.

During an emergency shutdown all modules' power is switched off. ***No test files (results or configurations) are saved****.*

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Battery Charging Time

The total charging time depends on the remaining battery capacity percentage and the actual current load in the test unit. An idle test unit would recharge faster than an active one.

Attention!

- *For safety reasons, the battery charging time is always limited to a maximum of three hours.*
- *If the unit is being used while charging and a full charge (100% capacity) cannot be achieved within three hours, the charging will stop automatically.*
- *To resume charging, unplug the AC/DC adapter and use the test unit on battery power for a couple of minutes before plugging the adapter back into the unit. This will reset the charging circuitry.*

Warning!

DO NOT disconnect the AC/DC power supply when the unit is running under heavy load conditions (greater than the battery's current ratings), such as certain multi-module multi-test applications.

If the current required is too high, but still within the battery's limits, a warning message will be displayed when the AC/DC adapter is unplugged. All the tests are properly closed and the test unit shuts down.

Under overload conditions, the battery may not be able to supply enough current to keep the test scenario running and its safety mechanisms may shut the battery down without warning and test results may be lost.

Battery Safety Precautions

For more information on safety precautions for batteries, see Lithium-ion Battery Precautions in Safety Information.

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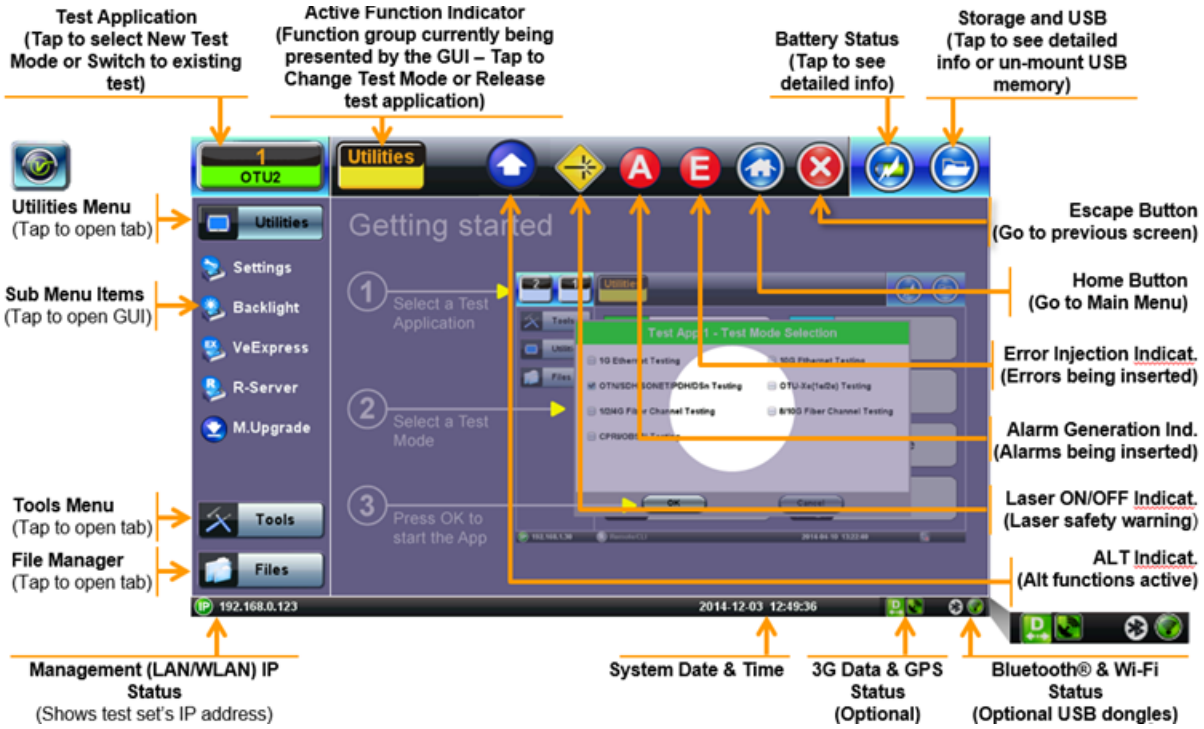
Home Screen

A Quick Guide is always present in the Home screen after booting up (actual image may vary with models and software version). *This screen can be displayed at any time from any screen.*



Menu Navigation

Navigate between test applications, setup menus, tabs, or active functions using the supplied stylus or by pressing ▲ / ▼ followed by ↵ on the keypad.

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Quick Access Menu

This multi-tasking section provides convenient and immediate access to system features, connectivity, accessories, results, etc., always at your fingertip. Those features are always available, independently of whether tests are running or not.

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AOC

AOC DOC Local Test Dual Port

Local = The use of Port 1 and Port 2 of the same unit

- **The AOC/DAC Local Test is similar to the Advanced Transceiver test.**

- **Allows for quick and easy verification and troubleshooting of AOC/DAC cables that are common in datacenters.**
  - Pre-FEC BER test
  - Optional pos-FEC test

- **Quick setup:**
  - Test Duration
  - Thresholds: Frequency (ppm), MAX BER, and RX power levels.
  - Optional Pos-FEC test
-
  - **Results**
    - Summary of overall functionality
    - Pre-FEC (Labe BERT) results
    - Post-FEC Results
    - Results of both Port 1 and Port 1 included in the report.

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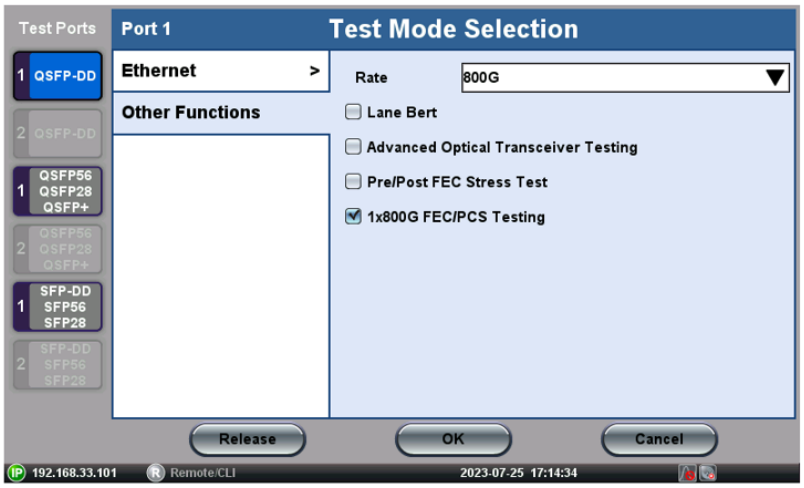
- **Interface/Rates Supported**
  - QSFPDD: 400G
  - QSFP56: 200G
  - QSFP28: 100G
  - QSFP+: 40G
  - SFPDD: 100G
  - SFP56: 50G
  - SFP28: 25G
  - SFP+: 10G and 1G

UI Access

400G, 200G, 100G (QSFP28): All accessed from **Port 1**



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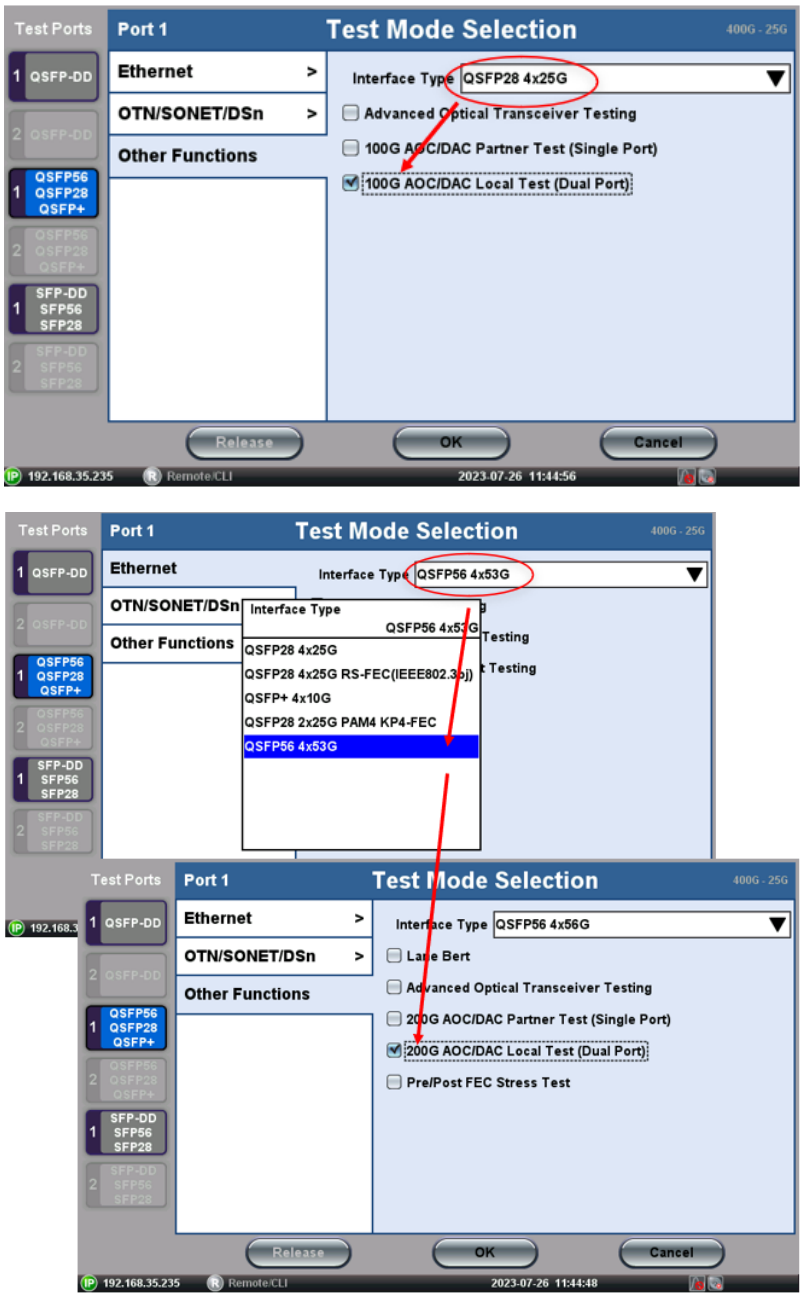

100G (SFP-DD), 50G (SFP56), 25G (SFP28), 10G/1G (SFP+)

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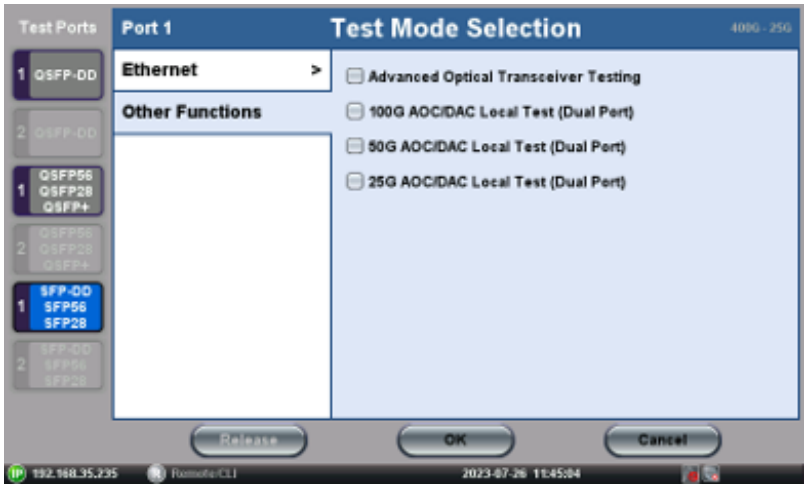
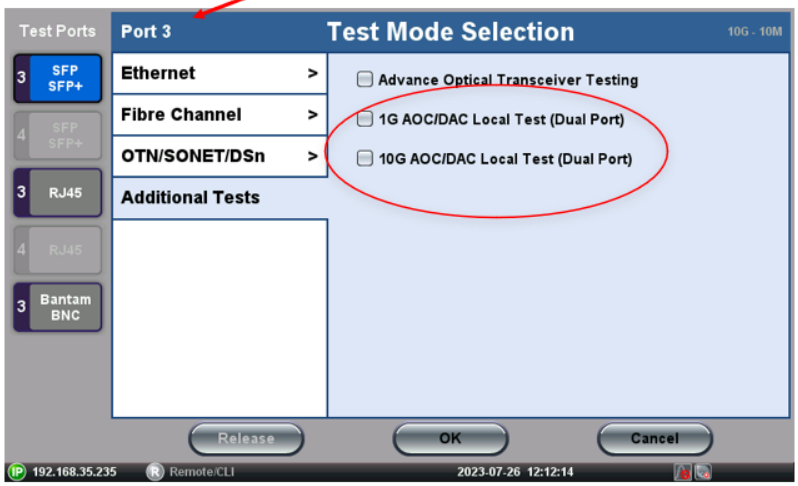


Accessed from Port 3



Test Setup

Settings configured are applied to Port 1 and Port 2 of the AOC/DAC.

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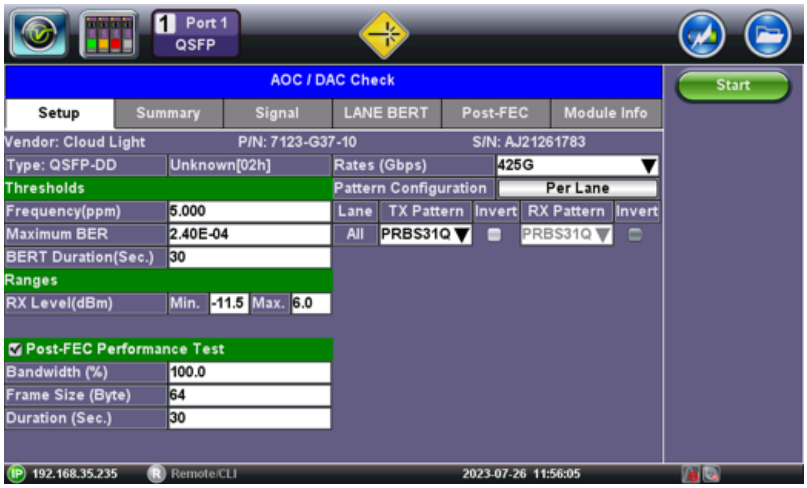

- **Thresholds:**
  - Frequency (ppm): If the measured frequency offsets exceeds the configured thresholds, the test will be considered a fail.
  - MAX (pre-FEC) BER: IEEE standard is set to the default.
  - RX Power Leve Ranges: Min, Max, are read from the transceiver and set to defaults. The field is user configurable.

- **BERT Duration: duration of the pre (FEC) BER test.**
  - Patter Configuration: applied to the pre-FEC BER test.

- **Post-FEC**
  - BW% and Frame size are set to the MAX and minimum, respectively, for maximum stress.
  - Duration: test duration for the Post-FEC Performance test

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Summary

A **Summary** tab is displayed with the overall status of the AOC/DAC test.

Tap on **Start.**

UI shows the checks already done, the test in progress, and the test pending.

An overall **PASS/FAIL** will be displayed in this menu and replace the “Running” box at the end of the test.

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Signal

Signal tab

RX and TX optical power levels

RX Optical power level (Page 1)

TX Optical power level (Page 2)

Per Lane frequency offset measurements.

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Per Lane frequency offset measurements. (Page 3)

LANE BERT

LANE BERT Aggregate

Aggregate Bit error count and BER measurements

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LANE BERT Lane

Per **Lane** Bit Error count and BER measurements

LANE BERT Events

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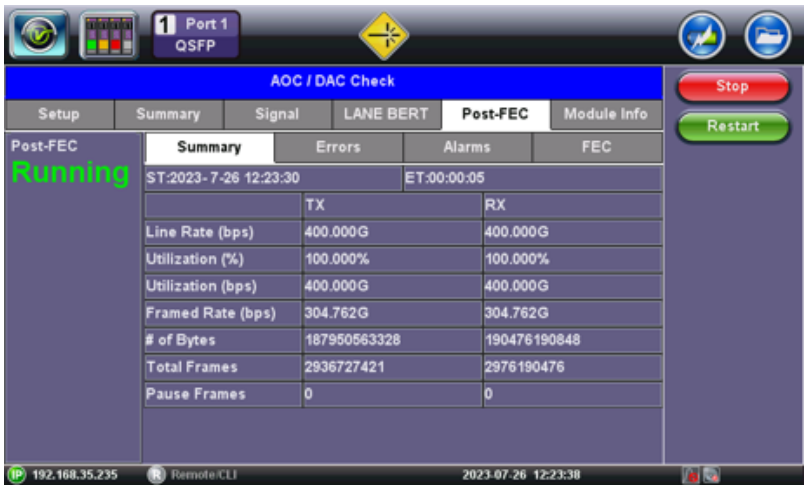
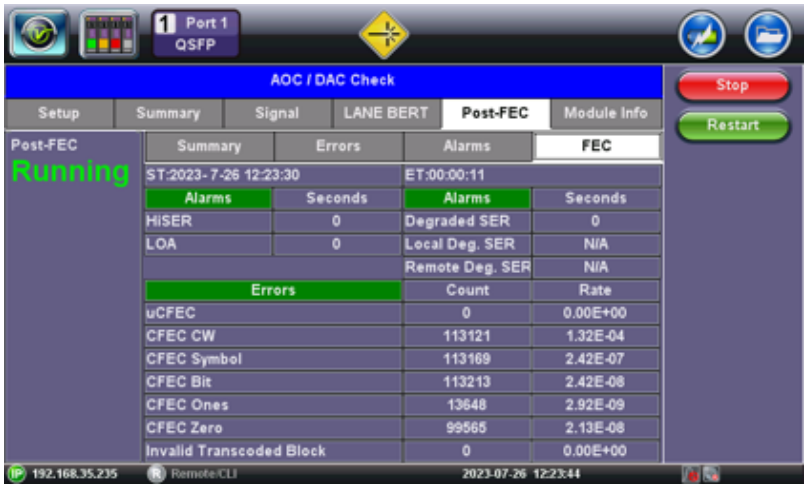
Post-FEC

Post-FEC Performance Test results



Post-FEC Summary

FEC Statistics



Post-FEC FEC

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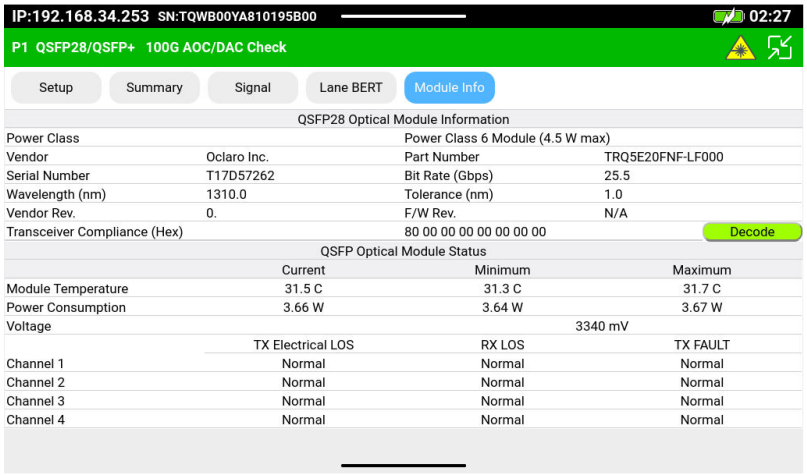
Module Info



Module Info (Page 1)

- AOC/DAC cable information
- Vendor, Model, PN

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Module Info (Page 2)

- Module temperature
- Power consumptions
- Voltage measurement

Test Summary

Overall Summary at the end of the test

Summary

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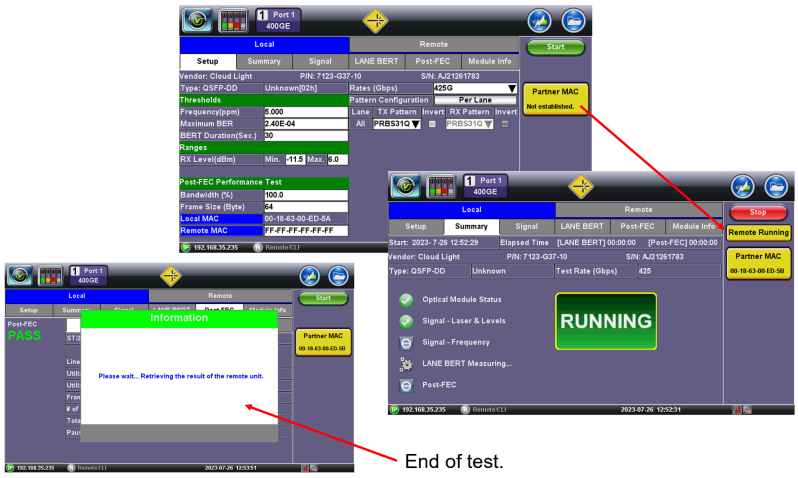
AOC/DOC Partner Test (Single Port)

- The AOC Partner test is designed to be used with two RXT-6402 units
- The application run on a single port, compared to a dual port application like the Local AOC/DAC test.
- Setup parameters and test functions are the same as in the Local test.
- The only difference is that the AOC/DAC cable is plugged between the two RXT-6402 units.
- Both units must be operating in the “AOC/DAC Partner Test” for the same interface/rate.
- Once the AOC/DAC is plugged in and the applications are running on both units, the user can setup the parameters and press start on one unit.
- Pressing start will carry out a simple MAC address discovery of the partner unit and display it on the UI.

for demo purposes, the user can run an AOC Partner test between Port 1 and Port 2 of the same unit.

Remote MAC address of the partner unit is displayed when the test is started.



At the end of the test, results of the remote unit are retrieved and included in a single result file.

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Ethernet

Ethernet Setup

Test Port Selection

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

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

Single/dual port combinations present on RXT-6402:

- Single port 400GE (QSFP-DD)
- Single port 200GE (QSFP56)
- Single port 100GE (QSFP28)
- Single port 100GE (SFP-DD)
- Single port 50GE (SFP56)
- Single port 50GE (QSFP28)
- Single port 40GE (QSFP+)
- Single port 25GE (SPF28)
- Single port 10GE (SFP+)
- Single port 1GE (SFP+)
- Single port 10/100/1000Base-T (RJ45)

- Dual port 400GE (QSFP-DD)
- Dual port 200GE (QSFP56)

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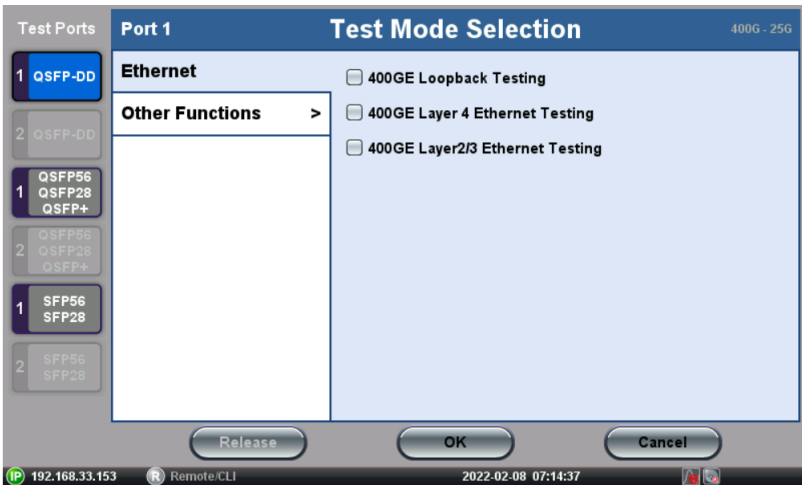
- Dual port 100GE (QSFP28)
- Dual port 100GE (SFP-DD)
- Dual port 50GE (SFP56)
- Dual port 50GE (QSFP28)
- Dual port 40GE (QSFP+)
- Dual port 25GE (SPF28)
- Dual port 10GE (SFP+)
- Dual port 1GE (SFP+)
- Dual port 10/100/1000Base-T (RJ45)

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



Test Mode Selection

When the dual port interfaces and software options are enabled, the test module can operate a combination of two ports at the same time.

Port selection buttons

are available at the top of the screen, the yellow port is the one that is active on the screen, to swap ports click on the red port which will turn yellow and become active.

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

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

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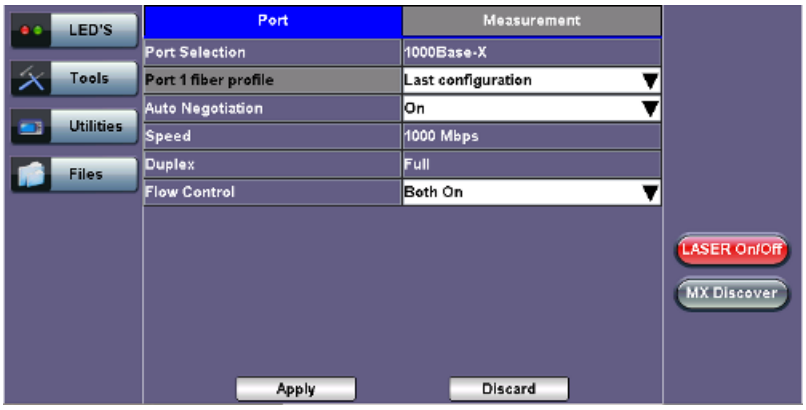
Port Setup

Port setup or test interface configurations are accessed via the **Setup** menu**Setup**located on the Home page. The available configuration settings depend on the interface selected in the Test Mode selection.

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

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



100/1000Base-X Port Setup

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

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

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1 GE Fiber Port Setup

1 GE Fiber Port

- **Network Type:** LAN.
- **Auto Negotiation:** On or Off. Matches the test set's negotiation settings to those of the link partner.
- **Speed:** Default set to 1000 Mbps.
- **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.
- **Clock Source:** Internal, External (2Mbps, 2MHz, 1.5Mbps, 1.5MHz, 10MHz, 1PPS), RxCLK, GPS1PPS.

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10GE Port Setup

10 GE Port

- **10GE Mode:** LAN.
- **Flow Control:** Enable chosen as default option.
- **Clock Offset (ppm):**The frequency may be offset in parts per million.
- **Link Fault Response:** Disable or Enable (also enables Local link and failure, remote, failure).

25 GE Setup

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25 GE Port

- **Network Type:** LAN
- **Clock Source:** Internal, External (2Mbps, 2MHz, 1.5Mbps, 1.5MHz, 10MHz, 1PPS), RxCLK, GPS1PPS
- **Clock Offset (pmm):** 0.0
- **Link Fault Response:** Enable/Disable

40 GE Port

40 GE Port

- **Network Type:** LAN
- **Flow Control:** Enable/Disable
- **Clock Source:** Internal, External (2Mbps, 2MHz, 1.5Mbps, 1.5MHz, 10MHz, 1PPS), RxFCf, GPS1PPS
- **Clock Offset (ppm):** 0.0
- **Link Fault Response:** Enable/Disable

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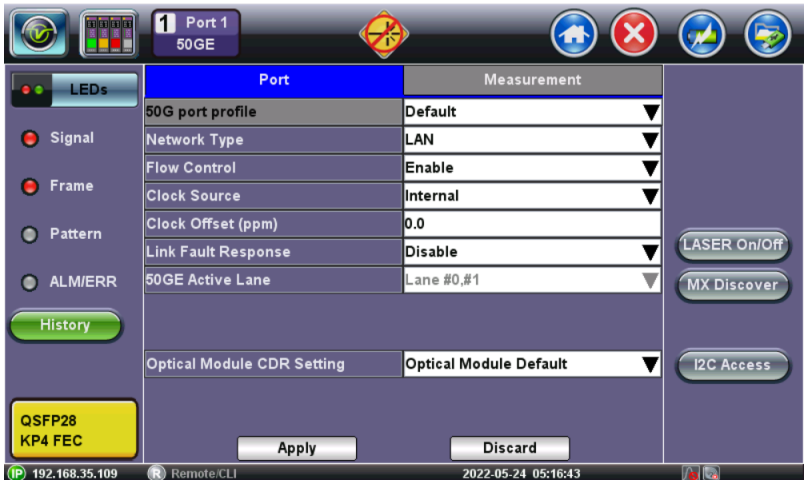

50 GE Setup (QSFP28)

50GE Port (QSFP28)

- **Network Type:** LAN
- **Flow Control:** Enable/Disable
- **Clock Source:** Internal, External (2Mbps, 2MHz, 1.5Mbps, 1.5MHz, 10MHz, 1PPS), RxCLK
- **Clock Offset (ppm):** 0.0
- **Link Fault Response:** Enable/Disable
- **50GE Active Lane:** Lane #0,#1
- **Optical Module CDR Setting:** Optical Module Default, Custom

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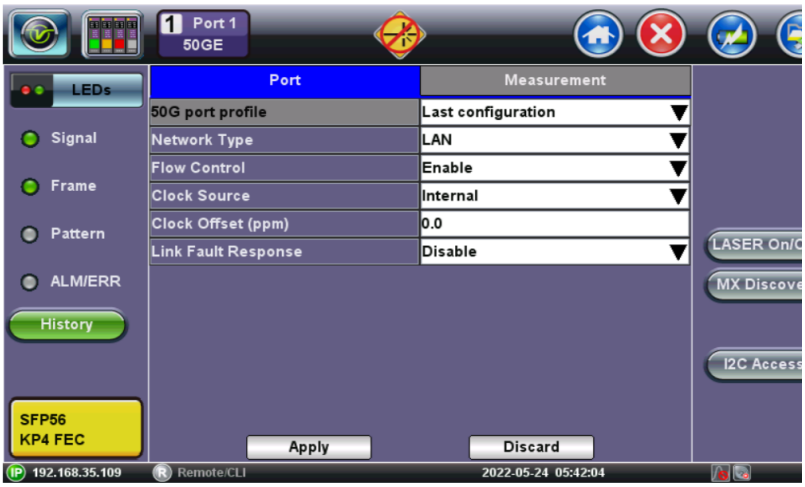
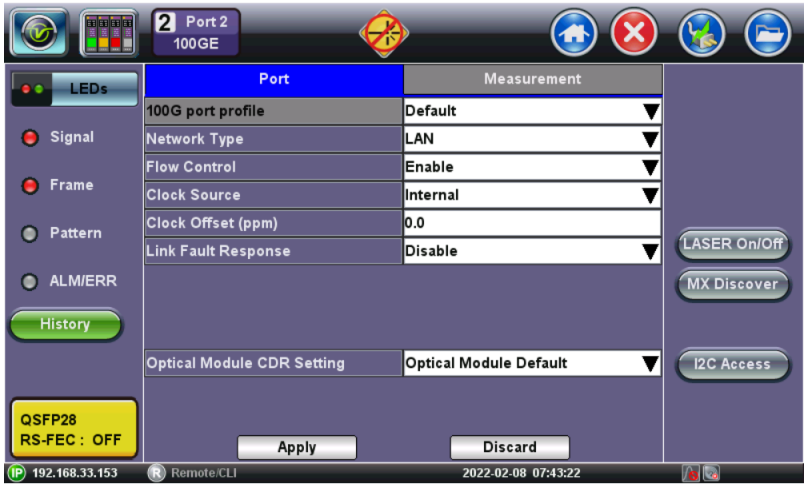


50 GE Setup (SFP56)

50GE Port (SFP56)

- **Network Type:** FEC
- **Flow Control:** Enable/Disable
- **Clock Source:** Internal, External (2Mbps, 2MHz, 1.5Mbps, 1.5MHz, 10MHz, 1PPS), RxCLK
- **Clock Offset (ppm):** 0.0
- **Link Fault Response:** Enable/Disable



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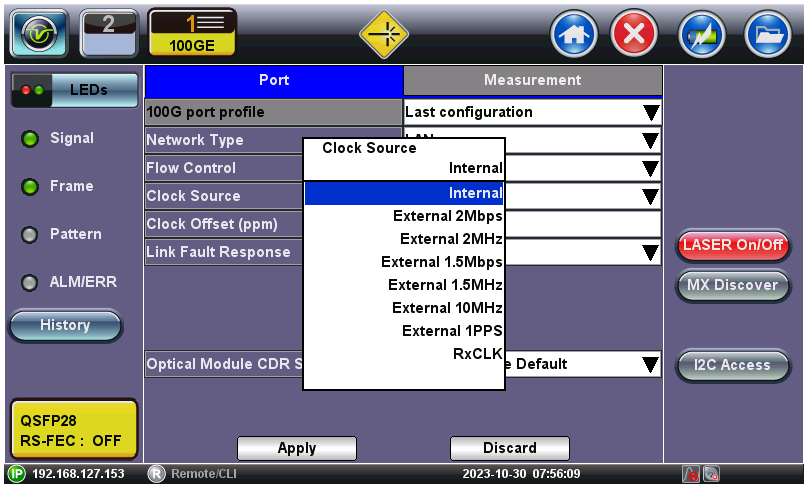

100 GE Setup (QSFP28)

100 GE Port (QSFP28)

- **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):** 0.0
- **Link Fault Response:** Disable/Enable
- **Optical Module CDR Setting:** Optical Module Default, Custom

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100 GE Setup (SFP-DD)

100 GE Port (SFP-DD)

- **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):** 0.0
- **Link Fault Response:** Disable/Enable

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200 GE Setup

200 GE Port

- **200G 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):** 0.0
- **Link Fault Response:** Disable/Enable

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400 GE Setup

400 GE Port

- **400G port profile:** Default
- **Network Type:** LAN
- **Flow Control:** Enable/Disable
- **Clock Source: I**nternal, External (2Mbps, 2MHz, 1.5Mbps, 1.5MHz, 10MHz, 1PPS), RxCLK, GPS1PPS
- **Clock Offset (ppm):** 0.0
- **Link Fault Response:** Disable/Enable

800 GE Setup

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800 GE Port

- **800G port profile:** Default
- **Network Type:** LAN
- **Flow Control:** Enable/Disable
- **Clock Source: I**nternal, External (2Mbps, 2MHz, 1.5Mbps, 1.5MHz, 10MHz, 1PPS), RxCLK, GPS1PPS
- **Clock Offset (ppm):** 0.0
- **Link Fault Response:** Disable/Enable

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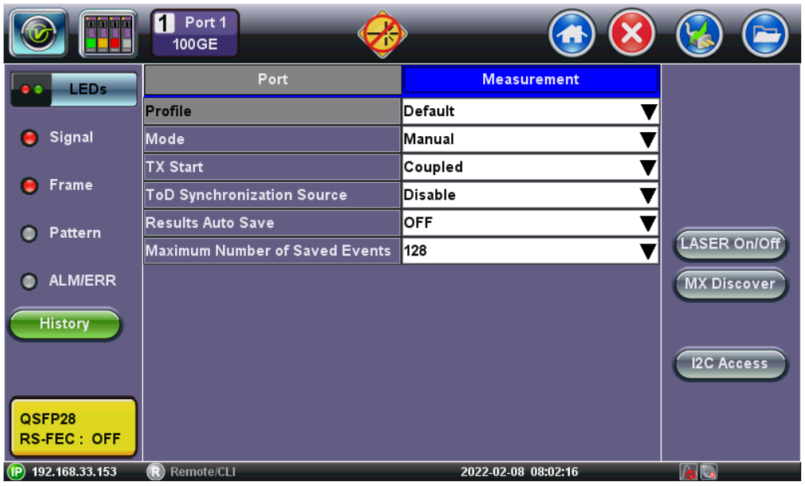
Measurement Settings



1GE/10GE/100 GE Measurement Setup

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

- **Profile:** Last configuration, Lock, 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.

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

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- **TX Start:** Separated or Coupled. Configures how the measurements are started when in BERT and Multiple Streams test modes.
    - **Separated:** Independent control (Start/Stop) of the transmitter is enabled. At the start of the test only the receiver is turned on -- the user must start the transmitter manually.
    - **Coupled:** Transmitter and receiver are turned on at the same time, and the Tx and Rxmeasurements start at the same time at the start of the test.

- **Clock (ToD) Synchronization Device:** Disable, GPS, 1PPS, Local, Atomic 1PPS. Select the device to be used to synchronize the clock to perform the One Way Delay.

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

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

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

- **Gratuitous ARP:** ON or OFF. If set to ON, a gratuitous ARP is performed. When the test port has an IP connection, an ARP request will be transmitted at regular intervals to keep the router/gateway ARP table aware of the test set's IP address. This setting is useful for long-term L3 routed testing.
- **Results Auto Save:** ON or OFF. If set to ON, results will be saved automatically.
- **Maximum Number of Saved Events:** 128/256/512/1024

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400 GE Measurement Setup

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

- **Profile:** Last configuration, Lock, Delete, Save, Save as..., Default.
- **Mode:** Manual or timed.
  - **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.
- **Results Auto Save:** Off/On.
- **FEC Bypass Indication:** Enable/Disable.

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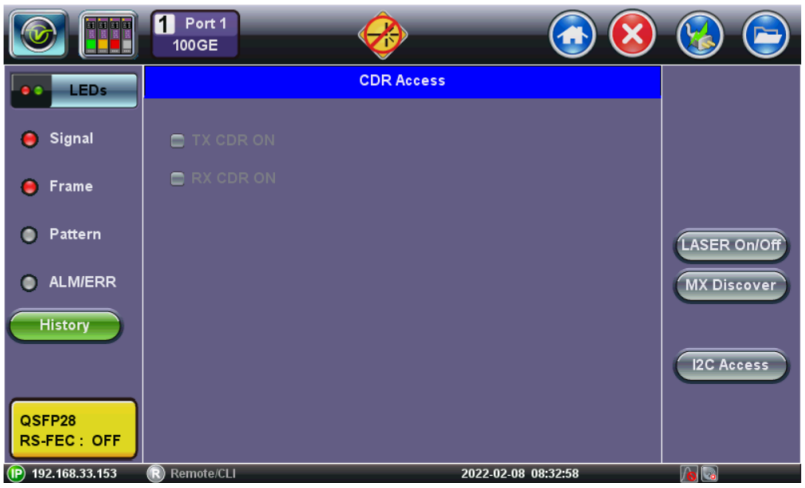
- **FEC HI SER Detection:** Enable/Disable.
- **Maximum Number of Saved Events:** 128/256/512/1024.
- **High Temperature Power OFF:** The SFP will power off at this temperature.
- **High Temperature Warning:** User defines the value at which temperature warnings is displayed.

CDR Access

(100GE Only)



CDR Access

Enables TX and RX CDR to be turned on

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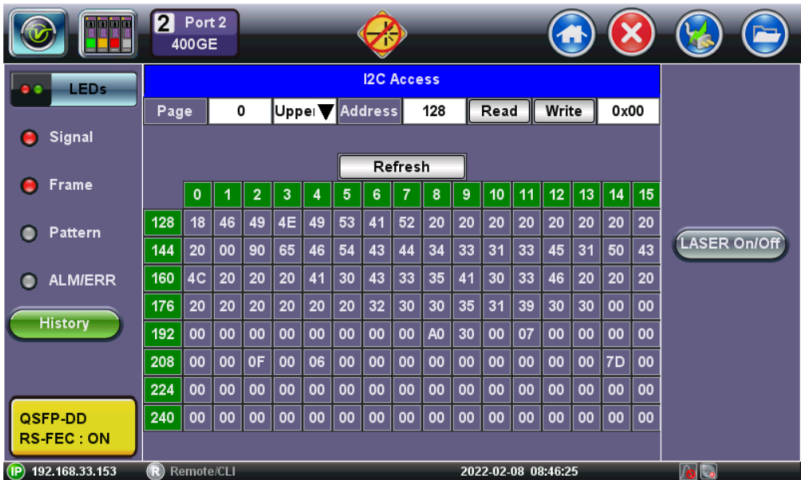
I2C Access



IC2 Access

- **Transceiver I2C (MDIO) Register Read/Write**
  - Module information, settings, status and control
  - Reconfigure the PHY and monitor status

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Pre Emphasis

Pre-emphasis

- **Per-lane PAM4 Pre-emphasis Settings**
  - Advanced user can configure PAM4 signal conditioning circuits for each lane, on the host side, to match a transceiver for the best performance
  - Per-lane Pre-taps (1,2,3), Post-tap and Attenuation
  - Can be used to verify/stress transceiver tolerances

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IP

IP Connection

Port setup and IP connection are required prior to performing the following Ethernet applications: Ping, Trace Route, Web/FTP, ARP Wiz, VoIP, IPTV testing, and 1388v2 (except Layer 2).

IP menu option

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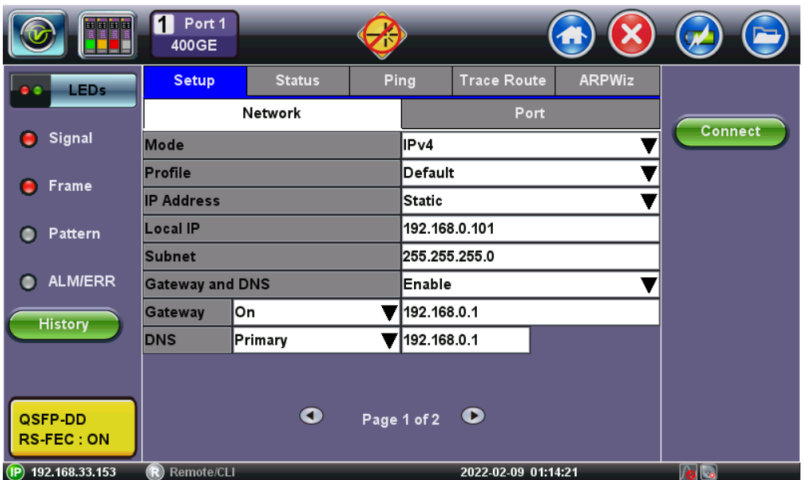
Setup

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

Point-to-Point Protocol over Ethernet (PPoE)

- **Authentication:** PAP, CHAP, or CHAP & PAP.
- **User ID:** Enter user ID
- **Password:** Enter password
- **DNS:** Selecting Manual DNS opens another menu. Select from Off, Primary, or Primary & Secondary. Enter the Primary and/or Secondary DNS if required.
- **VLAN:** Off ,1 Tag, or 2 Tags. For each VLAN tag, enter the following:
- **ID:** VLAN ID. Enter value 0 to 4095.
- **Pri:** VLAN priority 0 to 7.

IPv4 or IPV6



IP Setup - IPv4

- IPv4 or IPv6.
- **Profile:** Delete, Save, Save as ..., Default.
- **IP Address:** Static, DHCP (IPv4 only) or AUTO (IPv6 only).

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- **Static:** Enter a Local IP, Gateway address, and Subnet. All Static fields can be filled by tapping on the section to access an alphanumeric keyboard.
    - **Local IP:** IPv4/IPv6 address of the test set.
    - **Gateway:** IPv4/IPv6 address of the network gateway.
    - **DNS:** Input a primary and secondary DNS.
    - **CIDR** (IPv6 only)**:** Enter a Classless Inter -domain Routing Network.
    - **Subnet** (IPv4 only)**:** Enter a subnet mask.
- **Gateway and DNS:** Enable/Disable. Enables entering the Gateway and DNS.
- **VLAN:** Off, 1 Tag, 2 Tags. For each VLAN tag, enter the following:
    - **ID:** VLAN ID. Enter value 0 to 4095.
    - **Pri:** VLAN priority 0 to 7.

Status

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

PASS Status

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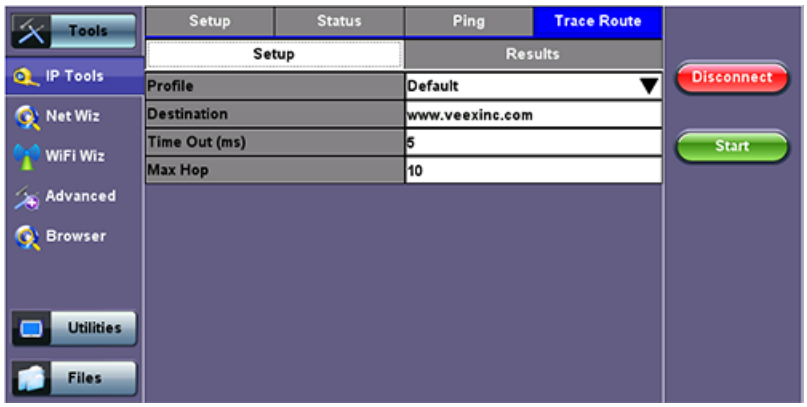
- **DHCP:** PASS indicates that an IP address has successfully been assigned.
- **IP:** PASS indicates that the IP address assigned has been verified to be unique in the network.
- **Gateway:** PASS indicates that the gateway IP address is valid.
- **DNS:** PASS indicates that the DNS IP address is valid.

Trace Route

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



Trace Route Setup

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

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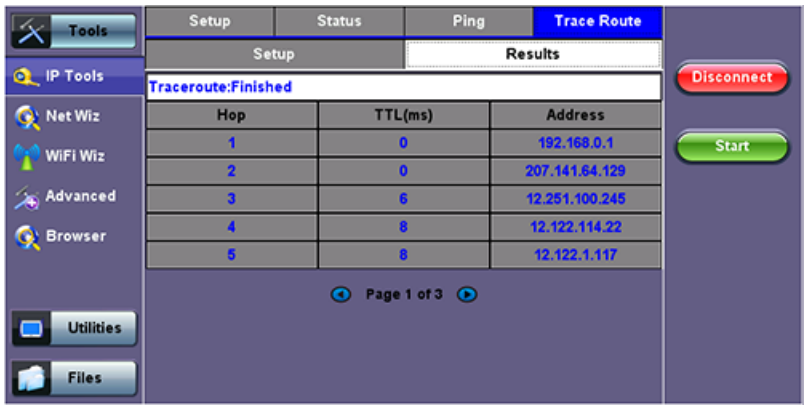
Once the parameters are configured, press **Start** to begin the test.



Results

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

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

ARP Wiz

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

ARP Setup

Configure the following parameters and press **Start**. The test will continue to run until **Stop** is pressed. A finished status indication will display when the test finishes.

- **Profile:** Default, Delete, Save, or Save As...
    - **Start IP:** Starting IP Address.
    - **End IP:** Ending IP Address.
    - **Time Out(s):** Range from 1-99 seconds. Input using the numeric keypad.

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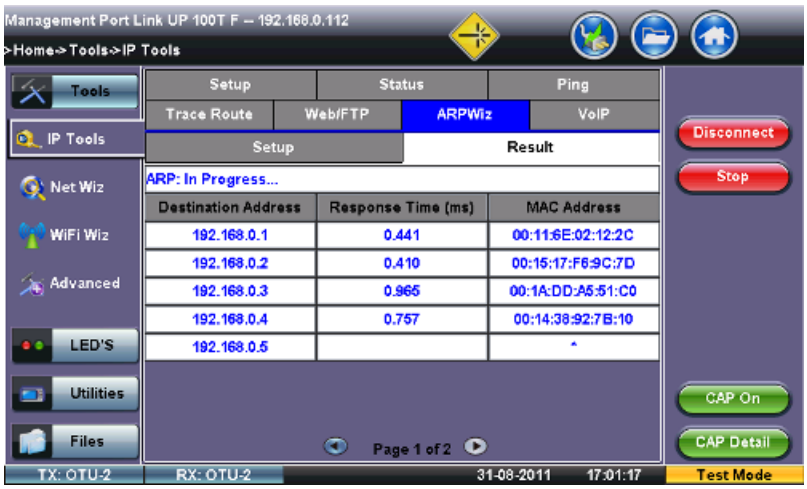
ARP Wiz Setup

ARP Result

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

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



ARP Wiz Result

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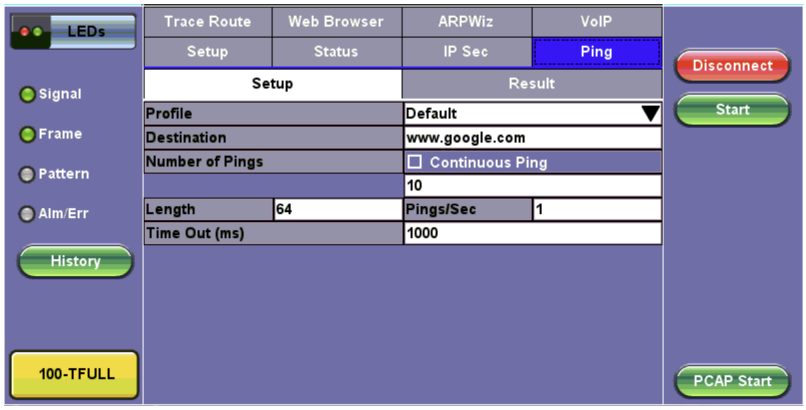
Ping

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

Ping Testing

Ping is a popular computer network tool used to test whether a particular host is reachable across an IP network. A ping is performed by sending an echo request or ICMP (Internet Control Message Protocol) to the echo response replies.

Ping Setup



Ping Setup

- **Profile:** Delete, Save, Save as..., or Default. Recall a Ping profile from memory or create/delete new test profile.
- **Destination:** Press the drop-down menu and enter the destination IP address or URL to ping.
- **Number of Pings:** Enter the number of ping attempts (up to 10000) that will be performed to reach the network device.

  *If Continuous Ping is selected, the number of pings is not required. The test set will continuously ping the target host until **Stop** is pressed.*

- **Length:** Enter the length of the ICMP echo request packet transmitted.
- **Ping/Sec:** Enter the Ping repetition rate (Ping/second).
- **Time Out:** Time-to-Live (TTL) in milliseconds. Enter the maximum time allowed (in ms, up to 99999 ms) between an ICMP ping and echo response.

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

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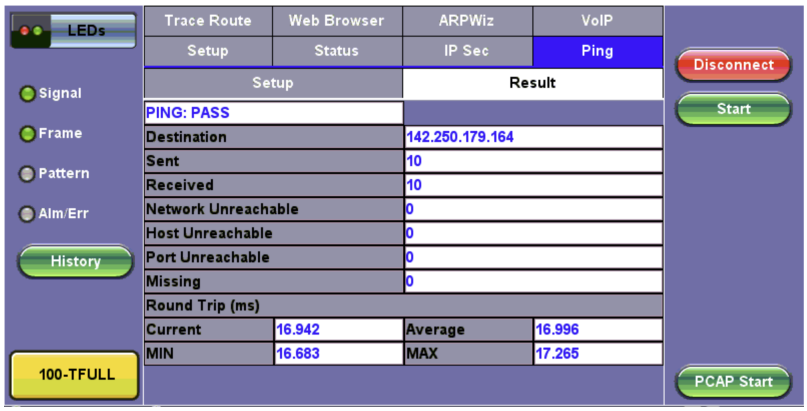
Ping Results

Pressing **Ping** displays the **Result** tab and starts the Ping test.



Ping Result

- **Destination:** Destination IP address.
- **Ping status:** In Progress, PASS, or FAIL.
- **Sent, Received, Unreach, Missing:** Number of pings sent, received, unreached or missing. A Ping is counted missing if no response is received before timeout. A Ping is counted unreached if an echo response is received with host unreachable set.
- PING also estimates the **Round-Trip** time in milliseconds.
    - **Current:** Current time for a Ping request to be answered.
    - **Average:** Average time recorded for a Ping request to be answered.
    - **Max:** Maximum time recorded for a Ping request to be answered.
    - **Min:** Minimum time recorded for a Ping request to be answered.

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BERT

BERT Setup

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

Overview

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

- **Layer 1:** Unframed mode (fiber ports only) or Framed mode
  - **Unframed mode:** Test traffic consists of a bit stream of the selected test pattern
  - **Framed mode:** Test pattern is encapsulated into a valid Ethernet frame with SOF, Preamble, and CRC field
- **Layer 2:** Framed BERT (same as Layer 1 Framed)
  - **MAC Address:** A default or user configured Media Access Control (MAC) address is added to the frame
- **Layer 3:** Framed BERT (same as Layer 1 & 2 Framed)
  - **MAC Address:** A default or user configured Media Access Control (MAC) address is added to the frame
  - **IP Address:** A default or user configured IP address is added to the frame
- **Layer 4:** Framed BERT (same as Layer 1, 2, & 3 Framed)
  - **MAC Address:** A default or user configured Media Access Control (MAC) address is added to the frame
  - **IP Address:** A default or user configured IP address is added to the frame
  - **UDP** or **TCP Address:** A user defined source and destination port address is added to the frame

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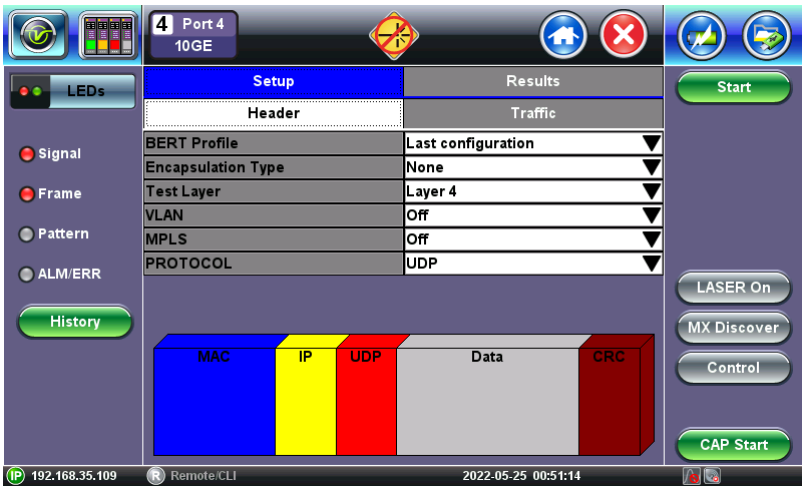

BERT Setup - Header (Layer 4)

Header Settings

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

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

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

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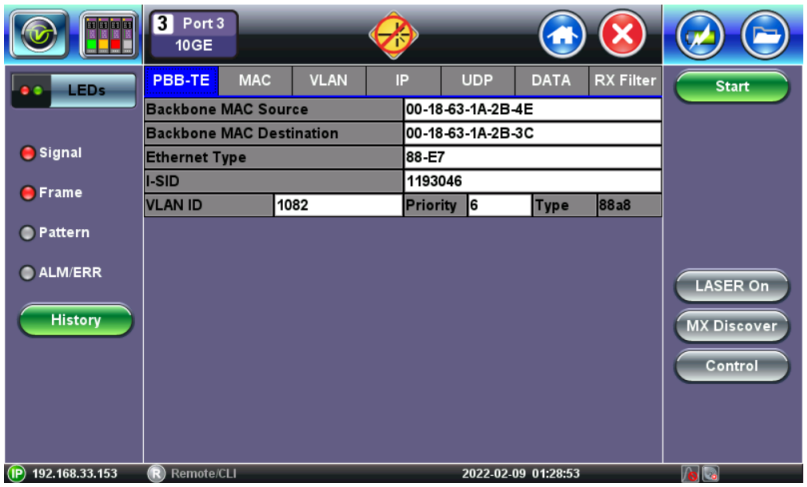
MPLS-TP:

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



PBB

- **Test:** Select the test layer to perform the BERT .
  - Options are Layer 1 Unframed, Layer 1 Framed, Layer 2, Layer 3, and Layer 4.
- **Frame Type:** Select the Ethernet frame type for Layer 2 or Layer 3 .
  - 802.3 Raw (IEEE 802.3 frame without LLC) - Not available when Layer 3 is selected .
  - 802.3 LLC (IEEE 802.3 frame with LLC header) .
  - 802.3 SNAP (IEEE 802.3 frame with SNAP header).
  - Ethernet II (DIX) (named after DEC, Intel, and Xerox, this is the most common frame type today).

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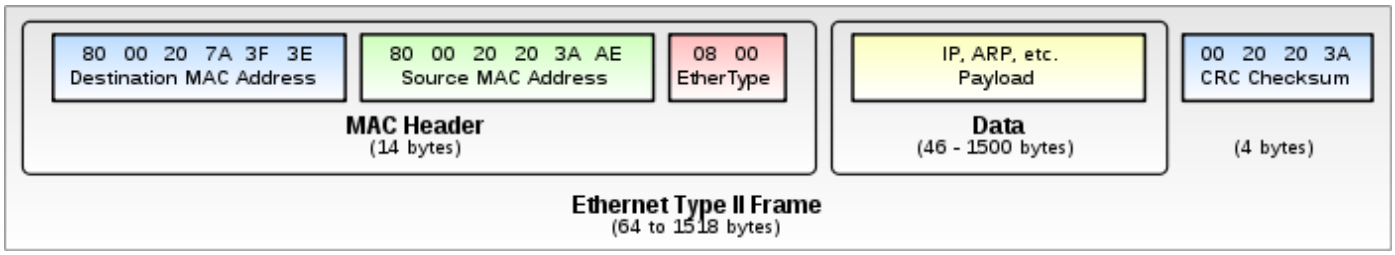
- **MAC/IP:** Tap the MAC and IP blocks on the Frame image to access the setup menus .
    - Set the Source and Destination MAC address for Layer 2.
    - Set the Source and Destination MAC and IP addresses for Layer 3 and Layer 4.
- **VLAN:** Off, 1 tag, 2 tags, 3 tags .
    - The user is able to configure 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

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

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(ARP) or the Gateway (ARP GW).

A valid IP connection needs to be up to use these functions. Refer to IP Connections.

Port setup and IP connection are required prior to performing the following Ethernet applications: Ping, Trace Route, Web/FTP, ARP Wiz, VoIP, IPTV testing, and 1388v2 (except Layer 2).

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

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

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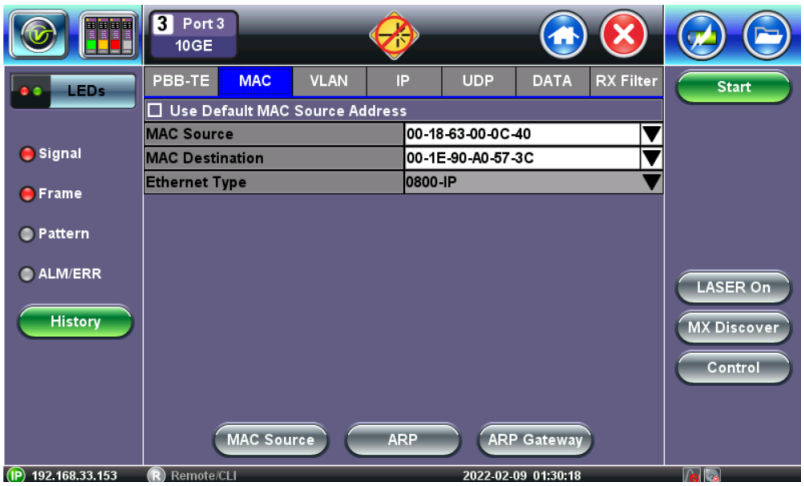

BERT Setup - MAC address settings (Layer 3)

- **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).

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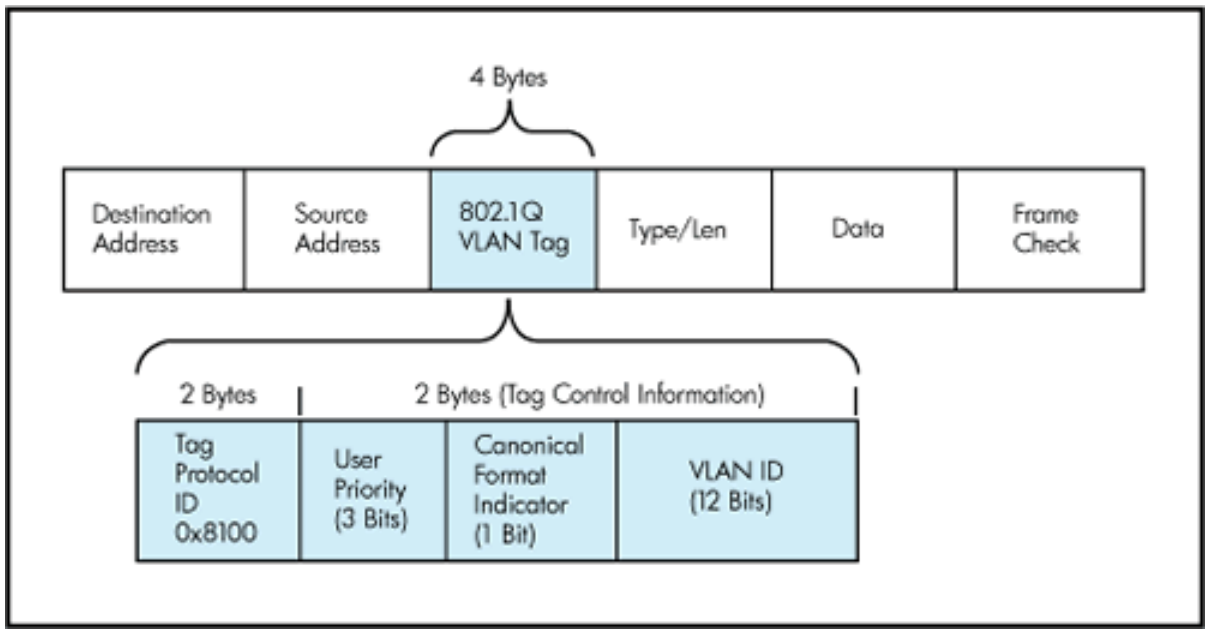
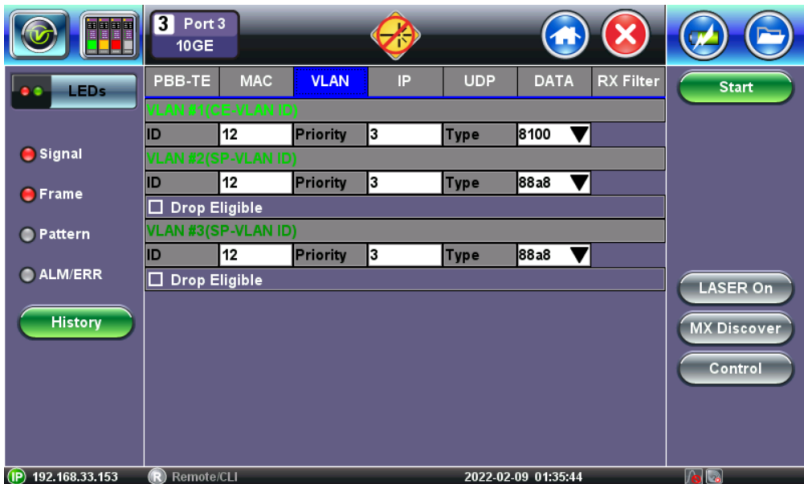
- **Drop Eligible:** If enabled, drop eligibility flag will be set.
- **VLAN Flooding:** Enable/Disable.
- **VLAN Flooding Range:** Specifies the number of VLAN IDs. Enter a number from 0-4096. The VLAN IDs will be incremented by 1 until it reaches the number of times entered in the flood range.



IEEE 802.1Q VLAN Tag in an Ethernet Frame



BERT Setup - VLAN Tag configuration (Layer 3)

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- **MPLS Tab:** In the MPLS tab the following parameters are configured:
  - **MPLS label:** Configurable in the range 16 through 1,048,575 (labels 0 to 13 are reserved).

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

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

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

    Used to decrement the time-to-live counter.

BERT Setup - MPLS label configuration

- **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:

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- **IP Type:** IPv4 .
- **IP Src and IP Dest:** For IP Src, if the IP connection is up, refer to "IP Connection" on page 89. 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.

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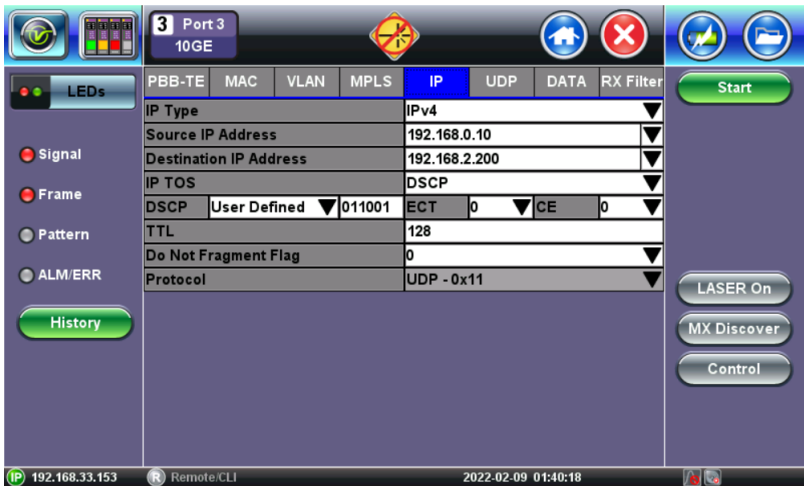
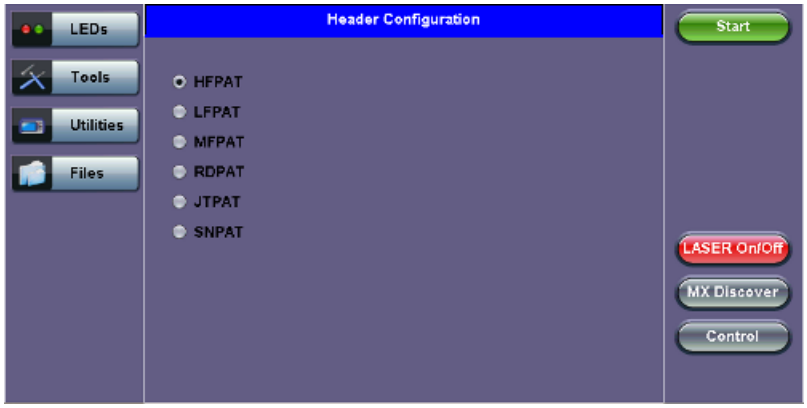


BERT Setup - IP Address settings (Layer 3)



- **Layer 2, 3, & 4 test patterns**
  - **PRBS:**
    - 2^31 -1 (147 483 647-bit pattern used for special measurement tasks, [e.g., delay measurements at higher bit rates]).
    - 2^23 -1 (8 388 607 bit pattern primarily intended for error and jitter measurements at bit rates of 34 368 and 139 264 kbps).
    - 2^13 -1 (32 767 bit pattern primarily intended for error and jitter measurements at bit rates of 1344, 2048, 6312, 8448, 32 064 and 44 736 kbps).

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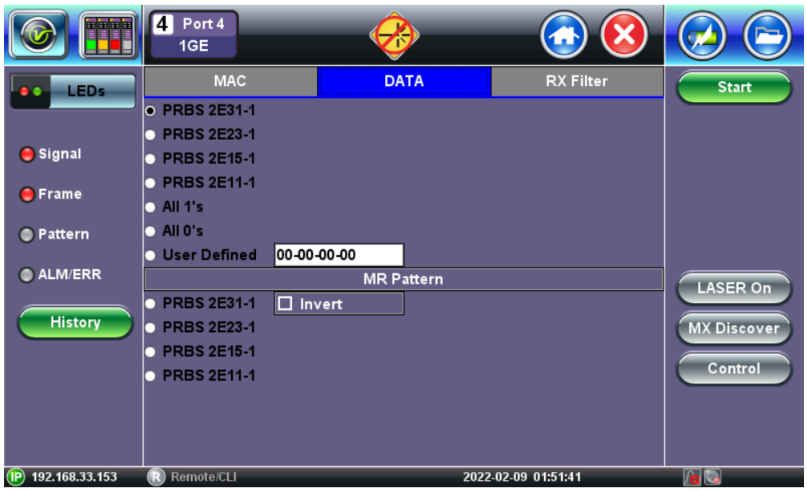
- 2^11 -1 (2047 bit pattern primarily intended for error and jitter measurements on circuits operating at bit rates of 64 kbps and N x 64 kbps).

- **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.

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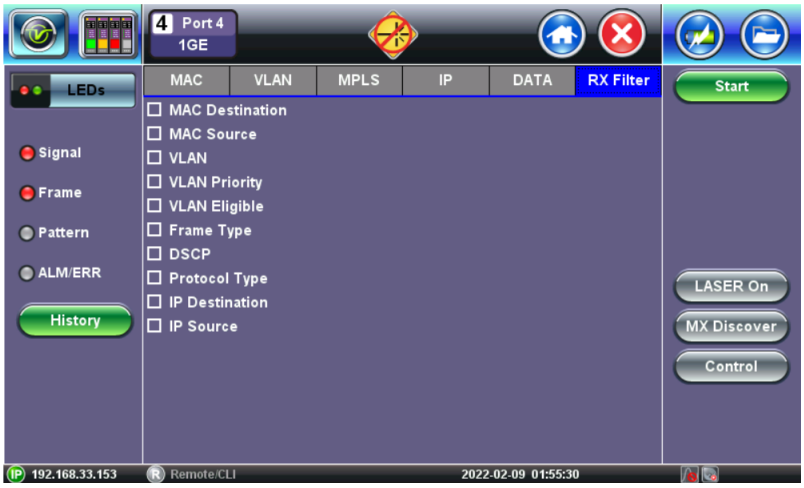
- **RX Filter Tab:**

  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 Tab:** Input Source Port and Destination Port.

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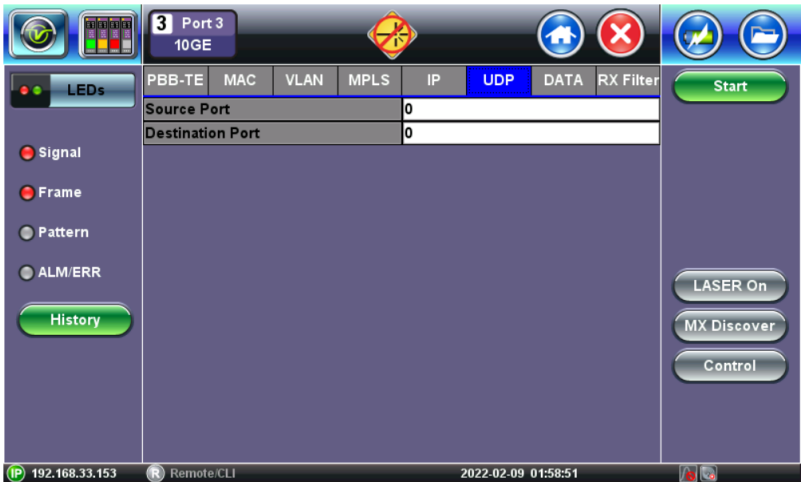

BERT Setup - RX Filter selection

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Traffic Settings

Traffic tab:

Configure the traffic profile for the stream, including traffic flow, frame size, frame type, and transmit rate.

- **Traffic Flow:** Select from the following traffic flows:
  - **Constant:** The selected frame is transmitted continuously according to the selected bandwidth %.
  - **Ramp:** The selected frame is transmitted at maximum bandwidth according to the selected duty cycle and burst period.
  - **Burst:** The selected frame is transmitted in a staircase profile according to user selectable step time, number of steps, and maximum bandwidth.
  - **Single Burst:** Configure the number of frames to be transmitted in the burst along with the bandwidth. For example, if 100000 frames are transmitted at 12.5% of bandwidth, on a 1Gbps line, 100000 frames will transmit at a rate of 125Mbps and then the burst will stop.
- **Frame Size Type:** Fixed or Uniform min and max frame length values. Uniform traffic is traffic generated with a uniform distribution of frame lengths.
  - **Frame Size (bytes):** Enter the frame size when a Layer 2, 3, or 4 BERT is selected .
    - Frame size configuration is not available for Layer 1 BERT.
  - Frame sizes can be from 64 bytes to 1318 bytes, in addition to jumbo frames up to 10000 bytes.
- **BW (Transmit Bandwidth):** Configure the transmit rate for the test .
  - When traffic flow is equal to Burst, two burst bandwidths are configured with burst time .
  - When traffic flow is equal to Ramp, starting and an ending bandwidth are configured along with the bandwidth step size and duration.

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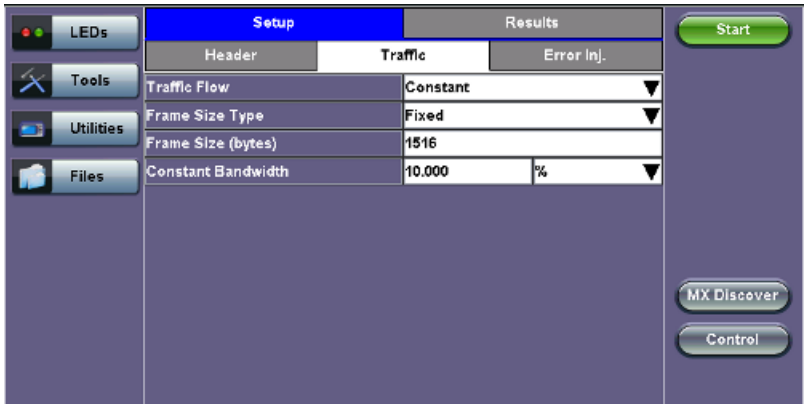

BERT Setup - Constant Traffic

Frame Size Limitation

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

Error Injection

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

- **Stream #:** Select the stream to configure.
- **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.

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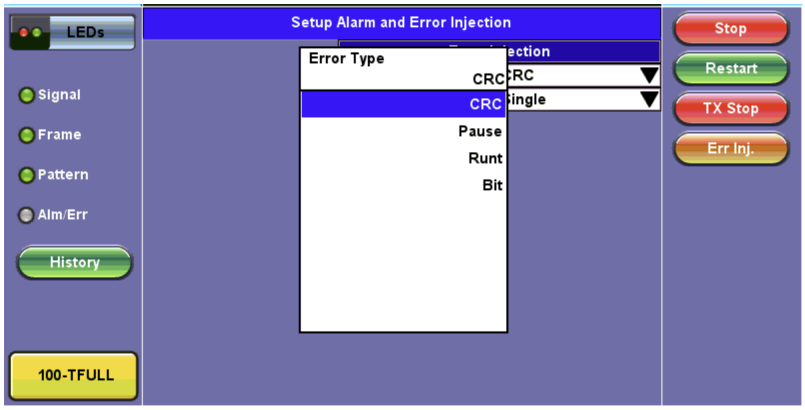

BERT Setup - Error Injection Error Inj. Function

Error Injection

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

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.

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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.

BERT Results

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).

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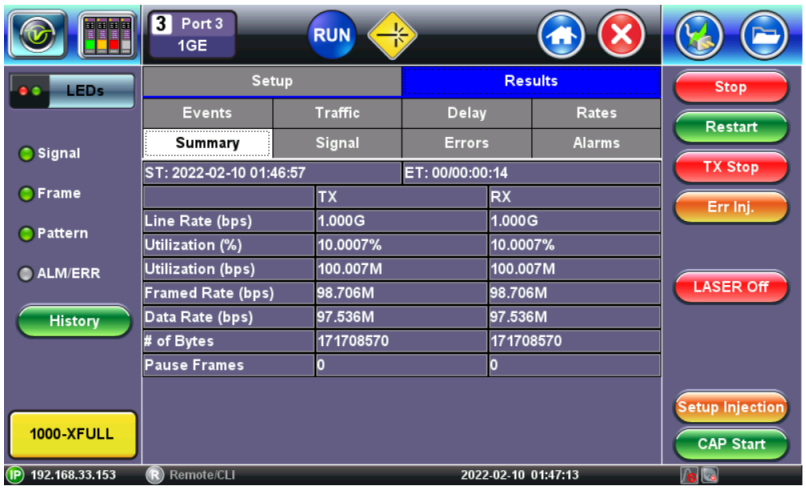
- **Number of bytes**
- **Pause Frames:** Total number of transmitted and received ethernet pause flow-control frames.



BERT Results - Summary

Errors

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

- **Bits:** Indicates errors related to test pattern (Bit Error or LSS [Pattern Loss]).
- **BER:** Bit Error Ratio.
- **Symbol:** Declared when an invalid code-group in the transmission code is detected.
- **FCS/CRC:** Number of received frames with an invalid FCS.
- **IP Checksum** (Layer 3 only) .
- **Jabber frames:** Number of received frames larger than 1318 bytes containing an invalid FCS.
- **Runt frames:** Number of received frames smaller than 64 bytes containing an invalid FCS.

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BERT Results - Errors

Events

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

BERT Results - Events

Traffic

Traffic tab: The following Traffic statistics are displayed:

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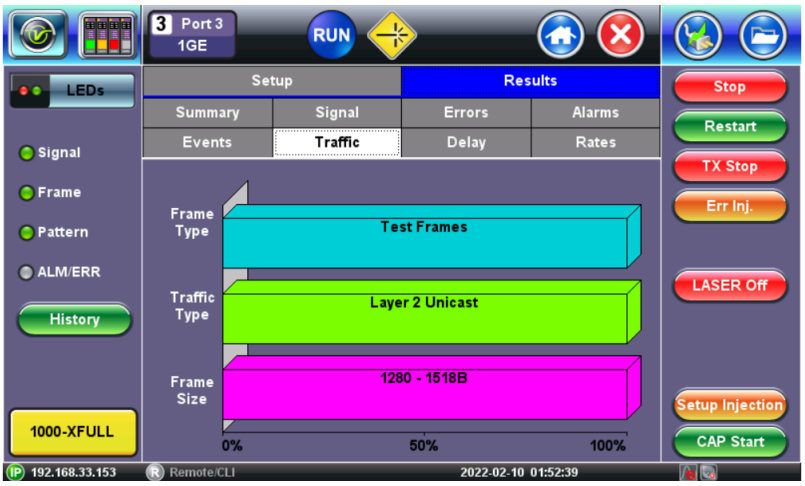
- **Frame type:** Test and non-test frames
- **Traffic type:** Layer 2 and Layer 3 Unicast, Broadcast, and Multicast frame percentage
- **Frame size distribution**
- **Pause frames**

Tap on the **graph** for detailed screens.



BERT Results - Traffic Distribution

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

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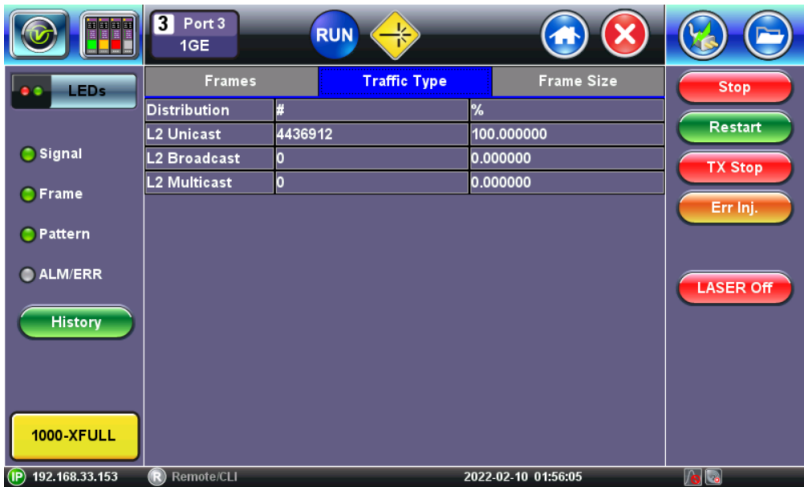
- **Pause frames:** Total number of transmitted and received Ethernet pause flow-control frames

BERT Results - Frames

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

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

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

BERT Results - Frame Size

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)

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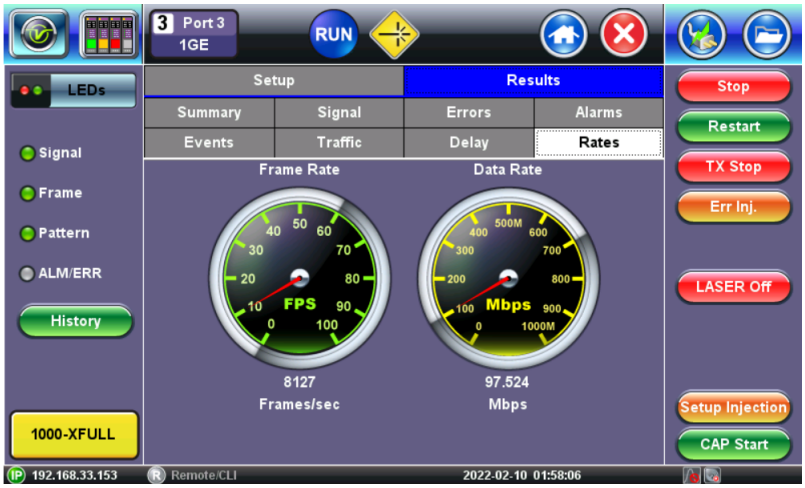
- **Data rate in Mbps:** Received data rate expressed in Mbps

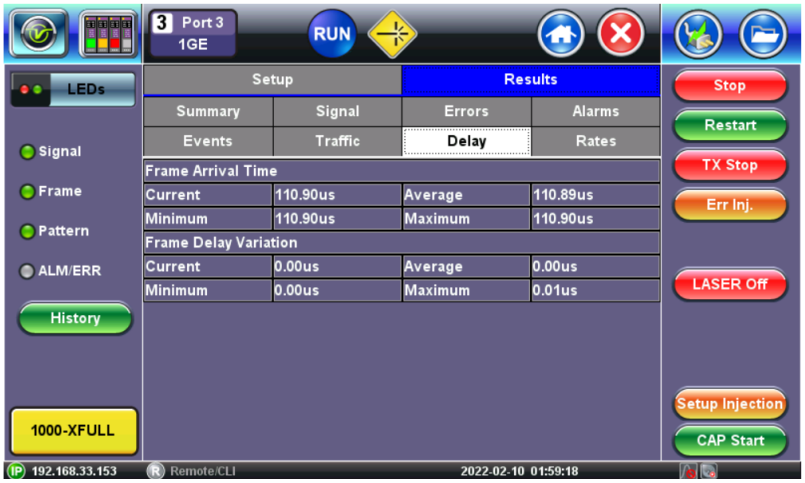


BERT Results - Rates

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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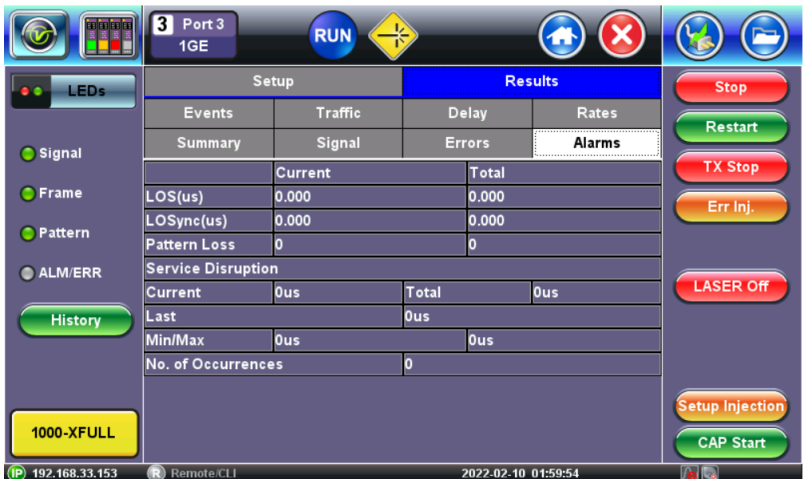
Alarms

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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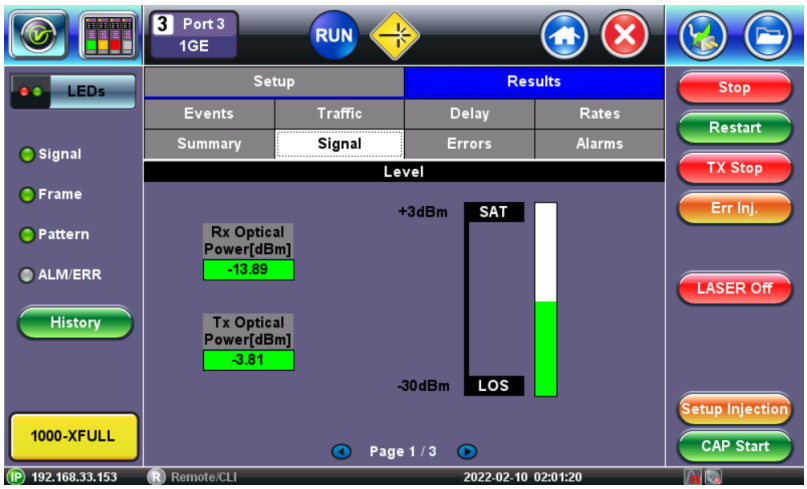
Signal

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

Signal (Page 1) displays the level measurement in dBm for the optical signal.

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



BERT Results - Signal (Page 1)

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

BERT Results - Signal (Page 2)

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Signal (Page 3) Displays the received signal frequency and offset measured and performed on the optical interface (SFP).

BERT Results - Signal (Page 3)

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

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RFC 2544 Conformance Testing

RFC2544 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).

Swipe **up** and tap on Setup

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)

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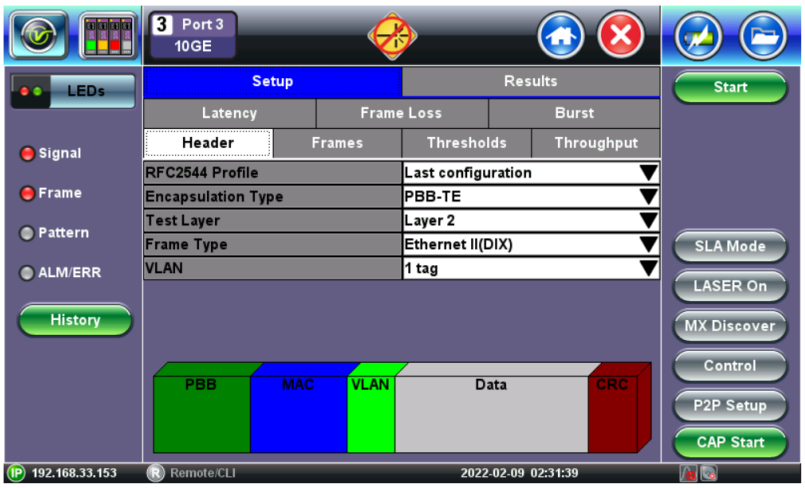

RFC 2544 Setup - Layer 2 parameters

Setup - Standard Mode

Unless otherwise noted, the Frame Header and related setups are identical to the setups described in "Header Settings " on page 98.

Header Settings

With the exception of the **Data** tab, RFC 2544 Header setup options are identical to the setups described in the BERT application.

See BERT "Header Settings " on page 98

RFC 2544 Setup

- Profile
- Encapsulation Type
- Test
- Frame Type
- MAC/IP
- VLAN
- MPLS
- MAC, VLAN, MPLS, IP, and Test Pattern Configurations

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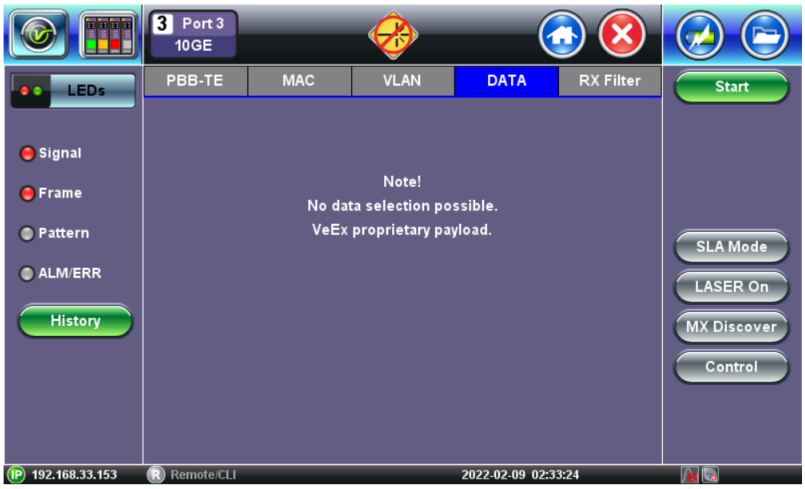
- MAC Header Tab
- Data Tab: No payload selection is possible. The payload area is populated with a VeEX signature field and other proprietary data.
- RX Filter Tab
- VLAN Tab
- MPLS Tab
- IP Tab



RFC 2544 Data tab

Frame Settings

Frames tab: User configures the following:

- **Preset Frames:** User selects from a list of recommended test frame sizes defined in RFC 2544:
  - Test frames are 64, 128, 256, 512, 1024, 1280, and 1518 bytes.
  - The default selected frames are 64 and 1518 bytes.
  - To select/deselect any of the recommended test frames, check the box to the right of the desired frame.

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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

Threshold Settings

Threshold tab

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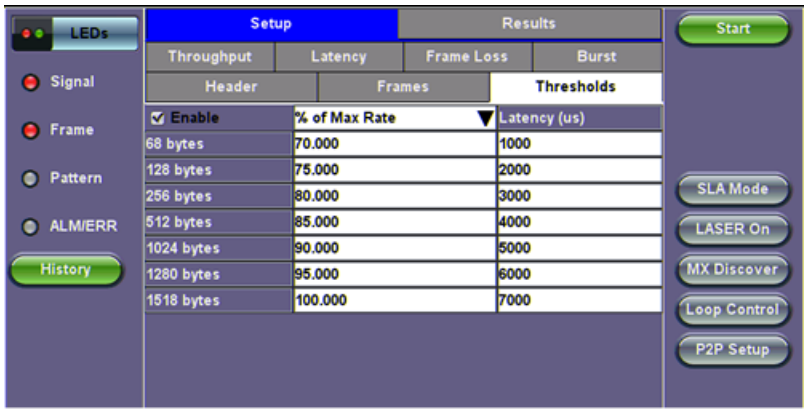
- Enable or disable threshold settings for the throughput and latency tests.
    - When enabled, threshold settings can be configured for all of the test frames selected in the frame settings tab.

- A Pass/Fail criteria will be applied when the threshold settings are enabled. Select a **rate type** from the drop-down menu that will be used to determine pass/fail criteria. Options are % of Max Rate, % of Line Rate, Utlized Line Rate (Mbps).
    - For example, if the throughput threshold value for a 64 byte frame is configured for 80%, then a Pass criteria is assigned if the throughput rate is 80% or better.
    - The threshold values for Throughput and Latency can be customized per user requirements. Tap on the selected value to edit.



RFC 2544 Setup - Threshold Settings

Throughput, Latency, Frame Loss, and Burst Settings

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

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

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Throughput tab:

- **Test Rate:** Throughput Rate or Custom Rate per frame size.
    - **Throughput rate**: Throughput test will be performed at the specified maximum rate.
    - **Maximum Rate:** Up to 100% of the negotiated line rate. The default value is 100%.
        - This is the maximum transmit rate to perform the throughput test for each test frame size.
        - This rate can be configured as a % of the total line rate or in Mbps. For example, if the Max Rate to is configured to be 90% and the negotiated line rate of the link is 100Mbps, then the maximum transmit rate will be 90Mbps or 90% of the line rate.
    - **Custom Rate per frame size:** Configure a custom rate in % or Mbps for each test frame. Tap on **Rate Table Config**. to configure rates for each frame. After making edits tap **Apply** to confirm edits or **Apply to All** to apply rates to all tests.
- **Resolution:** Input any value between 0.001% and 1%. The default value is 1%. Resolution refers to the resolution in searching for the throughput rate. If 1% is selected, the throughput rate will be searched with ±1% accuracy.
- **Duration:** The default value is 20 seconds.
  The duration is the amount of time the throughput test is run for, for each frame size at a given rate.
- **Frame Loss Limit (%):** Configures the frame loss tolerance used in the throughput rate search algorithm. If the frame loss count stays below the configured Frame Loss limit, the throughput rate search will stop, otherwise the throughput rate search will continue to the next step.

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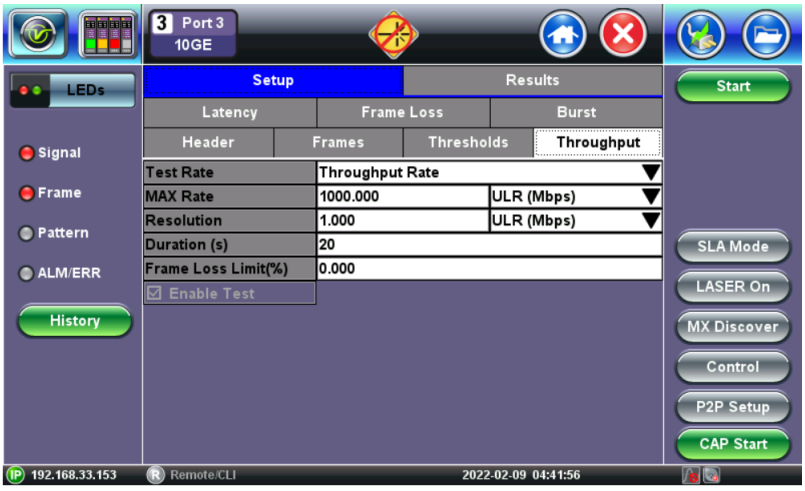

RFC 2544 Setup - Throughput Settings

Latency tab:

- **Test:** Throughput Rate or Custom Rate. The default value is throughput.
  - **Throughput rate**: Latency test will be performed at the throughput rate found for each of the tested frame sizes.
  - **Custom rate:** User configures a custom rate in % or Mbps.
  - **Custom Rate per frame size:** The user can configure a custom rate in % or Mbps for each test frame. Tap on **Rate Table Config**. to configure rates for each frame. After making edits tap **Apply** to confirm edits or **Apply to All** to apply rates to all tests.
- **Rate:** Only available if Custom Rate is selected. Enter up to 100% of the negotiated line rate or enter the rate in Mbps.
- **Duration:** The default value is 20 seconds.
  This is the amount of time that the latency test will be performed for each test frame size.
- **Repetitions:** 1 to 100. The default value is 1.
  This is the amount of times that the latency test will be repeated for each test frame size.
- **Jitter Test:** Coupled or Uncoupled. Coupled will run the jitter test at the same time as the latency test.

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RFC 2544 Setup - Latency Settings

Frame Loss tab:

- **Max Rate:** Up to 100% of the negotiated line rate. The default value is 100%. This is the maximum transmit rate to perform the frame loss test for each test frame size. The user may configure this rate as a % of the total line rate or in Mbps. For example, if the user configures the Max Rate to be 90% and the negotiated line rate of the link is 100Mbps, then the maximum transmit rate will be 90Mbps or 90% of the line rate.
    - **Throughput rate**: Latency test will be performed at the throughput rate found for each of the tested frame sizes.
    - **Custom rate:** User configures a custom rate in % or Mbps.
    - **Custom Rate per frame size:** The user can configure a custom rate in % or Mbps for each test frame. Tap on **Rate Table Config**. to configure rates for each frame. After making edits tap **Apply** to confirm edits or **Apply to All** to apply rates to all tests.
- **Rate:** Only available if Custom Rate is selected. Enter up to 100% of the negotiated line rate or enter the rate in Mbps.
- **Step Size:** 1 to 10%. The default value is 10%. The step size is the rate % that the frame loss test will be reduced by in the event of any frame loss. For example if the Max Rate is 100Mbps (or 100%) and frames are lost at this rate, then the transmit rate will be reduced to 90Mbps (or 90%). The frame

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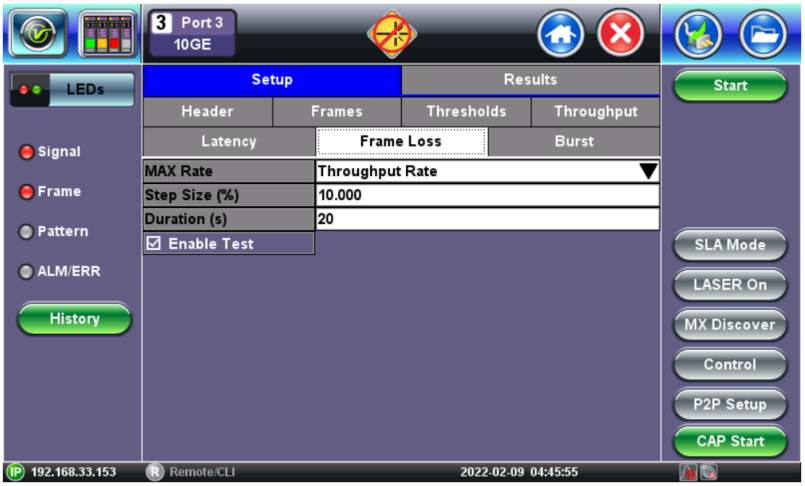
loss test will now be performed at the new rate until there is zero frame loss at two consecutive rate settings. This means that the test will have to be performed at 80% (assuming that there was zero frame loss at 90%).

- **Duration:** 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

Burst (Back-to-Back) tab:

- **Max Rate:** Up to 100% of the negotiated line rate. The default value is 1000 ULR (Mbps). In the burst test, frames are always transmitted at the maximum rate for a given minimum and maximum burst duration. This rate may be configured as a % of the total line rate or in Mbps. For example, if the Max Rate is configured to be 90% and the negotiated line rate of the link is 100Mbps, then the maximum transmit rate will be 90Mbps or 90% of the line rate.
    - **Throughput rate**: Latency test will be performed at the throughput rate found for each of the tested frame sizes.
    - **Custom rate:** User configured custom rate in % or Mbps.

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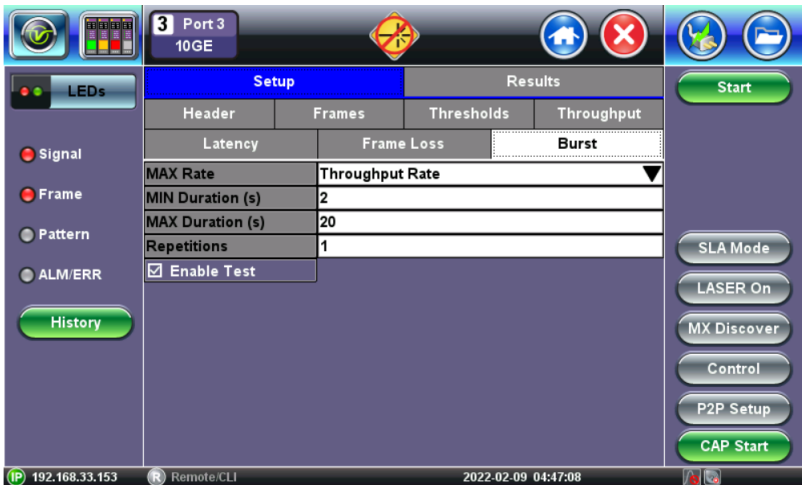
- **Custom Rate per frame size:** A custom rate can be configured in % or Mbps for each test frame. Tap on **Rate Table Config**. to configure rates for each frame. After making edits tap **Apply** to confirm edits or **Apply to All** to apply rates to all tests.

- **Rate:** Only available if Custom Rate is selected. Enter up to 100% of the negotiated line rate or enter the rate in Mbps.
- **Minimum Duration** Default value is 2 seconds.
  This is the duration of the first burst.
- **Maximum Duration:** 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

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.

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- **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.

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

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

Summary tab

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

- **Line Rate** (Mbps)**:** Negotiated rate of the interface (10M, 100M, 1000M or 10GE). This value is always fixed since it depends on the maximum capacity of the link under test, hence the test interface that is configured.

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- **Framed Rate:** (Payload + MAC/IP Header + VLAN Tag + Type/Length + CRC) / (Payload + Total Overhead) * Line Rate % (in Mbps).
- **Data Rate:** Payload / (Payload + Total Overhead) * Line Rate %.
- **Utilization:** % of Line Rate. For example, if we transmit 100Mbps on a 1Gbps interface then the utilization value is 10% (or 100Mbps) of the total link capacity (or Line Rate).
- **Total Frames**
- **Bad Frames**
- **Pause Frames:** Total number of transmitted and received ethernet pause flow-control frames.

RFC 2544 Results - Summary

Signal tab

The Signal tab (fiber ports only) displays the optical level measured by the SFP transceiver. The RFC 2544 Signal tab is identical to the Signal tab for the BERT application. Refer to "Lane BERT Signal" on page 199 for more information.

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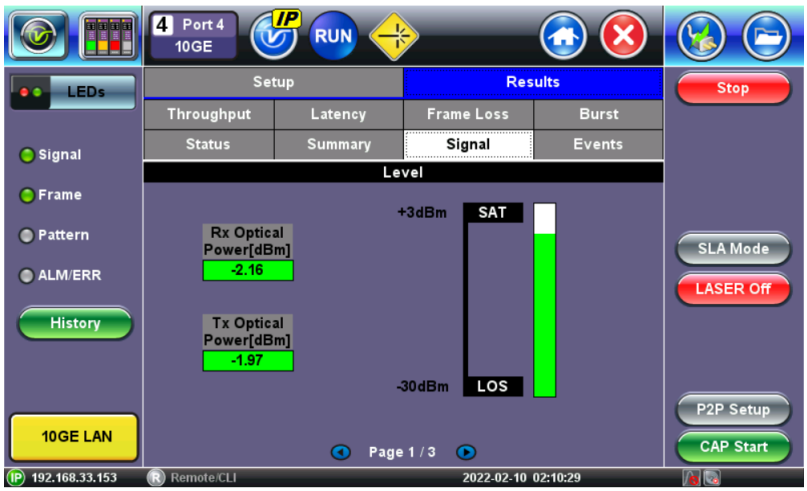
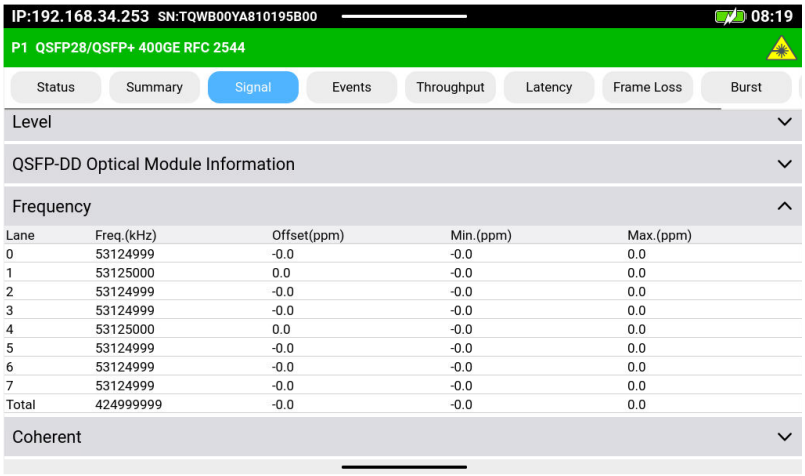
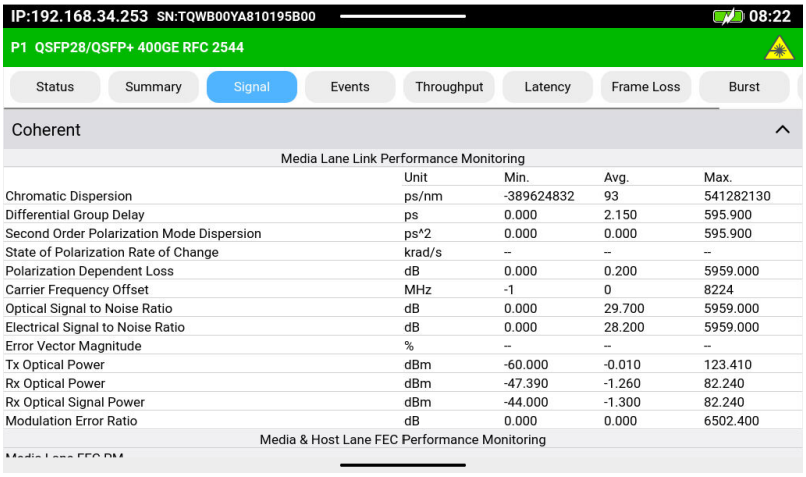


RFC 2544 Results - Signal (Page 1)





Events tab

A time stamped log of each test is displayed.

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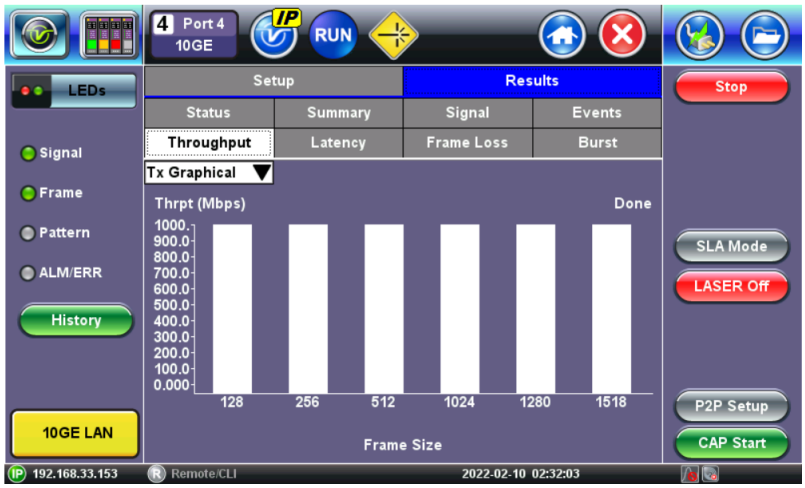
RFC 2544 Results - Events

Throughput tab

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

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



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RFC 2544 Results - Throughput (Tx Graphical)

RFC 2544 Results - Throughput (Summary Table)

RFC 2544 Results - Throughput (Test Log)

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

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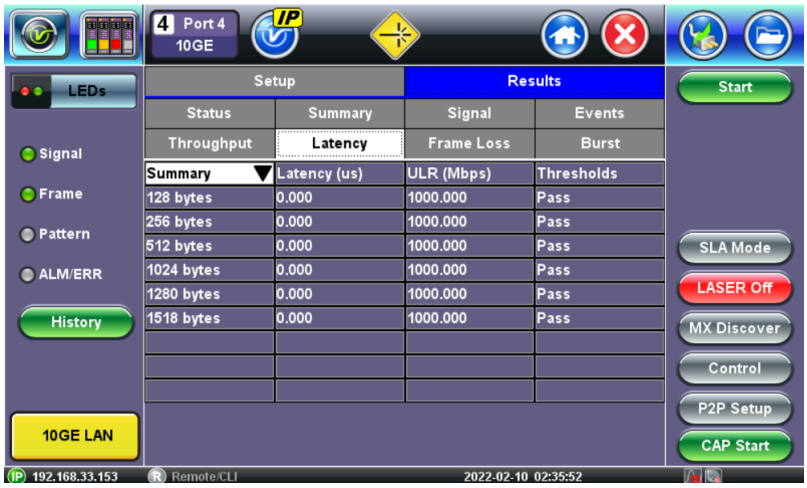
- **Graphical:** Latency results displayed in line graph form (Latency [us] vs Frame size [bytes]).
- **Summary and Test log tables display:**
    - **Byte size**
    - **Latency (us):** Round trip delay latency.
    - **Rate (%):** Percentage of frames transmitted. Data rate used for latency test.
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



RFC 2544 Results - Latency (Summary)

RFC 2544 Results - Latency (Graphical)

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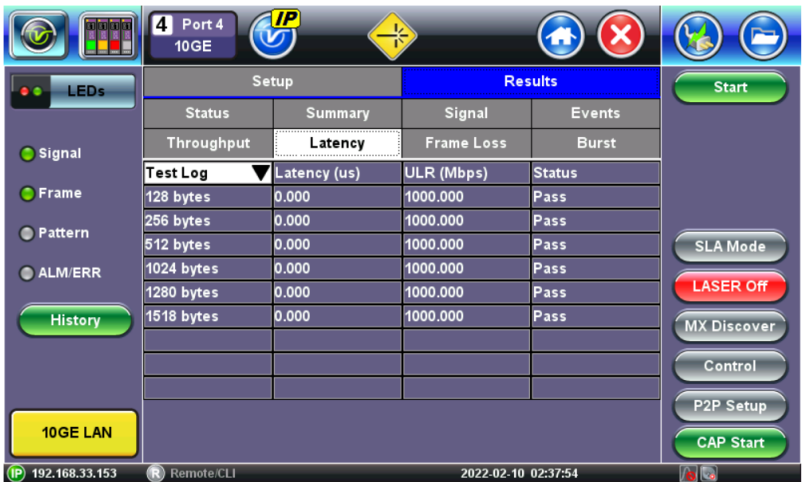
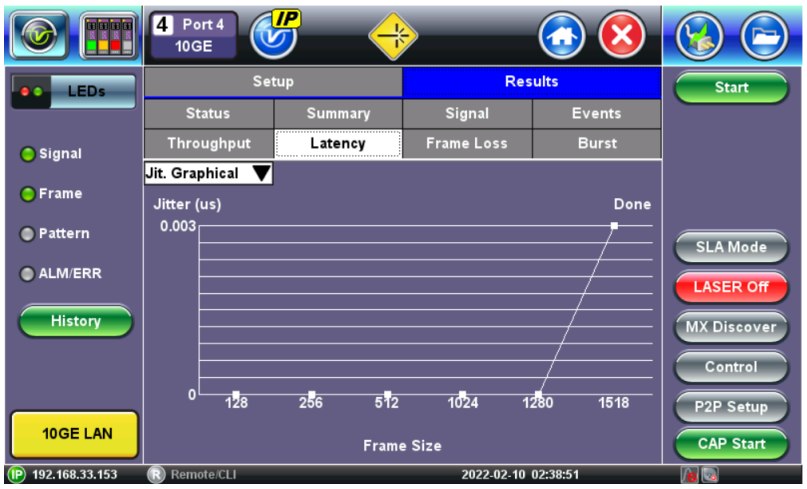


RFC 2544 Results - Latency (Test Log)



RFC 2544 Results - Latency (Jitter Graphical)

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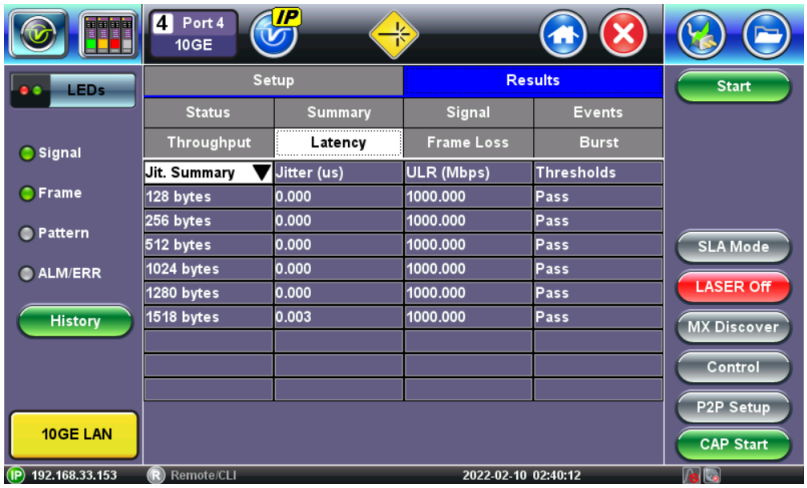
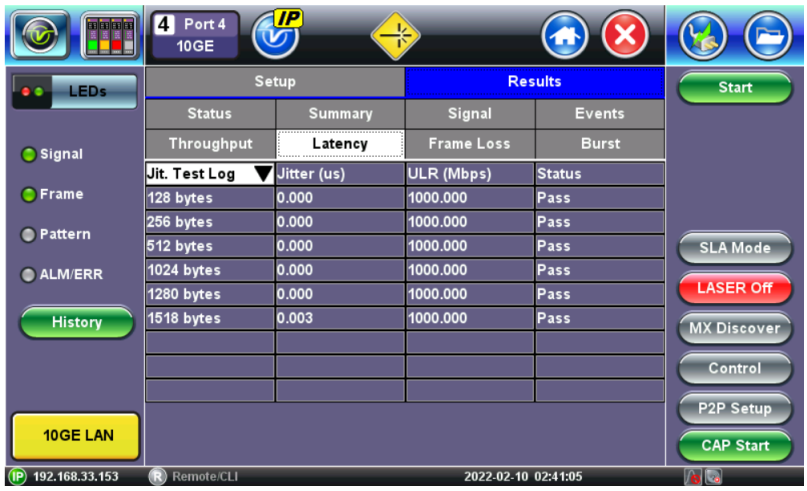


RFC 2544 Results - Latency (Jitter Summary)



RFC 2544 Results - Latency (Jitter Test log)

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

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

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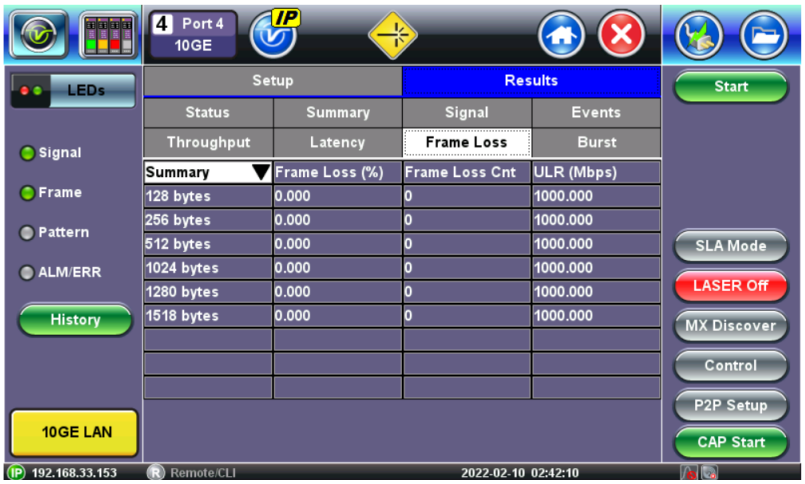
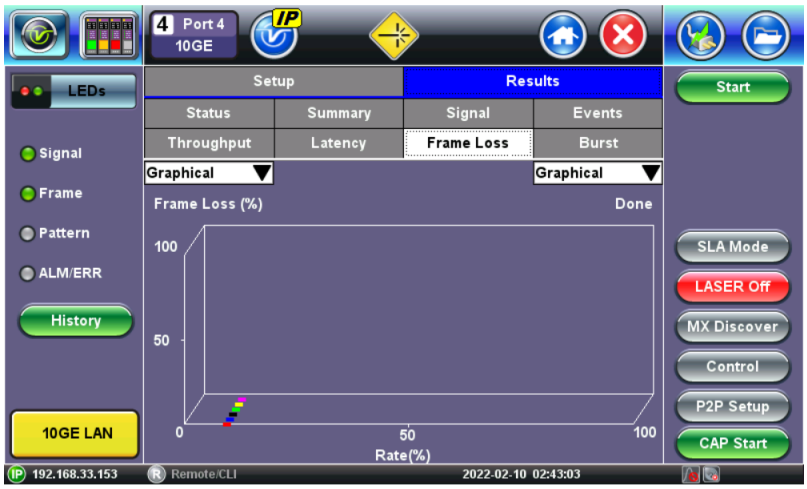


RFC 2544 Results - Frame Loss (Summary)



RFC 2544 Results - Frame Loss (Graphical)

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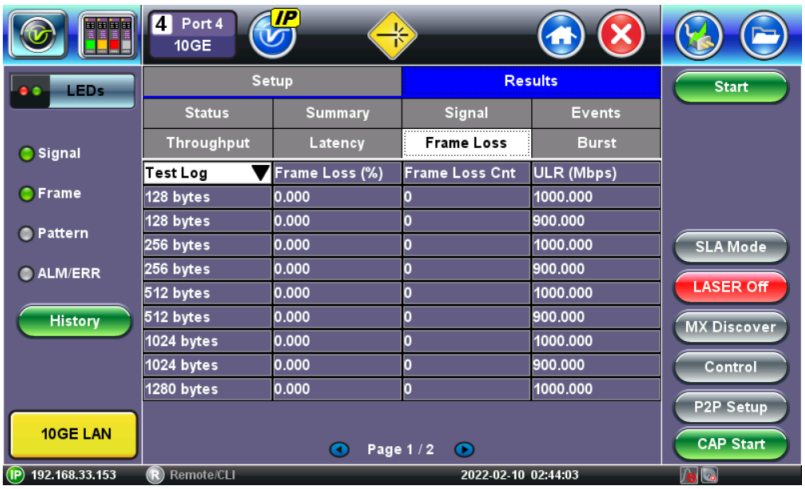
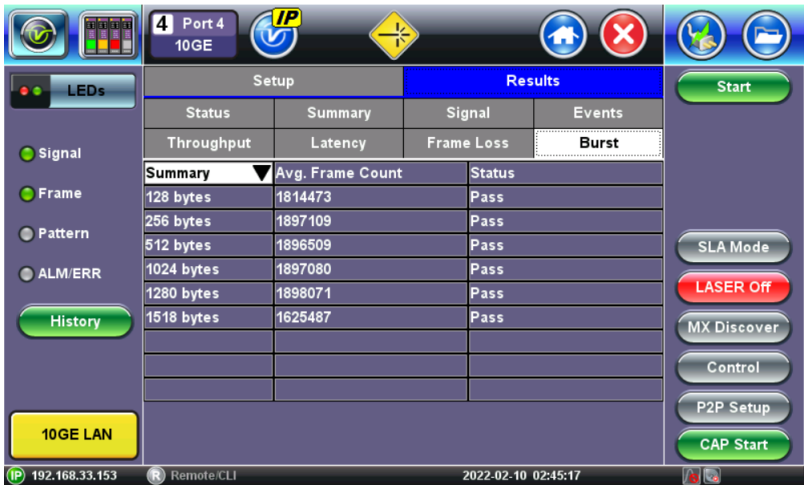


RFC 2544 Results - Frame Loss (Test log)

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)

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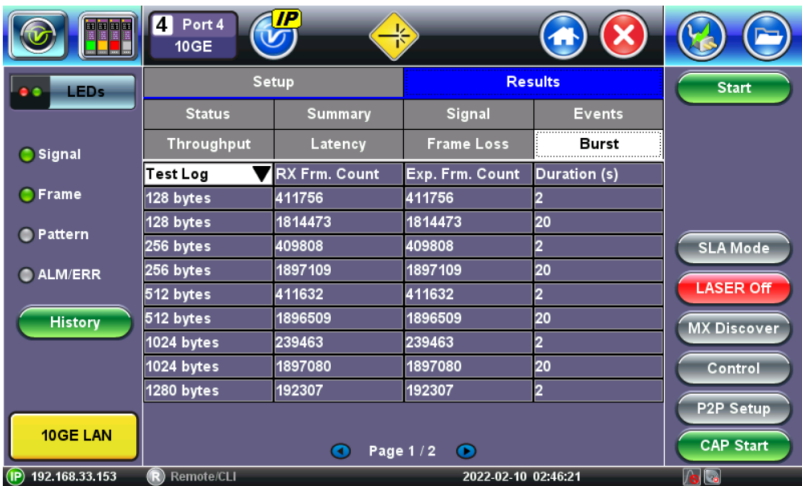
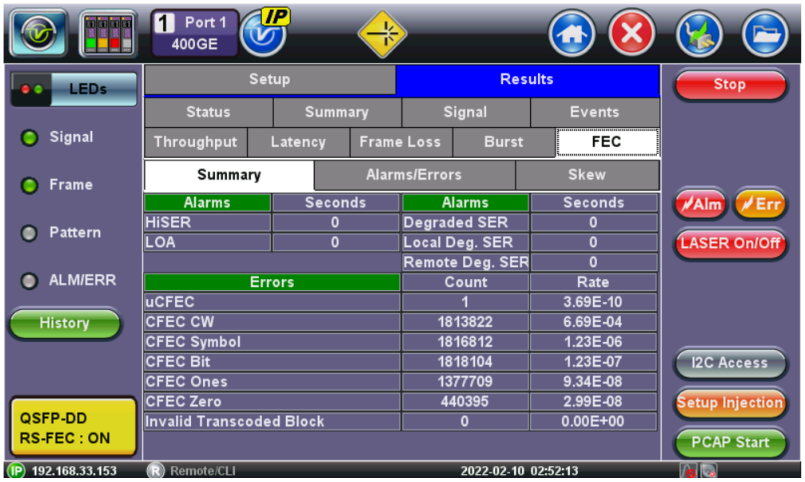


RFC 2544 Results - Burstability (Test Log)

FEC tab:



RFC 2544 Results - FEC Summary

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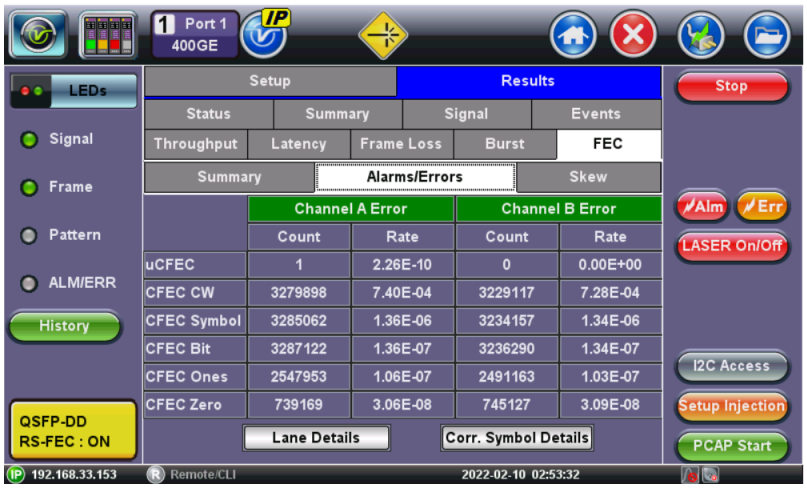

RFC 2544 Results - FEC Alarms/Errors

RFC 2544 Results - FEC Alarms/Errors Lane Details

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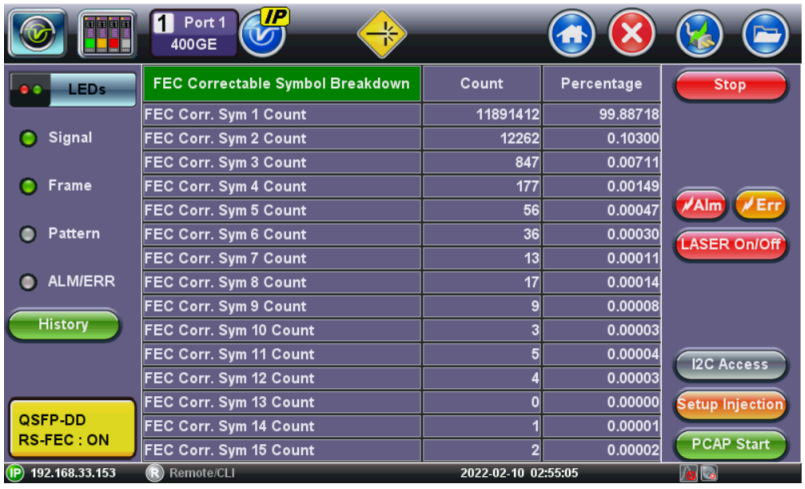
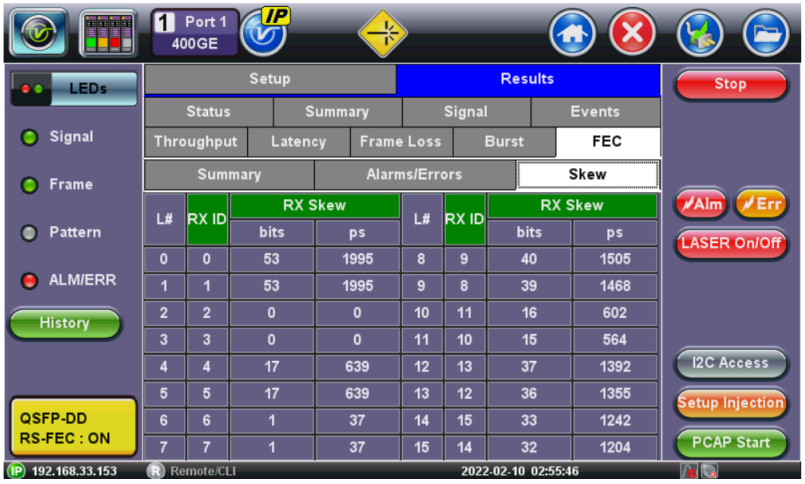


RFC 2544 Results - FEC Alarms/Errors Corr. Symbol Details

The **FEC Correctable Symbol Breakdown** page shows the Symbol Errors per FEC Codeword distribution, which is important to benchmark the quality of the transceiver and/or PAM4 signal. KP4 FEC can only correct up to 15 symbol errors per codeword, so rows 1 to 15 show the amount of correctable errors, based on how many bad symbols found in the received codeword. The closer the numbers are to the top, the better the quality and performance of the link. Any codeword with more that 15 symbol error becomes an uncorrectable FEC error and will affect the payload (Ethernet traffic), hence not counted on this screen.



RFC 2544 Results - FEC Skew

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Saving RFC 2544 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, view or rename the results file by going to File Manager at **Utilities** > **Files** > **Saved**. Refer to File Manager for more information.

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V-SAM

V-SAM

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

- RFC 2544 was limited to test at the maximum throughput line rate for a single service. SAM is able to run multiple services on a single 10/100/1000 or 10G Ethernet line at a bandwidth ranging from 0 to the line rate, allowing for more realistic stream testing.
- The Frame Delay Variation, also known as (packet) jitter was not included in RFC 2544. Jitter is a critical parameter for real time voice and video services. It is now part of the SAM test suite.
- RFC 2544 validates the service parameters like frame loss, throughput and latency, one after the other, while SAM allows testing all the service critical parameters simultaneously. This results in significant time saving compared to RFC 2544.

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

Comparison of RFC 2544 and Y.1564

Test Methodology

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

- **Phase 1: Service Configuration test**: The services running on the same line are tested one by one to verify the correct service profile provisioning.

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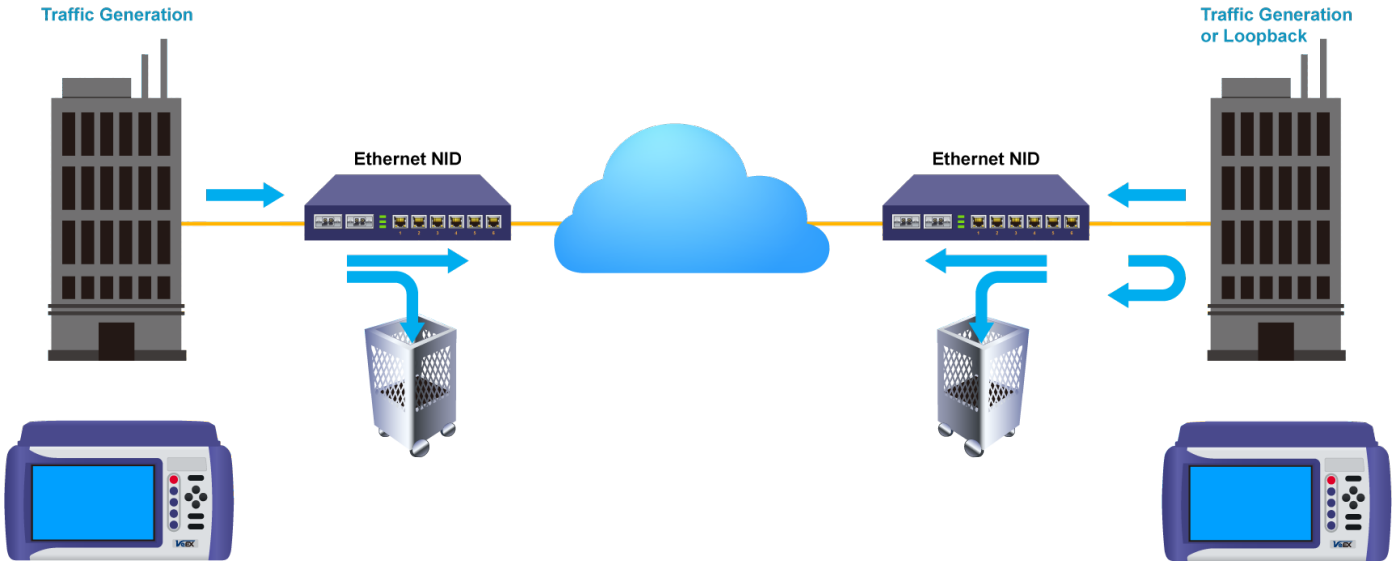
- **Phase 2: Service Performance test**: The services running on the same line are tested simultaneously over an extended period of time, to verify network robustness.



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.*

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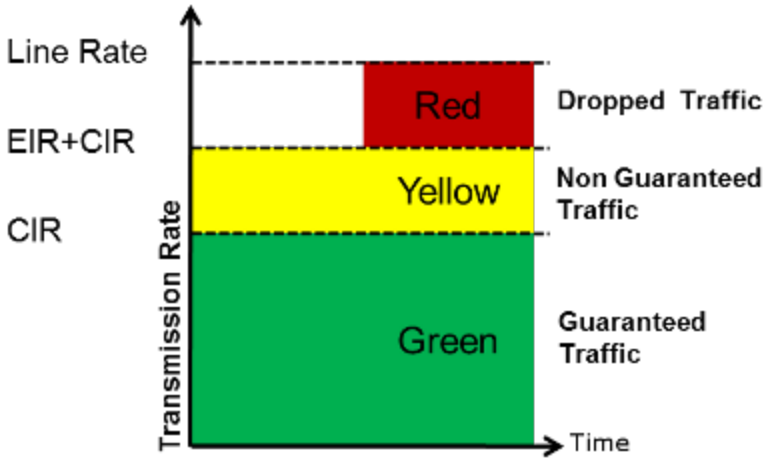


Service Bandwidth Profile

Phase 2: Service Performance Test

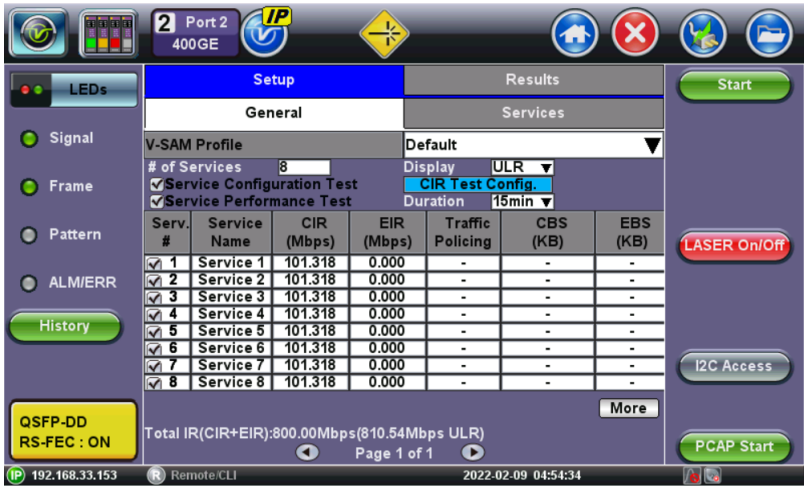
Services running on the same line are tested simultaneously over an extended period of time, to verify network robustness. Service Acceptance Criteria (SAC) including Frame Transfer Delay (FTD), Frame Delay Variation (FDV), Frame Loss Ratio (FLR) and Availability (AVAIL) are verified for each service.

V-SAM Setup

General (Page 1 and 2)

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.



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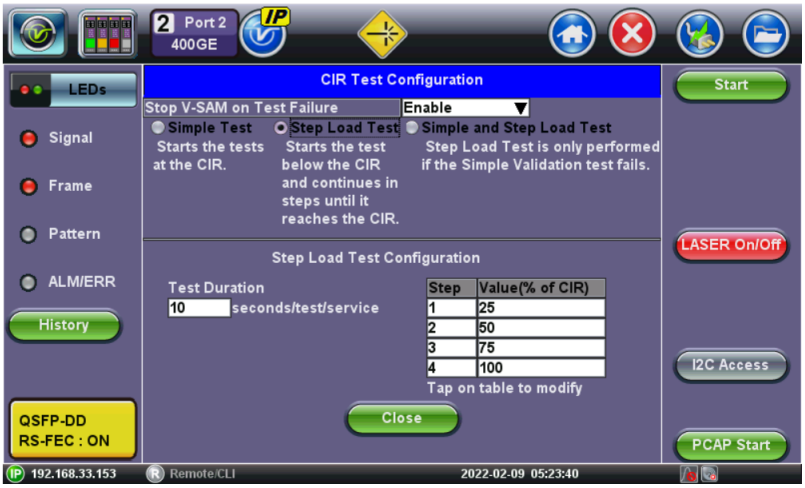
CIR Test Configuration

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 the **Test Duration** box to input a test duration (test duration must be less than 999 sec).

Tap the table to modify the CIR value percentage for each step.



CIR Test Config

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Header Settings

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

    Any EMIX configuration of 5 frames is allowed.

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

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

PBB:

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

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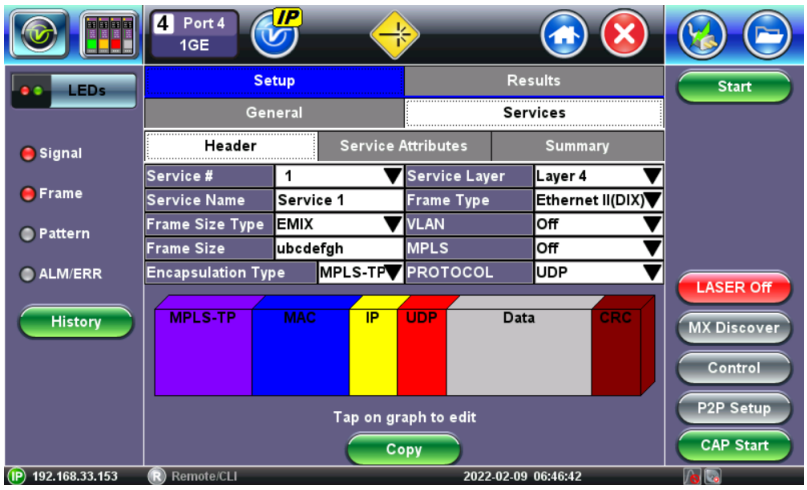
MPLS-TP:

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

After making changes, tap **Apply to All**, for MPLS-TP configuration.

Unless otherwise noted, the Frame Header and related setups are identical to the setups described in "Header Settings " on page 98.



V-SAM Setup - Services - Header Settings

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V-SAM Setup - Services - EMIX Frame Size Settings

V-SAM Setup - Services - MPLS-TP Settings

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

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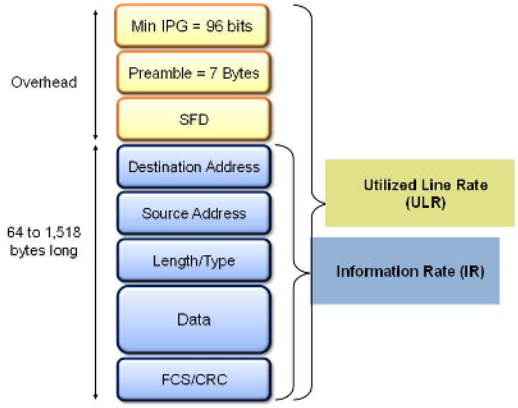
0.01Mbps to the line bandwidth.

- **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.

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- **CBS** and **EBS**: Committed Burst Size (CBS) and Excess Burst Size (EBS).
    - CBS can be enabled without enabling EBS.
    - If EBS is enabled, then CBS is automatically enabled too.
    - Values between 4 KBytes and 100 KBytes can be input for both CBS and EBS.

V-SAM Setup - Services - Service Attributes

Enabling/Disabling Tests

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

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.

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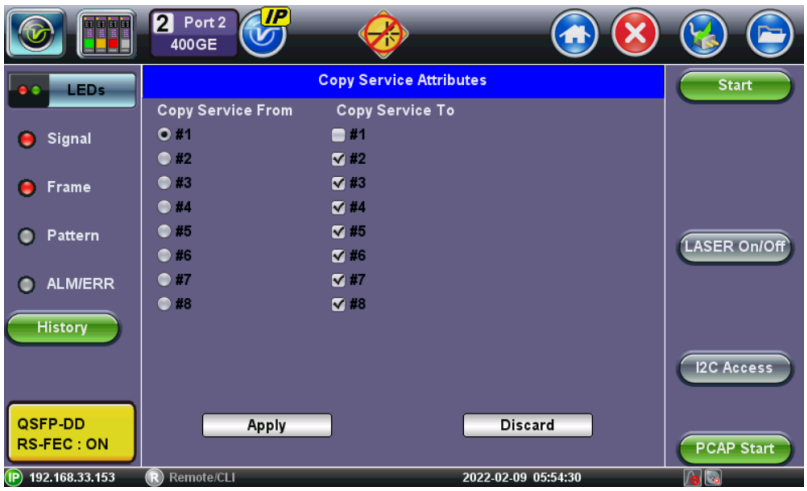
- **IFDV:** Maximum frame jitter allowed to still be compliant with the SLA. FDV is only guaranteed for traffic conforming to the CIR. Values are measured in us, ms, or sec. Input a value within the digital range of .001-999 and 1 us-999sec. The user can also choose to **Disable** the IFDV threshold 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.*

Results

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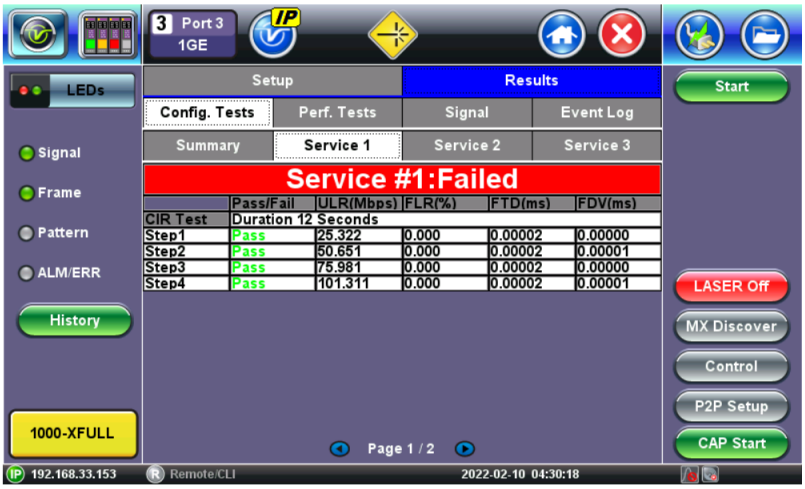
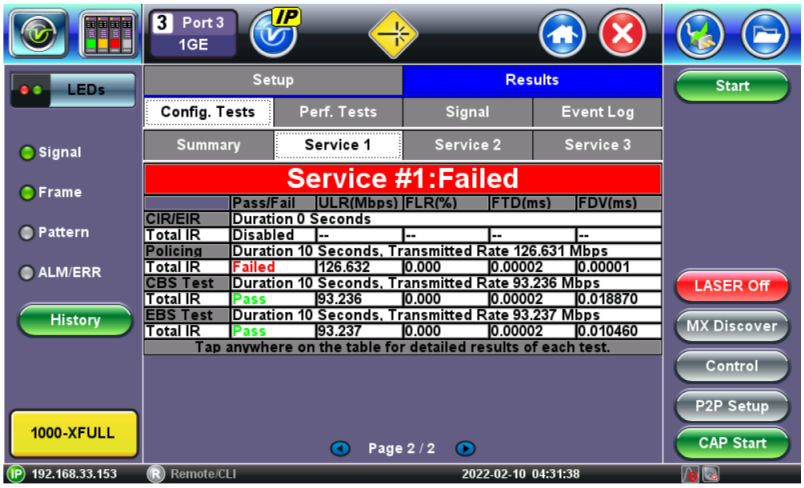
To access V-SAM results, swipe **up** and tap on **results**



Results - Config. Tests - Service 1



Results - Config. Tests - Service 1 Page 2

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

Configuration Test

The **Config. Tests** tab lists the Pass/Fail status of each service and test. Tapping on the table brings up a screen with **CIR** and enabled tests including **CIR/EIR, CBS, EBS,** and **Policing Test** results for the chosen Service**.** The test tabs display min, mean, and max values for **IR Mbps**, **FTD**, **FDV**, **Frame Loss Count**, and **Frame Loss Ratio (%).** If Step Load was selected for the CIR Test, these values will be displayed for each

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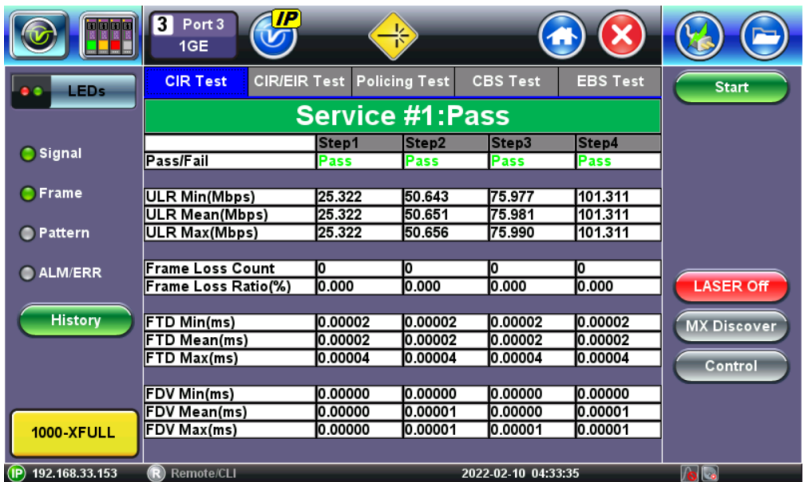
step. If any measured values do not meet the service test parameters set in the Bandwidth and Threshold tabs, the test fails.

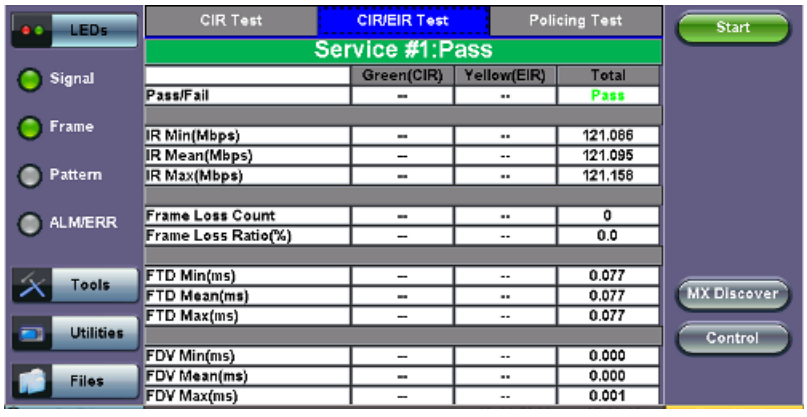
- **IR Mbps:** Information Rate. Measures the average Ethernet frame rate starting at the MAC address field and ending at the CRC.
- **FTD:** Measures the time that the frames can take to travel from source to destination.
- **FDV:** Measures the frame jitter.
- **Frame Loss Count:** Counts the number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



	Step1	Step2	Step3	Step4
Pass/Fail	Pass	Pass	Pass	Pass
ULR Min(Mbps)	25.322	50.643	75.977	101.311
ULR Mean(Mbps)	25.322	50.651	75.981	101.311
ULR Max(Mbps)	25.322	50.656	75.990	101.311
Frame Loss Count	0	0	0	0
Frame Loss Ratio(%)	0.000	0.000	0.000	0.000
FTD Min(ms)	0.00002	0.00002	0.00002	0.00002
FTD Mean(ms)	0.00002	0.00002	0.00002	0.00002
FTD Max(ms)	0.00004	0.00004	0.00004	0.00004
FDV Min(ms)	0.00000	0.00000	0.00000	0.00000
FDV Mean(ms)	0.00000	0.00001	0.00000	0.00001
FDV Max(ms)	0.00000	0.00001	0.00001	0.00001

Tap the Table to View Test Details such as CIR Test

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



	Green(CIR)	Yellow(EIR)	Total
Pass/Fail	--	--	Pass
IR Min(Mbps)	--	--	121.086
IR Mean(Mbps)	--	--	121.095
IR Max(Mbps)	--	--	121.156
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

Tap the Table to View Test Details such as CIR/EIR Test

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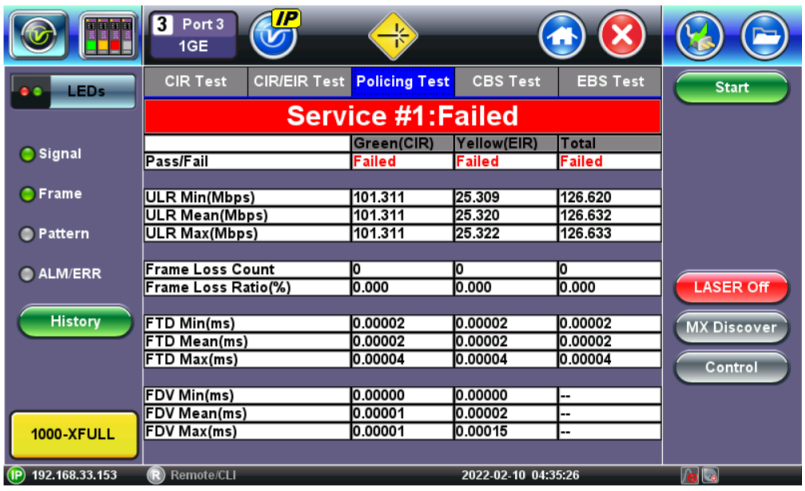
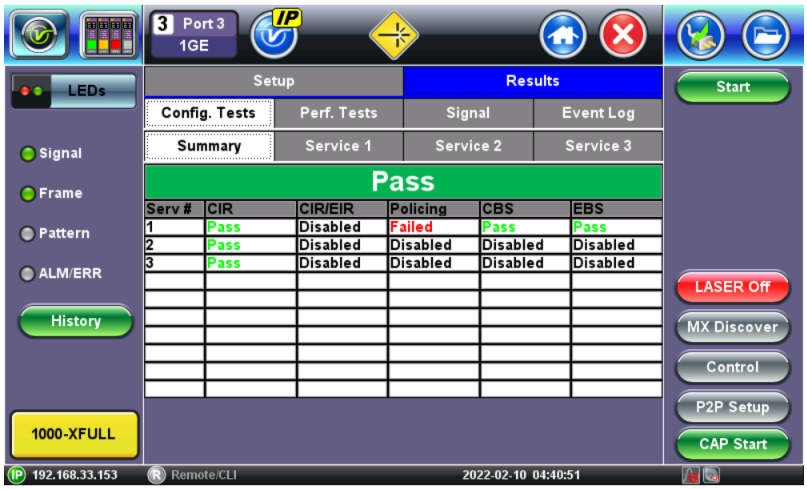
CIR/EIR test: The test passes if the received IR value is between the CIR (minus the margin allowed by the FLR) and CIR+EIR.



	Green(CIR)	Yellow(EIR)	Total
Pass/Fail	Failed	Failed	Failed
ULR Min(Mbps)	101.311	25.309	126.620
ULR Mean(Mbps)	101.311	25.320	126.632
ULR Max(Mbps)	101.311	25.322	126.633
Frame Loss Count	0	0	0
Frame Loss Ratio(%)	0.000	0.000	0.000
FTD Min(ms)	0.00002	0.00002	0.00002
FTD Mean(ms)	0.00002	0.00002	0.00002
FTD Max(ms)	0.00004	0.00004	0.00004
FDV Min(ms)	0.00000	0.00000	--
FDV Mean(ms)	0.00001	0.00002	--
FDV Max(ms)	0.00001	0.00015	--

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.



Serv #	CIR	CIR/EIR	Policing	CBS	EBS
1	Pass	Disabled	Failed	Pass	Pass
2	Pass	Disabled	Disabled	Disabled	Disabled
3	Pass	Disabled	Disabled	Disabled	Disabled

Results - Config. Tests - Summary

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

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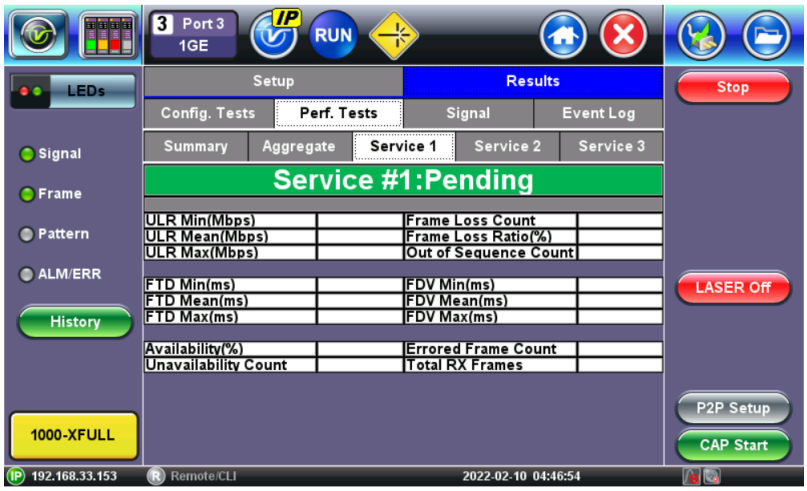

Perf. Test - Service 1

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**.

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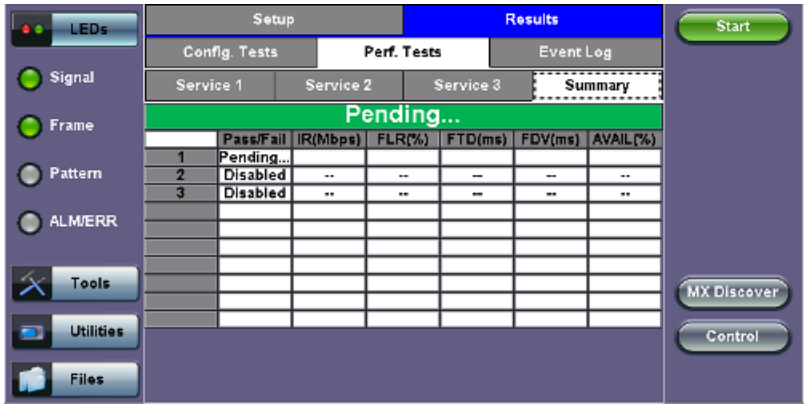
Perf. Tests - Summary

Signal tab: The Signal tab (fiber ports only) displays the optical level measured by the SFP transceiver. The RFC 2544 Signal tab is identical to the Signal tab for the BERT application. Refer to "Signal" on page 121 from the BERT section for more information.



Perf. Tests - Signal

Event Log

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

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Event Log

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Throughput Testing

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.

Setup

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

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

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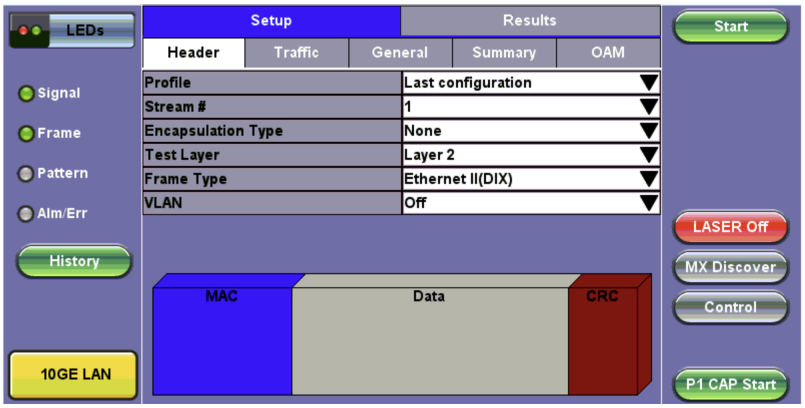

Setup Header

General Throughput Settings (Global Configuration)

Page 1:

- **# of Streams:** From 1 to 10streams.
- **Stream #:** Allocated Bandwidth per Stream: The total bandwidth for all streams cannot exceed 100%.
- **Total (%):** Sum of all stream rates in %.
- **Stream TX Start**: Coupled or Separated. Configures how the measurements are started for multiple streams.
    - **Separated:** Independent control (Start/Stop) of the transmitter is enabled. At the start of the test only the receiver is turned on -- the user must start the transmitter manually.
    - **Coupled:** Transmitter and receiver are turned on at the same time, and the Tx and Rx measurements start at the same time at the start of the test.

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Throughput Setup - General Settings

Page 2:

- **#of Streams:** From 1 to 10streams.

  # of Streams can be specified either on Page 1 or Page 2. It will be reflected on both pages.

- **Delay Measurement Mode:** Disable, Round Trip Delay. Local One way delay measurement, Atomic one way delay, or GPS one way delay are also available depending on the Glock Synchronization device selected in the Setup (home menu) > Measurement menu. Refer to Measurement Settings for more information. Round Trip Delay should only be enabled when running the test to a remote loopback.
- **Histogram:** Enable / Disable.
- **Sampling Period:** 1sec, 10secs, 30secs, 1min, 10min, 30min, 1hr. Defines how often the RTD (round trip delay) measurement is evaluated against the RTD threshold.
- **Threshold (Max RTD allowed):** Input the value in us, ms or sec. Defines the maximum allowed round trip delay value. If the RTD value exceeds the threshold, an event is logged with corresponding time stamp.
- **SDT Measurement**: Enable/Disable. The Service Disruption Test is triggered based on user established thresholds.

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

- **Traffic Loss Trigger:** If the receiver does not detect incoming traffic within the configured threshold time, a traffic loss trigger is recorded in the event log.
- **RTD Unit Auto Scale:** On/OFF.

Throughput Setup - General Settings(Page 2).

Multiple Streams

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

Per Stream Configurations

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

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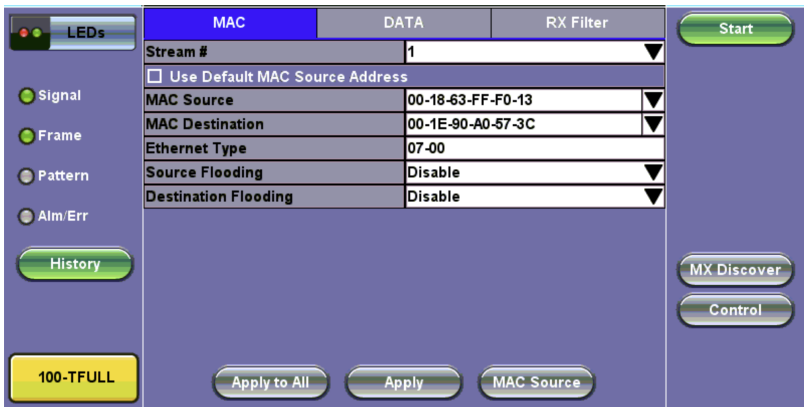
- "Header Settings " on page 98
- "MAC, VLAN, MPLS, IP, and Test Pattern Configurations" on page 100
- "Traffic Settings (Per Stream Configuration)" on the next page
- "Error Injection Setting (Per Stream Configuration)" on page 170

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

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.



MAC Setup

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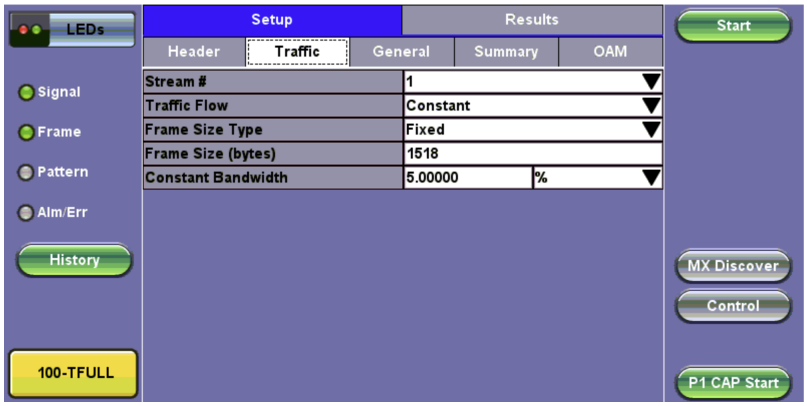
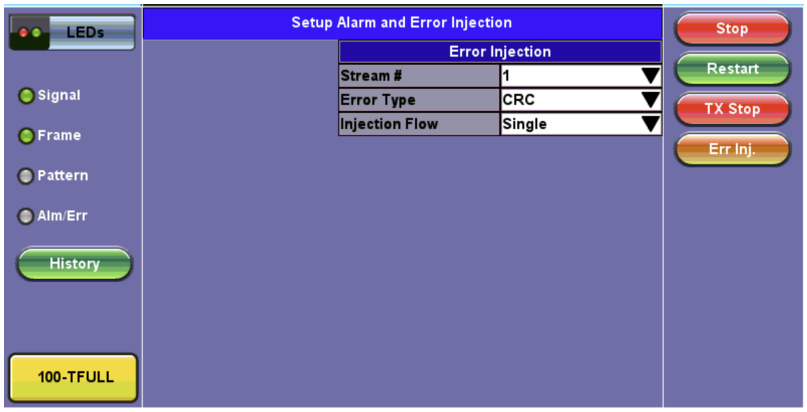


Throughput Setup - Traffic Setup - Constant Traffic Flow



Throughput Test - Error Injection Settings per Stream

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

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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 BERT Traffic Settings.

Throughput Setup - Traffic Setup - Constant Traffic Flow

Error Injection Setting (Per Stream Configuration)

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), Sync Header Error, Block Type Error, Pause, or Bit. With Pause selected, the unit will transmit a pause frame when the **Error Injection** icon is pressed. The Pause time duration is configurable in

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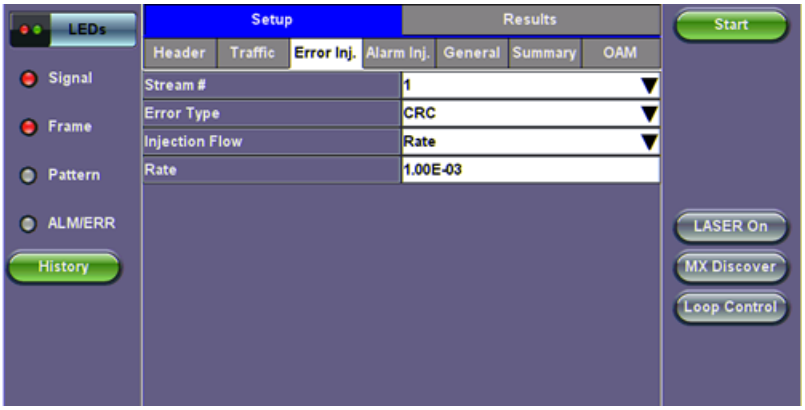
units of 512 bit time. At Gigabit Ethernet speed, this is equivalent to 512 ns. For example, if pause time is set to 1000, the pause duration will be set to 1000x512 ns.

- **Injection Flow:** The error injection flow determines how the selected errors will be injected. The user can select a single error, a specific count, or rate.
- **Count and Rate:** The user will be able to configure the error count via numeric keypad.



Throughput Test - Error Injection Settings per Stream

Alarm Injection settings

Alarm injection can be performed during the 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, PCS-HI-BER, PCS-LOBL
- **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.

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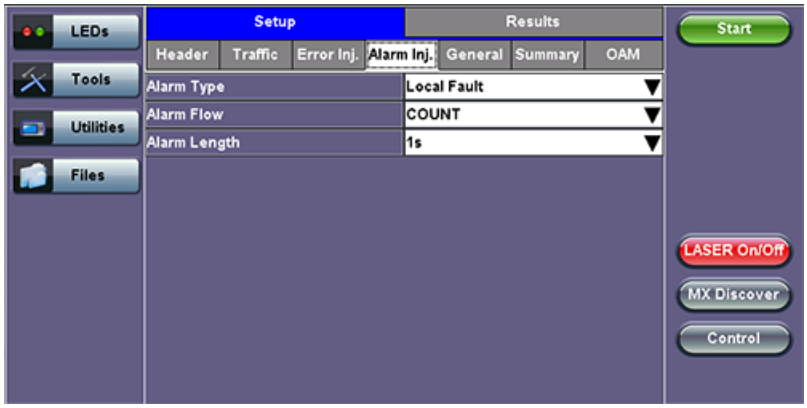
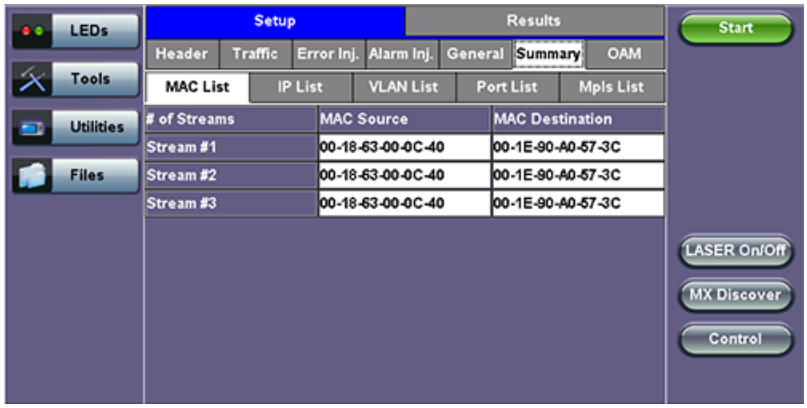


Throughput Alarm Injection Setup

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)
- Throughput Test - Summary (MPLS List)
- Throughput Summary Gateway List

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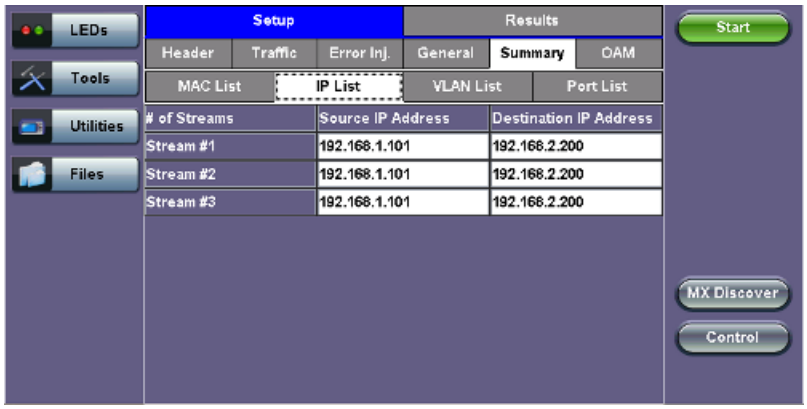
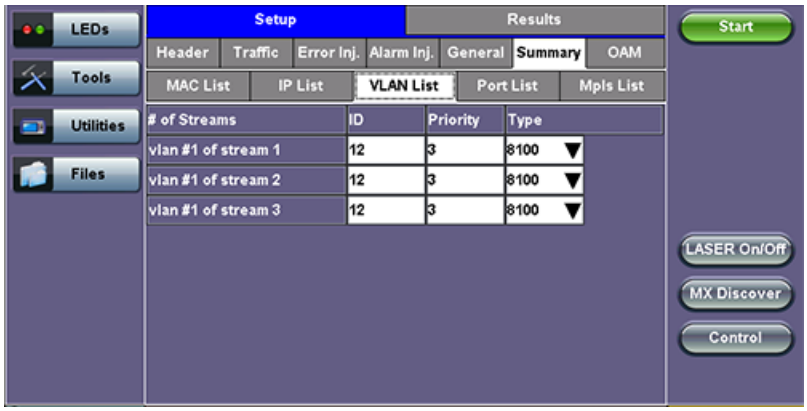
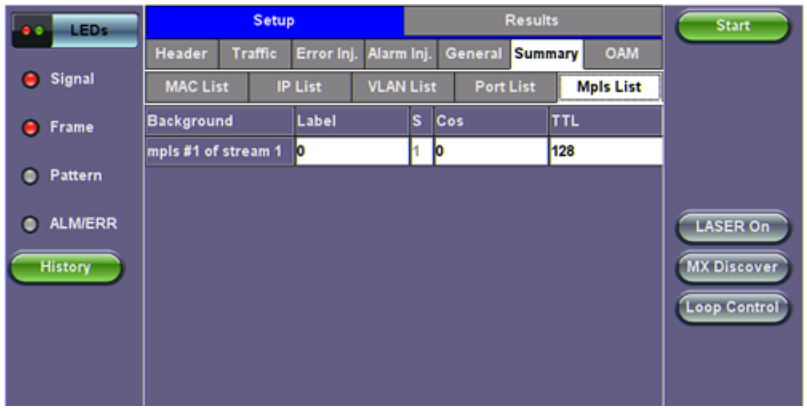
Throughput Test - Summary (MAC List)



Throughput Test - Summary (IP List)



Throughput Test - Summary (VLAN List)



Throughput Test - Summary (MPLS List)

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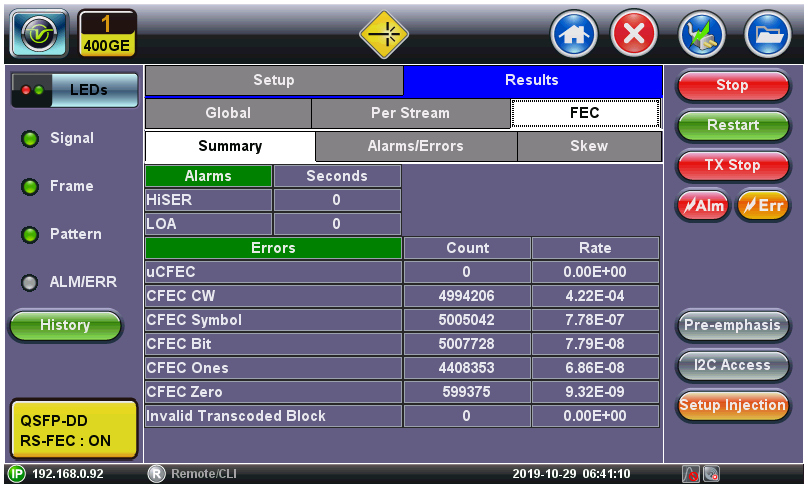
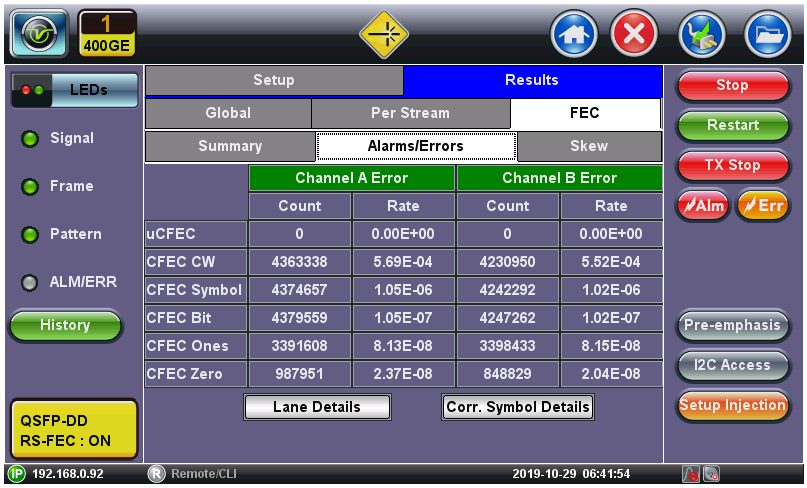


Throughput Test - FEC Summary



Throughput Test - FEC Alarm/Errors

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Lane ID	FEC ID	LOAMPS	CFEC Symbol		CFEC Bit	
		Seconds	Count	Rate	Count	Rate
0	1	0	2605134	4.39E-07	2615677	4.41E-07
1	0	0	136819	2.31E-08	136847	2.31E-08
2	3	0	1490082	2.51E-07	1490784	2.51E-07
3	2	0	246636	4.16E-08	246705	4.16E-08
4	5	0	8080	1.36E-09	8080	1.36E-09
5	4	0	231414	3.90E-08	231420	3.90E-08
6	7	0	3251532	5.48E-07	3253730	5.49E-07
7	6	0	2122789	3.58E-07	2124004	3.58E-07
8	9	0	12466	2.11E-09	12466	2.11E-09
9	8	0	23677	4.01E-09	23677	4.01E-09
10	11	0	552156	9.35E-08	552194	9.35E-08
11	10	0	164257	2.78E-08	164259	2.78E-08
12	12	0	44817	7.59E-09	44817	7.59E-09
13	13	0	22819	3.86E-09	22819	3.86E-09
14	14	0	103966	1.76E-08	103966	1.76E-08
15	15	0	64647	1.10E-08	64648	1.10E-08

Throughput Test - FEC Alarm/Errors Lane Details

FEC Correctable Symbol Breakdown	Count	Percentage
FEC Corr. Sym 1 Count	13910364	99.70631
FEC Corr. Sym 2 Count	40372	0.28938
FEC Corr. Sym 3 Count	567	0.00406
FEC Corr. Sym 4 Count	30	0.00022
FEC Corr. Sym 5 Count	4	0.00003
FEC Corr. Sym 6 Count	0	0.00000
FEC Corr. Sym 7 Count	0	0.00000
FEC Corr. Sym 8 Count	0	0.00000
FEC Corr. Sym 9 Count	0	0.00000
FEC Corr. Sym 10 Count	0	0.00000
FEC Corr. Sym 11 Count	0	0.00000
FEC Corr. Sym 12 Count	0	0.00000
FEC Corr. Sym 13 Count	0	0.00000
FEC Corr. Sym 14 Count	0	0.00000
FEC Corr. Sym 15 Count	0	0.00000

Throughput Test - FEC Alarm/Errors Corr. Symbol Details

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Throughput Test - Skew

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.

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

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

Throughput Results

Viewing Throughput (Multiple Streams) Test Results

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

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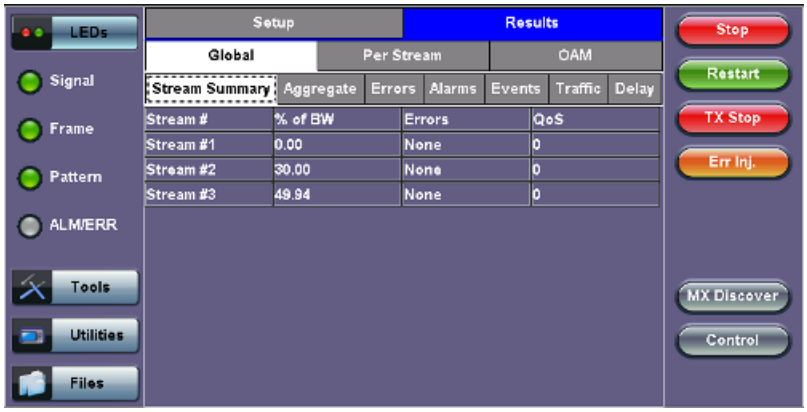
Global/Aggregate Results

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

The **Stream Summary** screen displays:

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



Throughput Results - Global Stream Summary

QoS

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

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

IP Network QoS Class Definitions and Network Performance Objectives (Classes 0-3)

Network Performance Parameter	QoS Classes			
	Class 0	Class 1	Class 2	Class 3
IPTD	≤ 200 ms/2	≤ 800 ms/2 (400	≤ 200 ms/2	≤ 800 ms/2 (400

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	(100 ms one-way)	ms one-way) AND > 200 ms/2	(100 ms one-way)	ms one-way) AND > 200 ms/2
IPDV	≤ 50ms	≤ 50ms	U	U
IPLR	> 1/100,000 AND ≤ 1/1000	> 1/100,000 AND ≤ 1/1000	> 1/100,000 AND ≤ 1/1000	> 1/100,000 AND ≤ 1/1000
IPER	> 1/1,000,000 AND ≤ 1/10,000	> 1/1,000,000 AND ≤ 1/10,000	> 1/1,000,000 AND ≤ 1/10,000	> 1/1,000,000 AND ≤ 1/10,000

IP Network QoS Class Definitions and Network Performance Objectives (Classes 4-7)

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

The **Aggregate** screen displays these parameters:

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

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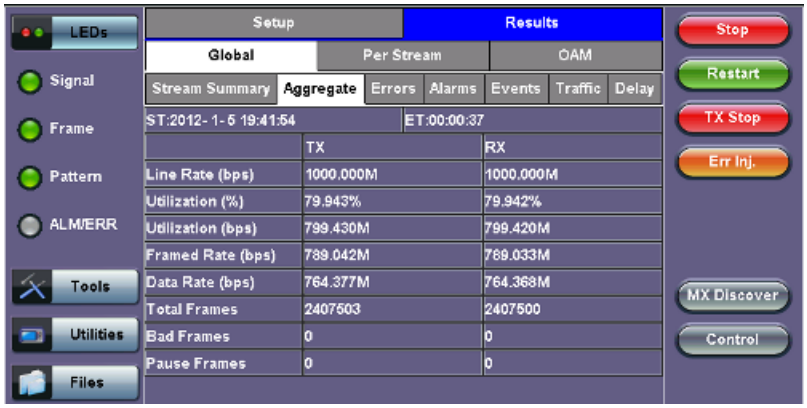
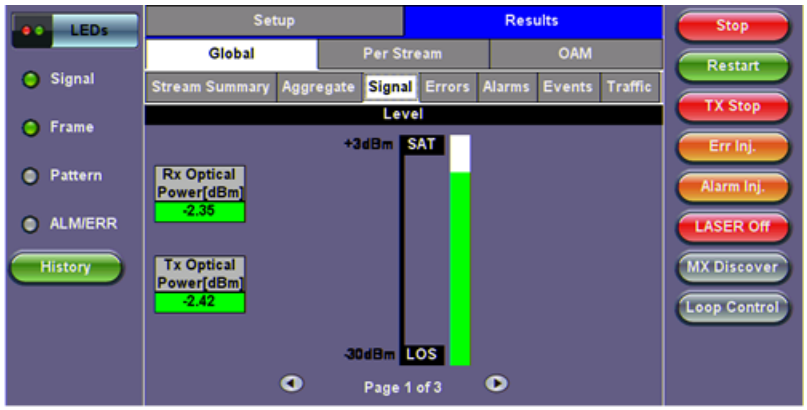


Throughput Results - Global Aggregate

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

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



Throughput Results - Global Signal (Page 1)

Signal (Page 2)

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

Signal (Page 3)

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

- **Current:** Indicates the frequency of the input signal.
- **Offset:** Indicates the difference between the standard rate and the rate of the input signal.

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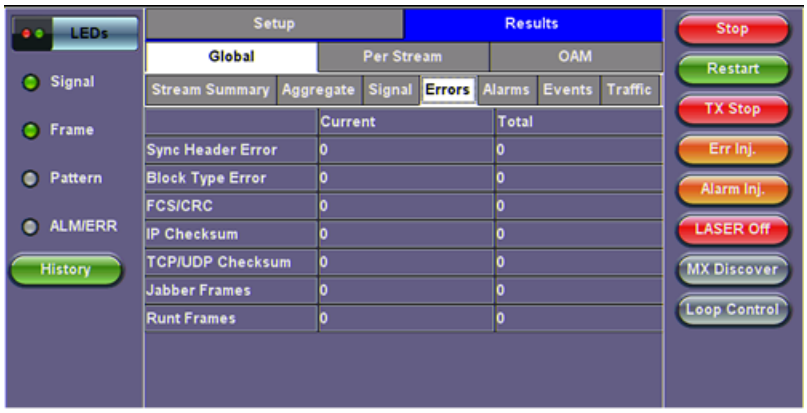
- **Min (ppm):** Indicates the difference between the standard rate and the minimum deviation detected in the input signal.
- **Max (ppm):** Indicates the difference between the standard rate and the maximum deviation detected in the input signal.

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

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

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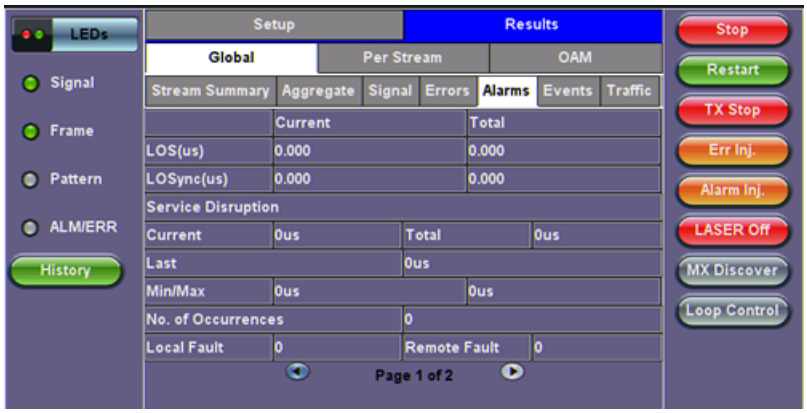
- **LOS:** Loss of Signal .
- **LOSync:** Loss synchronization .
- Service disruption associated with loss of signal:
  - **Current:** Duration of the current service disruption.
  - **Total:** Total accumulated duration of the service disruptions.
  - **Min/Max:** Minimum and maximum duration of the service disruption events.
  - **No. of Occurrences:** Counter of service disruption events.
- **Local/Remote Fault**
- **PCS-HI-BER:** PCS High BER.
- **PCS-LOBL**: PCS Loss of Block Lock.



Throughput Results - Global Alarms

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

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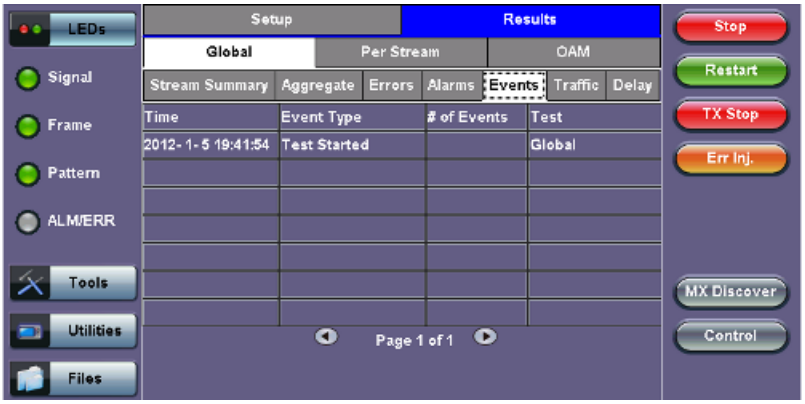
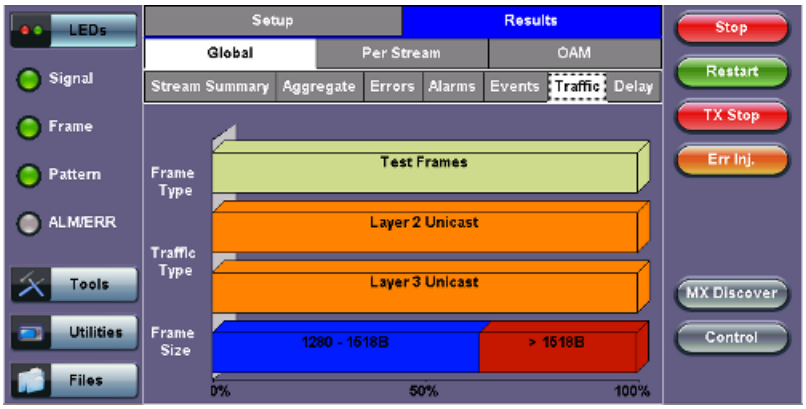


Throughput Results - Global Events

The **Global Traffic** screen displays:

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



Throughput Results - Global Traffic Summary

Tap on the **bar graph** for frame and traffic distribution statistics.

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

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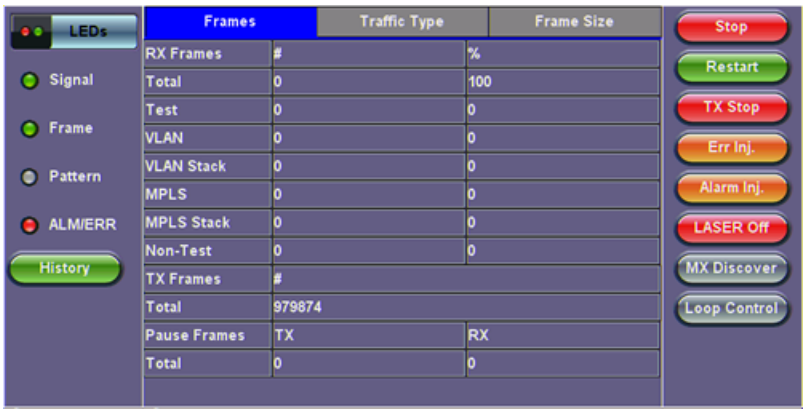
- **Received (RX) frames:**
  - Total frames.
  - Test frames.
  - VLAN tagged frames.
  - Q-in-Q VLAN stacked frames.
  - Non-test frames.
- **Transmitted (TX) frames:**
  - Total frame - Total # frames transmitted.
- **Pause frames:** Total number of transmitted and received Ethernet pause flow-control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



Throughput Results - Frames Type

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

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

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

- < 64 bytes frames
- 64-127 byte frames

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- 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

Per Stream Results

The **Per Stream** tab displays the same type of statistics as seen in Global Results.

*For descriptions of the parameters in each tab, with the exception of **Rates**, please refer back to "Global/Aggregate Results" on page 178.*

- **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.

  Round trip delay measurements are only available in the per-stream results screen and requires a traffic loop at the far-end.
- **Rates:** Rate information associated with each stream.

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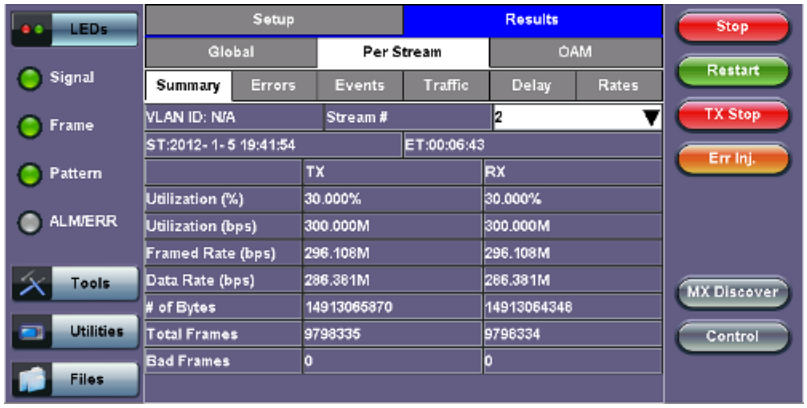

Throughput Results - Summary per Stream

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**

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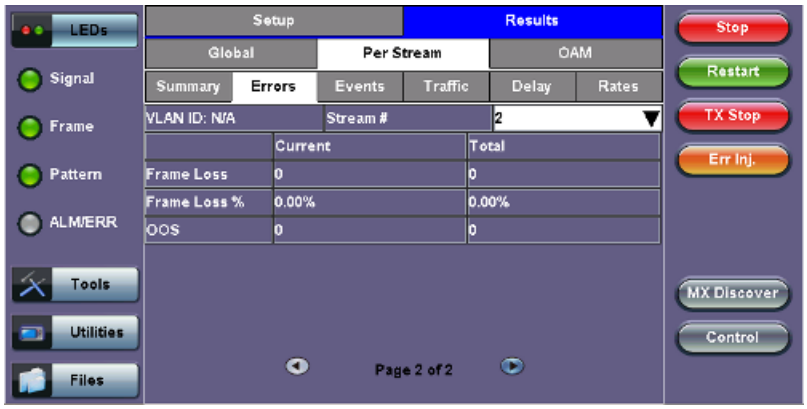
Throughput Results - Errors per Stream



Throughput Results - Errors per Stream (page 2)

Service Disruption Test (SDT)

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

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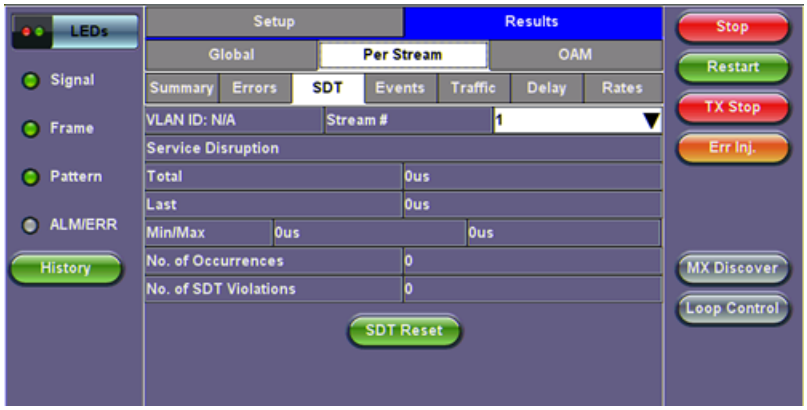
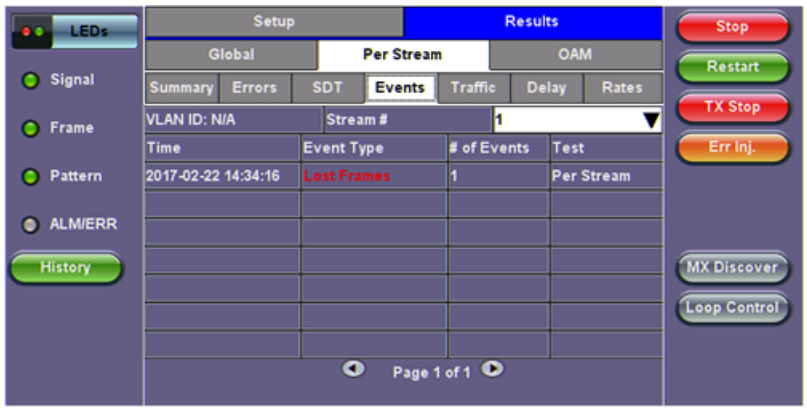


SDT Per Stream Results

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

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

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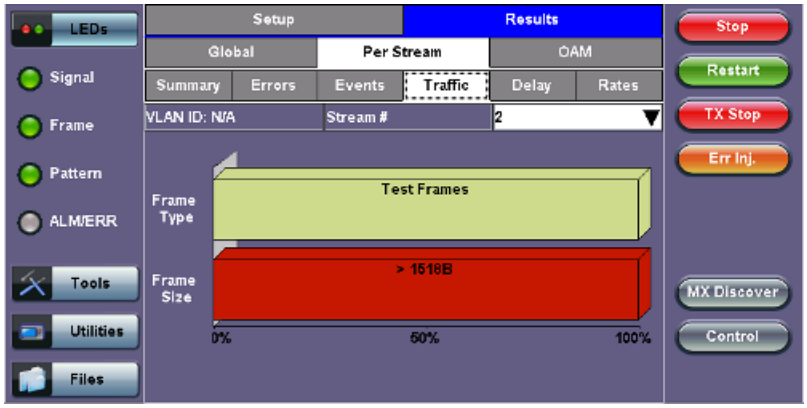

Throughput Results - Traffic per Stream

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

Round Trip Delay Results per Stream - Summary

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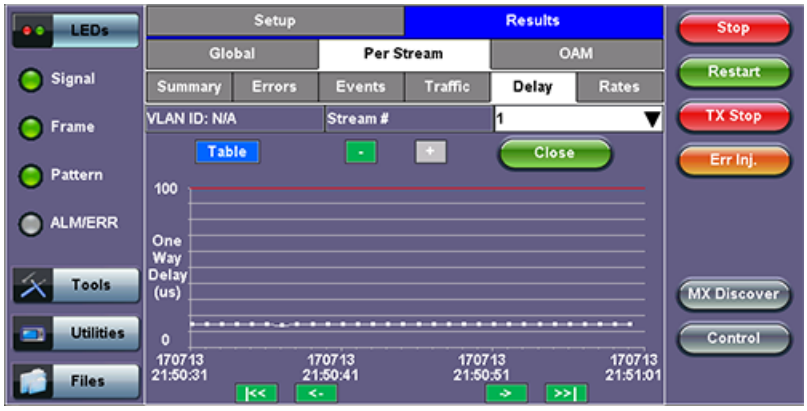
Round Trip Delay Histogram

One Way Delay Results and Histogram (Table and Graph)

Throughput Results - Delay per Stream (One Way Delay)



Throughput Results - One Way Delay Histogram Graph

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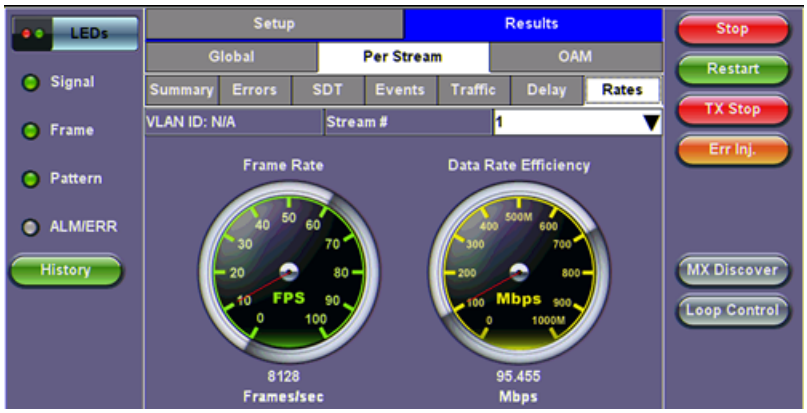
Throughput Results - One Way Delay Histogram Table

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



Throughput Results - Rates per Stream

Throughput Results - Rates per Stream (Rate Details)

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Saving Throughput (Multiple Streams) Results

Once the test has been stopped the results can be saved by pressing the **Save** key on the VePAL's keypad. The results will be saved and named automatically. Once the results are saved, the user may view or rename the results file by going to File Manager at **Utilities** > **Files** > **Saved.** Refer to File Manager

Autoscripting

Autoscripting runs BERT[1] and Throughput[2] test profiles in succession.

Profiles are configured from the test application or ReVeal software.

Autoscripting Setup

Setup

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

---

[1]BERT or bit error rate test is a testing test method for digital communication circuits that uses predetermined stress patterns consisting of a sequence of logical ones and zeros generated by a test pattern generator.
[2]Throughput is one of the key metrics in performance testing. It's used to check how many requests a software will be able to process per second, per minute or hour. As a rule, every test plan has a throughput goal.

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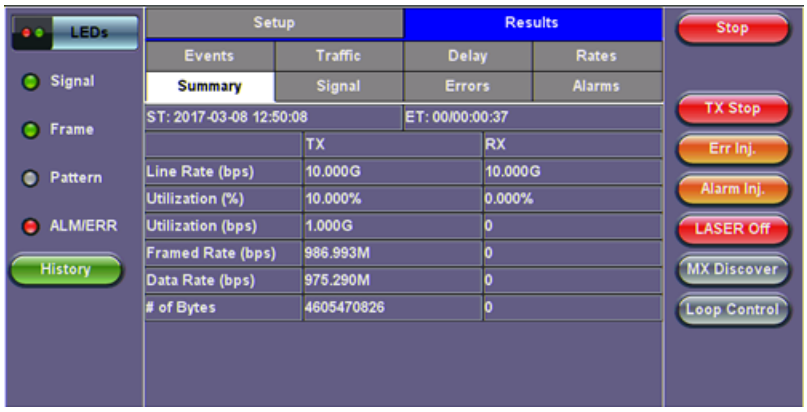
- Testing duration can be set for seconds, minutes, hours, or days.
- Tap **View Setup** to view test setup parameters. Setup cannot be configured from this menu.

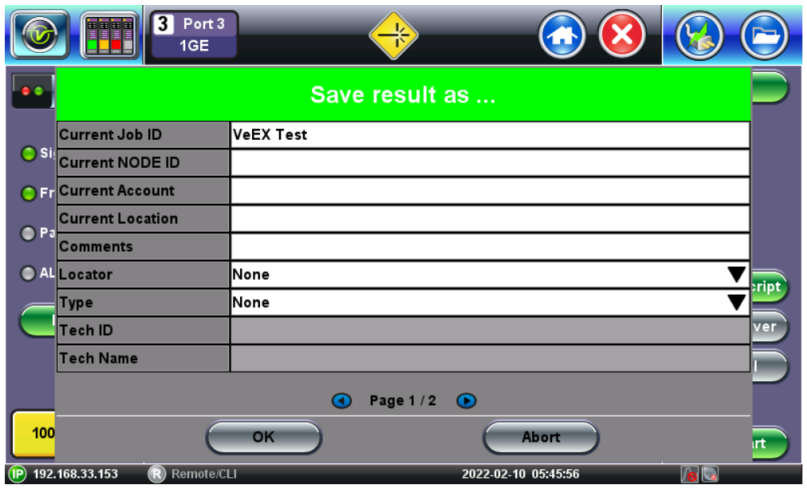
Tap the green **Start** button to begin Autoscripting. The soft LED light indicates the status of finished tests:

Green: No error or alarm was detected.

Red: An error or alarm was detected.



Autoscripting - BERT Results



Autoscripting - Saving Results

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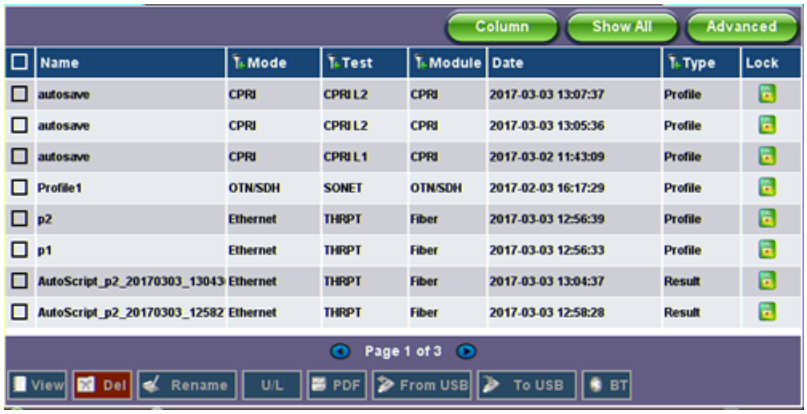
Autoscripting - Saving Results

Results

Starting the test brings up the BERT/Throughput Results tab. Test status is displayed in green on the bottom of the screen. When testing finishes, results are automatically saved. Use the File Manager to access saved results.



File Manager - Saved Results

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Packet Capture

Packet Capture Setup

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

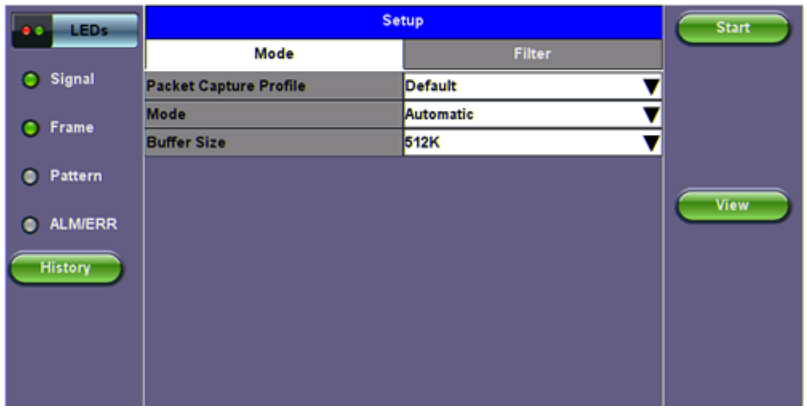
The following packet capture options are available in the **Capture Mode** tab:

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

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

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

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



Capture Mode Setup

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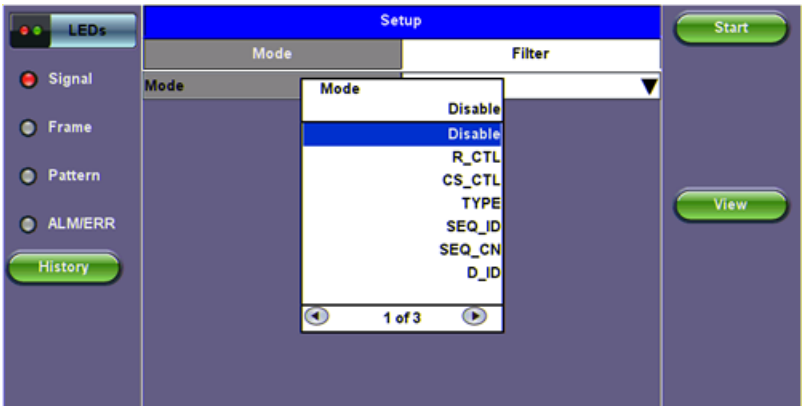
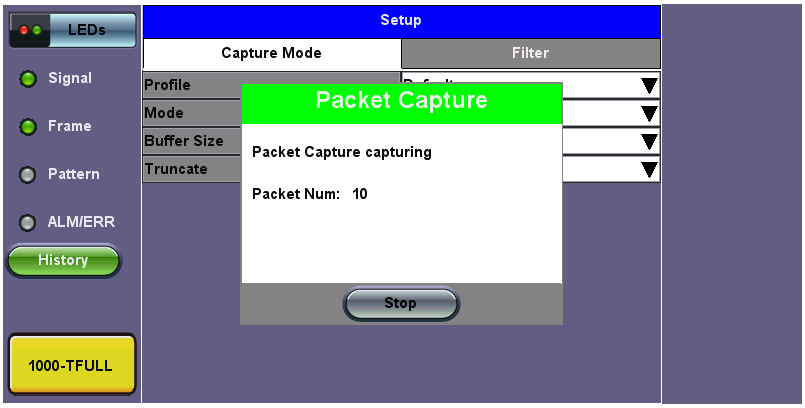
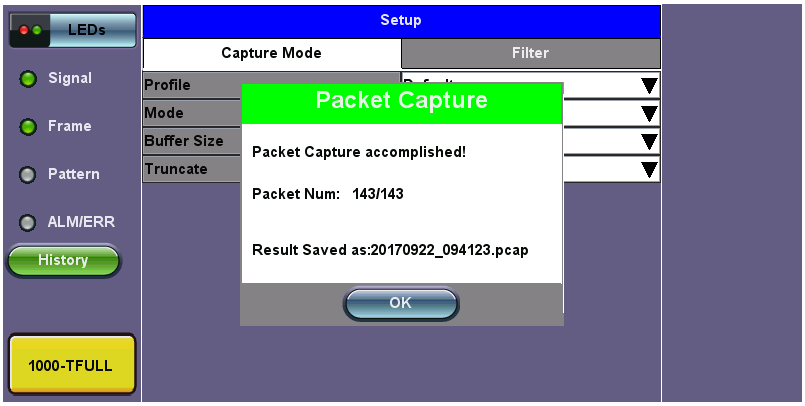


Filter



Packet Capture In Progress



Packet Capture Save

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Capture Save

Packet Capture Results

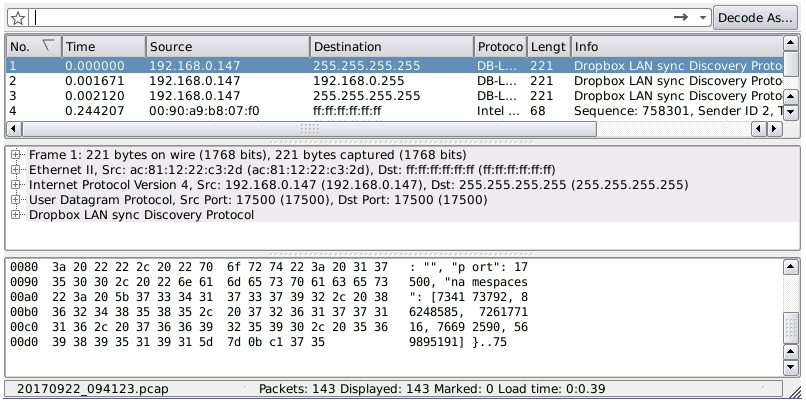
To finish packet capture and manage packet capture results, press **Stop**.

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

The file is stored in the Files folder. It can be viewed on the test set or exported and analyzed on PC Wireshark. Refer to File Management.

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.



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Top section:

- Time
- Source
- Destination
- Protocol
- Length
- Info

Middle and Lower Sections:

- Frame details
- Ethernet frame details

Lane BERT

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

Lane BERT Setup

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

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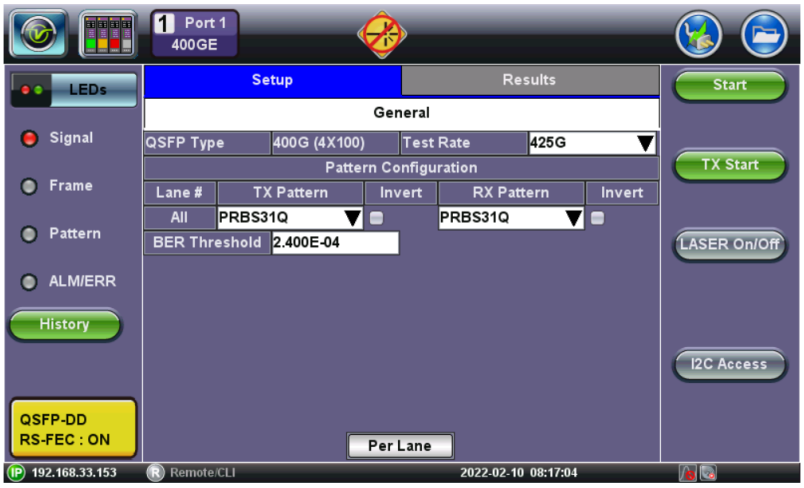

Lane BERT Setup Per Lane

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

The options to set PRBS patterns per lane or for all lanes is available in newer 40G/100G/400G modules, depending on the test set and software version.

Lane BERT Results

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

Lane BERT Signal

Signal (Page 1-2)

The Signal tab (fiber ports only) displays the receiving (RX) and transmitting (TX) optical level measured by the QSFP28, QSFP-DD, QSFP+ or OSFP transceiver.

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

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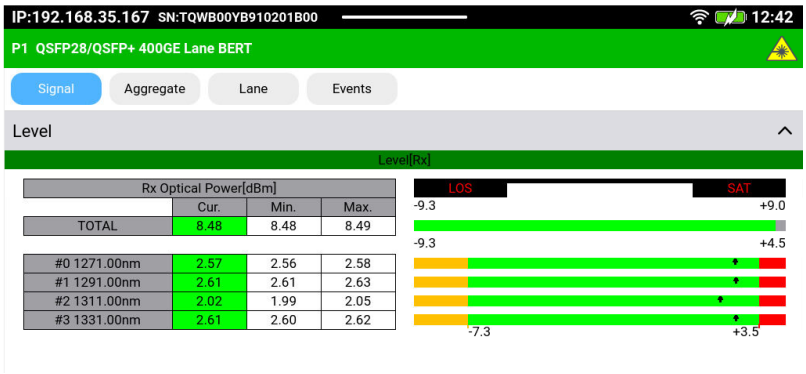

Signal (Page 1)

Signal

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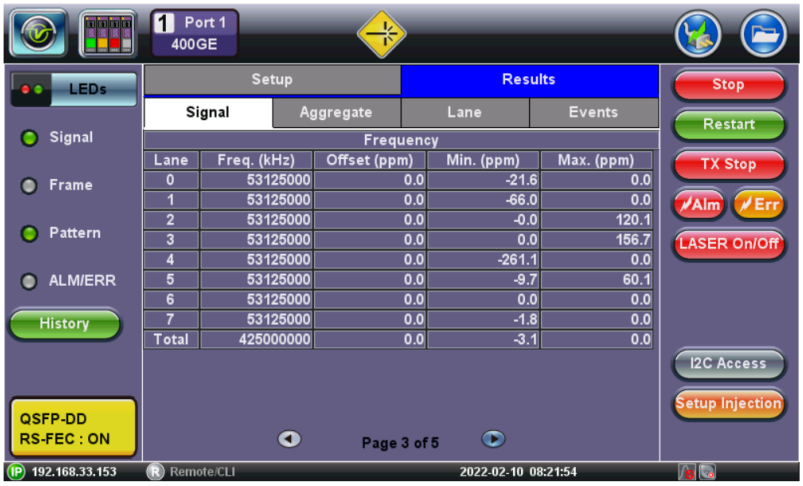
Signal (Page 3)

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

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



Signal (Page 3)

Signal (Page 4-5)

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

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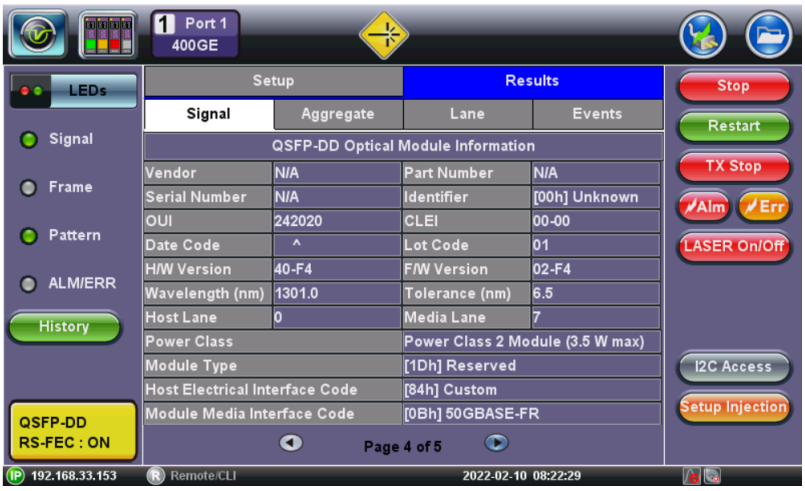
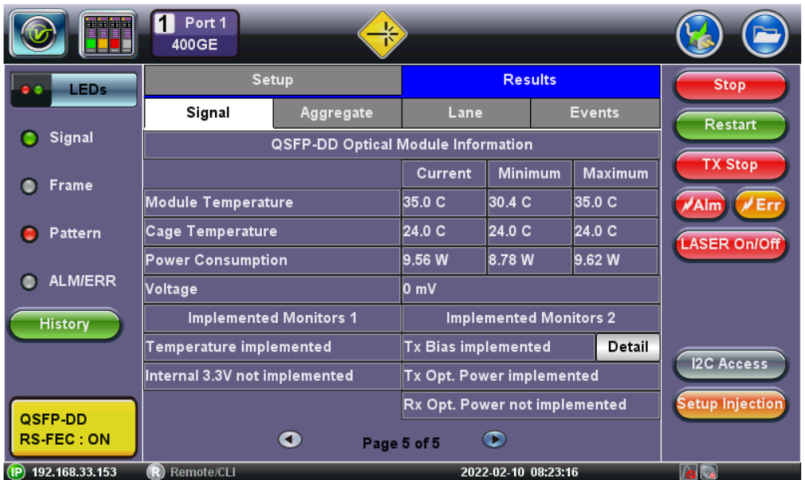


Signal (Page 4)



Signal (Page 5)

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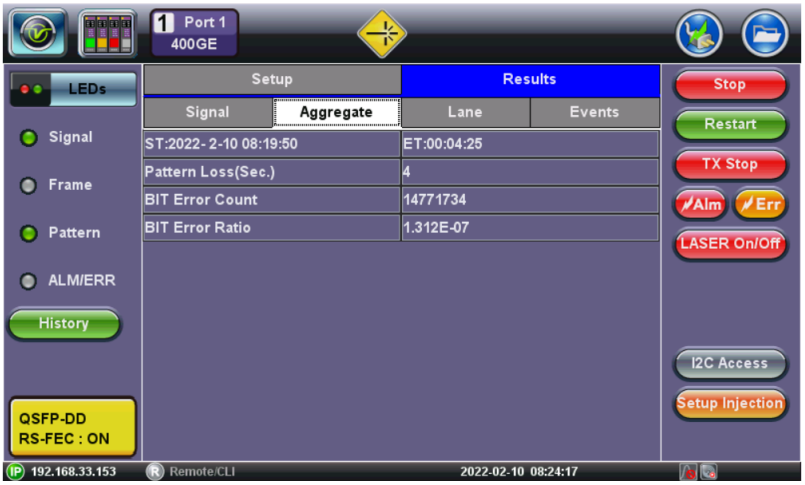
Lane BERT Aggregate

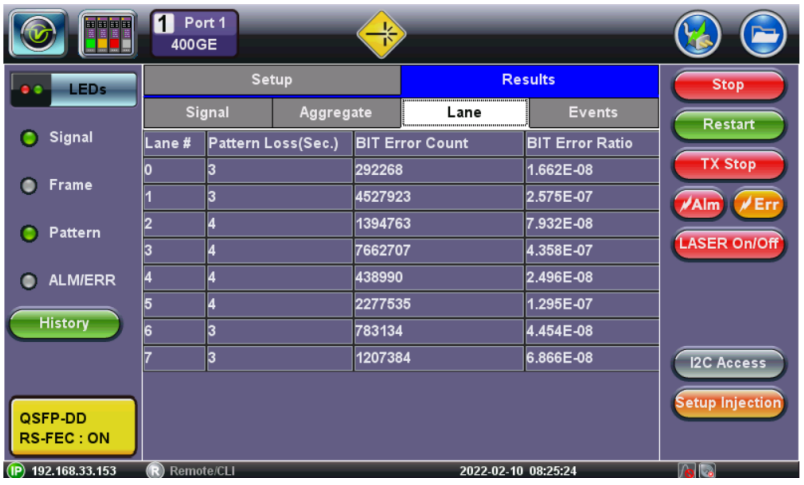
The Aggregate tab displays errors related to the test pattern (Bit Error or Pattern Loss).



Aggregate

Lane BERT Lane

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



PCS Results - Alarms/Errors

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Lane BERT Events

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

PCS Results - Events

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FEC

FEC Codeword Symbol Error Distribution

- Verify/Monitor PAM4 Signal Integrity
  - Codeword Symbol Error distribution
- PAM4 always has pre-FEC Errors
  - Differentiate between Correctable and Uncorrectable Errors
  - Identify how hard FEC is working
  - Benchmark/Compare transceiver preformances
  - Beyond 15 Symbol Errors per Codeword, the errors become Uncorrectable and start affecting the payload
- Zero post-FEC Errors
  - Client/Test traffic payload must remain Error Free (no uncorrectable errors)

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FEC Setup

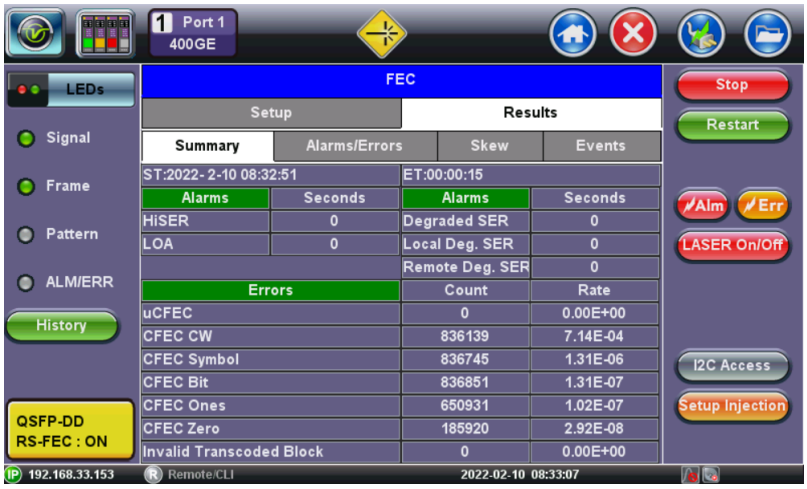
(400G Only)

Stress Test Setup: After configuring setup, tap **Start**.

FEC Setup

FEC Result Summary

Results Summary: Tap on the **Results>Summary** tab to view test results.



FEC Results Summary

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FEC Alarms/Errors

FEC Results Alarms/Errors Lane Details

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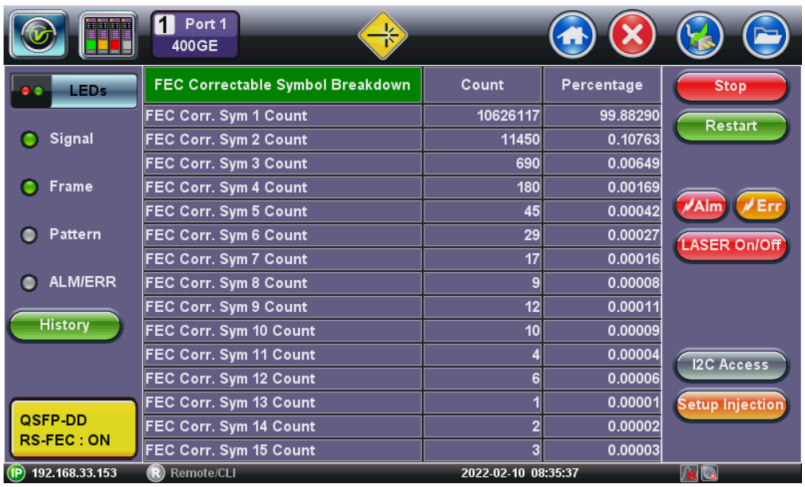
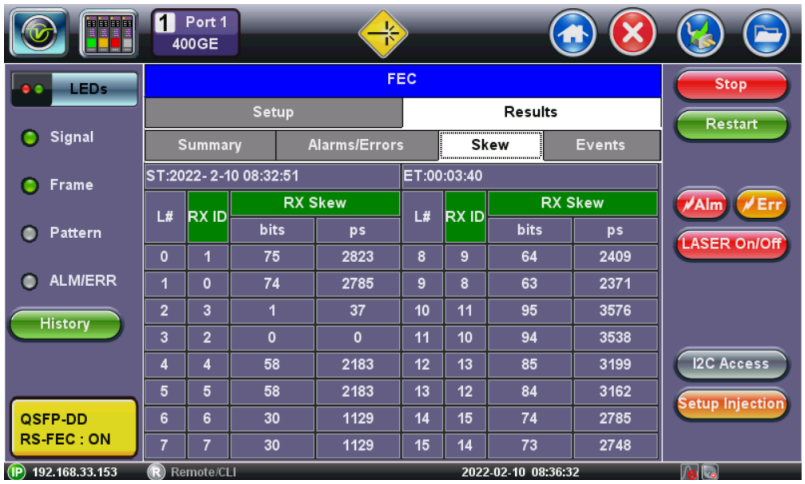


FEC Results Alarms/Errors Corr. Symbol Details

Skew



FEC Skew

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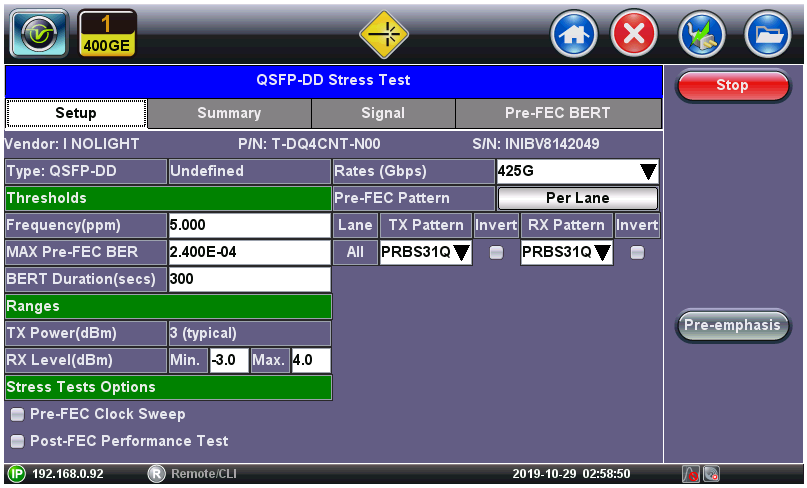
Advanced Optical Transceiver Test & Stress Test

Advanced Optical Transceiver Test & Stress Test

The **Transceiver Stress Test** and **Advanced Optical Transceiver Test** features perform a batch of PASS/FAIL tests to check the health and capabilities of high-speed transceivers. From checking optical signal power levels, Lane BERT (pre-FEC) performance, voltage and frequency swing tolerances, I2C/MDIO registers read/write, pre-emphasis manipulation, all the way to verifying error-free Ethernet Throughput.

Transceiver Stress Test

Stress Test Setup: After configuring setup, tap **Start**.



Stress Test Setup

Stress Test Summary: Tap on the **Summary** tab to view the test summary.

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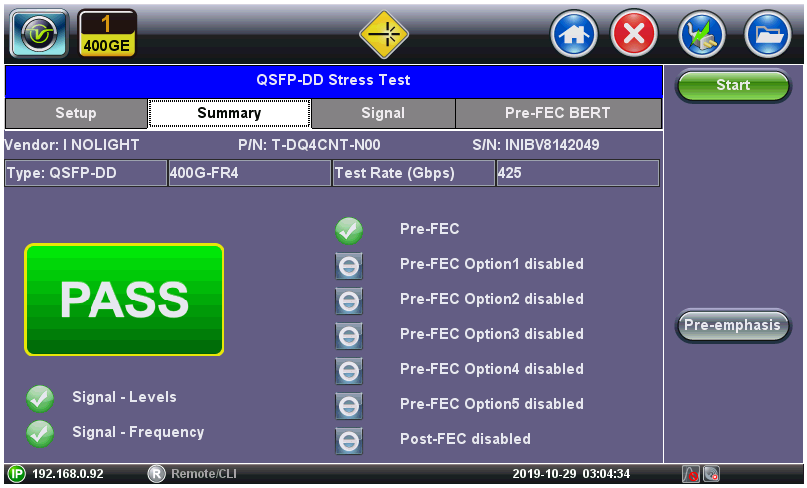
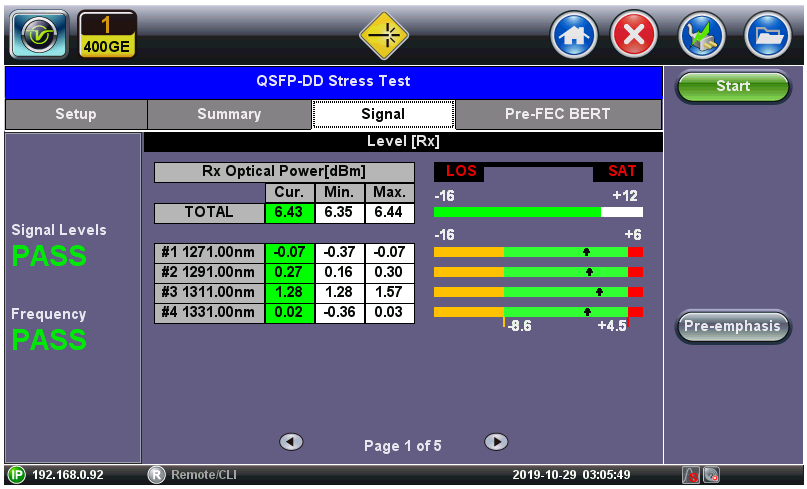


Stress Test Summary

Stress Test Signal Tab (Page 1): Tap on the **Signal** tab to view Signal Level (RX)



Stress Test Signal (Page 1)

Stress Test Signal Tab (Page 2): Tap on the **Signal** tab to view Signal Level (TX)

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Stress Test Signal (Page 2)

Stress Test Signal Tab (Page 3): Tap on the **Signal** tab to view Signal Frequency

Stress Test Signal (Page 3)

Stress Test Signal Tab (Page 4): Tap on the **Signal** tab to view QSFP Optical Module Information

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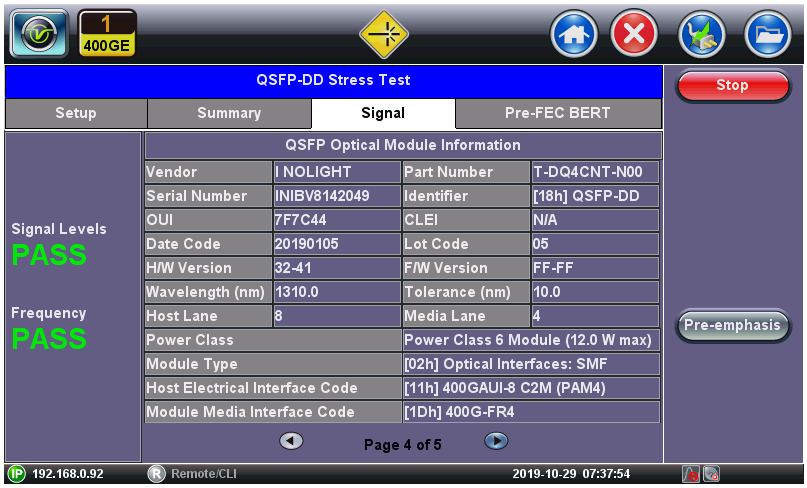

Stress Test Signal (Page 4)

Stress Test Signal Tab (Page 5): Tap on the **Signal** tab to view QSFP Optical Module Status

Stress Test Signal (Page 5)

Pre-FEC BERT Aggregate Tab: Tap on the **Pre-FEC BERT** tab and tap Start. The test will show as running.

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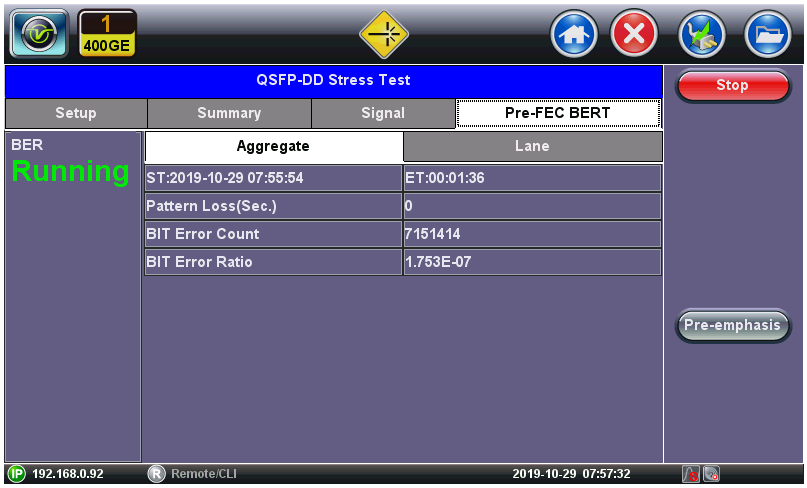
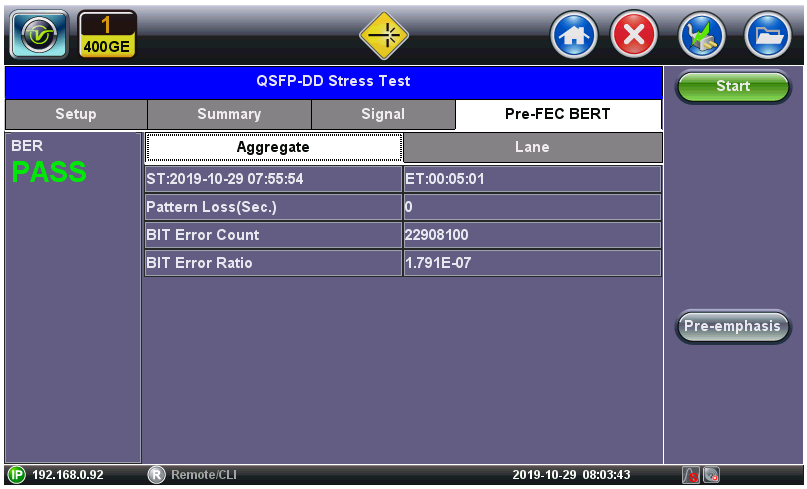


Stress Test Pre-FEC BERT Aggregate

Pre-FEC BERT Aggregate Pass: Once the test has finished the screen will show as **Pass**



Stress Test Pre-FEC BERT Aggregate PASS

Pre-FEC BERT Lane Tab: Tap on the **Pre-FEC BERT>Lane** tab and tap **Start**. The test will show as running.

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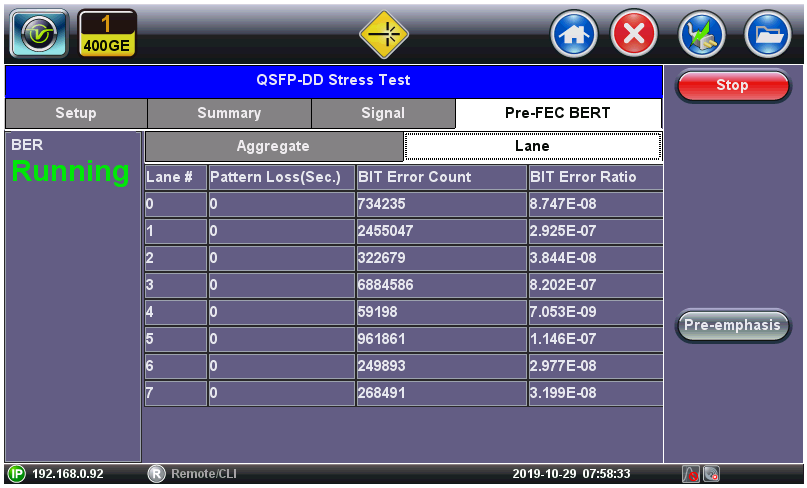
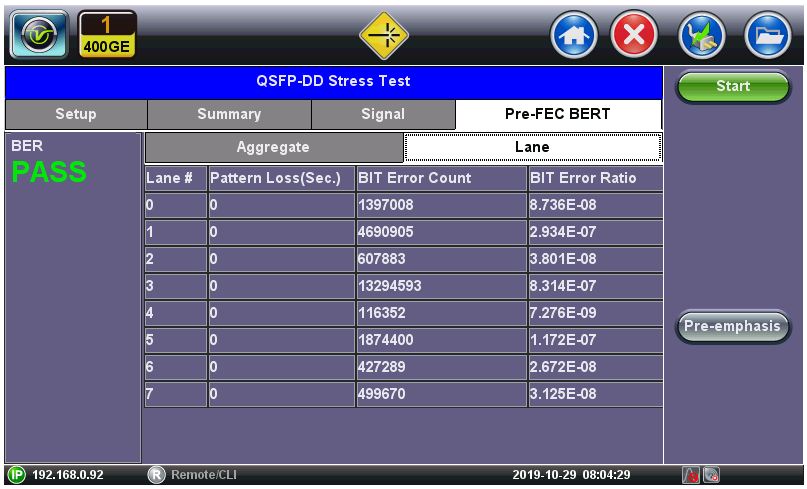


Stress Test Pre-FEC BERT Lane

Pre-FEC BERT Lane Pass: Once the test has finished the screen will show as **Pass**



Stress Test Pre-FEC BERT Lane Pass

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Advanced Optical Transceiver Test

To access the advanced optical transceiver test select **OSFP** or **QSFP-DD** port buttons, select **Other Functions**, then **Advanced Optical Transceiver Testing**.

Setup: The left side of the screen contains all the configuration items. Tap on the different buttons to have access to general Setup, Voltage swing, Pre-FEC BERT, Frequency Offset, Pre-emphasys settings and I2C registers read/write access.

Use the check boxes to enable or disable the different sub tests.

Results: The right side of the screen shows the different results. The status indicators on top (Pre-BER, Frequency Offset, Temperature, TX Optical Power, RX Optical Power, Supply Voltage) not only show the current results, but provide access to the detailed results if you tap on them.

Advanced Optical Transceiver Setup

Module Tab: Tab on the **module** tab to view module information.

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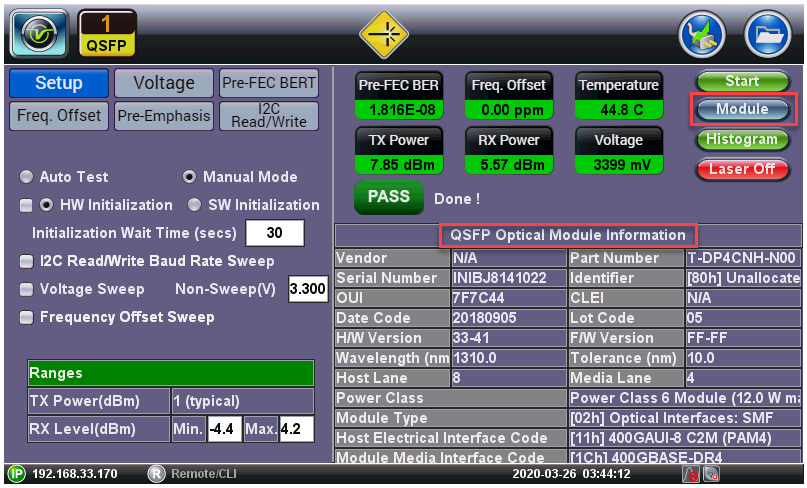
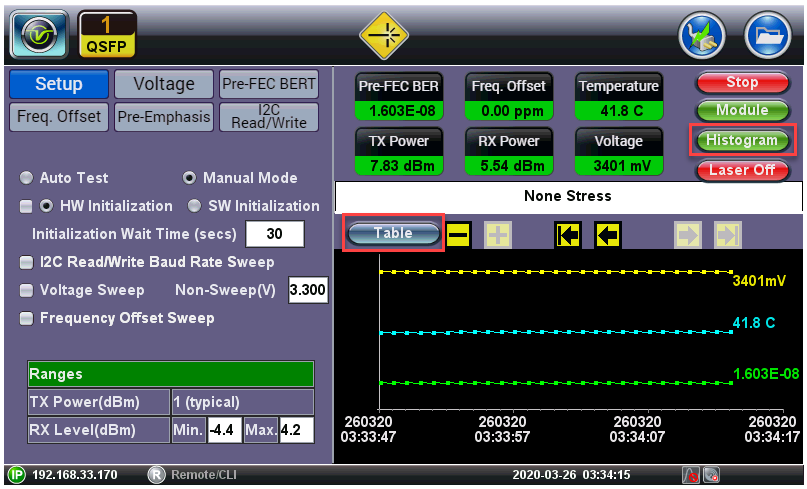


Advanced Optical Transceiver Module

Histogram Tab: Tap on the **histogram** tab, can be viewed in Table or Graph form.



Advanced Optical Transceiver Histogram Graph

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Advanced Optical Transceiver Histogram Table

Voltage Tab:

Advanced Optical Transceiver Voltage

Pre-FEC BERT Tab:

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Advanced Optical Transceiver Pre-FEC BERT

Freq. Offset Tab:

Advanced Optical Transceiver Freq. Offset

Pre-Emphasis Tab: Tap on the **Pre-Emphasis** tab to view the **TX Pre-equalization settings**. To return to the previous screen tap on the red cross.

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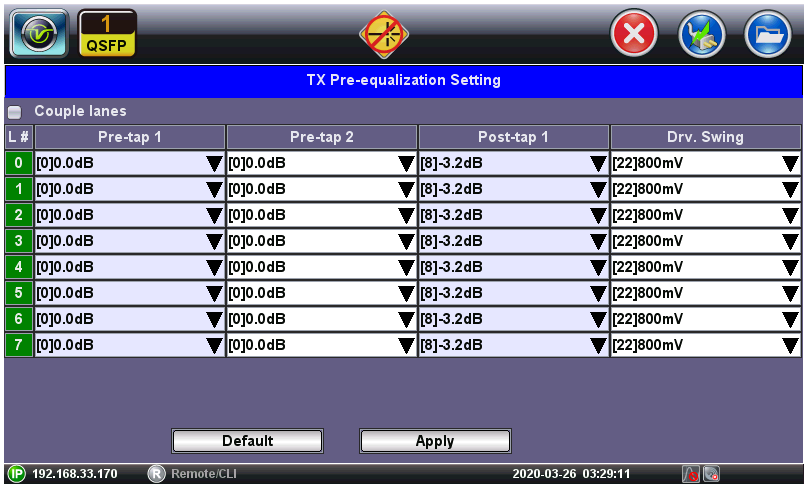

Advanced Optical Transceiver Pre-Emphasis

I2C Tab: Tap on the **I2C** tab to view the **I2C** Access. To return to the previous screen tap on the red cross.

Advanced Optical Transceiver I2C Read/Write

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OTU3/OTU4

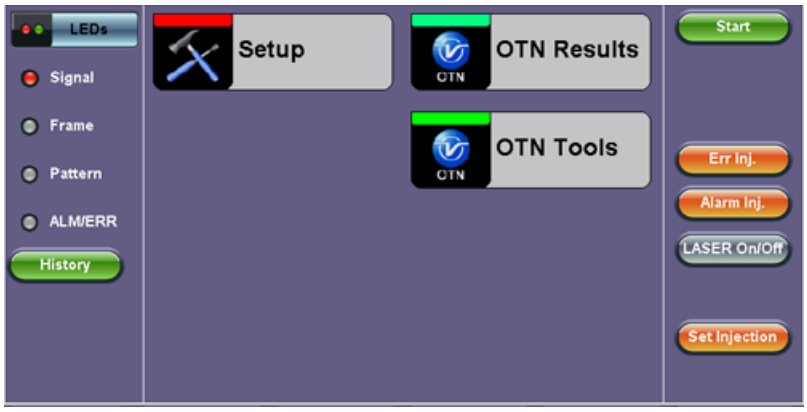
OTU3/OTU4 Test App

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.

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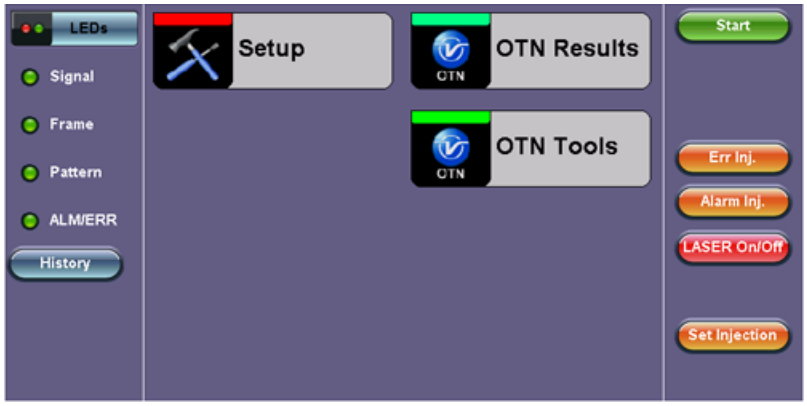

Ready for Testing Tasks

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

The following fields are pre defined:

- **Payload:** Bulk.

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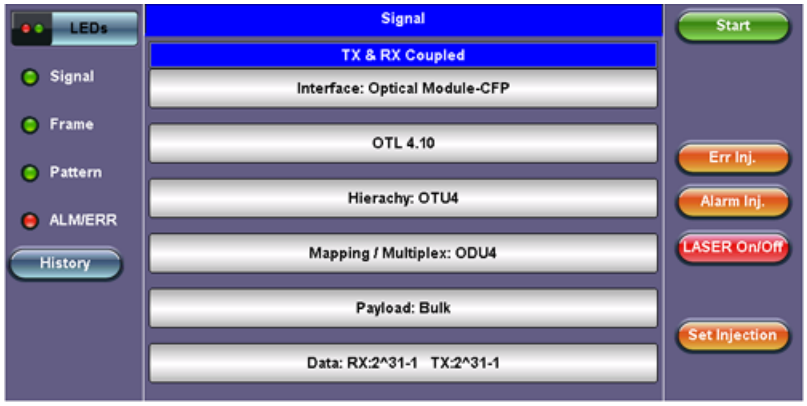
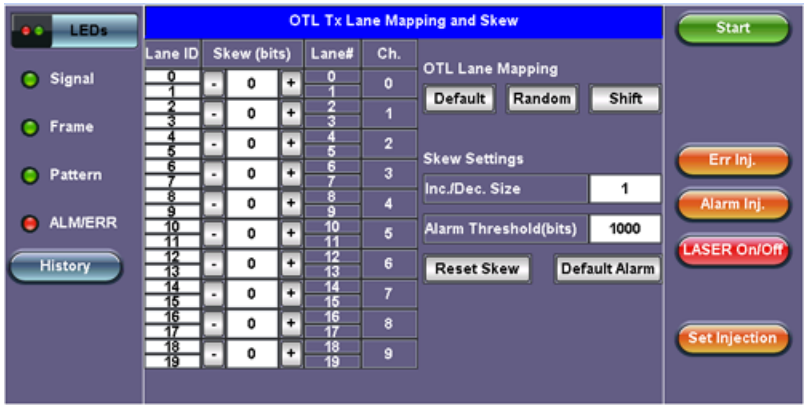


OTU4 Setup Home

OTL

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



OTL Tx Lane Mapping and Skew

Hierarchy

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.

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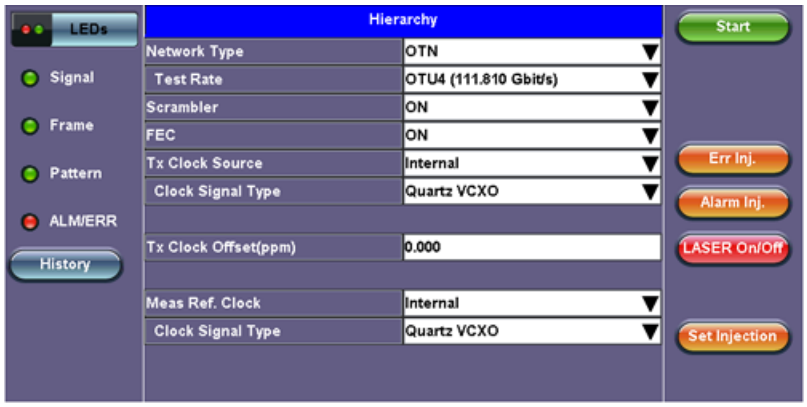
- **Tx Clock Source:**
  - **Internal:** The clock for the transmitter is derived from the internal clock. The internal clock has an accuracy of +/- 3.5ppm conforming to G.812 recommendations.
  - **Received:** The clock for the transmitter is derived from the received signal and the jitter of the incoming 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)

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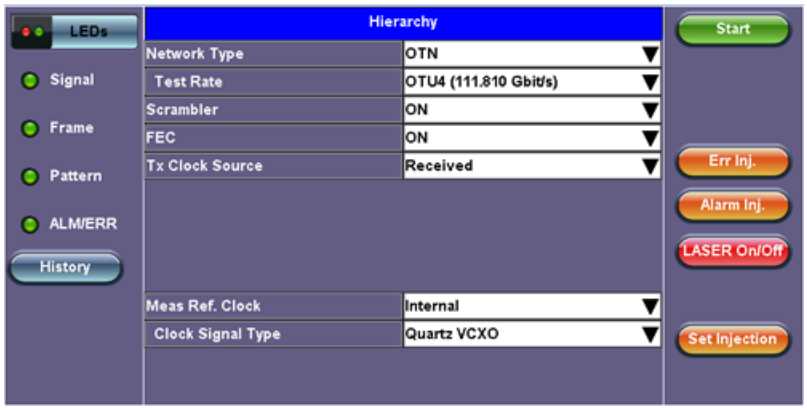
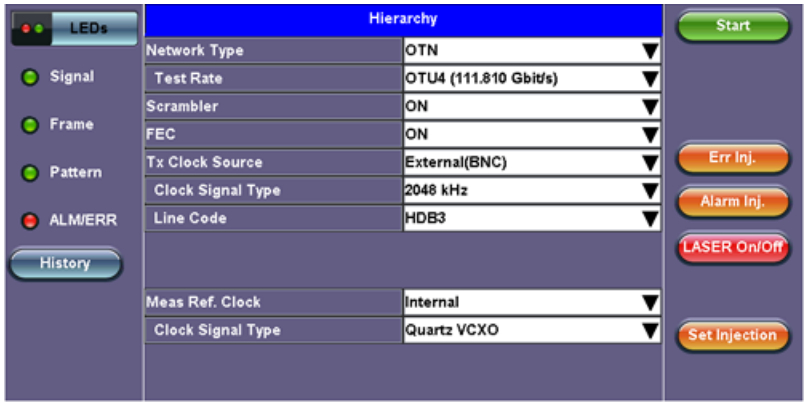


OTU4 Heirarchy Setup (Received Clock)



OTU4 Heirarchy Setup (External Clock)

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

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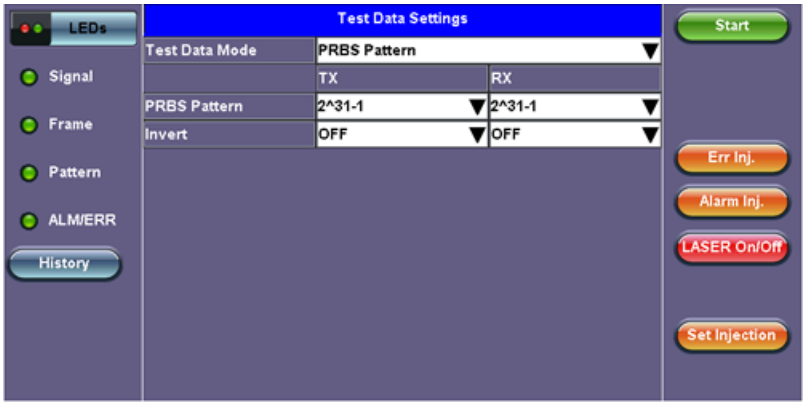

OTU4 Setup - Test Data Settings

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OTN, SDH/SONET, PDH/Dns Test Mode

Setup

OTN, SDH/SONET, PDH/DSn Test Mode Setup

Accessing Setup: Please see "Launching Test Applications" on page 46 for information on launching Test Applications.

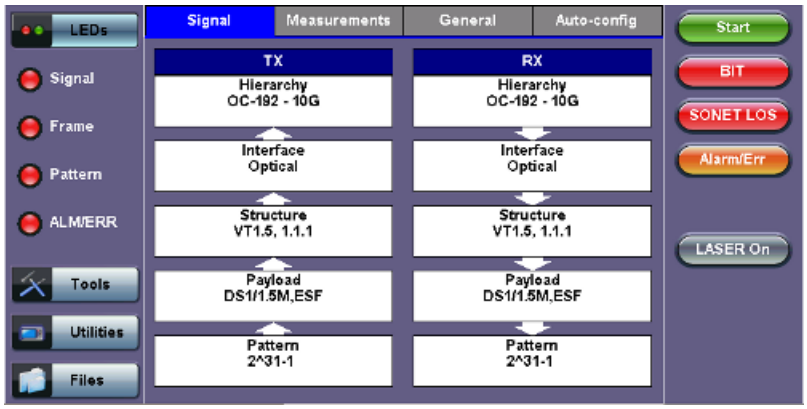
SONET Home Page

After selecting the test application, Setup page is shown. The **Setup** page has four tabs for setting the SDH/SONET and PDH parameters: Signal, Measurements, General, and Auto-Config tabs.

Signal Setup

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

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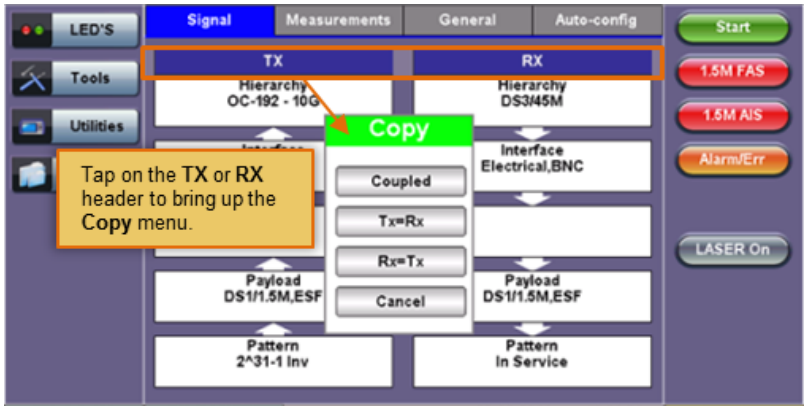
TX and RX Configurations

The Transmitter (TX) and Receiver (RX) configurations are grouped into a simple yet intuitive block diagram. The TX and RX signal parameters can be modified by tapping the applicable block which displays 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 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.

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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 SDH, SONET, PDH signal and network types, including the bit rate and higher order mapping, if applicable.

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

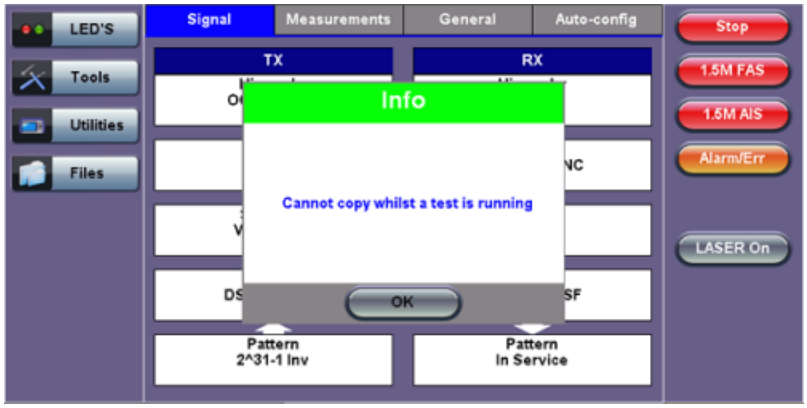
Structure: Applies to SDH/SONET signals only and allows the user to configure lower order mapping and the channel number.

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

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

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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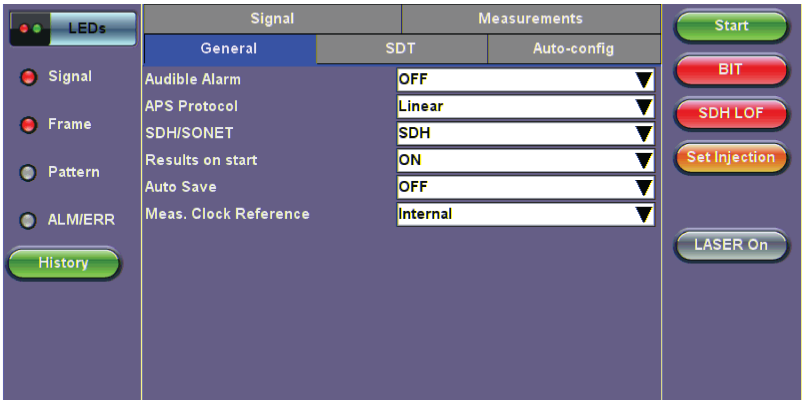

SDH/SONET selection from the General tab

SDH/SONET Selection from the General tab

Accessing PDH Testing

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

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

Transmitter/Receiver Setup

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

Hierarchy

Tapping the Hierarchy box opens the Hierarchy setup screen, allowing users to select the test interface and rate. The screen examples shown in this part of the manual depict and describe the settings for 1.5M or DS1 signals. Options for other bit rates and modes are described in text format.

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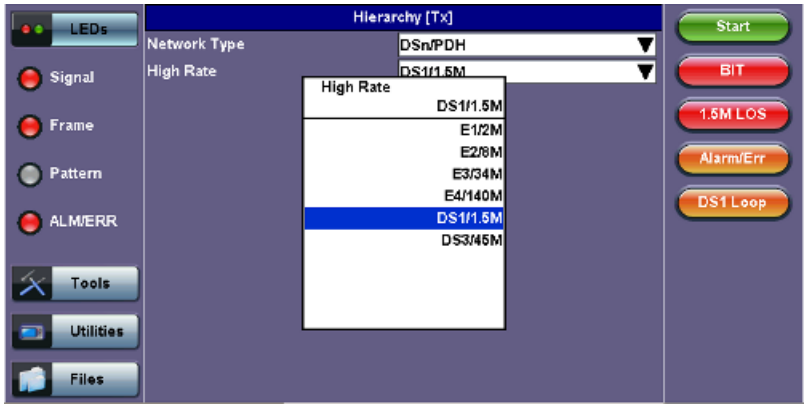
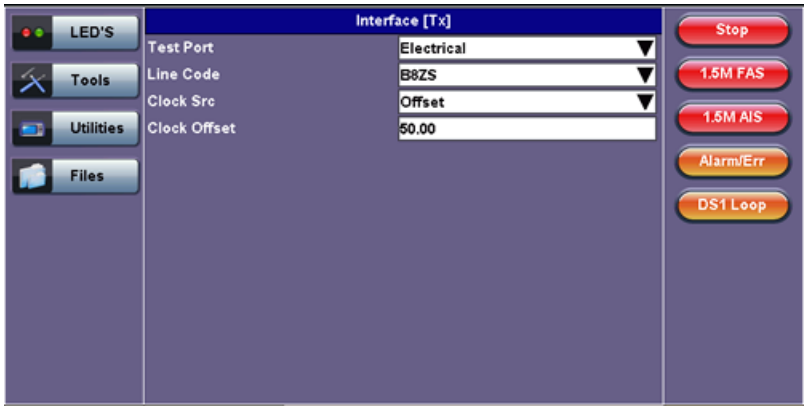


Tx Hierarchy Setup

- **Network Type:** Select PDH as the network type.

Interface

Tapping the **Tx** Interface box opens the electrical Interface Setup screen shown below.



Tx Interface Setup

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

- In DS1 mode, the line code options default to B8ZS or AMI
- In DS3 mode, the line code is B3ZS or AMI

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

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

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

Clock Source, can be configured as follows:

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

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

Payload

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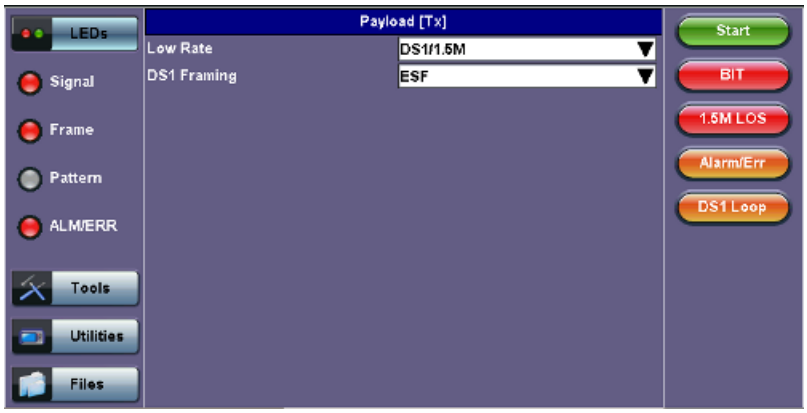
Tapping the Payload box opens the Tx Payload Setup screen.



Tx Payload Setup

Low Rate (test payload):

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

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

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

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

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

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

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

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

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

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

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

Framing:

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

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- In E1 mode, the options are unframed, PCM31, PCM31C, PCM30, and PCM30C. Framing conforms to G.704 and G.706 recommendations and are briefly described below. Te C indicates whether the CRC4 checking is turned ON or OFF.
- In E2 mode, the option is framed G.742.
- In E3 and E4 mode, the options are unframed, framed G.751.

For Nx64 and Nx56 rates:

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

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

- *Unframed signal types are not supported in the Nx64 fractional mode because framing is required to determine the location of timeslots.*
- *Timeslots 1-31 correspond to channels 1-31 when using PCM-31 framing. When using PCM-30 framing, timeslots 1-15 correspond to channels 1-15, while timeslots 17-31 correspond to channels 16-30. Timeslot 16 is used for the Multi Frame Alignment Signal.*

Pattern

Tapping the **Pattern** box opens the Tx Pattern Setup screen shown below. Any binary test sequence can be applied to all PDH/DSn and SDH/SONET rates; however, ITU-T recommends certain sequences depending on the bit rate under test.

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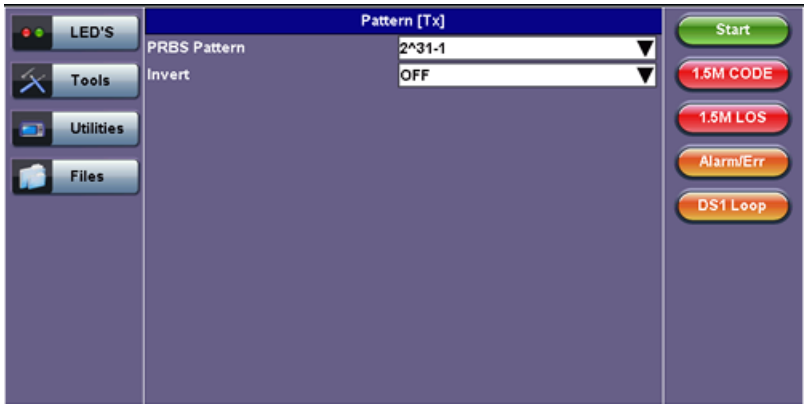

Tx Pattern Setup

- **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.

ITU-T specification 0.150 recommends the following test patterns:

Test Sequences for PDH signals according to ITU-T 0.150 recommendation		
PRBS	Zeros	Application
2^9-1	8	Error measurements for bit rates ≤ 14.400 kbits/s
2^11-1	10	Error & jitter measurements for bit rates of n x 64 kbit/s & 64 kbits/s
2^15-1	15	Error & jitter measurements for T1, E1, E3 and DS3 bit rates
2^20-1	14	Error & jitter measurements for T1, E1, E3 and DS3 bit rates
2^23-1	23	Error & jitter measurements for E3 and E4 bit rates
2^31-1	31	Delay measurements for E3, DS3 and E4 bit rates

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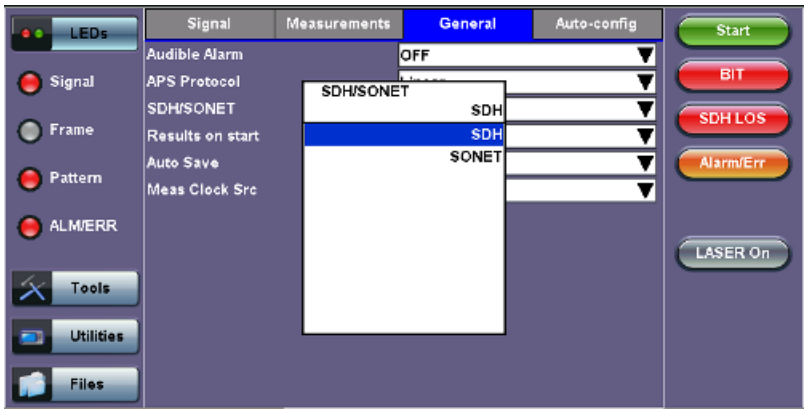
Setup: SDH



SDH/SONET selection from the General tab

Accessing SDH Testing

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

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

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

Transmitter Setup SDH

Transmitter Setup

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

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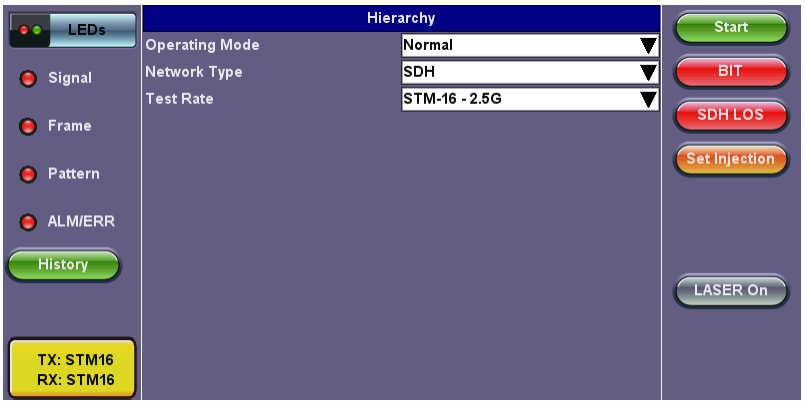

Coupled Hierarchy - Normal Operating Mode

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

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

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

Interface

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

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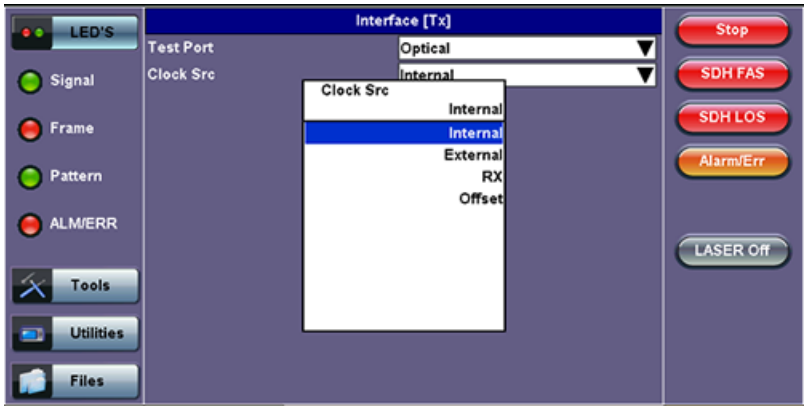

Tx Interface Setup

Test Port: Optical or Electrical.

- Optical interface is available for STM-0, STM-1, STM-4, STM-16 and STM-64 signals.
- Electrical interface is available for STM-0E, STM-1E signals.

Clock Source: Can be configured as follows:

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

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.

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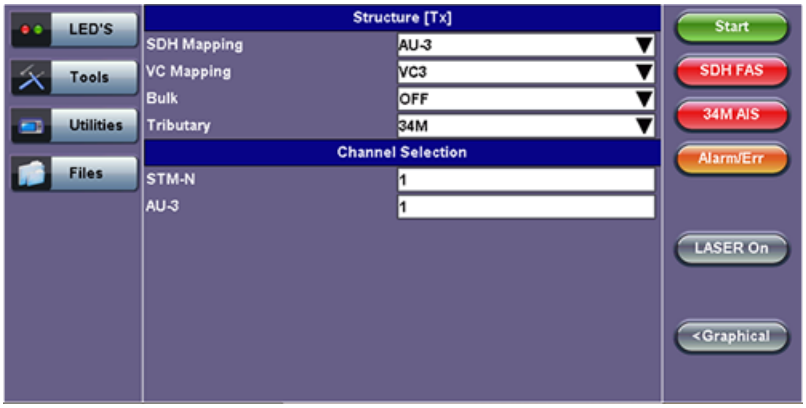
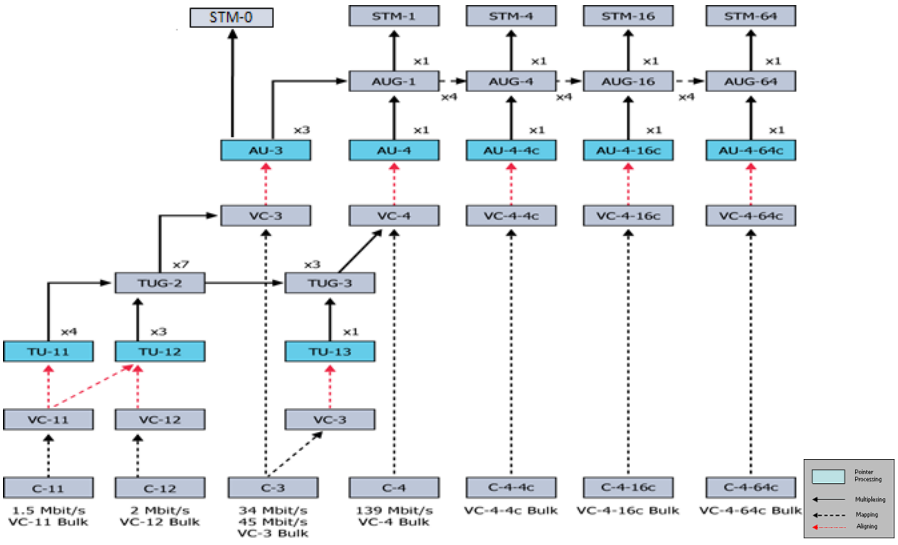
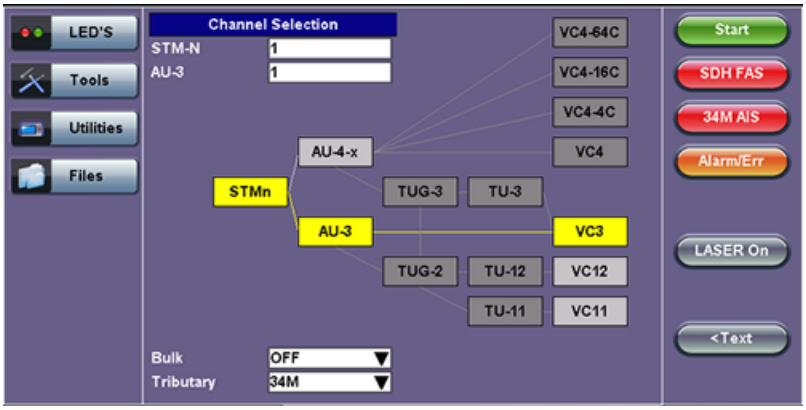


Tx Structure Setup - Text Mode

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





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

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

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

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

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

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

Thus the naming convention per SDH rate is as follows:

- For STM-16: [C, B, A] convention is used.
- For STM-4: [B, A] convention is used.

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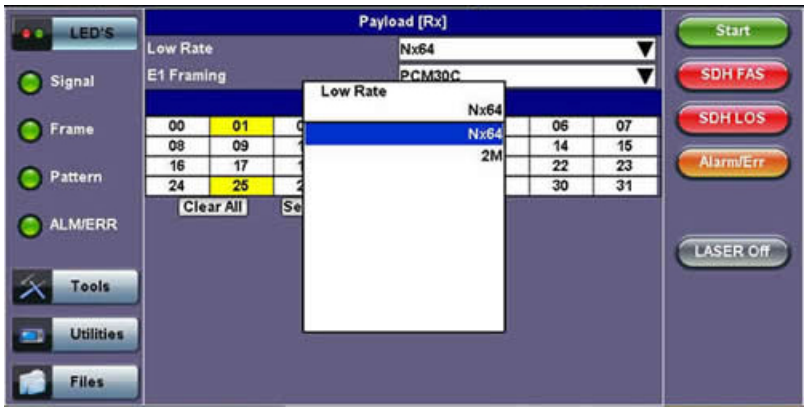
- For STM-1 using AU-3 mapping: [A] convention is used.
- For STM-1 using AU-4 mapping: [0] convention is used.

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.

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).

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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

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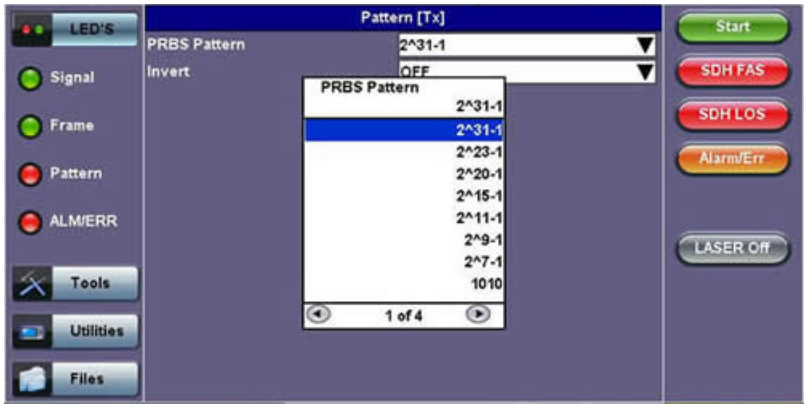
to G.704 and G.706 recommendations and are briefly described below.

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

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.

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.

Interface

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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.

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.

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.

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.

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.

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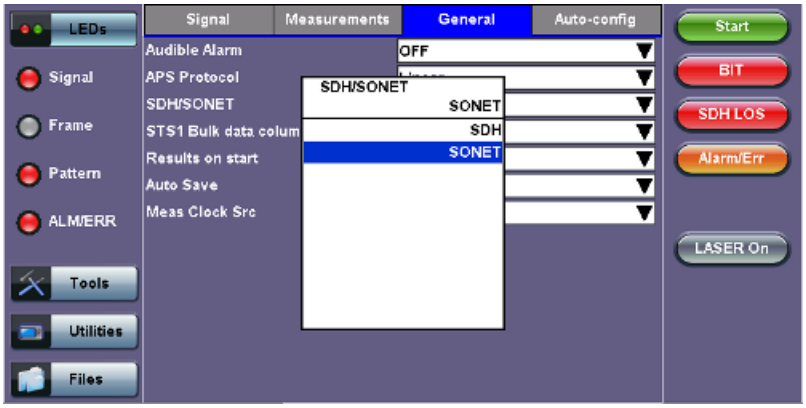

Selecting SONET from the General tab

Setting up SONET Testing

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

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

Transmitter Setup SONET

Hierarchy

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

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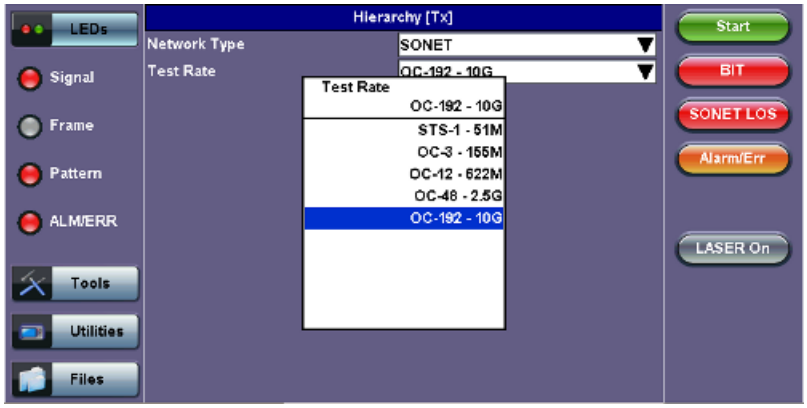

Coupled Hierarchy Setup

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

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

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

Interface

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

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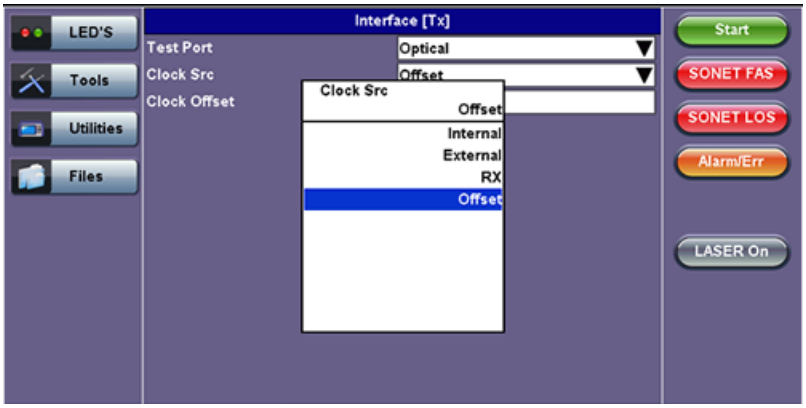

Tx Interface Setup

Test Port: Optical or Electrical.

- Optical interface is available for STM-0, STM-1, STM-4, STM-16 and STM-64 signals.
- Electrical interface is available for STM-0E, STM-1E signals.

Clock Source: Can be configured as follows:

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

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.

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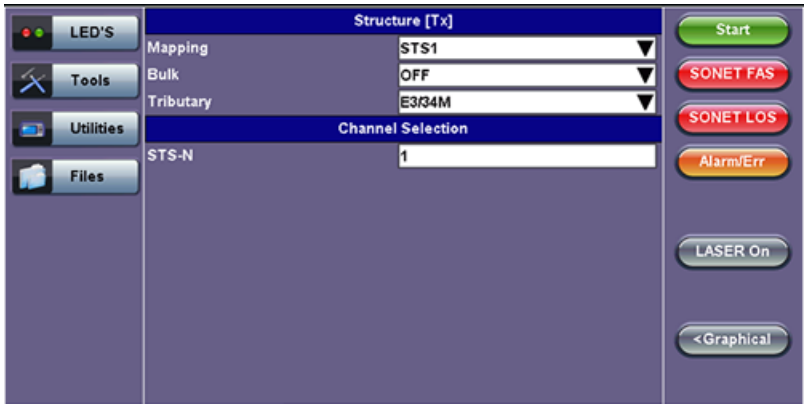
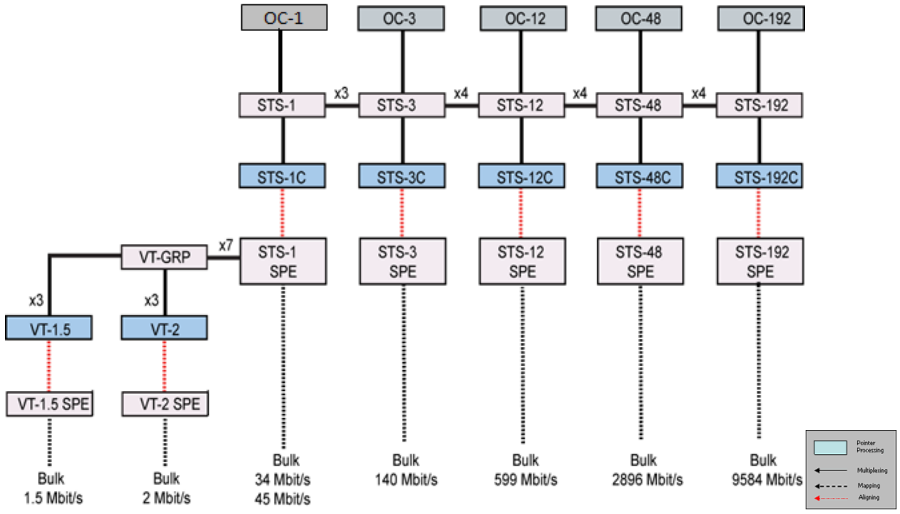


Tx Structure Setup - Text Mode

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.



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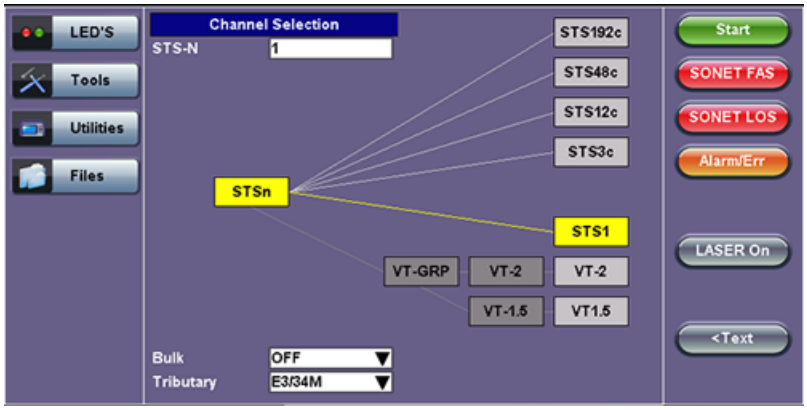
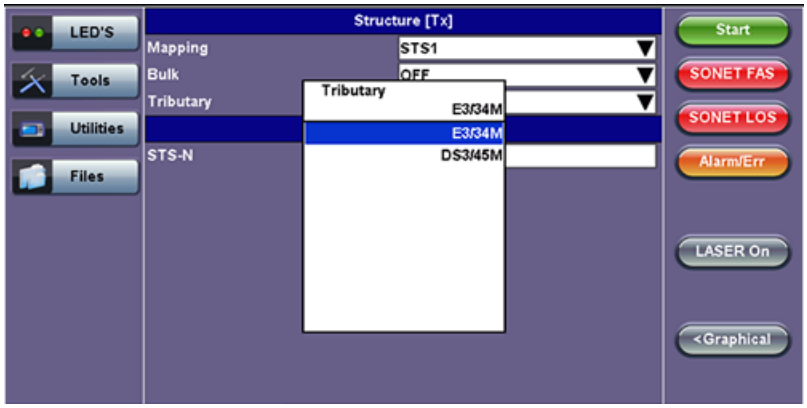


Tx Structure Setup - Graphical Mode

- **Bulk:** Tap the check box to enable the setting. In Bulk mode, the entire VT container is filled with a test pattern per ITU-T 0.181 recommendations.
- **Tributary:** Preset to DS1, E1, DS3, and E3 depending upon the options and mapping.
- **Other channels:** Unequipped—used to fill up unused (idle) timeslots, broadcast.
- **Sync:** Async, Bit, Byte.

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



Tx Structure Setup - Tributary

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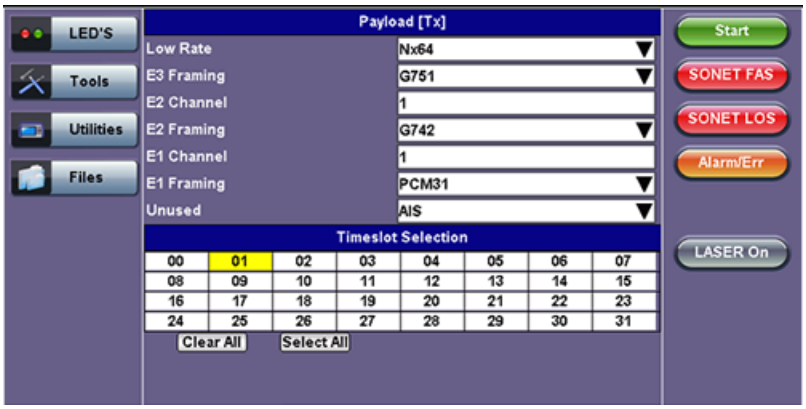
- ***VT-GRP:*** *In order to carry a mixed size of VTs in a STS-1 SPE in an efficient manner, VT Group (VTG) is defined. The size of the VTG is 12 columns, which is the least common multiple of the four sizes of VTs. Only one type of VT can be contained within each VTG. Therefore, a VTG can be formed 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.*

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.

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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.

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- 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.

- **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.

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.

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.

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.

Structure

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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.

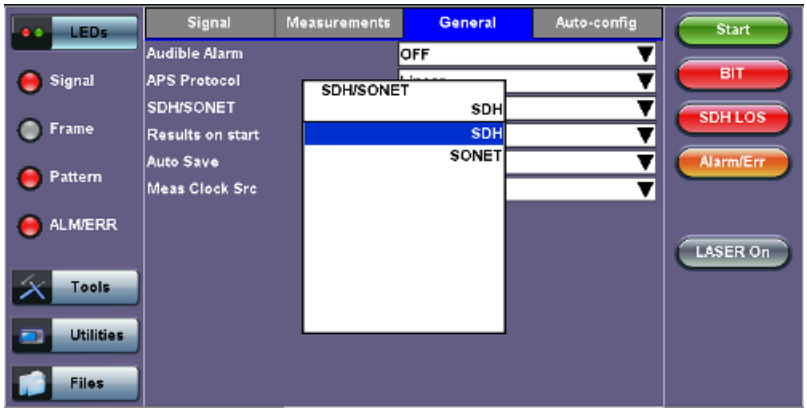
Payload

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.

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.

Setup: OTN/SDH



Selecting SDH from the General tab

Setting up SDH

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

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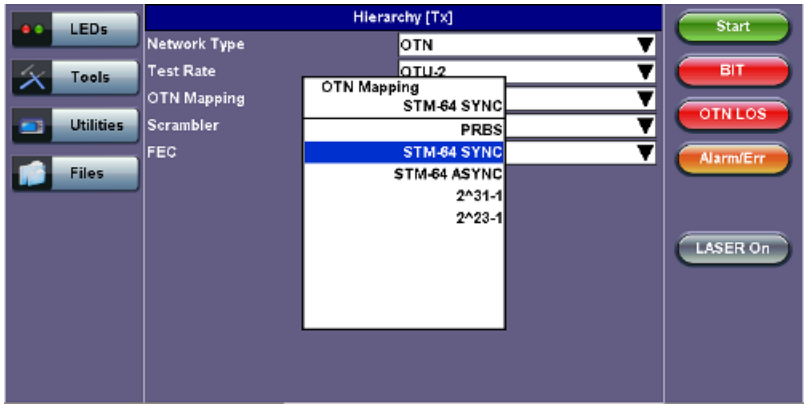
Transmitter Setup SDH

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

Hierarchy

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



Coupled Hierarchy Setup

- **Network Type:** In the OTN mode, only optical interface options are available.
- **Test Rate:** OTU-1 and OTU-2.
- **OPU Rate:** OPU-0, OPU-1, OPU-2 (available for OTU-2 test rate).
- **ODTU2 Type (OTU-2 only):** ODTU12, ODTU2.1.
- **ODTU12 Channel** (OTU-2 only).
- **OPU2 Mapping** (OTU-2 only): BMP, AMP.
- **ODTU01 Channel**
- **OPU1 Mapping:** BMP, AMP.
- **OPU0 Mapping:** GMP.

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.

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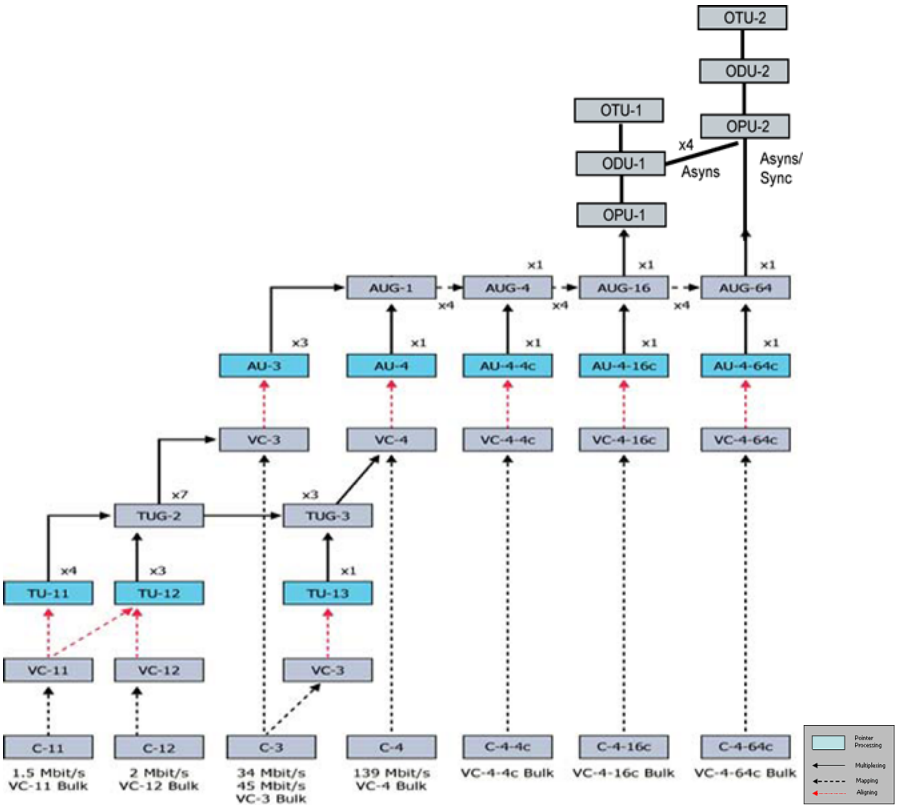

- **Scrambler:** ON/OFF.
- **FEC:** FEC encoder can be ON/OFF (activated / deactivated).
- **OPU Type:** SDH.
- **Test Rate:** STM-1-155M, STM-4-622M.

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.

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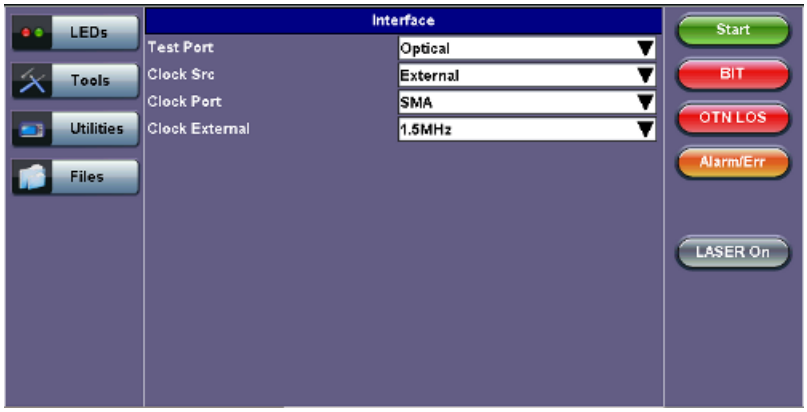
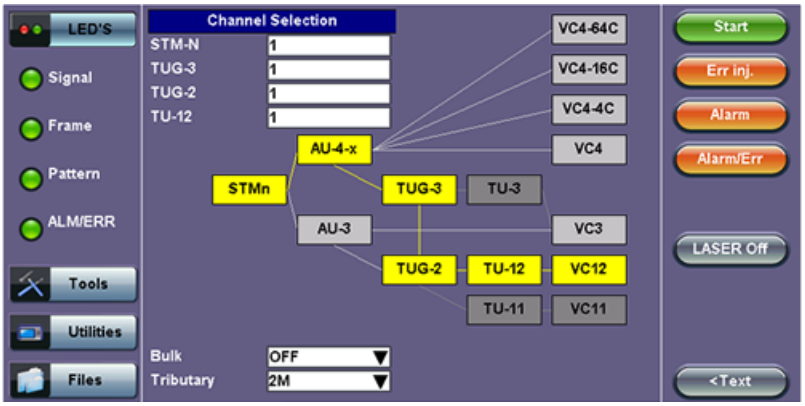
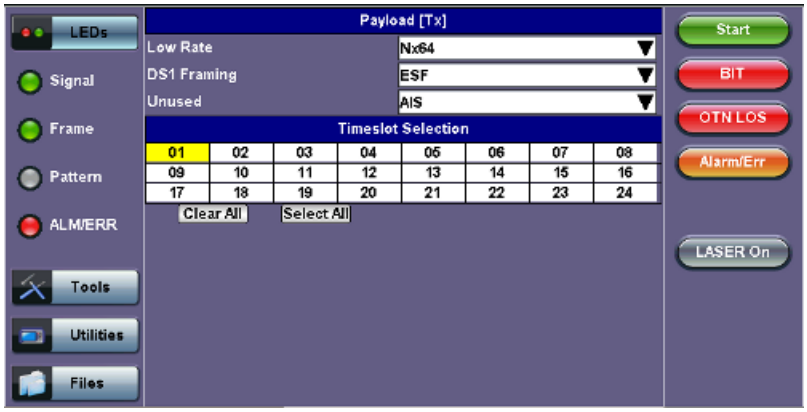


Tx Interface Setup



Tx Structure Setup - Graphical Mode



Tx Payload Setup

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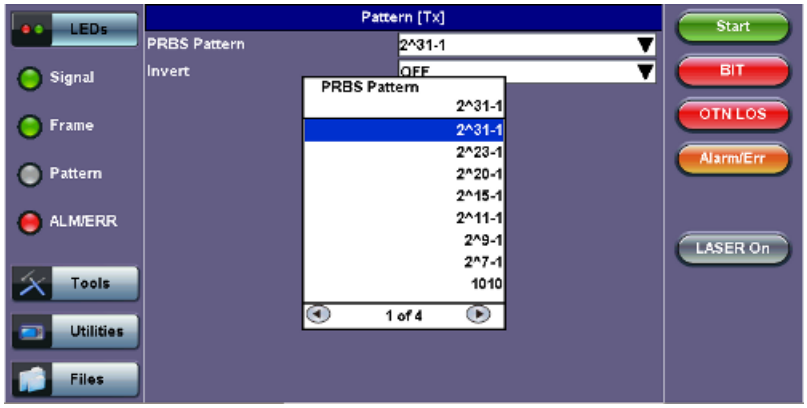

Tx Pattern Setup

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.

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.

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.

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.

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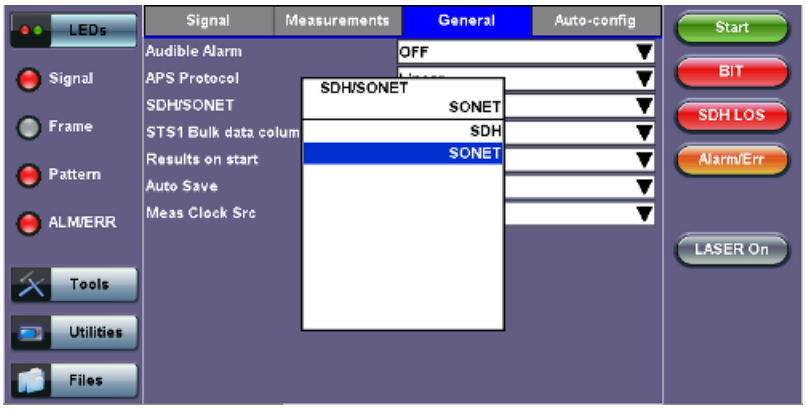
Payload

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.

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.

Setup: OTN/SONET



Selecting SONET from the General tab

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

Transmitter Setup OTN/SONET

This section of the manual describes the OTN configuration capabilities. The block diagram of the Tx and Rx structure is described in "Signal Setup" on page 226.

Hierarchy

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

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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.

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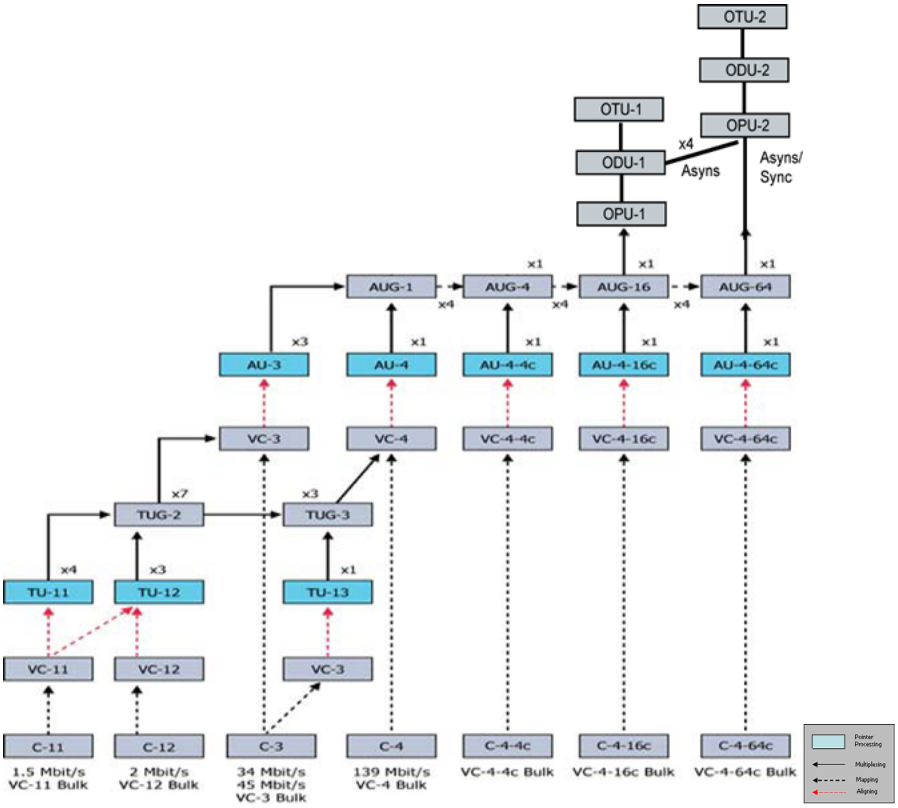

Scrambler: ON/OFF.

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

Interface, Structure, Payload, and Pattern

Refer to "Transmitter Setup SONET" on page 245 for details about Interface, Structure, Payload, and Pattern TX block configurations.

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Tx Interface Setup

Tx Structure Setup - Text Mode

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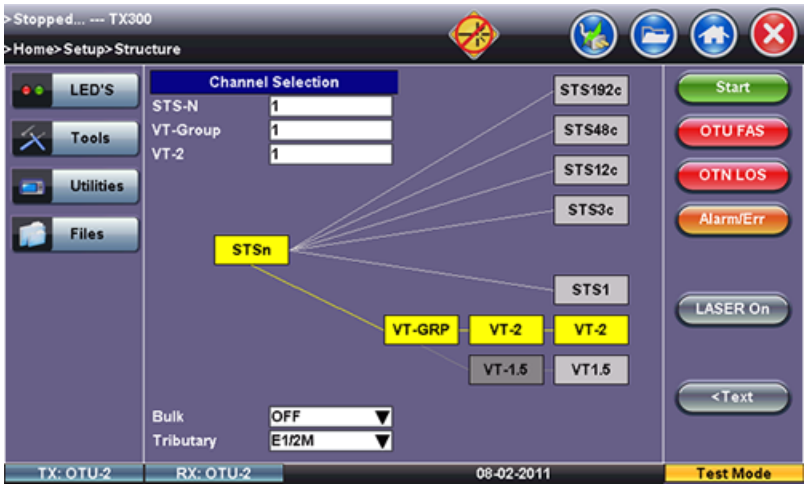
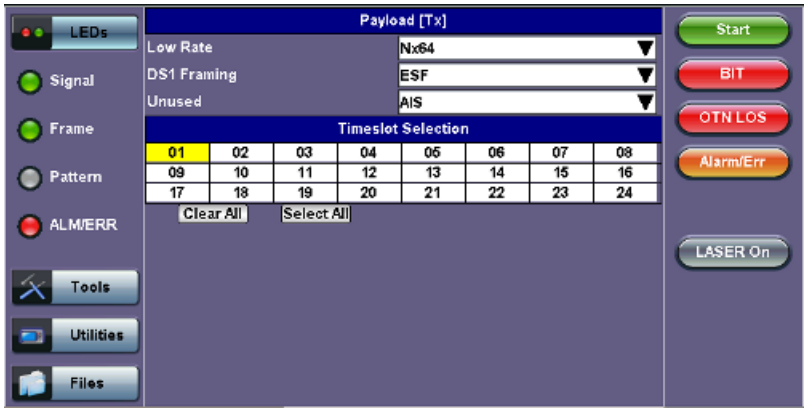
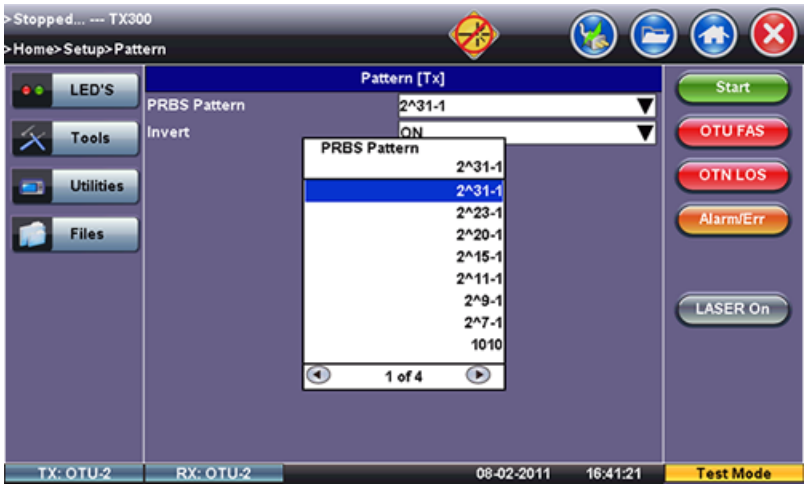


Tx Structure Setup - Graphical Mode



Tx Payload Setup



Tx Pattern Setup

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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.

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.

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.

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.

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.

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.

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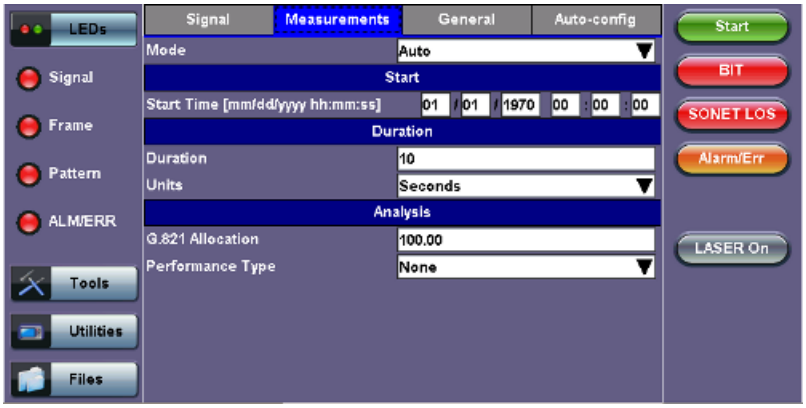
Measurement Configuration

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



Measurements tab

Timer Setup

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

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

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

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

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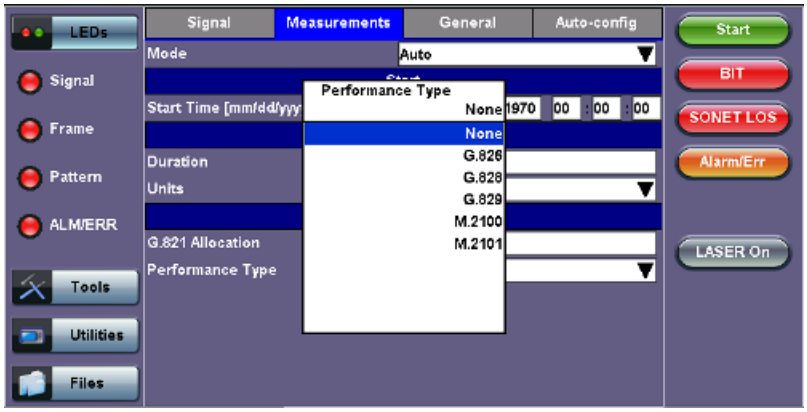
Performance Analysis

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



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 S.ervice (OOS).
    - Based on measuring bit errors.
    - Evaluation period of 30 days.
    - Since there is no overhead structure at these bit rates, in-service measurements are not recommended.
- **G.826:** End-to-end error performance parameters and objectives for international, constant bit rate digital paths and connections.
    - Long term error performance for Out of Service (OOS) and In-Service Monitoring (ISM).
    - Based on measuring bit errors for connections and block errors for paths.
    - Evaluation period of 30 days.

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

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- **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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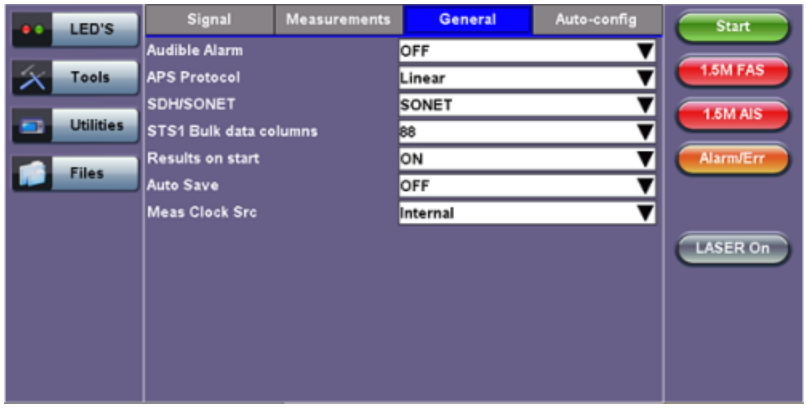
General

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



General tab

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

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Auto Config

Auto-config tab

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

Procedure

Tap 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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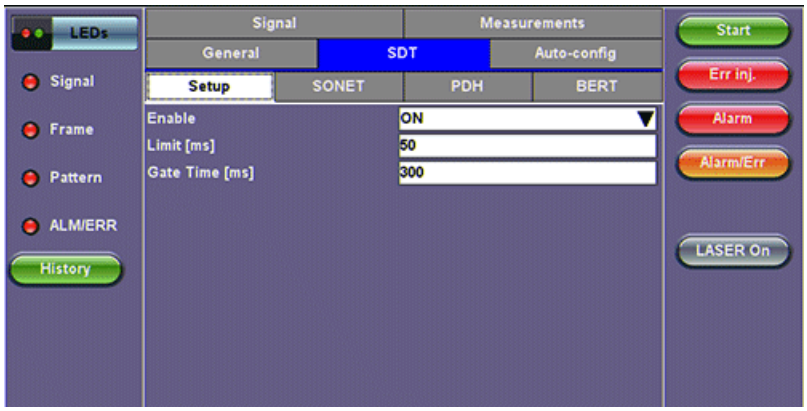
Service Disruption Test (SDT)



SDT Setup

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

Testing Process

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

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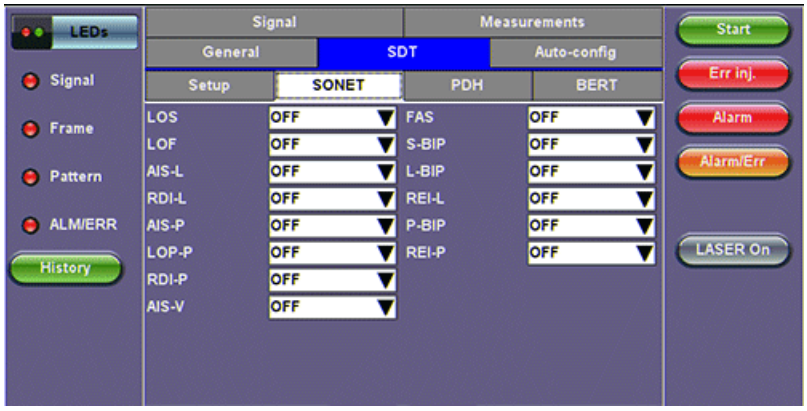
Setup

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



SDT SONET

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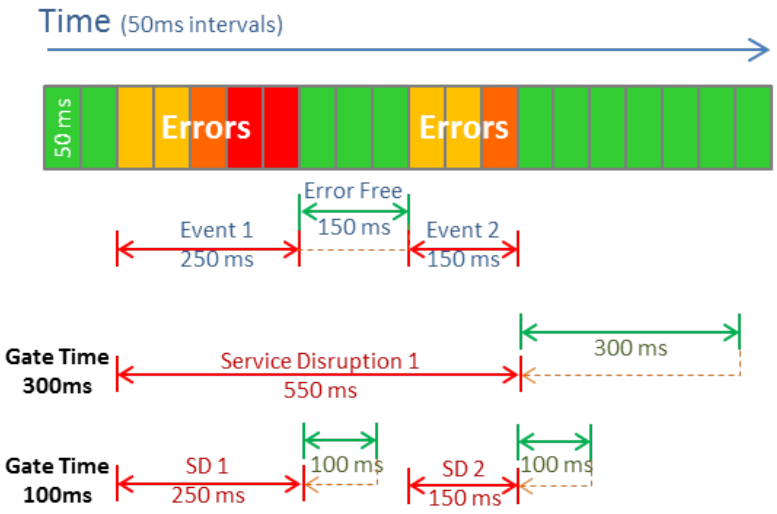

Multiple Service Disruptions

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

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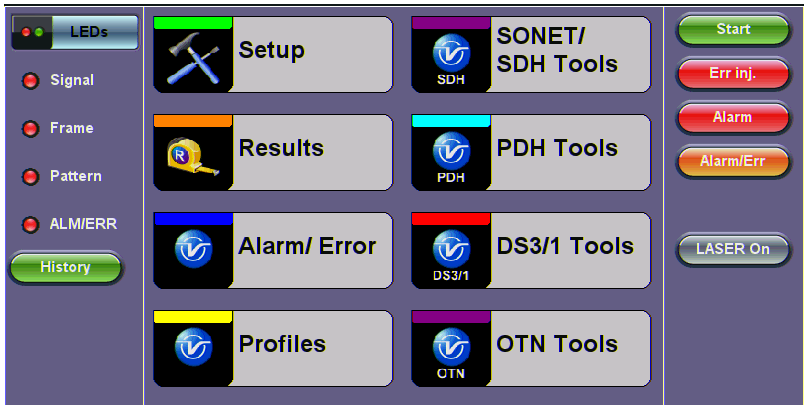
Results

OTN, SDH/SONET, PDH Results

Accessing Results

To access measurements for PDH, SDH, SONET and OTN, tap **Start**, which starts testing. Alternatively, tap **Results** in the main menu. The results comprise a range of tabbed pages, similar to the setup pages.

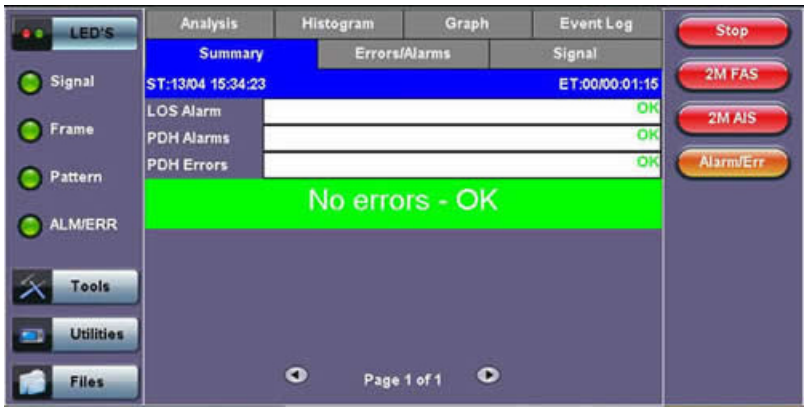


Results Button

Results: PDH

Summary

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



Summary tab

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Errors and Alarms

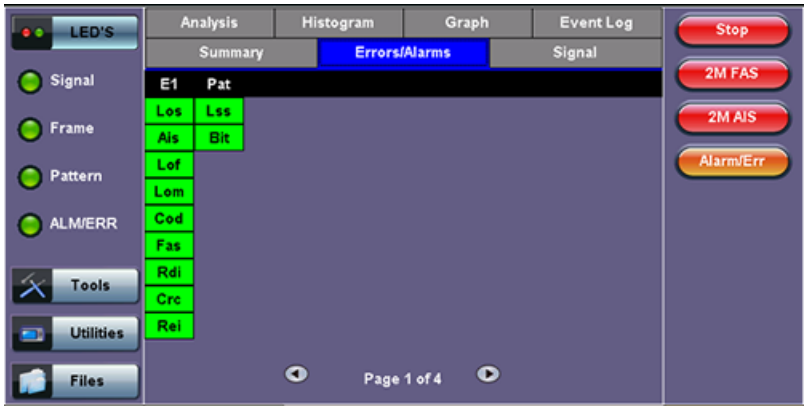
The **Error/Alarm** tab displays several pages showing the errors and alarm status. Alarms/Errors results provides an overview of all the Errors and Alarms applicable to the signal or network under test. The color of the page tab is normally blue; however, it will turn red when an alarm error condition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

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

Green: No error or alarm is present.

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

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



Errors/Alarms (Page 1)

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

Errors/Alarms (Page 2)

Page 2 lists the Alarms in logical order that are associated with the signal under test. All alarms are evaluated and stored. The time resolution of alarms is 100ms.

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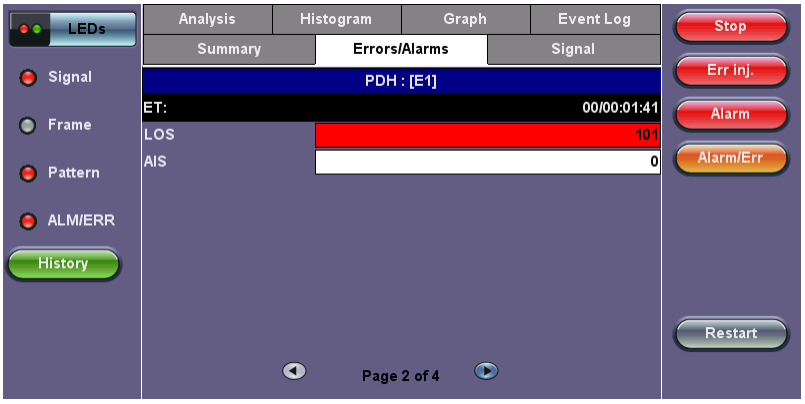
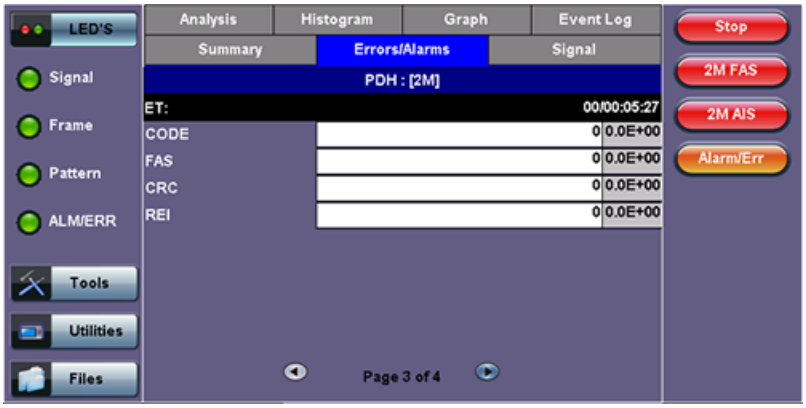


Errors/Alarms - PDH (Page 2)

Errors/Alarms (Page 3)

Page 3 lists the Errors in logical order that are associated with the signal under test. All errors are counted simultaneously and stored.



Errors/Alarms - PDH (Page 3)

Errors/Alarms (Page 4)

Page 4 lists the Bit Error Performance (BERT) associated with the signal under test.

Event Log

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

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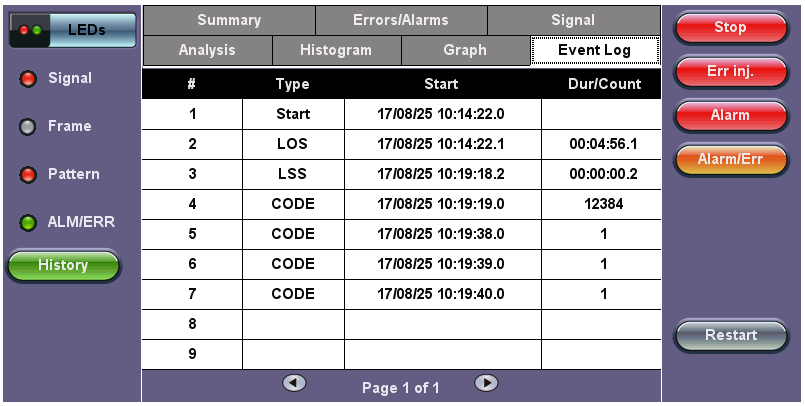
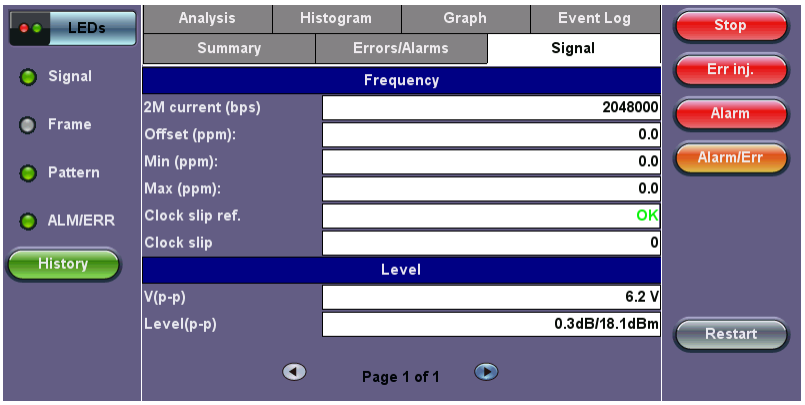
- **Number (#):** Event number, events are numbered sequentially
- **Type:** Indicates alarm or error type
- **Start:** Indicates when the alarm or error was detected
- **Dur/Count:** Indicates for how long the alarm or error was detected and provides duration (alarms) and ratio/count (errors). The duration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



Event Log

Signal Log

The **Signal** tab displays the frequency and level result screen.



Signal tab

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

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

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

Frequency Tolerances for PDH and T-Carrier Systems	
Signal	**Frequency Specification**
E1 PDH	2,048 Mbps ± 112 bps (± 54.6 ppm)
E3 PDH	34,368 Mbps ± 848 bps (± 24.8 ppm)
E4 PDH	139,264 Mbps ± 2730 bps (± 19.6 ppm)
DS1 T-Carrier	1,544 Mbps ± 57 bps (± 36.6 ppm)
DS3 T-Carrier	44,736 Mbps ± 1101 bps (± 24.6 ppm)

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

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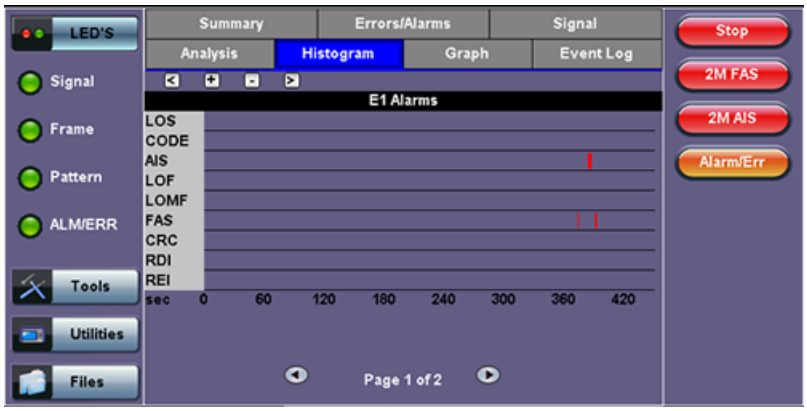
PDH Signal Levels per ITU-T G.703 Recommendations				
Signal	Bit Rate	Line code	Input	
			Termination	Level
E1	2 Mbit/s	HDB3	75 ohm unbalanced BNC 120 ohm balanced RJ45	Terminate: 2.37 Volt peak Monitor: 2.37 Volt peak with 20 or 26dB gain Terminate: 3.0 Volt peak Monitor: 3.0 Volt peak with 20 or 26dB gain
E3	34 Mbit/s	HDB3	75 ohm unbalanced BNC	Terminate: 1.0 Volt peak Monitor: 1.0 Volt peak with 20 or 26dB gain
E4	140 Mbit/s	CMI	75 ohm unbalanced BNC	Terminate: 1.0 Volt peak Monitor: 1.0 Volt peak with 20 or 26dB gain

Histogram Log

The **Histogram** tab displays a historical record of the Alarms and Errors recorded during the measurement interval. A dedicated page is available for errors and alarms including BER. Scroll through the various pages to display the anomalies of interest.



Histogram - E1 Alarms (Page 1)

The alarms and errors presented will depend on the signal type and structure selected. A graphical timeline on the horizontal axis indicates when the event occurred since the test was started. The upper left and right

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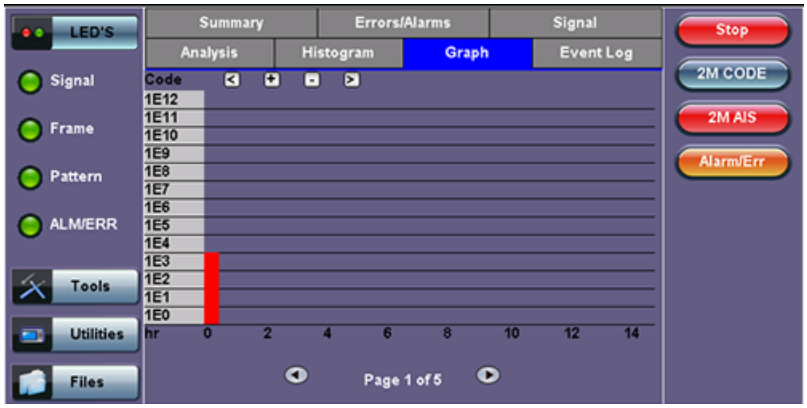
arrows allow the user to scroll through the measurement period while the + and – keys allow zooming in/out of the time axis. The events presented above are shown in the table below.

The screen below depicts BER and bit errors (LSS stand for Loss of Sequence Synchronization).

Graph

The **Graph** tab displays a screen displaying a log of the errors recorded during the measurement interval. A dedicated page is available for each error type. Scroll through the various pages to display the anomaly of interest.



Graph tab

A graphical timeline on the horizontal axis indicates when the event occurred while the vertical axis indicates the logarithmic scale of errors. 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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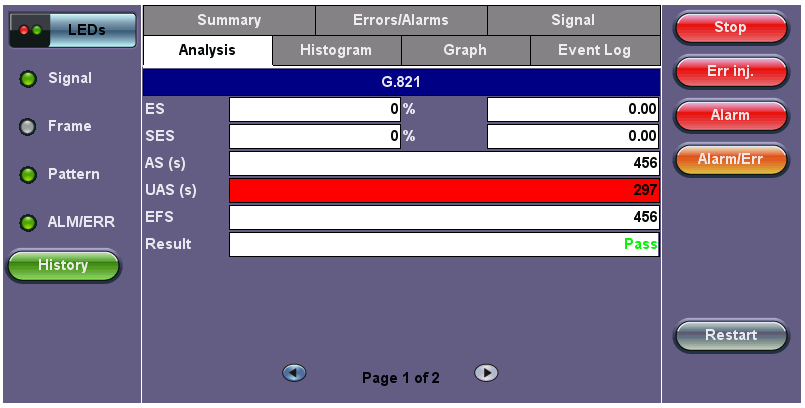

G.821 Analysis

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, see **Measurement Configuration:** "Performance Analysis" on page 265.

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.

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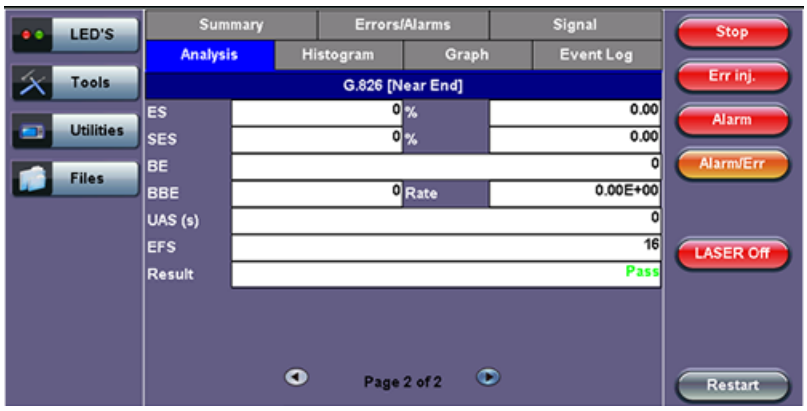
- Framed patterns and bulk signals.
- Pass/Fail result is in conjunction with path allocation between 0.1 and 100%.

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.



G.826 Analysis

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.

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

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

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

Definitions:

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

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

Evaluation According to ITU-T G.828

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

- ES, SES, BBE, UAS and SEP are evaluated.
- Pass/Fail result is in conjunction with path allocation between 0.1 and 100%.

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

- B1
- B2
- MS-REI
- B3
- HP-REI

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- LP-BIP
- LP-REI
- Bit errors (TSE)

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

Bit errors can be evaluated for:

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

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

Evaluation According to ITU-T G.829

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

ES, SES, BBE and UAS are evaluated.

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

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

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

Bit errors can be evaluated for:

- Unframed patterns.
- Framed patterns and bulk signals.

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

Evaluation According to ITU-T M.2100

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

ES, SES and UAS are evaluated.

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

Settings for S1 and S2:

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

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

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

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

Bit errors can be evaluated for:

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

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

Evaluation According to ITU-T M.2101

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

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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.

Service Disruption Test (SDT)

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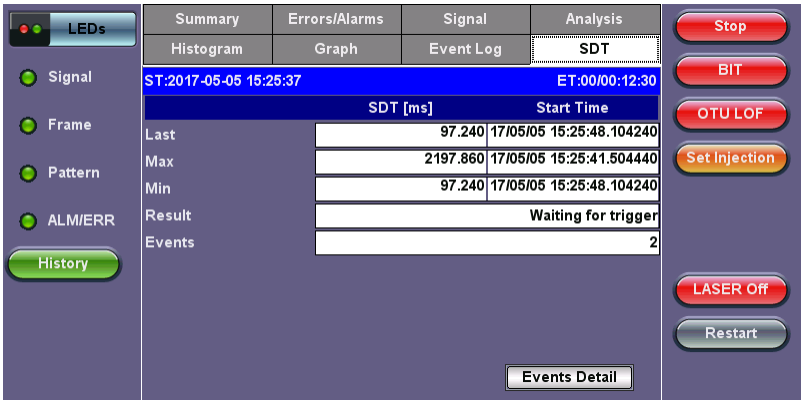
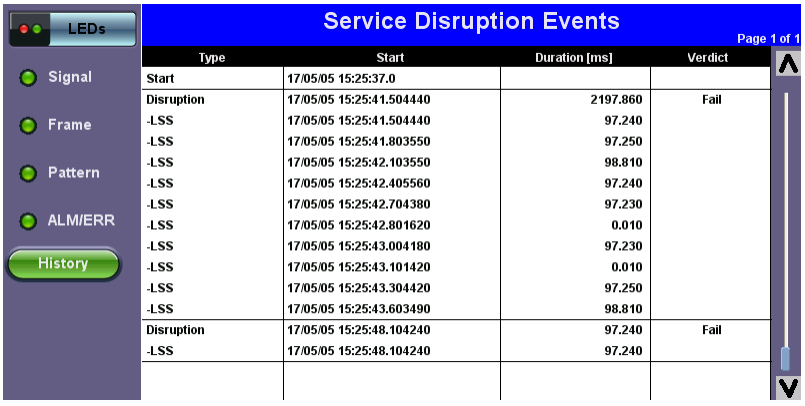


SDT Results

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

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

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



SDT Events Detail

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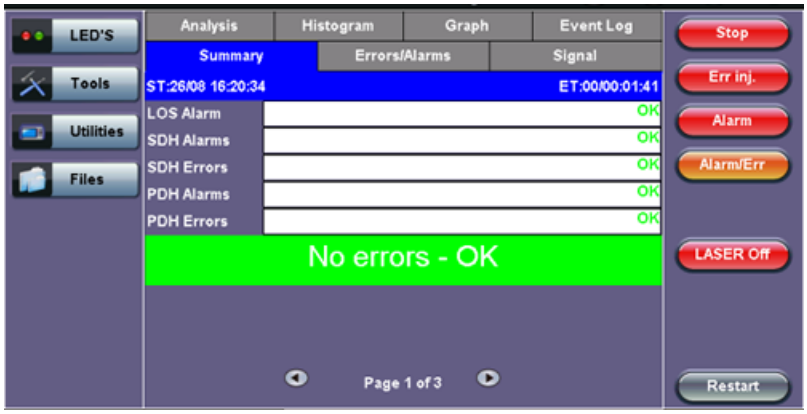
Summary

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

Errors/Alarms

The **Errors/Alarms** tab displays several pages showing the errors and alarms status.

Errors/Alarms (Page 1)

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.

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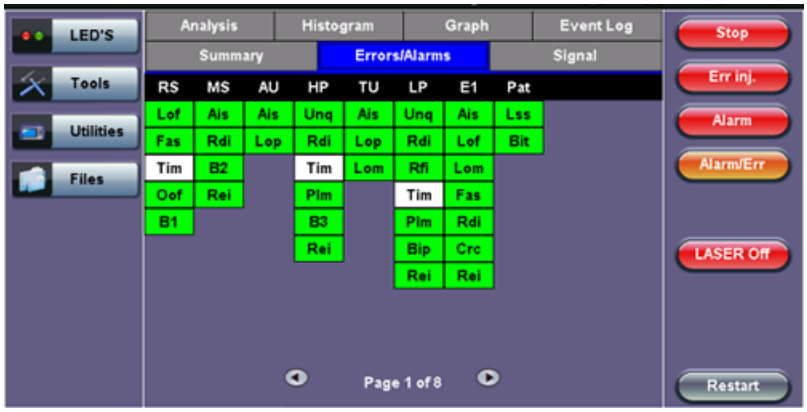

Errors/Alarms (Page 1)

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

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

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	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 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.

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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 superframes.
TU-LOP	Tributary Unit Loss of Pointer Declared when no valid pointer is detected in N consecutive superframes (N>8 and <10), or if N consecutive NDFs "1001" patterns are detected.
TU-LOM	Tributary Unit Loss of Multiframe (H4)

Low Order Path - Alarm Definitions	
LP-UNEQ	LO path unequipped Declared when bits 5, 6, 7 of the V5 byte contain "000" for five consecutive frames.

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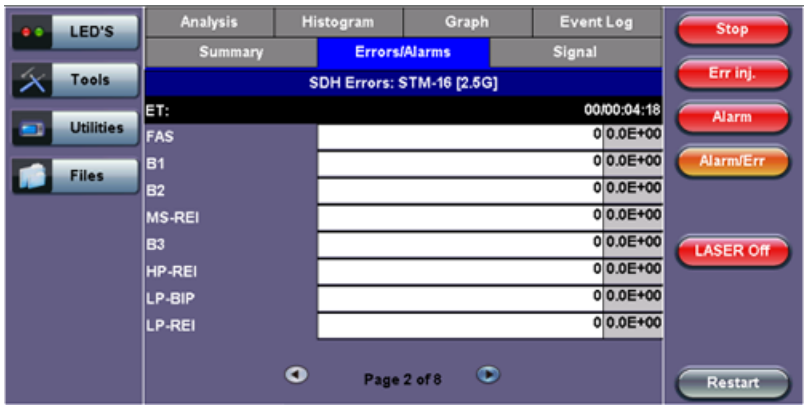
LP-RDI	LO path Remote Defect Indication Declared when bit 5 of the V5 byte contains a "1" in five consecutive TU superframes while bits 6,7 of the K4 byte contain "00" or "11".
LP-RFI	LO path Remote Failure Indication Declared when bit 4 of the V5 byte contains "1" in five consecutive frames.
LP-TIM	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.

Refer to "Results: PDH" on page 273 for more information.

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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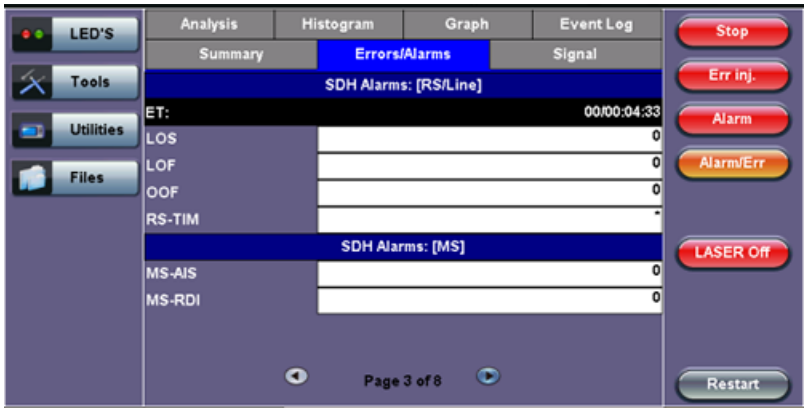
Errors/Alarms (Page 3)

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)

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 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 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 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.

Event Log

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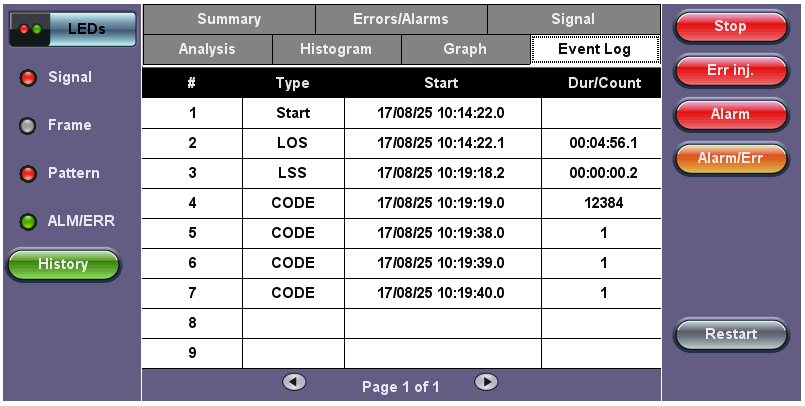
The Event log tab displays the screen listing the Error and Alarm events recorded during a test. The events are presented in chronological sequence:

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



Event Log

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.

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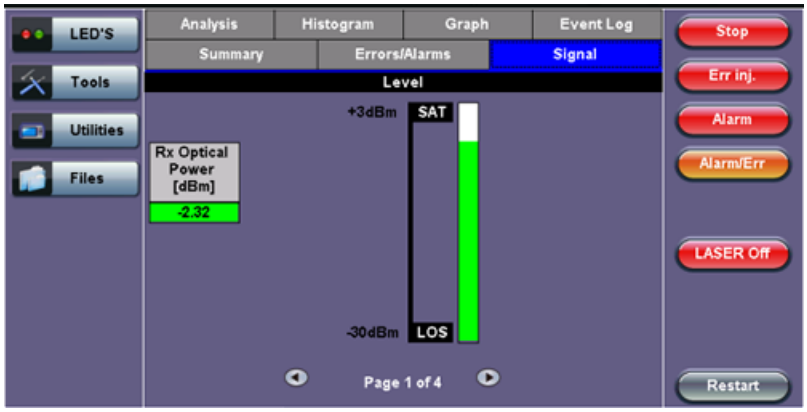
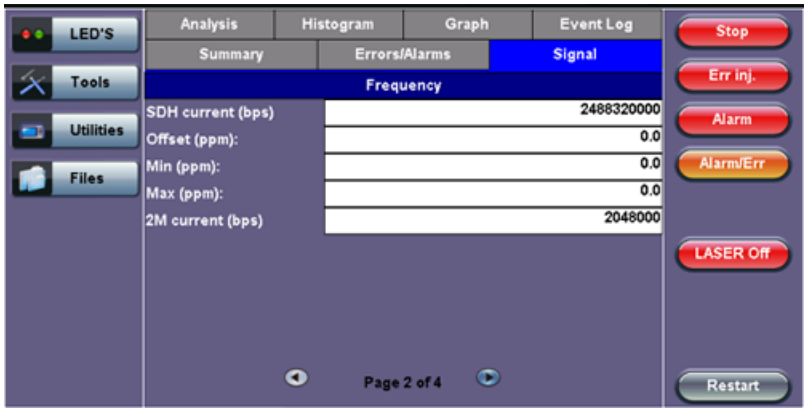


Signal (Page 1)

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 (SFP or XFP).



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.

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- **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	< 4.6 ppm
622,080	<4.6 ppm
2,488,320	<4.6 ppm
9,953,280	<4.6 ppm

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

Optical Information (Page 3)

Page 3 displays the Optical module (SFP or XFP) information which includes Vendor name, Part number, and Optical Wavelength.

Optical Information (Page 4)

Page 4 displays the Optical module (SFP or XFP) Power Measurement Graph.

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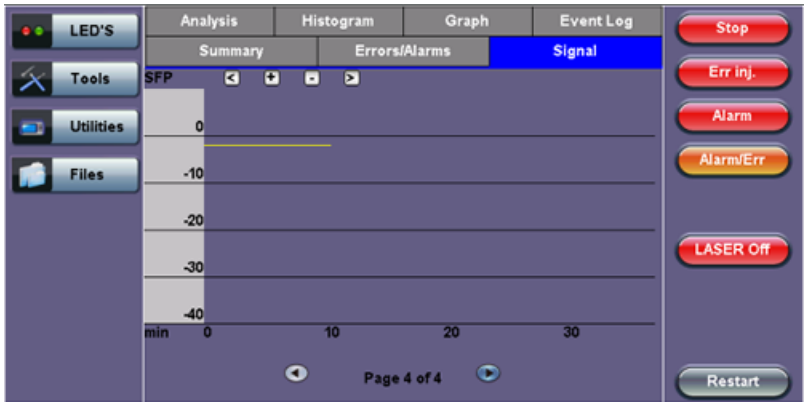


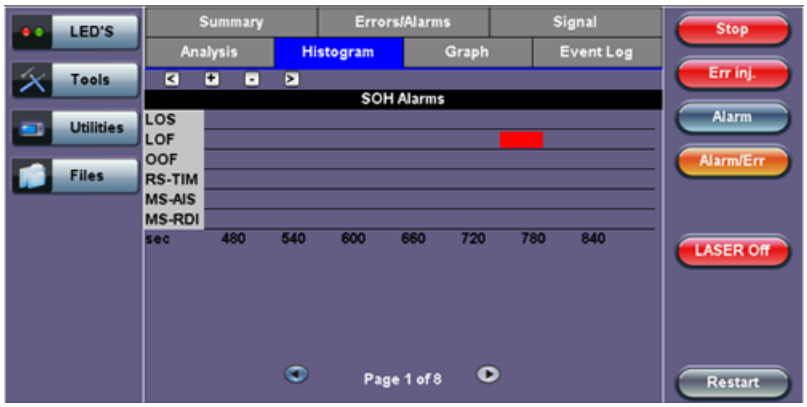
Signal - Optical (Page 4)

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.

Histogram (Page 1)

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).

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 (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 (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 (Page 6)

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).

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- 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 (Page 7)

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

Histogram (Page 8)

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

Graph

The Graph tab displays 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.

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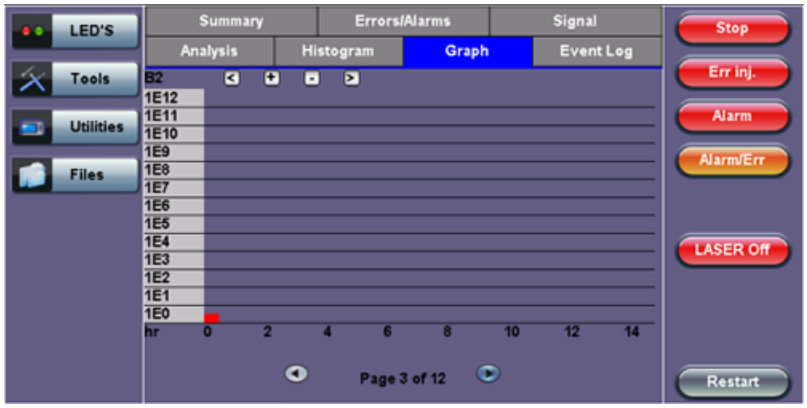
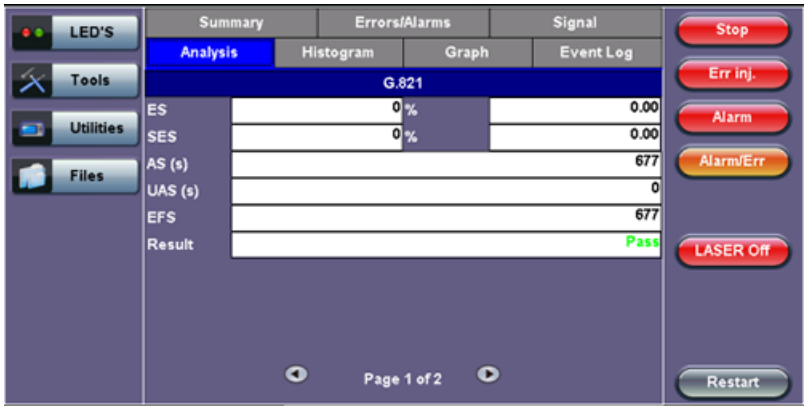


Graph (Page 3)

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, see **Measurement Configuration:** "Performance Analysis" on page 265.

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:

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- 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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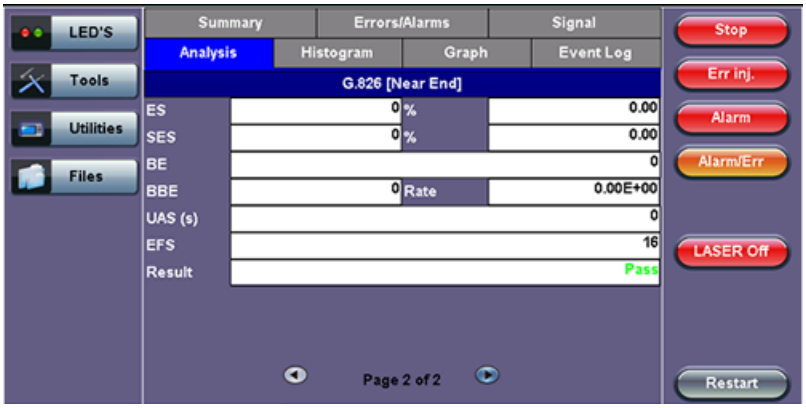

G.826 Analysis

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.

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:

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

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

Bit errors can be evaluated for:

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

Evaluation According to ITU-T M.2100

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

ES, SES and UAS are evaluated.

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

Settings for S1 and S2:

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

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

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

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Evaluation is made at the “Near End” and at the “Far End” for PCM-30/31 signals with CRC.
Bit errors can be evaluated for:

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

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

Evaluation According to ITU-T M.2101

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

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

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

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

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

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

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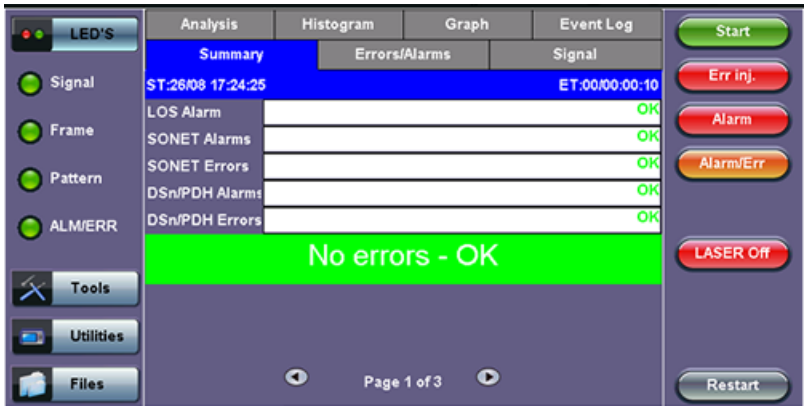
- Unframed patterns.
- Framed patterns and bulk signals.
- Overhead bytes E1/E2 (order wire), F1/F2 (user), D1 - D3 and D4 - D12 (DCC) in the SDH Overhead (SOH and POH).

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

Results: SONET

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

Errors/Alarms

The **Errors/Alarms** tab displays several pages showing error and alarm statuses.

Errors/Alarms (Page 1)

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.

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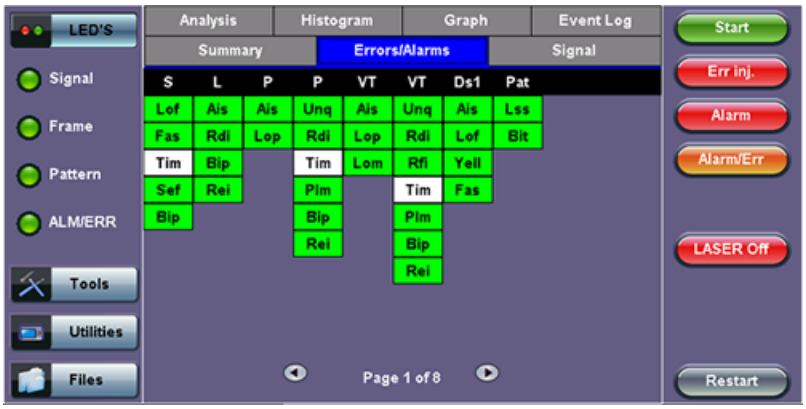
The soft LEDs on screen are arranged logically and will depend on signal hierarchy, structure, payload, and framing selected. The soft LEDs have a tricolor function:

Green: No error or alarm is present.

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

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



Errors/Alarms (Page 1)

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

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:

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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:

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	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

Refer to "Results: PDH" on page 273 for more information.

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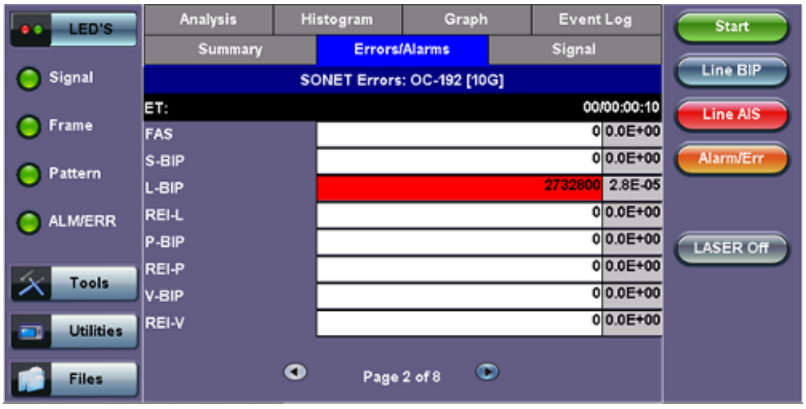
Errors/Alarms (Page 2)

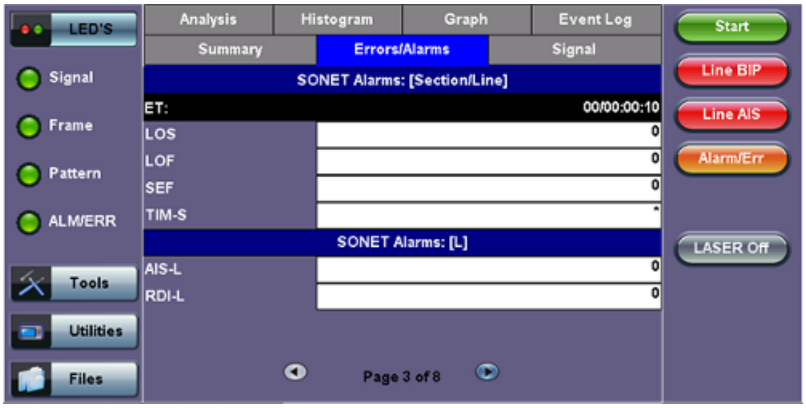
Page 2 lists the SONET Errors in logical order that are associated with the signal under test. All errors are evaluated and stored. The Elapsed Time [ET] is shown in the right hand corner of the header. Error conditions are displayed in red including count and rate.



Errors/Alarms (Page 2)

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.

Errors/Alarms (Page 4 and 5)

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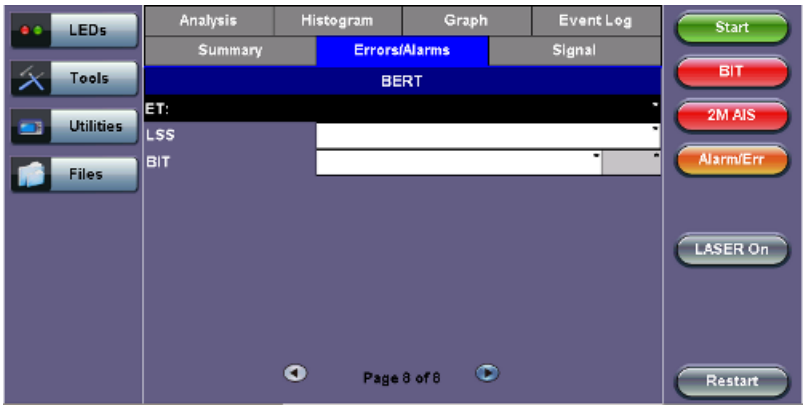
Page 4 & 5 lists the STS Path and VT path in logical order that are associated with the signal under test. All alarms are evaluated and stored.

Errors/Alarms (Page 6 and 7)

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 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)

Event Log

The **Event log** tab displays 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.

Refer to **PDH Results:** "Event Log" on page 292 for details.

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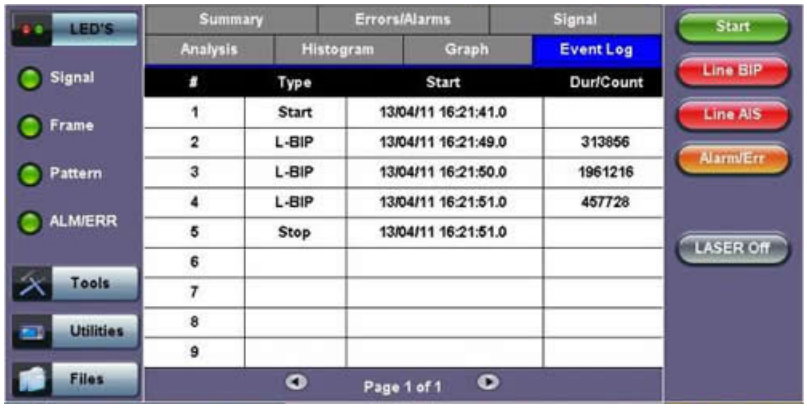


Event Log

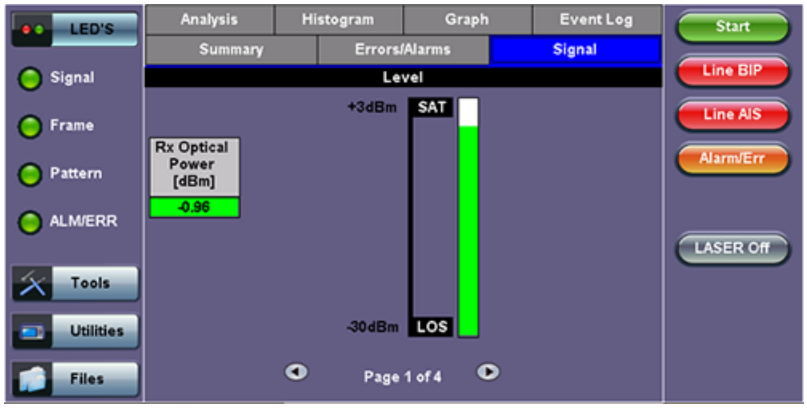
Signal

The **Signal** tab displays the Level and Frequency screen.

Signal (Page 1)

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)

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 (SFP or XFP).

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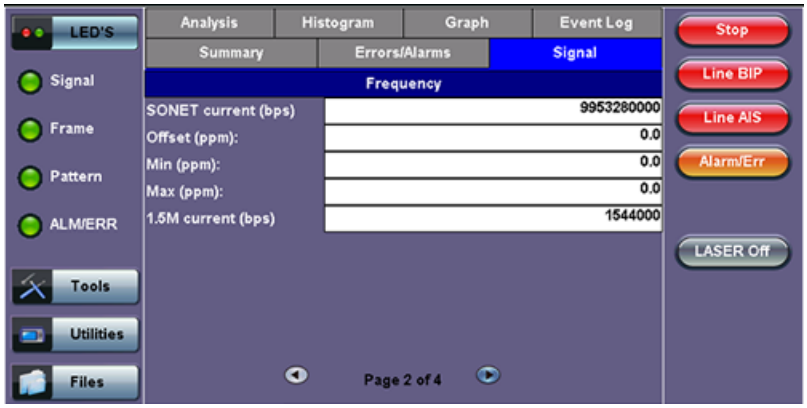

Signal (Page 2)

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.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

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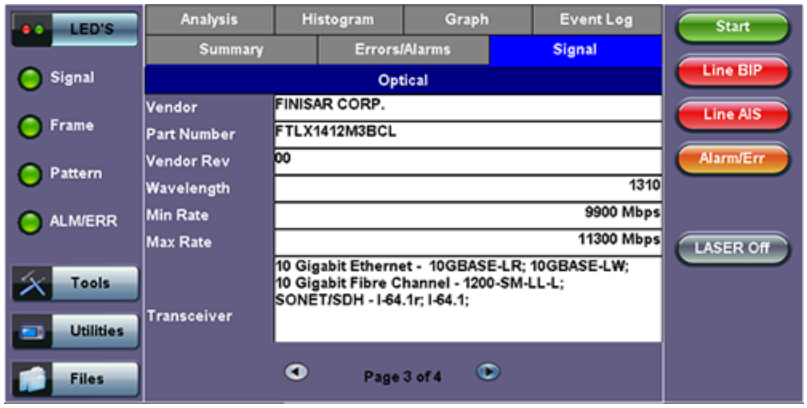
Level: Measures the Peak and Peak-Peak voltage values of the incoming signal. The levels for STS-3 electrical signal according to GR.253 recommendations are presented.

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

Optical Information (Page 3)

Page 3 displays the Optical module (SFP or XFP) 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 (SFP or XFP) Power Measurement Graph.

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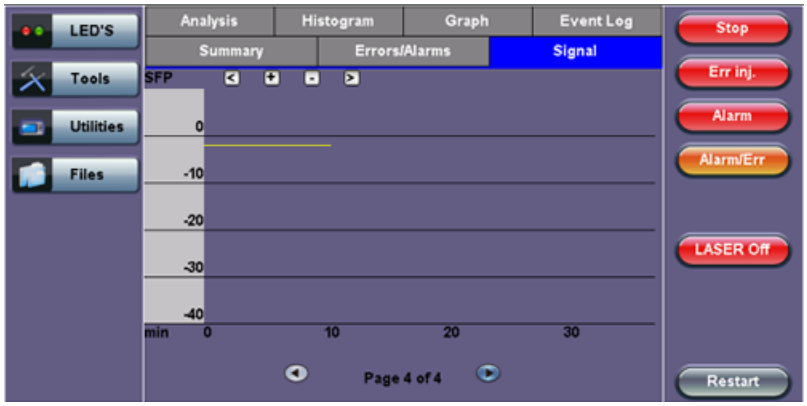

Signal - Optical (Page 4)

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.

Histogram (Page 1)

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

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.

Histogram (Page 2)

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

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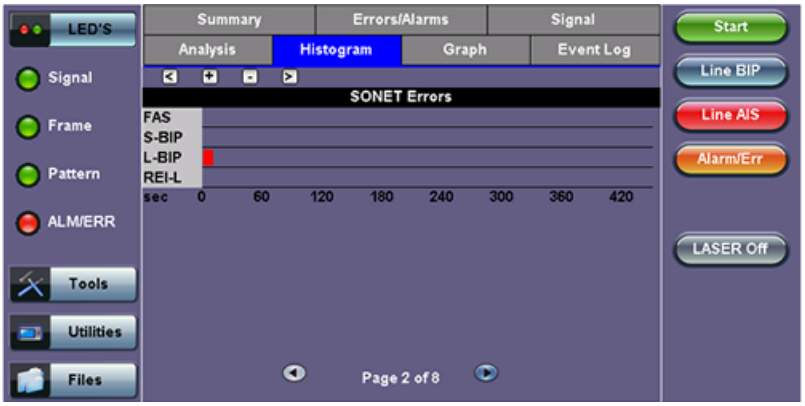

Histogram - SONET Errors (Page 2)

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 (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 (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)

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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 (Page 7)

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

Histogram (Page 8)

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

Graph

The **Graph** tab displays 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

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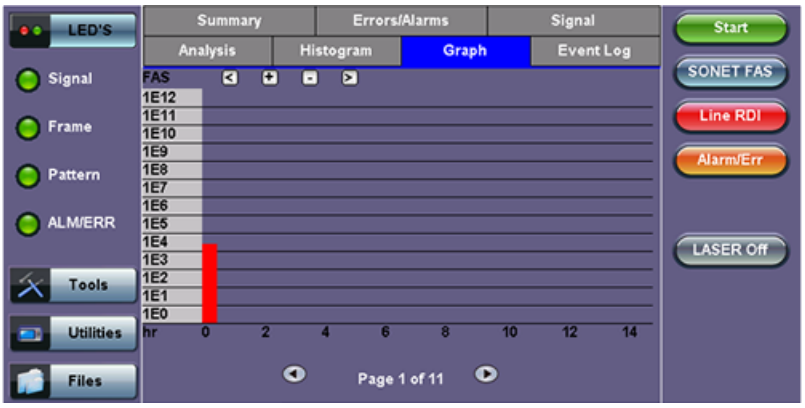
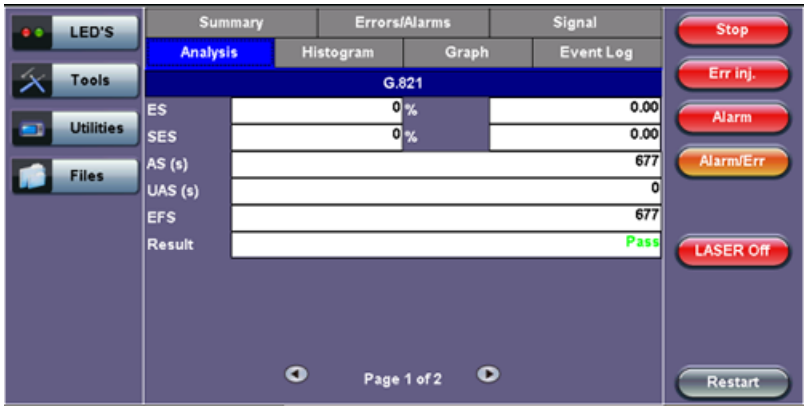
- REI-V
- PDH/DSn errors depending on payload

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)

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, see **Measurement Configuration:** "Performance Analysis" on page 265.

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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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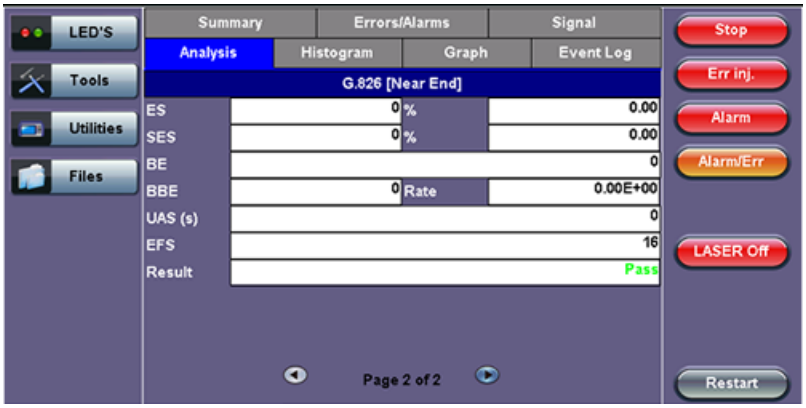

G.826 Analysis

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.

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:

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

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

Bit errors can be evaluated for:

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

Evaluation According to ITU-T M.2100

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

ES, SES and UAS are evaluated.

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

Settings for S1 and S2:

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

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

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

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Evaluation is made at the “Near End” and at the “Far End” for PCM-30/31 signals with CRC.
Bit errors can be evaluated for:

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

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

Evaluation According to ITU-T M.2101

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

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

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

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

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

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

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- 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).

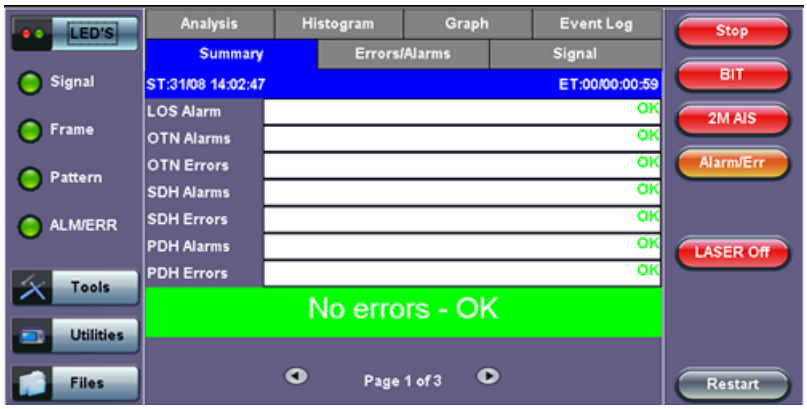
M.2101 measures block errors, therefore bit error evaluation is disabled.

Results: OTN

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

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 or OTN/SONET signal and its payload.



OTN/SDH Summary (International and Advanced Versions)

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Errors Alarms

The **Error/Alarm** tab displays several pages showing the errors and alarm status.

Errors/Alarms (Page 1)

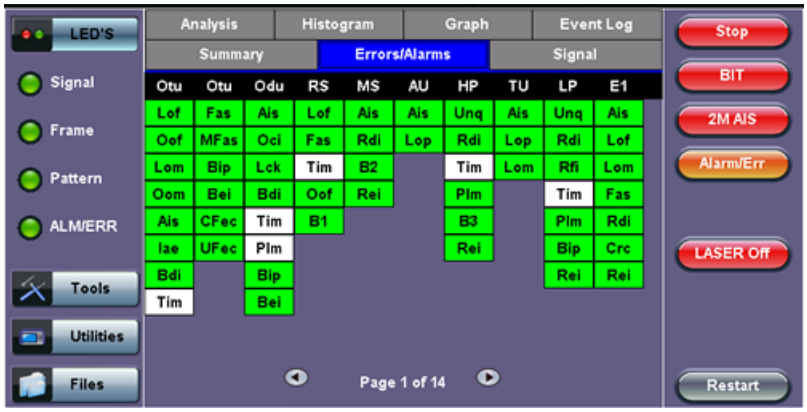
Page 1 provides an overview of all the Errors and Alarms applicable to the signal or network under test. The color of the page tab is normally blue; however, it will turn red when an alarm error condition has been detected or recorded.

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

Green: No error or alarm is present.

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

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



Errors/Alarms (Page 1)

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

The colored headers are described in the table below:

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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:

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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

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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

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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

GMP-Generic Mapping Procedure			
	GMP	Description	Notes
Errors	LO-Sync	Loss of Synchronization	Local
	Cm=0	No payload	Local
	CRC-5	CRC-5 Error	Local
	CRC-8	CRC-8 Error	Local

Refer to **SONET Results:** "Errors/Alarms" on page 305 and "Errors/Alarms" on page 287 for more information on SONET and SDH alarms,

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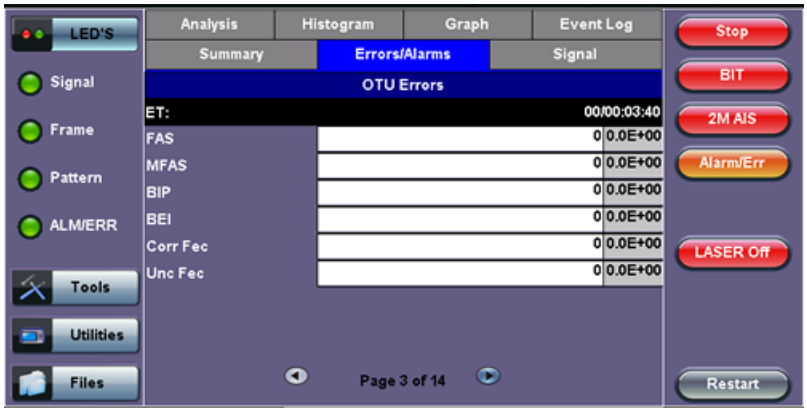
Errors/Alarms (Page 3)

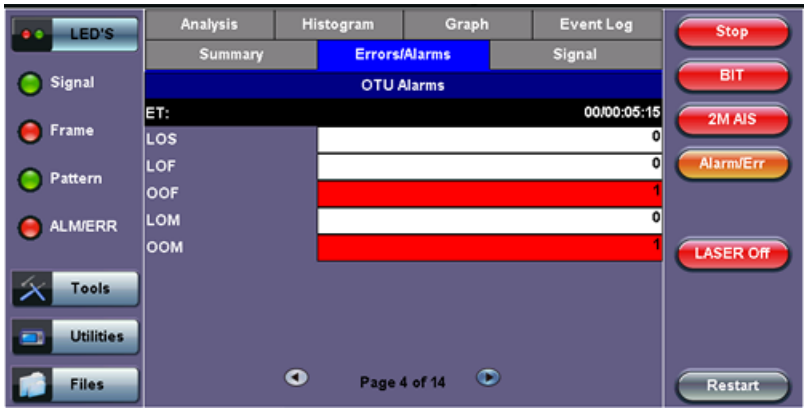
Page 3 lists the **OTU Errors** in logical order that are associated with the signal under test. All errors are evaluated and stored. The Elapsed Time [ET] is shown in the right hand corner of the header. Error conditions are displayed in red including count and rate.



Errors/Alarms (Page 3)

Errors/Alarms (Page 4 and 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)

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

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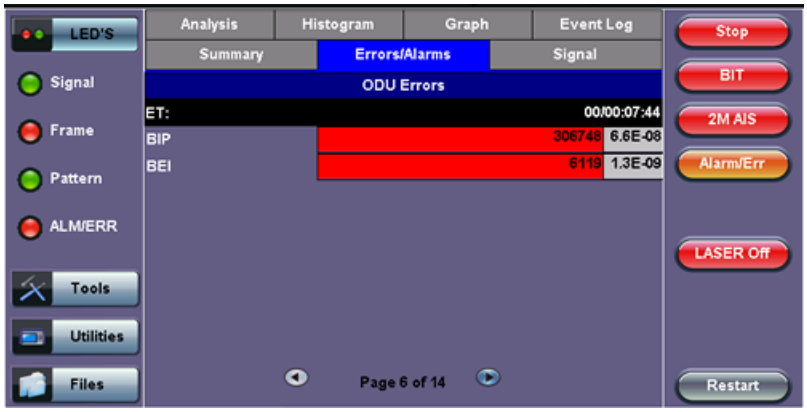
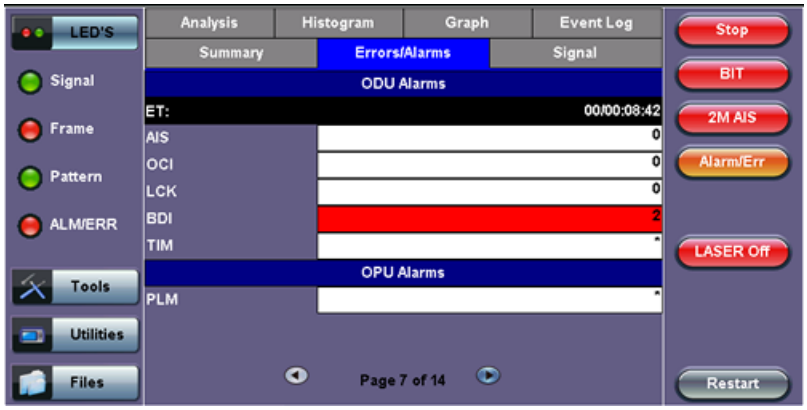
Errors/Alarms (Page 6 and 7)

Page 6 and 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)

Errors/Alarms (Page 8 to 14)

Pages 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.

Refer to **PDH Results:** "Errors/Alarms" on page 274 and "Errors/Alarms" on page 287 for more information on PDH and SDH alarms,

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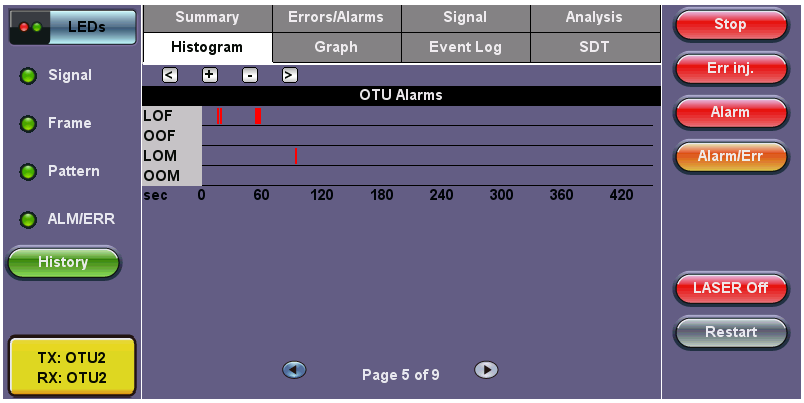
Event Log

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

Histogram



Histogram - OTU Alarm

The Histogram tab displays a historical record of Alarms and Errors recorded during the measurement interval in a graph format for easy time correlation. This helps identify the sequence of events that occurred before and after a disruption. A dedicated page is available for errors and alarms including BER.

Histogram (Page 1)

Page 1 displays the Alarms associated with the OTU Alarms.

Histogram (Page 2)

Page 2 displays the Errors associated with the OTU Errors.

Histogram (Page 3)

Page 3 displays the Alarms and Errors associated with the ODU2 Alarms.

Histogram (Page 4)

Page 4 displays the Alarms and Errors associated with ODU2 Errors.

Histogram (Page 5)

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Page 5 displays the Alarms and Errors associated with OTU Alarms.

Histogram (Page 6)

Page 6 displays the Alarms and Errors associated with OTU Errors.

Histogram (Page 7)

Page 7 displays the Alarms and Errors associated with ODU1 Alarms.

Histogram (Page 8)

Page 8 displays the Alarms and Errors associated with ODU1 Errors.

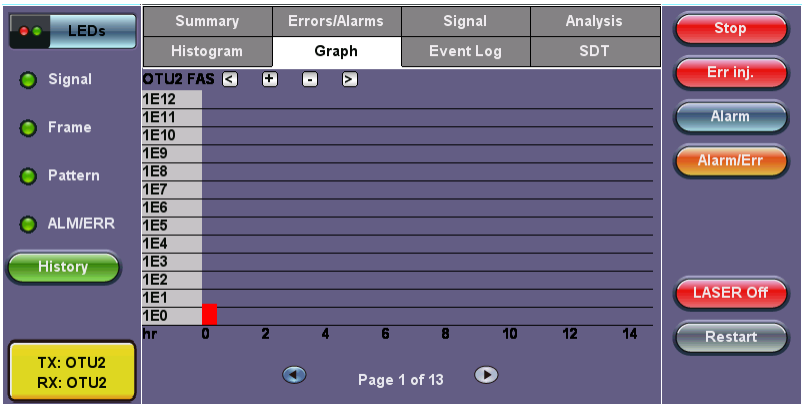
Histogram (Page 9)

Page 9 displays the BERT Alarms/Errors associated with the test pattern.

Graph

The **Graph** tab displays the behavior of individual alarms and errors over time, providing a visual indication of severity (count or rate) of the Errors and Alarms recorded during the measurement interval. A dedicated page is available for each of the error types.

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 - OTU2 FAS

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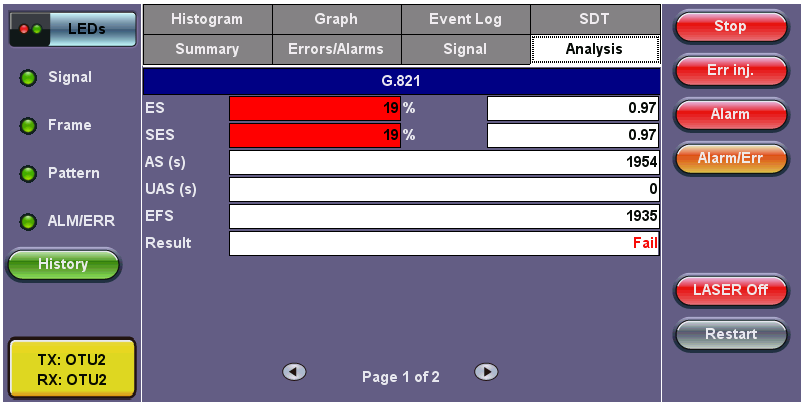

G.821 Analysis

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, see **Measurement Configuration:** "Performance Analysis" on page 265.

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.

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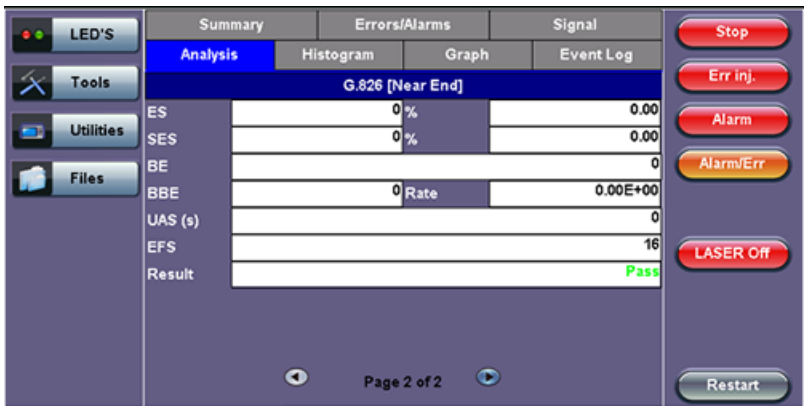
- Framed patterns and bulk signals.
- Pass/Fail result is in conjunction with path allocation between 0.1 and 100%.

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.



G.826 Analysis

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.

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

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

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

Definitions:

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

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

Evaluation According to ITU-T G.828

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

- ES, SES, BBE, UAS and SEP are evaluated.
- Pass/Fail result is in conjunction with path allocation between 0.1 and 100%.

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

- B1
- B2
- MS-REI
- B3
- HP-REI

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- LP-BIP
- LP-REI
- Bit errors (TSE)

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

Bit errors can be evaluated for:

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

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

Evaluation According to ITU-T G.829

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

ES, SES, BBE and UAS are evaluated.

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

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

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

Bit errors can be evaluated for:

- Unframed patterns.
- Framed patterns and bulk signals.

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

Evaluation According to ITU-T M.2100

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

ES, SES and UAS are evaluated.

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

Settings for S1 and S2:

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

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

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

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

Bit errors can be evaluated for:

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

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

Evaluation According to ITU-T M.2101

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

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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.

Alarms/Errors

Alarm Generation and Error Insertion

Accessing Alarm Generation and Error Insertion

Tap **Home (main menu) > Alarm/Error** to open the Alarm and Error setup menu.

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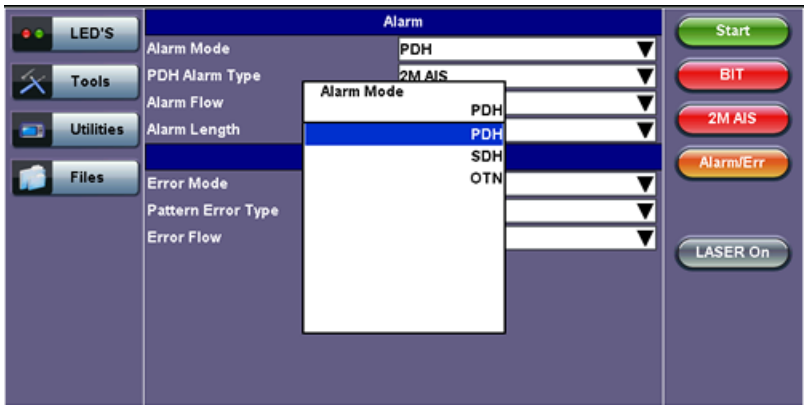
The alarm and error functions are used in conjunction with the drop-down menu which has dedicated buttons for error injection and alarm generation. Alarms and errors selected in the drop-down menu are assigned to the Alarm and Error injection buttons. Alarm and error selections will depend on PDH, SDH,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

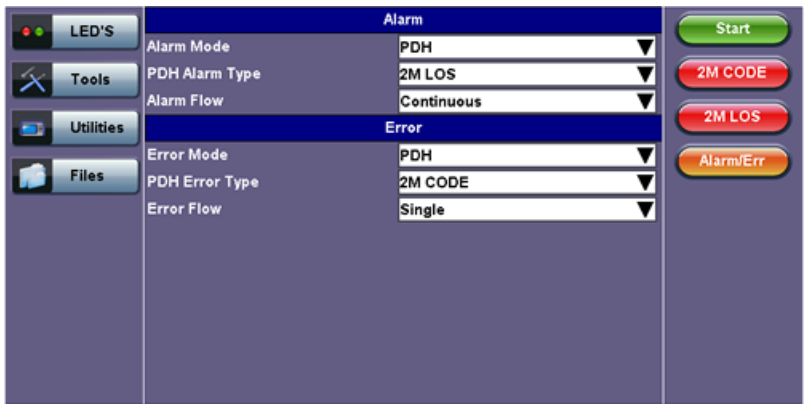


Alarm Setup

Alarm Generation

Generates a 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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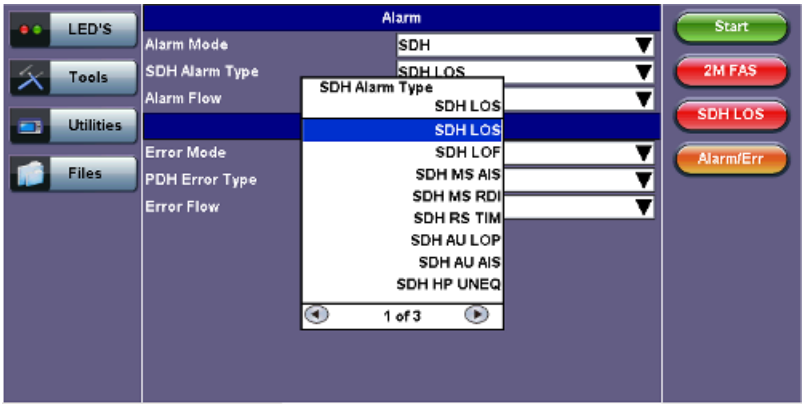
SDH Alarms

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 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

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

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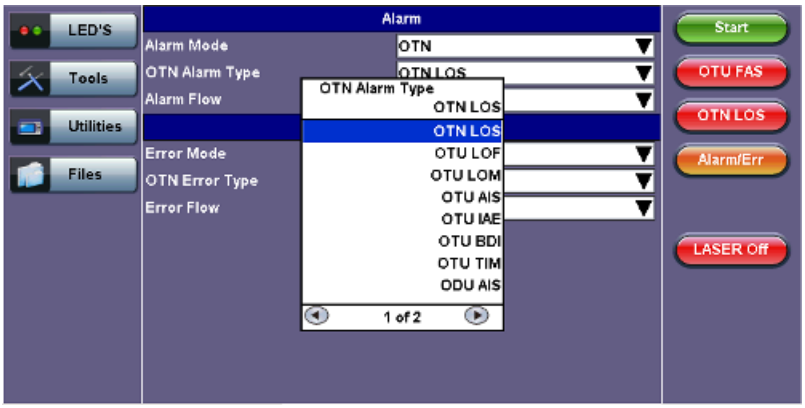
- **PDH Payload alarms (depends on payload):** DS1-AIS, DS1-LOF, 2M-AIS, 2M-RDI, 2M-LOF, 34M-AIS, 34M-LOF, 34M-RDI, 45M-AIS

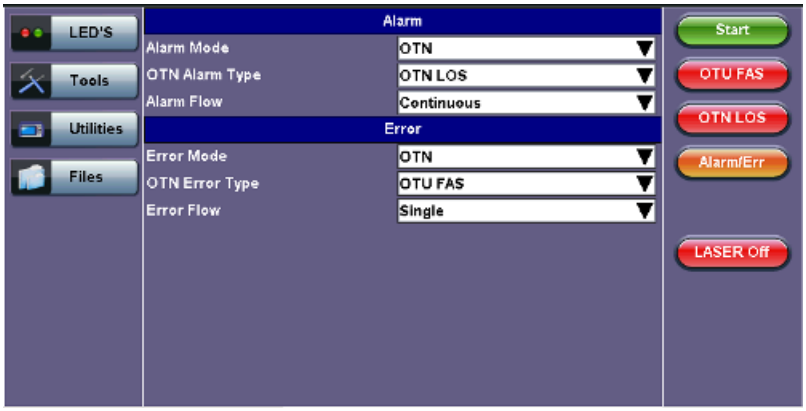
Mode: Static (enable/disable) using drop-down menu function.



OTN Alarm Type

Error Insertion

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



SDH Errors

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

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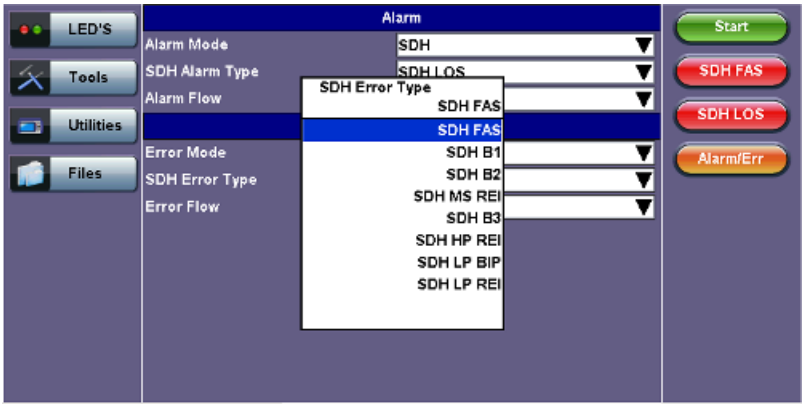
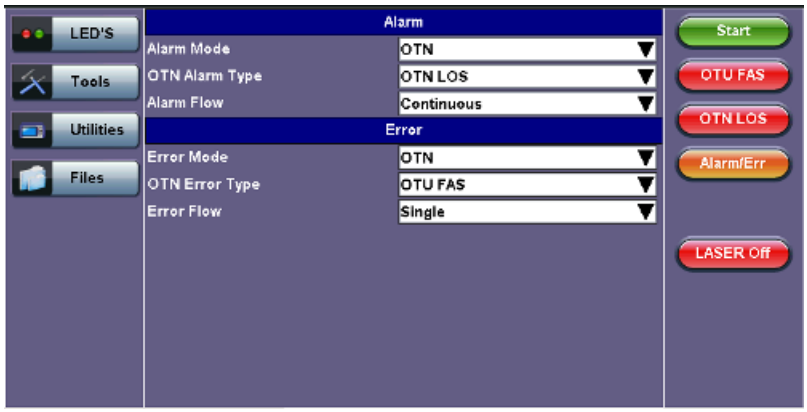
- **STM-1/4/16/64 signals:** FAS, B1, B2, MS-REI, B3, HP-REI, LP-BIP, LP-REI
- **Depends on payload:** 2M-FAS, 2M-CRC, 2M-REI, 34M-FAS, 45M-FAS, 1.5M-FAS



SDH Error Type

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

Error Flow: OTN, SDH, SONET, PDH signals

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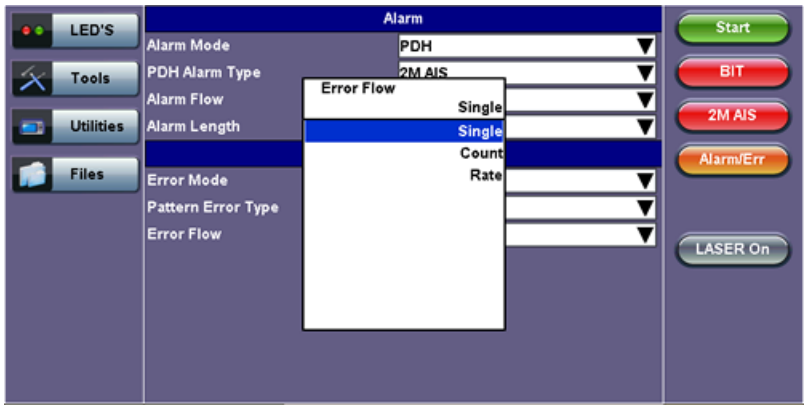
- **Single:** Inserts a single error every time the insertion button is tapped.
- **Count:** Specific count or number of errors when the insertion button is tapped.
- **Rate:** Specific rate between 1x10-3 and 5x10-6.

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.

OTN Tools

Shortcuts

Accessing OTN Tools

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

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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:**

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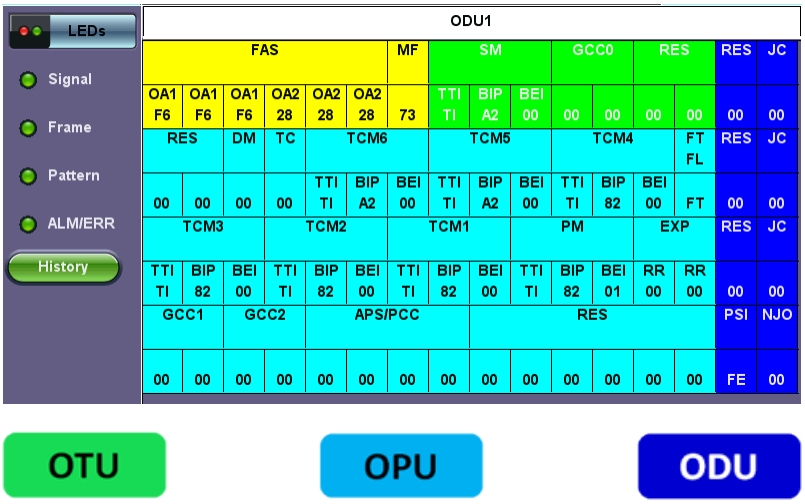
- PSI field transports a 256-byte message aligned with the ODU multiframe.
- PSI0 contains the Payload Type (PT) identifying the payload being transported.
  - The OPU Payload Type (PT) is a single byte defined within PSI to indicate the composition of the OPU signal, or in other words, the type of payload being carried in the OPU.

- **TCM Tasks:**
  - Used to analyze or edit the sequence of TCMi (i = 1 to 6) bytes by generating alarms and errors in the Tandem connection sub-layer.
- **Round Trip Delay (Propagation Delay):** Measurement works by sending a test pattern. Bit errors are transmitted in the pattern. The time it takes for the error to reach the receiver is the propagation time through the network.

Overhead Analyzer & Generator

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



Overhead Analyzer Menu

The Overhead is color coded for simplified viewing.

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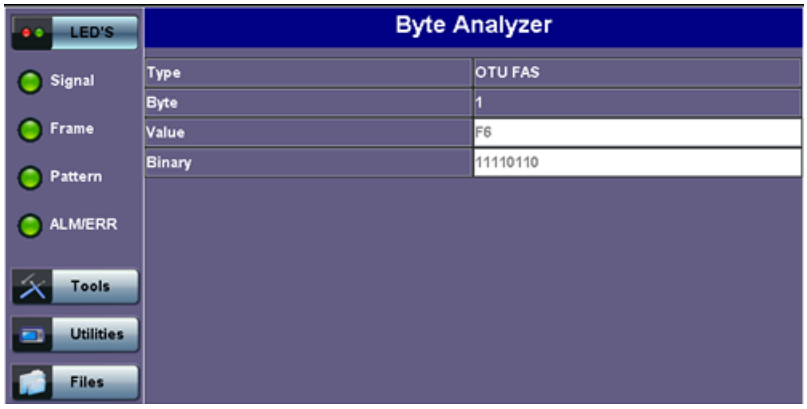
Decoding Bytes

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

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

Optical Transport Unit (OTU) Analysis

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

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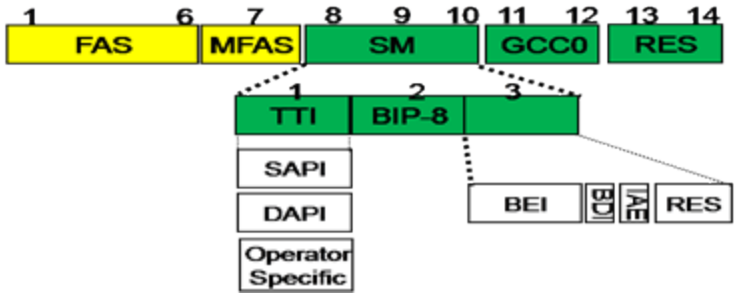
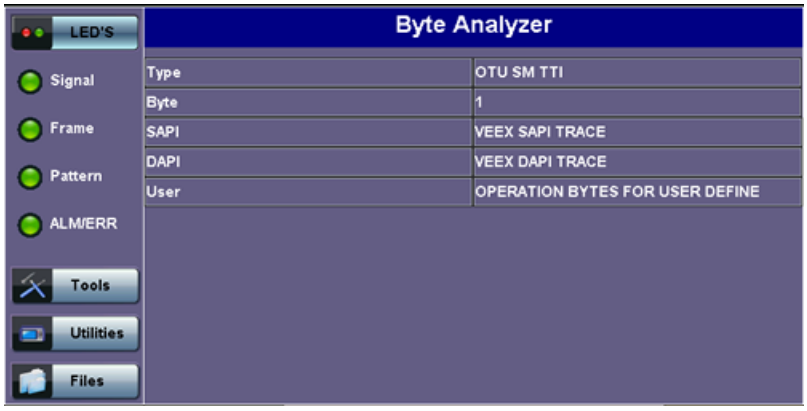


- Section Monitoring (SM)
  - Bytes are used for the Trail Trace Identifier (TTI), Parity (BIP-8) and the Backward Error Indicator (BEI) (also known as the Backward Incoming Alignment Error [BIAE]), Backward Defect Indicator (BDI), and Incoming Alignment Error (IAE).
  - The TTI is distributed over the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

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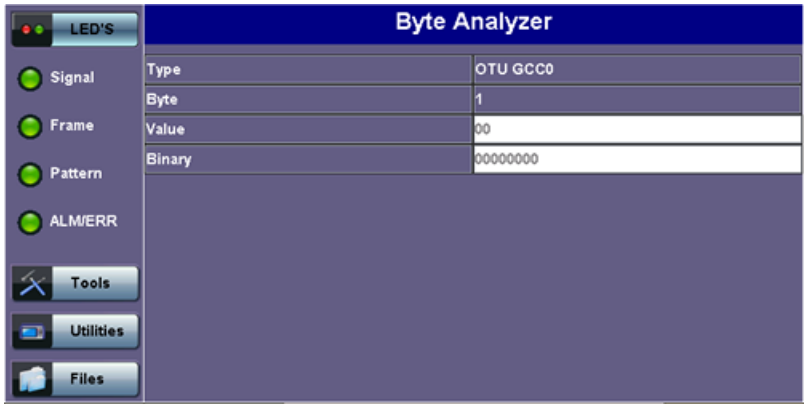
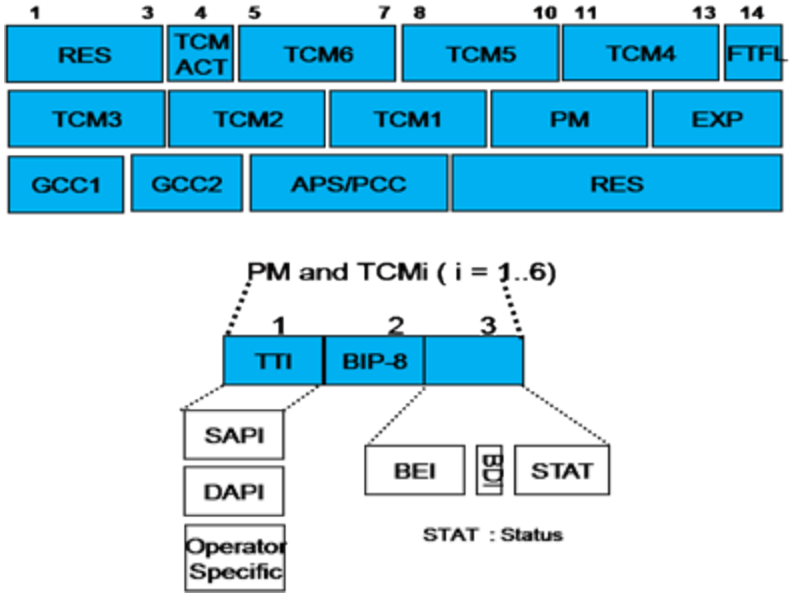


GCCO Type

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

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.

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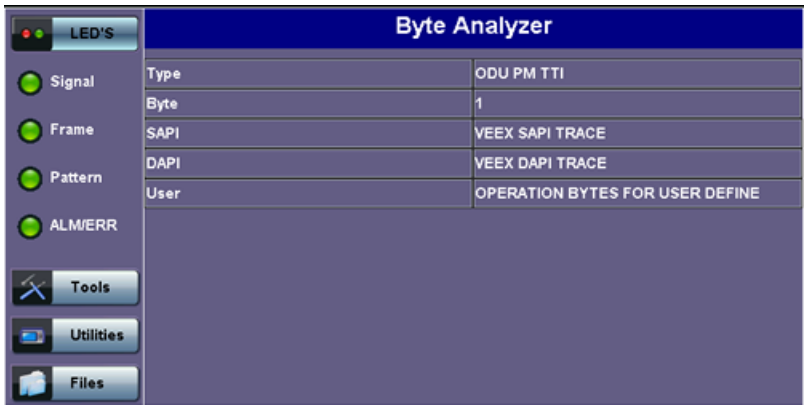
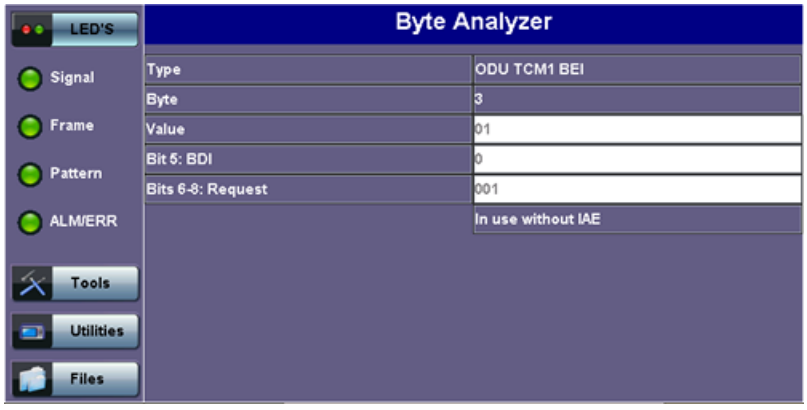
- Path Monitoring (PM).
    - Field is similar to the SM field described above. It contains the TTI, BIP-8, BEI, BDI, and Status (STAT) subfields.



PM TTI Type

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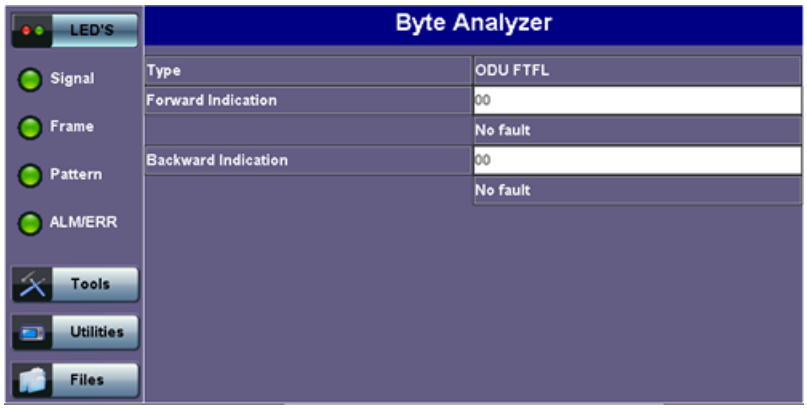
- **Fault Type and Fault Location (FTFL)**
  - Reporting communication channel field used to create a message spread over a 256-byte multiframe.
  - Provides the ability to send forward and backward path-level fault indications.



FTFL Type

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ITU-T G.709 Figure 15-20

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

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

ITU-T G.709 Figure 15-20

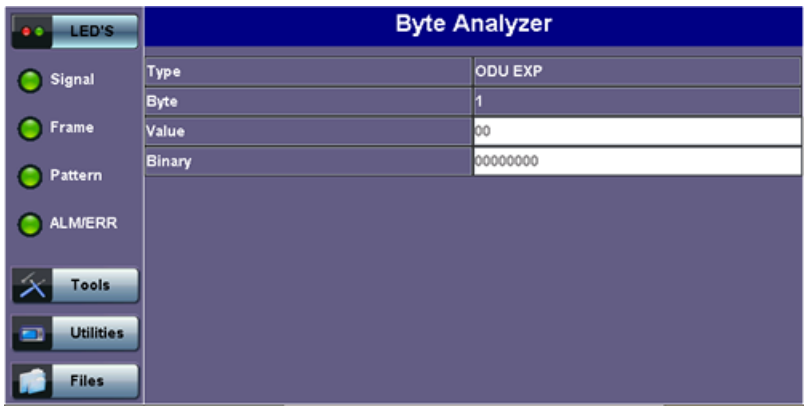
128	129	137	138	255
Fault indication field	Operator identifier field	Operator specific field		
Backward field				

ITU-T G.709 Figure 15-21

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

ITU-T G.709 Figure 15-6

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



EXP Type

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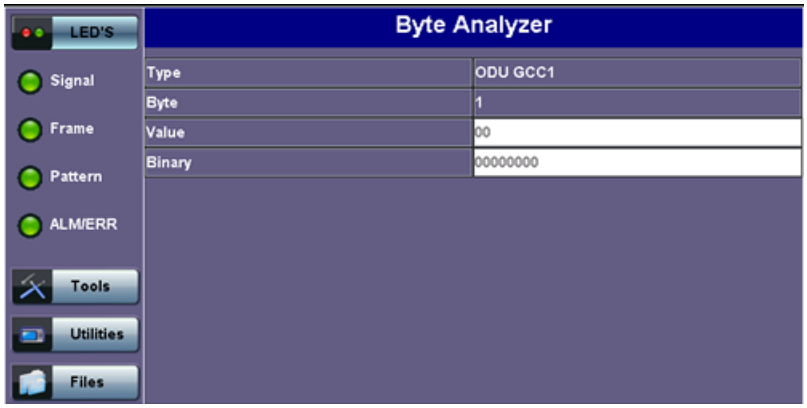
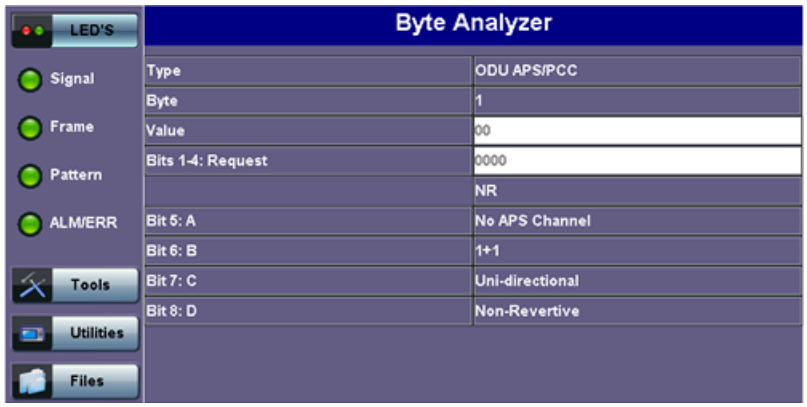
- **General Communication Channels 1 and 2 (GCC1/GCC2)**
  - Fields are very similar to the GCC0 field, except that each channel is available in the ODU.



GCC1 Type

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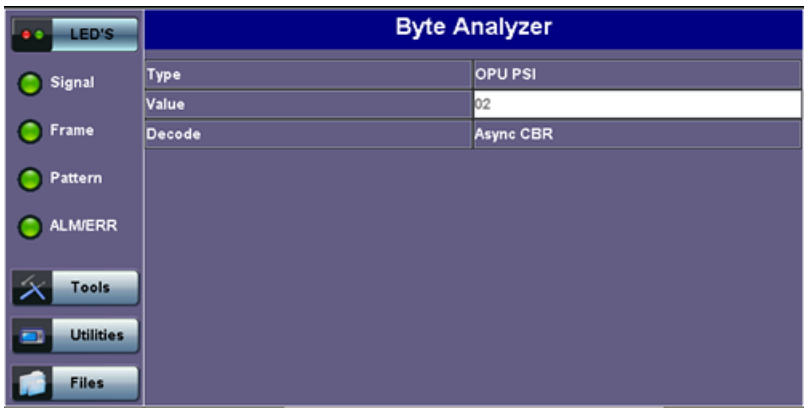
- **Payload Structure Identifier (PSI)**
  - Primary overhead field associated with the OPU.
  - A 256-byte multiframe whose first byte is defined as the Payload Type (PT). The remaining 255 bytes are currently reserved.



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.

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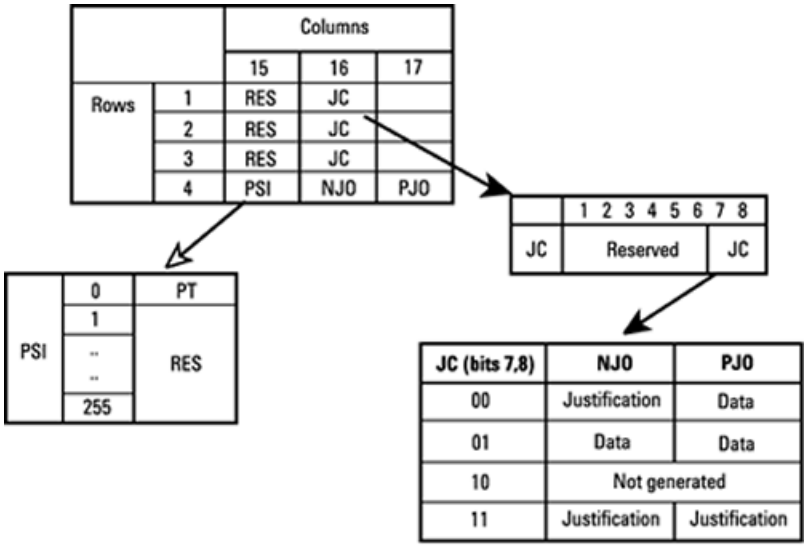
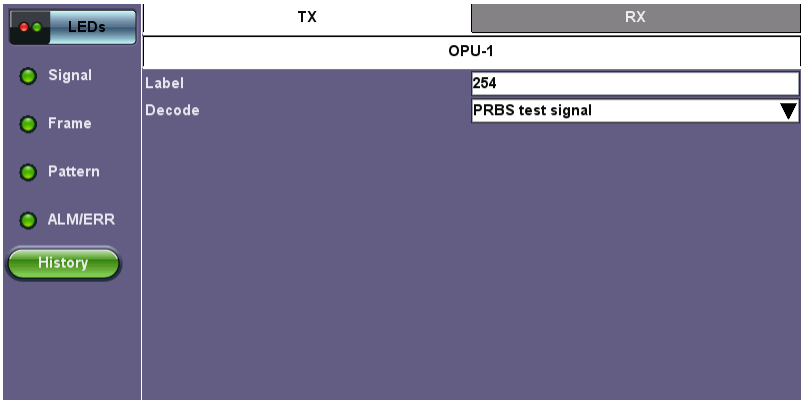


OPU2, O/H for synch mapping of 10 Gb/s SDH/SONET

Payload Label (Payload Structure Identifier)

Tap the **Payload Label** button 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.

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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

Additional Payload types include the following:

Hex Code	Interpretation
07	PCS Ethernet
08	FC-1200 into OPU2e
0A	STM-1 mapping into OPU0
0B	STM-4 mapping into OPU0

Trace Identifier (Trail Trace Identifier)

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

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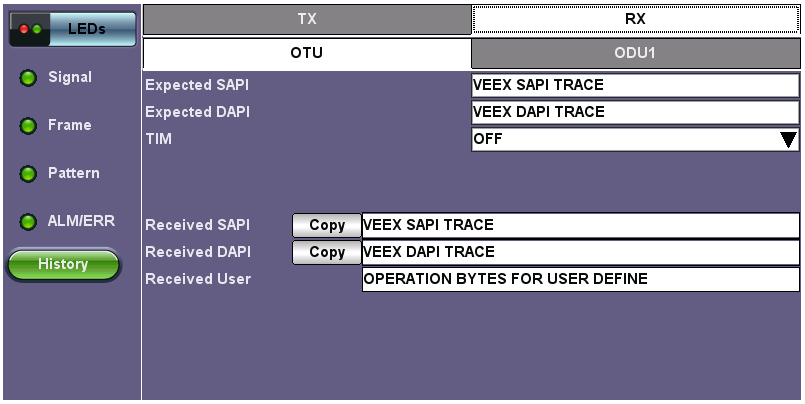


Trace Identifier (Trail Trace Identifier)

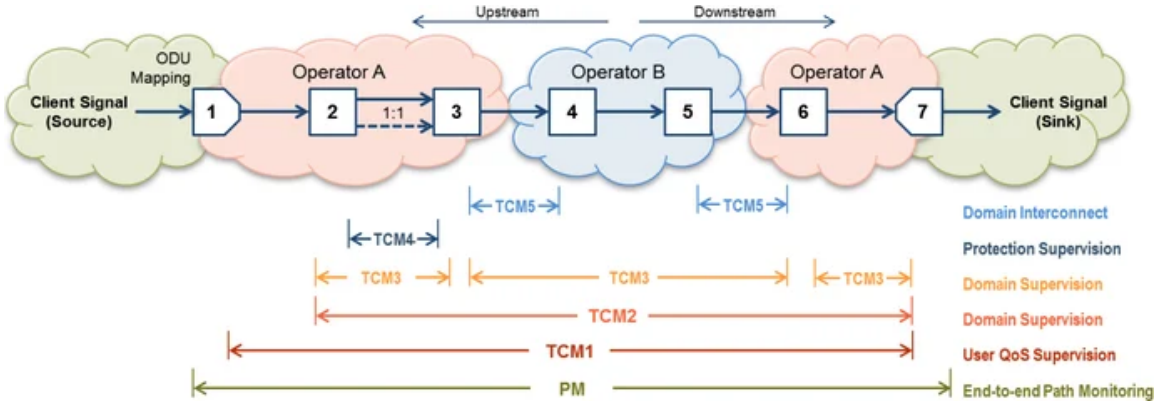
Trail Trace Identifier

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.

TCM Task (Tandem Connection Monitoring)

How To Generate/Modify and Monitor OTN TCMi Overhead Bytes

Some VeEX test sets offer dedicated TCM-specific functions, such as the TCM Tasks. TCMi Bytes are part of the OTN Overhead, however, each TCMi channel contains its own Parity, Errors and Alarms, based on the different segments of the link under test.



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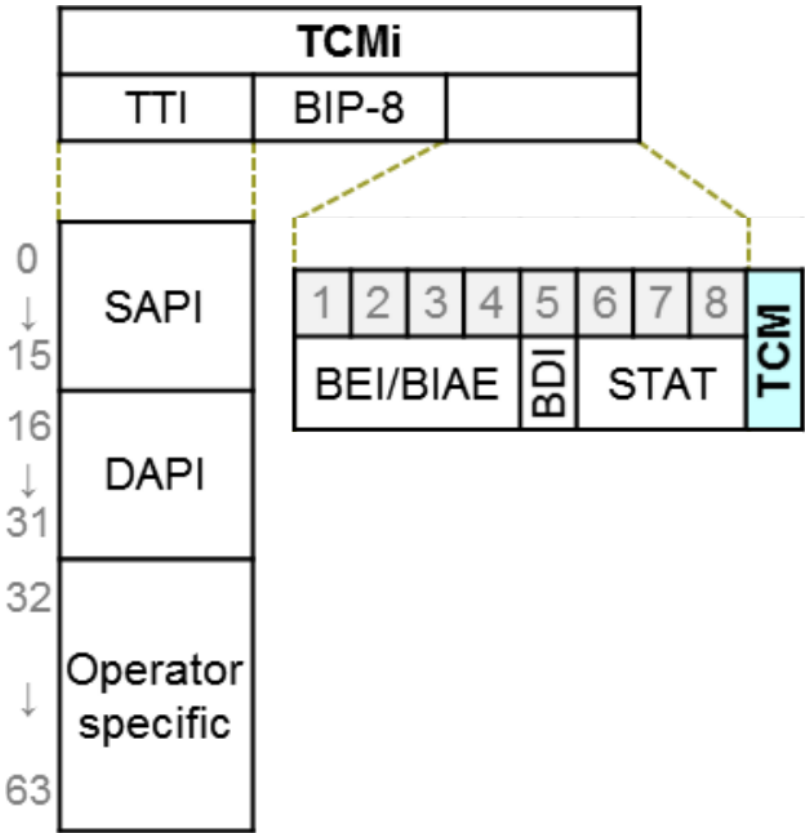
The OTN Tandem Connection Monitoring (TCMi, i = 1 to 6) channels are used to monitor the status of the different segments that make an end-to-end path, allowing operators to monitor and pinpoint problematic segments during testing or troubleshooting. It becomes very useful when multiple carriers or service providers are involved in the delivery of a service. Note that every level of ODUk, within the OTN map/mux structure, has its own TCMi channels.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	FAS						MFAS	SM			GCC0		RES		RES	JC1
	OA1	OA1	OA1	OA2	OA2	OA2	MF	TTI	BIP-8	BEI/BDI	00	00	00	00		00
2	RES		DMp/ti	TC	TCM6			TCM5			TCM4			FTFL	RES	JC2
	00	00	00	ACT	TTI	BIP-8	BEI/BDI	TTI	BIP-8	BEI/BDI	TTI	BIP-8	BEI/BDI	FTFL		00
3	TCM3			TCM2			TCM1			PM			EXP		RES	JC3
	TTI	BIP-8	BEI/BDI	TTI	BIP-8	BEI/BDI	TTI	BIP-8	BEI/BDI	TTI	BIP-8	BEI/BDI	RR	RR		00
4	GCC1		GCC2		PCC / APS			RES							PSI	NJO
	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00



The TCMi functionality is part of the OTN overhead and it is used to independently monitor up to six tandem connections within a link (end-to-end path). The i index refers to the individual sections being monitored. There are six TCMi fields in the ODUk section of OTN overhead, each one with three bytes. The information is carried in a multi-frame format.

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The TCMi bytes contain the following information:

- **TTI** - Trail Trace Identifiers
    - **SAPI** - Source Access Point Identifier
    - **DAPI** - Destination Service Point Identifier
    - Operator Specific Information
- **BIP-8** - Bit Interleaved Parity
- **BEI** - Backward Error Indication
- **BIAE** - Backward Incoming Alignment Error
- **BDI** - Backward Defect Indication
- **STAT** - TCM Monitoring Status bits

Testing OTN Links with TCMI (Handheld test sets)

Select the **Test Port Group >Test Port**, pick the **OTN** or **OTN/SDH/SONET** tab from the technology menu, and pick the desired OTN test feature, for example, **OTN SDH/SONET Mapping**. Press **OK** to load and launch the test application.

Use the **Setup** menu to configure the test set's OTN test interface to match the network/link port or system under test. Use a clean and inspected patch cord to connect the test set to the link under test.

Knowledge of OTN, TCM theory, link architecture, OTN Errors and Alarms are required, to avoid unwanted responses from the far end or intermediate nodes and to get meaningful results (and interpretations).

Enabling Tandem Connection Monitoring

All required active TCMi (1 to 6), for each ODUk level needs to be enabled, to match the monitoring structure of the link or port under test. In normal conditions, active TCMi channels transmit STAT=001 and disabled ones transmit STAT=000.

The graphical user interface (GUI) for OTN functions may be a bit different for native Ethernet over OTN (direct mappings) and OTN with legacy TDM payloads (SDH/SONET).

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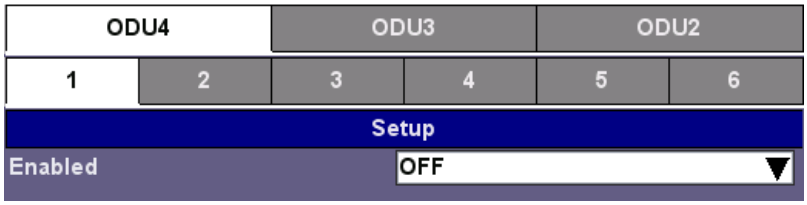
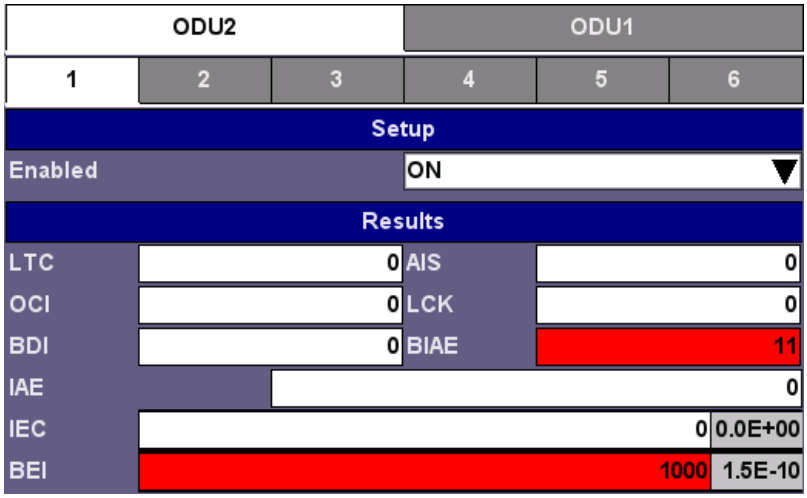
To enable individual TCMi channels, go to **>OTN Tools >TCM Tasks** and set the **Enabled** field to **ON** for each of the required TCMi channels, in each ODUk level, to be monitored and included in the test. There is one tab for each TCM channel.



When enabled, individual Alarm and Error results for each monitored segments will be shown on those tabs (not on the main OTN BERT Results or Summary screens).



TCM ALARMS

ODU-LTC - Loss of Tandem Connection

- STAT = 000

TCM-OCI - Open Connection Indication

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- Defect: STAT = 110 for ≥ 3 consecutive frames
- Clear: STAT ≠ 110

TCM-BDI - Backward Defect Indication

- Defect: Set to 1 for ≥ 5 consecutive frames
- Normal: Set to 0 for ≥ 5 consecutive frames

TCM-AIS - Alarm Indication Signal

- Defect: STAT = 111 for ≥ 3 consecutive frames
- Clear: STAT ≠ 111

TCM-LCK - Tandem Connection is Locked

- Defect: STAT = 101 for ≥ 3 consecutive frames
- Clear: STAT ≠ 101

TCM-BIAE - Backward Incoming Alignment Error (BEI/BIAE bits)

- B (1011) ≥ 3 consecutive frames

TCM-TIM - Trail Trace Identifier Mismatch

- Received and expected TTI strings do not match (are different). This is not an OTN alarm, but one warning indication generated by the local device (e.g., test set or network element)

TCM ERRORS

TCM-BIP-8 - Bit Interleaved Parity-level 8 code error (mismatch)

- Received and calculated BIP are different

IAE- Incoming Alignment Error (OTUk, SM)

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IEC - Incoming Error Count

TCM-BEI - Backward Error Indication (BEI/BIAE bits)

- 0..8 Number of BIP-8 violations detected
- 9..A No BIP-8 error detected
- B Refer to BIAE
- C..F No BIP-8 error detected

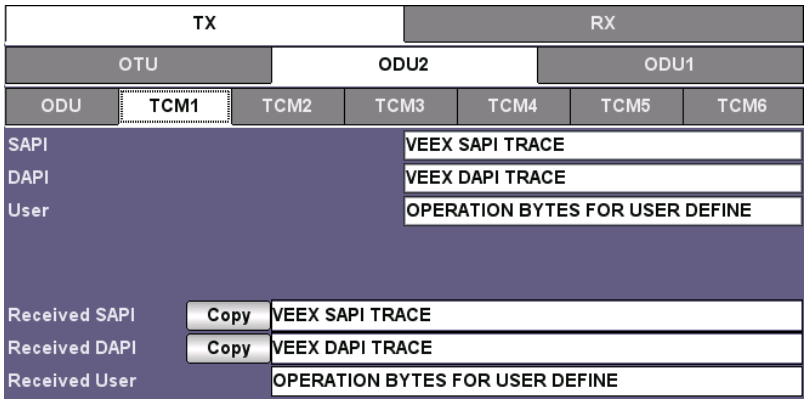
TCMI Trail Trace Identifiers (TTI)

Each of the TCM channels has their own set of identifies. The TTI byte is actually a 64-byte multi-frame string, consisting of:

- **SAPI** - Source Access Point Identifier
- **DAPI** - Destination Access Point Identifier
- Operator specific trace

Transmitted TTIs

When TCM is enabled, test sets transmit pre-defined strings by default. However, each of those traces can be customized (edited) by going to the **>OTN Tools >Trace Identifier** page, selecting the **TX** tab and customizing all the required OTU, ODUs and TCMs to match all the identifiers expected by the network.



Use the **Copy** buttons on the **Received** fields, to copy the received string to the corresponding setting for the test set's transmitter. Users can edit the transmit fields after copying.

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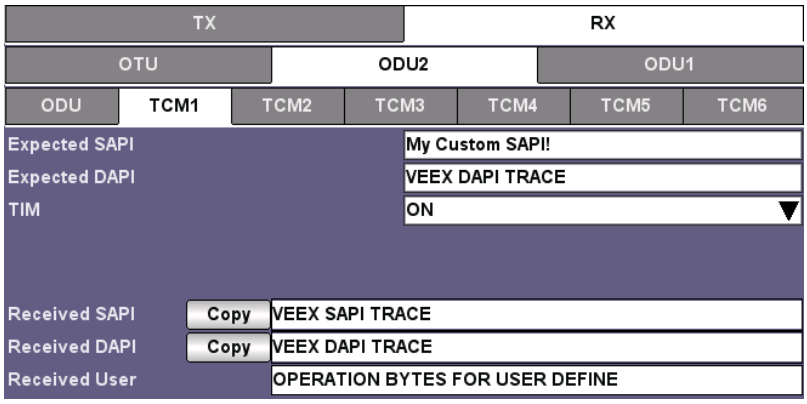
Received and Expected TTIs

On the **>OTN Tools >Trace Identifier** page, tap on the **RX** (Receive) tab and select the OTU, ODUs and TCMs required for the link under test. By default, the **TIM** validation fields are set to **OFF**, so the test equipment ignores the received traces.



Users have the option to turn the **TIM** validation **ON**, for the test set to compare the **Received** SAPI/DAPI traces against the (user programmed) **Expected** SAPI/DAI traces. When enabled, the test set will generate a Trace Identification Mismatch (TIM) warning indication if/when any of the received traces don't match the expected string.

TCM Fields in the Overhead Analyzer/Monitor

Go to **>OTN Tools >Overhead Analyzer** to view the received TCMi bytes in the OTN overhead. Users can tap on individual byte fields to get quick decode of the current value or text strings.

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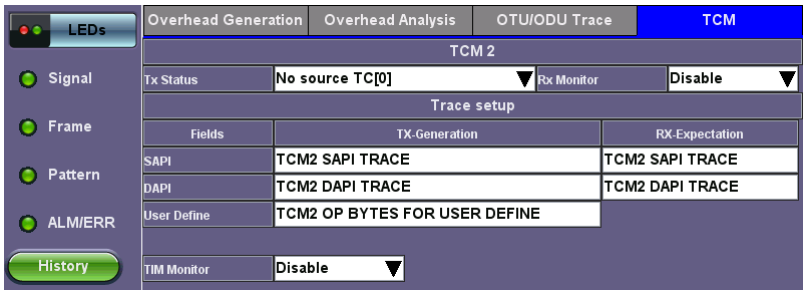
The TCMi fields on the **Overhead Generator** function are marked **xx**, to indicate that they can't be generated or modified from that page. Use the **TCM Tasks** feature instead.

TCM in OTN with ETHERNET (EoOTN) Test Modes

Test sets with **OTU4** and **OTU3 with Ethernet & Bulk Payloads** test modes may offer a slightly different user interface. All the TCM features are conveniently consolidated within the **Overhead** function. Go to **>OTN Tools >Overhead** and select the **TCM** tab. Use the small arrow buttons near the bottom of the screen to navigate through the six TCMi pages.



To activate a particular TCMi channel for monitoring, **Enable** the **Rx Monitor** field on each of the required TCMs.

Transmit and Expected traces can be programmed right on the same screen, using the **Tx Generation** and **Rx Expectation** fields.

To be alerted of Trace Identification Mismatches, **Enable** the **TIM Monitor** field for each of the TCMi channels to be monitored.

The **Overhead Generation** tab also allows users to modify certain bytes in real time. For the TCMi fields, users can modify the TTI text strings and the BEI bytes by tapping on the fields. Modified values (bytes) will be displayed in red color font, as a reminder. If critical bytes are modified, an **OH** (overhead) warning icon OH is displayed on the top of the screen, to remind users that non-standard values are being transmitted. Use the Reset OH **Reset OH** button to bring the original values back.

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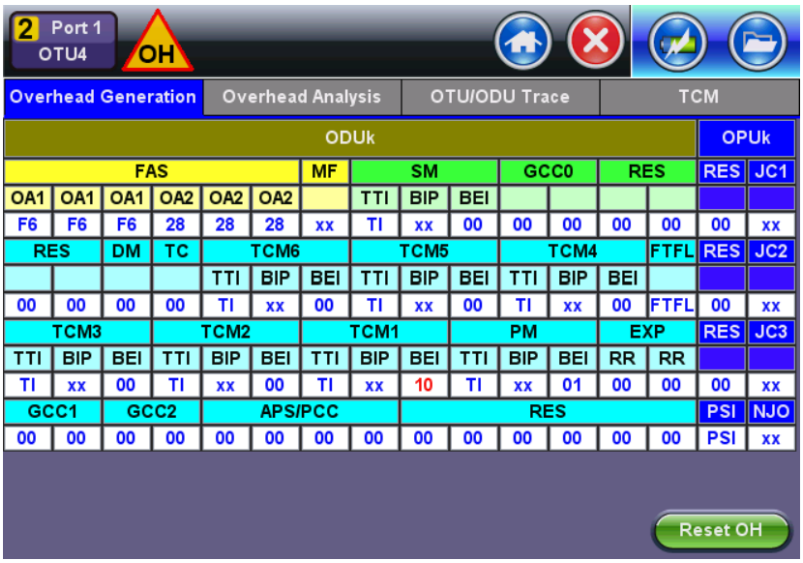
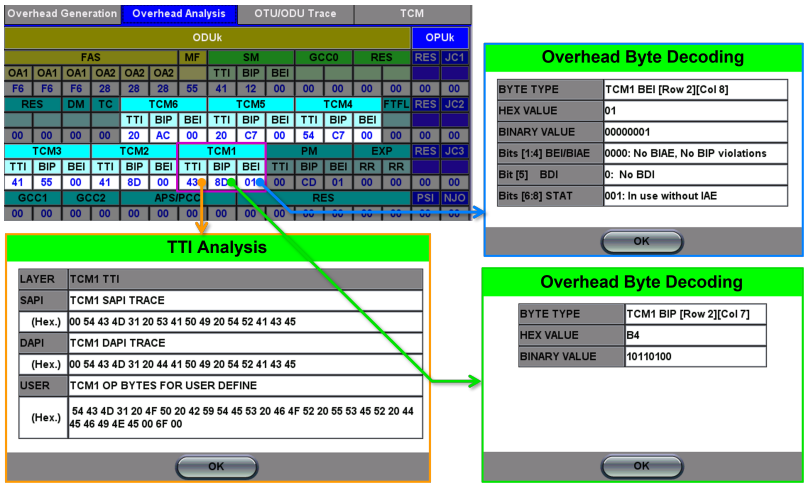


The **Overhead Analysis** tab behaves in a similar fashion, allowing users to decode the different bytes being received, by tapping on the desired fields.



Some test sets may also allow to capture up to 256 values (consecutive frames) for a selected overhead byte. The capture can get started as soon as users tap on a field (byte), or by looking for specific values with the **Pre**, **Mid** and **Post** trigger functions for advanced troubleshooting purposes. To enable this, change the **BYTE** field from DECODING to **CAPTURE** mode.

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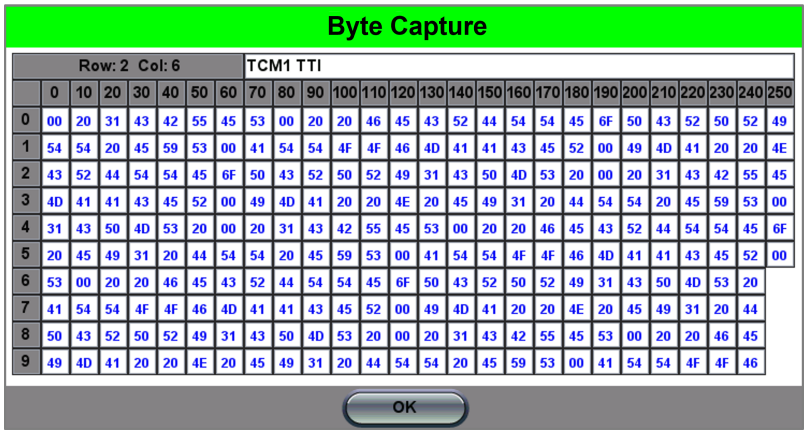

Once the capture mode has been enabled, users can select the **Trigger Type** to program when the acquisition stars. Use **Multi Frame #0** to start at the beginning of the multi-frame or **Pre, Mid** and **Post** to start capturing after, before-and-after or before the specified **Byte Value** trigger is detected.

Alarm & Error Generation

During tests, users can inject different Alarms and Errors into the different levels of the OTN mapping and multiplexing structures. Use the Set Injection **Set Injection** button, on the right side of the screen, to configure the type of impairments to be inserted into the transmitted test signal. There are two dedicated injection buttons for Alarm and Error.

Select the **Mode** (e.g., ODU2 TCM) or **Layer** (e.g., OTU4/ODU4), then the Error and/or Alarm **Type, TCM #** to be affected and the expected **Behavior**. Once set, the Error and Alarm buttons will behave as programmed by the user.

Alarm and/or error icons will be displayed on the top of the screen, to indicate that impairments are currently being injected into the test signal.

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Alarm Behaviors

- **Continuous** - The selected alarm is manually turned ON and OFF by pressing the button.
- **Count** - Upon pressing the Alarm button, the associated alarm will remain active for the number of seconds programmed and then it turns off automatically.
- **Single Burst** - Upon pressing the Alarm button, the associated alarm will remain active for the number of **ON Frames** programmed and then it turns off automatically.
- **Continuous Burst** - The selected alarm is generated affecting a number of **ON** Frames as programmed, followed by a number of **OFF Frames** without alarms, as programmed. The behavior repeats until the alarm button is pressed again.

Error Behaviors

- **Single** - Generates a single error every time the button is pressed.
- **Count** - Lets user program the exact number of errors to be generates each time the button is pressed.
- **Single Burst** - The programmed number of errors are generated consecutively.
- **Continuous Burst** - The selected error is generated affecting a number of **ON Frames** as programmed, followed by a number of error free OFF Frames, as programmed. The behavior repeats until the error button is pressed again.
- **Fixed Rate** - Lets users select from a pre-defined list of common error rates.
- **Rate** - Lets user set specific error rates in X.XXE-YY format.

SDH/SONET Tools

Accessing SDH/SONET Tools

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

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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

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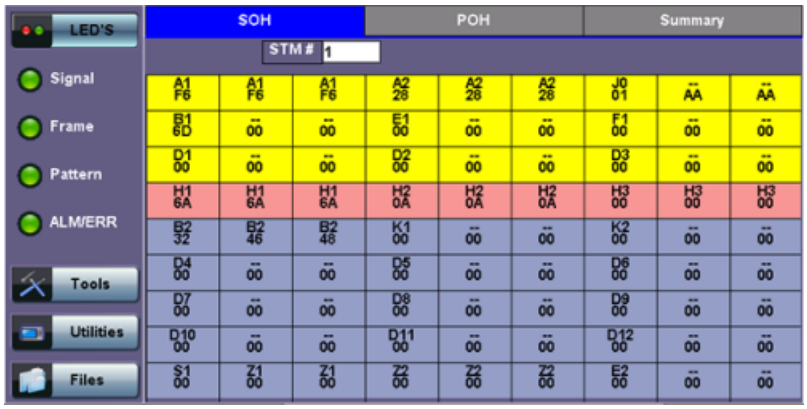
- **TCM Tasks:** Used to analyze or edit the sequence of N1 and N2 TCM bytes by generating alarms and errors in the Tandem connection sub-layer.
- **Round Trip Delay (Propagation Delay):** Measurement works by sending a test pattern. Bit errors are transmitted in the pattern. The time it takes for the error to reach the receiver is the propagation time through the network.

Overhead Analyzer

Tap the **Overhead Analyzer** button to display the SOH 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

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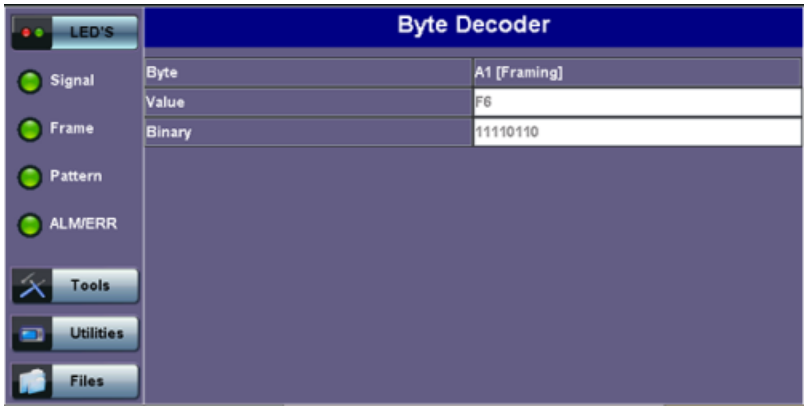
Framing Bytes (A1/A2)

- 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

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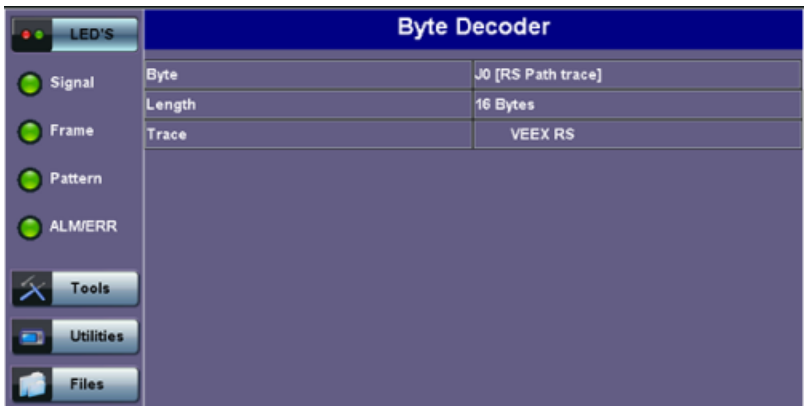
B1 Byte (RS-BIP)

- 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

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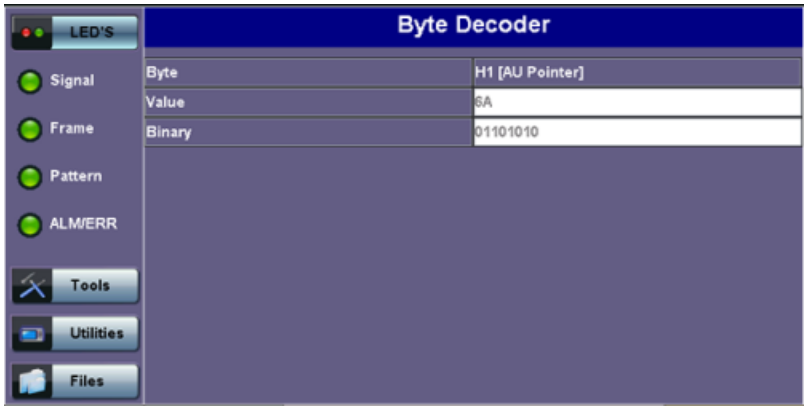
Data Communications Channel Bytes (D1/D2/D3)

- 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

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

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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

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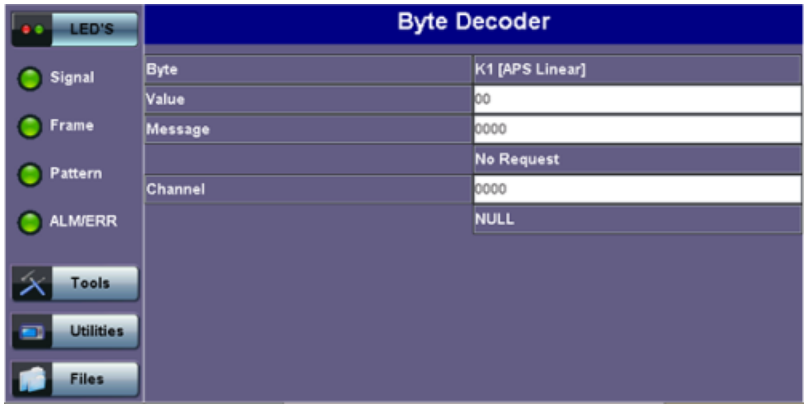

K1 Byte (APS-Linear)

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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

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- 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

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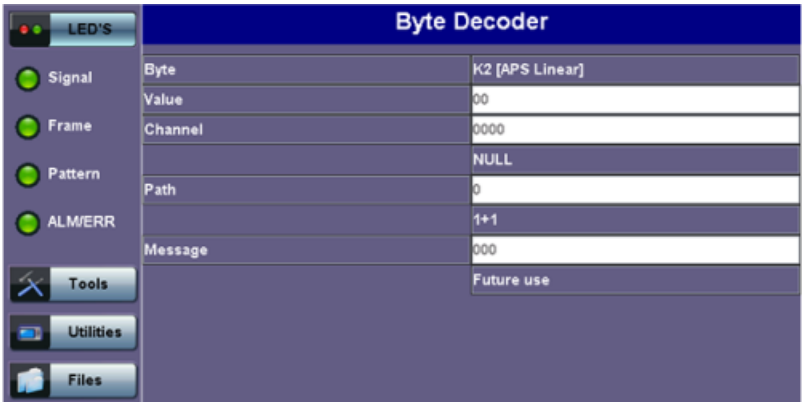
K2 Byte (APS-Ring)

- 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

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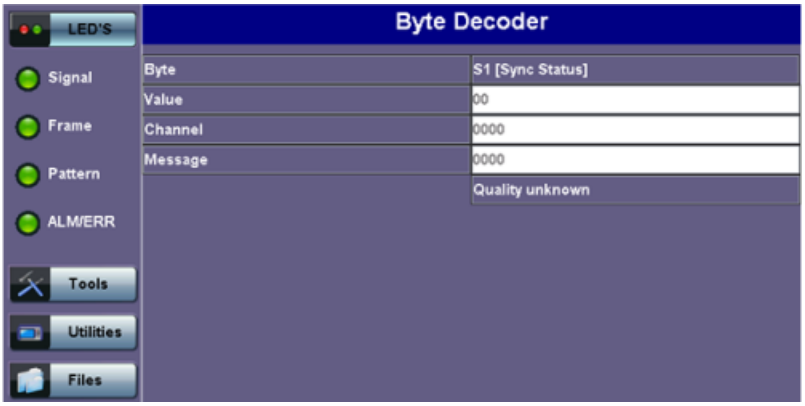

S1 Byte (Synchronization Status)

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

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

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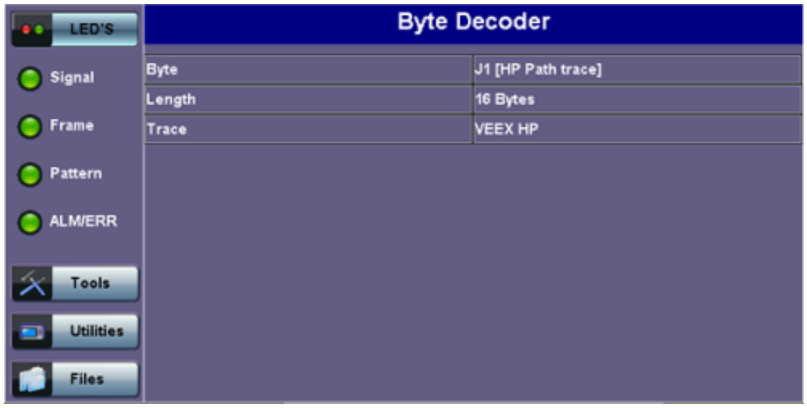

J1 Byte (HP Path Trace)

- **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

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C2 byte (HP signal label) for SDH mode

- Indicates mapping of the VC-n.
- The table below indicates the standard C2 binary values:

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

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

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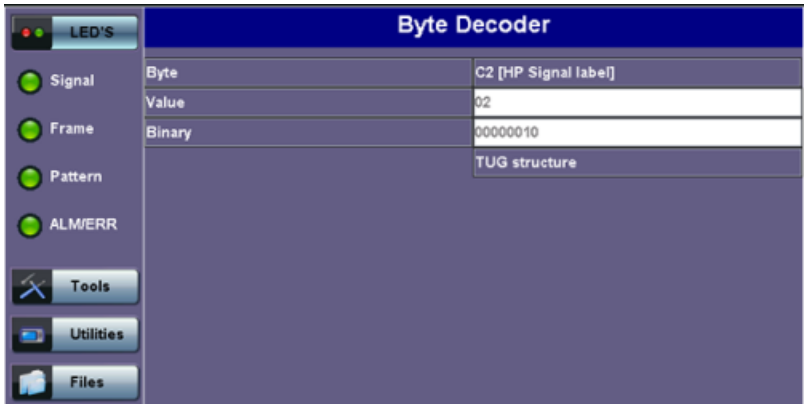
F0	STS-1 payload with 16 VT-x payload defects
F1	STS-1 payload with 17 VT-x payload defects
F2	STS-1 payload with 18 VT-x payload defects
F3	STS-1 payload with 19 VT-x payload defects
F4	STS-1 payload with 20 VT-x payload defects
F5	STS-1 payload with 21 VT-x payload defects
F6	STS-1 payload with 22 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.)



C2 Byte (HP signal label)

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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)

- **G1 byte (Path status)**
  - High Order path status byte
  - Used to convey the path terminating status back to the originating path, thus allowing bi-directional 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)

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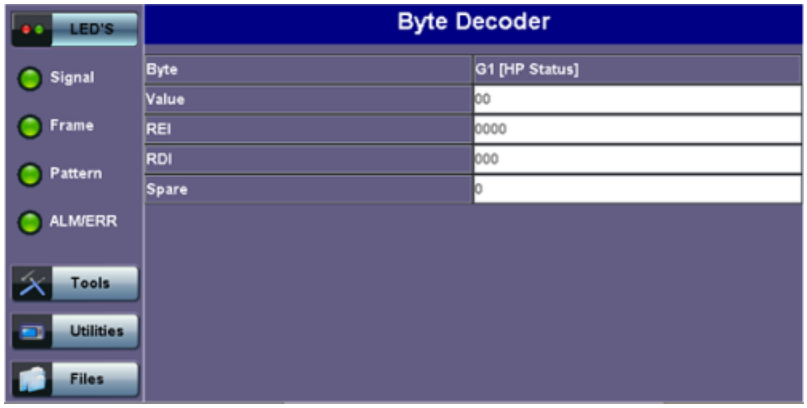

G1 Byte (HP Status)

- **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

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- **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

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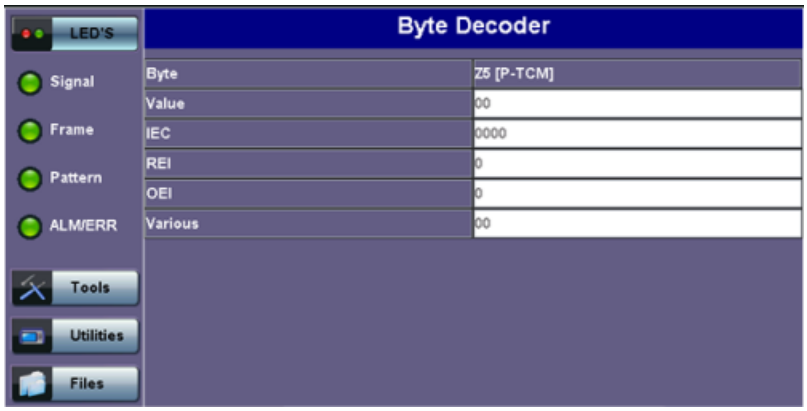
- 000 Unequipped
- 001 Equipped (non-specific)
- 010 Asynchronous
- 011 Bit synchronous
- 100 Byte synchronous
- 101 Extended
- 110 0.181 test signal (TSS4)
- 111 VC-AIS

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



V5 Byte (VT signal label)

- **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

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- **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	

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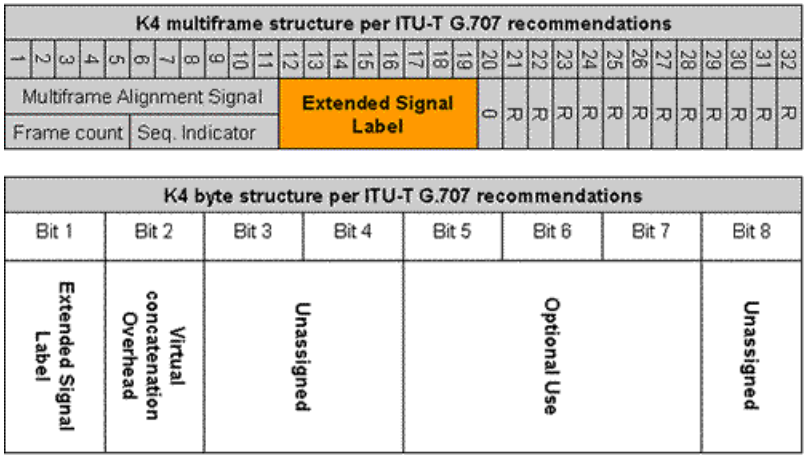
- **K4 byte (LP path Extended Label)**
  - When bits 5-7 of V5 byte are set to 101 (value = 5), then the signal label in K4 byte becomes valid where:
    - Bit 1 is allocated to the extended signal label
    - Bit 2 is allocated to virtual concatenation
    - Bits 3 and 4 are unassigned and are reserved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



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

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

- **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.

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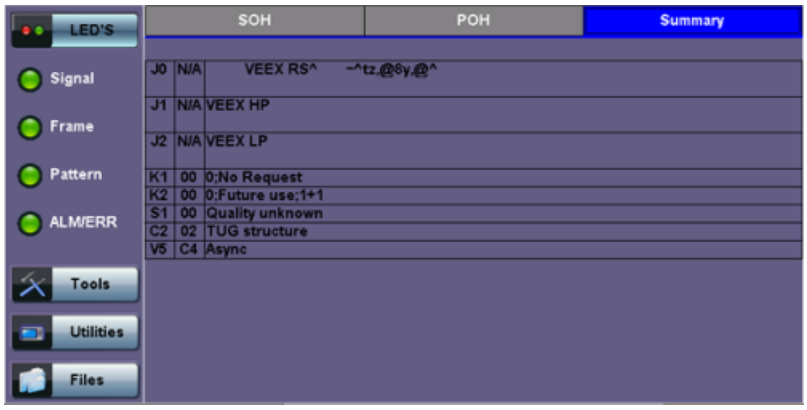
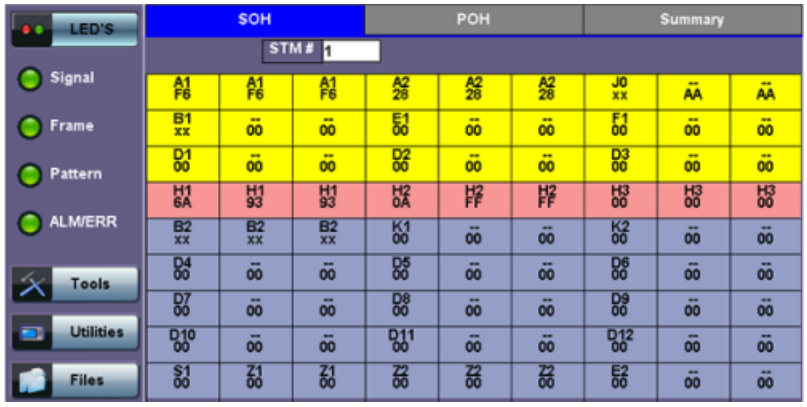
- Column #1 - Indicates the byte type
- Column #2 - Provides the hexadecimal value of the byte (if applicable)
- Column #3 - Provides a byte decode (Please refer to the byte definitions for an explanation of the listed bytes)



Summary

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

Overhead Generator



SOH

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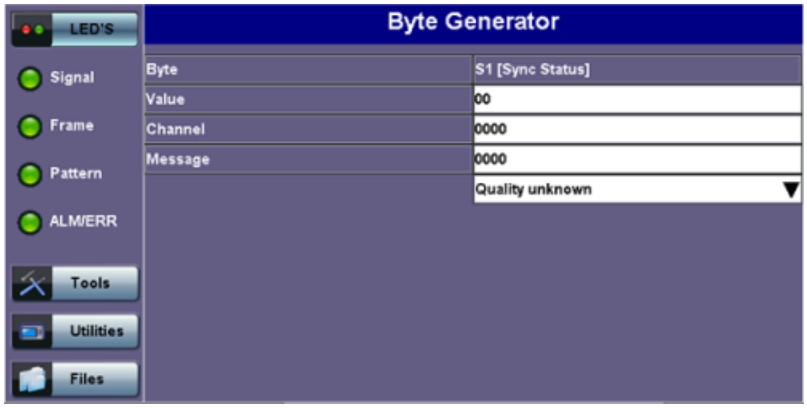
Tap the **Overhead Generator** button to display the OH screens shown below. There are three tabs:

- **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.

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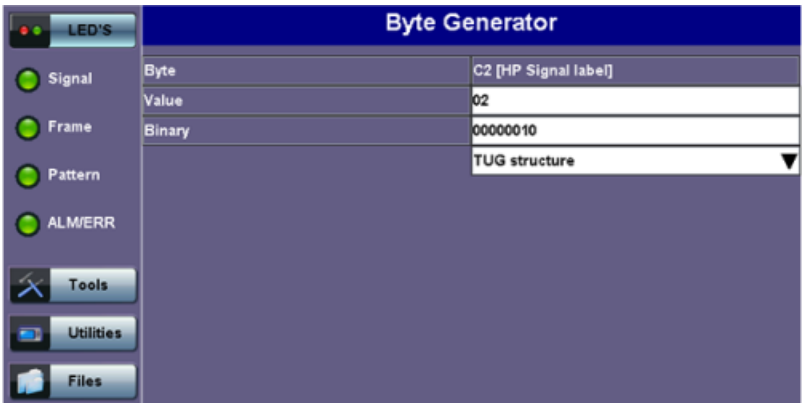
- Convenient drop-down selections. In some instances, the drop-down options will be available over multiple pages.



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.

Pointer Tasks

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

SDH/SONET Tools Menu

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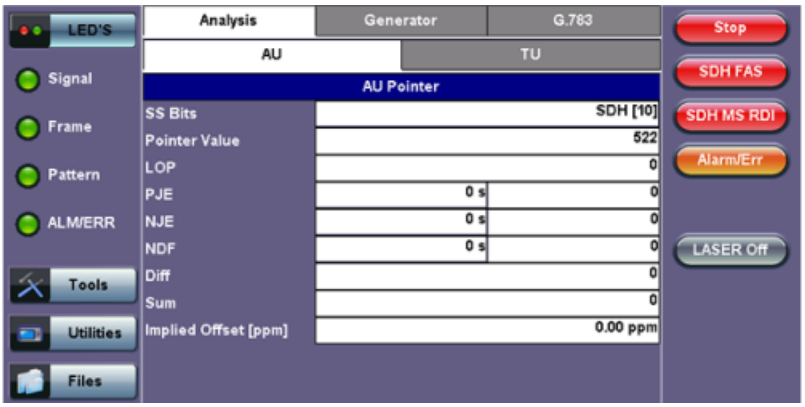
Pointer Analysis

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

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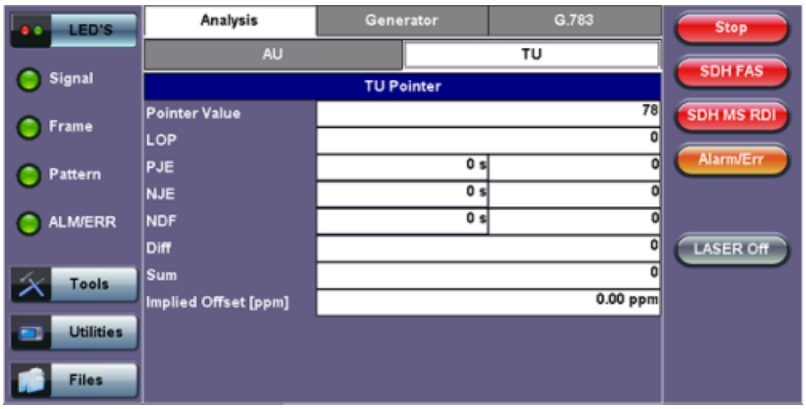
- **For TU pointers:**
  - Pointer value
  - LOP (Loss of Pointer)
  - PJE and NJE
  - NDF or New Data Flags
  - Difference and Sum



Analysis > TU tab

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.

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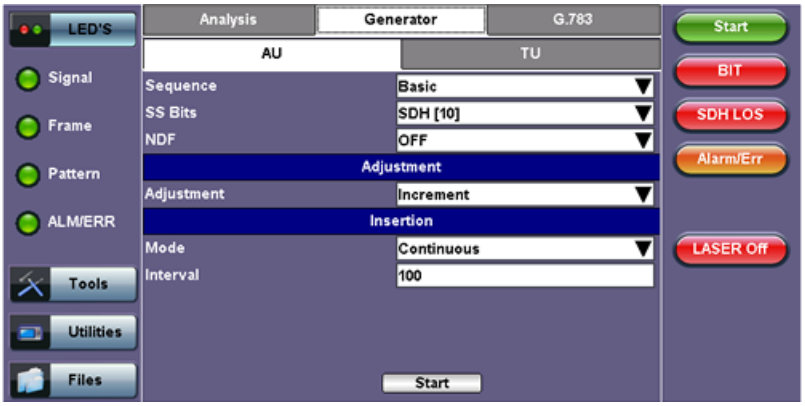
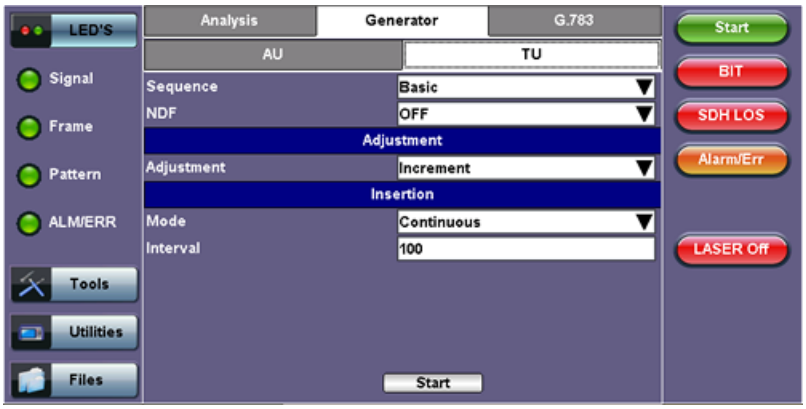


Generator > AU tab

- **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

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:

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- **Sequence:** Decide how to affect the pointer sequence
    - 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
    - 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/multifram

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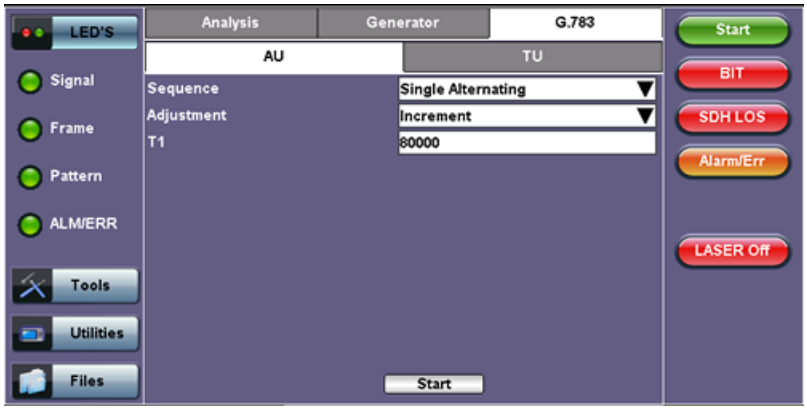
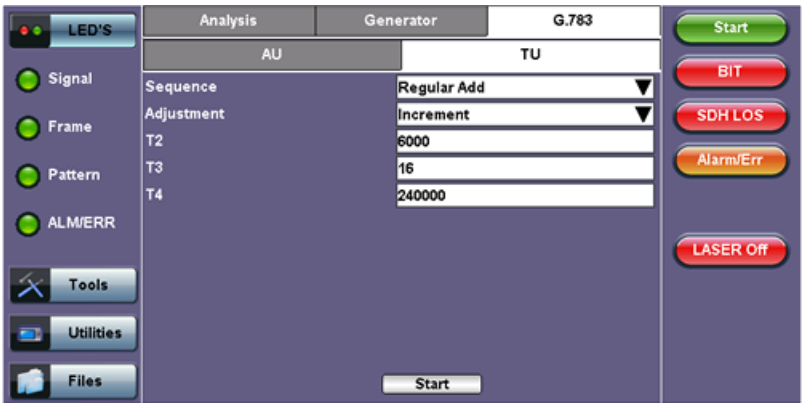


G.873 > AU tab

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

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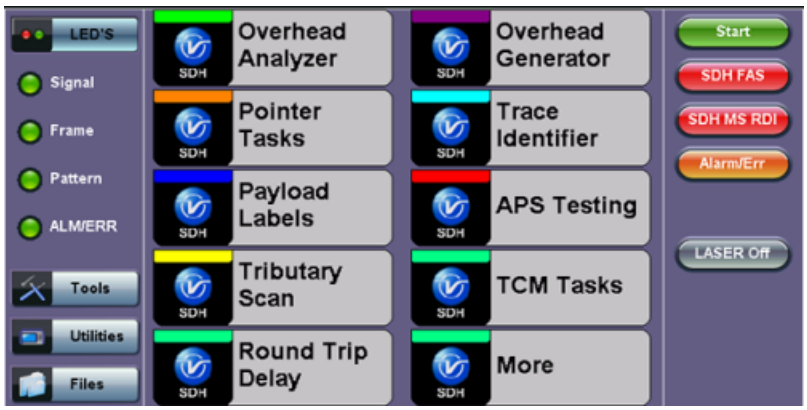
Pointer Sequence Testing

- 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.

Trace Identifier

Tap the **Trace Identifier** button 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.

Transmitted Traces (TX)

- J0 [RS]: Regenerator section trace
  - Program a 1 or 16-byte identifier to check the connection between regenerators

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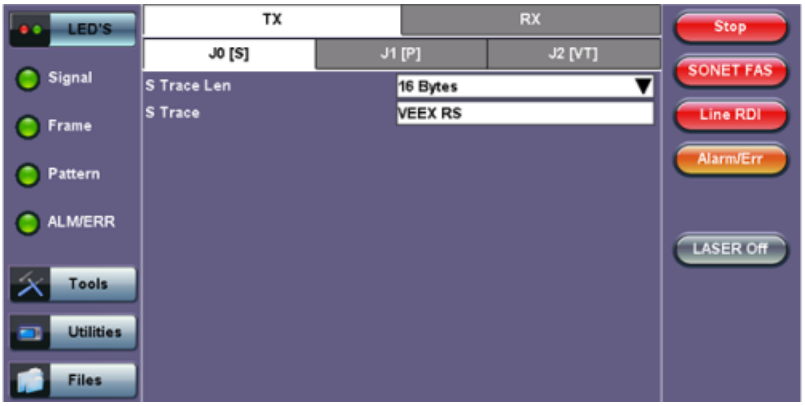
- J1 [HP]: High order path section trace
  - Program a 1J1 [HP]: High order path section trace 6 or 64-byte identifier to check the high order transmission path
- J2 [LP]: Low order path section trace
  - Program a 16 or 64-byte identifier to check the low order transmission path

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



TX - JO [S]

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

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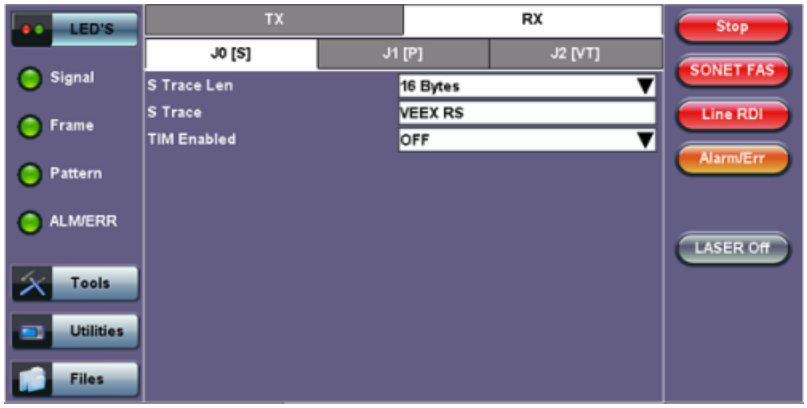
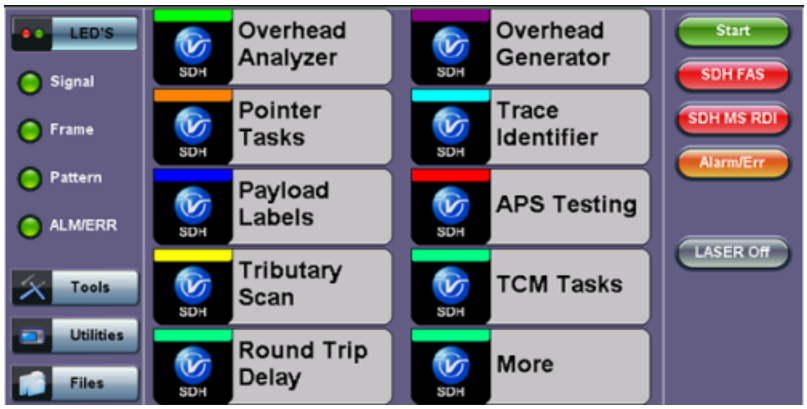
- Program a 16 or 64-byte identifier to set and check the expected trace
- Enable or disable the TIM (Trace Identifier Mismatch) alarm



RX - JO [S]

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** Button to display the payload label screens. There are dedicated tabs for Transmitted and Received payload labels and setups:

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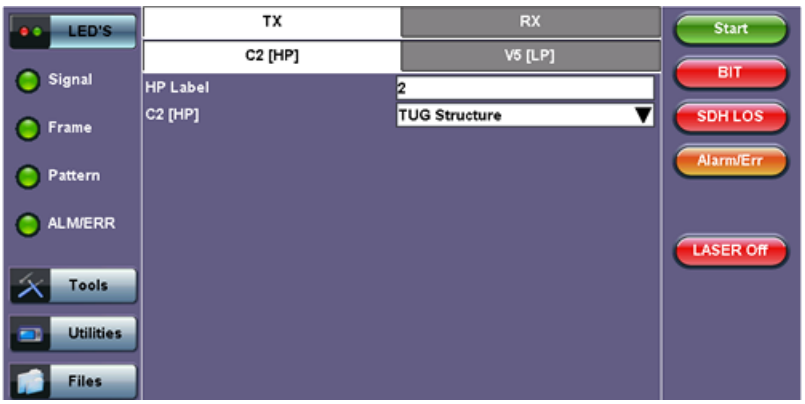
- **C2 [HP Path]: Path signal label**
  - Specifies the mapping type in the VC-n
  - Program the TX or RX label by editing the hexadecimal value or by using the convenient drop-down menu selection
  - For the RX label, enable or disable the Payload Mismatch (PLM) Alarm



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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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.

See section Service Disruption Test (SDT) for APS (SDT) setup.

Tap the **APS Testing** button to display the APS testing screen shown below.

- **Start:** Press to begin the test.
- **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

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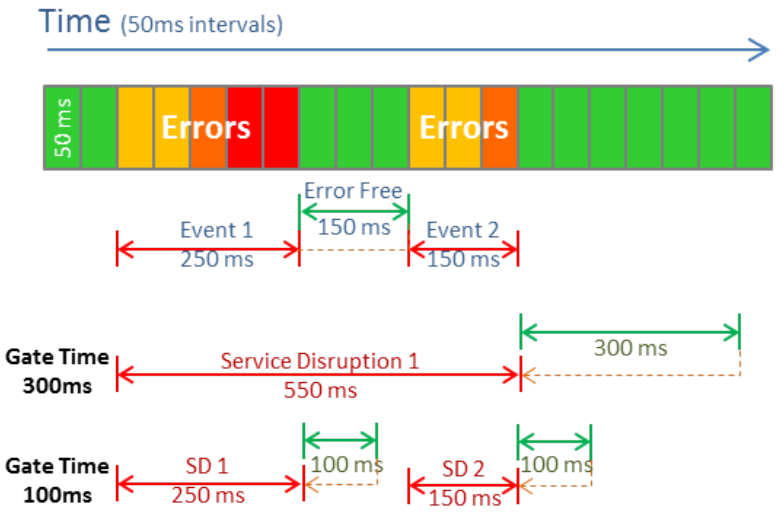
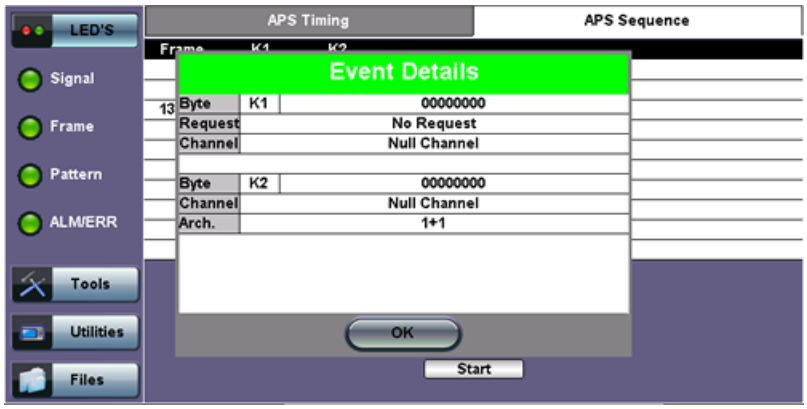


Service Disruptions

APS Sequence

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



Event Details

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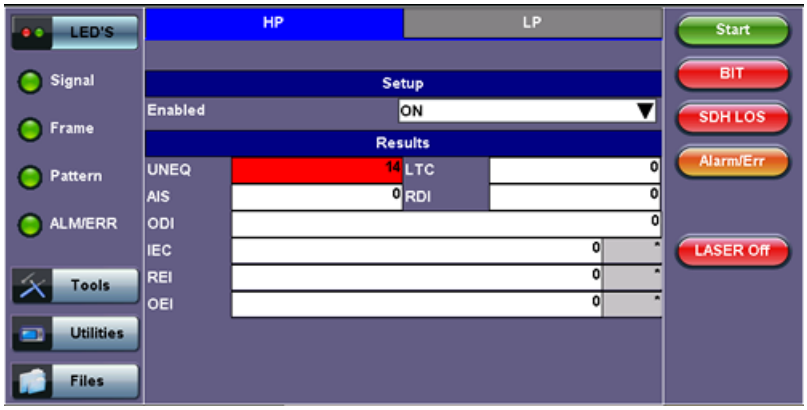

HP Setup

- **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

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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

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

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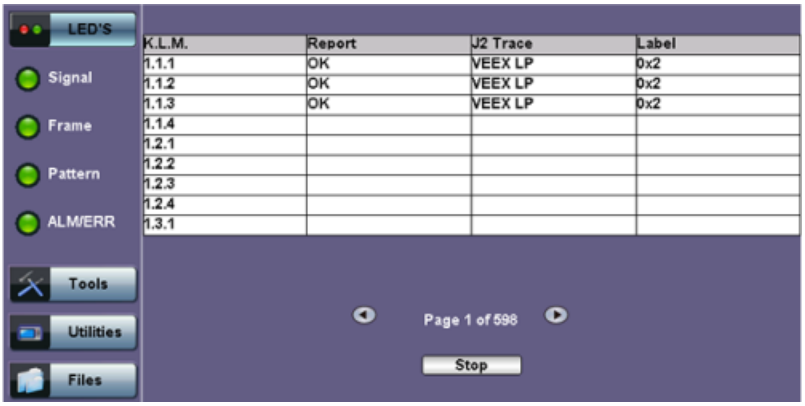
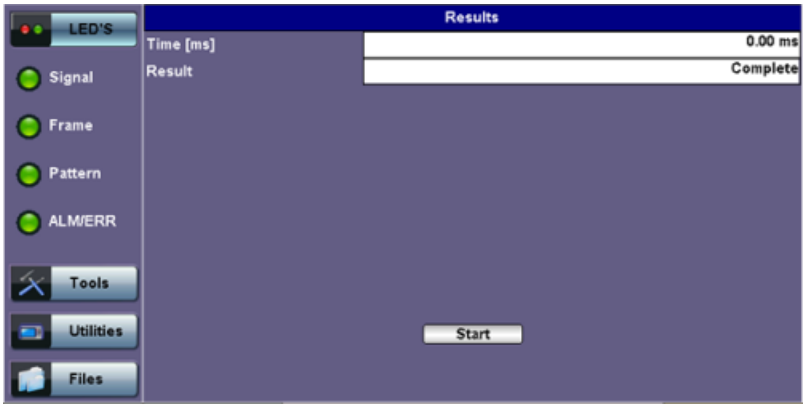


Tributary Scan

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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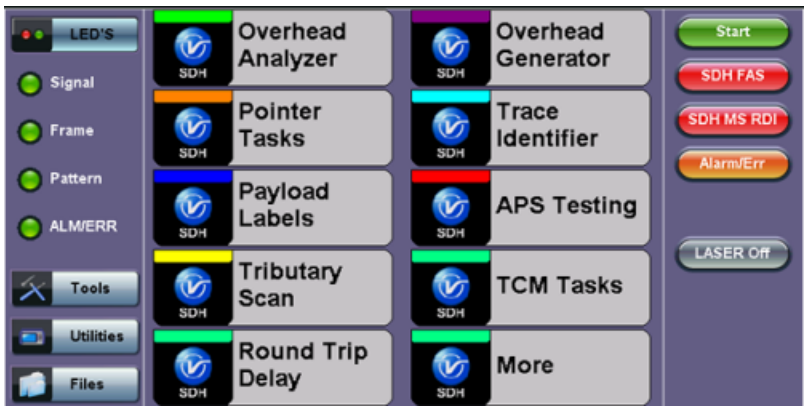
Jitter and Wander

For more information on Jitter and Wander, see Accessing Jitter and Wander.

SONET Tools

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

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.

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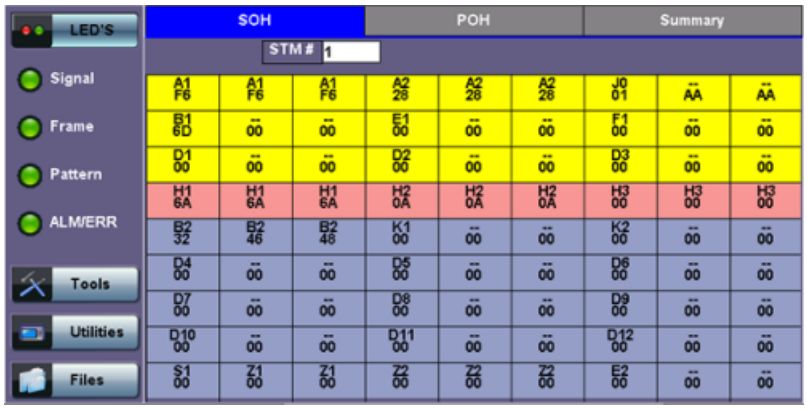
- **Payload Labels:** Used to set the C2 and V5 Path Signal Labels which indicate the content of the STS path and VTs.
- **APS Testing:** Used to measure Automatic Protection Switching limits. Using selectable triggers, the drop out times of tributary connections are measured and compared with preset 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.

Overhead Analyzer

Tap the **Overhead Analyzer** button to display the SOH 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

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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.

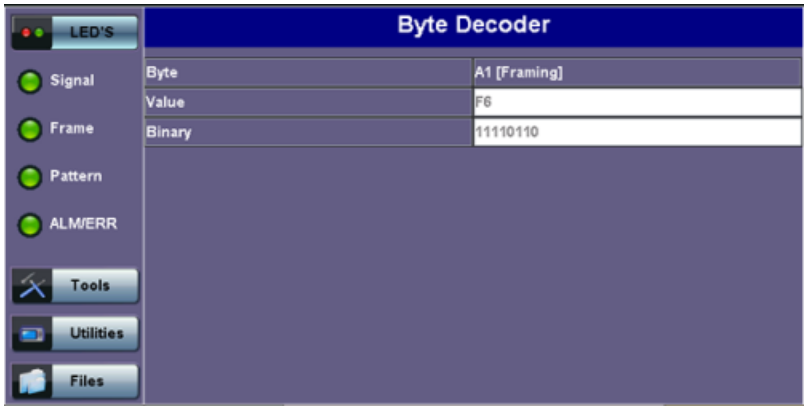
Section Overhead

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

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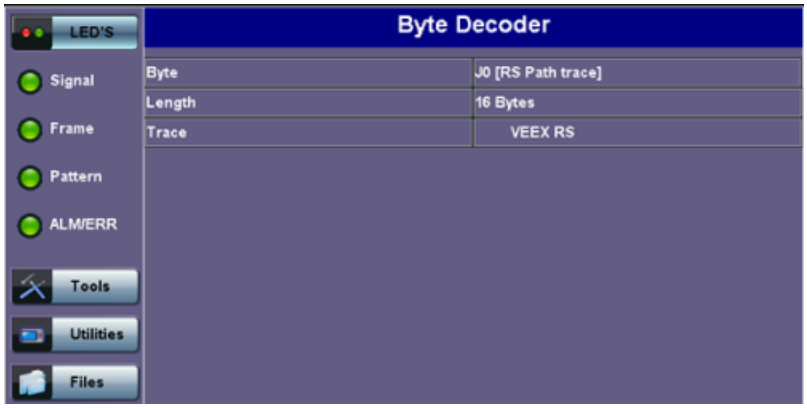
Path Trace Byte (J0)

- 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

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F1 Byte

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

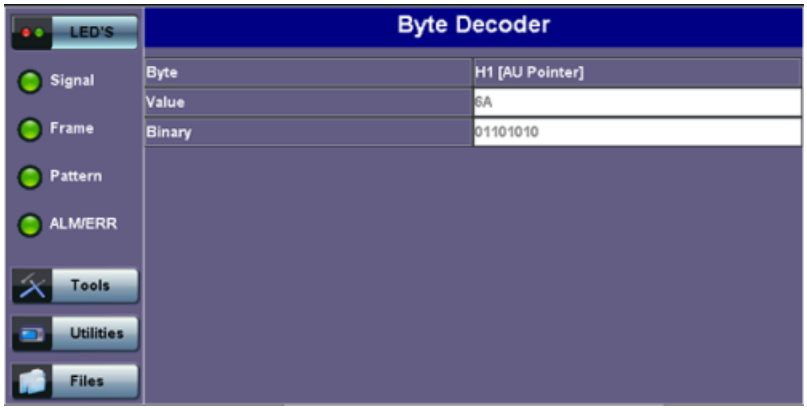
Data Communications Channel Bytes (D1/D2/D3)

- 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

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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

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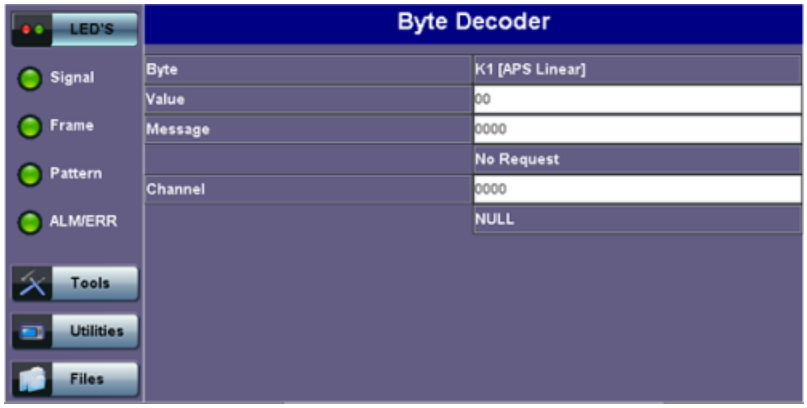

K1 Byte (APS-Linear)

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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

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- 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

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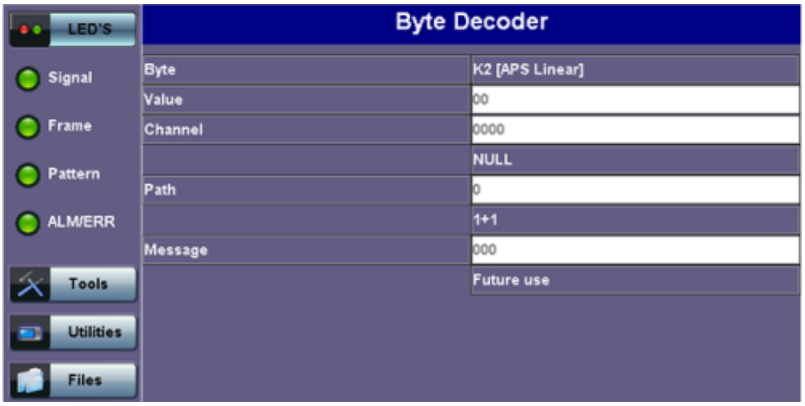
K2 Byte (APS-Ring)

- 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

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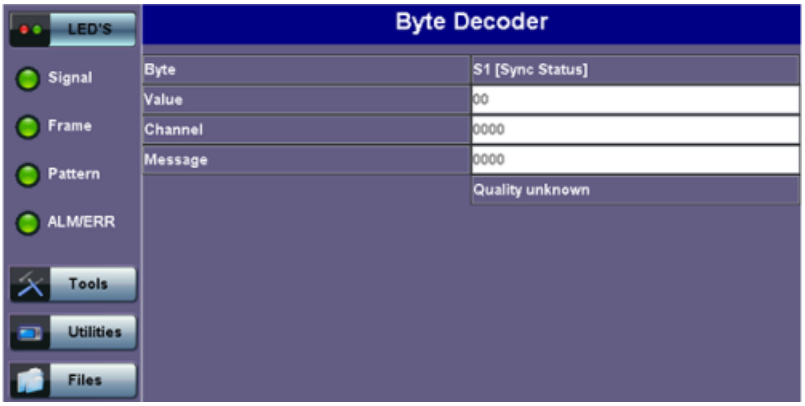

S1 Byte (Synchronization Status)

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

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

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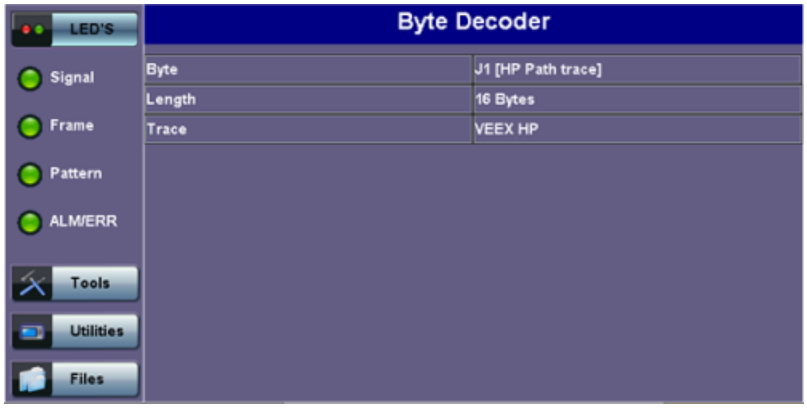

J1 Byte (HP Path Trace)

- **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

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C2 byte (HP signal label) for SDH mode

- Indicates mapping of the VC-n.
- The table below indicates the standard C2 binary values:

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

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

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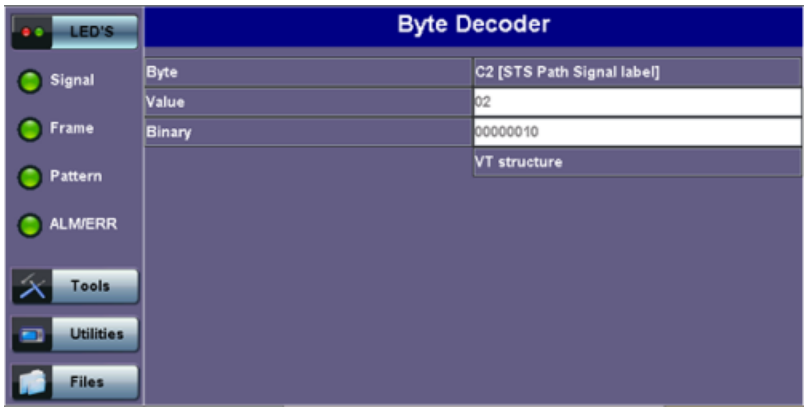
F0	STS-1 payload with 16 VT-x payload defects
F1	STS-1 payload with 17 VT-x payload defects
F2	STS-1 payload with 18 VT-x payload defects
F3	STS-1 payload with 19 VT-x payload defects
F4	STS-1 payload with 20 VT-x payload defects
F5	STS-1 payload with 21 VT-x payload defects
F6	STS-1 payload with 22 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.)



C2 Byte (STS Path signal label)

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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 bid-irectional monitoring of the complete path

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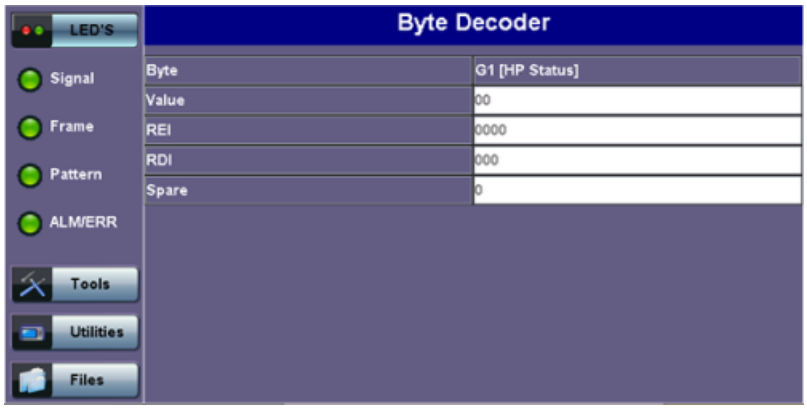
- Bits 1-4: Remote Error Indication (REI-P) indicates number of bit errors detected by B3
- Bit 5: Remote Defect indication (RDI-P) set to 1 if signal failure is detected
- Bits 6-7: Enhanced RDI information to differentiate between payload defects (PLM-P), connectivity defects (TIM-P, UNQ-P) and server 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

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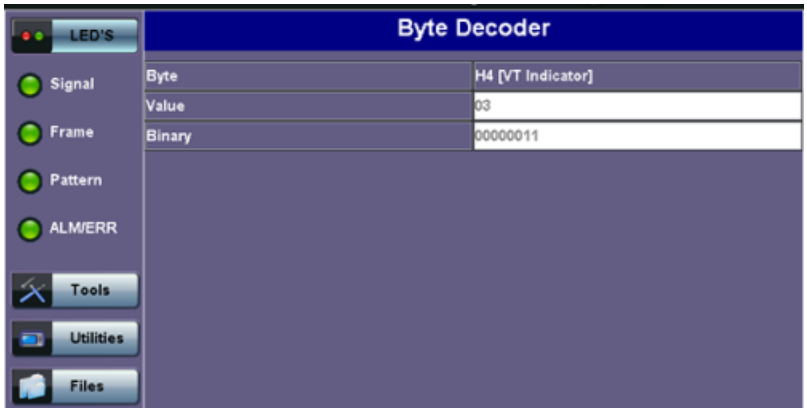

H4 Byte (VT Indicator)

- **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

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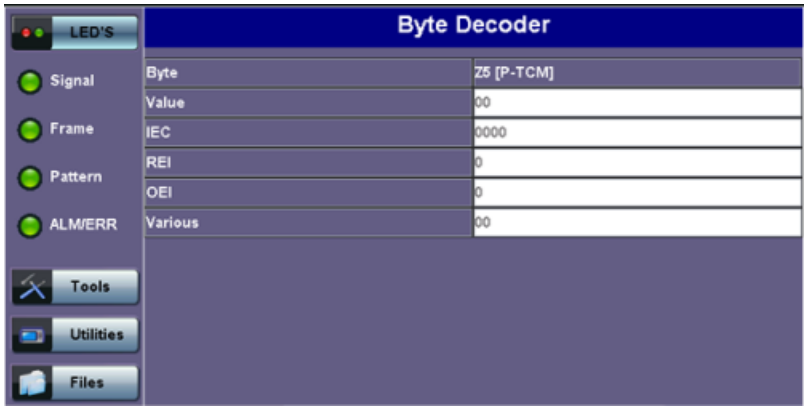
- Frame 74 > ODI indicating to the far-end that AU/TU-AIS has been inserted into egressing STS-n VTG-n due to defects before or within the tandem connection
- Frames 73-76 > Reserved capacity



- **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)

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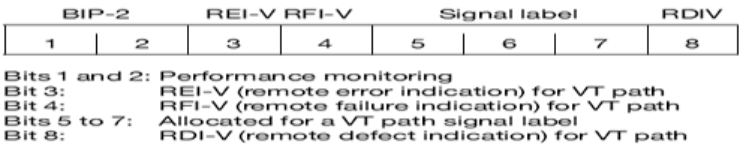
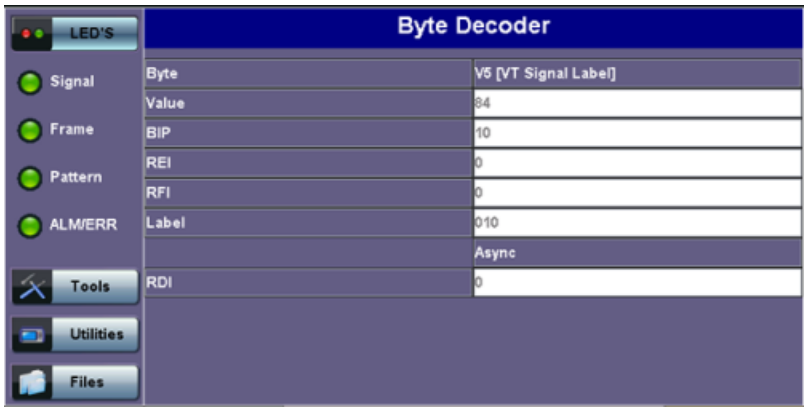
- 010 Asynchronous mapping for DS1
- 011 Bit synchronous mapping for DS1
- 100 Byte synchronous mapping for DS1

- 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”

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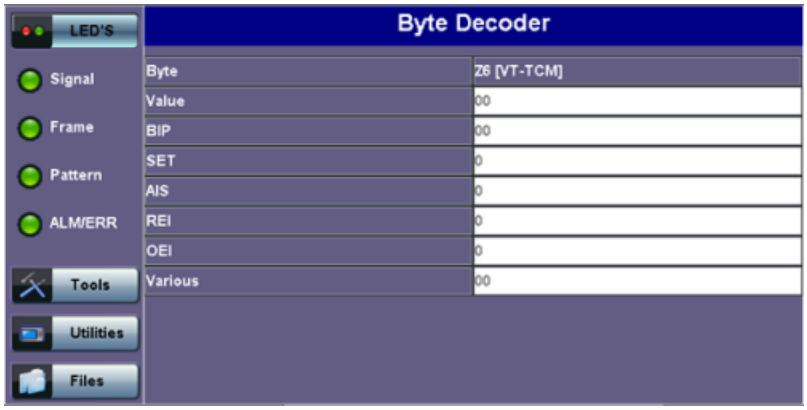
- Bit 4: Incoming AIS indicator (0 = no defect; 1 = defect occurred before tandem connection)
- Bit 5: TC-REI indicating errored blocks caused in the tandem connection
- Bit 6: OEI indicating errored blocks of the egressing STS-1n
- Bits 7-8: operate in a 76 multi-frame structure:

- 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)

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

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

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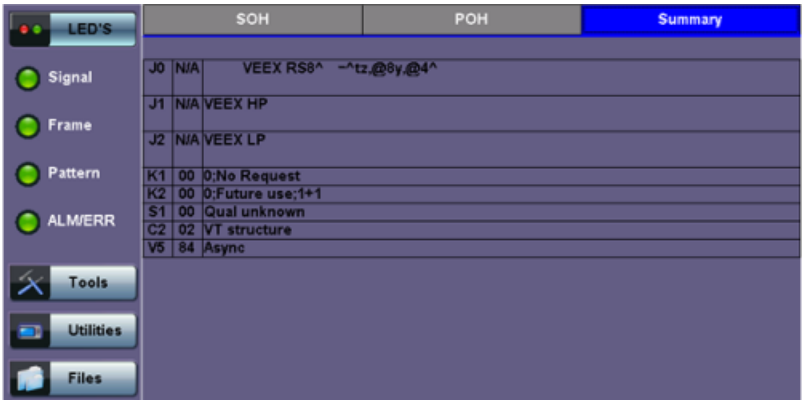
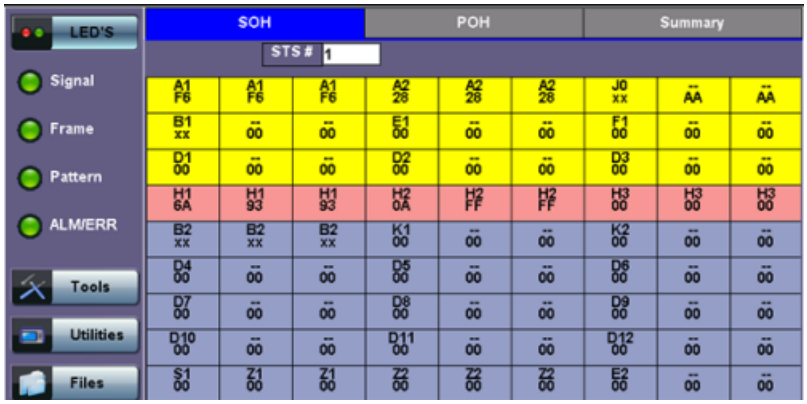


Summary

Overhead Generator



SOH

Tap the **Overhead Generator** button 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.

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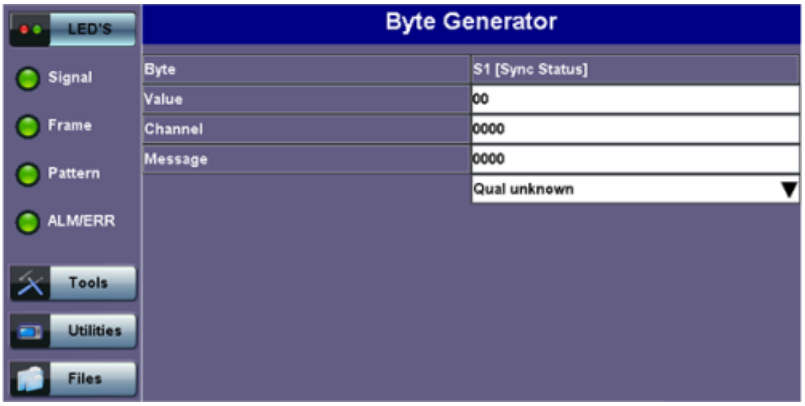
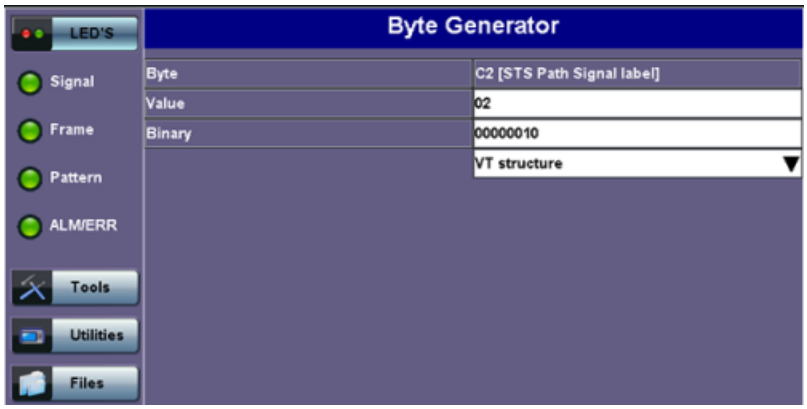
While programming of most overhead bytes is possible using the OH Generator feature, dedicated functions are available for Pointer Tasks, Payload Labels, Trace Identifier, APS Testing, TCM testing. In some instances, more advanced editing is possible using the dedicated functions.



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

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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.

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

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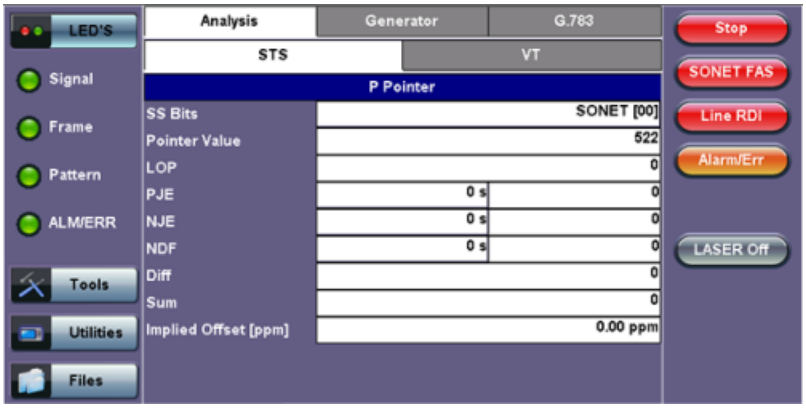
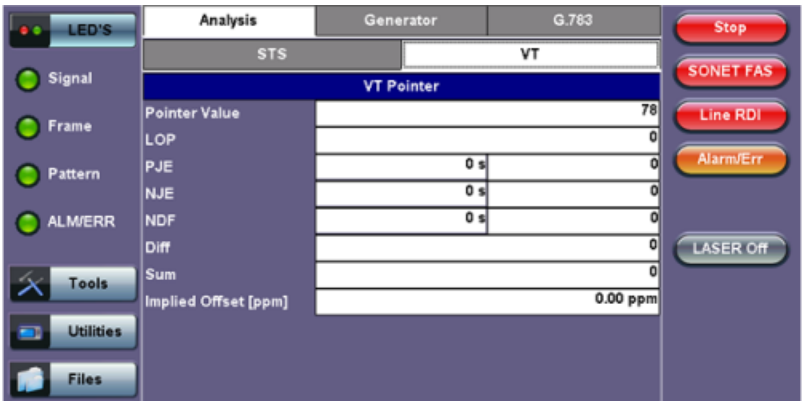


Analysis > P Pointer

- **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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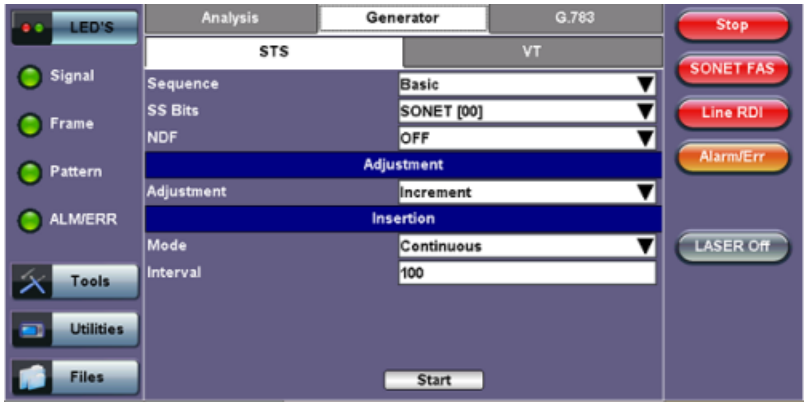
Pointer Generator

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

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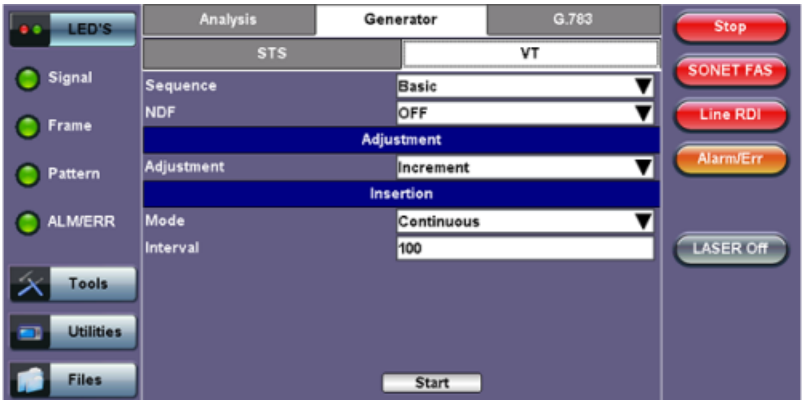

Generator > VT tab

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)

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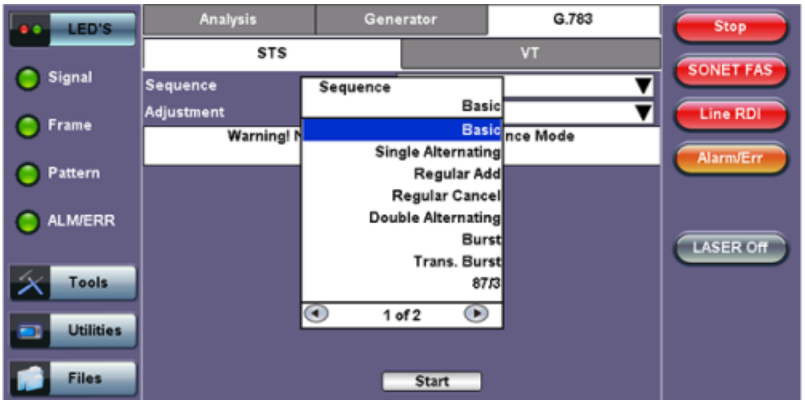
- **87-3 Cancel:** Generate an 87-3 pattern (87 consecutive pointer adjustments, 3 consecutive pointer value, with reduce the number of adjustments by one)
- **Unit:** Select the type of unit to count :Frames
  - N: Specify the number of pointer adjustments in a row: 1—9999 (default=6)
  - T: Specify 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

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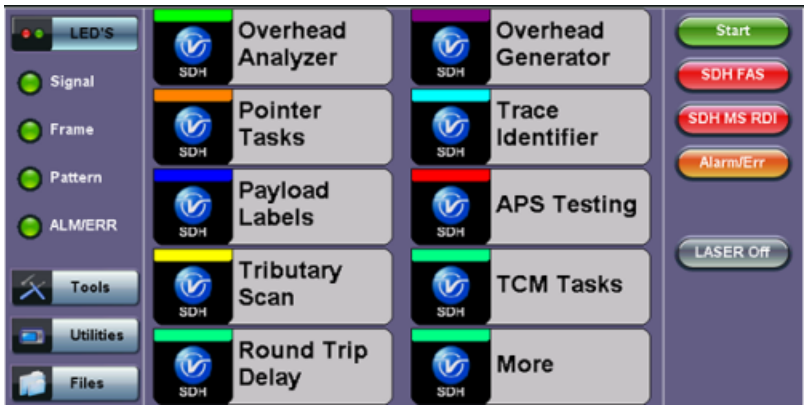
the maximum positive and negative frequency offset applicable to the line rate increases the stress on the pointer processor.

- The test procedure includes an initialization period followed by a cool down period of 30 seconds with no pointer movements.

Trace Identifier

Tap the **Trace Identifier** button 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.

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 1J1 [HP]: High order path section trace 6 or 64-byte identifier to check the high order transmission path

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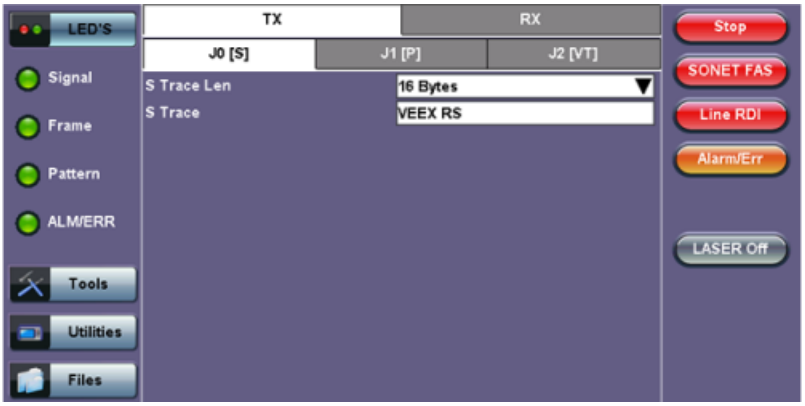
- J2 [LP]: Low order path section trace
    - Program a 16 or 64-byte identifier to check the low order transmission path

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



TX - JO [S]

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

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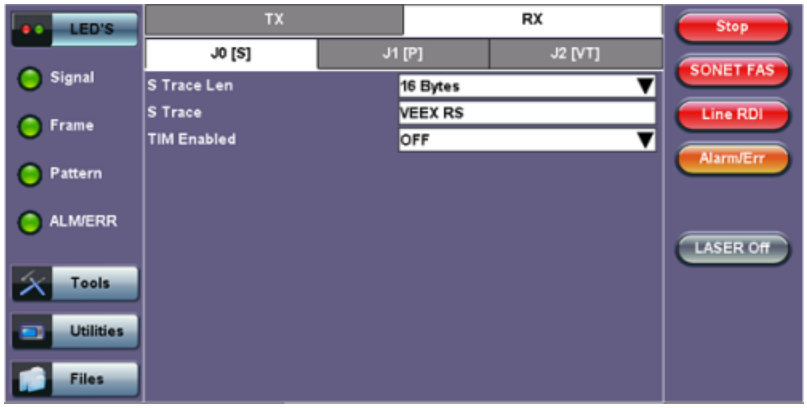
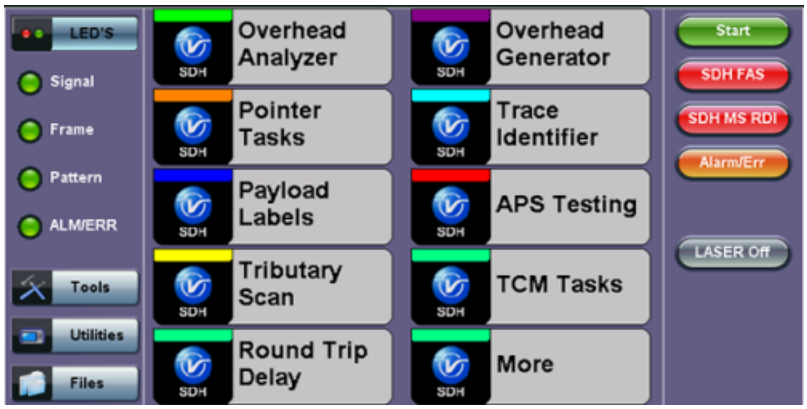


RX - JO [S]

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** Button to display the payload label screens. There are dedicated tabs for Transmitted and Received payload labels and setups:

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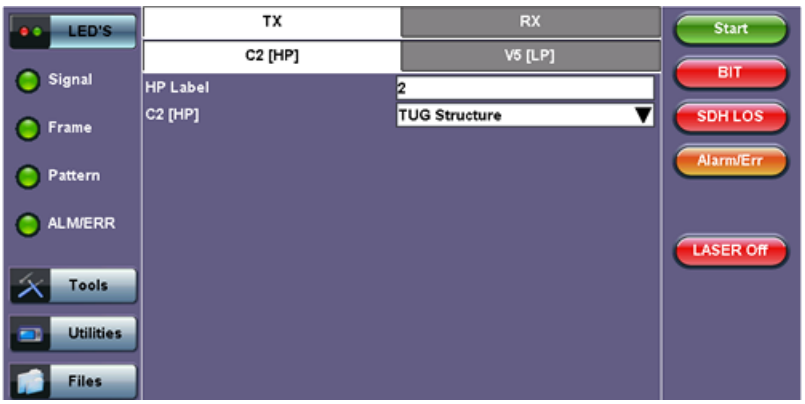
- **C2 [HP Path]: Path signal label**
  - Specifies the mapping type in the VC-n
  - Program the TX or RX label by editing the hexadecimal value or by using the convenient drop-down menu selection
  - For the RX label, enable or disable the Payload Mismatch (PLM) Alarm



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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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.

See section Service Disruption Test (SDT) for APS (SDT) setup.

Tap the **APS Testing** button to display the APS testing screen shown below.

- **Start:** Press to begin the test.
- **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

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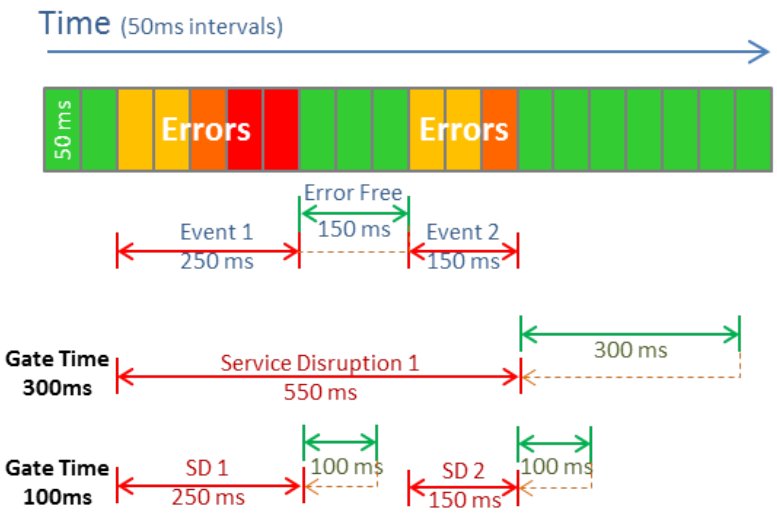
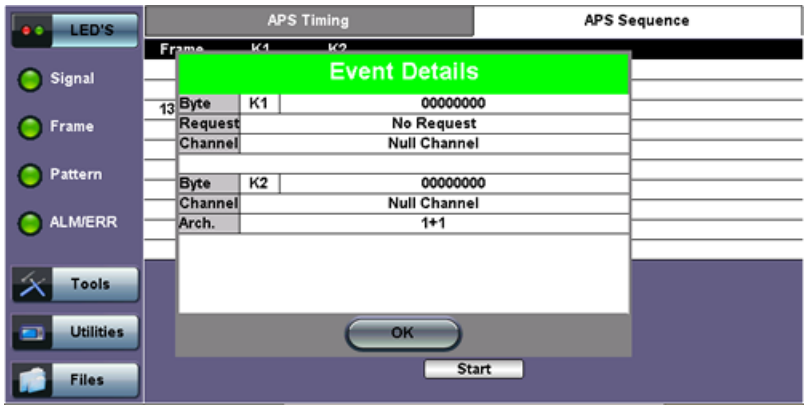


Service Disruptions

APS Sequence

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



Event Details

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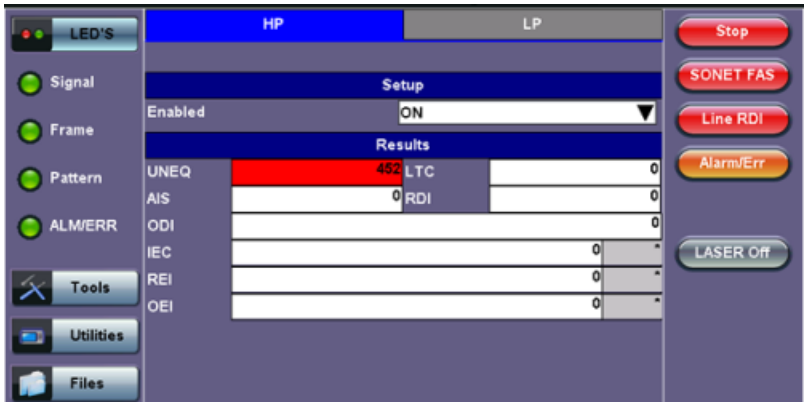

HP Setup

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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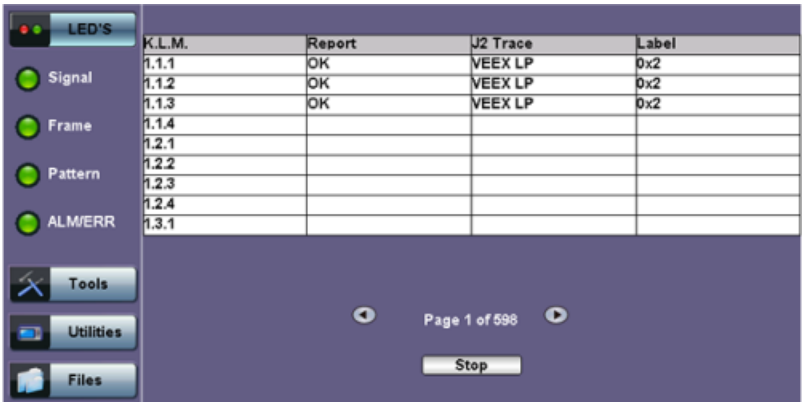
Tributary Scan

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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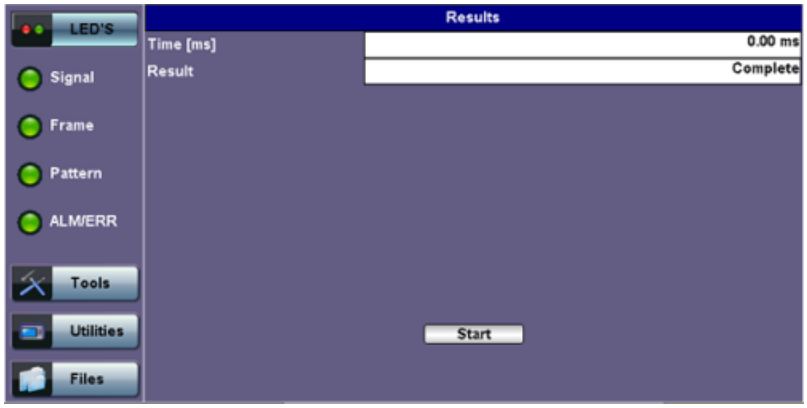
Round Trip Delay



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.

Jitter and Wander

For more information on Jitter and Wander, see Accessing Jitter and Wander.

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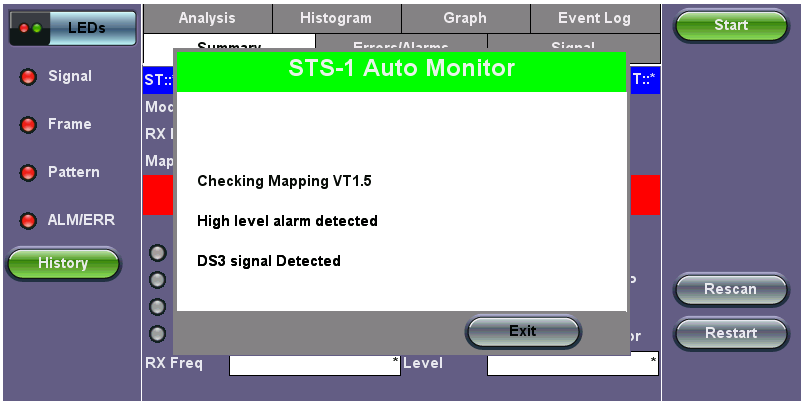
STS-1 Monitor



STS-1 Auto Monitor scanning the signal

STS-1 Auto Monitor mode automatically configures the unit to the incoming (receiving) signal structure. Once the signal structure is configured, tap OK to begin testing or Exit to exit the screen. The Summary tab displays SONET test results and measurements alarms, errors, or signal failure pertaining to the SONET signal and payload.

Refer to "Results: SONET" on page 305 for more information on the test result tabs.

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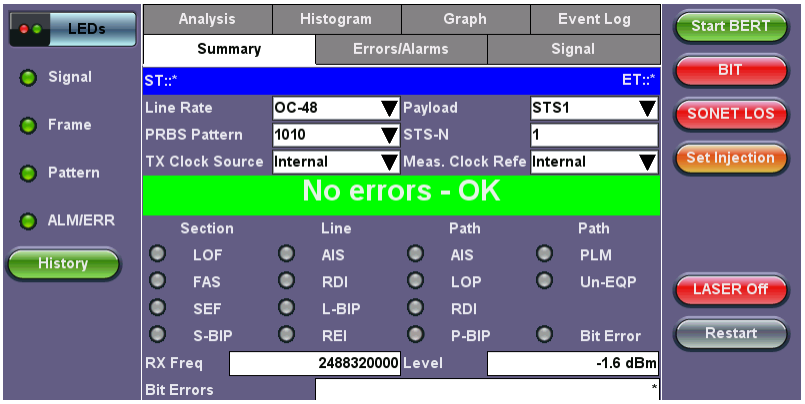
SONET BERT

The Summary screen combines a simplified test interface setup and alarm/error monitor in a single convenient screen. For more complex scenarios refer to **Advanced Mode > Setup.**

Hierarchy, Interface, Payload, and test Pattern settings can be configured in the Summary tab using the drop-down menus.

Signal status, error and alarms, and Pass/Fail indicators are also displayed.

Refer to "Results: SONET" on page 305 for more information on the test result tabs.



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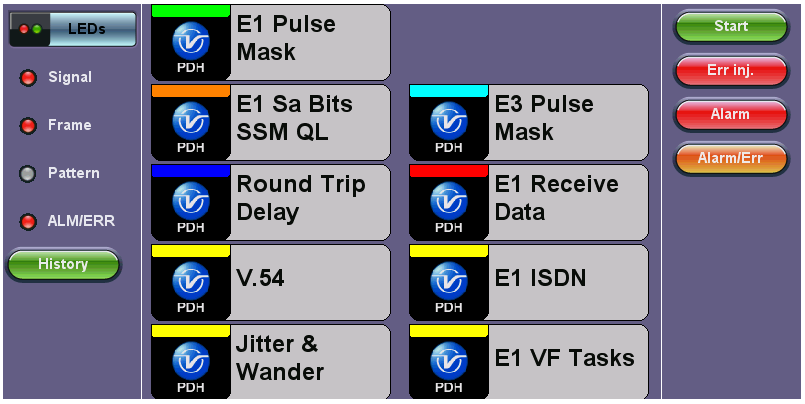
PDH Tools

Accessing PHD Tools

Accessing PDH Specific Tools

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



PDH Menu

E1 Pulse Mask

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

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

According to the G.703 recommendation, E1 pulses need only be measured at the transmitter output, and are not required to meet the pulse template over a variety of cable lengths. This of course will not provide information on distortions caused by misalignment and other impairments of the line. The test set on the other hand

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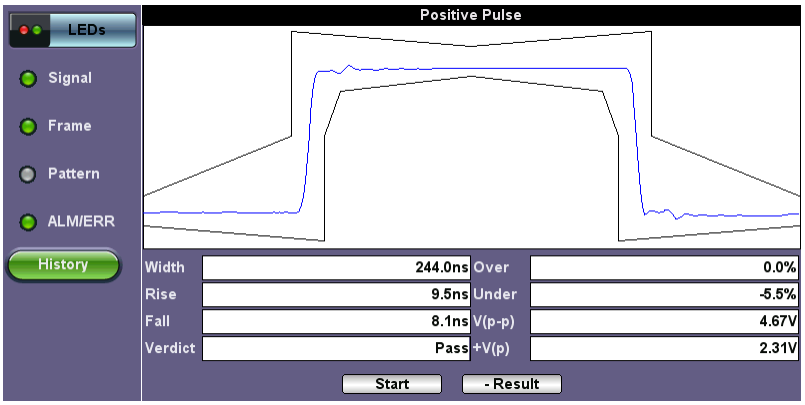
can connect to a live system at the TX output port via a Protected Monitoring Point (PMP) or at the far-end of a transmission line. In either case, the signal will be attenuated or amplified as necessary to compensate for test point or cable attenuation characteristics.

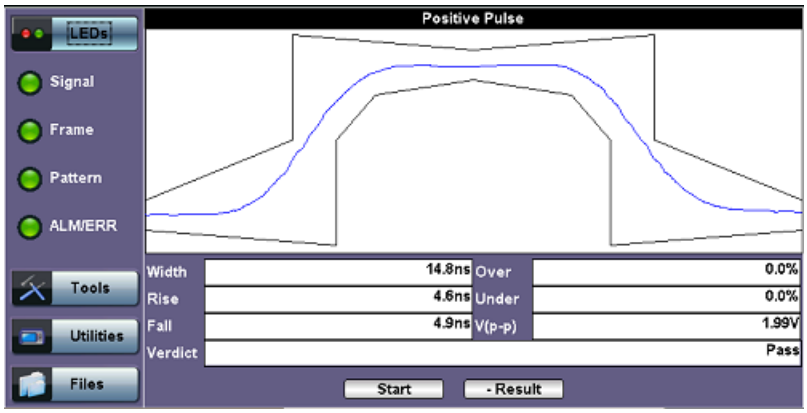


E1 Pulse Mask

E3 Pulse Mask

This function captures and analyzes E3 (34.368Mbps) pulse shape. The purpose of maintaining the correct pulse shape is to reduce inter-symbol interference – if the logic 1s and 0s cannot be detected by the receiver correctly, bit and code errors will result.

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



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E1 Sa Bits & SSM QL (Clock Quality Level)

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

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

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

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

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

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

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

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

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

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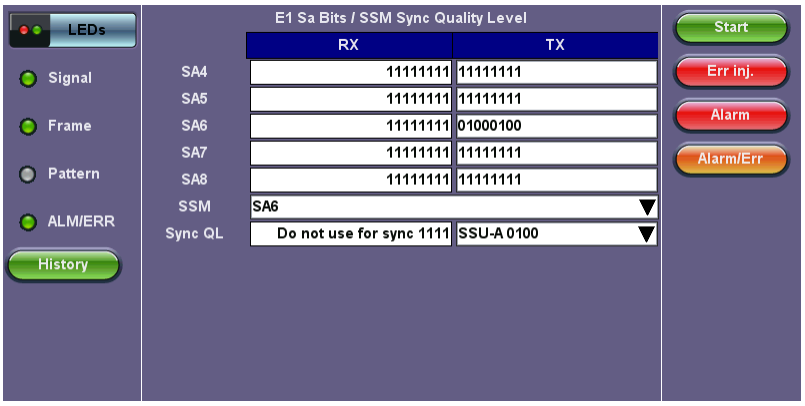
Sync Quality Level Values	
Quality Unknown	0000
Reserved	0001
G.811 PRC	0010
Reserved	0011
SSU-A	0100
Reserved	0101
Reserved	0110
Reserved	0111
SSU-B	1000
Reserved	1001
Reserved	1010
SETS/SEC	1011
Reserved	1100
Reserved	1101
Reserved	1110
Do not use for sync	1111



E1 Sa Bits SSM QL

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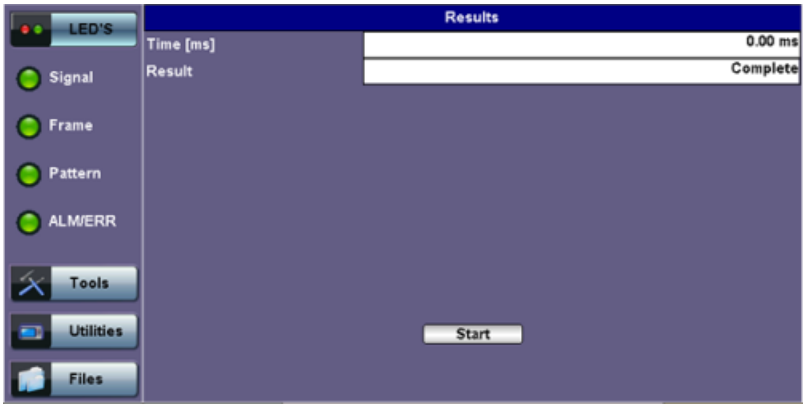
Round Trip Delay



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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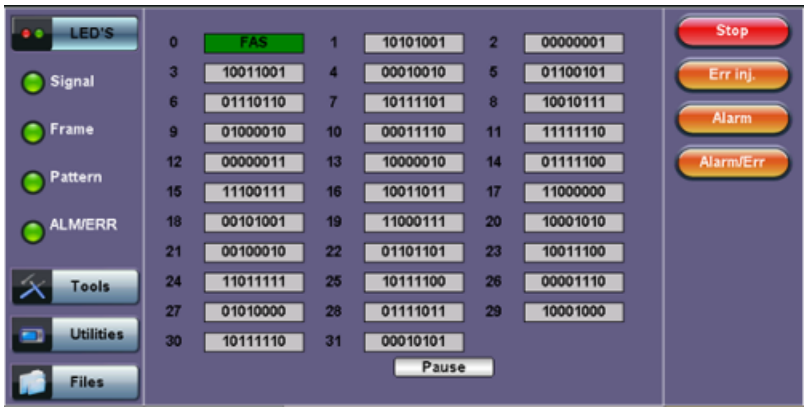
E1 RX Data

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

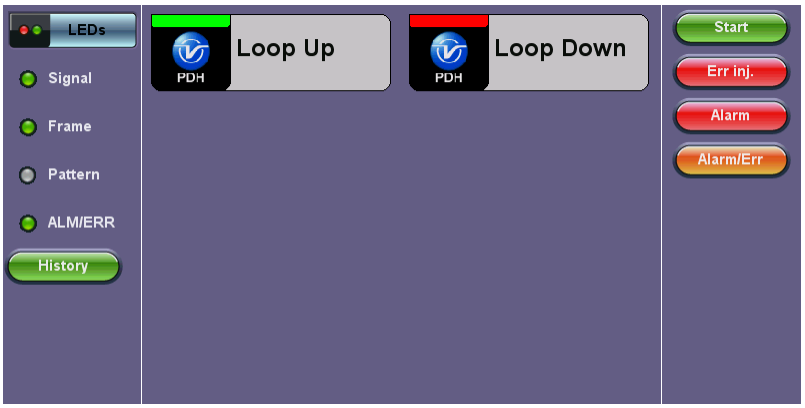


E1 RX Data

V.54

The V.54 menu features the **Loop Up** and **Loop Down** functions for Loopback testing. To access V.54, set the payload to Nx64 **(Setup button (Home menu) > Signal > Payload > Rate > Nx64)**.

Tap **Loop Up** or **Loop Down** to create or cancel a loopback.



V.54 Menu

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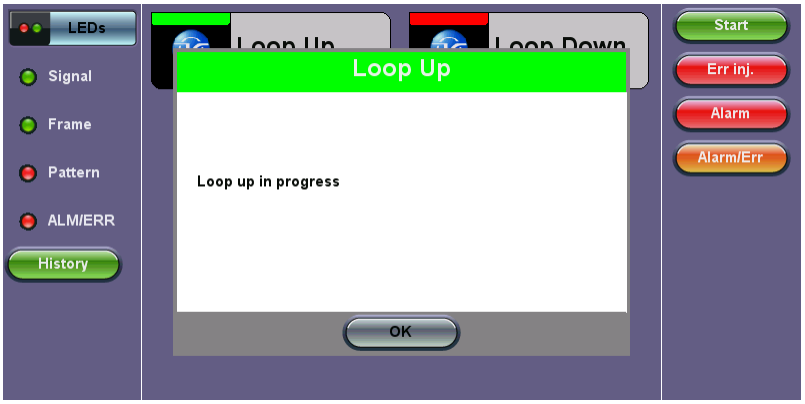

Loop Up Message

E1 ISDN PRI

E1 and DS1 ISDN PRI offer identical test options. Setup instructions for both E1 and DS1 are discussed below.

ISDN PRI Call

Setup (PRI Call Setup)

Configuration parameters for ISDN PRI Call are as follows:

Page 1

- **Mode:** TE, NT, or Monitor. In TE or NT mode, the test set can place up to 2 simultaneous data or audio calls on any primary line
    - **TE (PBX):** Terminating Equipment used when the test set is emulating customer equipment. TE generally uses the received signal to clock the transmitter.
    - **NT (CO):** Network Terminal is used when the test set is emulating an ISDN switch, such as DMS-100, 5ESS. NT generally uses the internal clock.
    - **Monitor:** Trace message details:

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- D Channel decodes help to verify that a call is successfully established, or determine why a call was not completed by examining the protocol cause values.

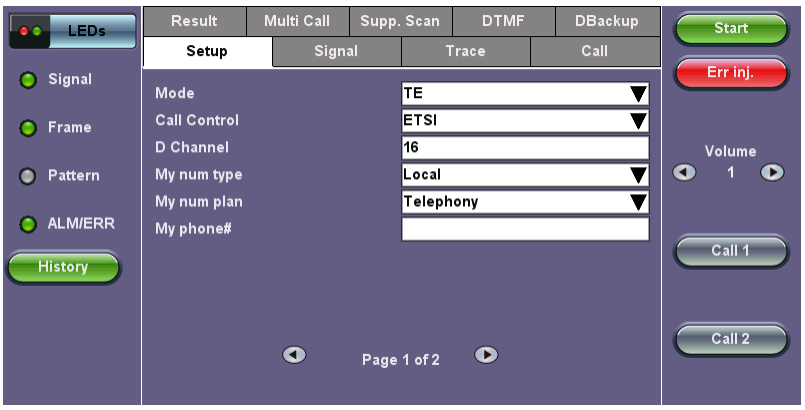
- **Call Control:** The Q.931 specification indicates which type of ISDN switch is to be tested. AT&T and NTI are only available for DS1.
  - AT&T relates to the 5ESS switch
  - NTI relates to the Northern Telecom DMS-100 switch
  - ETSI is the ETSI standard

- **D Channel:** Designates the time slot to transmit D Channel messages. The D Channel decoder helps to verify that a call is successfully established, or determine why a call was not completed by examining the protocol cause values.

- **My num type:** Unknown, International, National, or Local

- **My num plan:** Unknown, Telephony, or Private

- **My phone#:** Tap on the box and enter the phone number using the alphanumeric keyboard



ISDN Setup (Page 1)

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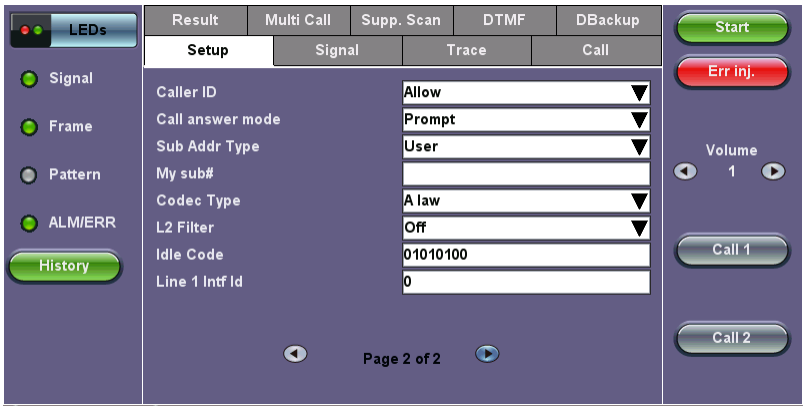
Page 2

- Caller ID: Blocked/Allow.
- Call Answer: Prompt, Accept or Cancel.
    - Prompt: Prompts the user to answer or reject incoming calls. Selecting Prompt displays an answer and reject button on the Call tab.
    - Accept: Automatically answers incoming calls.
    - Cancel: Automatically rejects incoming calls.
- Sub Addr Type: NSAP or User.
- My sub#: Tap on the box and enter the sub address number using the alphanumeric keyboard.
- Codec Type: A law or U law.
- L2 Filter: Turn ON or OFF layer 2 filter. Turning on the filter prevents layer 2 messages from displaying in the captured trace.
- Idle Code: Code to be transferred on unused channels. Tap on the box and use the alphanumeric keyboard to enter the code.
- Line 1 Intf Id: Line interference ID. Tap on the box and enter the line interference ID using the alphanumeric keyboard.



Setup (Page 2)

The symbols RDY and OOS are port status indicators. Below each status is the port number.

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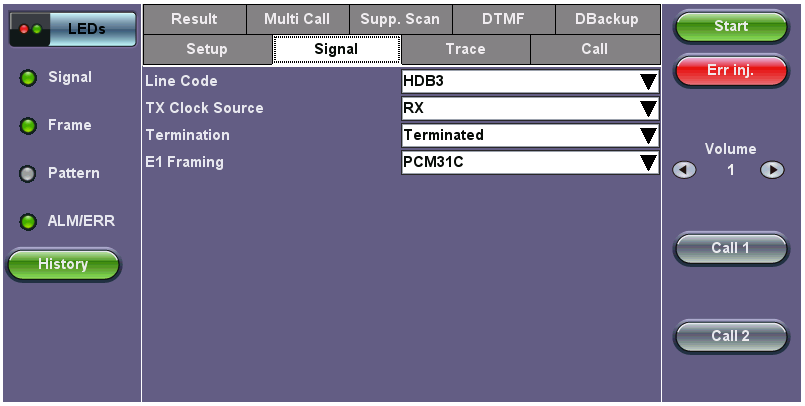
Status	Description
	OOS indicates that the port is **Out of Service** and will be unable to run any tests. If OOS displays on the unit, check for proper connection between the physical ports and cables and that both units' setup screens are configured correctly. The port number in this example is 2.
	RDY indicates that the test port is **Ready** for use. The port number in this example is 1.

Signal

- **Line Code:** HDB3 or AMI
- **Clock Source:** Internal, External, Rx, or Offset. If the test set is in TE mode, select Rx to receive timing signals from the master clock
- **Termination:** Terminated, Monitor, or Bridge
- **DS1/E1 Framing:** Unframed, PCM31, PCM31C for E1; SF or ESF for DS1.



Signal

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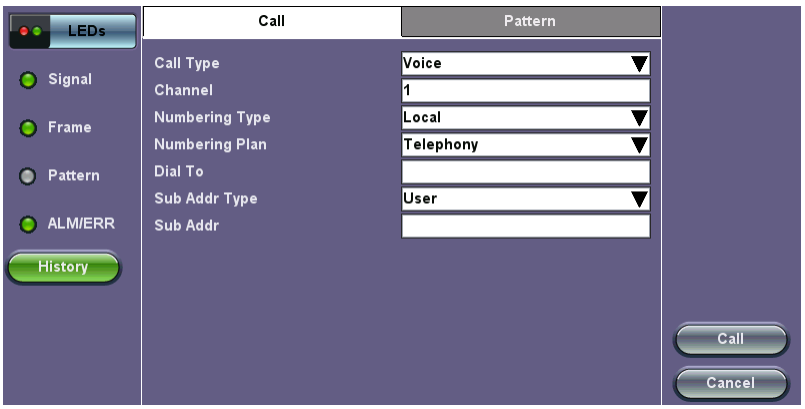
Main Setup

- Connect to the CPE or Network.
- Connect headsets to the 2.5mm audio jack port (or use the 3.5mm to 2.5mm headset adaptor)
- Select Call Control protocol type
- Select the emulation type (TE or NT)

Call Voice 3.1K Audio Setup

Once the unit is ready, as indicated by the **RDY** status symbol, the **Call** buttons will appear. Press Call to bring up the Call Setup menu. Voice and 3.1K Audio calls follow the same setup procedure. Both are outlined below:

- **Call Type:** Select Voice or 3.1K Audio
- **Channel**
- **Numbering Type:** Unknown, International, National, or Local
- **Numbering Plan:** Unknown, Telephony, or Private
- **Dial To:** Tap on the corresponding box and use the alphanumeric keypad to enter the number of the receiving line.
- **Sub Addr Type:** NSAP or User
- **Sub Addr:** Tap on the corresponding box and use the alphanumeric keypad to enter a subaddress



Call - Voice Setup

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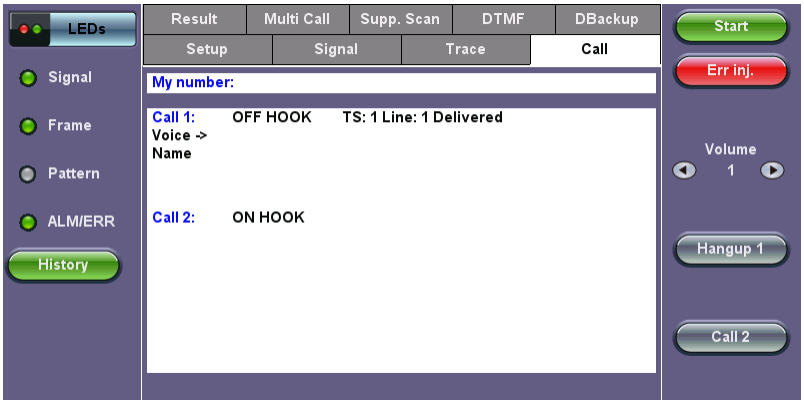
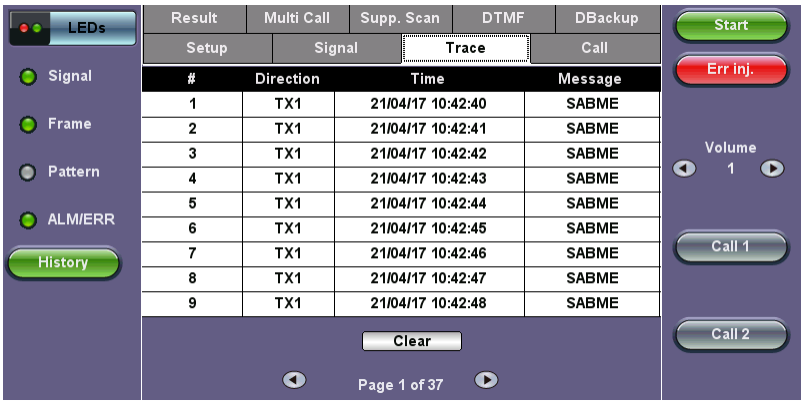
Press the **Call** button to initiate a call to the receiving number. If Prompt was selected for Call Answer in the Setup tab, the unit receiving the call will ring and the user can press **Answer** or **Reject** to accept or reject the call. The caller can tap **Hangup** on the transmitting unit while the call is in progress. Use the left and right arrows below **Volume** to adjust ringing and call volume.



Call In Progress

Trace: ISDN Protocol Decode

D-Channel Decodes help to verify that a call is successfully established or determine why a call was not completed by examining the protocol cause values. We can monitor the release cause code in Layer 3 (Q.931) messages on the D-channel in both terminate and monitor modes. Layer 2 results give technicians the ability to check link and D-channel status, verify LAPD frames and check utilization rates. Following link establishment, Layer 3 decodes allow technicians to verify such factors as call state, who made or dropped the call, why the call was dropped, where the call is being carried (Interface ID/B-Channel), and call types.



ISDN Trace

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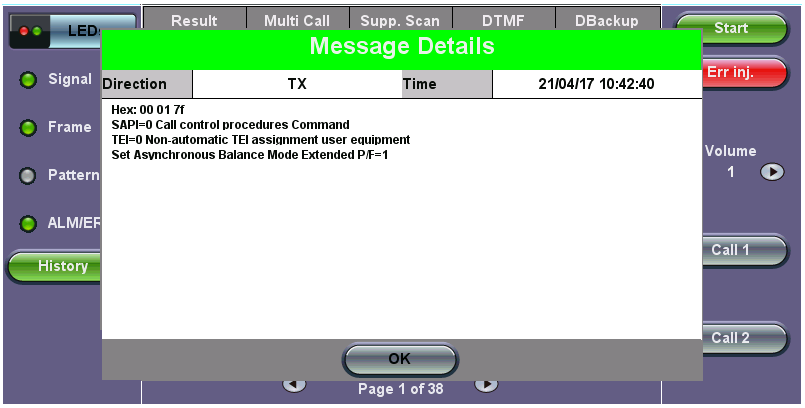


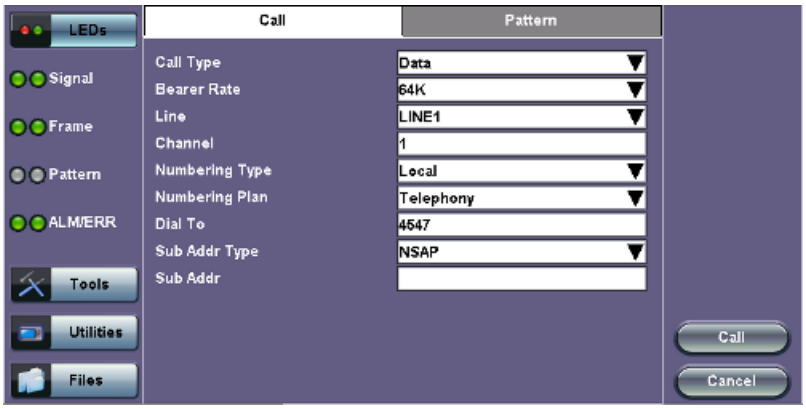
Message Details

Call Data Setup

Press the **Call** button to bring up the Call Setup menu. Data calls follow the same setup procedure as voice calls but with a few minor differences.

- Fill out the call setup as described in Call - Voice and 3.1K Audio Setup, but select Data as the Call Type.
- Select a **Bearer Rate** in the call setup options.
- Press the **Pattern** tab and select a test pattern to be transmitted on the B channel during data calls.

Test pattern is only applied when call button is pressed.



Call - Data Setup

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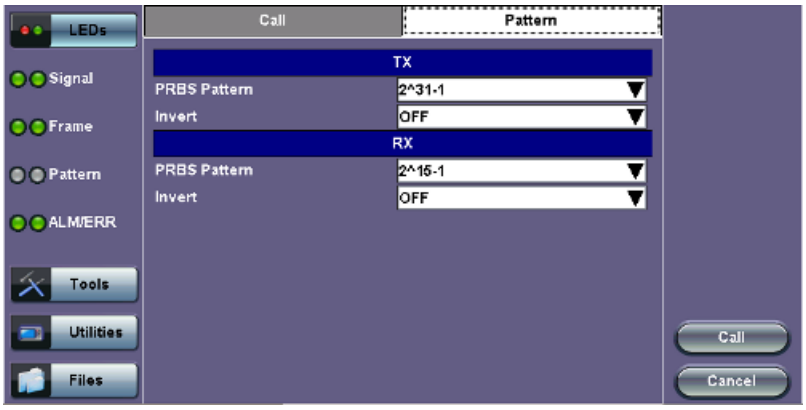


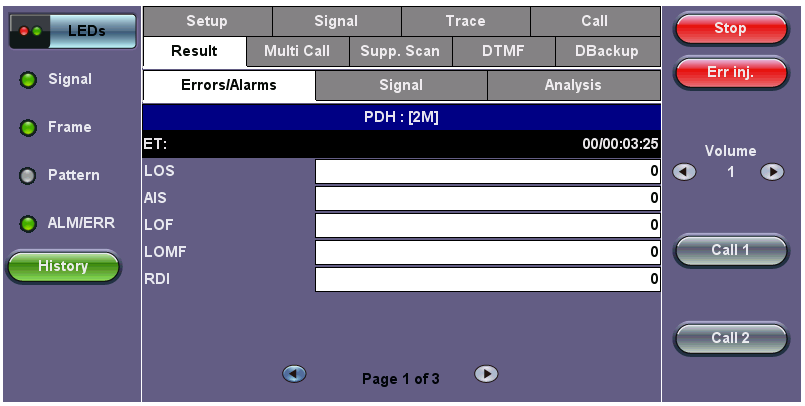
Pattern Setup

Press **Call** and the other unit should ring.

Call BERT Results (Results Tab)

After successfully placing a data call, the BER is available. The Result tab presents the measurement parameters specified in G.821. Only DATA-64/56 and Nx64 Data Call Type in the CALL mode can give BER measurements. When viewing BER measurements, verify that both the PAT SYNC LED and the appropriate framing LED are green. These two LEDs signify that the patterns and framing match for the transmitting and receiving patterns.

PDH and SDH Results are discussed in Results: PDH and Results: SDH, respectively.



Data Call - BERT - Errors/Alarms

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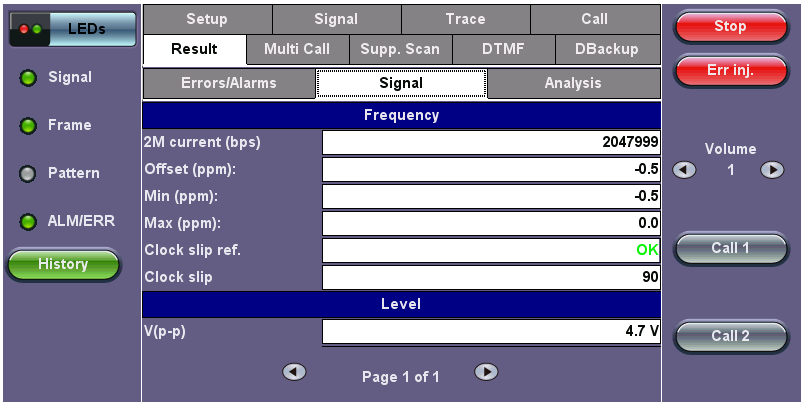
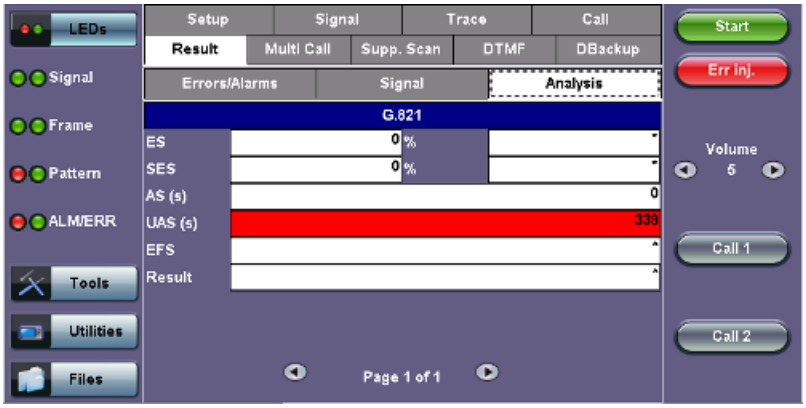


Data Call - BERT - Signal



Data Call - BERT - Analysis

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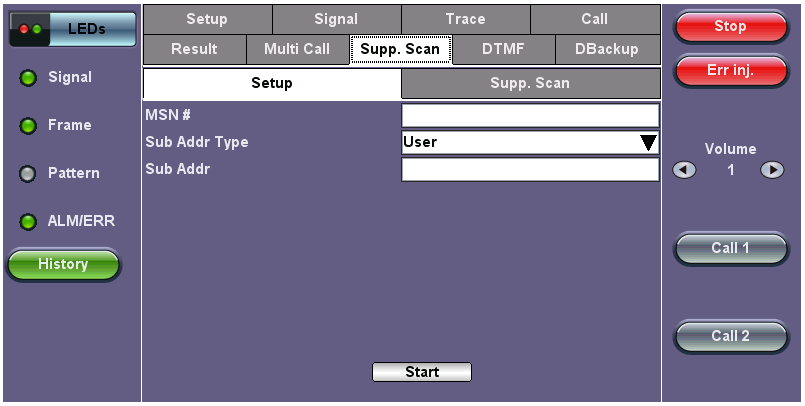
Supplementary Service Scan

In ETSI protocol, a Supplementary Service Scan scans a line to determine which of a variety of supplementary services are available on it.

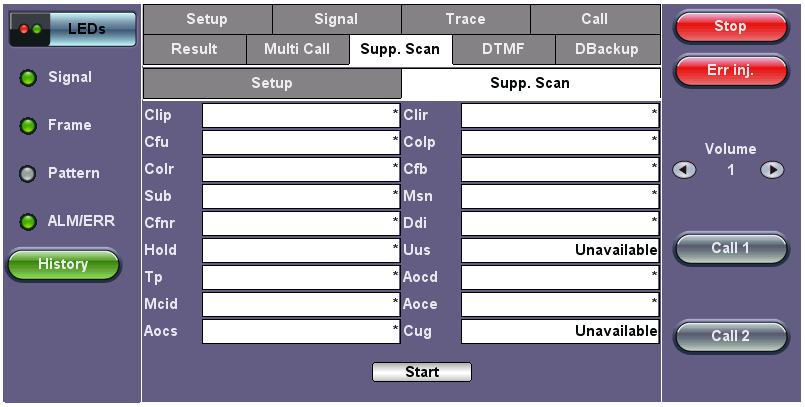


Supplementary Scan Setup

SubAddress Type:

- NSAP to select the Network Service Access Point subaddress
- User to use a subaddress defined by a user (no standard applied)

When the test is finished, the screen displays a list of these services:



Supplementary Scan Results

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- **CLIP:** Calling Line Identification Presentation - presents the Calling Party Number to the called user.
- **CLIR:** Calling Line Identification Restriction - prevents the Calling Party Number from showing to the called user.
- **CFU:** Call Forwarding Unconditional - diverts a received call to a specified different number.
- **COLP:** Connected Line Identification Presentation - the answering party's number is conveyed to the calling party.
- **COLR:** Connected Line Identification Restriction - allows the connected subscriber to stop COLP from operating.
- **CFB:** Call Forwarding Busy - Calls are forwarded to a specified number only when the subscriber's (called party) number is busy.
- **SUB:** Sub Address - a digit is added to an incoming call to specify an extension.
- **MSN:** Multiple Subscriber Number - multiple full numbers are assigned to one BRI line.
- **CFNR:** Call Forwarding No Reply - Calls are forwarded to a specified number only when the subscriber (called party) does not pick up the line in a specified amount of time.
- **DDI:** Direct Dialing In - adds a number of telephone number to a circuit which can be used to dial that BRI (common use is a company number with individual 4 or 4 digit extension numbers that can be dialed)
- **HOLD:** Call Hold - the user may interrupt a call, then reestablish it later. Interruption frees the associated B-channel.
- **UUS:** User to User Signaling - allows a user to send an Information message in the Setup, Alerting, or Connect message on the D-channel, without connecting the call; the message shows on the ISDN phone display.
- **TP:** Terminal Portability; the ability to suspend and reconnect a call; for example, to move a phone from one plug to another.
- **AOC-D/E/S:** Advice of Charge - Determines when charging information is available to the served user; during the call, when the call is terminated, when the call is established.

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- **MCID:** Malicious Call Identification - the called party, on a per call basis, requests the network to register the called party phone number, the calling party number, and the date and time of the calls.
- **CW:** Call Waiting - informs a user of an incoming call which has no B-ch available; user may accept, reject, or ignore.
- **CUG:** Closed User Group; a private network which restricts communication between members and nonmembers.

Multi-Call Test

In E1 and DS1 ISDN test modes, the Multi-Call tab offers different ways to test more than one channel or destination number, in sequence or parallel, to stress the whole PRI link or to verify that numbers and services are routed correctly. These types of tests require an auto answer device or function to terminate the test calls at the far end (e.g. just answer, answer with a voice message, or answer with a data loop).

Type: Single Number (Single PRI destination)

This mode allows users to place multiple calls to a single PRI destination (same phone number), with each call placed in different channels, in sequential or parallel mode.

Page 1 or 2

- **Mode:** Sequential or Parallel calling. In Sequential mode, the test set places test calls one channel at a time, increasing the time slot number, until all (or a group of) PRI channels have been tested. The Parallel mode places calls in all (or a group of) PRI channels at once and keeps them active until the test is stopped.
- **Call Type:** Voice.
- **Numbering Type:** Local, National, International, Unknown.
- **Numbering Plan:** Telephony, Private, Unknown.
- **Dial Number:** Enter destination phone number.

Page 2 of 2

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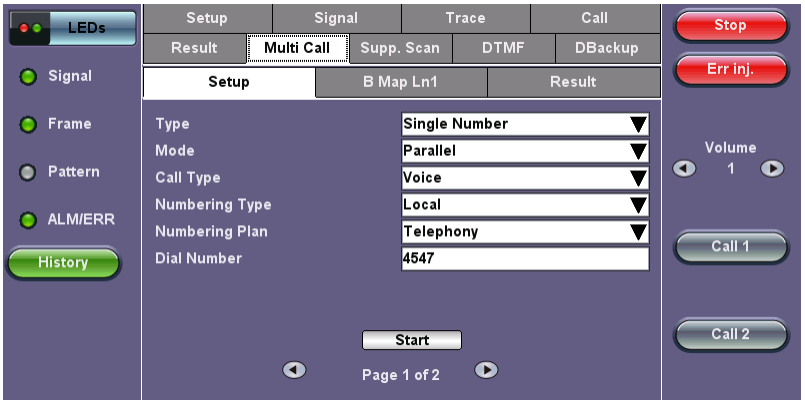
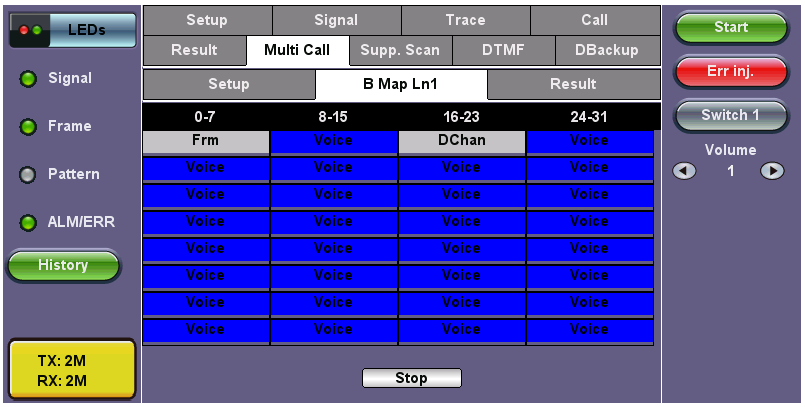
- **Ring Wait (sec):** Number of ringing seconds before abandoning the call.
- **Duration (sec):** Duration of the test call once it has been answered. In sequential mode, once this time has elapsed, the test set will hang up.
- **Start B Channel:** To limit the time slots (channels) to be tested, users can program a block of time slots to be used for the test. Enter the first channel to be tested.
- **Stop B Channel:** To limit the time slots (channels) to be tested, users can program a block of time slots to be used for the test. Enter the last channel to be tested.



Multi Call Setup (Page 1)



Parallel Call Results

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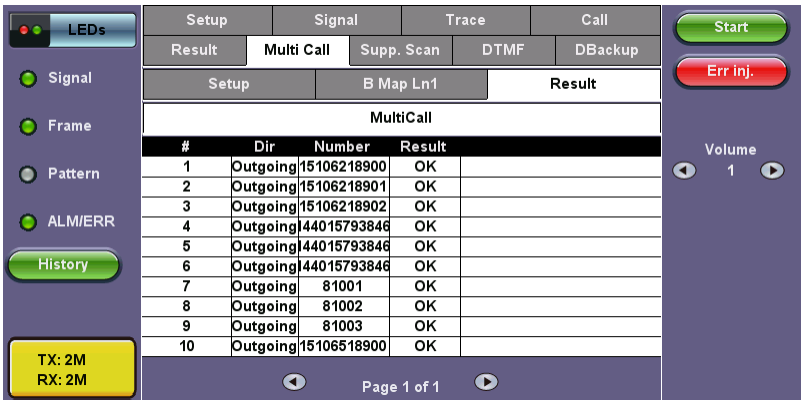
Type: Number Script (Multiple Destinations)

This mode displays a phone number list to place calls to multiple PRI or BRI destinations, using specific channels and services to test routing and bearer services capabilities. The calls are placed in sequence, following a list created with ReVeal RXTS. The test set requires the phone list to perform this type of test.

- **Ring Wait (sec):** Number of ringing seconds before abandoning the call.
- **Duration (sec):** Duration of the test call, once it has been answered. In sequential mode, once this time has elapsed, the test set will hang up.



Phone Number Script Results

Creating a Phone Number List

Use VeEX ReVeal RXTS PC software's ISDN Phone Number List function (Home > Profiles > ISDN Phone Number List) to create a customized Number List. After creating the list, use the Upload function (Home > Profiles > Upload) to transfer it to test sets. The list can contain multiple destination phone numbers with individual characteristics:

- **Call Type:** Voice, Data64K, Audio3.1K
- **Number Type:** Local, National, International, Unknown
- **Number Plan:** Telephony, Private, Unknown
- **B Channel:** Specific time slot to be used for the call

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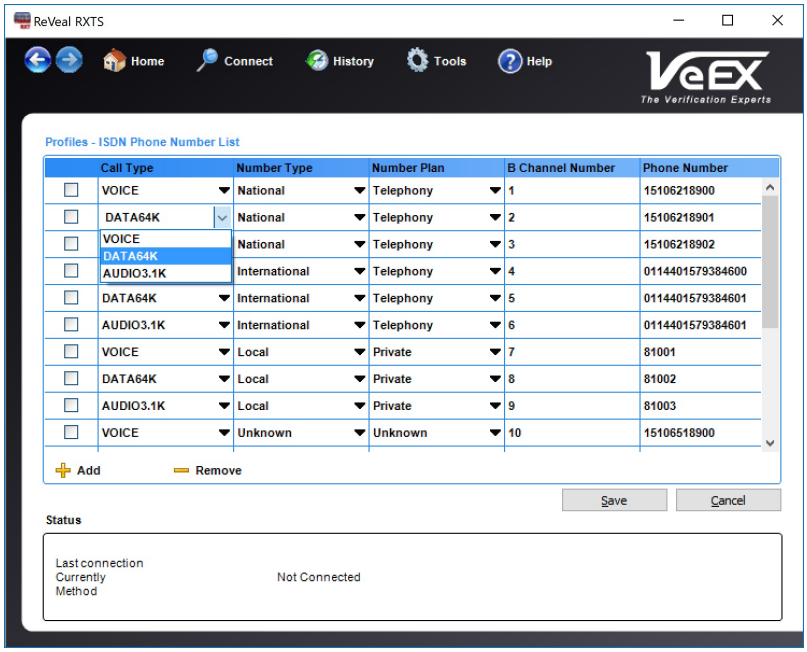
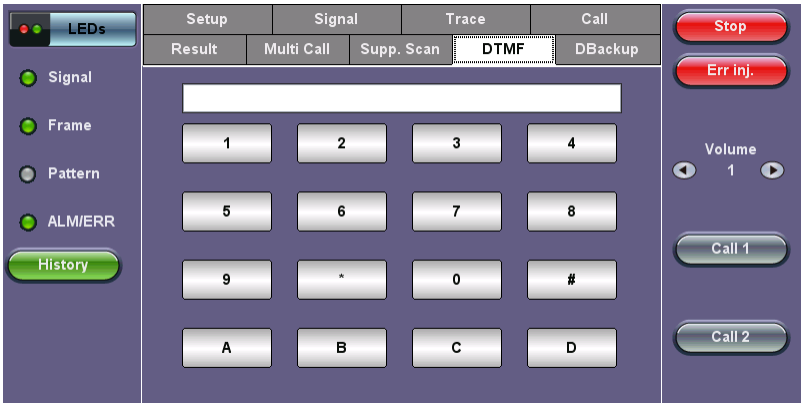


Multi Call List Using ReVeal RXTS

DTMF

During the call DTMF tones can be transmitted.

To transmit DTMF tones, access the DTMF tab. An alphanumeric keypad will be displayed. DTMF tones are transmitted as soon as they are typed.



DTMF

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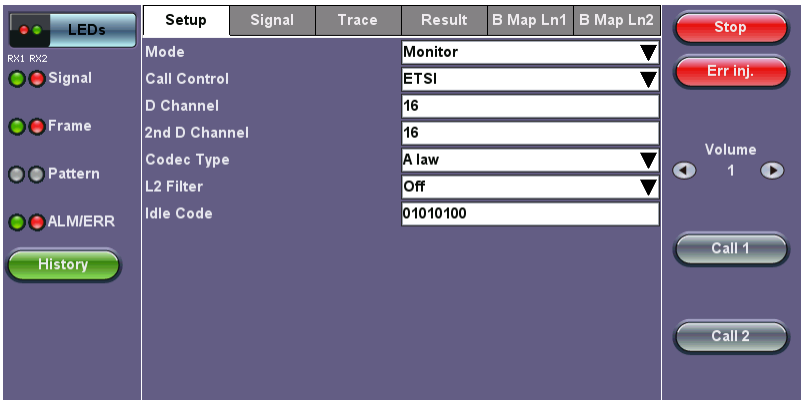

ISDN PRI Monitor Setup

The ISDN PRI Monitor's setup and results resemble those found in ISDN PRI Call. Please refer to ISDN PRI Call for more information on these respective sections:

- **Setup: Setup (PRI Call Setup)**
- **Signal: Signal**
- **BMap Line:** Detects active traffic on the timeslots. The user can listen to the conversation by pressing on active call cells. Please see Multi Call for more information.
- **Trace:** Please see Trace: ISDN Protocol Decode under Call - Voice and 3.1K Audio Setup.
- **Result:** Press the green arrow to access the action menu and press Start to initiate BERT Testing. Please refer to Data Call BERT Results for more details.

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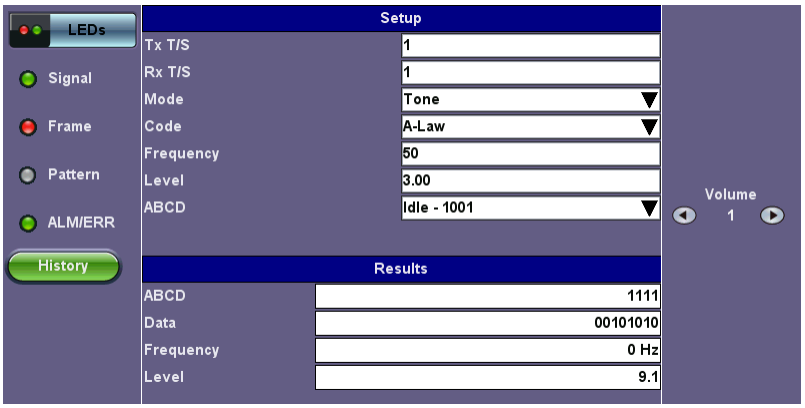
E1 VF

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



VF Tasks

VF Testing Do not attempt to enter VF Tasks if the Frame LED is not green.

Green LEDs indicate that the framing found on the received signal matches the framing selected in the Setup screen.

It is impossible to talk, listen, or perform other channelized functions in the absence of frame synchronization, since channels can be identified only within a framed signal.

Setup:

- **Time Slot:** Channel to test for both transmitting and receiving. Input a number from 1 - 31.
- **Mode:** Talk or send a tone on the transmit signal. It is possible to transmit audio data from the external headset into selected timeslot.
- **Code:** u-Law or A-Law.
- **Transmitted Frequency (Tone only):** 50 to 3950Hz.
- **Transmitted Level (Tone only):** -60 to 3dBm.

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- **Programmable ABCD:** Change the signalling bits transmitted with the associated transmit channel. These bits will be transmitted only if the test set is using MFAS (PCM-30) framing, found in Setup > Payload. Pressing IDLE(1001), SEIZE(0001), User (manually set) will place that signal onto the A/B/C/D position. D: Manual edit ABCD (User) or IDLE, SEIZE.

Results:

- Measure signal frequency and level in selected timeslot
- Listen to the voice channel in selected timeslot via external headset
- ABCD: View the received Channel Associated Signalling System (CAS) bits
- Data: View the live 8-bit channel data as it is received from the selected channel
- ABCD bits monitor and view data in selected T/S channel

Jitter and Wander

For more information on Jitter and Wander, see Accessing Jitter and Wander.

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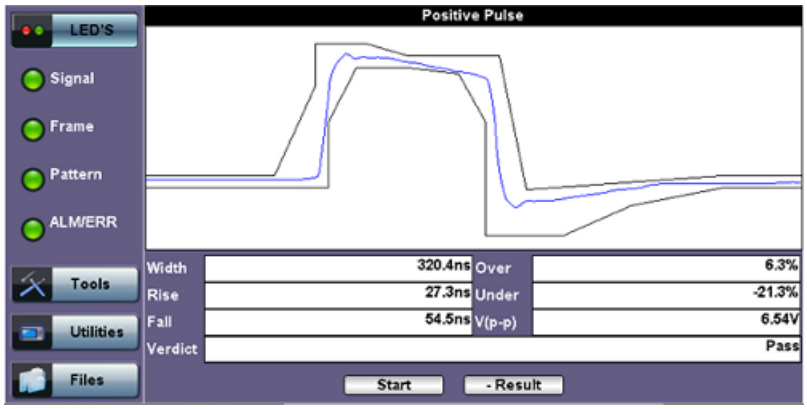
DS1/3 Tools

DS1 Pulse Mask

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

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



DS1 Pulse Mask

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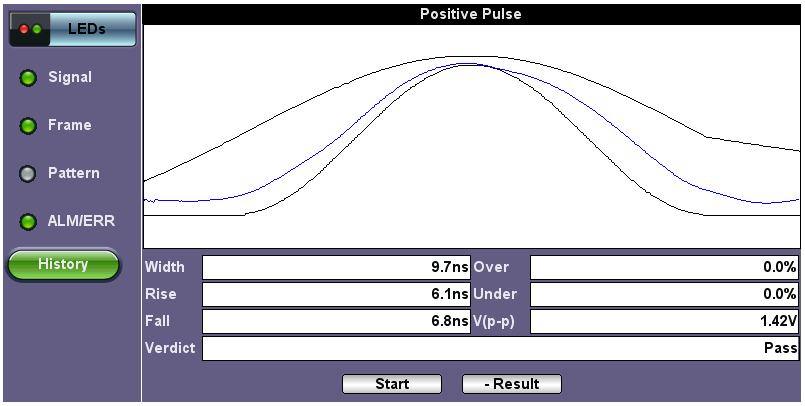
DS3 Pulse Mask

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

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



DS3 Pulse Mask

DS1/3 Loop

When in DS1 mode, users can tap the DS1 Loop button DS1 Loop on the right side of the screen. In DS3 mode, this appears as a DS3 button with DS3 Loopback features. Select the appropriate loopback command set by pressing on the corresponding check box. Testing interfaces allow the user to troubleshoot problems and to check the quality of links at the T1 Layer. Depending on the module installed, available loopback features will vary.

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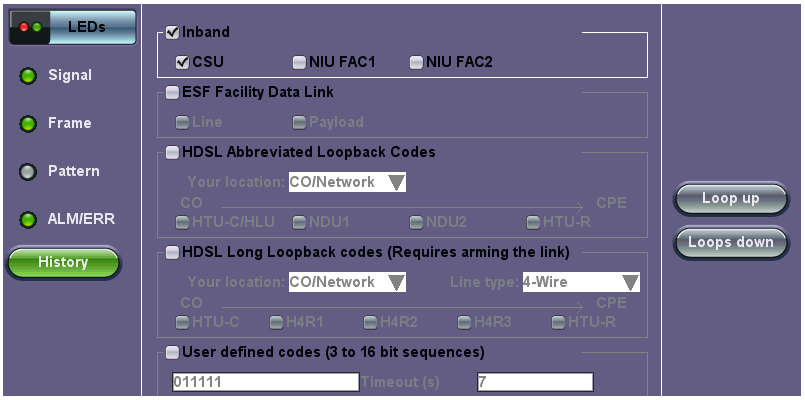
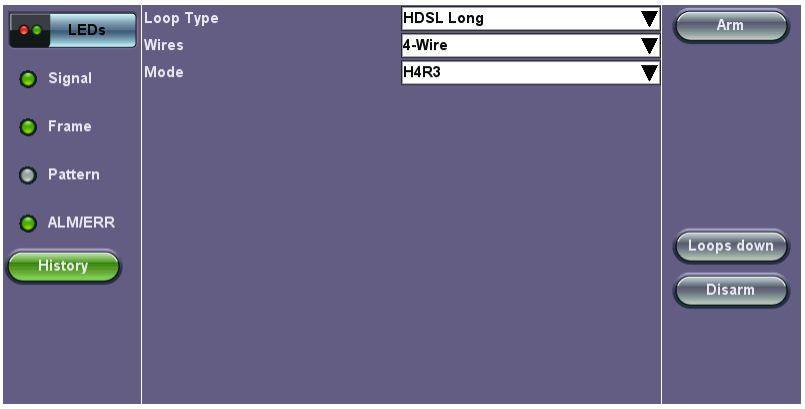


DS1 Loop (USA version)



DS1 Loop (International version)

Select the loopback command set.

In-band, ESF DFL, and HDSL Abbreviated Loopbacks functions allow only one element in loopback mode. Loop down any previous element before addressing a new one, or else a warning message "Error - Pre-existing loop found" will display.

In-band

Use this mode to loop up and loop down CSU and NIU using in-band loop codes. **Loop up** sends the loop command and **Loop down** sends the release command. This function will only allow one element in loopback mode. NIU FAC1 requires T1 framing to be set as ESF, otherwise the item will be grayed out.

ESF (Out-of-band)

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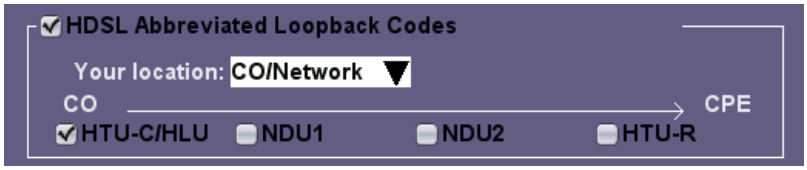
Uses the Extended Super Frame Facility Data Link control to send a repeating 16-bit ESF data link code word to the remote end requesting a Payload or Line loopback. ESF FDL loop codes require T1 framing to be set as ESF, otherwise the items will be grayed out.

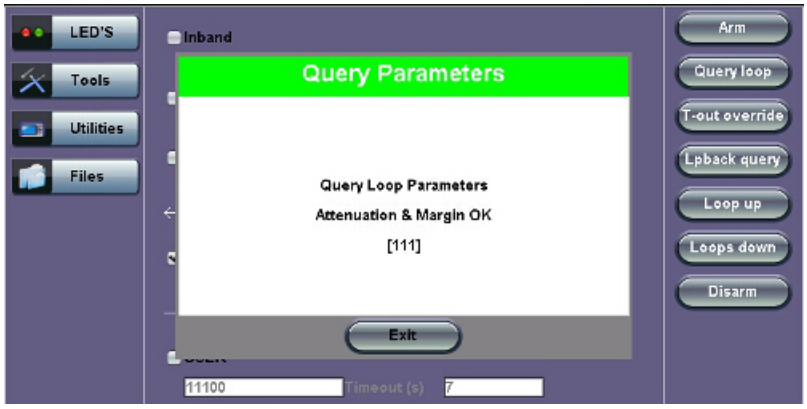
HDSL Abbreviated Loopbacks (Short)

Also known as short loop codes, HDSL abbreviated loopbacks are used to loop specific network elements of a compatible line, including CO, repeaters, CPE equipment and line cards. Users must select the location from which the test is to be conducted (CO/Network or CPE), select the network element to be addressed and send the Loop up or Loop down command. The white arrow is used as a visual indicator to remind the user in which direction the codes are being sent. NDU1 requires T1 framing to be set as ESF, otherwise the item will be grayed out.



HDSL In-band Loopbacks (Long)

Also known as long loopback codes, HDSL in-band loopbacks are a more complete loopback system that uses 16-bit code-words to loop specific network elements and provide confirmation and status. These confirmations are based on a burst of errors sent back to the test set. The number of errors sent depend on the type of confirmation and meaning. The status pop-up messages will show the meaning of those confirmation “codes” and the respective number of errors in brackets; for example: [111] indicates “Attenuation and Margin OK." See HDSL2 and HDSL4 Command Reference Table below for code meanings.



Query Parameters Message

User must select the type of HDSL cards being tested (2-wire vs. 4-wire), the location from which the test is to be conducted (CO/Network or CPE), the network element to be addressed, and the Loop up or Loop down

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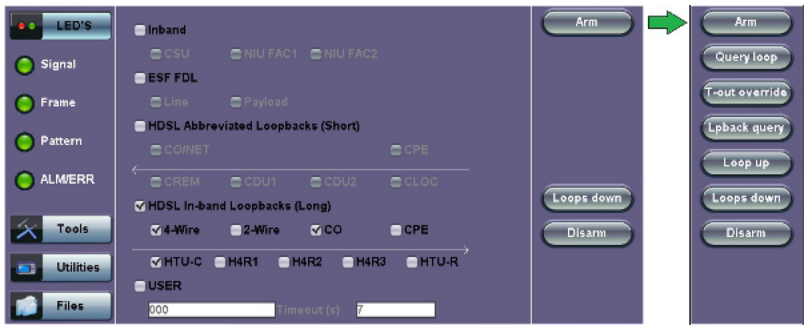
command. The white arrow is used as a visual indicator to remind the user in which direction the codes are being sent.

DS3 Loopback Commands

DS3 Loopback is possible with NIU and Line commands.

Procedure

Before sending any loop command, the line must be armed, otherwise loop commands will be ignored. When the user enters the function, the GUI will only show commands to Arm the link, loop down any element previously looped up, or disarm an already armed link. Once the Arm command is sent, the GUI will make other functions available.



- **Arm:** Sends the arming code (11000b) to the link. The status of the link can be confirmed by looking a the Arm/Lbk LEDs on any of the line cards in the link. Some HTU-Rs configured in NIU/Smartjack mode will loop up with the Arm command. The test set will notify the user when this is the case.
- **Query Loop:** When sent from the CO and the HTU-C is in loopback mode, it reports the status of the physical link based on attenuation and margin characteristics.
- **Time Out Override:** Disables any automatic (timed) loop down feature in the link, so any loop will stay permanently until it is manually looped down.
- **Loopback Query:** Send the loopback query code to identify the first device in loopback mode. Once detected, the test set will display which device is in loopback mode.

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- **Loop Up:** Sends the appropriate loop code to the selected network element (HTU-C, repeaters, or HTU-R), a confirmation message will be shown to indicate whether the loop was successful or not. Upon successful completion of a Loop up, a status message will display "Loop up success" and the user can press **Start Test** to proceed to BERT testing. The soft LEDs in the test set should all be green and can be used as a confirmation, as the test pattern should be coming back.
- **Loops down:** Sends the loop down without disarming code. The link will remain armed and ready to receive new commands. Some HTU-Rs configured as NIU/Smartjack will not loop down with this command and the instrument will notify the user if that is the case.
- **Disarm:** Sends the disarming code and brings down any loopbacks in the link, including the HTU-R in NIU/Smartjack mode.

"Loop up success" Message

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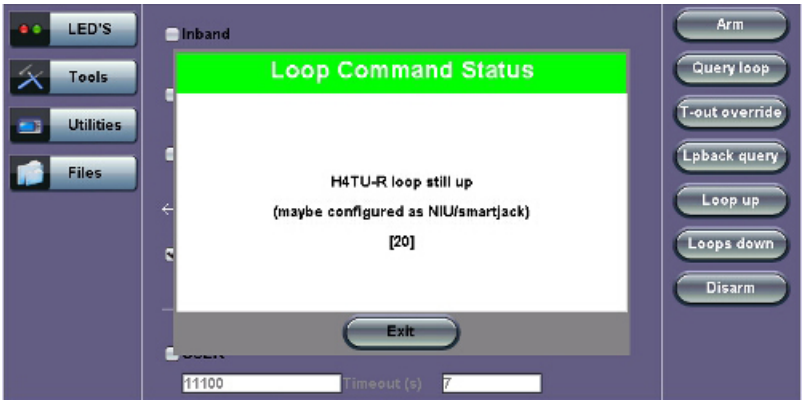

Loop Command Status Message

The long codes will allow multiple elements to be in loopback mode, as long as the elements are looped up from farthest to nearest. The white arrow on the DS1 Loop Setup screen is used as a visual indicator to remind the user in which direction the codes are being sent.

Adtran 4 Wire and 2 Wire Commands

4W	Arm	Disarm	HTUC	H4R1	H4R2	H4R3	HTUR Ext	HTUR Cust	Loop Down w/o Disarm	Timeout Override	Loop Back Query	Query Loop
From CO	11000	111000	D3D3	C741	C754	C743	C742	3F02	9393	D5D6	D5D5	DBDB
	2 in 5	3 in 5										
From CPE	11000	111000	D3D3	C741	C754	C743	C742	3F02	9393	D5D6	D5D5	
	2 in 5	3 in 5										
2w	**Arm**	**Disarm**	**HTUC**	**H4R1**	**H4R2**	**H4R3**	**HTUR Ext**	**HTUR Cust**	**Loop Down w/o Disarm**	**Timeout Override**	**Loop Back Query**	**Query Loop**
From CO	11000	111000	D3D3				C754	3F02	9393	D5D6	D5D5	DBDB
	2 in 5	3 in 5										
From CPE	11000	111000	D3D3				C754	3F02	9393	D5D6	D5D5	
	2 in 5	3 in 5										

Command Responses

Response (BIT Errors)	4W		2W	
	From CO	From CPE	From CO	From CPE
HTUC	231	231	231	231
HRE1	10	10		
HRE2	200	200		
HRE3	30	30		
HTUR	20	20	200	200
Query Loop	111 Loop Good	NA	111 Loop Good	NA
	11 Loop Bad		11 Loop Bad	
LoopBack query	Same as Above		Same as Above	Same as Above
LoopBack Time Out	Same as Above		HTUC 231	HTUC 231
			HTUR 20	HTUR 20

HDSL2 and HDSL4 Command Reference Table

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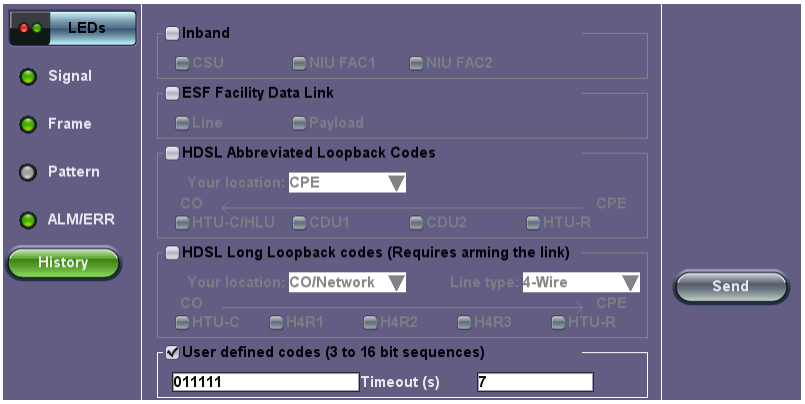
Confirmation based on number of errors received.

User

The user code allows sending programmable codes of up to 16 bits (LSB first) and can be used for those codes or elements not directly supported by the DS1 Loopback feature. Tap in the binary field and use the on-screen keypad to enter the binary combination, and press the Apply button to return to the main screen. The Timeout field allows the user to set the exact time, in seconds, in which the code will be sent and constantly repeated. User can adjust the period between 1 to 99 seconds. Entering 0 would send the loop pattern continuously until a new loop pattern is sent. A confirmation message will be displayed once the time is up.



User Code

Send: Press this button to send the programmed code for the amount of time set in the time out field. The test set will stop sending the code once time is up.

Round Trip Delay

Refer to Round Trip Delay in SDH/SONET Tools for more information.

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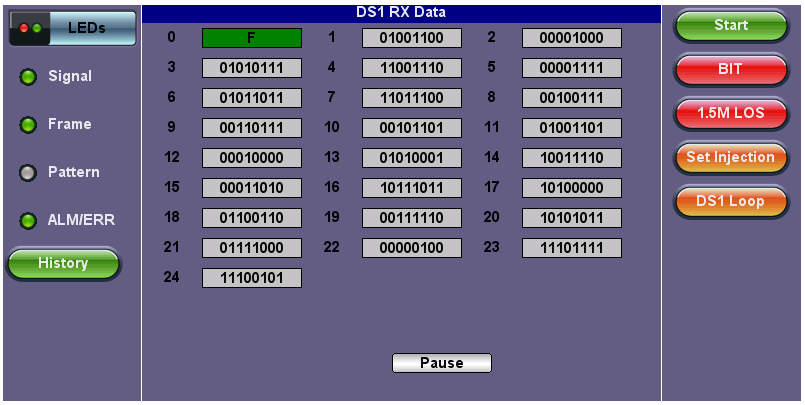
DS1 RX Data

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



DS1 Data

DS3 FEAC Tasks

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

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

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

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

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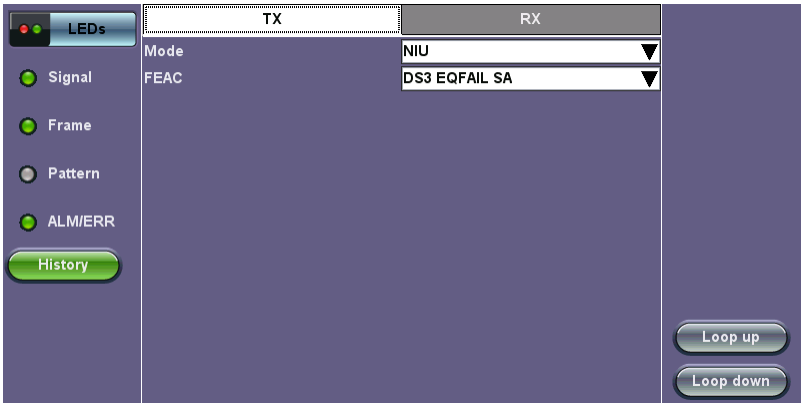
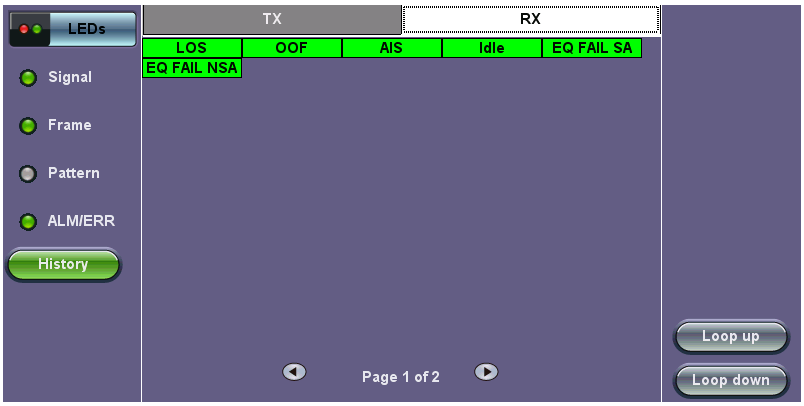


FEAC Tasks TX Setup

Alarm TYPE

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

LOOP TYPE: Options: NIU, LINE



FEAC Tasks RX

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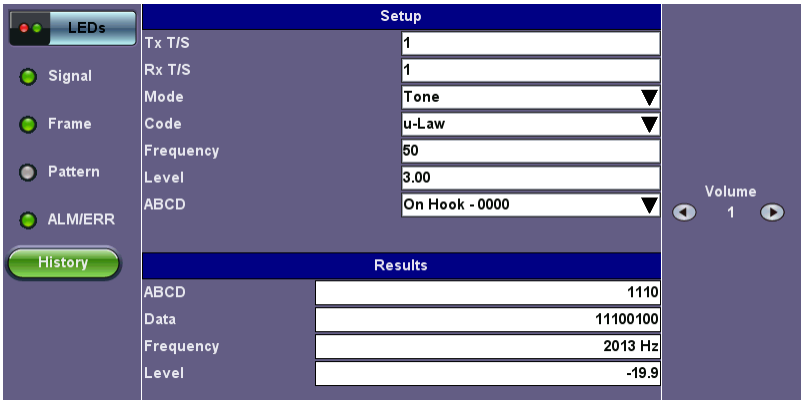
DS1 ISDN PRI

E1 and DS1 ISDN PRI offer identical test options. DS1 ISDN PRI instructions are discussed in E1 ISDN PRI.

DS1 VF Tasks

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



DS1 VF Tasks Setup

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

The VF Tasks screen features the following options:

Setup

- **Tx and Rx T/S:** Input the number of channels (1-24) to test for transmitting and receiving time slots.
- **Mode:** Talk or send a tone on the transmit signal. Transmit audio data from the external headset into the selected timeslot.
- **Code:** Select u-Law or A-Law.
- **Transmitted Frequency:** Input a frequency to transmit from 50 to 3950 Hz.

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- **Transmitted Level:** Input a frequency to transmit from -60 to 3dBm.
- **ABCD:** Options are ON-HOOK, OFF-HOOK, WINK, or User (Manually set). Change the signalling bits transmitted with the associated transmit channel. In SF-D4 framing these will be A/B and ESF framing will place that signal onto the A/B/C/D position.
- **Programmable ABCD:** Manual (User) or IDLE, SEIZE.

Results:

- Measure signal frequency and level in selected timeslot.
- Listen to the voice channel in selected timeslot via external headset. **Volume** can be adjusted using the left and right arrow keys.
- **ABCD:** View the received Channel Associated Signalling System(CAS) bits.
- **Data:** View the live 8-bit channel data as it is received from the selected channel.
- ABCD bits monitor and view data in selected T/S channel.

Jitter and Wander

For more information on Jitter and Wander, see Accessing Jitter and Wander.

CSU/NIU Emulation for DS1

The test set can emulate DS1 customer premises equipment, simulating a CSU or NIU. CSU/NIU emulation allows the test set to be looped up from the central office to verify DS1 service across the entire length of the span.

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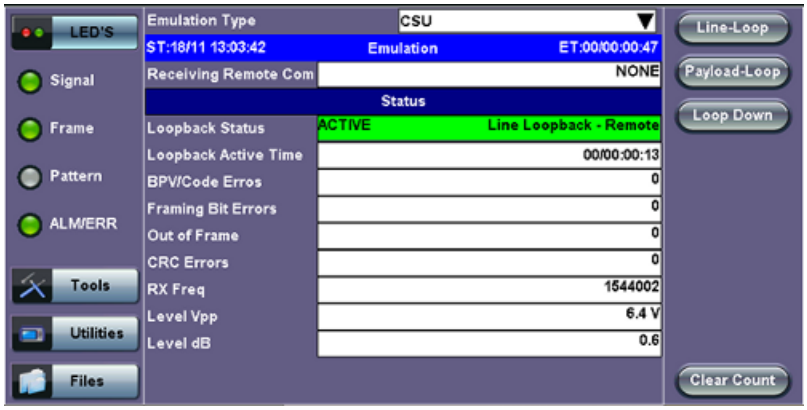

CSU/NIU Emulation

Emulation Type: NIU or CSU

Receiving Remote Command: “None”. After the remote command disappears, “None” is displayed. When receiving command, the following are displayed:

- In-band loop up
- In-band loop down
- ESF FDL Line loop up
- ESF FDL Line loop down
- ESF FDL payload loop up
- ESF FDL payload loop down

When in un-loop state, Line 1 TX sends AIS

Loopback Statuses:

- Loopback Active Time: Loopback time elapsed (s)
- BPV/code errors
- Framing Bit Errors
- Out of Frame errors

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- CRC Errors
- Receiving frequency (Hz)
- Peak-to-peak voltage and voltage level

Button	Command	Description
Line-Loop	*Line-Loop*	Loopback RX to TX, unchanged
Payload-Loop	*Payload-Loop*	Loopback RX to TX, only the payload
Loop Down	*Loop Down*	Can be used to unloop at anytime
Clear Count	*Clear Count*	Clear all the counters to 0. Loopback state, no change

CSU/NIU Buttons

In SF mode, only in-band commands can be checked.

In ESF mode, FDL and in-band commands are both checked.

Remote loopback control qualification time is 5 seconds (that is, must receive loopback commands for 5 seconds before activate or deactivate loopback state)

DS1/3 Auto Monitor

Auto Monitor mode automatically configures the unit to the incoming (receiving) signal structure. Once the signal structure is configured, tap OK to begin testing or Exit to exit the screen. The Summary tab displays DS1 test results and measurements alarms, errors, or signal failure pertaining to the DS1/3 signal and payload.

Refer to Results:PDH for more information on the test result tabs.

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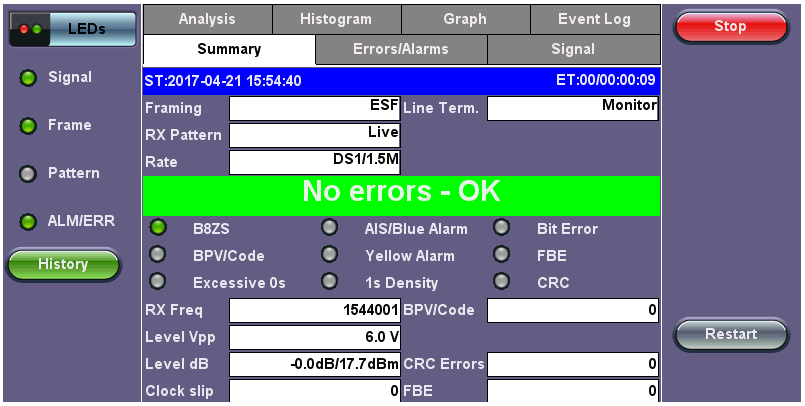
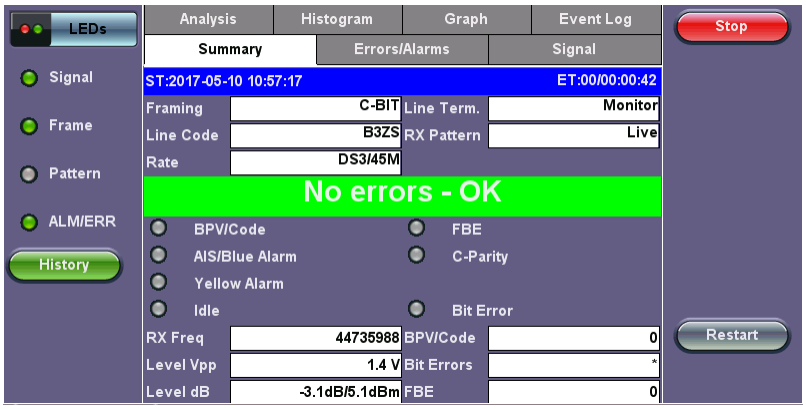
DS1 Auto Monitor Scan



DS1 Auto Monitor - Summary



DS3 Auto Monitor - Summary

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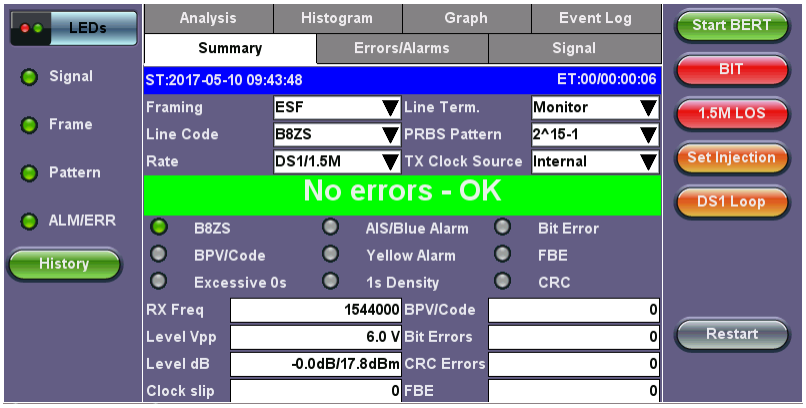
DS1 BERT

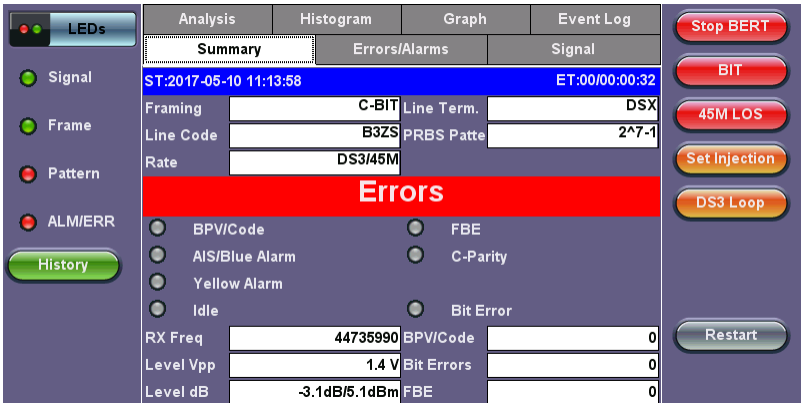
DS1 Interface, Payload, and Pattern settings can be configured in the Summary tab using the drop-down menus.

Signal status, error and alarms, and Pass/Fail indicators are also displayed.

Refer to Results: PDH for more information on the test result tabs.



DS1 BERT Setup



DS3 BERT In Progress

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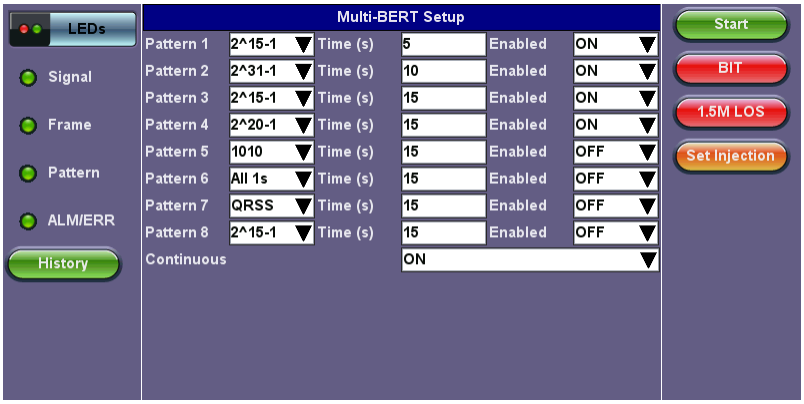
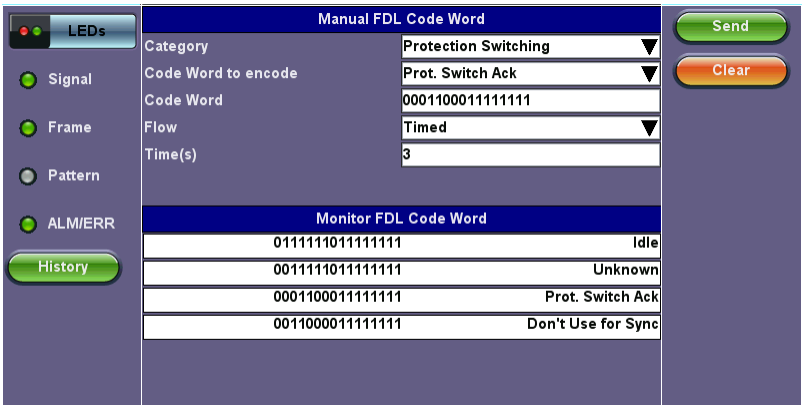
DS1 (Stress) Multi BERT

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



DS1 (Stress) Multi-BERT Setup

DS1 FDL & SSM QL



DS1 FDL & SSM QL

DS1 Synchronization Status Messages (SSM) indicate the clock source quality level. They are only carried by the Extended Super Frames (ESF) Facility Data Link (FDL) channel. The data link is a bit-oriented code (BOC) or Bit-patterned Message (BPM) defined by T1.403. SSMs have the format of 0xxxxxx0 11111111 (right-to-

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left), where xxxxxx are the six information bits of the message. ANSI standard T1.101 lists the SSM codes carried by DS1 timing signals..

Sync Status Messaging (SSM) provides a means for Network Elements downstream from the BITS system to be alerted the Stratum Level of the timing signal. With a system of coded messages transmitted “out-of-band” on a T1 ESF or E1 signal, SSM allows Network Elements to follow an automatic, pre-determined process for selecting the timing source of the highest Stratum Level; thereby eliminating outages due to timing failures. For T1-ESF, the Facility Data Link carriers the SSM codes as shown below.

For SSM to be useful, connected Network Elements must be configured with instructions for actions to be taken in event of degradation of the SSM code. For example, a normal SSM message of Stratum 1 (PRS) indicates the T1 or E1 signal is traceable back to a Stratum 1 source. While the SSM is not a guarantee of signal quality, it can be used to automatically alert connected Network Equipment if the BITS knowingly becomes degraded.

T1 Sync Status Message DS1 Data Link/FDL (Binary)	DS1 Data Link/FDL (HEX)	
00000100	11111111	Stratum 1 (PRS) Traceable
00001000	11111111	Sync Traceability Unknown (STU)
00001100	11111111	Stratum 2 Traceable
01111100	11111111	Stratum 3E Traceable
00010000	11111111	Stratum 3 Traceable
00101000	11111111	Stratum 4 Traceable
01111000	11111111	Transit Node Clock
00110000	11111111	Do Not Use for Sync

Ethernet over OTN (EoOTN)

OTU2e & OTU1e Overview

ODU0, ODUflex, OTU2e and OTU1e are commonly used for Ethernet over OTN (EoOTN) transport applications.

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.

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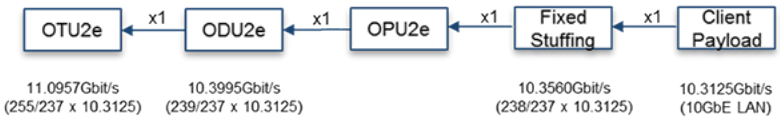
OTU1e (11.0491Gbps) bit rate support (without fixed stuffing)



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

OTU2e OTU1e with Ethernet Payloads

OTU2e (11.1 Gbps), OTU1e (11.05 Gbps), or OTUXe, also referred to as overclocking, is an adaptation technology that increases the frequency (data rate) of the standard OTU2 (10.7 Gbps) interface, in order to better accommodate 10GE payloads (which the standard ODU2 was not capable to achieve transparently). Although the use of physical overclocked interfaces has faded away (and is considered non-standard), the use of the ODU2e container became a permanent part of the G.709 standard.

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

Signal Setup

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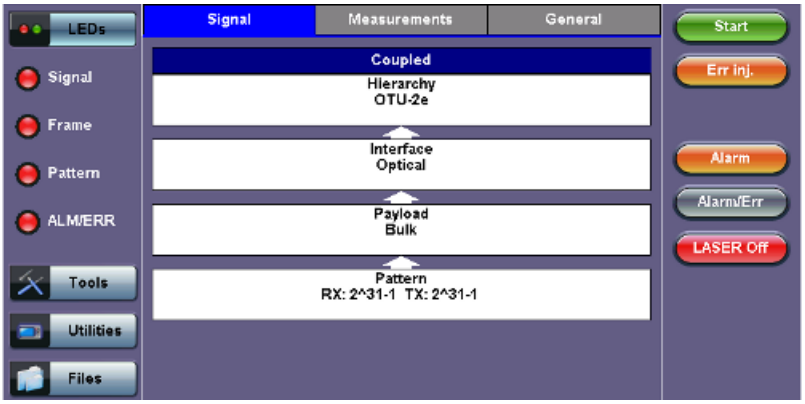


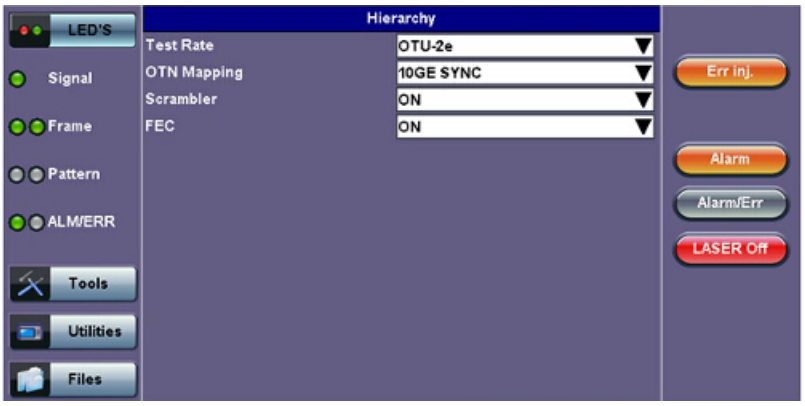
Signal Setup

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

The TX and RX ports setup can be **Coupled** to share the same configuration. For more complex test scenarios in which the TX and RX port settings need to be different, tap on the blue bar (on top of the Hierarchy box), to select **Independent** mode. This enables the TX and RX to be set to different rates.

Hierarchy

To access the physical interface and rate setting, tap on the Hierarchy box from the Signal tab.



Hierarchy Setup

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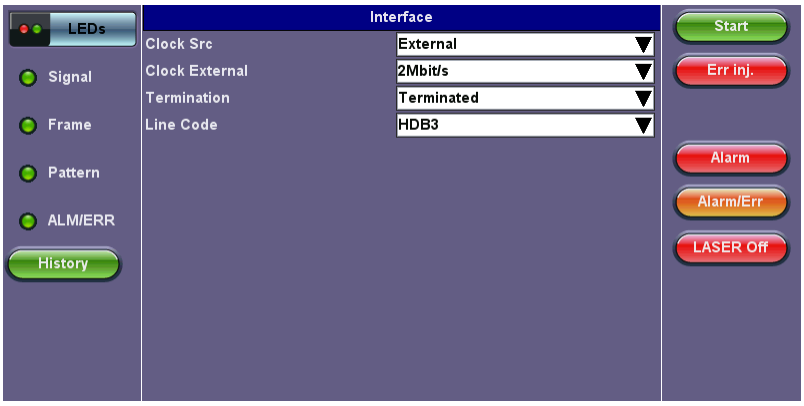
- **Test Rate:** Options are OTU-1e and OTU-2e (referring to 11.049G and 11.095G respectively).
- **OTN Mapping:** 10GE SYNC, 10GE ASYNC, and Test pattern (Bulk).
- **Scrambler:** ON/OFF.
- **FEC:** FEC encoder can be ON/OFF.

Interface

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



Interface Setup

- **Clock Source:** Internal, External, Rx, or Offset
  - **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

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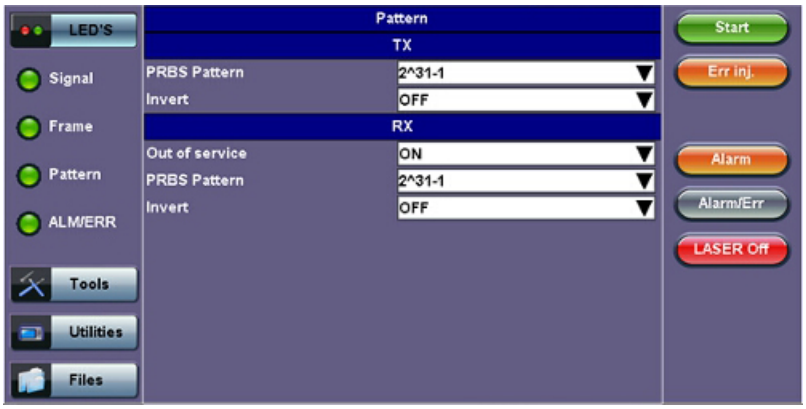
These options can be selected from them **Clock Src** box.

- **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.

- **Termination** (2 Mbps only):
  - **Terminated:** The received signal is terminated with a 75 ohm or 100 ohm (120 ohm in E1) impedance enabling the unit to decode the signal over a wide range of cable losses.
  - **Monitor:** To be used when the measurement is made at a Protected Monitoring Point (PMP) of network equipment. The PMP level can range between -20 and -26dB.
  - **Bridge:** Available on in DS1 or E1 mode. Select this mode for a high impedance monitor test or when the receiver is connected directly in parallel to a DS1 or E1 line carrying live traffic. The isolation circuit of the unit protects the DS1 or E1 signal from any possible disruption.
- **Line Code (1.5 Mbps, 2 Mbps only):** HDB3, B8ZS, AMI.

Pattern

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



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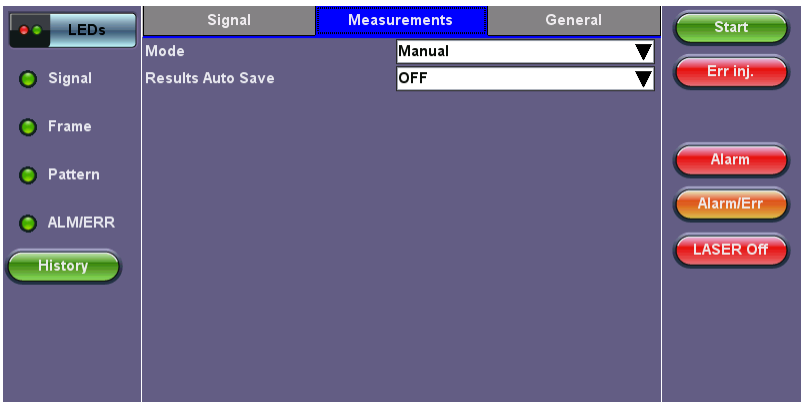
- **PRBS Pattern:** Use the pattern drop-down box to select the test pattern which will be inserted into the transmitted signal. Pseudo Random Bit Sequences (PRBS) defined by ITU-T 0.150 and 0.151 standards, fixed words and 24-bit or 32 bit user defined patterns are available. Note, if the 32 bit user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

Measurements



Measurements tab

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

Interval Save/Results Auto Save and Auto Server Upload is available in all modes. Depending on the V300 unit and test module installed, Interval Save will appear as Results Auto Save.

- **Interval Save or Results Auto Save:** Test results automatically save at a specified interval. To enable interval save, select ON and enter the Save Interval (in minutes.
- **Auto Server Upload:** Automatically uploads results to the server. The unit needs to be connected and registered to an R-Server or FTP-Server to use this function. Selecting a server type will display a message prompt with the option to connect and register to the server.

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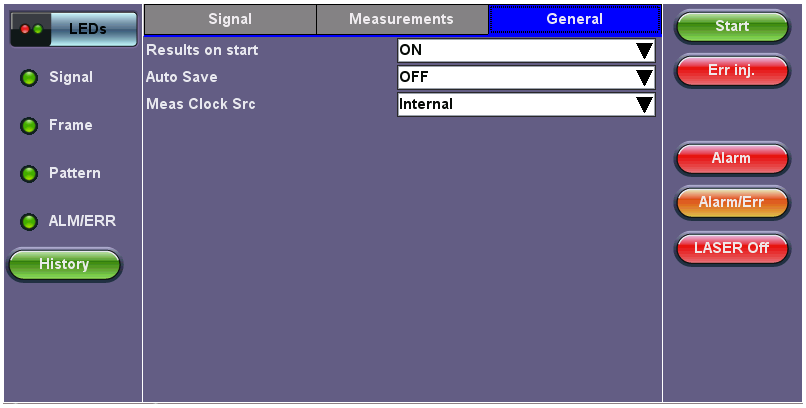
General



General tab

OTU2e & OTU1e Results

Accessing Results

Measurements are accessed by tapping the Results button 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 button will not be available on the Home menu. To access results, press the **OTN Results** button OTN Result from the selected Ethernet application.

For information on Ethernet payloads, refer to the Ethernet section for more information.

For Bulk (PRBS) payloads, refer to Results: OTN/SDH and OTN/SONET

OTU2e & OTU1e 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.

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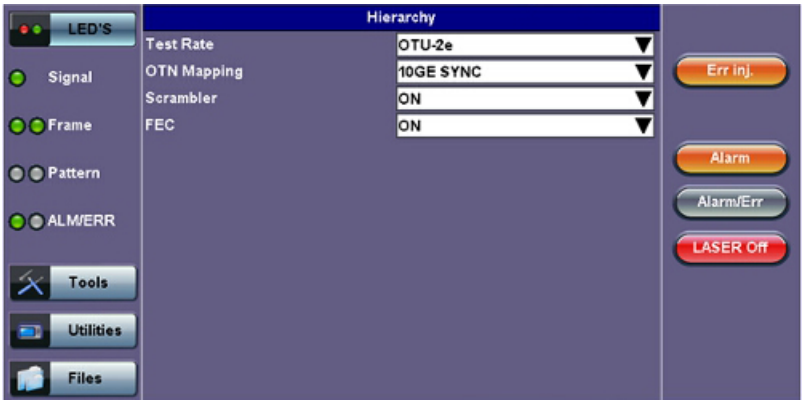

Hierarchy Setup

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:

- **OTU2e & OTU1e with 10GE BERT** redirects to BERT
- **OTN/10GE RFC 2544 Conformance Testing** redirects to RFC 2544 Conformance Testing
- **OTN/10GE Throughput Testing (Multiple Streams)** redirects to Throughput Testing
- redirects to BERT

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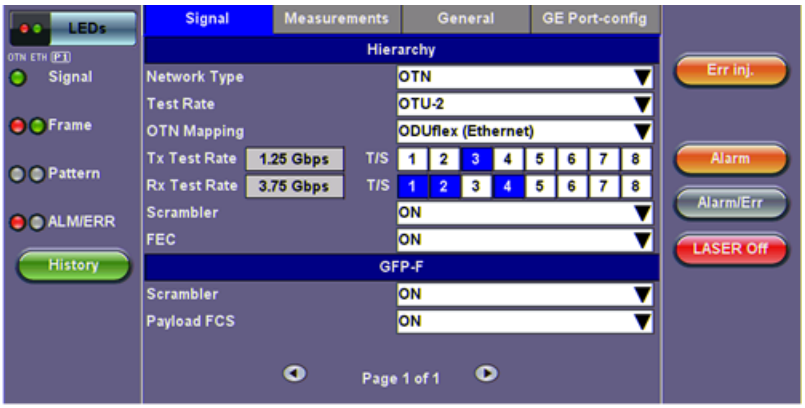
- 14.4.2 OTN/10GE RFC 2544 Conformance Testing redirects to RFC 2544 Conformance Testing
- 14.4.3 OTN/10GE Throughput Testing (Multiple Streams) redirects to Throughput Testing

ODU0 and ODUflex Overview

ODU0 (1.25 Gbps) can accommodate a 1GE client transparently. As its name implies, ODUflex adds flexibility in the data rate and is capable of carrying Nx1.25 Gbps payloads, including Ethernet. Refer to VeEX's OTN Reference Guide, QG20, for a technological overview of ODU0 and ODUflex.

ODU0 and ODUflex Setup Menu

Signal Setup



Signal Setup for ODUflex (Ethernet)

Soft LED Indicators

For OTN Mapping modes with Ethernet payload testing, OTN and ETH refer to the test signal health status while **P1** or **P2** indicates the port in operation.

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

- **Network Type:** This is applicable to OTN links only.
- **Test Rate:** OTU1 (2.7 Gbps) or OTU2 (10.7 Gbps) test interface selection.

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- **OTN Mapping:** These are the different test payload options available, including basic PRBS (Bulk) and Ethernet. OTU2 interfaces can carry lower rate payloads (e.g. 1GE) by multiplexing multiple ODU0s (e.g. OTU1-ODU1-ODU0-1GE, OTU2-ODU2-ODU0-1GE, or OTU2-ODU2-ODU1-ODU0-1GE).
    - When Bulk is selected, the test set runs a typical BER test, filling the payload with the selected test pattern.
    - When an Ethernet payload is selected, then ethernet-centric tests such as BERT, Throughput or RFC25544 must be used to test the link and payload.
    - ODUflex allows flexible selection of multiple ODU0s, contiguous or non-contiguous, within an OTU2 interface, to achieve the desired (or closer) Nx1.25 Gbps rate required for the payload. Tap on the Tx and Rx tributary slot blocks to select the channels and data rate. N = 1 to 8.
- **Tx/Rx Test Rate (ODUflex Ethernet only):** Tap on the numbered blocks representing tributary slots to select a test rate.
- **Tx and Rx ODUk Channels:** Depending on the physical interface (OTU2 or OTU1), the test payload rate and the multiplexing structure, the test set offers these fields to generate and identify the test payload position, within the OTN signal.
- **ODU0 GE, ODU1->0 PRBS, ODU1->0 GE:**
    - Tx/Rx ODU0 Channel.
    - **Scrambler:** Turns the standard scrambler function ON and OFF. It is recommended to leave it ON.
    - **FEC:** Turns the standard Forward Error Correction function ON and OFF. It is recommended to leave it ON.
    - **Payload FCS:** When an Ethernet test payload is selected, this turns the standard Frame Check Sum generation and evaluation ON and OFF. It is recommended to leave it ON.
- ODU0 PRBS and ODU1 PRBS: PRBS Patterns are configurable on Page 2.

Pattern

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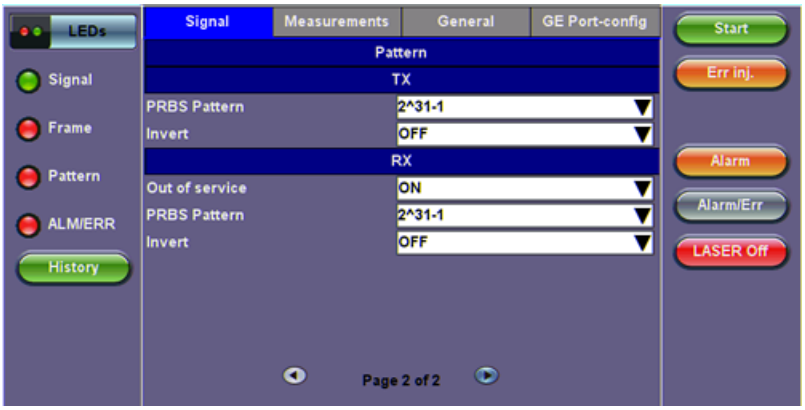
The pattern setup appears when OTN Mapping is set to a PRBS Test Pattern.



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. 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.
- **Out of Service:** Should be selected if the incoming signal is expected to contain a known test pattern. Deselect this option if signal is expected to contain live network traffic – this will disable the pattern detection process and will enable the reporting of LSS.

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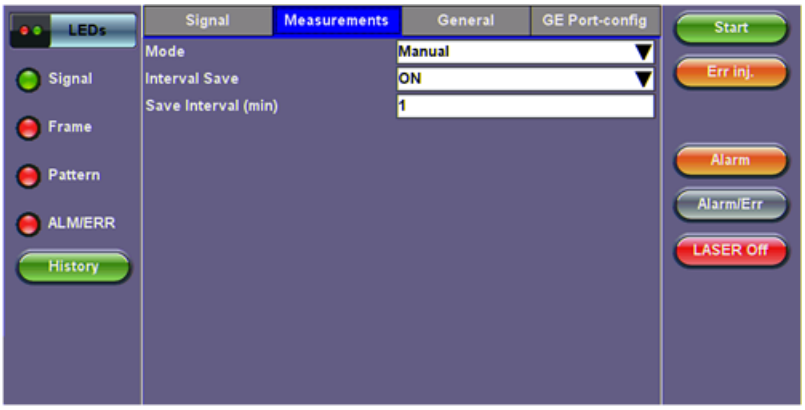

Measurements tab

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

Configure a test to run for a fixed duration or a delayed start. Manual mode is chosen as the default configuration for starting/stopping the test.

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 and the test will be activated automatically when the programmed start time is reached.

Interval Save/Results Auto Save and Auto Server Upload is available in all modes. Depending on the V300 unit and test module installed, Interval Save will appear as Results Auto Save.

- **Interval Save or Results Auto Save:** Test results automatically save at a specified interval. To enable interval save, select ON and enter the Save Interval (in minutes.

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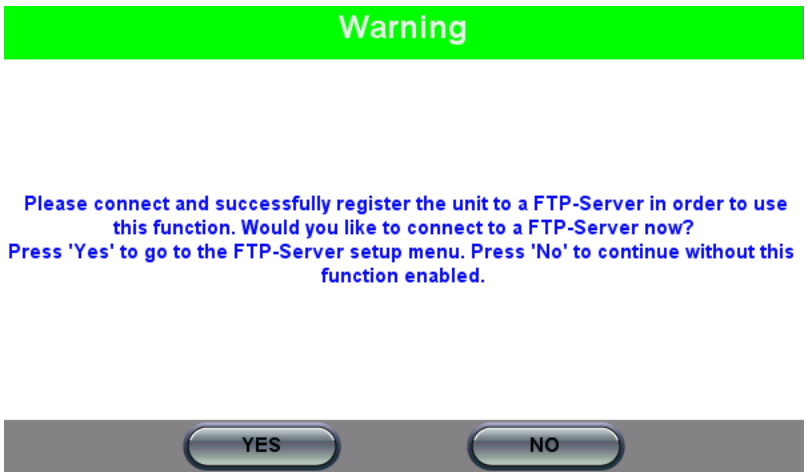
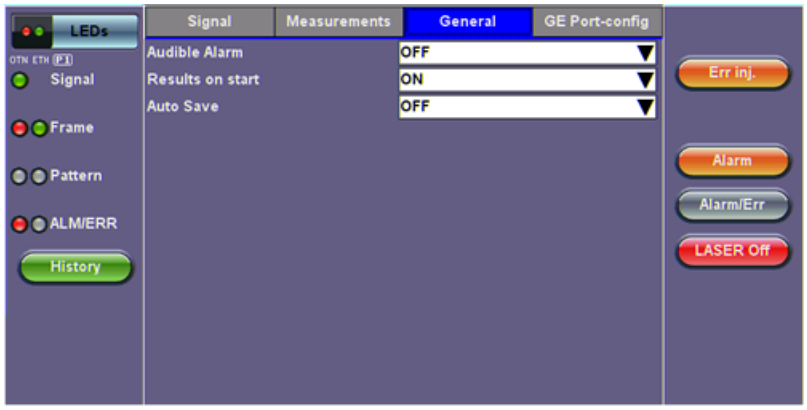
- **Auto Server Upload:** Automatically uploads results to the server. The unit needs to be connected and registered to an R-Server or FTP-Server to use this function. Selecting a server type will display a message prompt with the option to connect and register to the server.



Server Prompt

General



General tab

- **Audible Alarm:** OFF, ON. Unit beeps every time an alarm is detected. This feature is not available on all test sets.

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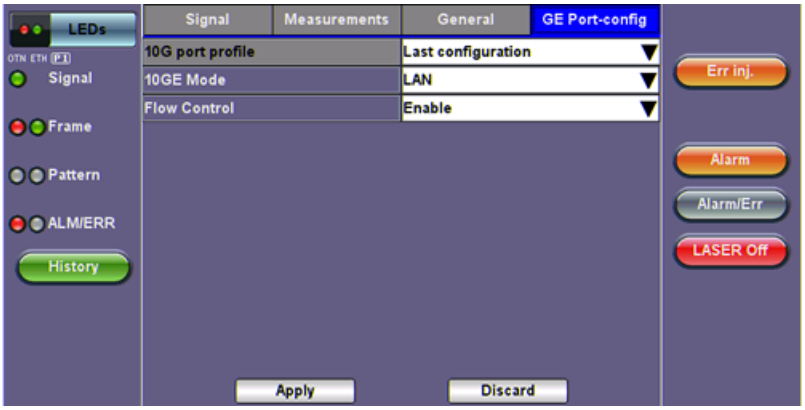
- **Results on start:** On or Off. Provides an automatic move to Result screen when it starts.
- **Auto Save:** Automatically saves the results file.

GE Port-config



GE Port-config tab

GE Port-configuration is available for GE OTN Mapping.

- **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.

For ODUflex (Ethernet), 10GE Mode LAN and enabled Flow Control are set as default.

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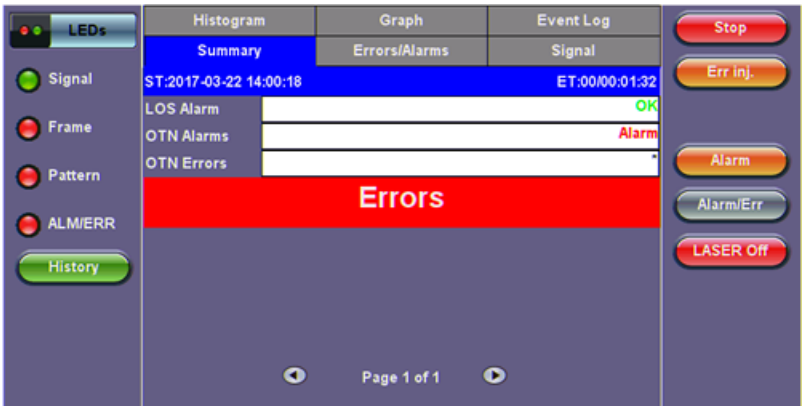
ODU0 & ODUflex Results

Tap the green **Start** button to view the OTN Results page.

For information on Ethernet payloads, refer to the Ethernet section for more information.

For Bulk (PRBS) payloads, refer to Results: OTN.



Results

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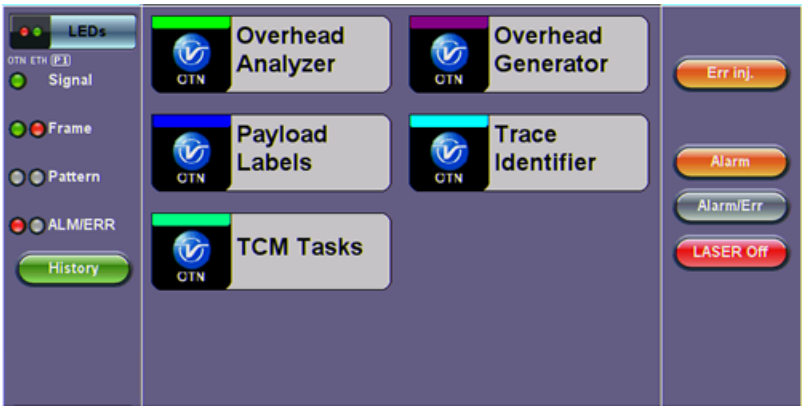
OTN Tools

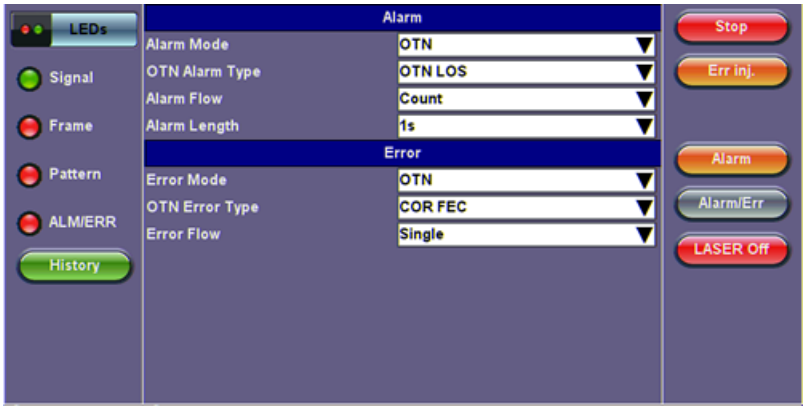
The OTN Tools applications featured in ODU0 and ODUflex Test Mode are the same as the ones featured in OTN/SDH Single and Dual Test Modes. Refer to OTN Tools in the OTN/SDH section for more information on these test applications.



OTN Tools in ODU0 and ODUflex Test Mode

Alarm/Error

The Alarm/Error application featured in ODU0 and ODUflex Test Mode is the same as the application in OTN/SDH Single and Dual Test Modes. Refer to Alarm/Error in the OTN/SDH section for more information.



Alarm/Error in ODU0 and ODUflex Test Mode

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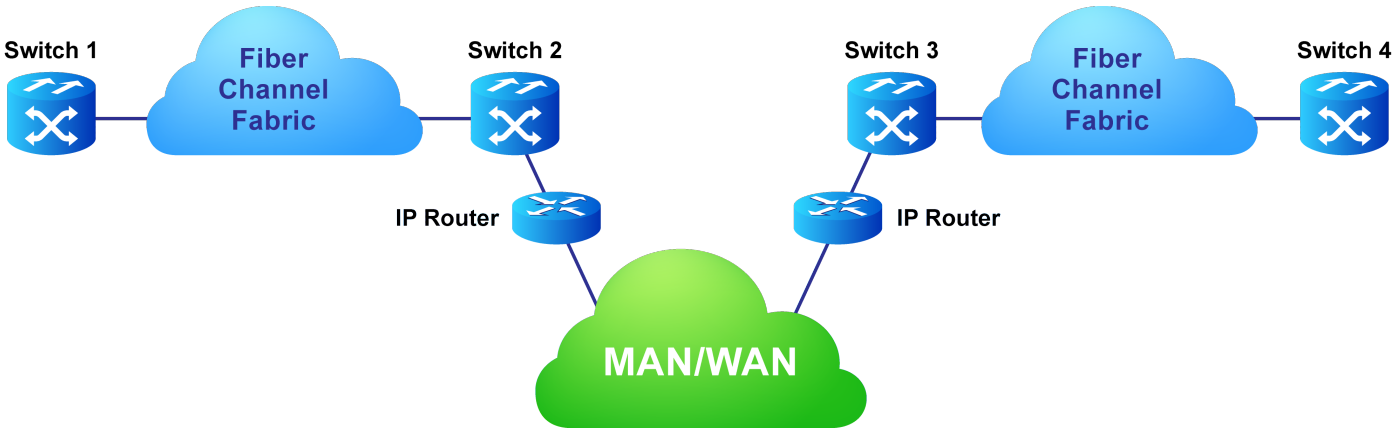
Fiber Channel

Fiber Channel Applications

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

Fiber Channel over IP

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



Fiber Channel over SDH/SONET

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

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Key Test Applications

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

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

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

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

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"Fibre Channel" versus "Fiber Channel"

Confusing naming and spelling conventions have stuck with Fibre Channel during its development. The word “channel” in no way indicates a preference for channel protocols or environments.Even though “fibre” and “fiber” are semantically equivalent (“fibre” is the international English spelling), “Fibre Channel” is the official spelling for the technology.

“Fiber” has come to mean more specifically the optical (glass) media used for long-distance (up to 10 km) connections.

Test Applications

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

Fiber Channel Main Menu

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

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

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

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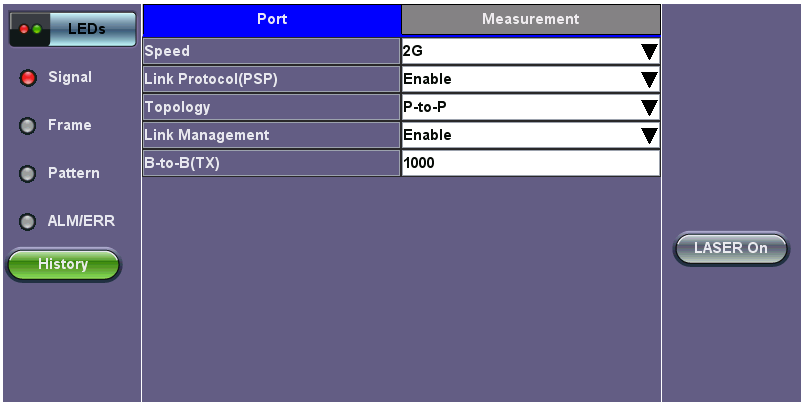
Port Configuration



Fiber Channel - Port Setup

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

- **Speed**
  - 1G (1.0625 Gbps)
  - 2G (2.125 Gbps)
  - 4G (4.25 Gbps)
  - 8G (8.50 Gbps)
  - 10G (10.52 Gbps)
- **Link Protocol:** Enables or Disables the PSP.

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

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Sequences supported by the standard are:

- Offline (OLS)
- Not Operational (NOS)
- Link Reset (LR)
- Link Reset Response (LRR)

- **Topology:**Point-to-Point (P-to-P) mode is supported.
  In Point-to-Point mode, only two ports are used, connected by a fiber optic link. The transmitter of each port is connected directly to the receiver of the opposite port. There is no ambiguity in addressing, and there is no question of availability.

  : Fibre Channel defines three topologies: 1) Point-to-Point, 2) Arbitrated Loop, and 3) Fabric; however, Point-to-Point topology is the least complex.

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

- **B-to-B (Tx): Buffer to Buffer:** Valid settings are in the range from 1 to 65535.
  - Number of local port frame buffers are available to receive frames from another port.
  - Determines how many frames can be sent before receiving R_RDY acknowledgments.
  - “Credits”, or the number of frames, are negotiated between the n_ports and f_ports at the time of login.
  - Both ports on the link exchange values of how many frames they are willing to receive at a time from the other port. This value becomes the other port's BB_Credit value and remains constant as long as the ports are logged in.

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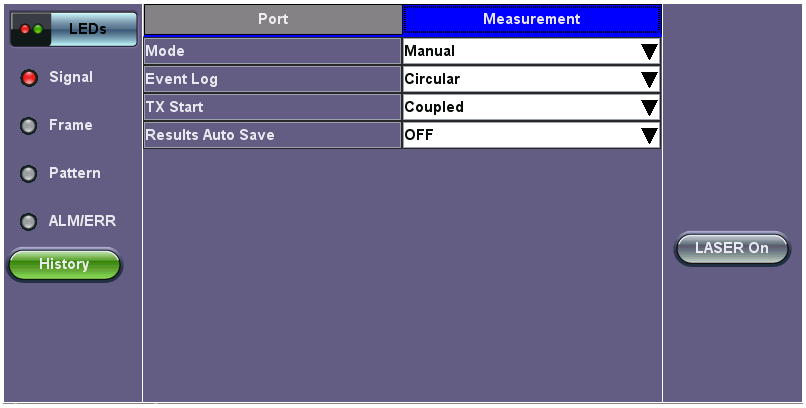
- Each port also keeps track of BB_Credit_CNT.
  - **Transmitter**: For each frame transmitted, BB_Credit_CNT is incremented by 1.
  - **Receiver**: The value is decremented by 1 for each R_RDY Primitive Signal received from the other port.



Fiber Channel - Measurement Setup

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

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

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- **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.

BERT/Throughput

Overview

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

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

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

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

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

Fiber Channel Layers

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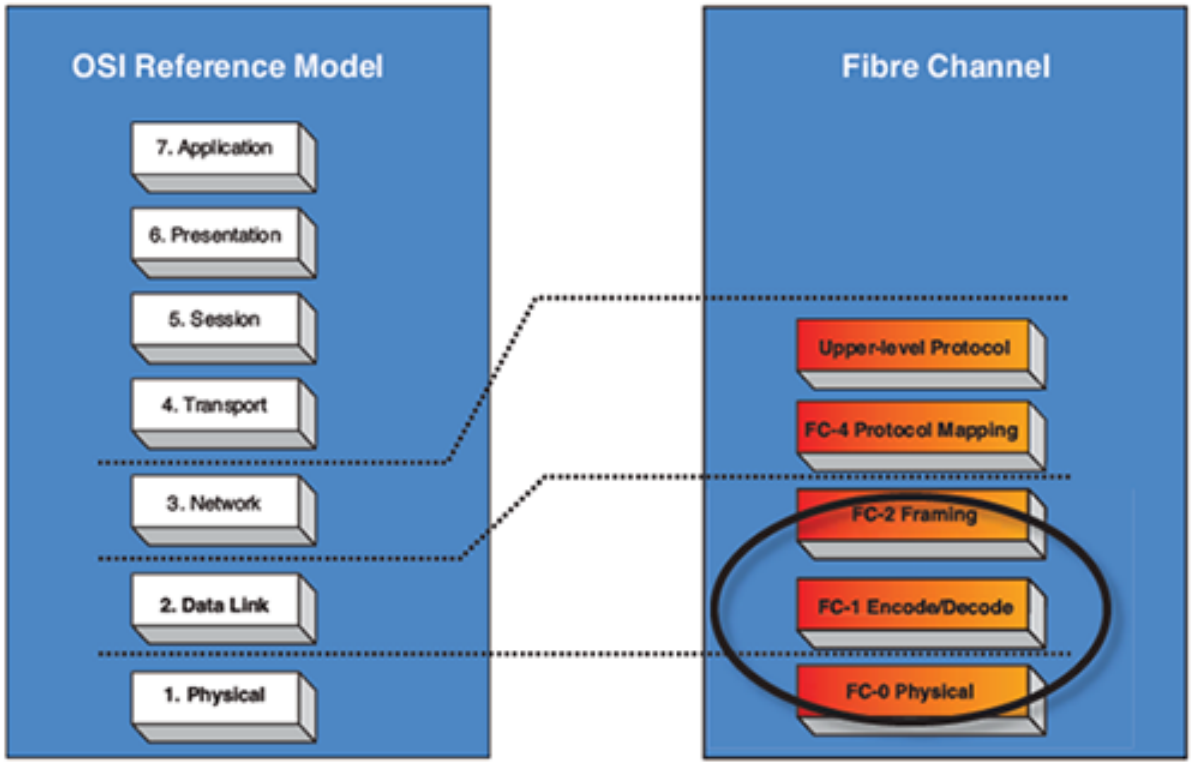
The Open Systems Interconnect (OSI) model breaks communications into seven layers namely, Physical, Data Link, Network, Transport, Session, Presentation, and Application. Fibre Channel does not follow the ISO model - instead, the protocol has been broken into five layers: FC-0, FC-1, FC-2, FC-3, and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



OSI layers versus FC layers

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

- **FC-1** defines the transmission protocol, encoding, order of word transmission, and error detection. This level is in the FC-PH standard.

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- 8B/10B character encoding (1/2/4/8G FC) or 64/66B character encoding (10G FC)
- Link maintenance

- **FC-2** defines the signaling and framing protocol, including frame layout, frame header content, and rules for use. It also contains independent protocols such as login. This is the bulk of the FC-PH standard.
  - Frame format
  - Sequence management
  - Exchange management
  - Flow Control
  - Classes of Service
  - Login/Logout
  - Topologies
  - Segmentation and Reassembly

Fiber Channel layers and functionality

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

- **FC-3** defines common services that may be available across multiple ports in a node. This level has no standard now.
  - Services for multiple ports on one node

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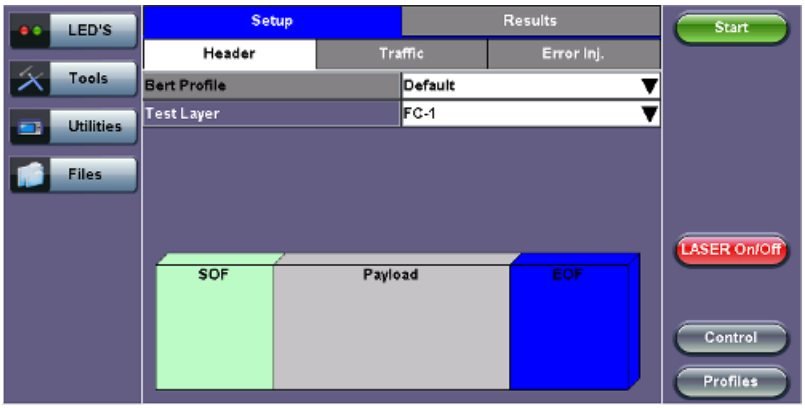
- **FC-4** defines the mapping between the lower levels of Fibre Channel, and the command sets that use Fibre Channel.
    - Upper Layer Protocol (ULP) mapping
        - Small Computer System Interface (SCSI)
        - Internet Protocol (IP)
        - High Performance Parallel Interface (HIPPI)
        - Asynchronous Transfer Mode - Adaption Layer 5 (ATM-AAL5)
        - Intelligent Peripheral Interface - 3 (IPI-3) (disk and tape)
        - Single Byte Command Code Sets (SBCCS)

Setup



FC-1 BERT - Test Frame Setup

- **Profile:** User Defined Profile or Default setting can be used for testing.
- **Test layer:** FC-1 or FC-2 only. Testing at other layers is not supported.
- **FC-1:**Information is transmitted using an adaptive code (8B/10B or 64/66B) depending on test rate and the encoding process results in the generation of transmission characters.

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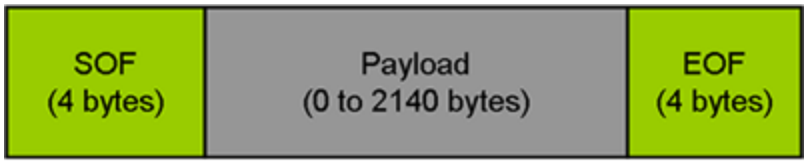
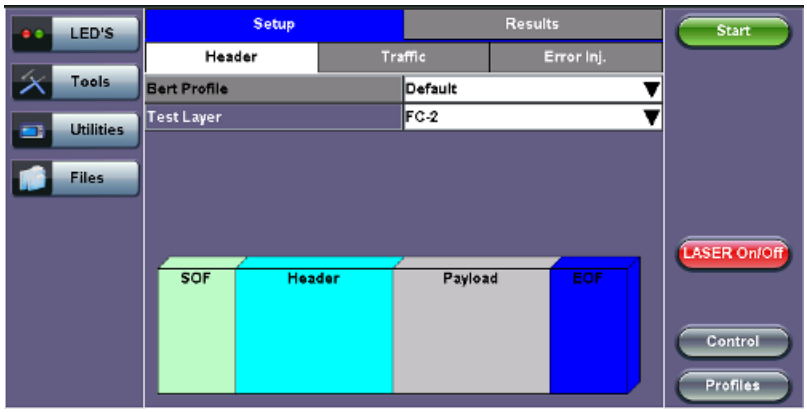
- The two types of Transmission Characters defined are data and special. Certain combinations of Transmission Characters, referred to as Ordered Sets, are designated by this standard to have special meaning.
- Ordered Sets are used to identify frame boundaries, transmit primitive function requests, and maintain proper link transmission characteristics during periods of inactivity.



FC-1 Frame Structure



FC-2 BERT - Header Setup

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

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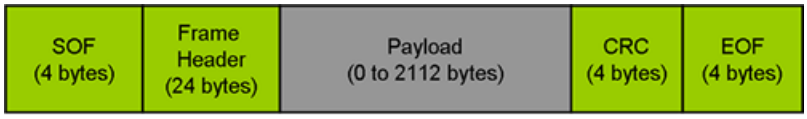
- Exchange
- Protocol



FC-2 Frame Structure

FC-2 Header

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

Understanding the Basic Test Channel Frame Structure

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

- **SOF and EOF**
  - A Start of Frame (SOF) delimiter and End of Frame (EOF) delimiter mark the beginning and end of each Fibre Channel frame
  - Available for both FC-1 and FC-2 frame formats
- **Frame Header**
  - Is the first field of the frame content and immediately follows the SOF delimiter and is transmitted on a word boundary
  - Is used to control link operations and device protocol transfers as well as detect missing or out of order frames
  - Available in FC-2 frame format only
- **CRC** - The Cyclic Redundancy Check (CRC)
  - Is a four byte field that follows the Data Field and is used to verify the data integrity of the Frame Header and Data Field.
  - SOF and EOF delimiters are not included in the CRC verification

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- The CRC field is calculated on the Frame Header and Data Field prior to encoding for transmission and after decoding upon reception

Frame Delimiters

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

Ordered Set

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

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

- **Primitive Signals**

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

- **Primitive Sequence**
  - **(OLS)** Off-line
  - **(NOS)** Not Operational

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- **(LR)** Link Reset
- **(LRR)** Link Reset Response

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

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

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

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

The following SOF Service Class selections are available:

- **SOF Initiate** (SOFix)

  A Sequence shall be initiated and identified by using SOFi1, SOFi2, SOFi3, or SOFi4 in the first

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frame. SOFix is used to represent these four SOF delimiters.

- **SOF_i3:** Contains a code value of 0x2E indicating SOF Initiate Class 3. A SOFi3 should be used on the first frame of a Sequence for Class 3 Service.

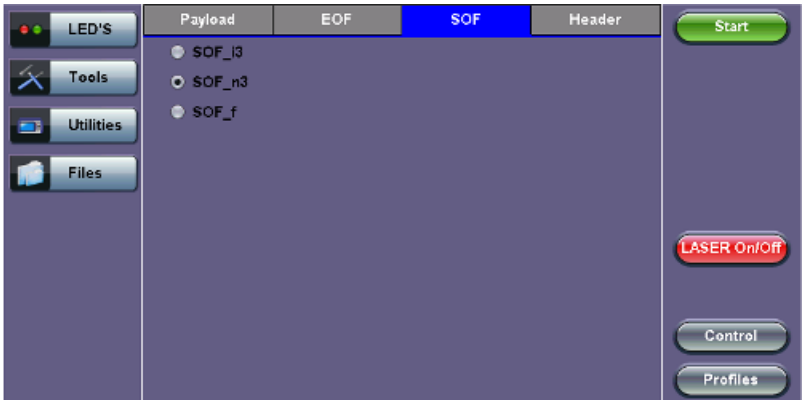
- **SOF Normal** (SOFnx)

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

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

- **SOF Fabric (SOFf)**

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



FC-2 BERT - SOF Setup

End of Frame (EOF)

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

The following selections are available:

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

FC-2 BERT - EOF Setup

Payload

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

FC-1 Payload (test pattern)

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

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

- **CSPAT:** Compliant Supply Noise Pattern
    - Represents worst case power supply noise

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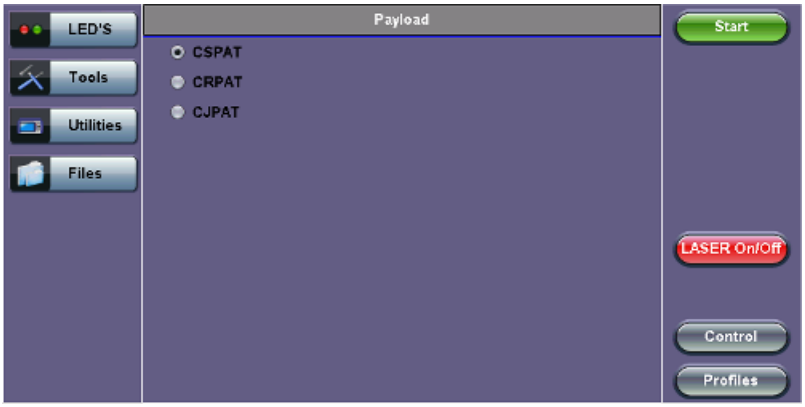
- **CRPAT:** Compliant Random Pattern
  - Provides broad spectral content and minimal peaking for the measurement of jitter at component or system level
- **CJTPAT:** Compliant Jitter Test Pattern
  - Jitter Tolerance Pattern that stresses a receiver by exposing it to extreme phase jumps thereby stressing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



FC-1 BERT - Payload Setup

FC-1 Test Patterns

CRPAT sequence is offered for TX jitter measurements.

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

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

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

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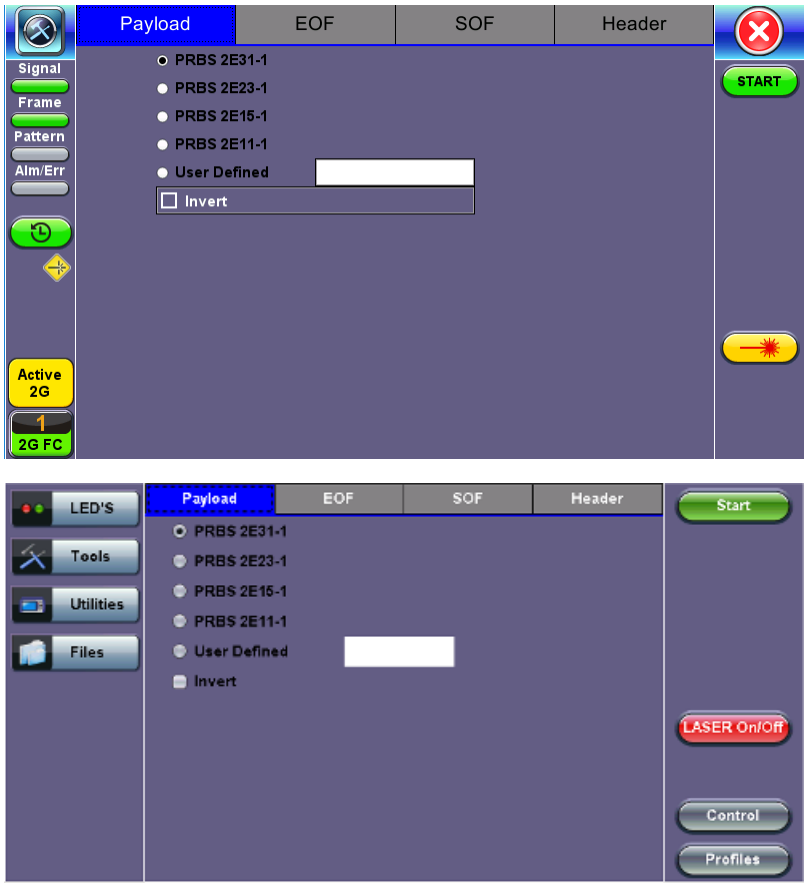
- **2E31-1:** 147 483 647-bit pattern used for special measurement tasks, (e.g., delay measurements at higher bit rates)
- **2E23-1:** 8 388 607 bit pattern primarily intended for error and jitter measurements at bit rates of 34 368 and 139 264 kbps
- **2E15-1:** 32 767 bit pattern primarily intended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



BERT Testing Tips

A BERT samples every incoming bit and looks for something that doesn't occur often. This traditional method typically used in SONET/SDH measurements, can however take a very long time. For example, in a 1Gbps Fiber Channel system, errors occur on average once every 1000 s (about 17 Min) for $1x10^{-12}$ BER, so you

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would need to detect at least 10 to 100 errors before you can have confidence in your measurement. Bear in mind that for a quick measurement, you need a test pattern that repeats frequently. A PRBS-11 sequence (2047 bits) repeats many times a second at a 1-Gbps rate, however a PRBS-31 pattern, with 2 billion bits, repeats only every 2 s at 1 Gbps.

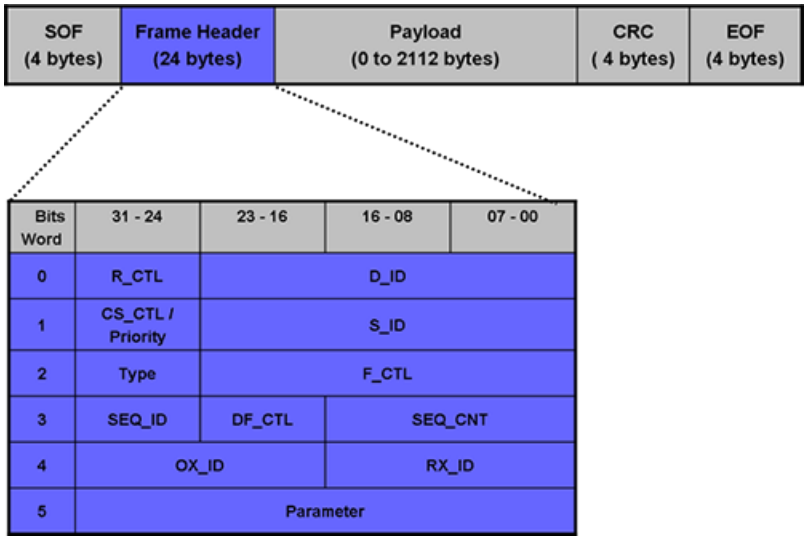
A general rule of thumb is to choose a PRBS that is closest to the nature of the data you will be passing through your network. Patterns between 2^{11}–1 and 2^{31}–1 (such as 2^{15}–1 and 2^{23}–1) offer good gradual steps in difficulty that allow you to see where networks fail, or how much margin you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

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

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

Header Setup (FC-2 only)

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



FC-2 Header Format

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

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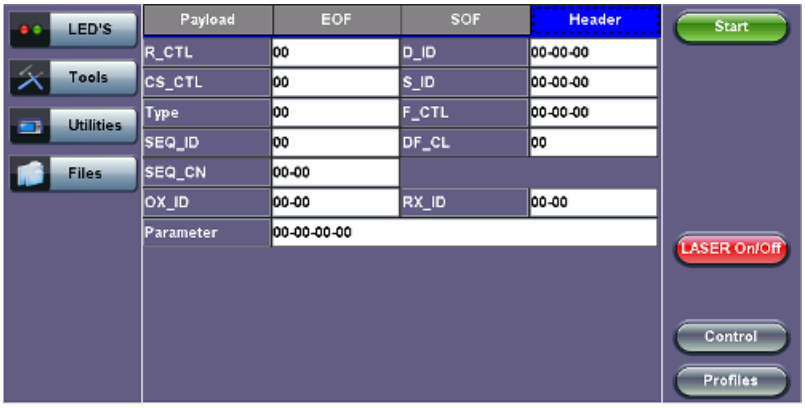

FC-2 Header Setup

- **Routing Control (R_CTL):**
  - The R_CTL field is a one-byte field in Word 0 Bits 31-24 that contains routing bits and information bits to categorize the frame function.
  - When used in combination with the TYPE field (Word 2, bits 31-24), it provides an FC_Port with assistance in frame routing, data routing, or addressing.
  - The R_CTL field is further subdivided into the ROUTING field (bits 31-28) and the INFORMATION field (bits 27-24).
- **D_ID Address Identifier:**
  - Destination Identifier is a three-byte field (Word 0, Bits 23-0) that contains the address identifier of the destination Nx_Port.
  - Each Nx_Port has a native N_Port_ID that is unique within the address domain of a Fabric. It may also represent hunt groups, domain controllers, and other servers.
- **Class Specific Control (CS_CTL)/Priority:**
  - When bit 17 of F_CTL is set to zero, Word 1, bits 31-24 of the Frame_Header is defined as the CS_CTL field.
  - Contains management information for the class of service identified by the SOF. The meaning of the CS_CTL field is dependent on the class of service.

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- When supported by FC_Ports, the Priority field shall be used to resolve resource contention or to determine the order to deliver frames. The definition and use of the Priority field is class dependent.

- **S_ID Address Identifier:**
  - The S_ID is a three-byte field (Word 1, Bits 23-0) that contains the address identifier of the source Nx_Port.
- **Type (Data Structure Type):**
  - The data structure type (TYPE) is a one-byte field (Word 2, Bits 31-24) that identifies the protocol of the frame content for Data frames.
- **Frame Control (F_CTL):**
  - The Frame Control (F_CTL) field (Word 2, Bits 23-0) is a three-byte field that contains control information relating to the frame content such as exchange, retransmission, or sequence control. It is also used to identify the function of the CS_CTL/P field.
- **Sequence Identifier (SEQ_ID):**
  - The SEQ_ID is a one-byte field (Word 3, Bits 31-24) assigned by the Sequence Initiator that is unique for a specific D_ID and S_ID pair while the Sequence is open.
  - Both the Sequence Initiator and the Sequence Recipient track the status of frames within the Sequence using fields within the Sequence_Qualifier.
- **Data Field Control (DF_CTL):**
  - Data Field Control (DF_CTL) is a one-byte field (Word 3, Bits 23-16) that specifies the presence of optional headers at the beginning of the Data_Field for Device_Data or Video_Data frames.
  - DF_CTL bits are not meaningful on Link_Control or Basic Link Service frames.

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- **Sequence count (SEQ_CNT):**
    - The sequence count (SEQ_CNT) is a two-byte field (Word 3, Bits 15-0) that indicates the sequential order of Data frame transmission within a single Sequence or multiple consecutive Sequences for the same Exchange.
- **Originator Exchange_ID (OX_ID):**
    - The Originator Exchange_ID is a two-byte field (Word 4, Bits 31-16) that identifies the Exchange_ID assigned by the Originator of the Exchange.
    - Each Exchange is assigned an identifier unique to the Originator or Originator - Responder pair.
- **Responder Exchange_ID (RX_ID):**
    - The Responder Exchange_ID is a two byte field (Word 4, Bits 15-0) assigned by the Responder that provides a unique, locally meaningful identifier at the Responder for an Exchange established by an Originator and identified by an OX_ID.
- **Parameter:**
    - The Parameter field (Word 5, Bits 31-0) has meanings based on frame type.
    - For Link_Control frames, the Parameter field is used to carry information specific to the individual Link_Control frame.
    - For Data frames with the relative offset present bit set to 1, the Parameter field specifies relative offset, a four-byte field that contains the relative displacement of the first byte of the Payload of the frame from the base address as specified by the ULP.

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

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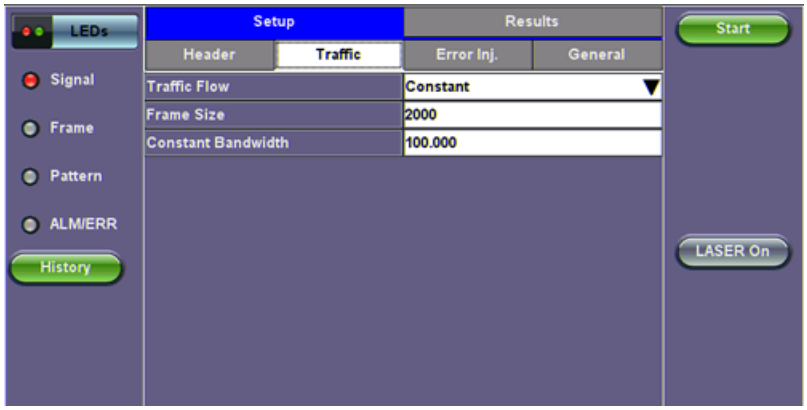
Traffic Setup

- **Traffic Flow:** Select from Constant, Ramp, or Burst traffic flow - available selections depend on FC-1 or FC-2
  - **Constant:** Continuous traffic (no traffic shaping)
  - **Burst:** Two burst bandwidths are configured with variable burst time in seconds
  - **Ramp:** Start and stop bandwidths are configured along with the bandwidth step size and duration
- **Frame Size:** Set the frame size in bytes.
  - Available in FC-2 mode only
  - Valid settings are 56 bytes to 2148 bytes.
  - The frame length includes the SOF and EOF overhead bytes.
- **Constant Bandwidth:** Configure the transmit rate or bandwidth in %
  - Valid settings are 1% to 100% in 0.01% increments



FC-BERT/FC-Throughput Traffic Setup

Error Injection Setup

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

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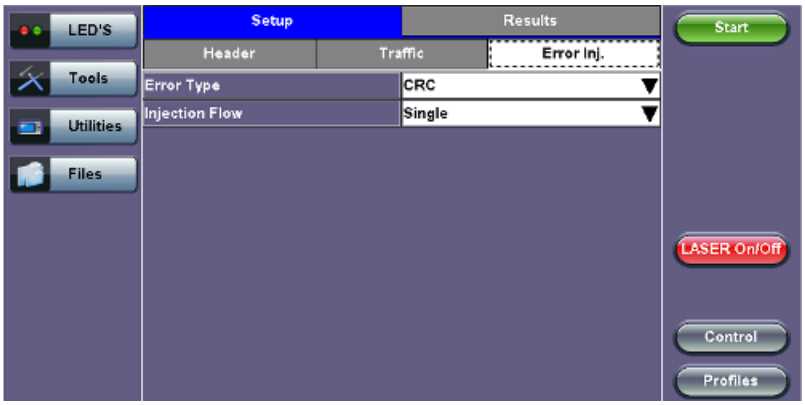
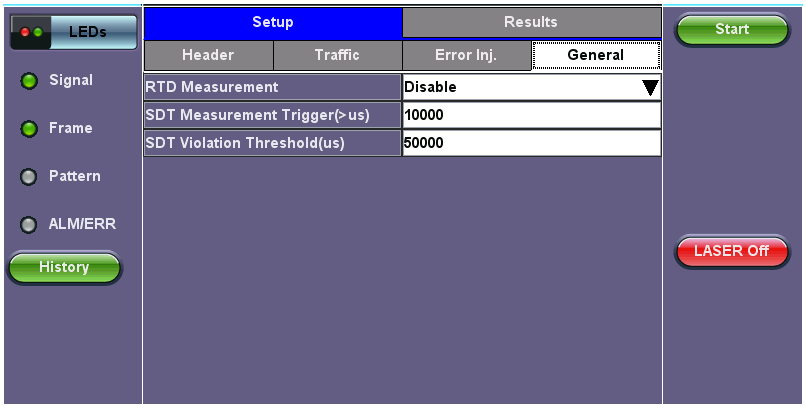
- **Error type:** Select from Bit and CRC.
- **Injection Flow:** Determines how the selected errors will be injected. The user can select a single error injection, a specific count, or error rate.
- **Count:**When Count is selected, configure the error count via the numeric pop-up keypad.



FC-BERT/FC-Throughput Error Injection Setup

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



FC-1/2 Throughput - General

General tab *(Throughput only)*

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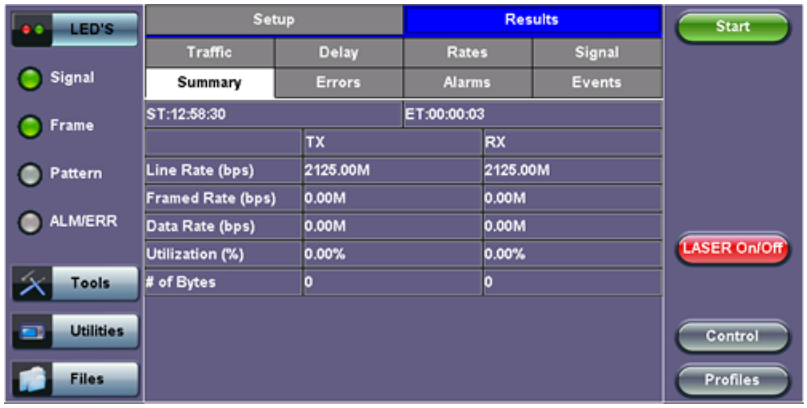
- **RTD Measurement:** Enable or Disable Round Trip Delay Measurement
- **SDT Measurement Trigger (>µs)**: Any inter-frame gap that is equivalent or greater than the configured threshold will trigger the SDT measurement. This is useful if a known threshold is expected from a given network under test.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

Starting Measurements

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



FC-1/2 BERT - Prior to Starting

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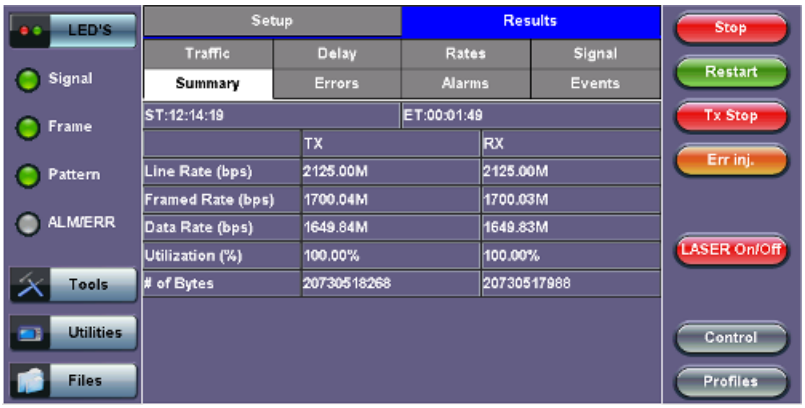
Results

Summary

- **Line Rate:** Indicates the transmitted and received bit rate
    - 1.0625 Gbps, 2.125 Gbps, 4.25 Gbps, 8.50Gbps, or 10.52 Gbps, 14.025G, 16G displayed in Mbps
- **Framed Rate:** Total number of frames including overhead of any type per second (Mbytes)
- **Data rate:** Total count of frames with payload data per second (Mbytes)
- **Utilization:** Bandwidth utilization in %
- **# of Bytes:** Number of bytes transmitted versus bytes received.
- **BB Credits Used:** Number of Buffer Credits used.

Summary *(Throughput only)*

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



FC - BERT - Summary

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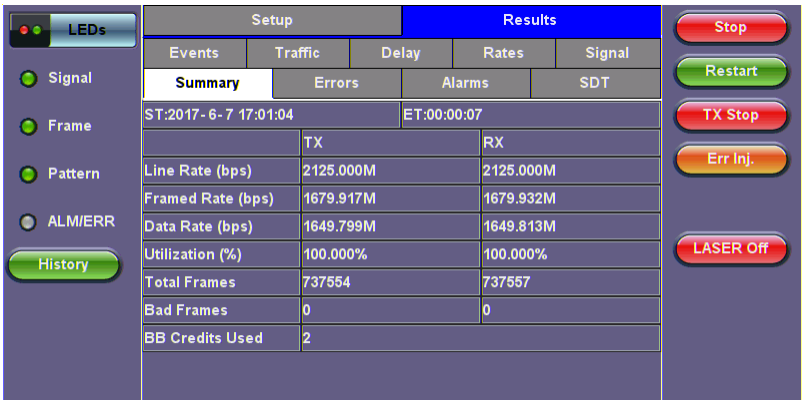

FC - Throughput - Summary

Errors

Current and Total values for:

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

Errors *(Throughput only)*

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

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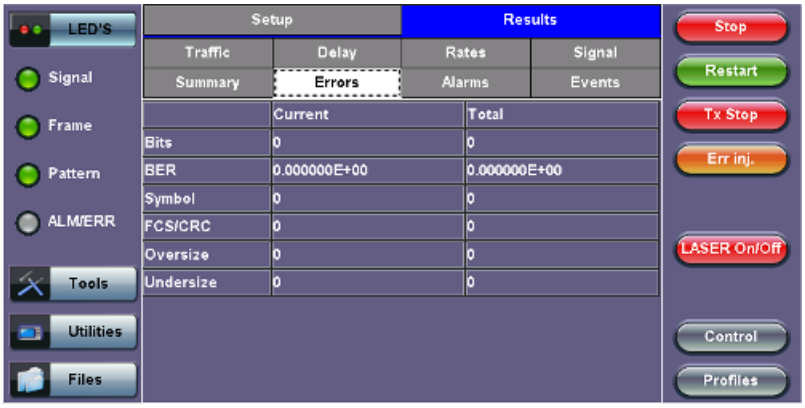
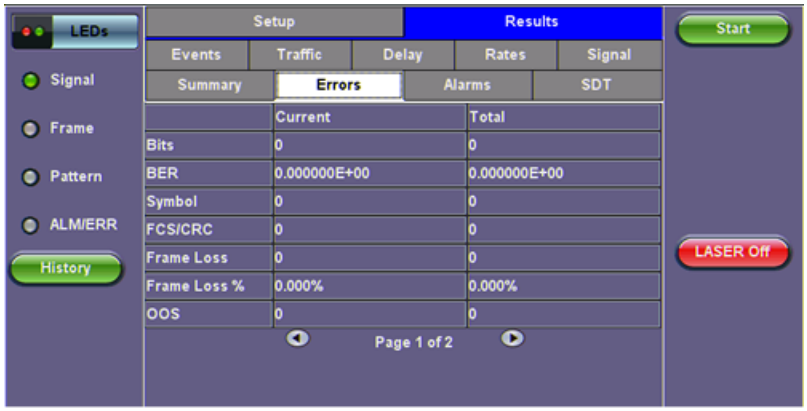
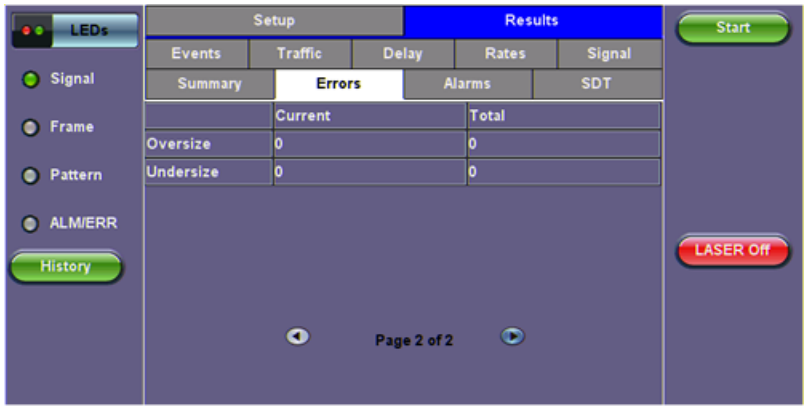


BERT - Errors



Throughput - Errors (Page 1)



Throughput - Errors (Page 2)

Alarms

Current and Total values for:

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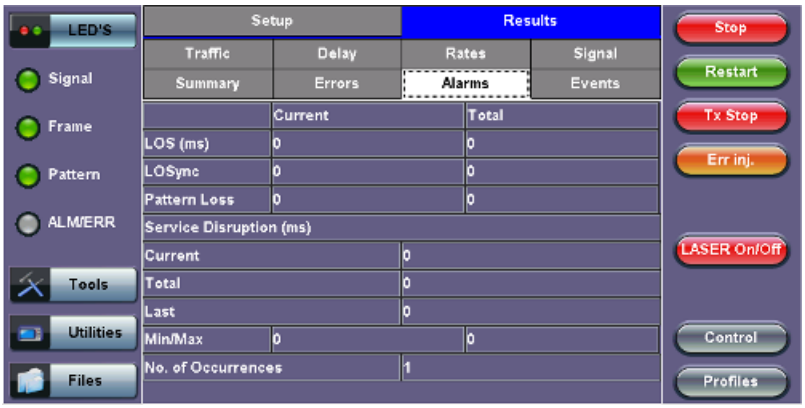
- **LOS:**Number of times the Link has transitioned to a Loss of Signal state in the measurement interval. Generally loss of optical signal.
- **LOSync:** Number of times the Link has transitioned to a Loss of Sync state in the measurement period
- **Pattern Loss:** Number of times test pattern or test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



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

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

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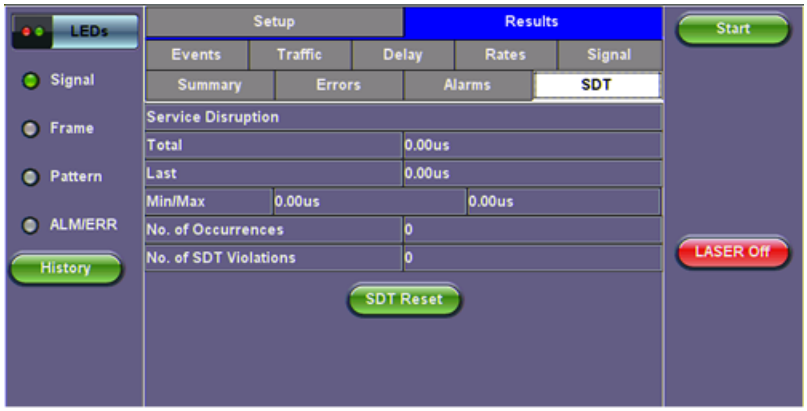
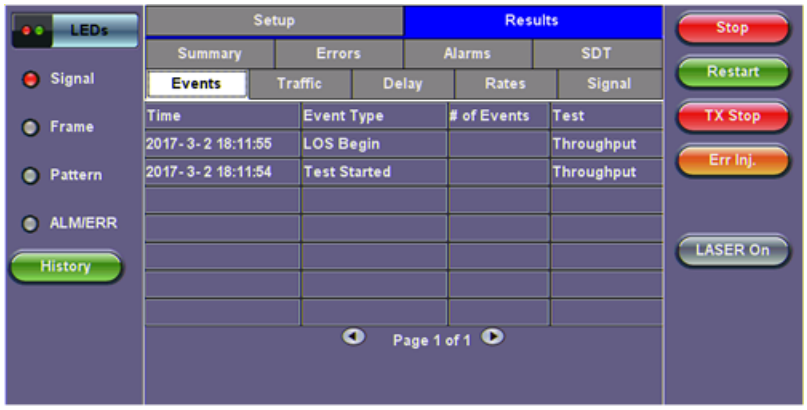


Events

Time stamped event table:

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



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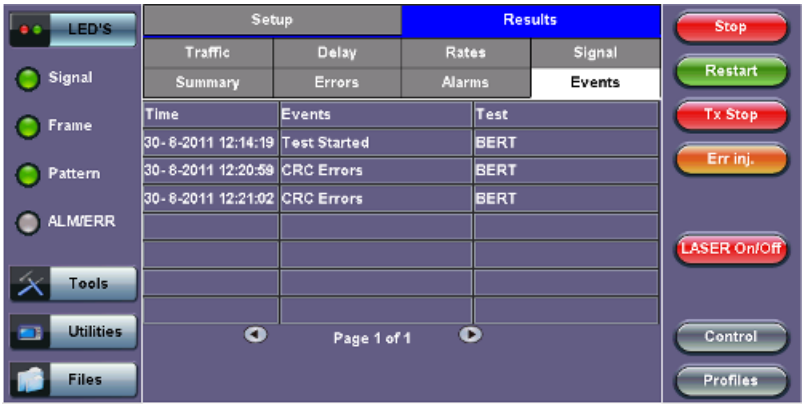
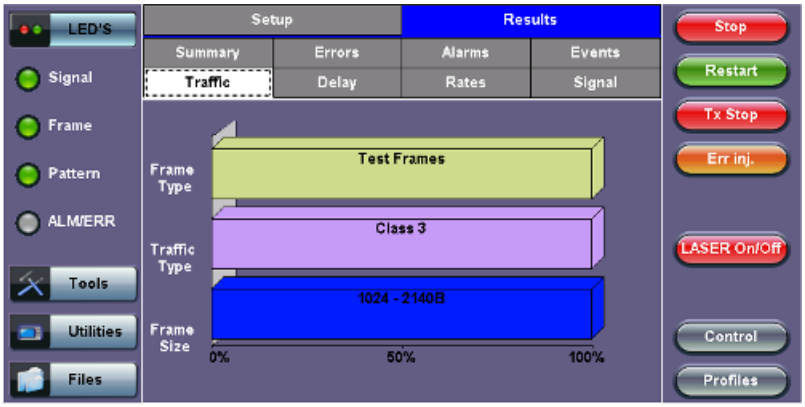


BERT - Events

Traffic Distribution Overview

Graphical representation of:

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



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Traffic Distribution Details - Frames

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

  Memory or “buffers” to temporarily store frames as they arrive and until they are assembled in sequence, and delivered to the upper layer protocol. Buffer Credits are the number of frames a port can store. To track the number of frames transmitted for which R_RDY responses are outstanding, the transmitting FC_Port uses the BB_Credit_CNT.
- **BB Credits Used**: The number of unacknowledged or outstanding frames awaiting R_RDY responses from the directly attached FC_Port.
- **BB Credits Available**: The number of frames transmitted and received R_RDY responses from the directly attached FC_Port.

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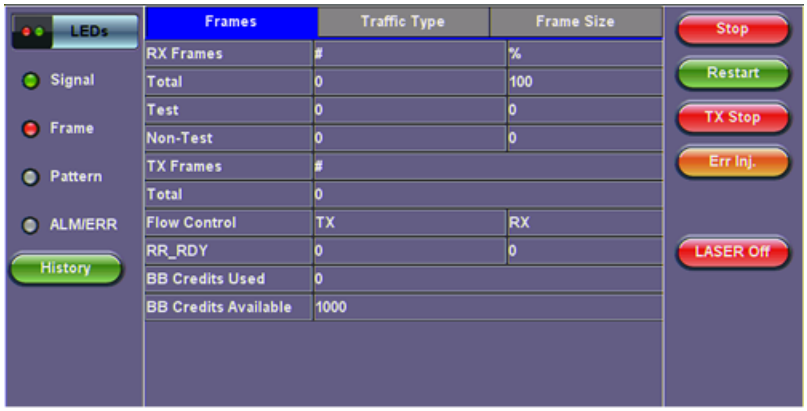
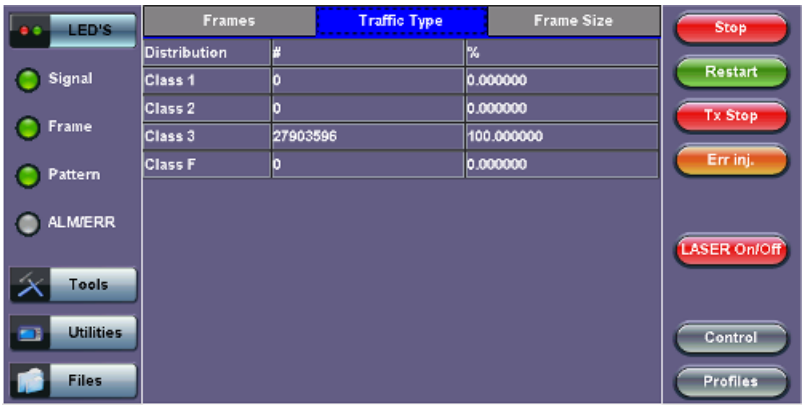


Traffic Distribution - Traffic Type

Fibre Channel supports three classes of services, and a fourth which is a combination of classes 1 and 2. Similar to ATM, different classes allow Fibre Channel to support a variety of communication needs.

- **Class 1:** Provides a circuit-emulation service for time-sensitive applications such as video tele-conferencing.
    - Designed for dedicated, non-bursty links between supercomputers. Class 1 traffic is circuit-switched.
- **Class 2**: Provides guaranteed delivery for connectionless traffic.
    - Class 2 traffic is switched on each frame rather than on a connection. An acknowledgment from the destination provides an end-to-end guarantee of delivery.
- **Class 3:** Offers a best-effort connectionless service.
    - Class 3 is similar to Class 2, except that no guarantee is given for delivery.



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Frame Size Distribution

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

Delay

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

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

Delay *(Throughput only)*

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

FC - BERT - Delay

Frame Rate Summary

Graphical representation of the Frame rates and Data rates.

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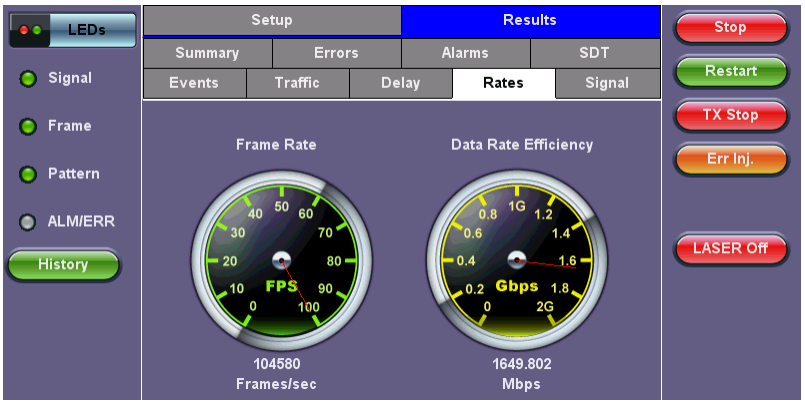
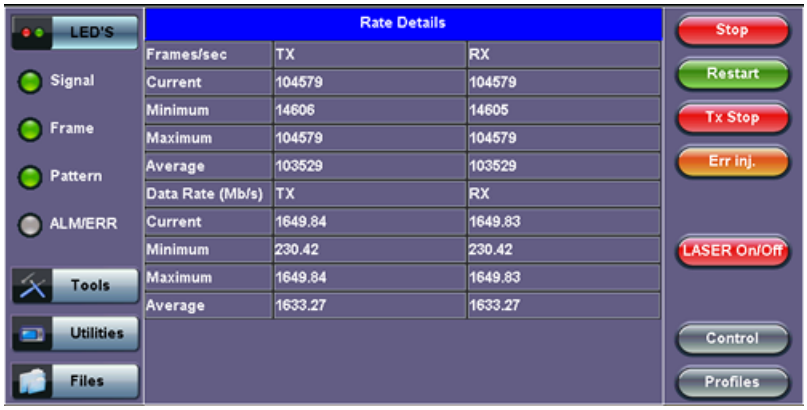


Frame Rate Details

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



Signal

Level (Page 1)

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

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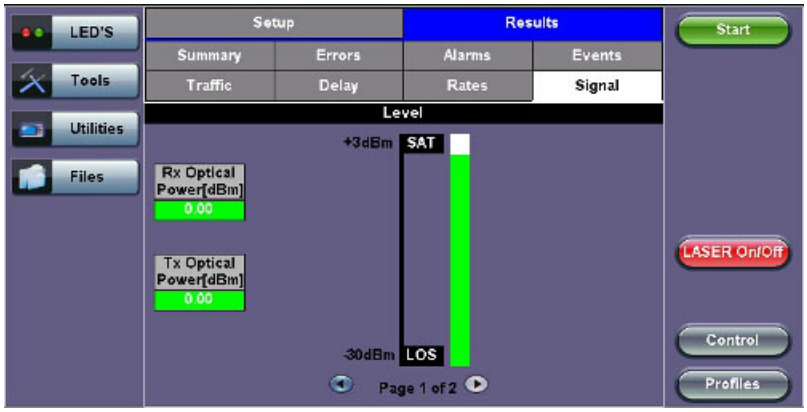
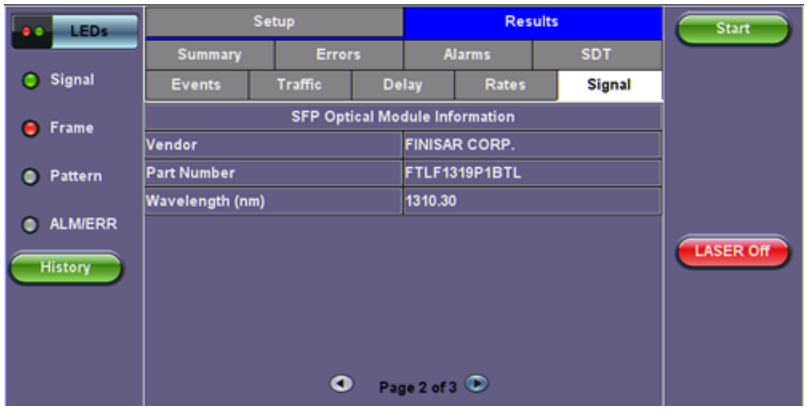


Optical Information (Page 2)

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



Frequency (Page 3)

Page 3 displays the Frequency information which includes:

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

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RFC 2544

RFC 2544 Ethernet testing is used to validate the Ethernet transport circuits that carry Fiber Channel traffic. These tests verify the performance of the underlying Ethernet service at rates such as 1 Gbps, 2 Gbps, 4 Gbps, 8 Gbps, and 10 Gbps SAN networks to ensure the underlying service is capable of supporting FC traffic. It does not test native Fiber Channel protocols. This approach is widely used during turn-ups, troubleshooting, and SLA verification for SAN networks that rely on Ethernet or OTN transport.

The automated RFC 2544 test routine/analysis ensures repeatable installations:

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

The test methodology is the same as for Ethernet testing. Refer to the "RFC2544 Conformance Testing" on page 123 section for details.

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Loopback

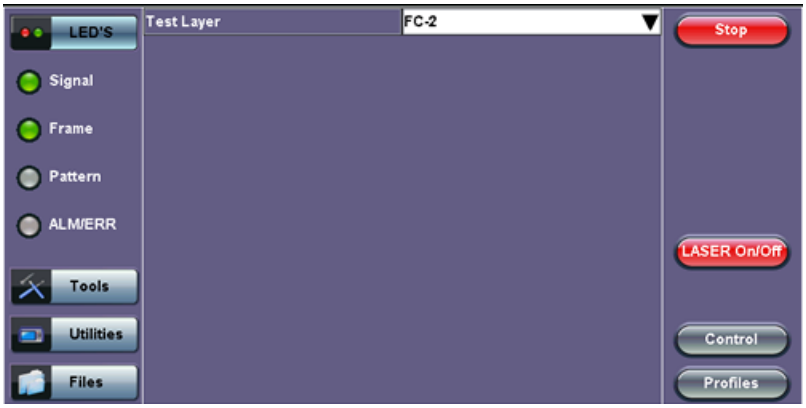
A Fiber Channel loopback test is a local, single-ended test to validate a native Fibre Channel link. It uses a loop-back port loopback to reflect native FC frames back to the originating port. The test set sends FC frames that come right back to it. Smart Loopback is ideal for turn ups when the far end is unmanned.

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

FC-1/2 Manual Loopback Setup

Modes of operation: Manual and Responder (future)

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



FC-1/2 Manual Loopback Active

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

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Packet Capture Setup

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

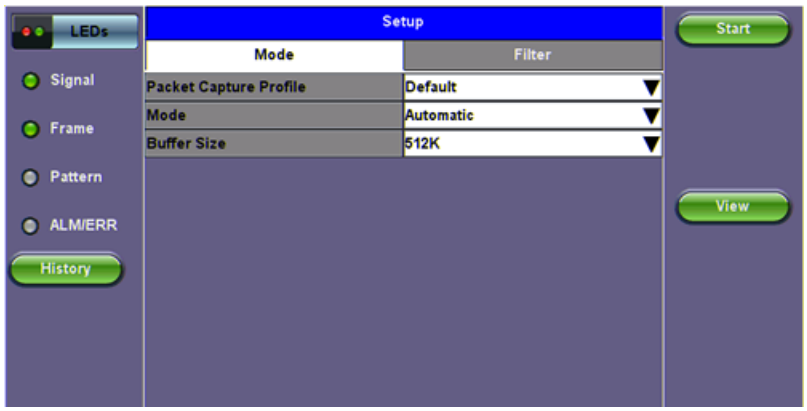
The following packet capture options are available in the **Capture Mode** tab:

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

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

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

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



Capture Mode Setup

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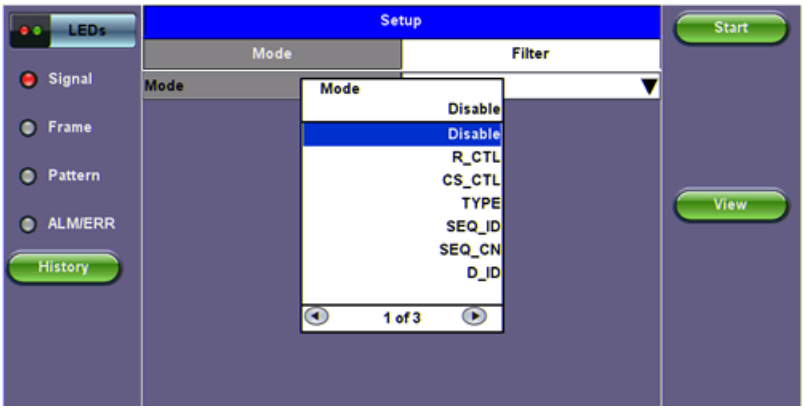
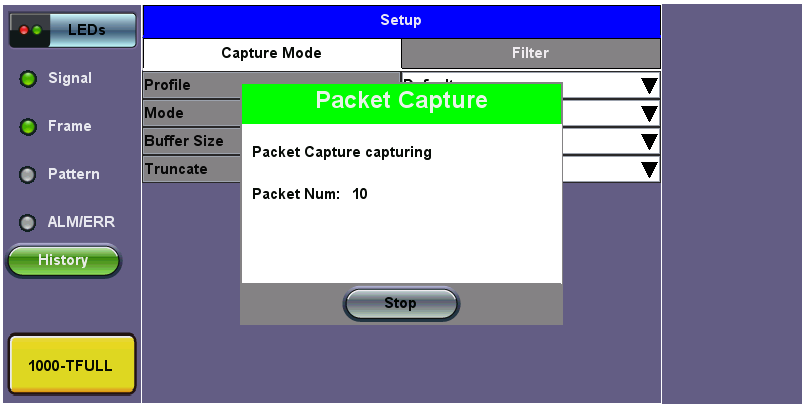
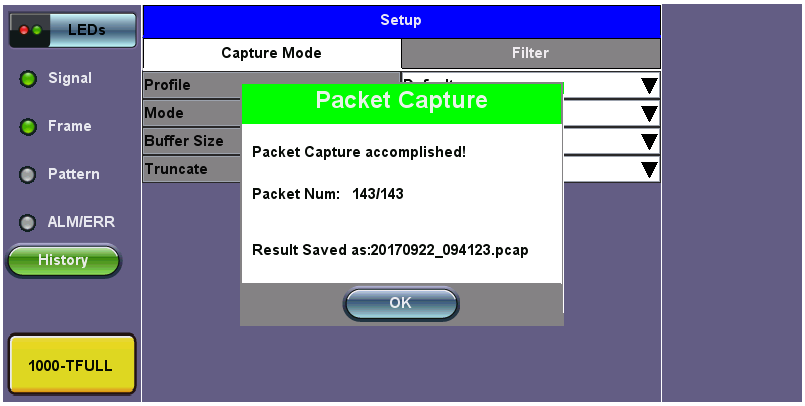


Filter



Packet Capture In Progress



Packet Capture Save

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Capture Save

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Platform Functions

Utilities

Utilities Overview

The **Utilities** tab provides settings for the global parameters of the test set or platform (system settings).

Utilities/Settings Menu

This section provides information about the software platform version, serial number, and other information relevant to the test set, which may be required when contacting Customer Support. The Software license tab provides a list of software licenses (optional test features) currently loaded in the test set.

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Software Options Tab

Activating New Licenses: Features and options marked as 'Expired' or "Disabled" (not currently loaded into the test set) can be purchased at any time and activated via VeExpress using an internet connection. Upon order confirmation, connect the test set to the internet via LAN or Wi-Fi, go to **>Utilities >VeExpress** and press the **Check** button. The test set will download all newly added features and options from VeExpress servers and install them automatically.

If company policy doesn't allow access to the public internet or the test sets are used within a secured network, request License Keys for manual activation. License keys must be requested at the time new options are purchased. To activate new features, tap on the **expired item** and enter the Activation Code received from VeEX, VeEX partner or manager. Press **Activate** to complete the licensing process. Each activation code is specific to a test set and a feature. If multiple features are ordered, individual activation codes will be sent for each of them. Manually activated features are specific to a test set and can't be shared with other test sets.

Backlight

This section provides backlight control of the unit. There are two intensity settings:

1. Battery power and
2. AC power.

On Battery Power

- Select a timer to turn off the backlight if the unit is not in use. This function helps improve the battery autonomy and preserve LCD life.
- To enable the timer, check "Turn off backlight if device is not used for" and with the drop-down menu, adjust the duration of the idle time before the backlight is turned off.

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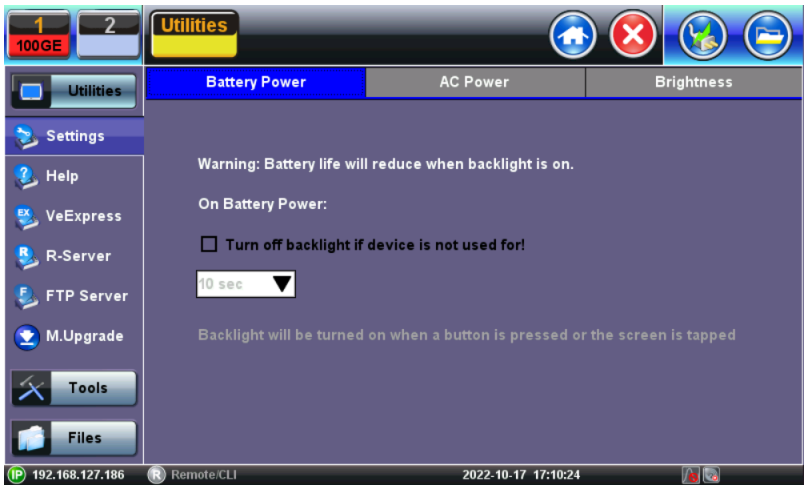
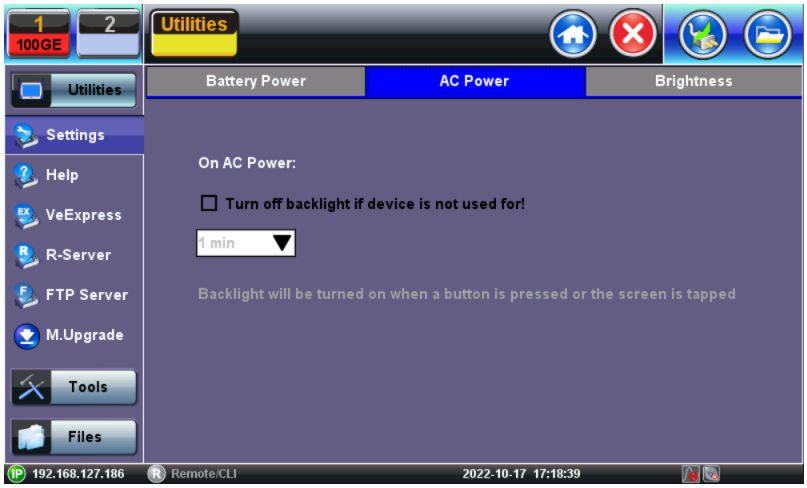
- Once the timer is active and the backlight turned off, any action on the test set (touch screen, keypad) will turn on the backlight again.



Backlight - Battery Power

On AC Power

Similar settings can be applied for when the test set is operating on **AC Power**.



Backlight - AC Power

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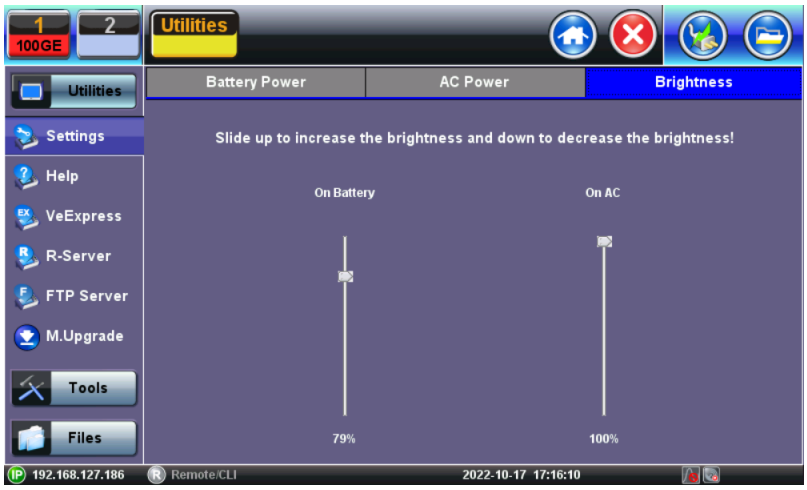
Brightness

Select the brightness level for Battery and AC operation modes.



Backlight - Brightness

Touch Screen Calibration

Screen calibration can be accessed from the **Utilities** > **Settings** > **Screen**.

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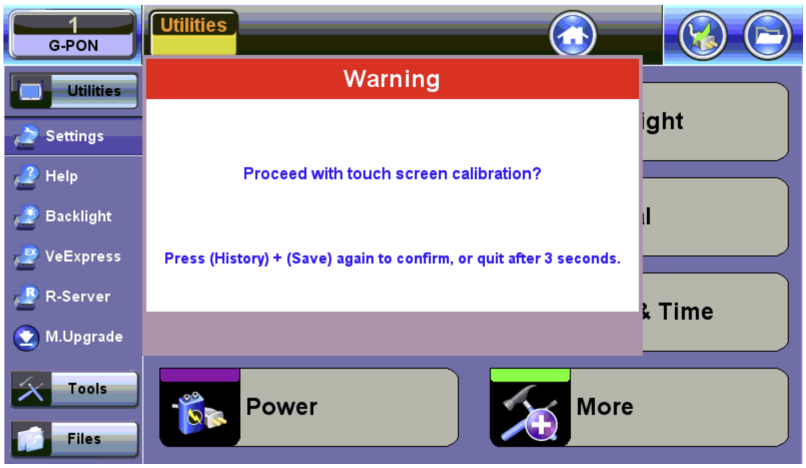
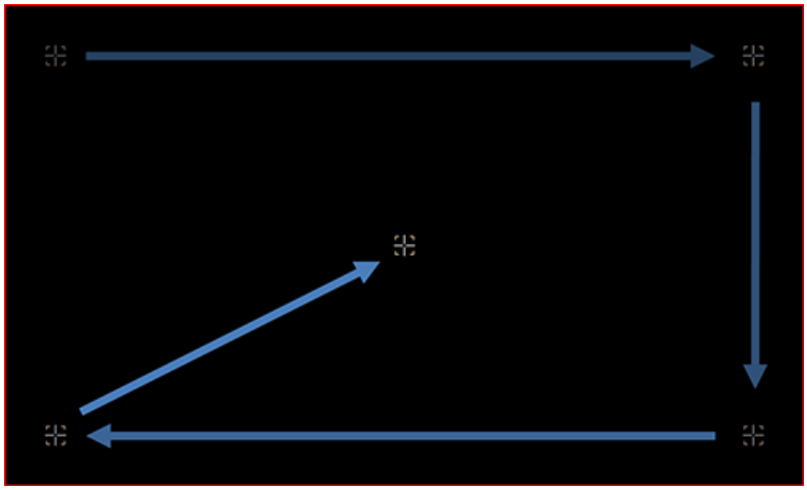


Press the **History** and **Save** buttons simultaneously to continue.



Once the touch screen calibration sequence has been started, it must be completed. Accurately touch the calibration points with the tip of the stylus.

In the rare case that a VeEX product loses touch screen calibration, use the Web Remote function (*see below*) to launch the Screen Calibration.

Besides using the built-in screen and its graphical user interface (GUI) to launch the Screen Calibration directly from the test set, VeEX offers alternatives to correct stylus-to-cursor offsets when it is not possible from the touch panel.

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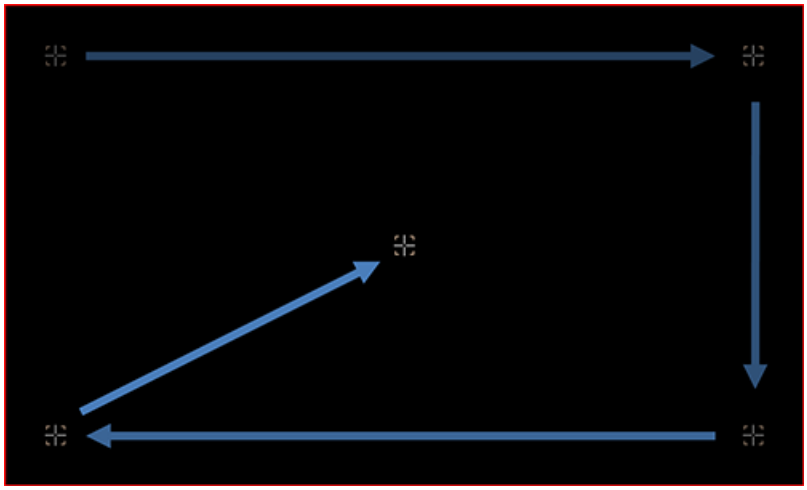
Calibrate via Web Remote

If the test set can still be connected to LAN or Wi-Fi, users can just launch a web browser, from a PC, tablet or smartphone, enter the test set's IP address, select Remote Control, enter the password.

Then, use the mouse to go to the touch Screen calibration function in the system tools menu and launch it. Go back to the test set and use the stylus to tap on all the calibration points with the tip of the stylus.



If the above procedures do not fix the touch screen issues, go to the VeEX website's Contact Us page, select [√] Customer Service/Tech Support, then provide the Product Type, Serial Number and a brief description of the behavior being experienced. If it is related to colder ambient temperatures, please state the approximate temperatures.

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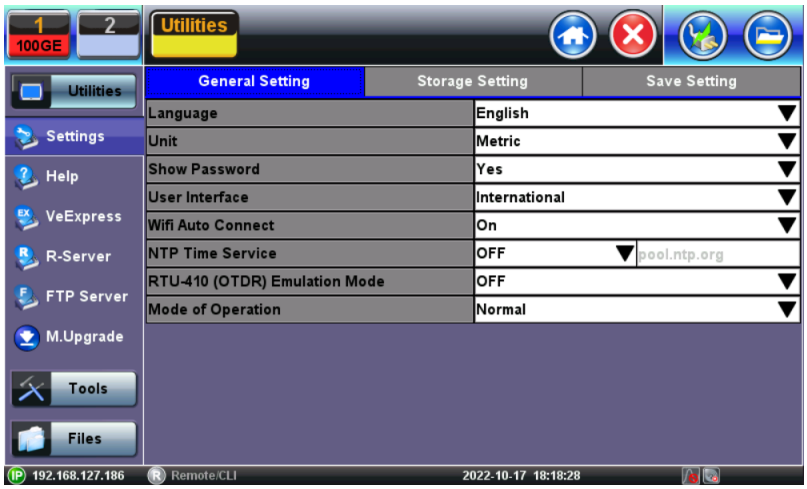
General Setting



Utility Settings - General Setting

- **Language:** An alternative language for the user interface (if available). The device must be rebooted to fully activate the new language.
- **Unit:** Measurement system (English - feet or Metric - meter).
- **Audible Alarm:** When enabled, the test set's buzzer will sound (beep) when alarms and errors are being detected (if supported by the test application).
- **Show Password:** Hides/unhides username and password information associated with FTP and related IP functions.
- **User Interface:** The USA user interface version presents SONET/DSn application-oriented menus, while the International setting is more open to all settings.
- **NTP Time Service**: Turn ON to allow the test unit periodically to obtain the current time from a public time server. Whenever the test set is connected to the Internet, the time will be updated.

If R-Server is used, the time service option can be made unavailable by the R-Server administrator. This ensures that all test sets have the same time, which is set by the R-Server.

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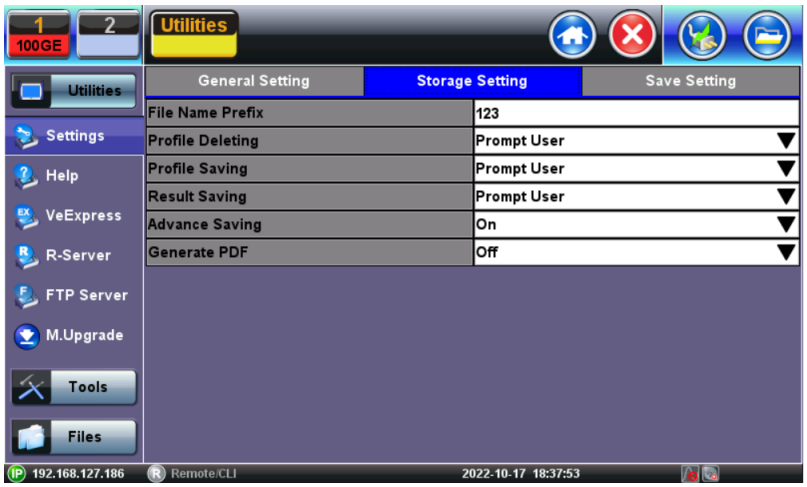
Storage Setting



Storage Settings are not currently supported for OTDR, OPM, and Fiberscope results.

- **File Name Prefix:** Tap on the box to enter the file name prefix using the pop up alphanumeric keypad. Not used for OTDR filenaming.
- **Profile Deleting:** Auto Delete or Prompt before deleting profile.
- **Profile Saving:** Auto Overwrite or Prompt before saving profile.
- **Result Saving:** Manual or Prompt before saving results.
- **Advance Saving:** Turn ON to add extra information to the results file to be uploaded to a centralized R-Server.

  Requires Advanced Management Option

- **Generate PDF**: On/Off. Generates PDF of test results.

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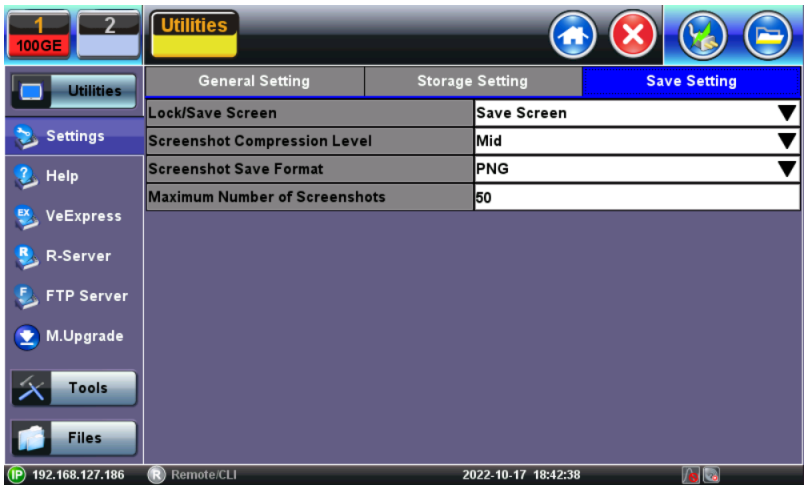
Save Setting



Utility Settings - Save Setting

These options configure the behavior of the Lock key on the keypad. The Lock key can be set to do the following:

- **Lock/Save Screen**: Lock/Unlock the unit's screen to prevent accidental interruption during a long term test.
- **Screenshot Compression Level**: The compression level of the screen image (affects size of file and quality).
- **Screenshot Save Format**: The file format for the saved screenshot.
- **Maximum Number of Screenshots**: Sets the maximum number of screenshots that can be saved on the unit. Each time the lock key on the keypad is pressed, a screen shot will be saved in memory.

Bluetooth

Built-in Bluetooth support offers wireless connectivity up to 10 meters (30 feet), providing an untethered connection between the tester and other Bluetooth compatible devices such as a PCs and smart phones, enabling users to transfer test results and other files.

A **Bluetooth** icon displayed on screen indicates the Bluetooth connectivity status. A grey icon indicates no Bluetooth connectivity, while a green icon indicates a successful Bluetooth connection.

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Bluetooth Adaptors - Compatibility

Not all Bluetooth adaptors on the market are supported. Please use adaptors that have been tested and supplied by VeEX only to ensure compatibility and correct operation.

Devices

Bluetooth details will be displayed including the MAC address of the device and the last 4 digits of the test set serial #. The last 4 digits of the test set will be the pairing code between the unit and the external device.

Bluetooth Devices

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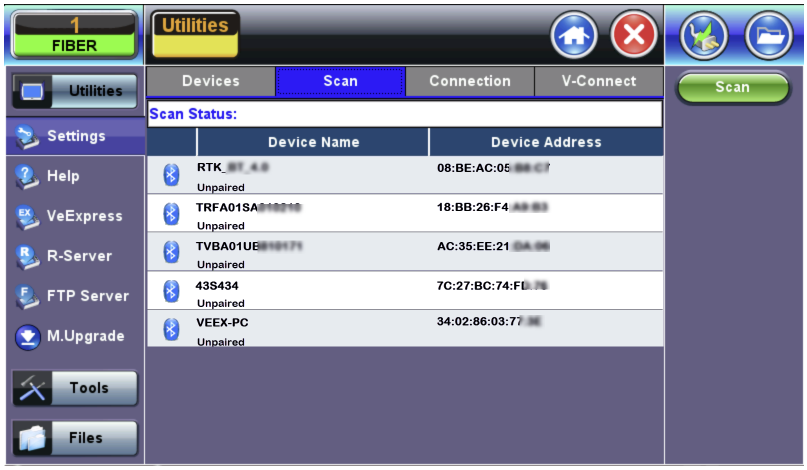
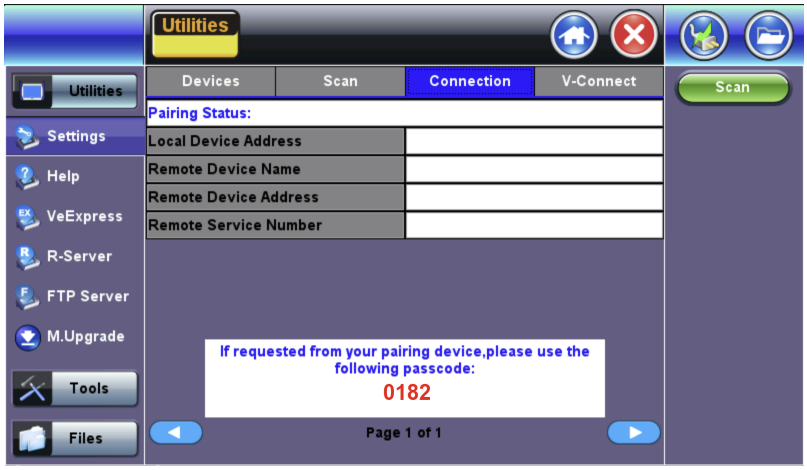


Bluetooth - Scan



Bluetooth - Connection - Passcode

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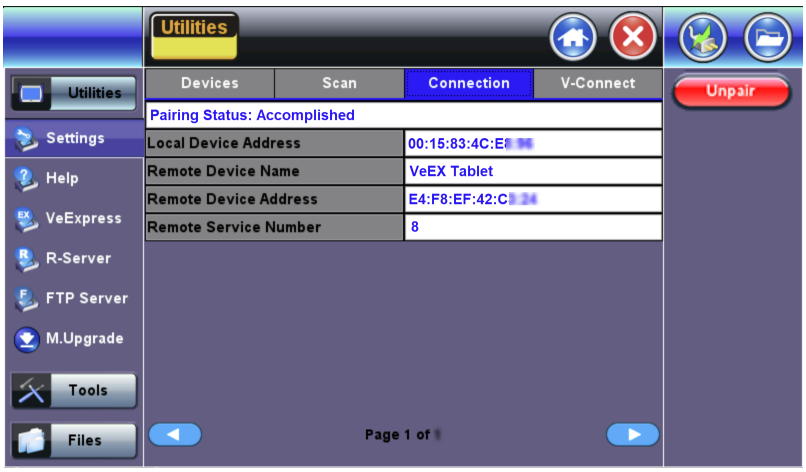
V-Connect/VxConnect

Bluetooth Setup

1. Press **Scan** to check for available Bluetooth devices. Once scanning is complete, a list of discovered Bluetooth devices will be listed. Please ensure the peripheral device is set to **Discoverable** during Scanning and Pairing operation.
2. Press **Pair BT** to begin the pairing process. During the pairing operation, you will be prompted to enter a code on the peripheral device (PC or Mobile Phone) in order to pair successfully. Enter the last 4 digits of the test set's serial number as shown in the **Connection** tab.
3. Once paired, click the **Services** button at the bottom of the screen to check the service attributes. To upload test results via Bluetooth, full data upload service will be required.



Bluetooth - Connection Established

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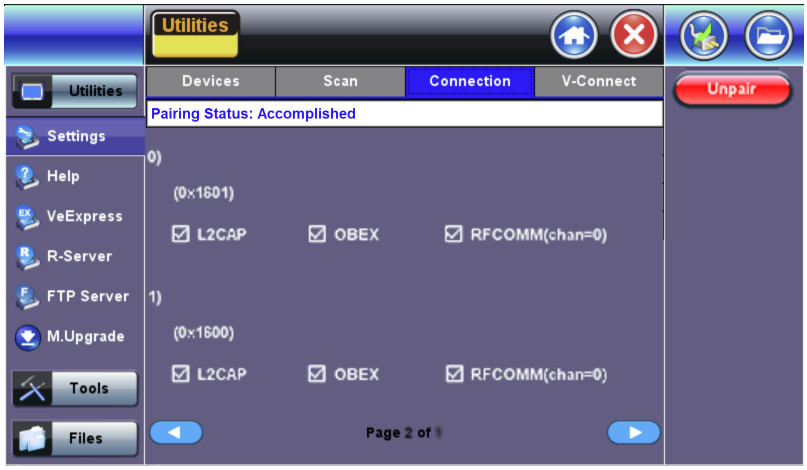
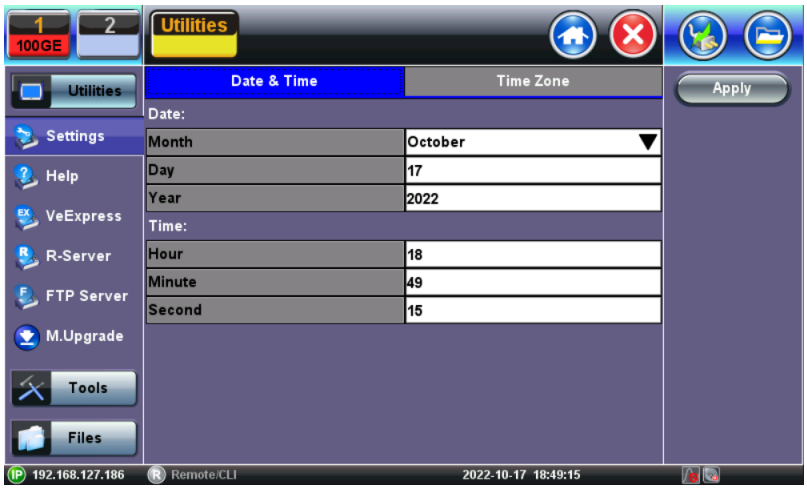


Bluetooth - Connection Page 2

Date and Time

This screen allows the date and time to be set. Daylight Savings Time (DST) is enabled automatically.



Date and Time Setup

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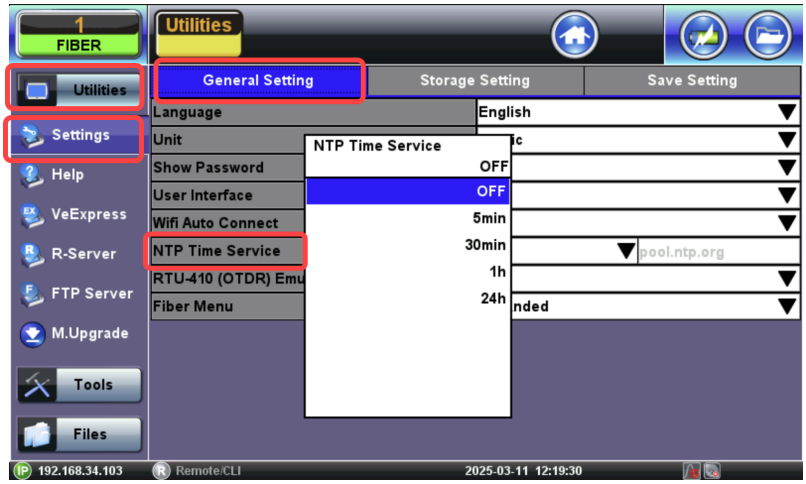
Time Zone Setup

Using NTP Server

For automatic time of day (ToD) synchronization, go to **System Tools >Utilities >Settings >Global >General Settings**, and enable the **NTP Time Services** field by selecting a synchronization period (e.g., 1 hour).

Click here for a list of local, regional and global public NTP servers.

An internet connection (Wi-Fi or LAN) is required to reach the selected public or private NTP server.



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To manually change the Date & Time:

Go to **System Tools >Utilities >Settings >Date & Time**, to manually set the date, time and time zone. Then, tap **Apply**.

To enable daylight saving time (DST), manually select a neighboring time zone with a +1:00 relative to the standard time zone of the current location. Set it back to the standard time zone offset when DST ends.

Get Standard Time from GPS/GNSS

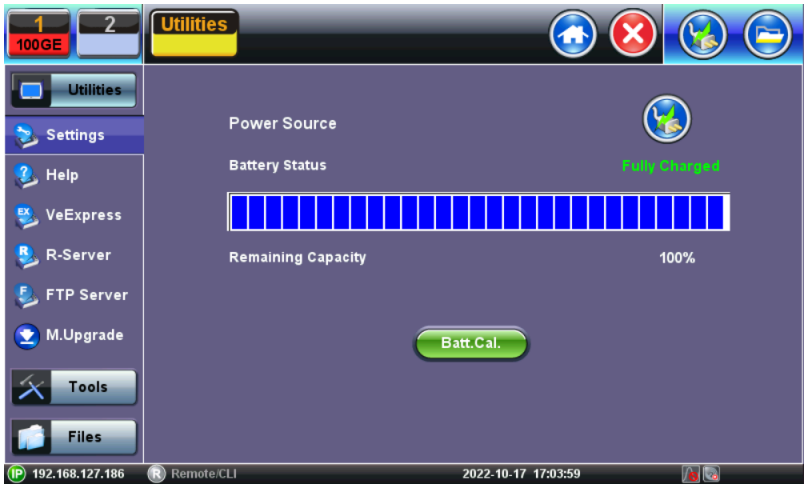
If equipped with the GPS/GNSS receiver (hardware option), manually copy the GPS time into the system.

Go to **System Tools >Utilities >Settings >GPS/High Precision Clock**, to configure the GNSS Receiver and turn it ON. Once it recovers time (ToD UTC) from the satellites, click the **Sync ToD** button to apply the standard time to the RTU. The standard time will be applied at the start of the next second (rise of the internal 1PPS timing signal). The local UTC Offset (Time Zone) setting is used to apply the correction for local time. This manual Sync ToD time setting function should not be used when NTP is enabled.

For more information on the atomic clock and relative phase monitoring, see "High Precision Clock Sources" on page 573 and "GNSS/GPS & Sky View" on page 641.

Power

This screen provides information about current power source and information about the battery's charge level and estimated autonomy (under current load conditions). Tap the **battery icon** on the top barto bring battery charge and estimated autonomy information. To recalibrate the battery, tap **Batt. Cal**.



Power Settings

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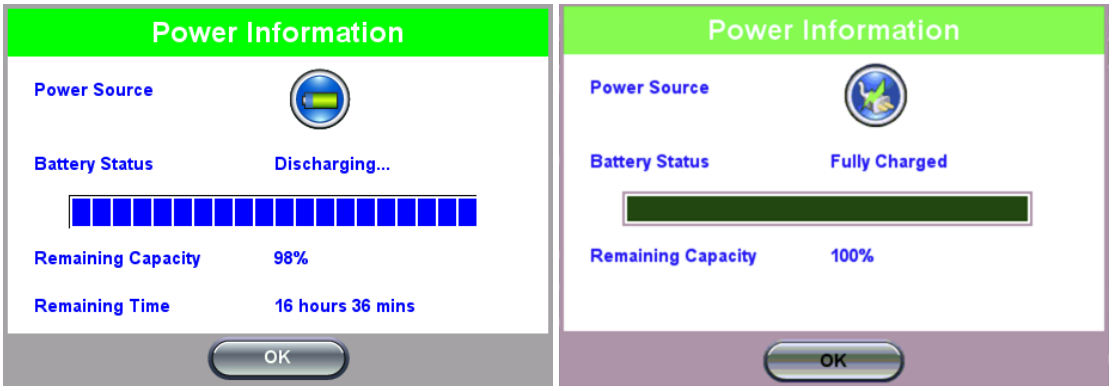


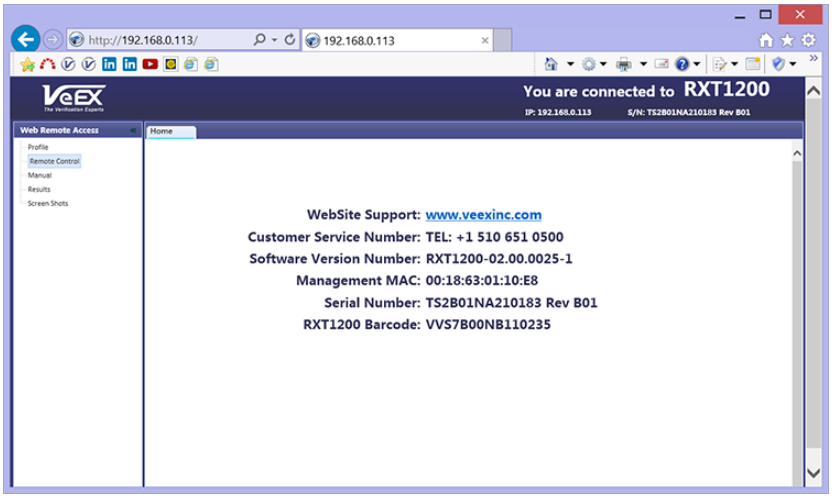
Battery Charge Information

Remote Access

There are different ways to control or access the test set and the information it contains, from a local (LAN) or remote (WAN) connected PC.

The EZ Remote service provides public registration servers to help users and test sets establish remote sessions, without having to get IT departments involved. It is considered a convenient on-demand service, for quick/temporary collaboration tasks. It should not be used for long-term applications (VeEX offers other remote tools for long-term applications). Refer to "EZ Remote" on page 564 for more information.

After accessing the test set remotely, a tab will open up for each selection made, allowing for quick access to each function.



Profiles

Test Profiles are configurations saved by the user that can be retrieved and reapplied to the test set. For example, commonly used configurations and test limits/thresholds can be saved as test profiles, for different types of services.

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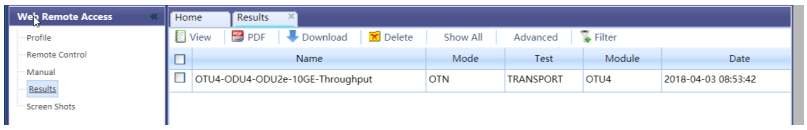
Manual

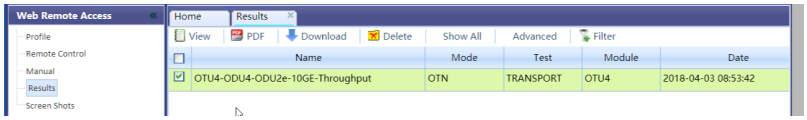
The feature provides access to the user manual that is built into the test set. In this application, the use of a local copy of the PDF file is recommended as the PDF client in the local computer is most likely faster than accessing the remote one and may offer better tools and function, including search capabilities. User manuals can be downloaded from the Product Resources page on the VeEX Inc website at resources.veexinc.com.

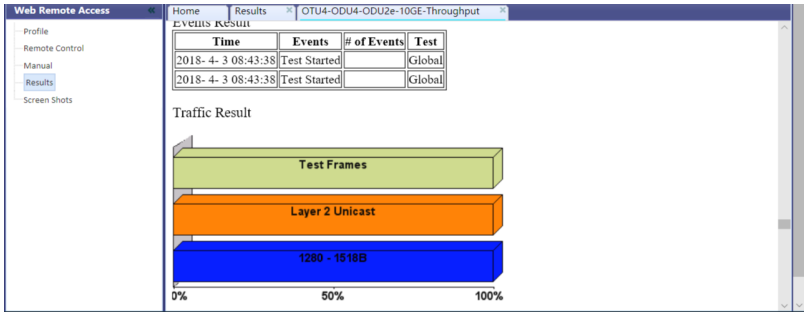
Results

Results list all the test results files currently stored in the remote test set. Users can **View**, **Rename** and **Delete** files stored in the remote test set, as well as **Download** selected files to the local computer or convert them to **PDF** and download.



To open a test results file, select it from the list and tap on **View**.





Files can be downloaded by clicking on **Download** (original file format) or **PDF**.

Screen Shots

Pictures (PNG) taken of the screen can be accessed from this link and sub-tab. Pictures can be viewed or downloaded to the local computer.

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Screen captures can be made using the Lock button ( ) on the test set or from the remote computer, using the links provided or the respective F-key on the computer's keyboard.

The screen capture function can be enabled in **>Utilities >Settings >Global >Save Settings**.

Remote Control (Screen Mirroring)

It is similar to using VNC, but in this case no VNC client installation is required. It uses standard Java-based web browser as a client. It mirrors the screen, mouse inputs and the rubber buttons available in the front panel of the test set.

1. On the test set, select the **Remote Access** option and enter the following information:
   - **VNC Service:** Enable or disable the remote access through remote web-browser clients running on PCs, Macs or certain tablets. The web browser must support Java (tm).
   - **Web Super User Password:** Defines the password for users allowed to control the test set via standard web browser clients
   - **Web Regular User Password:** Defines the password given to users who are only allowed to view the test set current screen via standard web browser clients, but not make any changes to test or test set.
2. In a web browser, enter the test set IP address. To locate the test set local IP address, refer to "Wi-Fi Wiz" on page 595.
3. Click **Remote Control** and enter the Super/Regular password when prompted for a password. Use the buttons and icons on the right to navigate the test set remotely.

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EZ Remote

The EZ Remote functionality allows users to quickly and securely connect to VeEX test sets all over the world, without the need for VPN, port forwarding or public IP addresses. This VeEX hosted service and user interface take care of all the complex tasks required, and present users with a simple application. Connect online anytime anywhere with any computer, tablet or smartphone, using standard web browser clients for screen-sharing, remote control and access to test results. Use it for remote control, collaboration, technical support or training purposes.

The basic EZ Remote service is offered by VeEX free of charge. It provides public registration servers to help users and test sets establish remote sessions, without having to get IT departments involved. All you need is internet access for the test set and a remote user. Feature location and functionality may vary from product to product.

VeEX's EZ Remote provides:

- **Remote Control** functionality to give users full control of remote test sets (screen mirroring and control).
- **Remote Access** functionality allows users to View, Download, Rename, Delete, Export and Convert results (PDF).

EZ Remote is considered a convenient on-demand service, for quick/temporary collaboration tasks. It should not be used for long-term applications (VeEX offers other remote tools for long-term applications).

Initiate an EZ Remote Session from the Test Set

1. Use the **System Tools** to connect the test set to a LAN using the RJ45 Ethernet management port, located on the side of the unit (recommended), or use **WiFi Wiz** to connect to a WLAN (using built-in Wi-Fi or a compatible external USB dongle). Make sure the test set gets a local IP address and that the LAN/WLAN provides access to the public internet (web).

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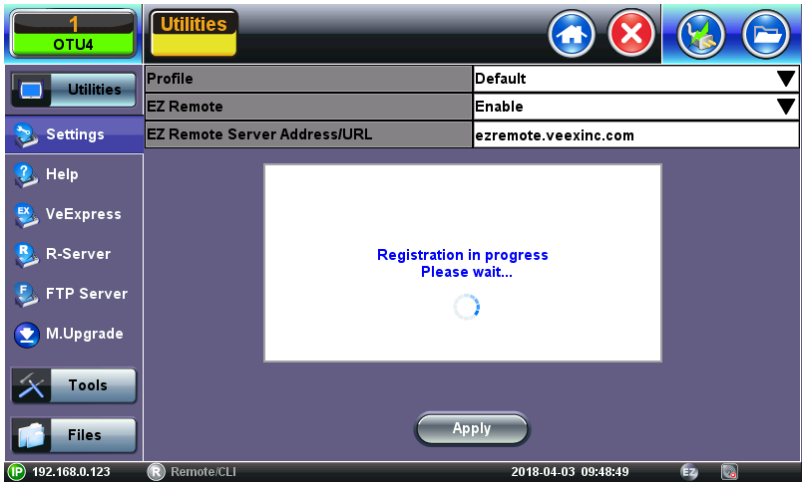
2. Go to **>Utilities >Settings >More >EZ Remote**.

3. On the EZ Remote screen, set **EZ Remote** to **Enable**, confirm the **URL** is **ezremote.veexinc.net** (without www.), and tap on **Apply** to connect and establish a session with the EZ Remote server.



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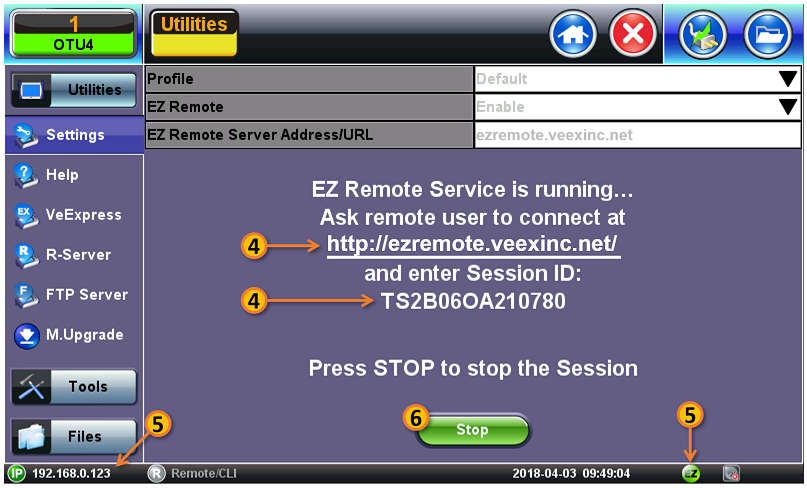
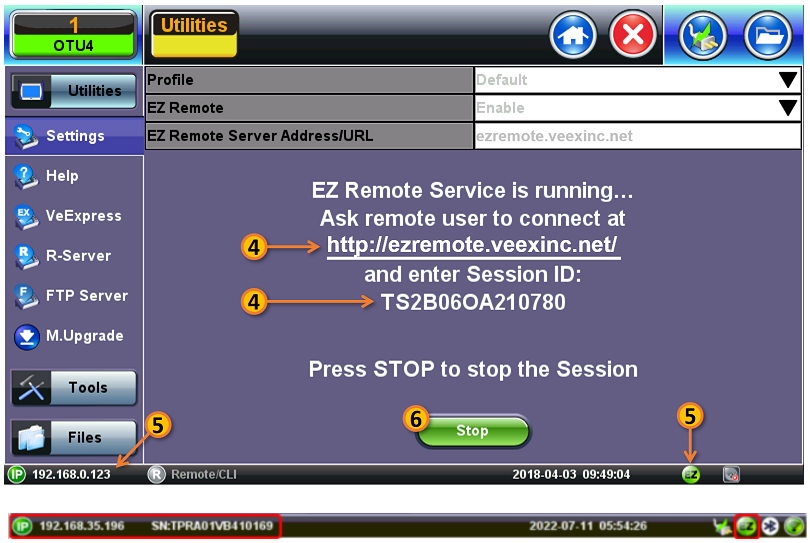
4. Provide the resulting **URL** and **Session ID** to the intended remote user.



5. You may continue to use the test set until a remote user logs in, then both will share control over the unit. Make sure the test set remains connected to the LAN/WLAN/Internet and that the **EZ remote session indicator** at the bottom of the screen stays green.



6. When finished, use the **Stop** button to terminate the EZ Remote session and disconnect from the server.

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Connect to the Remote Test Set from a Computer, Tablet or Phone

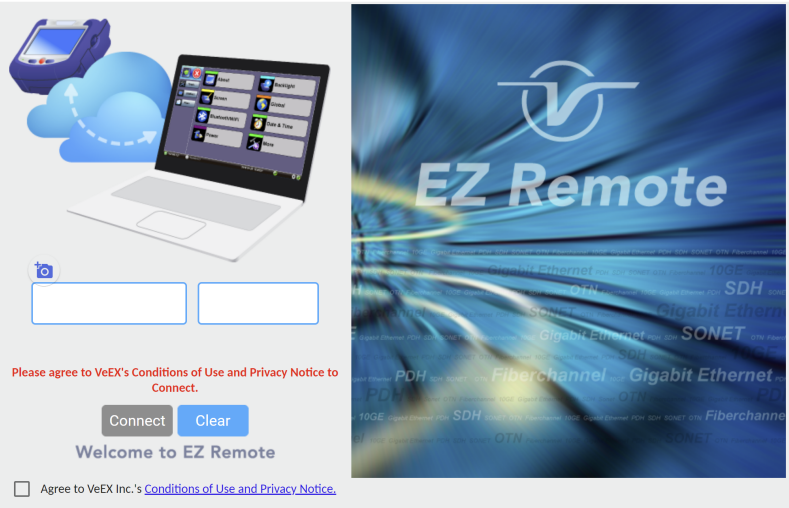
Establish a Remote Access Connection

EZ Remote provides two types of services:

- **Remote Control** (screen and mouse/touch mirroring) to operate a test set from a different location.
- **Remote Platform Access** to access information stored in the remote test set, such as Test Results, Profiles, User Manual, Screen Captures (screen shots), information about the test set (Home) and its local IP address.

Although multiple users could simultaneously log-in to the same test set, they would be sharing the same mirrored GUI image and mouse control. This is not recommended since it is equivalent to having multiple users trying to operate one test set at the same time (also known as "mouse fight"). Nonetheless, it may be effective for training purposes with one or two extra users.

1. From a PC, Mac, Tablet or Smartphone launch an industry-standard Web Browser application and enter the URL http://ezremote.veexinc.net (without the www.). Enable pop-ups for your browser and be sure to authorize access to the site, if confirmation is requested by the browser or OS.
2. Enter the **Session ID** provided, making sure not to confuse zeroes (0) with Os. Click **Search** to find the target test set and stablish a peer-to-peer connection.



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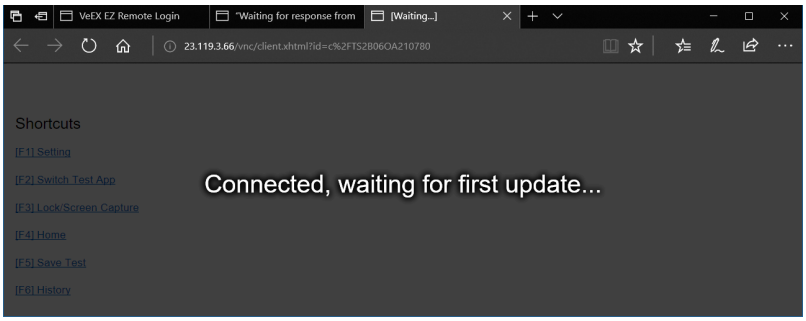
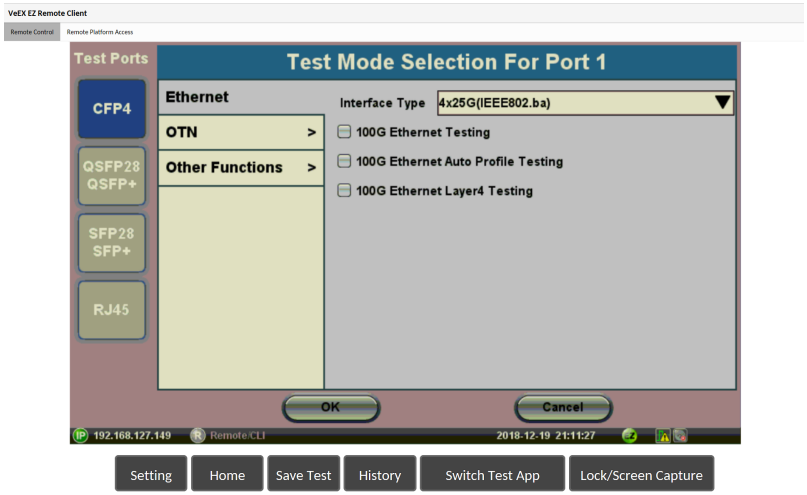
3. Once verified and connected, wait for the remote user interface to refresh. This may take a few seconds.



4. Depending on the type of test set used, shortcut buttons may be provided below the mirrored screen, allowing access to functions provided by physical buttons on the instrument, such as **Settings**, **Home**, **Save Test** results. Click or tap on the shortcut to activate it.



5. Once the remote GUI appears, you can use the **Remote Control** tab to operate the test set in the same way you would control a local unit from its touch screen.

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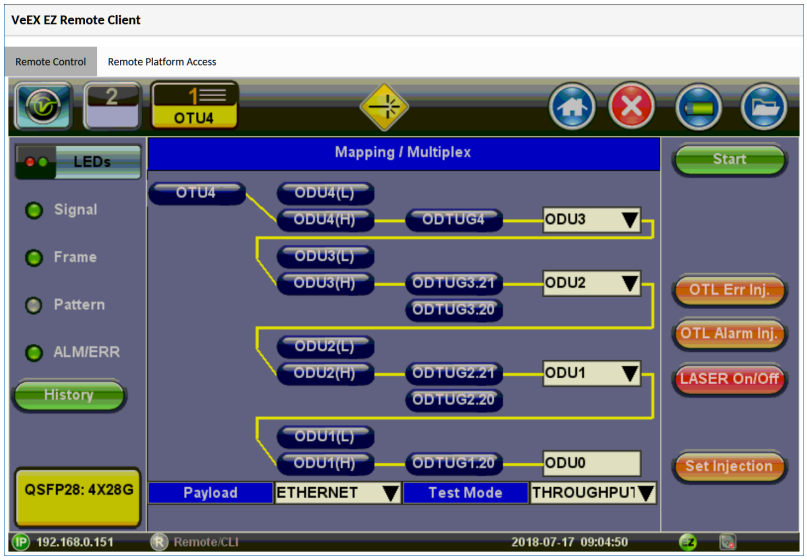

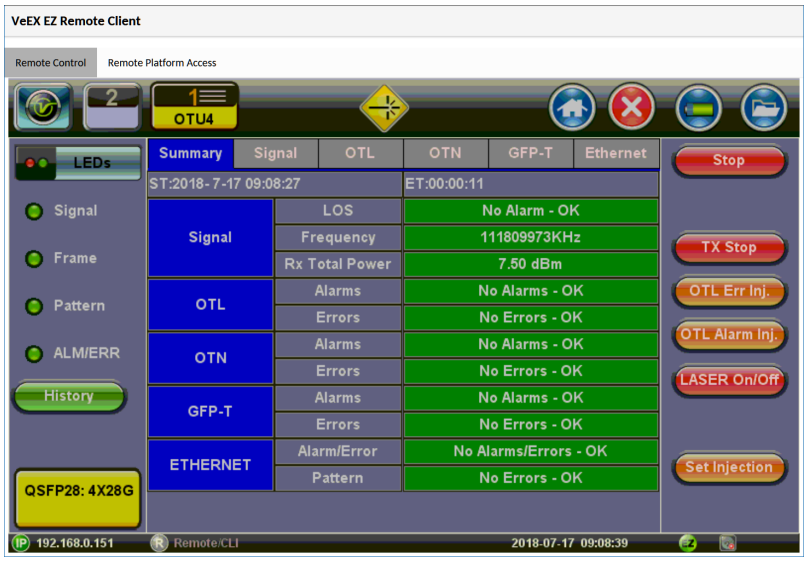

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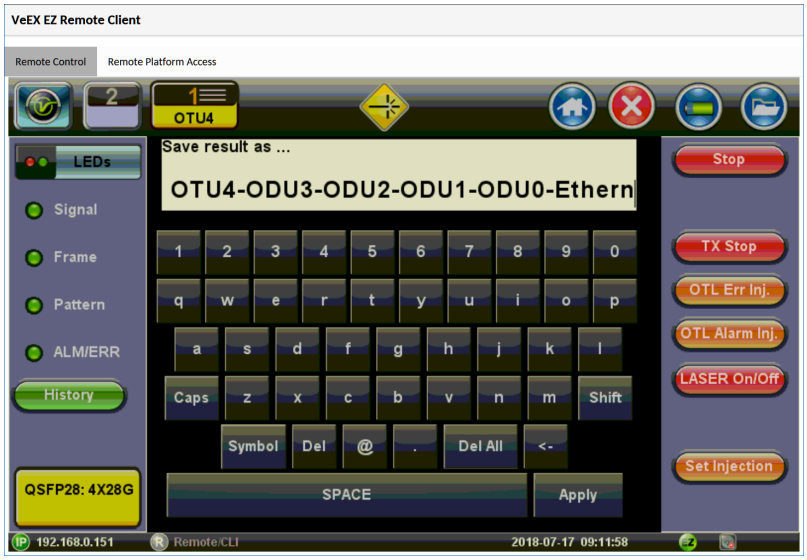
Save Test Results

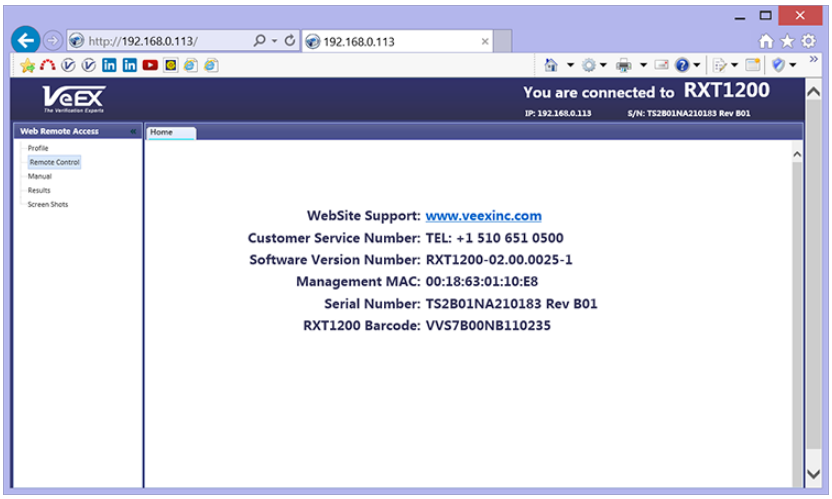
To save the results of a test, from the remote computer, press the **Save** button below the screen image. Then use the pop-up keypad and/or the PC keyboard to enter the file name and add any extra details (if Advanced Save is enabled).



Access Remote Test Result Files

The **Remote Platform Access** tab provides links to access test results, test profiles, screen shots, the user manual and other information stored in the test set.

After accessing the test set remotely, a tab will open up for each selection made, allowing for quick access to each function.



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Profiles

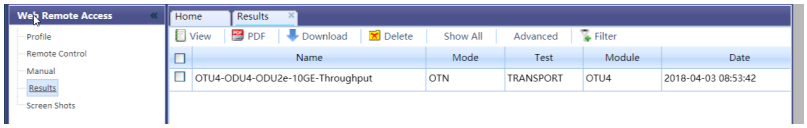
Test Profiles are configurations saved by the user that can be retrieved and reapplied to the test set. For example, commonly used configurations and test limits/thresholds can be saved as test profiles, for different types of services.

Manual

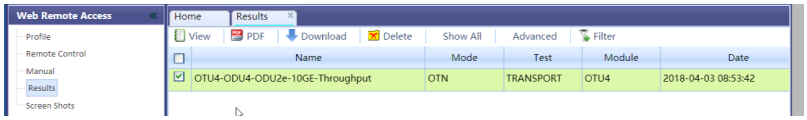
The feature provides access to the user manual that is built into the test set. In this application, the use of a local copy of the PDF file is recommended as the PDF client in the local computer is most likely faster than accessing the remote one and may offer better tools and function, including search capabilities. User manuals can be downloaded from the Product Resources page on the VeEX Inc website at resources.veexinc.com.

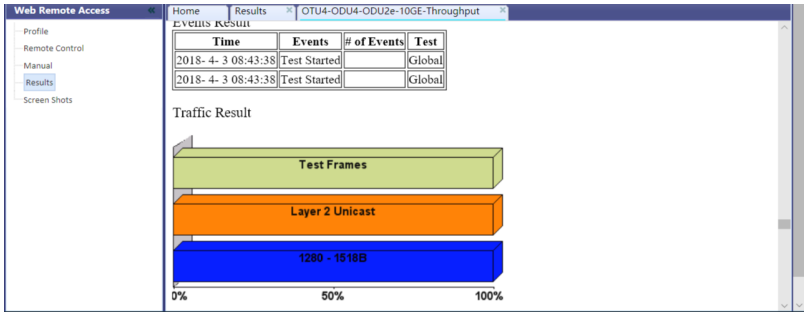
Results

Results list all the test results files currently stored in the remote test set. Users can **View**, **Rename** and **Delete** files stored in the remote test set, as well as **Download** selected files to the local computer or convert them to **PDF** and download.



To open a test results file, select it from the list and tap on **View**.





Files can be downloaded by clicking on **Download** (original file format) or **PDF**.

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Screen Shots

Pictures (PNG) taken of the screen can be accessed from this link and sub-tab. Pictures can be viewed or downloaded to the local computer.

Screen captures can be made using the Lock button ( ) on the test set or from the remote computer, using the links provided or the respective F-key on the computer's keyboard.

The screen capture function can be enabled in **>Utilities >Settings >Global >Save Settings**.

VF Noise Calibration (Microphone)

The test platform offers ambient audio Noise Reduction for its built-in microphone, to improve voice quality in Voice Frequency (VF) applications like ISDN and VoIP calls. When the microphone noise reduction function is enabled, in **>Utilities >Settings >Global >General Settings >Mic Noise Reduction = ON,**

Users can calibrate it to remove typical environmental noise and improve voice quality. The test set must be recalibrated before use and when moved to a different environment (e.g. from the equipment room to an office). The Noise Calibration function can be found in >Utilities >Settings >More >Noise Calibration.

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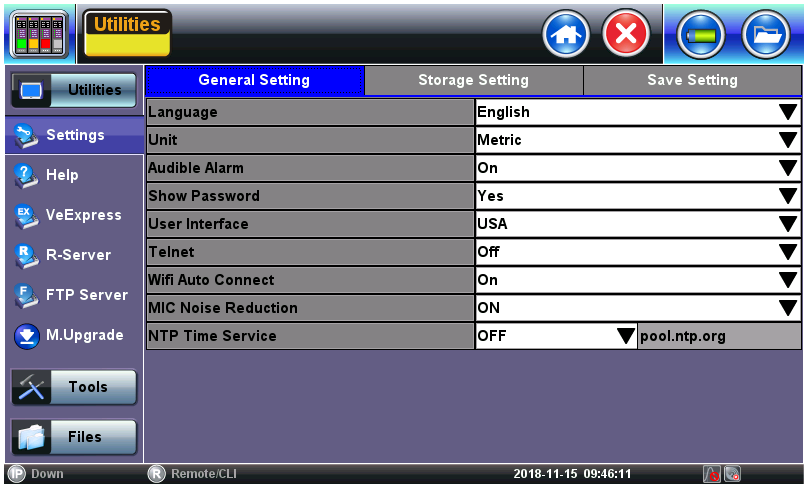

Stay silent while the calibration is in progress. If a headset is used for ISDN or VoIP calls, it must be plugged in during the calibration process.

High Precision Clock Sources

GPS/GNSS Receiver (HW Option)

The optional high-sensitivity GPS/GNSS modules (built-in) provide accurate Phase alignment and Coordinated Universal Time (UTC) synchronization to the test set, in the form of internal pulse-per-second (1PPS) clock synchronized to the standard second and timestamps. This is used to assure that two or more geographically-distributed test sets have the exact same time and can calculate delays. One example is the One-Way-Delay (Latency) tests used to identify asymmetry between each direction of a link.

The GPS Time of Day (ToD) can also be used to precisely set the local date and time in the test set, using the Sync ToD function, which will apply the local time zone correction before applying it to the test set system real time clock. This timestamp is used for reports and events, but not for time-sensitive testing.

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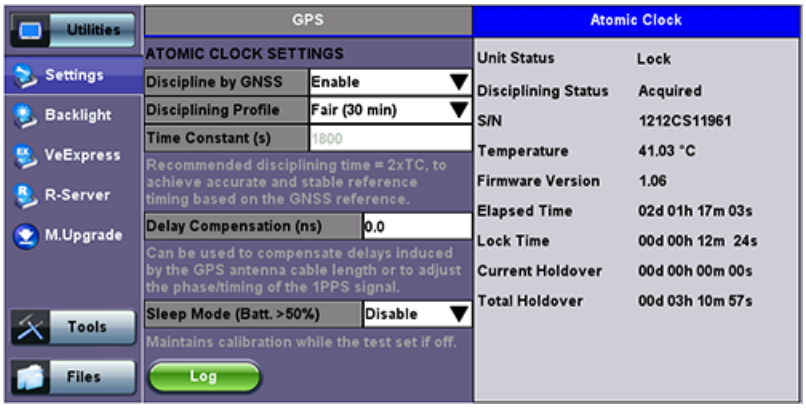
GPS ToD is also used in One-Way-Delay (OWD) measurements and time is applied directly to each test set before the test starts, so they all have accurate time.

The GPS/GNSS receivers can be turned **OFF** if not used, to save battery power.

A satellite table, showing satellites in view, satellites being used and signal to noise density, is provided for information only, so the correct antenna installation can be verified. Geographical coordinates are also provided for information only and it could be used in the future to geo-tag some position-sensitive results. The GPS/GNSS antenna must have direct view to the sky. At least four satellites with SNR of 34 dB-Hz or better are recommended for accurate testing.

Atomic Clock (HW Option – Factory installed)

The optional built-in chip-scale Atomic Clock module provides a highly stable clock source to the test set, in the form of a highly accurate and stable internal 10 MHz frequency and 1PPS timing references. These references can be used to drive PDH/DSn, SDH/SONET/OTN or SyncE Master transmitters or be used as a reference for Frequency, Phase, Time Error, and Wander measurements. Their main function is to serve as a precision reference to measure wander (clock stability), even in places where there is no reference clock signals available that can be traced back to a Primary Reference Clock (PRC) or Primary Reference Time Clock (PRTC).



GPS-Disciplined Clock

When GPS/GNSS and Atomic Clock options are installed and enabled, the Atomic Clock uses the GPS signal to calibrate its frequency (10 MHz) and timing references (1PPS), to improve their accuracy and stability. The Atomic Clock 1PPS phase is disciplined to the UTC to align it with the standard second. The raising edge of the 1PPS pulse indicates the beginning of a new second all over the world.

Disciplining can be disabled or enabled. When disabled, the atomic clock runs at its natural frequency (free-running), providing a very stable frequency source. When disciplining is Enabled, the atomic clock will use the GPS/GNSS accuracy to correct its frequency and align its phase.

The Disciplining Profile sets a time window the atomic clock's dynamic control loop, to filter any short term frequency and phase variations coming from the GPS/GNSS receiver, this is called Time Constant. The longer the time constant, the more accurate and stable the atomic clock output can be. The Disciplining Profile field provide suggested options for the minimum disciplining times and sets the equivalent Time Constant. The selection varies with applications and location, so some experimentation may be required by users to select

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their own default value. For quick field Wander or Phase measurements a disciplining time of ≥ 60 minutes (TC ≥ 1800 seconds) is recommended. Users can also enter a customized time constant in seconds.

Holdover

In case of GPS/GNSS signal loss (e.g. indoor testing) the high stability of the Atomic Clock can maintain synchronization for a few hours allowing users to perform quick Wander and Absolute Phase Error in conditions that were not possible before. This is called holdover mode.

Delay Compensation can be used to perform minor adjustments to the 1PPS phase, to align it to a specific reference or to compensate for short cable delays.

When enabled, the low power Sleep Mode keeps the atomic clock powered up when the test set is turned off. This way it maintains its last calibration by drawing little current from the batteries. In this state, the test set will only cut the power to the atomic clock if the battery charge reaches a level less than 50% of charge, to conserve battery. The Elapsed Time counts the time since its first initialization, including the time the test set has been off. If disabled, the atomic clock is shut down with the test set and will require full initialization the next time it is powered up.

Warm Up Times

All precision reference sources require a “warm up” time to achieve high accuracy and stability. The warm up term is being used loosely because it is not just about attaining the right temperature. It also includes disciplining of a local oscillator, negotiating and stabilizing a clock through protocol messages, etc. Each of the tasks involved takes time to stabilize before it can be used for testing.

Operational Temperature

It is still a major player in the warm-up waiting time and it all depends on the ambient temperature and the initial temperature of the test set. For example, a test set left in the trunk of a car in a winter night will take longer to reach operational temperature.

Atomic Clock Warm Up

If fitted with a chip-scale atomic clock, they are housed in a miniature oven to maintain its internal temperature constant in spite variations in ambient temperatures and it can take up to five minutes to warm up and should not be used until its status shows “Locked”. The atomic clock temperature and status can be monitored at \Utilities \Settings \More \High Precision Clock Source \Atomic Clock. The chip-scale atomic clock is oven-controlled and temperature-compensated to minimize the effects of ambient temperature variations.

Beside temperature, users must be aware of other factors that require time to settle, before accurate measurements can be made.

GPS Lock

The time to get an stable clock output varies depending on the conditions, antenna type and installation, sky visibility and whether or not the test set has changed position. Using the test set for the first time on a new site

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(different geographical position) would increment the time to its first satellite lock. Users can follow the different stages (Searching, Sync 1PPS, and Lock) by checking the GPS status GUI at **>Utilities >Settings >More >High Precision Clock Source >GPS.**

Disciplining Time

Disciplining the atomic clock means using the accurate GPS timing signal to correct or align the atomic clock output signals. GPS are known for their high accuracy as they are traceable to the universal time standard (UTC). Atomic Clocks are known for their great stability. So, the combination of GPS + Atomic Clock = Highly Accurate and Stable clock source. Achieving such levels of precision takes time. The total time to stable output depends on the precision required. The disciplining time can be programmed in the Atomic Clock settings and users must add it to the total “warm-up” time, before starting measurements.

Precision Timing Protocol

PTP, like IEEE 1588v2, require some time for the two ends (master and slave) to agree on the current time. This protocol “warm-up” time is dependent on the link conditions (traffic, latency, delay variations, PTP settings, etc.). Tests shall not be started until the protocol has stabilized and the recovered clock has achieved its maximum accuracy and stability. This is sometimes referred as “Convergence” or “Sync PDV” convergence. Users can use the long tail of the 1588v2 Sync PDV graph as an indication the PTP has reached synchronous state.

VeExpress™

VeExpress is a cloud-based asset management system. VeEX VeExpress cloud services is included with every test set. It offers the following:

- **Purchased licenses**: Retrieve newly purchased test features directly to the test set (new functions become immediately available).
- **Share licenses**: Release existing licenses from one test set, back to the company's common pool, so it is made available to be immediately requested and retrieved by another user who needs it. Administrators have the option to limit the amount of time shared licenses is assigned to a test set, make them permanent (non-shareable) or work as an honor peer-to-peer system.
- **Rent licenses**: Temporary licenses can be leased from VeEX to support special projects or for newer technology trials.
- **Keep test sets up-to-date**: Download and update platform and modules' software directly from the server to the test set (USB memory stick required). Its web interface also provides access to superseded software versions, in the rare case users are instructed to downgrade.

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- **Create basic working groups**: Administrators and managers can create simple organization charts (crews, garages, business units, cities, regions, etc.)
- **R-Server Integration**: Managers have direct access to VeExpress test set and license information directly from VeSion R-Server, with the ability to assign and release licenses for R-Server registered test sets.

Built-in VeExpress Client

- Enables connection to the VeExpress Cloud directly from the test set in the field using any available internet connection (LAN, Wi-Fi, modem, CPE, smartphone hotspot, cellular data card, etc.).
- Displays the test features currently assigned to the test set and the licenses available in the pool.
- Activates new licenses and allows users to perform software (firmware) updates.

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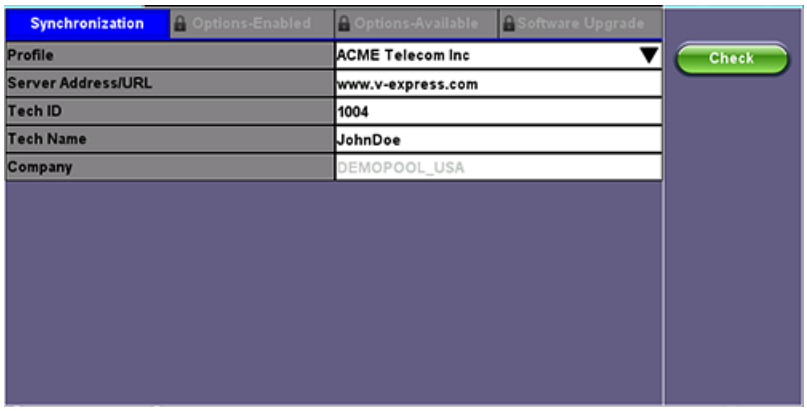
Connecting VeExpress



1. Connect the RXT-1200 to the Internet.
    - Use LAN, WLAN or Cellular Data Card.
2. Go to **>Utilities >VeExpress**.
3. Enter the URL **www.v-express.com** and select **Check**. The test set will receive the latest information directly from VeExpress Cloud, including recalled shared licenses and newly assigned licenses.

    BEFORE connecting to VeExpress Cloud, confirm that all tests are stopped and active Test Applications are released.

4. Wait for the confirmation message: "*Registered and Authorized*". Select **OK**. All licenses have been updated and any new features should be ready to use.

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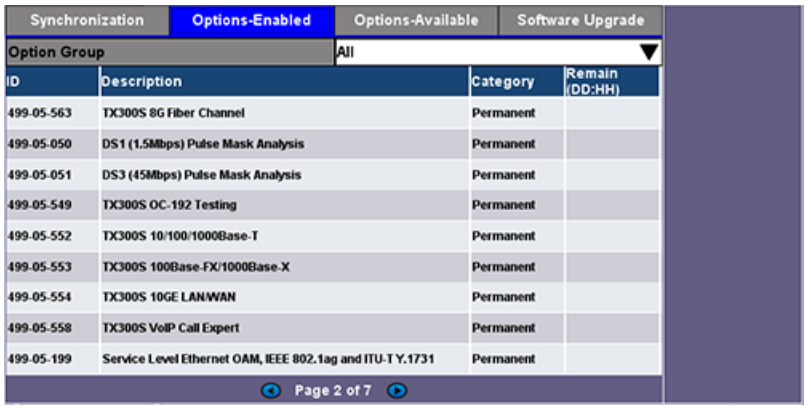
Options Enabled (in Test Set)



An up-to-date list of licenses assigned to the unit shows on the screen, listing whether the feature is purchased or leased.

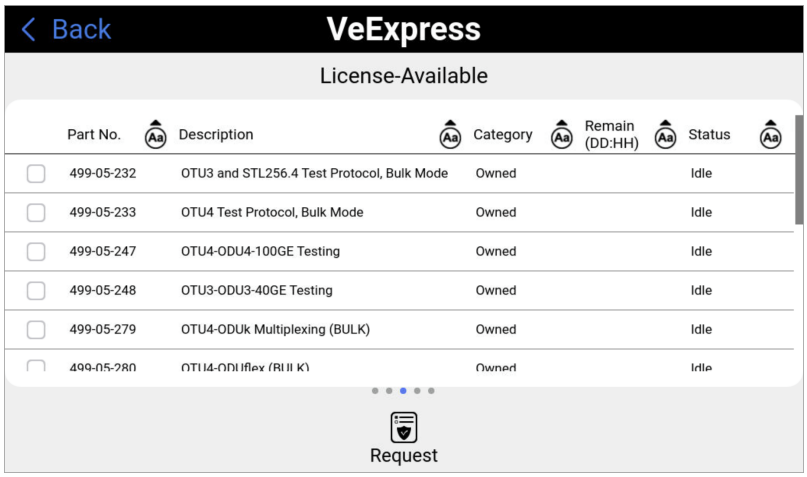
Category

- **Permanent** - Purchased and owned.
- **Leased** - Rented and temporary. The display shows the remaining lease time in days and hours.

  The countdown starts as soon as the license seat is assigned for the first time.

Both Permanent and Leased license seats can be shared by releasing the seat from one test set and assigning it to another.

Options Available (in the Cloud)



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Check with the company's or group's VeExpress Manager about assigning new features or functions after confirming license availability on the test set. The **Options Available** column lists all license options—**permanent** and **lease-eligible**—currently available in the company's or group's VeExpress account. If a license shows a status of "Idle," it is not currently being leased.

To request a license assignment, select the option and tap **Request**.

Software Upgrade

The **Software Upgrade** column indicates whether a new version of the test set software is available. Refer to the "Software Upgrade Procedure – Full Version" below or "Software Upgrade Procedure – Delta Version" on the next page, as needed, for instructions on upgrading the software using VeExpress.

Software Upgrade Procedure - Full Version

1. Select the **Software Upgrade** tab. A larger **Full Upgrade** package appears if the test set has not been updated for an extended period, when major new features are introduced, or when an OS update is required.
2. Attach the **DC charger** to the test set.
3. Insert a **FAT32 USB memory stick** (with more than 300 MB free) into the left-side USB port.
4. Confirm **IP connection** (IP address).
5. Select the new software version, then tap **Download**. Wait for the download to finish. The installation package is saved to the USB memory stick.
6. Power the test set **OFF**. Leave the USB memory stick attached.
7. Start the **Software Upgrade** process by pressing and holding the **App** and **Power** buttons until the test set beeps. Allow the upgrade to complete (this may take a few minutes). The test set reboots automatically when finished. The test set is now up to date.

DO NOT turn the test set OFF until the software update process has finished.

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Software Upgrade Procedure - Delta Version

1. Select the **Software Upgrade** tab. A smaller **Delta Update** package may be available between consecutive versions (e.g., 1.2.5 → 1.2.6) to allow faster field updates.
2. Attach the **DC charger** to the test set.
3. Confirm **IP connection** (IP address).
4. Select the checkbox for the **new software version**.
5. Tap **Download**. Wait for the download to finish. The installation package is saved to internal memory.

   DO NOT turn the test set OFF until the software update process has finished.
6. Power the test set **OFF**.
7. Power the test set **ON**. The test set software is now up to date.

For alternate methods of updating test set software, refer to Software Update Process.

R-Server™

Use the R-Server option to manage test sets and store test results.

Part of VeEX's VeSion centralized monitoring and management solutions, the VeSion R-Server™ Workflow and Asset Management system provides crucial tools to manage fleets of technicians, test equipment, standardized test profiles, thresholds, centralized test results collection, reporting, jobs/ticketing, and software update delivery to create coordinated and efficient disciplined workforce and test procedures. R-Server enhances the workflow to achieve the level of quality and repeatability required by telecommunications service providers, MSOs and their contractors. The flexible R-Server can be deployed in cloud, hosted, and corporate networks, on physical or virtualized servers.

Supervisors can preset and upload test parameters which are provided to the test sets as profiles. Technicians can download profiles, run tests, and upload results to a centralized system that stores and secures the data.

A test set must register to an R-Server (establish IP connection) before it can upload results to the server; otherwise, a reminder message will pop up. Use the Diagnostic button to show a chronological record of events performed when connected to R-Server (e.g., registration, download profiles, etc.).

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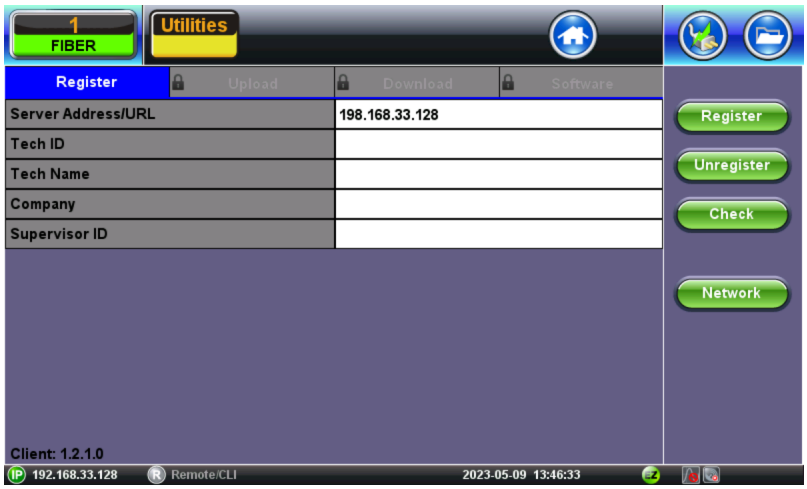
Register a test set (establish IP connection)



R-Server on test set

*If you are unsure if a test set has already been registered, press **Check**. If it has not been registered, complete the steps to register the unit.*

1. Contact the R-Server administrator and/or supervisor to get and enter the following information in the corresponding fields.
    - **Server Address/URL**: IP address or URL of the R-Server
    - **Tech ID**: Registered Tech ID
    - **Tech Name**: Registered Tech Name
    - **Company**: Company name. If no name is specified, the company name will be pulled from the supervisor's profile.
    - **Supervisor ID**: Supervisor ID; ties the test set to a specific Org Chart.
2. Press the **Register** button to register the test set on the R-Server. The test set sends the request to register to R-Server and a message appears saying that the registration is complete. Next, the registration must be authorized and approved by the R-Server manager in order to allow access.
3. When the test set registration is complete and approved by the R-Server manager, press the **Check**

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button to verify that the test has been authorized for use. Once authorized, results can be uploaded.

If authorized, a message appears saying the test set has been registered and authorized.

*To unregister a test set from a R-Server account, press the **UnRegister** button. Pressing the **UnRegister** button once will move the test set to Inventory Managment. Pressing the **UnRegister** button the second time will remove the test set from R-Server completely To select a network, press the **Network** button.*

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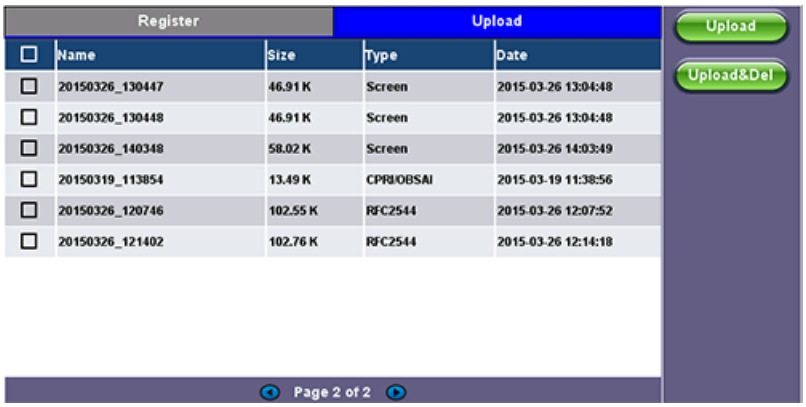
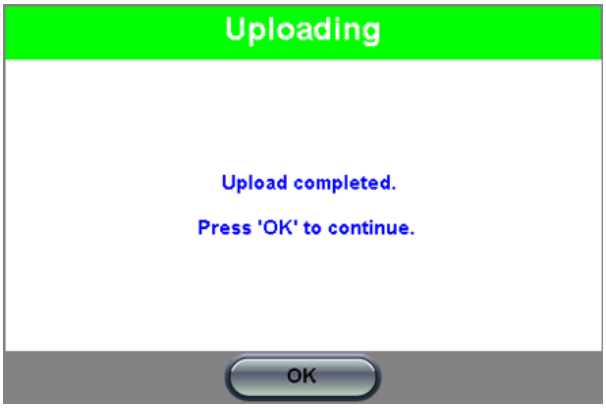
Upload Profiles and Results to R-Server



Uploading results to R-Server

1. Select the **Upload** tab, then select the desired files to upload. To filter displayed result files by Job ID and/or Location, select **Job**.
2. Tap **Upload** or **Upload&Del** for results.
   - **Upload**: Transfers the selected profile and result file(s) and keeps the file(s) in the test set.
   - **Upload&Del**: Deletes the result file(s) from the test set after uploading them.

   Upon successful upload, a confirmation message is displayed on the test set.



R-Server Upload Confirmation Message

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Download Profiles from R-Server

Select the **Download** tab to download all new profiles. If there are files that need to be downloaded, a message will appear at the bottom of the screen.
Tables, profiles, and software are listed as **NEW** or **Current**.

Upon successful download, a confirmation message is displayed on the test set. Press **OK** to restart the unit.

Download Software from R-Server

Tools

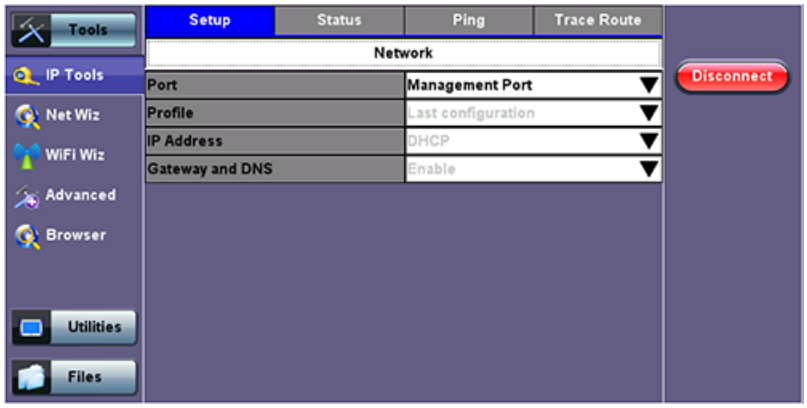
IP Tools

The LAN port, also known as Management Port, is used by the test platform functions, to communicate with remote clients, Internet, cloud applications and run some basic connectivity tests. Network parameters must be configured prior to performing any connection dependent measurements. An IP connection needs to be established in order to perform a Ping or Trace Route test. An (optional) external USB OTG to 10/100BASE-T adapter is required for LAN connection.

You can access the management port configuration on the **Tools > IP Tools** menu.

Setup

Network configuration settings are available in the **Setup** menu.



Setup

By default, the IP configuration is set to DHCP and the unit will automatically attempt to connect. Additional fields will vary depending on Static or DHCP connection:

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- **Port:** Select Management Port from the drop-down menu
- **Profile:** Default, Delete, Save, Save as..., Default, or Last configuration
- **IP Address:** Select from Static or DHCP
    - **Static:** If Static is selected, enter the Local IP, Gateway address (if Gateway and DNS are set to Enable), and Subnet. All Static fields can be filled by tapping on the section to access an alphanumeric keypad.
    - **DHCP:** If DHCP is selected, the unit will obtain IP address parameters from the DHCP server
- **Local IP:** IP address of the test set
- **Subnet:** Enter the subnet mask
- **Gateway and DNS:** ON or OFF
    - **ON:** If enabled, enter the IP address of the Gateway and DNS server in Static mode, or use the IP address provided by the DHCP server in DHCP mode

      If DNS is set to Primary or Primary & Secondary, a DNS IP is required in order to use the URL as a destination.
    - **OFF:** If disabled, no Gateway or DNS server will be used for the tests

Enter all parameters then press **Connect** to start the test.

Trace Route

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

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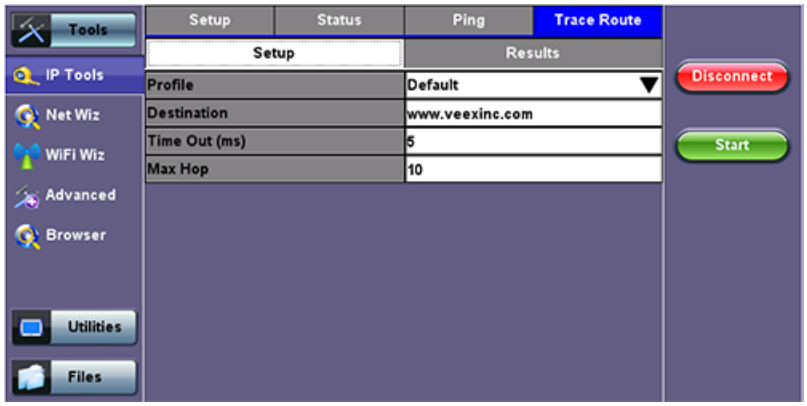
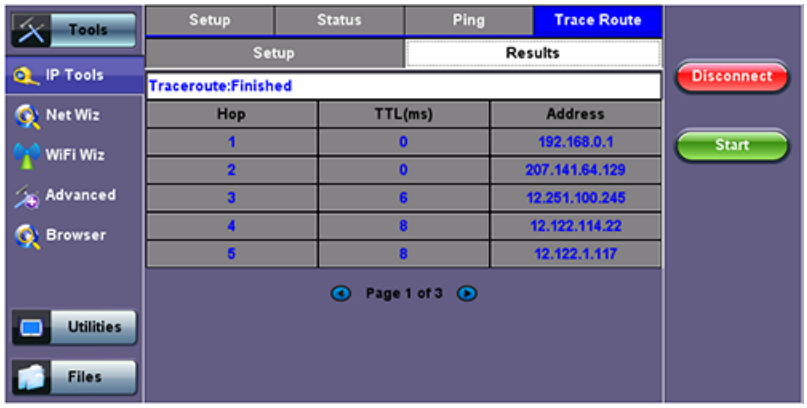


Trace Route Setup

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

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



Results

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

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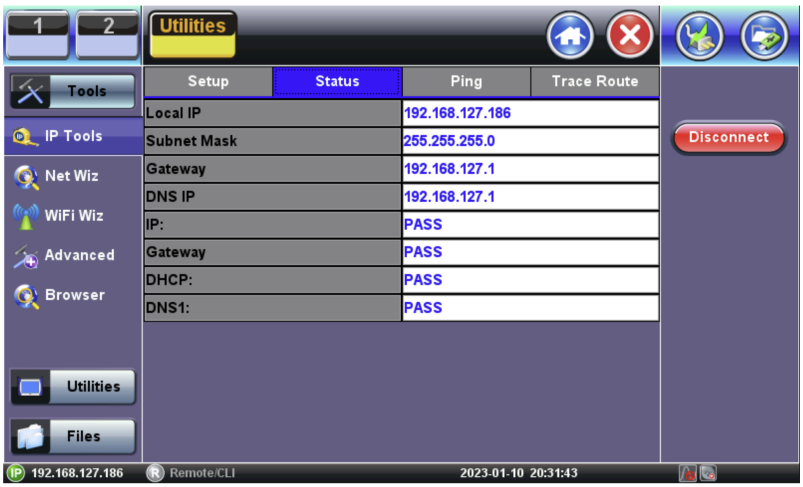
If there is no response from a particular hop, an asterisk will be displayed.

IP Connection Status

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



Status

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

Ping Testing

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

Ping is a popular computer network tool used to test whether a particular host is reachable across an IP network. A ping is performed by sending an echo request or ICMP (Internet Control Message Protocol) to the echo response replies.

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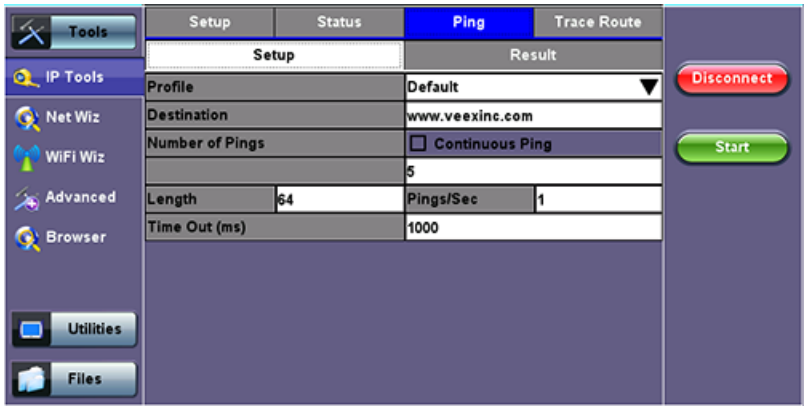

Ping Setup

Ping Setup

- **Profile:** Delete, Save, Save as..., or Default.
- **Destination:** Press the drop -down menu and enter the destination IP address or URL to ping.
- **Number of Pings:** Enter the number of ping attempts (up to 10000) that will be performed to reach the network device.

  *If Continuous Ping is selected, the user is not required to enter the number of pings. The test set will continuously ping the target host until the user presses **Stop**.*
- **Length:** Enter the length of the ICMP echo request packet transmitted.
- **Ping/Sec:** Enter the Ping repetition rate (Ping/second).
- **Time Out:** Time-to-Live (TTL) in milliseconds. Enter the maximum time allowed (in ms, up to 99999 ms) between an ICMP ping and echo response.

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

Ping Results

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

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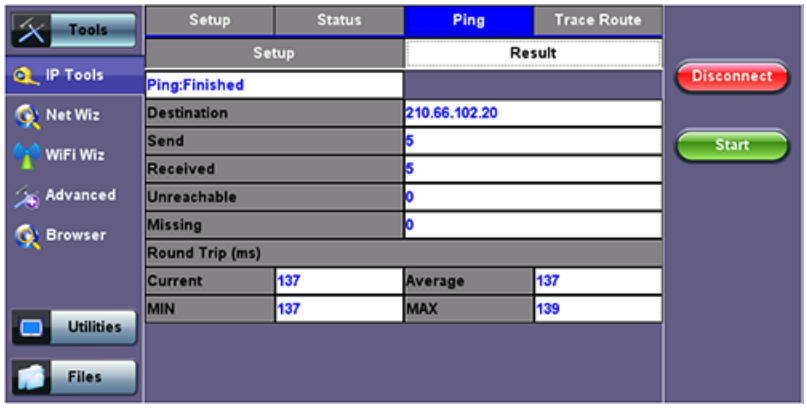

Ping Result

- **Destination:** Indicates the destination IP address.
- **Ping status:** In Progress, PASS, or FAIL.
- **Sent, Received, Unreach, Missing:** Number of pings sent, received, unreached or missing. A Ping is counted missing if no response is received before timeout. A Ping is counted unreached if an echo response is received with host unreachable set.
- PING also estimates the round-trip time in milliseconds.
    - **Current:** The current time for a Ping request to be answered.
    - **Average:** The average time recorded for a Ping request to be answered.
    - **Max:** The maximum time recorded for a Ping request to be answered.
    - **Min:** The minimum time recorded for a Ping request to be answered.

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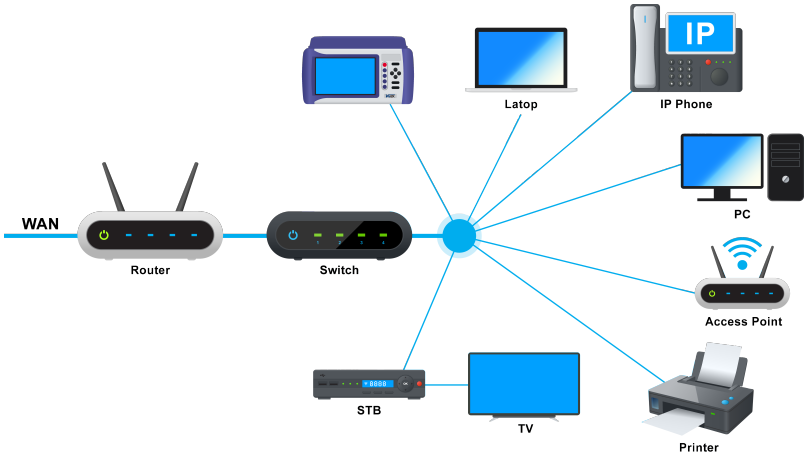
Net Wiz

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



Typical Net Wiz Application

Net Wiz tests include:

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

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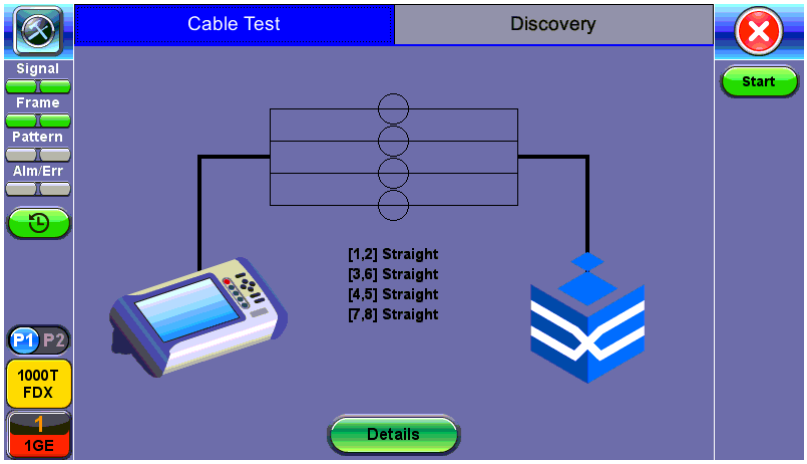
Before proceeding with any Net Wiz tests, make sure that an IP connection has been established. Refer to "IP Connection" on page 89 for more information.

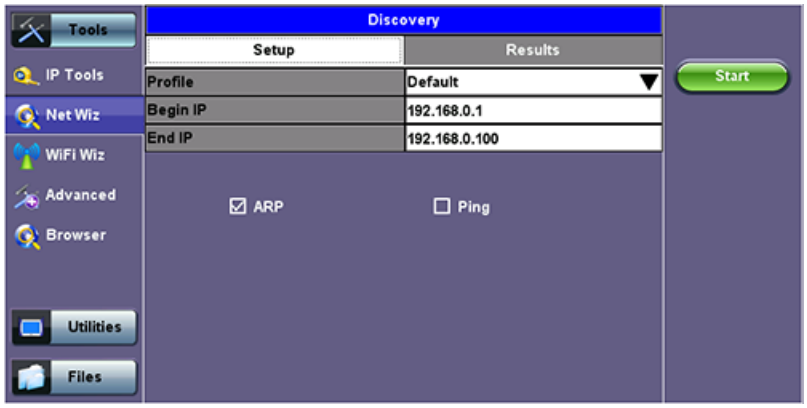
Cable Test



Cable Test

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

Discovery Setup



Discovery Setup

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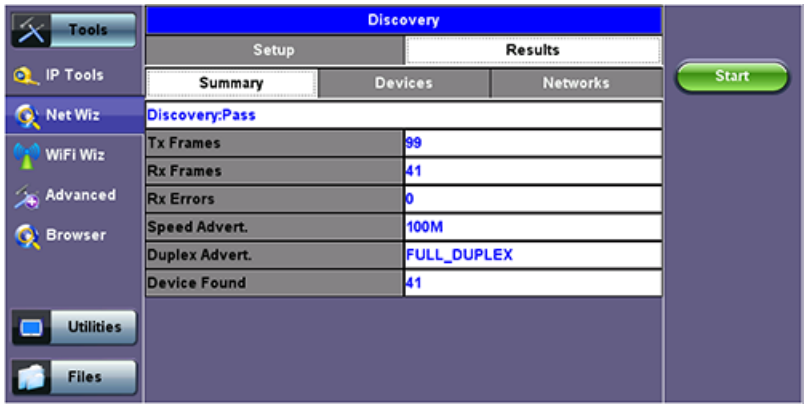
- **Profile:** Drop-down selections are Default, Delete, Save, Save As...
- **Begin IP:** Set the start address for the desired IP range using the numeric keypad
- **End IP:** Set the end address for the desired IP range using the numeric keypad

Select by placing a check mark in the corresponding box of any of the following: ARP, SNMP, NetBios, Ping, Net .

Discovery Results



Discovery Results - Summary

Summary indicates the test status and reports:

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

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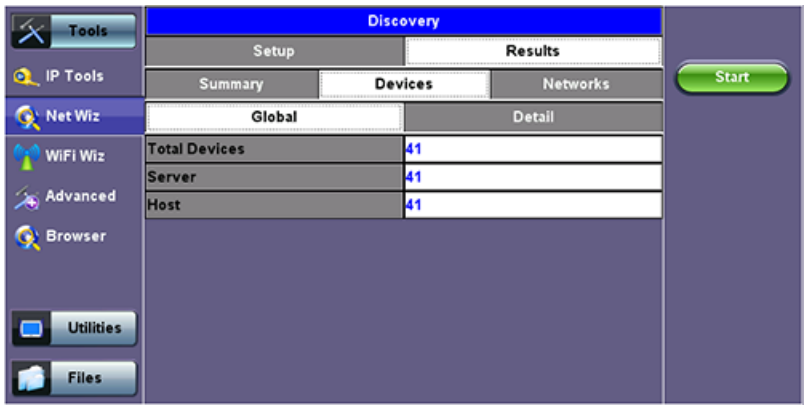
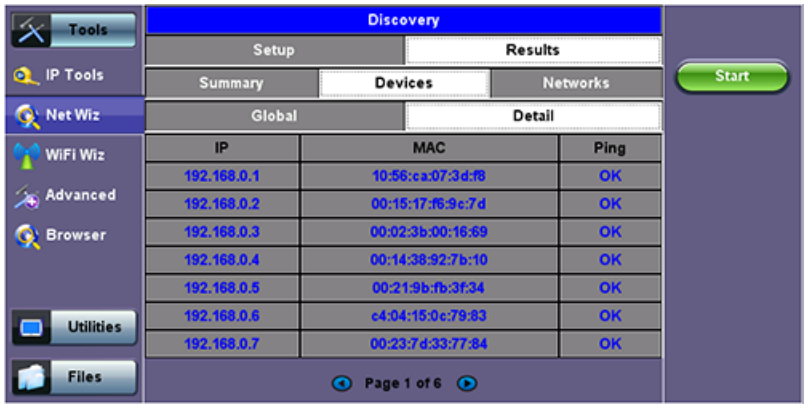
The **Devices** tab reports global and detailed device information.



Discovery Results - Devices - Global

Global reports:

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



Discovery Results - Devices - Detail

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

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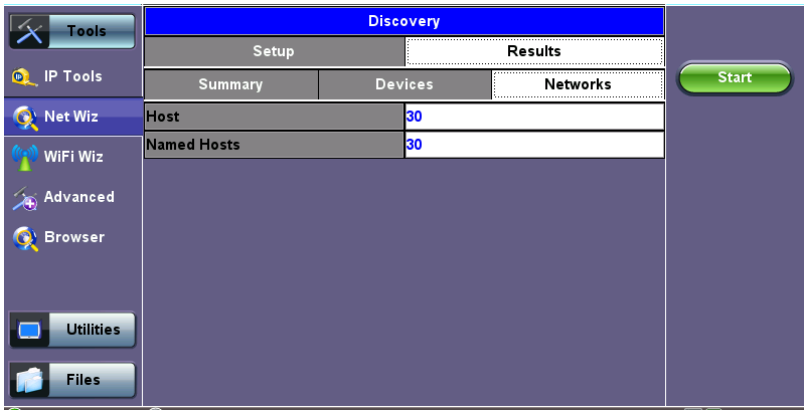
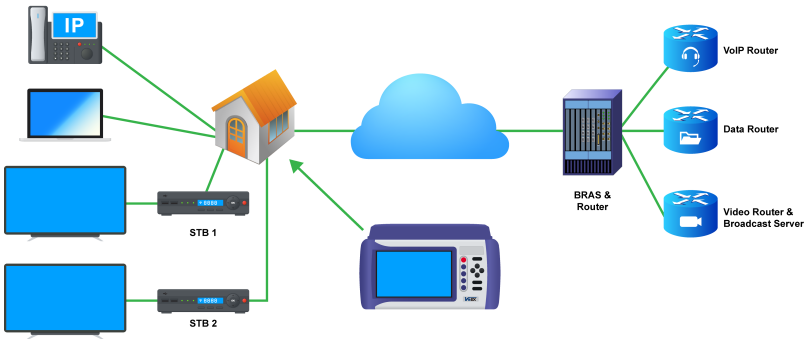


Discovery Results - Networks

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

Wi-Fi Wiz



Wi-Fi or Bluetooth options are available using Wi-Fi and/or Bluetooth dongles.

Built-in web browser remote control is available when Wi-Fi is enabled.

Passwords are case sensitive. If the wrong network key is entered, the test set will still connect to the Access Point but will not be able to connect to the web or perform the Ping test.

The Wi-Fi Wiz function can be used to provide Wi-Fi connectivity to the unit. Depending on the unit's model, it supports 802.11 b/g/n (2.4 GHz frequency band) connectivity or 802.11 a/b/g/n/ac (2.4 GHz and 5 GHz frequency bands) connectivity. Refer to the unit's specification sheet for details.

The Wi-Fi Wiz function supports:

- 802.11 a/b/g/n/ac standards (Wi-Fi USB adapter provided by VeEX)
- WEP, WPA, WPA2 Encryption

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- Scanning
- SSID broadcasting and report
- Signal Strength
- IP Connection and Ping Test

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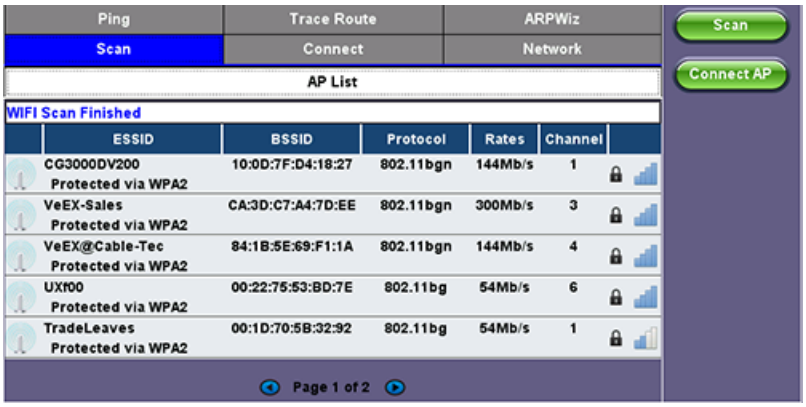
Wi-Fi Procedure

If using an adapter, plug the Wi-Fi adapter into the USB port. Allow at least 30-45 seconds for the unit to detect the wireless adapter and for the software driver to load.

Products support USB wireless adapters supplied by VeEX only and have the necessary software driver built into the test set.

1. To access the Wi-Fi option, tap **Tools**, and then tap **Bluetooth/Wi-Fi**.
2. Select the **Wi-Fi Wiz** tab.
3. Tap **Scan** to scan the list of available Wi-Fi APs.



Wi-Fi Wiz - AP List

Tapping **R-Server** will attempt to connect the test set to the R-Server Workflow and Asset Management System. See for "R-Server™" on page 581 more information.

AP List

The following information is displayed for each AP:

- SSID name of the AP
- BSSID (MAC address) of the AP
- 802.11 protocol version supported by the AP
- Max data rate supported by the AP

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- AP's radio channel number
- Lock symbol indicates if security is set on the AP (WEP, WPA or WPA2).
  When the AP is unsecured, no lock symbol is displayed.
- Signal strength of the AP

4. Select one of the Access Points (AP) to start a connection. If the AP is locked, a network key is required to complete the connection. The key can either be 10 characters or 26 characters. Once selected, an **Edit Settings** function key appears.

   If the wrong network key is entered, the test set will still connect to the Access Point, but will not be able to connect to the web or perform the Ping test.

5. Tap **Edit Settings** or **Connect AP** to change the Encryption Type and enter the Wi-Fi Key.
   - **Encryption Type:** Supported encryption types include WEP, WPA, and WPA2.
   - **Password/Key:** Security phrase or password necessary to access SSID and network. Tap the **Password** field to enter the AP password on the pop-up keypad.
     - ASCII formatting supported
     - The password/phrase can be hidden (**Global Settings** > **Show Password** > **Yes/No**).

       Passwords are case sensitive. For a list of saved access points, tap ***Saved AP****.*

6. Tap **Apply** after selecting the Encryption Type and entering the key/password. The **Connect AP** button will change to **Disc. AP** upon successful connection and the **Connect Net** key will appear.

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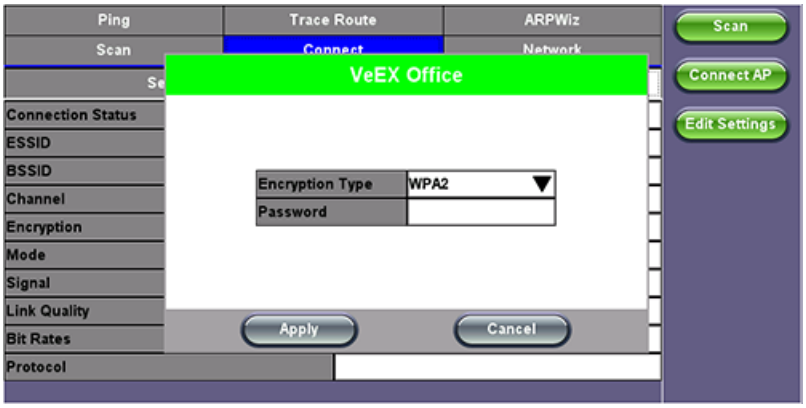
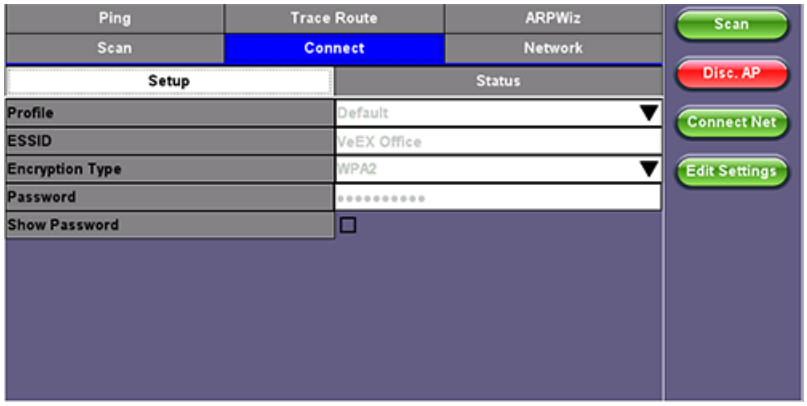


Wi-Fi Wiz - AP Encryption Settings

Connect

The **Setup** tab displays the Profile, ESSID, Encryption Type and Password.



Status

The Status Tab displays the following information on the connection:

- **Connection Status**
- **ESSiD:** Name connected to
- **BSSiD:** MAC address of wireless router/device connected to
- **Channel:** Wi-Fi Channel # connected to
- **Encryption:** Encryption type
- **Mode**

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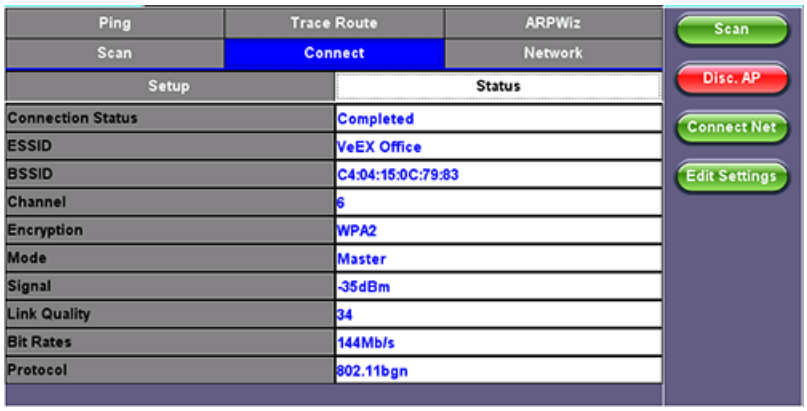
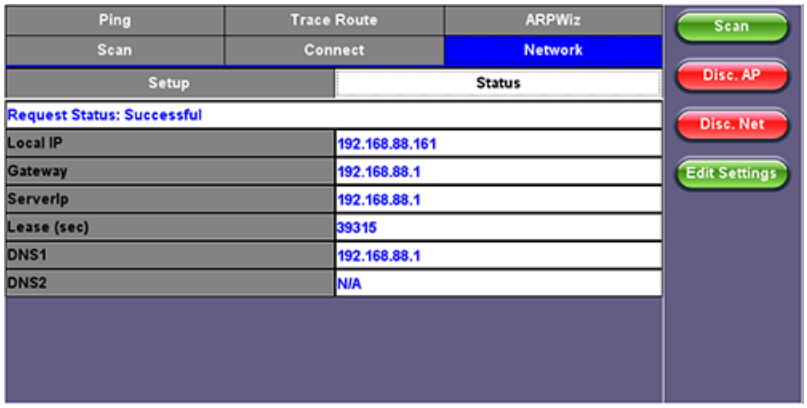
- **Signal:**
  - Radio signal level (dBm)
  - Link quality score
  - Max data rate
  - 802.11 protocols supported



WFi Wiz Connection Status

After a successful connection to the Access Point, tap **Connect IP** to obtain an IP address and access the additional IP tests like Ping, Trace Route etc.



Wi-Fi Wiz Connect IP

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ARP Wiz

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

ARP Setup

Configure the following parameters and press **Start**. The test will continue to run until **Stop** is pressed. A finished status indication will display when the test finishes.

- **Profile:** Default, Delete, Save, or Save As...
    - **Start IP:** Starting IP Address.
    - **End IP:** Ending IP Address.
    - **Time Out(s):** Range from 1-99 seconds. Input using the numeric keypad.

ARP Wiz Setup

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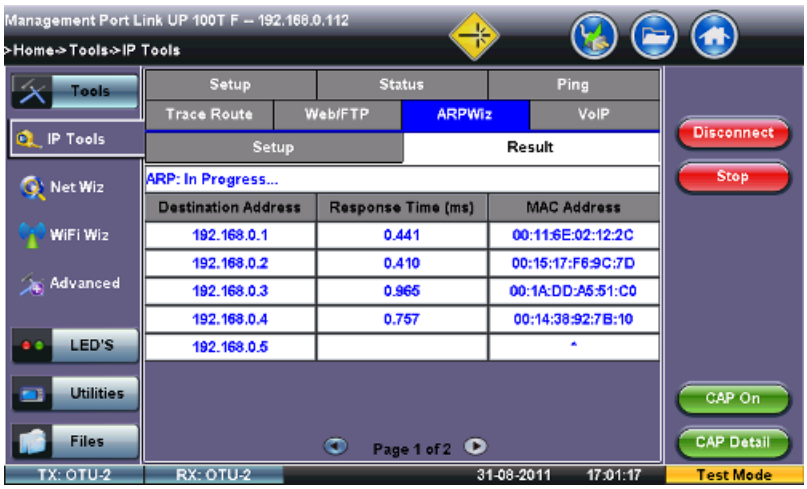
ARP Result

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

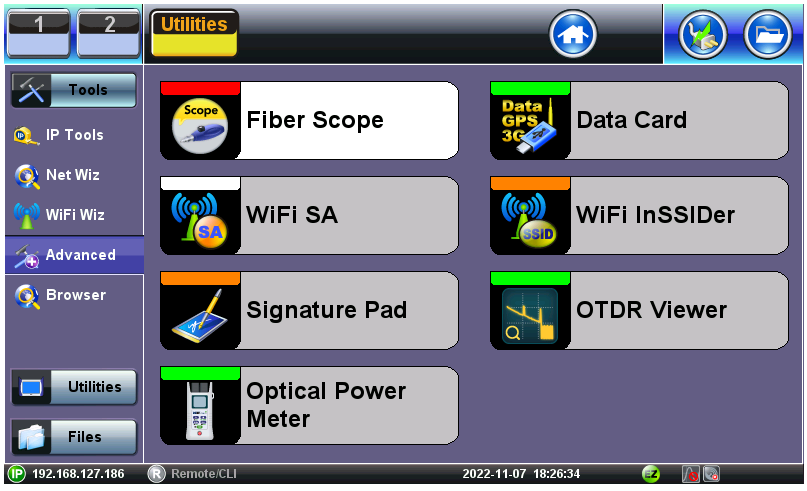
ARP Wiz uses the ARP protocol and can only work within the same subnet as the IP address provided to the test set in IP Status.



ARP Wiz Result

Advanced

Fiber Scope



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- "DI-1000 Digital Fiber Inspection Microscope" on the facing page
- "DI-1000MPO Digital Fiber Inspection Microscope for Single and Multi-Fiber Connectors" on the facing page
- "DI-3000 Auto-Focus Digital Fiber Inspection Microscope" on page 608

The VeEX digital fiber inspection scopes evaluate fiber optic connectors for dirt and end face quality. The hand-held probe design enables easy inspection of patch cords and connector panels. Extended tips are available for hard to reach bulkhead or patch panel connectors. Clear images are displayed on the test sets for immediate analysis and can be saved for record keeping.

The Fiberscope test application can be used in conjunction with any VeEX Digital Fiber Inspection Microscope.

All DI series fiberscopes can auto freeze image when focus is achieved to capture the image and qualify the connector endface for cleanliness and damage per IEC 61300-3-35. For more information about available connector tips, see the *DI-1000/DI-1000MPO/DI-3000 Digital Fiber Inspection Microscope Adapter Tips Guide*.

All wired fiber inspection scopes are powered via a USB Type-A connection with a host device or the VeEX Power Bank/Wi-Fi Bridge. For host devices that have Micro-B or Micro-C input ports, USB Type A to Micro-B or Micro-C OTG dongle adapters are available as an add-on order from VeEX.

The Importance of Fiber Connector Inspection

Dirty or scratched connectors introduce loss, increase ORL and/or damage other connectors (Loss and Return Loss becomes more critical at higher data rates). End-face contamination is a leading cause of fiber link failures in data centers, corporate networks, MSOs and Telecom environments.

Fiber Inspection Scopes provide a magnified image of the fiber optic connector's end face, focusing on the contact areas (most likely to impact network performance or permanent damage by mating of contaminated connectors). Images, visual inspection, and automated tools are often used to grade the health and cleanliness of connectors, after polishing or cleaning and before being used.

To achieve maximum power and prevent false readings, clean the optical fiber connector interfaces before inserting them into the test port.

Please ensure the correct fiber connector type is used before inserting it into the test port or connector. Mismatched connector types will damage the optical end faces and the test set.

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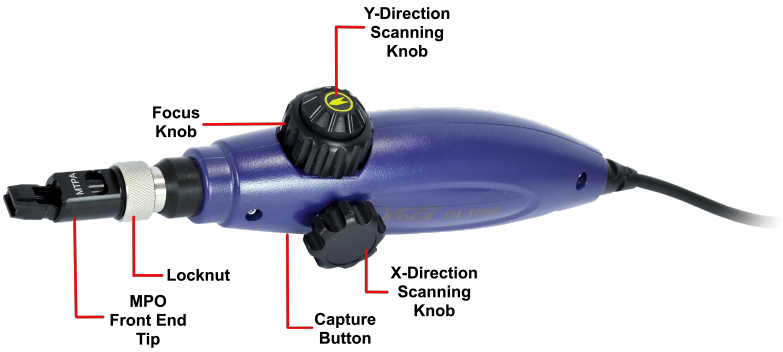
DI-1000 Digital Fiber Inspection Microscope

DI-1000 Digital Fiber Inspection Microscope

- **Locknut**: a threaded fastener that secures the tips in place.
- **Inspection Tip**: a front-end component inserted to view the connector endface
- **Capture Button**: a button that starts and stops (play or pauses) the video stream of the fiber end-face to save an image at the current frame.
- **Focus Knob**: a rotating dial that can be turned clockwise or counterclockwise to view clearer image. Make sure connector is properly seated in the adapter tip.
- **USB Type A output**: USB connector to plug into host power source to enable operation.

DI-1000MPO Digital Fiber Inspection Microscope for Single and Multi-Fiber Connectors



DI-1000MPO Digital Fiber Inspection Microscope for Single and Multi-Fiber Connectors

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- *WiFi support requires VeEX Power Bank/WiFi Bridge accessory and host device/test set has built-in WiFi capability. See the test set's data sheet on www.veexinc.com or contact VeEX Customer Care for more information.*
- *To work with single fiber tips, the front end tip should be replaced with the collar provided with the scope. For more information adapter tips, see the DI-1000/DI-1000MPO/DI-3000 Digital Fiber Inspection Microscope Adapter Tips Guide.*

For more information on using the DI-1000MPO, see the DI-1000MPO Quick Guide on www.veexinc.-com.

DI-1000MPO Fiber Analysis

There are two methods to inspect MPO fibers using the DI-1000MPO:

1. **Touchscreen (standard)**

   Press the **Capture Fiber** button on the touchscreen for every MPO fiber that has been properly focused, analyzed, and scoped. Press **Save** in the pop-up window to confirm the MPO fiber number and add the fiber screenshot to the list. Then, adjust the camera position using the scope's x-y axis controls to navigate to the next fiber.

2. **Fiber Scope button (fast)**

   Press the **Capture** button (located on the bottom of the DI-1000MPO fiberscope) successively to capture, confirm the MPO fiber number, and add the fiber screenshot to the list. Then, adjust the camera position using the scope's x-y axis controls to navigate to the next fiber.

   At any time, press **New Group** to create a new set of MPO images (this will remove all scope images from the capture window and delete any unsaved images).

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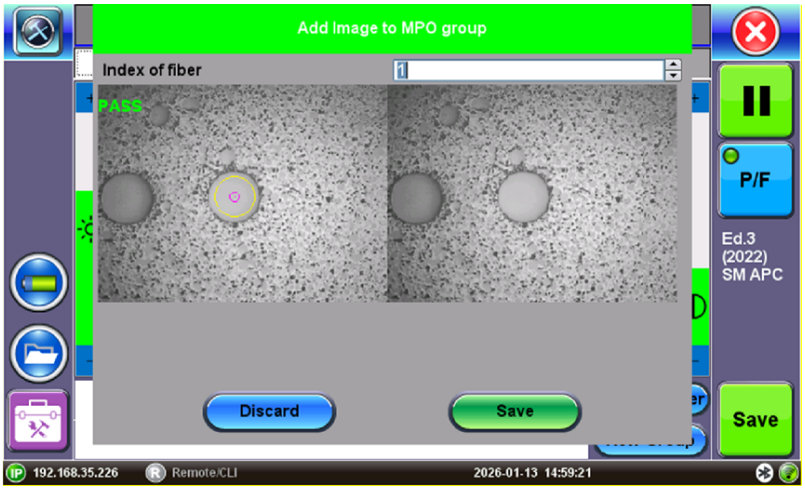
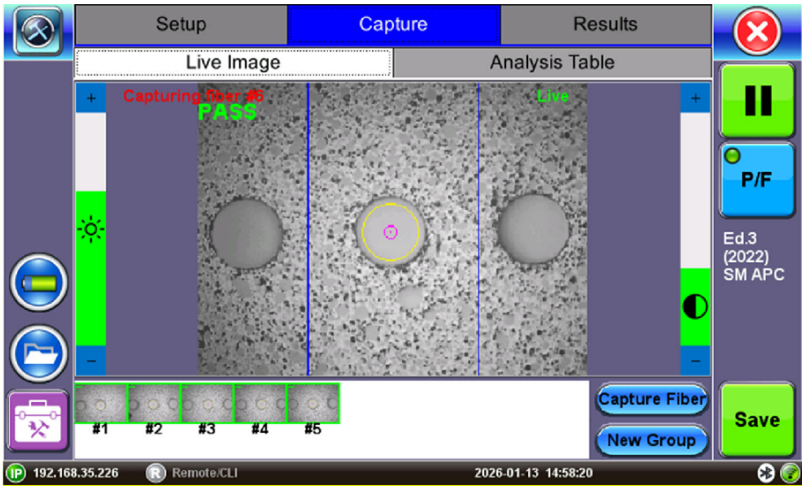


MPO Group - Add Image



Aligning Fiber for Analysis

When using a DI-1000MPO+, which has a wider field of view, align the correct fiber between the two lines for analysis.

The example below shows a completed MPO-12 cable inspection.

The key-up and key-down adapter that comes with the DI-1000MPO standard package is a straight-through connection so the MPO fiber # at the start matches the MPO fiber # at the end (not flipped). When using the adapter, fibers will be in the opposite orientation of the camera. In the below example, fiber #1 is on the right.

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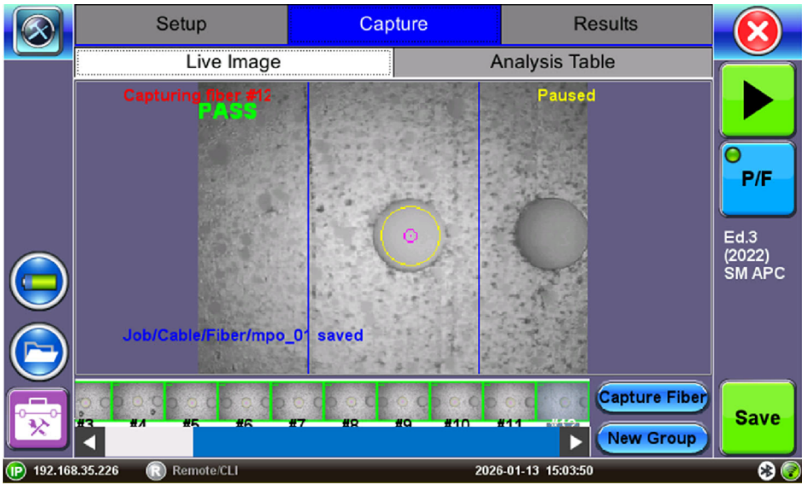


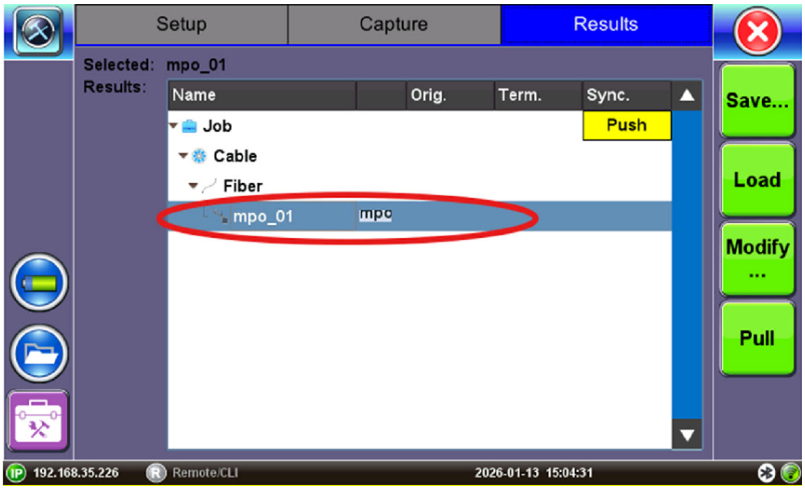
MPO Group - Completed (PASS)

To save MPO results, navigate to the **Results** tab once all fibers have been captured and press the **Save** button.

There are two ways to save MPO results:

1. On the **Capture** screen, select **Save** and confirm the results information (e.g. Job ID, etc.) by selecting **OK**. The results will be added to the **Results** tab.
2. Once all fibers have been captured, navigate to the **Results** tab and select **Save**. Then, press either **Save** or **Auto Save** and confirm the results information by selecting **OK**. The results will be added to the **Results** tab.

To view results on the unit, on the **Results** tab navigate to the **mpo** heading on the saved trace and press **Load**. Tap each individual screenshot to view the individual MPO fibers.



MPO results

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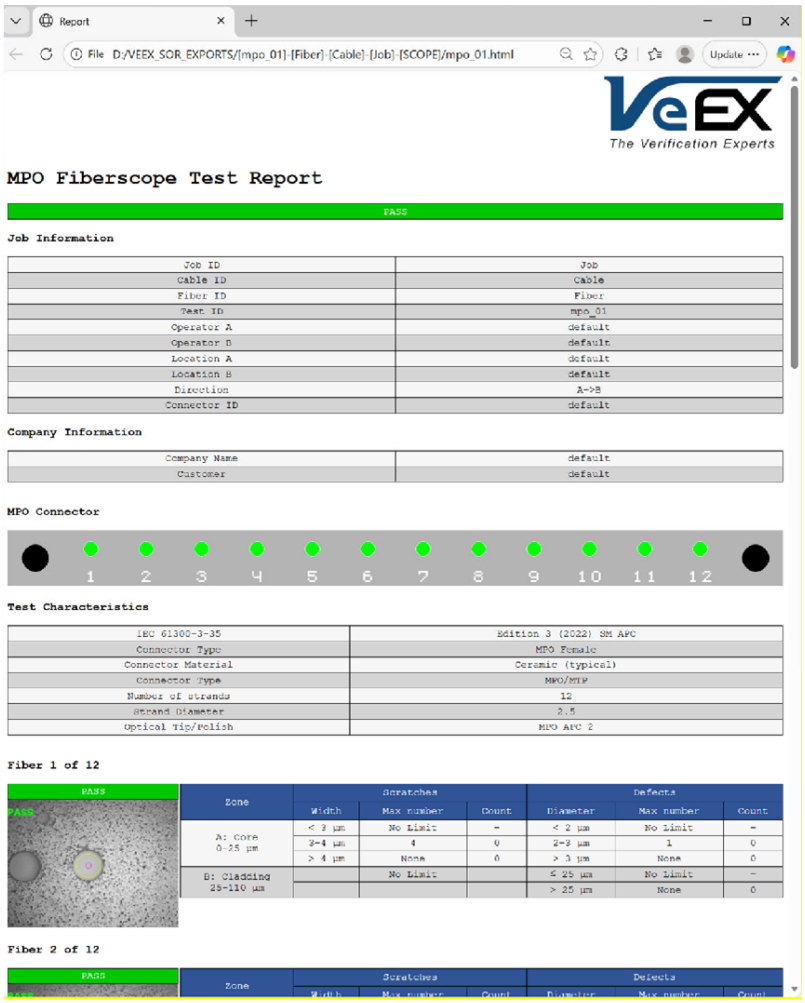

Fiberscope MPO endface test viewed in an HTML browser

DI-3000 Auto-Focus Digital Fiber Inspection Microscope

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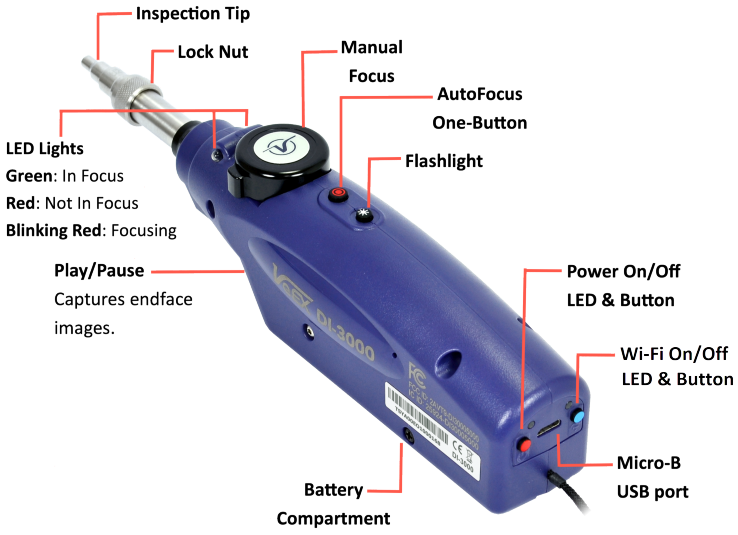

DI-3000 Wi-Fi Autofocus digital inspection scope

WiFi support requires host device/test set has built-in WiFi capability. See the test set's data sheet on www.veexinc.com or contact VeEX Customer Care for more information.

Connecting the Fiberscope

Use an USB-A OTG cable (optional with purchase) to connect a USB to the micro-B USB port. The port supports memory drives and USB add-on devices such as fiberscopes.

OPTICAL SAFETY

- *Deactivate the laser before connecting or disconnecting optical cables or patchcord.*
- *Never look directly into an optical patchcord or optical interface while the laser is enabled. Exposure to optical radiation for an extended period can caused irreparable damage to eyes.*
- *Never use a fiber microscope to check the optical connectors when a laser source is active.*

The operator is assumed to have received basic training in fiber optics and related testing and measurement practices.

Read the "Safety Information" on page 18 before beginning using optical features of the test set.

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Fiber Scope image view requires the Fiber Scope Expert option to be enabled on the chassis/platform except for the VS500 which can already include this option. This can be confirmed by viewing the device ID is either -1500 or -2500.

Attach the DI-1000/DI-1000MPO/DI-3000

Attach the fiberscope to an available USB Type-A interface on the test set.

Older analog fiberscopes require a USB adapter.

When the DI-1000, DI-1000MPO, or DI-3000 are powered, they will emit a blue LED. Select the tip that best matches the connector endface that is to be inspected . For more information about available connector tips, see the DI-1000 Digital Fiber Inspection Microscope Adapter Tips Guide on www.veexinc.com.

Scope tips are secured in place with a locknut. There is a slot (specialty tips may have more than one slot) that will ensure the tip is aligned properly to the top of the fiberscope prior to securing the locknut. Attach a tip by rotating the locknut clockwise (tip faced away). Remove a tip by rotating the locknut counterclockwise (tip faced away). With the correct tip fastened and secured, launch the Fiberizer application (PC, mobile, VeEX test set) and plug into an available USB interface or connect to the WiFi network.

Rotate the round focus knob to manually bring the image into focus. For the DI-3000 scope, a built-in autofocus button can also be used.

Once the fiberscope is detected, tap **Yes** in the pop-up window to enter the Fiberscope menu.

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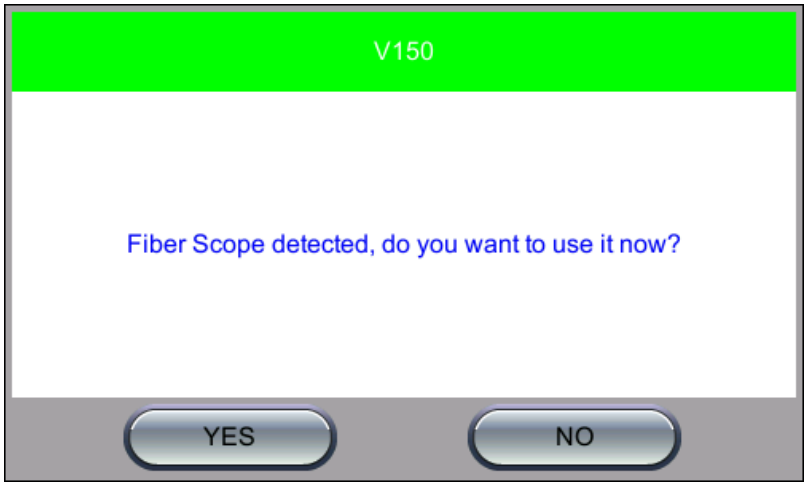
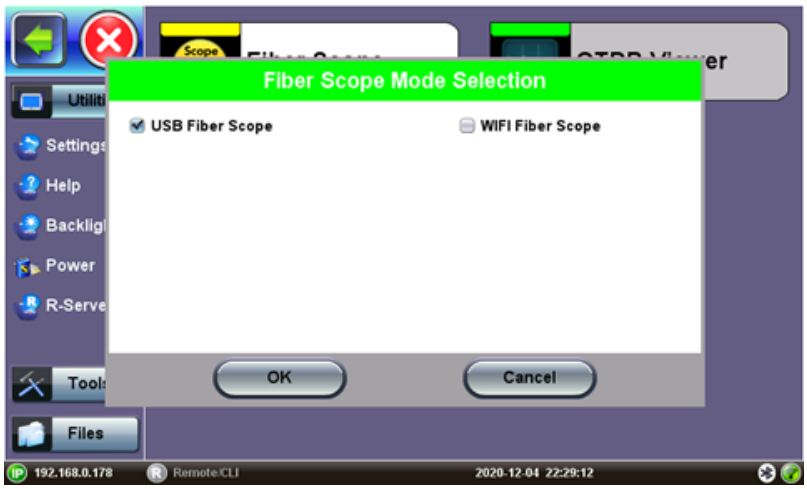


Fiber Scope Detected Message

Alternatively, the **Test Application icon** > **Utilities** > **Fiber Scope**.



Fiber Scope Connection Mode Selection (USB for direct connection, Wi-Fi for DI-3000 AP)

Select the **USB Fiber Scope** checkbox for wired fiberscopes, such as the DI-1000, DI-1000MPO, VS500 *(discontinued)*, or DI-3000 via USB.

Select **WiFi Fiber Scope** to initiate a scan for an available DI-3000. Refer to "Wi-Fi Wiz" on page 595 for more information on setting up a WiFi Access Point if automatic scanning fails.

The WiFi Access Point password is: "veex" plus the last six digits of the serial number of the DI-3000 to connect with e.g. "veexA00700", where the serial number is SN:LA-3KA00700.

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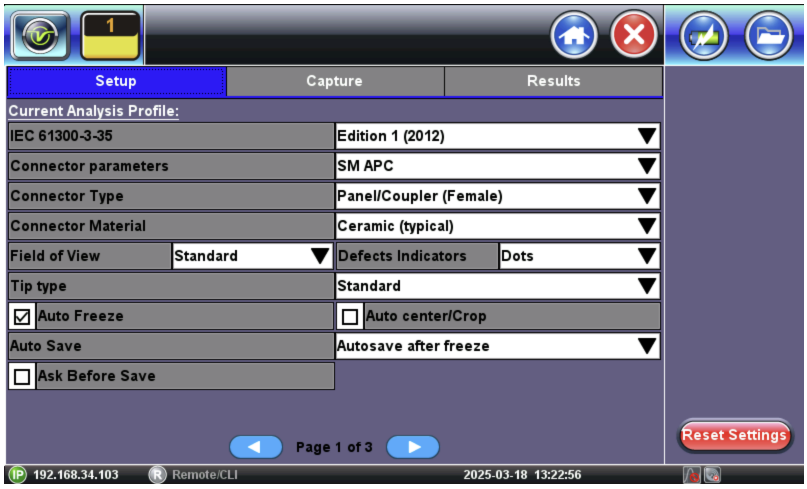
Fiberscope Setup

Captured patch cord image files are saved within a folder directory. In the **Setup** tab, name each folder and file in the directory and select a save increment.



Fiber Scope Setup - Page 1

- **Reset Setting**: Resets settings to their default values on the Setup screen.
- **Auto Save**: **Disable**, **Autosave on Tap**, or **Autosave after freeze**: Automatically saves the result when the video freezes (automatically or manually) or when the screen is tapped.
  If **Autosave on Tap** or **Autosave after freeze** is enabled, the unit automatically saves and creates the filename using the Trace ID after the test. The file location and name will display. Auto Save is available for single fiber analysis only.
  - **Disabled**: Turns off Autosave function. When Autosave is disabled, results can be manually saved on the Results tab after finishing the fiber endface inspection.
  - **Autosave on Tap**: On the **Capture** tab, tap the screen to automatically save the captured image. “Tap screen to save” will appear to indicate that the feature is enabled.
  - **Autosave after freeze**: Automatically saves the captured image upon freezing the image. (Auto-freeze enabled or normal Freeze.)

When **Ask Before Save** is selected, the **Save** menu will display with naming and comment options.

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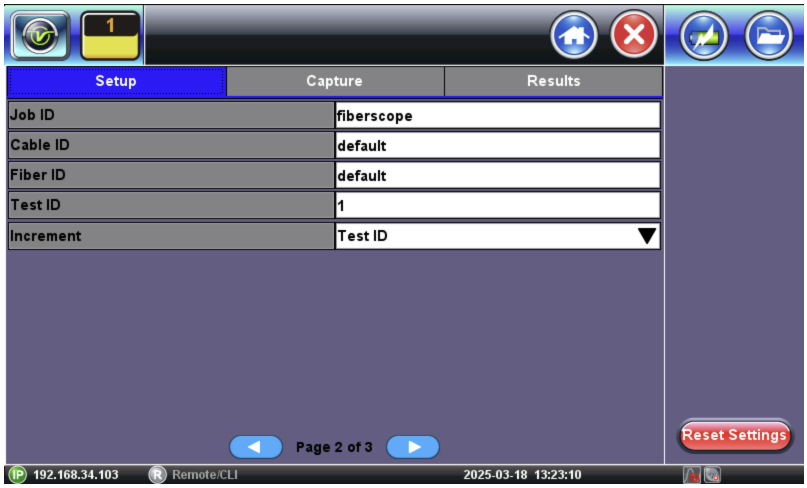

Fiber Scope Setup - Page 2

The details entered in the following fields can be used to pre-set the filename automatically and increment the fiber or test number automatically.

- **Job ID**, **Cable ID**, **Fiber ID**, and **Test ID** are nested folders that store saved results. Folders are nested in the following order: **Job** > **Cable** > **Fiber** > **Test**.

  Tap the blank fields to edit the names.

  > *The JobID/CableID/FiberID/TestID fields determine the location to which the results file is saved. If these settings are not set accurately, the file will not save to the desired location.*

- **Increment**: Increments the selected ID name if the **Auto Save** option is selected.

Saved image files can be retrieved from File Manager or managed from the **Results** tab. Refer to "File Manager: Working with Saved Results, Profiles, Images" on page 652 for more details.

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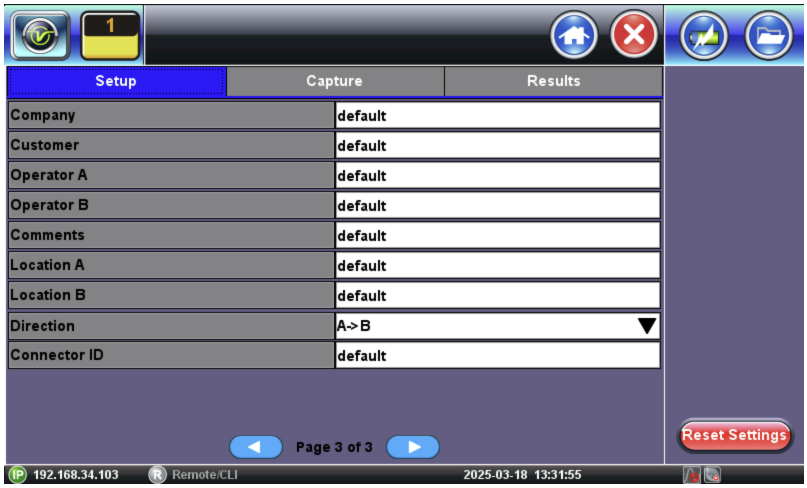

Fiber Scope Setup - Page 3

Include more specific details in the Test Report, such as Company, Customer, Operator(s), fiber segment direction, and Connector ID. This information appears on the Job Information portion of the Test Report.

Tap the blank fields to edit the names.

Analyze Fiber Connectors

Capture Images (View)

The **Capture** tab is the main user interface for the connector end face inspection and analysis. It presents a real-time view of the connector's end face allowing for alignment and focus. The capture screen displays a live image of the connector face and features analysis and freeze tools.

The fiber end face image will normally display near the middle of viewing window area. The exception will be when inspecting bulkhead/couplers of APC connectors or using A6 type tips. The end face image will appear off-center. AutoFocus and Shake OFF setting is recommended when inspecting couplers. Gently adjust centering while manually focusing the image and image will freeze as soon as focus is achieved.

For the DI-3000, press the autofocus (red target) button when the image is out of focus to enable the device's automated focusing operation. With a steady hand, the end face will be promptly autofocused and ready for capture.

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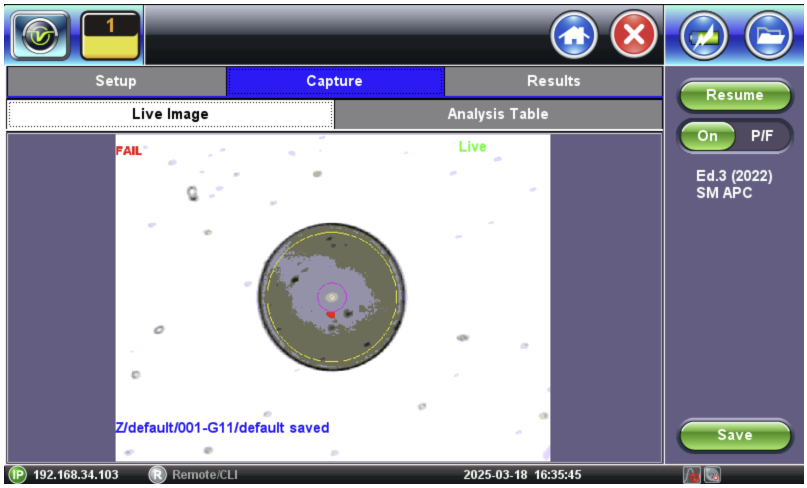
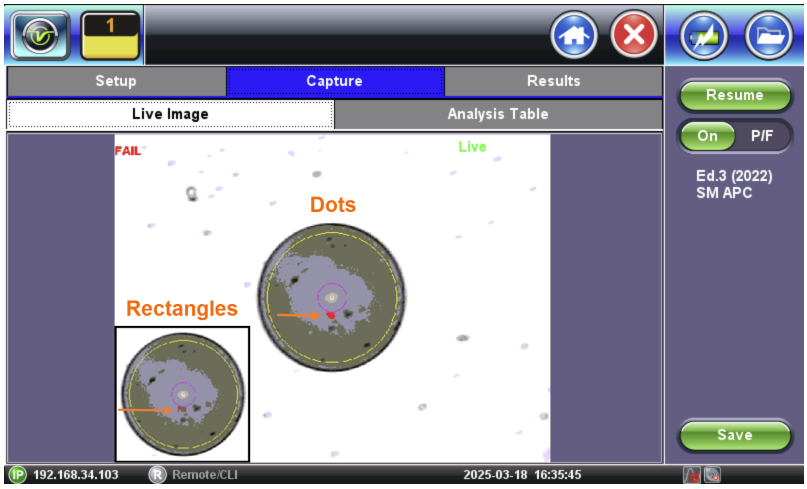


Real time video of the connector face. Red contours indicate scratches and defects.



Fiber Scope Capture - Dots vs Rectangles

- **Resume / Freeze**: Stops the video capture from the fiberscope. If the optional Auto Freeze feature is enabled, the test set will automatically freeze the image when it comes into focus. Once the image is frozen, tap the image to save it.
- **On / OFF**: Turn ON/OFF the automatic Pass/Fail threshold defined by IEC 61300-3-35.

To save the image on the screen, tap the screen after freezing or **Save**.

After saving, go to **Results** to push to the cloud. To view the Test Report, go to **> Utilities > Files**.

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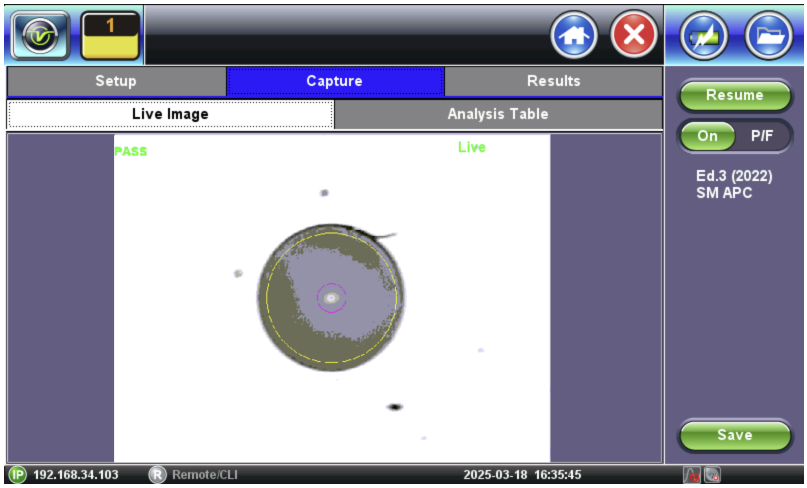
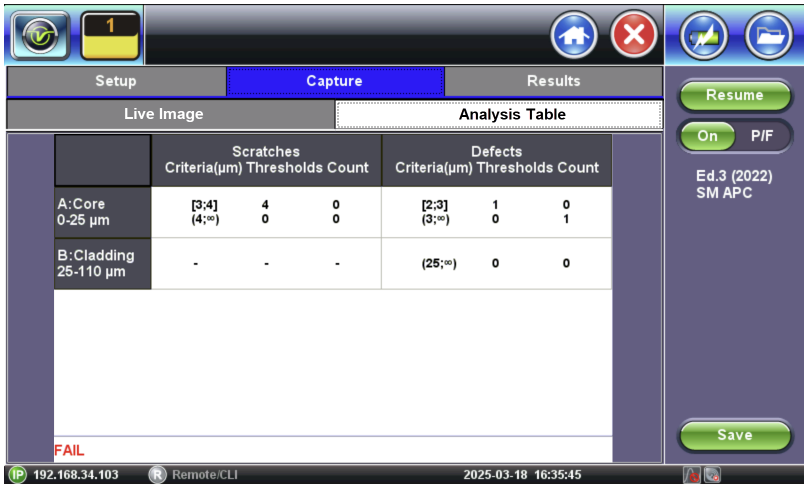


Fiber Scope Capture - PASS

When "Tap screen to save" appears on the image, it indicates that the **Autosave on Tap** option was enabled on the **Setup** tab. If **Autosave after freeze** were selected, the "Tap screen to save message" would not appear.

The **Analysis Table** displays all numeric results from defect and scratch events found for all four zones. These are used for the evaluation of the Pass/Fail criteria, according to the IEC 61300-3-35 standard. (Scratch requirements refer to width.)

This table will also be included in the reports.



Pass/Fail IEC analysis table

(Measured scratches and defects compared with threshold criteria for each fiber layer)

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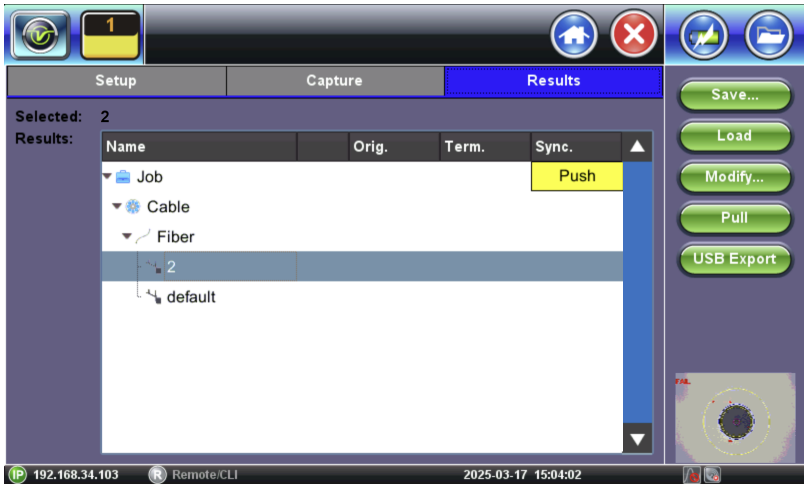
Fiberscope Results/Reports



Fiber Scope Results Files

The results screen is used to view previously saved results. Test results can be pushed/pulled from Fiberizer Cloud. The directory displays the location of stored files. Connect to Fiberizer Cloud, then select the file(s) by tapping them.

- **Push/In Sync**: Uploads locally saved results to Fiberizer Cloud. *In Sync* indicates the results have been saved to Fiberizer Cloud successfully.
- **Load**: Loads the selected results file for viewing.
- **Save**: Manually saves and names the results file (autosave is disabled). Once saved, the files can be accessed in the File Manager or "R-Server™" on page 581.
- **Modify**: Select a file or folder in the directory to modify. Options to Rename, Remove, and upload the selection to Fiberizer Cloud are available.
- **Pull**: When connected, pulls file from Fiberizer Cloud onto test set.
- **USB Export**: Exports files to USB stick. Choose Export Group to retain the tree format (sub-directory) or Export Flat to create a single filename using sub-directories to build a name.

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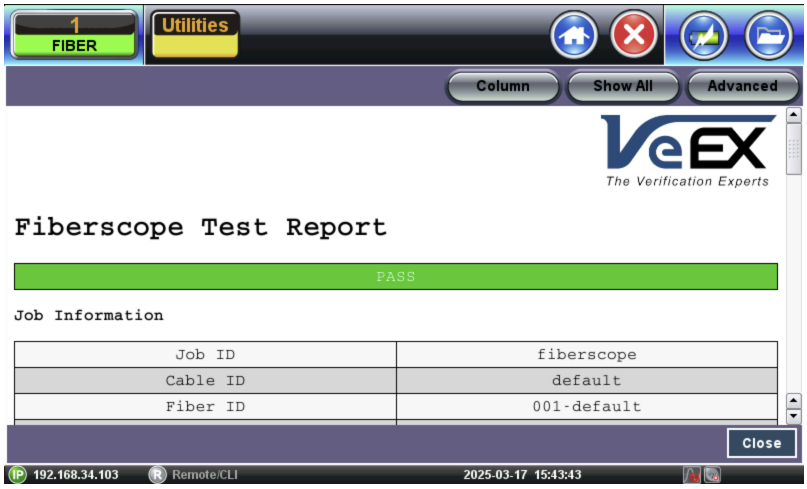
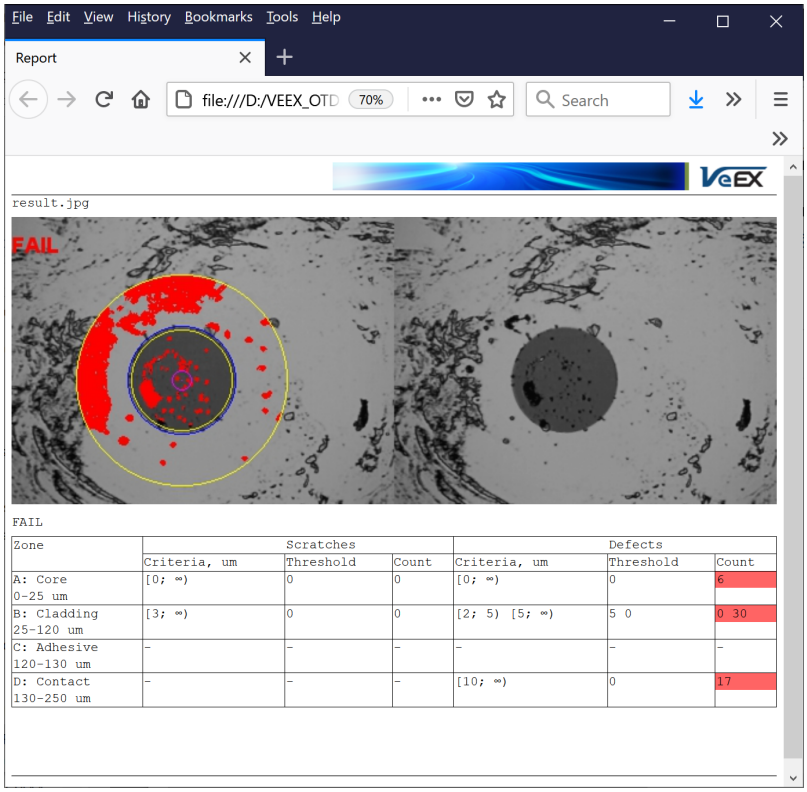
Test Analysis Report

To view the report files, tap **Utilities>Files>Save**. The Fiber Scope test report can be viewed in JPG format or exported to PDF. In addition, all fiber optic test results can be viewed using Fiberizer Cloud or the Fiberizer Desktop Plus PC software. For more information on viewing result files, see "File Manager: Working with Saved Results, Profiles, Images" on page 652.



Fiberscope Analysis Report



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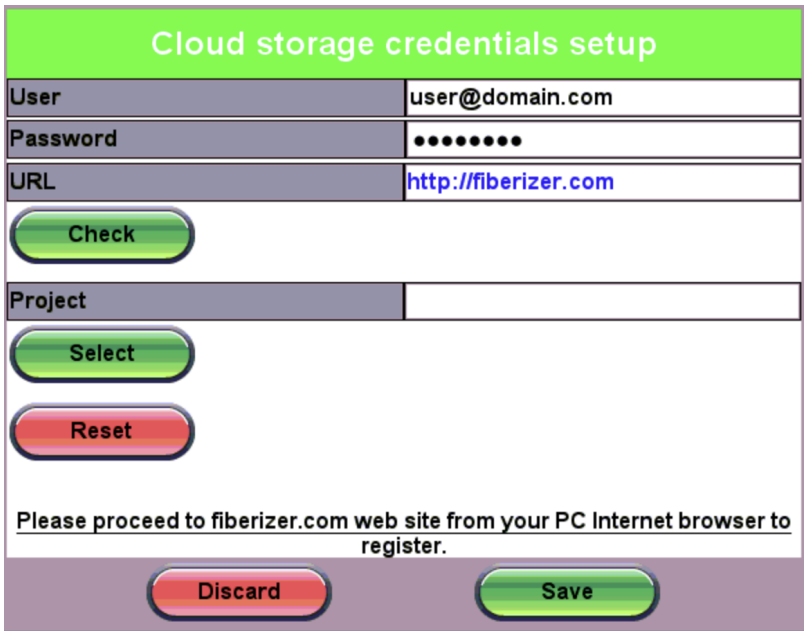
Fiberizer Cloud

Fiber test results, e.g. Fiberscope images, OTDR traces, OPM readings, can also be uploaded to a registered Fiberizer Cloud account. Registration is free. The Cloud account can be synchronized with Fiberizer DT+ Windows PC software, if needed.

Connecting to Fiberizer Cloud

To connect the test set to Fiberizer Cloud, you must be a registered user. For new users, go to https://cloud.fiberizer.com to register.

1. After registering, tap **Cloud**.
2. Enter the username and password, then tap **Check**. If the message ***Connection has been successfully verified*** does not display, recheck the username and password.
3. Tap **Select** to choose a project folder to upload files and tap **OK**.
4. Tap **Save** or **Discard**, respectively, to save or cancel the cloud login details.



Settings to connect to Fiberizer Cloud

The Project selection defines the project folder location on the Fiberizer Cloud account to which to save the results. It is limited to three projects. This allows the creation of a private or shared Project folder. The default setting on the test set uploads to the global root folder.

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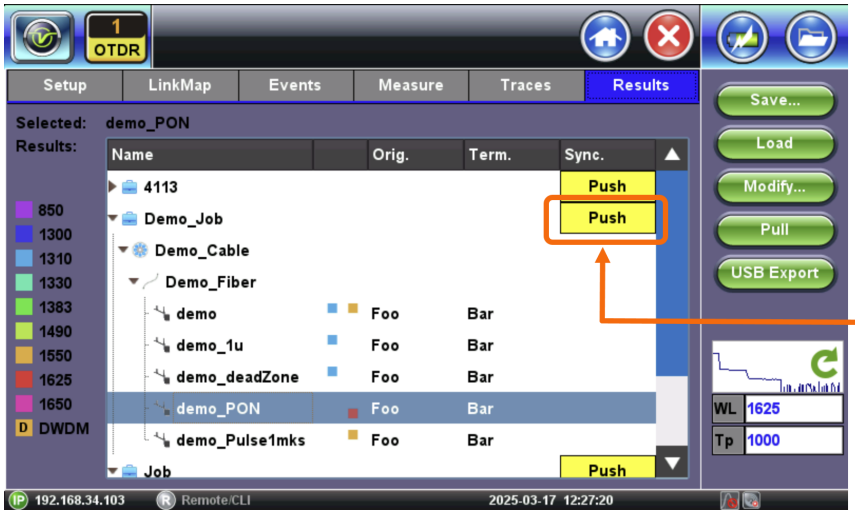
For a project folder to appear in the project list, it must be created in Fiberizer Cloud first. The test set cannot create Fiberizer Cloud project folders.

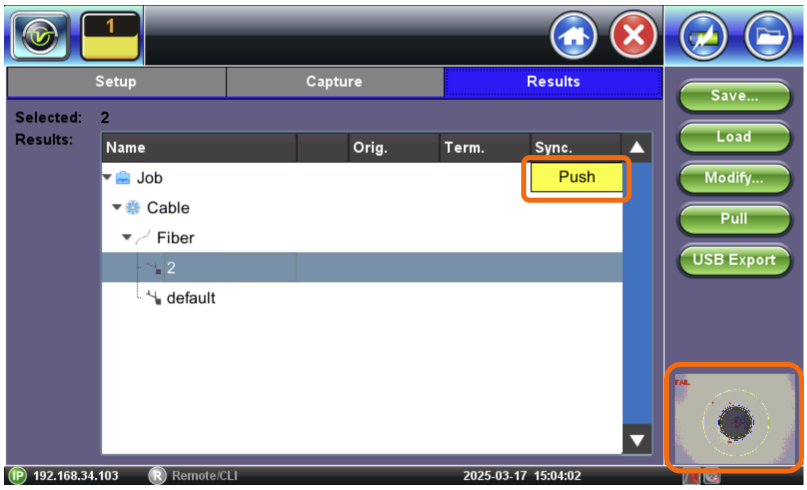
Uploading/Downloading Files with Fiberizer Cloud

Before attempting to upload or download, ensure that the test set is successfully connected to Fiberizer Cloud. Tap **Push** next to a directory item to upload it into Fiberizer Cloud. Tap **Pull** to download the directory collection from Fiberizer Cloud.



Tap **Push** to upload results to Fiberizer Cloud. In this example, the trace will be saved to: **Demo_Job>Demo_Cable> Demo_Fiber** both on Fiberizer Cloud and when files are exported to a USB stick from the test set.

OTDR Trace Result Files



Fiberscope Result Files

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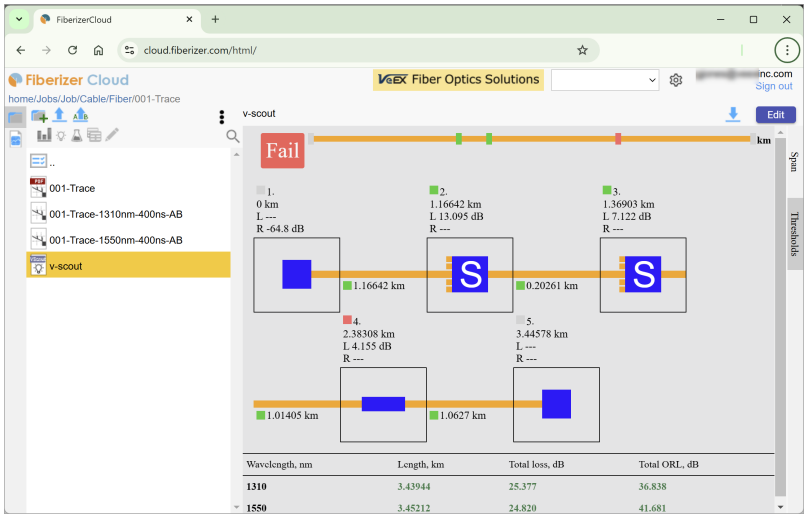
OPM Result Files

After pushing results to the Fiberizer Cloud project, check the Jobs folder to which the saved cable folder was uploaded. Use Fiberizer Cloud to create professional reports or serve as an online storage backup. The example below shows a link map for OTDR trace results on Fiberizer Cloud.



Fiber View on Fiberizer Cloud

Optical Power Meter (OPM)

The VeEX Inc Optical Power meters are made with fast and accurate testing in mind. They are used to measure the power running through a cable at a given wavelength, and interface with phone, PC, or other VeEX devices to save and generate reports on the findings. This information is used to verify that the cable span is working correctly and to find the source of the problem when it's not. When paired with a VeEX Optical Light Source (OLS) or as part of a VeEX Optical Loss Test Set (OLTS), which includes both, WaveID can be used to quickly test several wavelengths without having to adjust the OPM settings.

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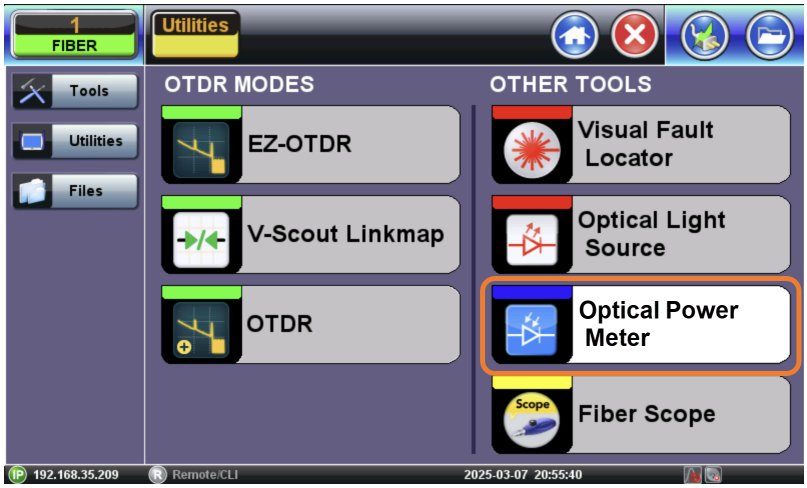

Optical Power Meter

Only optical power meters (e.g. Built-in or FX4x/8x OPM series meters) approved by VeEX are supported. WaveID will work with OLS in CW mode only. Accessing the Optical Power Meter module shuts down GPS and the atomic service.

Do not connect the fiber before opening the OPM application. First, zero the meter with the dust cap closed before making any measurements.

Connecting to the internal (built-in) OPM

1. Tap the **X** icon to close OTDR mode. The **Fiber main menu** appears.
2. Tap **OLS/OPM** on the main menu. The **OPM** screen appears with the **Caution** warning.

Alternatively, access the OPM screen by selecting **Optical Power(USB)** from the Platform menu.

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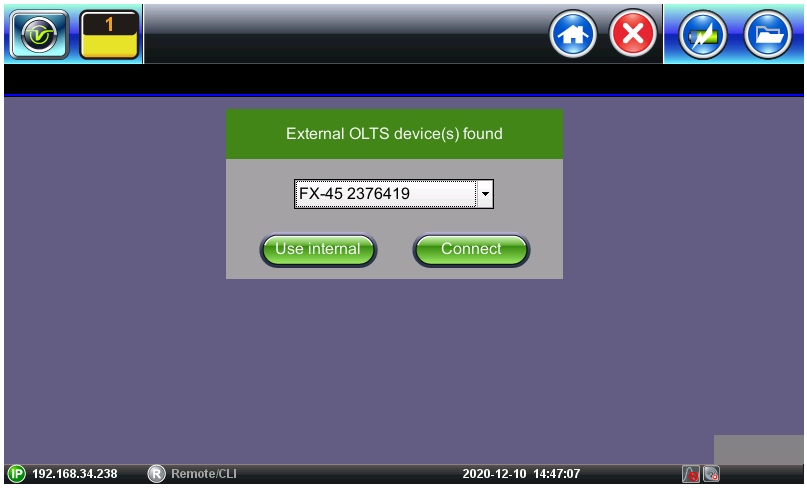
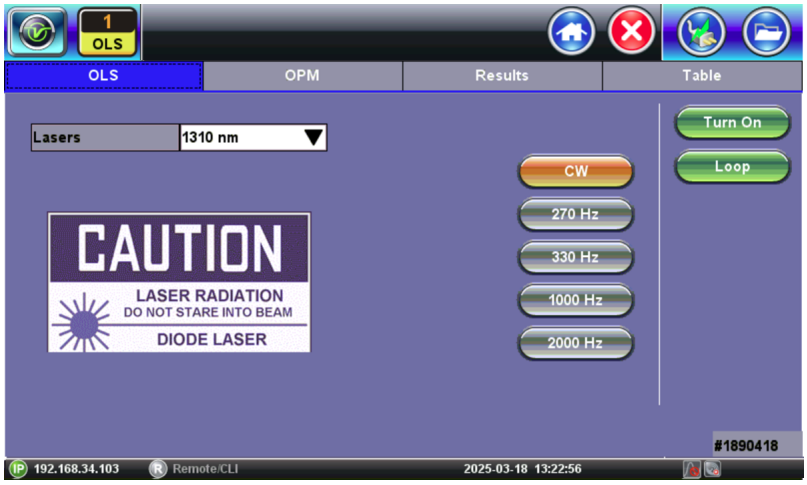
Connecting an External OLTS Device

1. Insert USB dongle into the test set's microUSB port and connect it to a VeEX Inc. supported Optical Light Test Set (OLTS) device before launching the application.
2. Power on the external meter. Then, tap **Optical Power Meter** on the menu. The **External OLTS device(s) found** screen appears.
3. Select the connected external meter and tap **Connect** to proceed to the external OPM menu or **Use Internal** to use the built-in OPM menu if it supported by the test set. The **OPM** screen appears with the **Caution** warning.



The Name of the External OLTS device is Displayed Once Detected



OLS Menu

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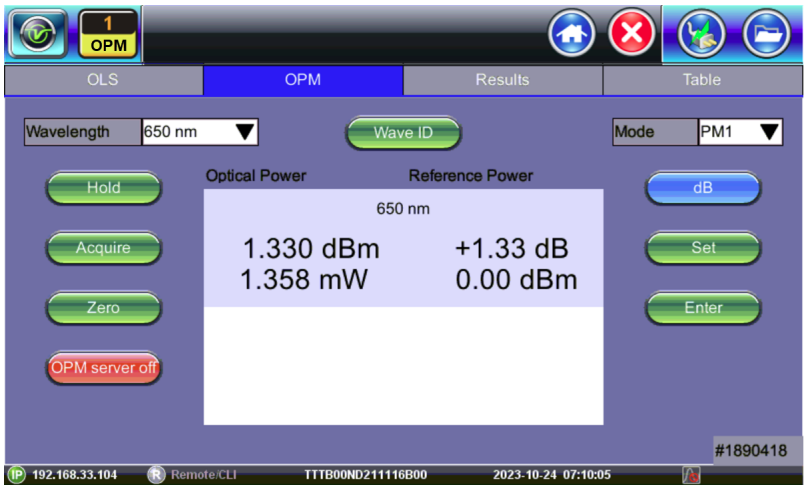

OPM Menu

- **Wavelength**: Matches the calibrated wavelength to the signal being measured.
- **Wave ID**: Detects the incoming wavelength automatically from a supported VeEX Inc.OLS. Use when operating the OLS in continuous wave (CW) mode with or without Loop enabled.
- **dB/dBm:** Switches between dB and dBm measurement units. A Green dB button shows absolute power level in dBm. A Blue dB button measures relative power loss in dB. Use the Set (Reference) and Enter (edit Reference) to set Reference, edit Reference, and view measurements in three units: dBm, dB, and Watts.

  After toggling to the dB button to blue, the Set and Enter buttons appear.
- **Set**: Sets the reference value for the current wavelength.
- **Enter**: Edits current wavelength reference value.

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- **Hold**: Freeze measurement to the last power or loss reading on the screen. “HOLD” appears next to “Optical Power” when tapped. Tap **Hold** again to unfreeze it.
- **Acquire**: Loads current measured value into the **Table** tab. The **Table** tab indicates how many new records have been temporarily saved into memory. In manual IL test mode, the **Acquire** button must be used to capture each individual reading (e.g. same fiber at different wavelengths) unless Loop is turned on.

If your device is equipped with a built-in clock, the saved measurement result will have a time stamp.

To permanently save the table of results, you must save into a test file.

- **Zero**: Recalibrates the OPM to treat current conditions as zero. Used when measurement conditions change significantly or to re-calibrate the OPM. Make sure the cover is shut on the OPM test port before tapping **Zero**. When in doubt, recalibrate prior to making any measurements, e.g, when testing in cold outdoor temperatures and then moving testing into a heated building.

Put the cover over the OPM test port BEFORE recalibrating.

- **OPM Server On:***Remote control feature not currently supported.* Broadcasts the IP address on the current network for users to connect to the test set module's built-in optical power meter through Ethernet/TCP/IP using **Fiberizer LTSync Windows Desktop** software for remote control and access.
- **Mode**: Designates the measurement specification built-in: PM1 (-70 to +10dBm), PM2 (-50 to +25dBm), or PM3 (-65 to +15dBm). For specific information on the PM1, PM2, and PM3 specifications, see the platform's datasheet at *www.veexinc.com*.

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Calibrating to Laser Source

To perform loss (dB) testing, the meter must be referenced (calibrated) to the Laser Source output.

To measure reference cable loss using the built-in light source (Loopback Referencing):

1. To begin testing, zero the meter by closing the dust cap and pressing the **Zero** button.
2. Connect the OLS (OTDR port) with the reference patchcord to the OPM port using a patchcord.
3. Turn on dB measurement by toggling the **dB** button to **blue**.
4. Select the **OLS** tab, select the laser wavelength, and turn **ON**. Press **Loop** to select and cycle through all desired wavelengths.
5. Select the **OPM** tab and select the measurement wavelength or press **Wave ID** to automatically detect the correct wavelength.
6. Tap **Set** to record the 0.00 dB point for each wavelength. A reference point is established and the calibrated LS can be connected to one end of the fiber with another OPM connected at the other end to measure the fiber link loss. Tapping **Set** will overwrite previously saved reference value(s).

To measure reference cable loss using an external light source:

1. Connect the OLS to the OPM port using a patch cord.
2. Turn on dB measurement by toggling the **dB** button to **blue**.
3. Select the measurement wavelength. If using a supported VeEX light source in CW mode, pressing "Wave ID" automatically selects the correct wavelength.
4. Tap **Set** to record the 0.00 dB point. A reference point is established and the calibrated LS can be connected to the far-end of the fiber to measure the loss. Tapping **Set** will overwrite previously saved reference value(s).

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Measuring Power (dBm)

1. To begin testing, zero the meter by closing the dust cap and pressing the **Zero** button.
2. Insert the fiber being tested into the OPM port.
3. Select the measurement wavelength. If using a supported VeEX light source in CW mode, pressing "Wave ID" automatically selects the correct wavelength.
4. Tap **Acquire** to record a result. Acquired results can be viewed from the **Table** tab and saved from the **Results** tab.

Measuring Loss (dB)

1. Set reference values for all testing wavelengths (refer to [Calibrating to Laser Source] for more details.
2. Remove the reference cable and connect fiber to the OPM port on the unit.
3. Tap **Acquire** to record a result. Acquired results can be viewed from the **Table** tab and saved from the **Results** tab.

Readings (Table tab)

OPM readings appear in the **Table** tab. Saving readings will permanently write data to the **Results** tab. More than one reading can be saved at a time. Use this function to organize/filter results in project batches, so that the correct set of results are grouped together appropriately. Pressing **Remove** will permanently remove the readings from the current list.

To view and save (enter) test results into the Results table:

1. Select the OPM tab. Verify the insertion loss (IL) values are acceptable, then tap **Acquire** to load values into the **Table** tab. The **Table** tab title shows how many fiber records have been temporarily saved in the format **Table*-*n* NEW**, where n is the number of new records.

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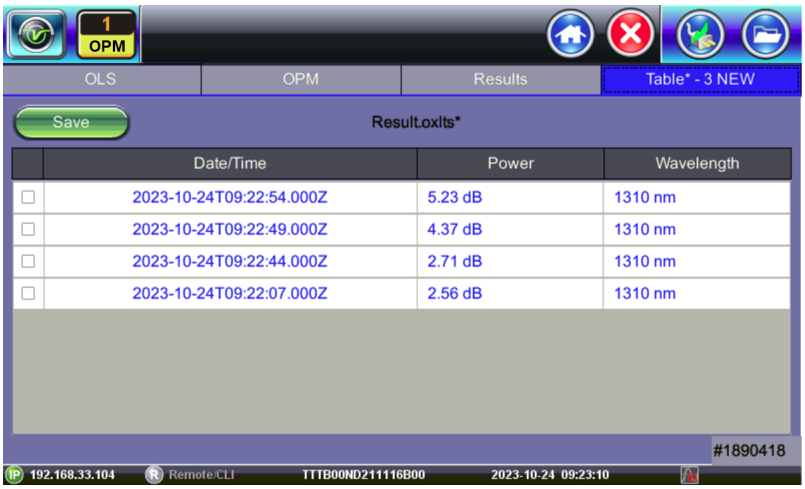
2. To view the active results table, select the **Table** tab.



Press Save to Save Results

3. To permanently save the fiber record locally, select the record(s) and press **Save**. The **Result saving** screen appears. The filename will default to the date/time stamp unless a specific file name is entered.

   The JobID/CableID/FiberID/TraceID fields determine the location to which the trace is saved. If these settings are not set accurately, the trace will not save to the desired location.

4. Tap **OK**. The readings are saved to a file and the table resets.

To remove results before saving, select the checkbox next to the reading(s), then tap **Remove**.

After saving power or loss readings to a file, access the file in the **Results** tab.

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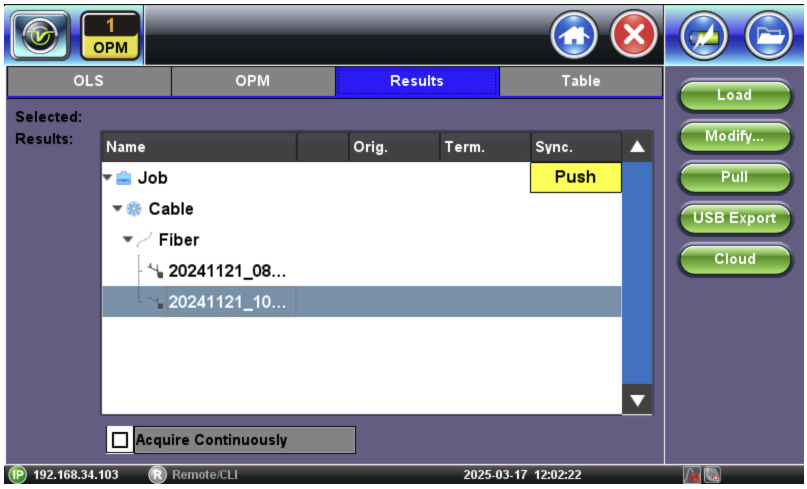
Results

Results can be saved to the test set, exported to USB, or uploaded to Fiberizer Cloud.



Results Management Menu

The results screen is used to view previously saved results. Test results can be pushed/pulled from Fiberizer Cloud. The directory displays the location of stored files. Connect to Fiberizer Cloud, then select the file(s) by tapping them. Refer to "Fiberizer Cloud" on page 619 for details on connecting to Fiberizer Cloud.

- **Push/In Sync**: Uploads locally saved results to Fiberizer Cloud. *In Sync* indicates the results have been saved to Fiberizer Cloud successfully.
- **Load**: Loads the selected results file for viewing.
- **Save**: Manually saves and names the results file (autosave is disabled). Once saved, the files can be accessed in the File Manager or "R-Server™" on page 581.
- **Modify**: Select a file or folder in the directory to modify. Options to Rename, Remove, and upload the selection to Fiberizer Cloud are available.
- **Pull**: When connected, pulls file from Fiberizer Cloud onto test set.
- **USB Export**: Exports files to USB stick. Choose Export Group to retain the tree format (sub-directory) or Export Flat to create a single filename using sub-directories to build a name.

Save continuously: To autosave results at a specified interval (1 to 60 seconds). Use this option to check power drift.

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Wi-Fi Spectrum Analyzer

The VeEX Wi-Fi SA USB dongle is discontinued and no longer supported.

Wi-Fi SA was a portable spectrum analyzer on a USB dongle that displayed all RF activity in the Wi-Fi bands (e.g., wireless networks, cordless phones, microwave ovens, Bluetooth devices, etc.).

For users who still have the dongle, the feature offers the following capabilities:

- Helps determine the best available WLAN channels quickly for optimal performance
- Helps to visualize and locate RF signals in the 2.4GHz and 5GHz spectrums
- Discover and remedy competing access points
- Optimize WLAN networks by locating and eliminating interference sources

Parameter	2.4 GHz	5 GHz
Frequency range	2.4 to 2.495 GHz	5.15 to 5.85 GHz
Frequency resolution	26 kHz to 3 MHz	24 kHz to 3 MHz
Filter bandwidth	58 to 650 kHz	54 to 600 kHz
Antenna type	RP-SMA	
Amplitude range	-100 dBM to -6.5 dBM	
Amplitude resolution	0.5 dBM	

Wi-Fi SA Specifications

- Supports 802.11a/b/g/n networks
- Supports both 2.4 GHz and 5 GHz bands
- Equipped with RP-SMA antenna jack
    - Allows user to replace standard external Omnidirectional antenna with a higher gain or directional antenna as needed
- The Wi-Fi Analyzer is a compact and portable USB dongle that plugs into the USB 2.0 port of the V300 series
- The Wi-Fi SA test application menu is located in the Tools/Advanced Tools menu

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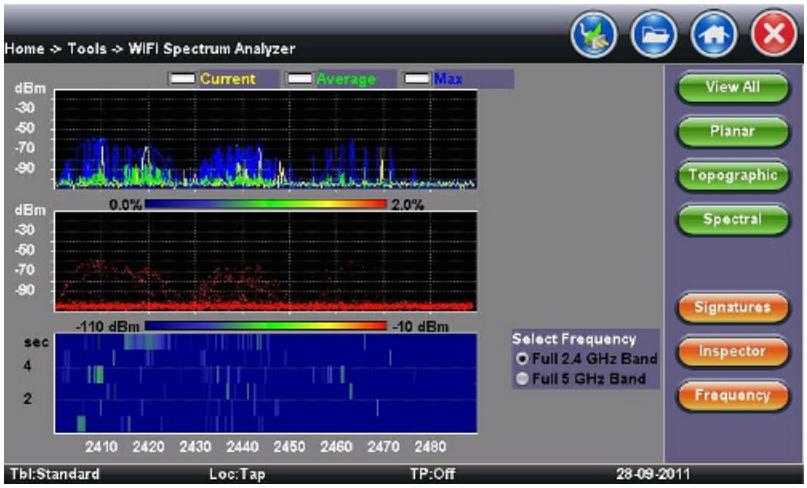

Wi-Fi SA Display Summary

Wi-Fi Analyzer USB dongle

Display Summary

- **Planar view:** Reports current, average, and maximum signal amplitude for each wireless frequency
- **Topographic view:** Emphasizes which frequencies are the busiest across the entire spectrum
- **Spectral view:** Historical view of wireless spectrum use at a point in time

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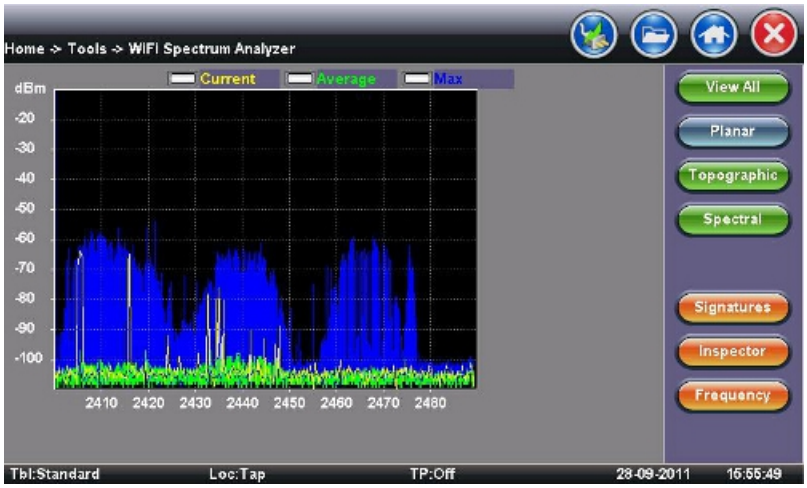
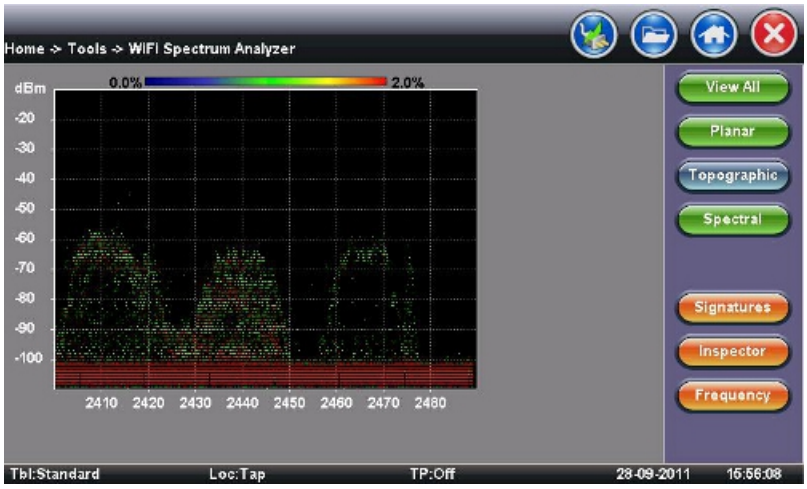


Wi-Fi SA - Planar View

Planar View

- Traditional Spectrum Analyzer view with Max, Average, and Current results
- Displays RF activity in real time and tracks average and max values over a given period



Wi-Fi SA - Topographic View

Topographic View

- Similar to a density map - plots frequency versus amplitude
- Uses a special color scheme to assign colors to frequency amplitude points and to identify how often a particular coordinate is recorded

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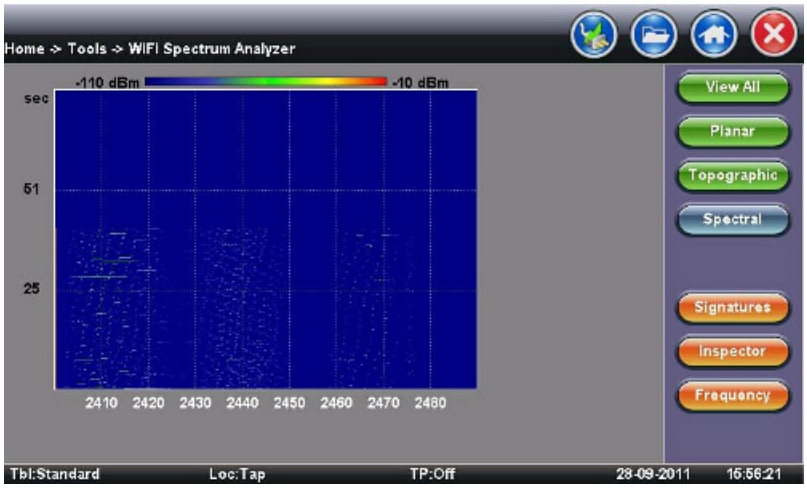
- Great resource for identifying devices with very low duty cycles
- Leaving it running will give a good indication of the typical local network conditions



Wi-Fi SA - Spectral View

Spectral View

- Waterfall type view across the whole band - graphs amplitude levels over time
- Uses color to pick out the relative signal strength at each point in time
- Great tool for troubleshooting intermittent problems, since it highlights devices that are perhaps emitting only short bursts of noise
    - For example - discover microwave oven in the kitchen interfering with WLAN

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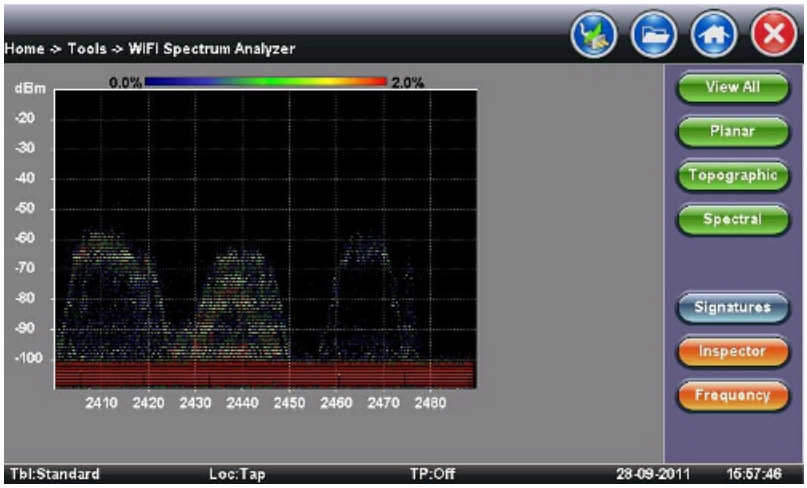
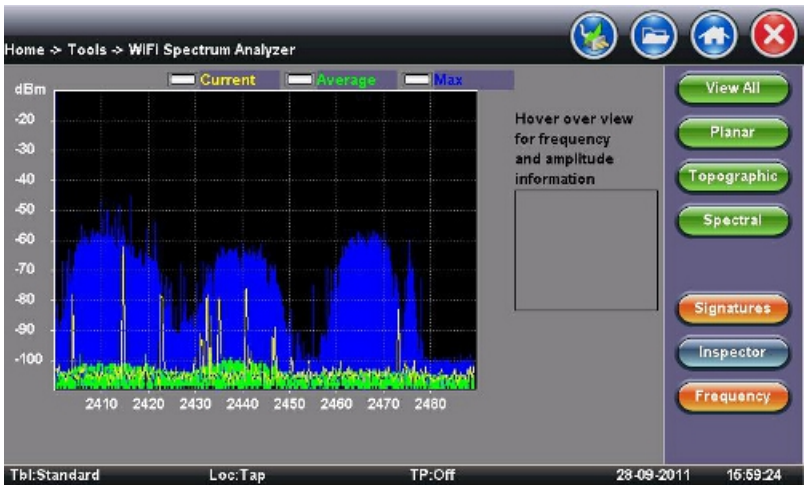


Wi-Fi SA - Signatures

Signatures

- The Signatures button presets are available to identify unknown sources of RF activity (e.g., microwave oven)
- Select a device in the sidebar and click the pattern in the Topographic view to identify a device



Wi-Fi SA - Inspector

Inspector

- The Inspector button setup allows the user to measure the frequency of the RF activity or interference of interest
- When selected, a prompt and result box appears

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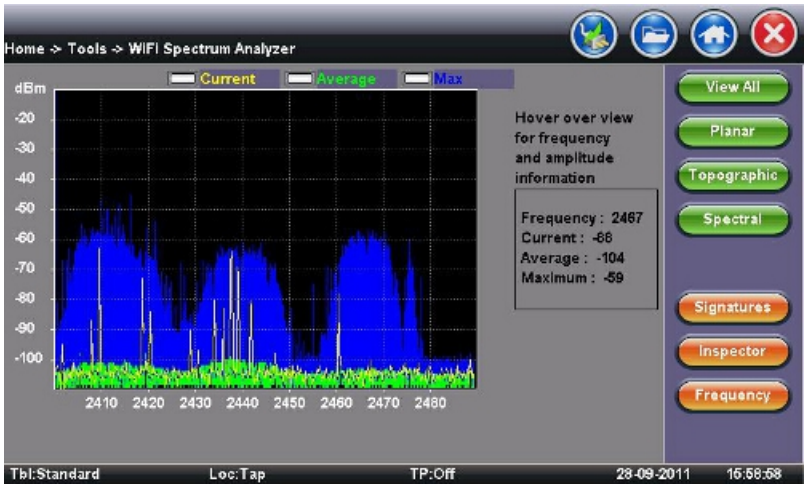
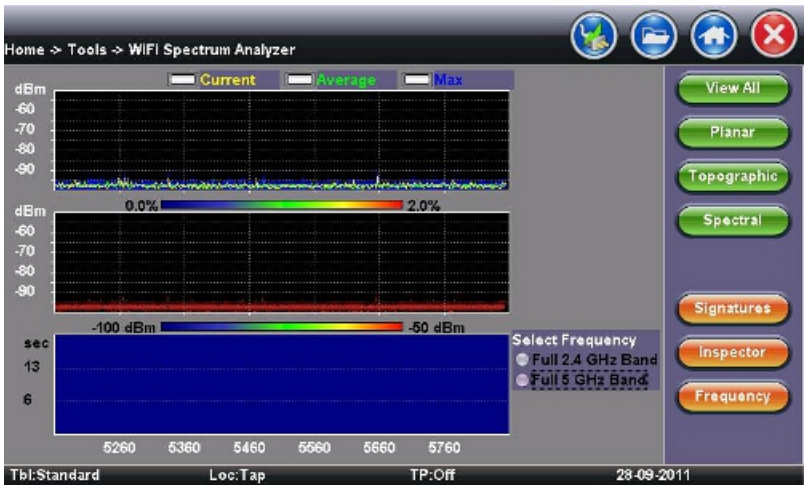


Wi-Fi SA - Inspector - Result

Inspector Button - Result

- Identifies frequency and amplitude
- Current, Average, and Maximum amplitude values provide an indication of level fluctuation over measurement period



Wi-Fi SA - Frequency

Frequency

- This button allows the user to select frequency band for testing

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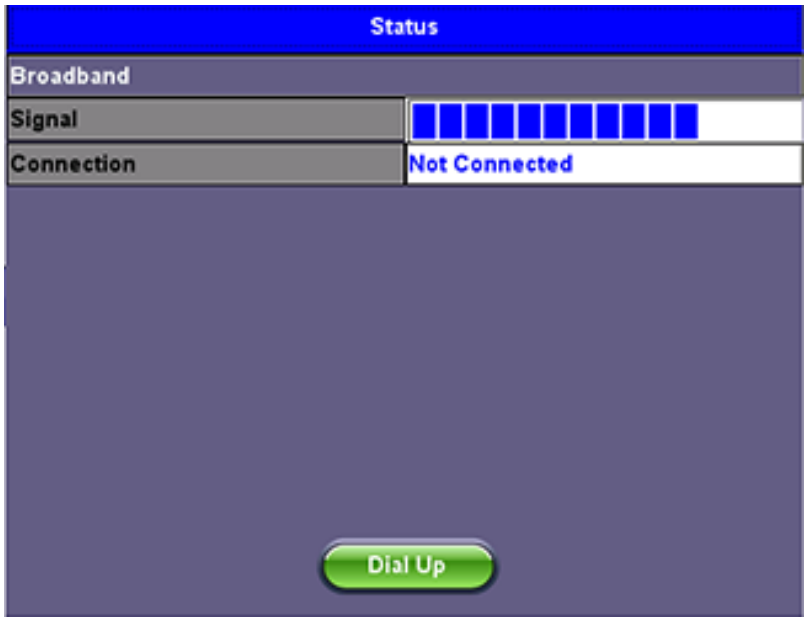
Data Card (3G/4G Cellular Modem)

To establish an IP connection using a data card, the data card must be connected to the USB port. Once connected, the **Data Card** icon will appear at the bottom of the screen.

Only datacards provided by VeEX are supported and have the driver necessary for connection.



Data Card - Status

Press **Dial Up**.In the **IP Tools Setup** menu, **Port** will be displayed as "Datacard Port".

The D for Data icon in the bar on the lower end of the screen will have a red cross to show that datacard is not connected .

Select the **configuration parameters**, then press **Connect**.

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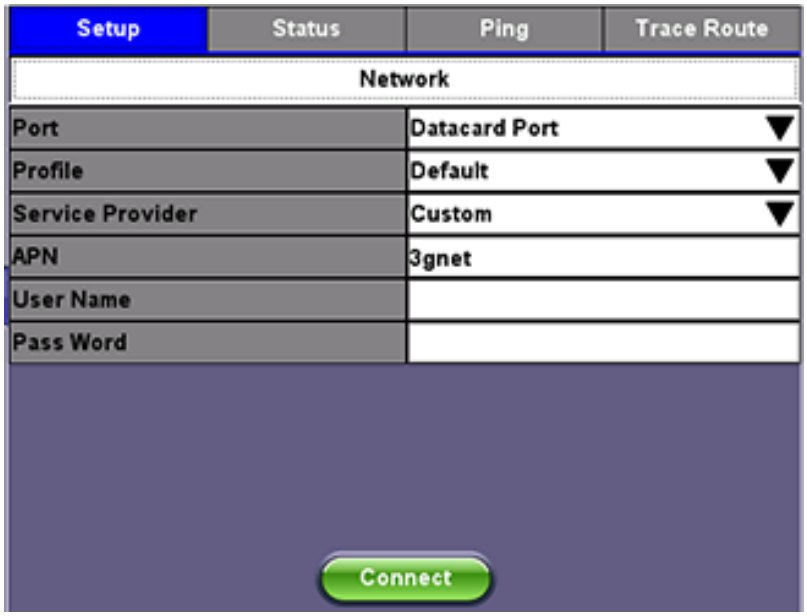

Data Card - Setup

When a connection is successfully established:

- The **D** for Data in the icon turns green .
- The connection details are displayed in the **IP Tools Status** tab.

If the test set is powered off/on and you are in a good reception area or if you enter a bad cell area and return to a good one, the test set will reconnect automatically.

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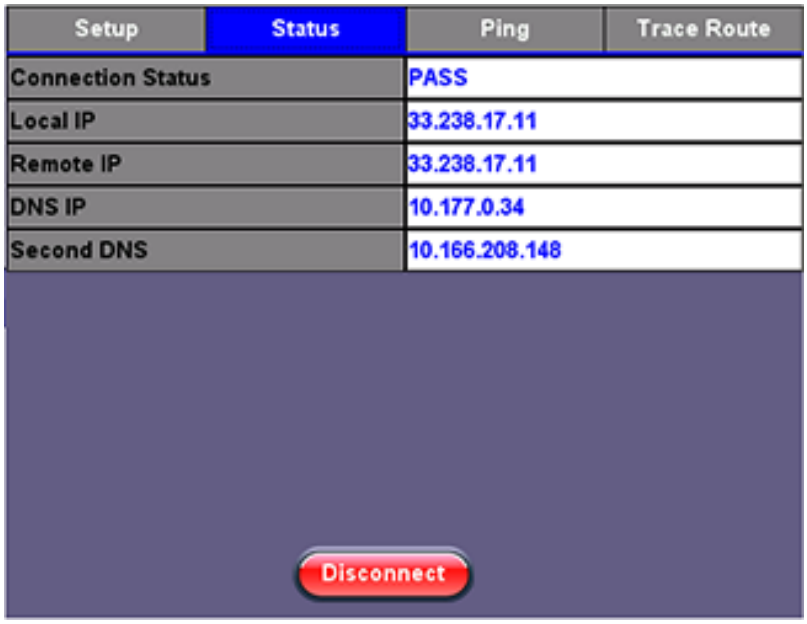
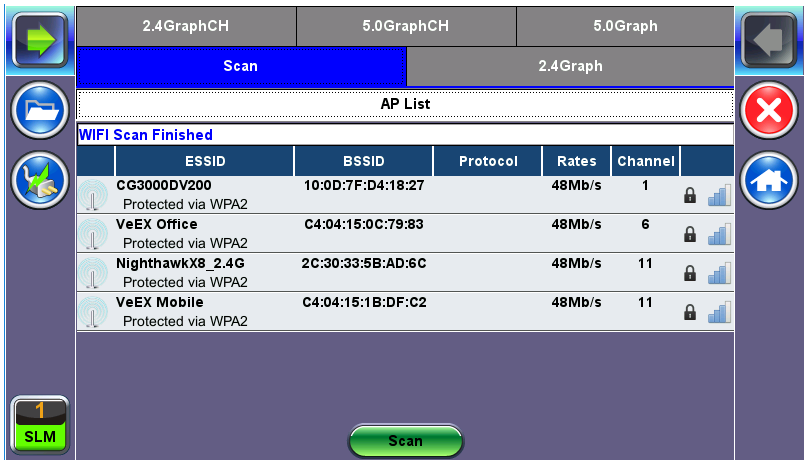


Data Card - Connection Established

Wi-Fi inSSIDer



Wi-Fi inSSIDer Home

The Wi-Fi InSSider supports only the 2.4 GHz frequency band or 2.4 GHz and 5 GHz frequency bands depending on the V150 product model (refer to product specifications for details). The home screen has tabs to display test results for both frequency bands and also for graphical presentation of results for both.

1. Tap the **Scan** button on the right side of the screen. After the scan is completed, the unit displays the list of access points (AP) detected in the 2.4 GHz and 5 GHz bands.
2. The following information is displayed for each AP:

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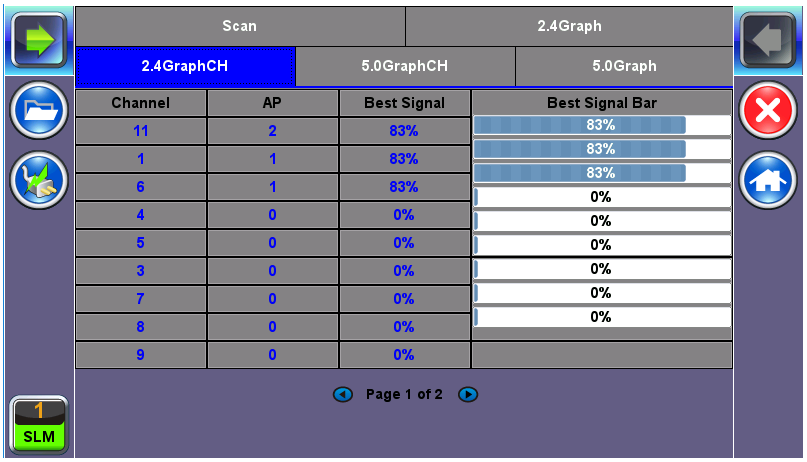
- SSID name of the AP
- BSSID (MAC address) of the AP
- 802.11 protocol version supported by the AP
- Max data rate supported by the AP
- AP's radio channel number
- Lock symbol indicates if security is set on the AP (WEP, WPA, or WPA2).
  When the AP is unsecured, no lock symbol is displayed
- Signal strength of the AP

Access Points in the 5.0 GHZ spectrum can only be displayed if the VeEX USB Wi-Fi adapter supports 802.11a/n or 802.11 a/n/ac. Refer to the USB Wi-Fi adapter specifications.

3. Use the 2.4GHz GraphCH and 5.0GraphCH tabs to view the number of Access Points detected for each channel in the 2.4GHz and 5GH bands and the strength of the strongest AP's signal for each channel.



2.4GHZ Channel

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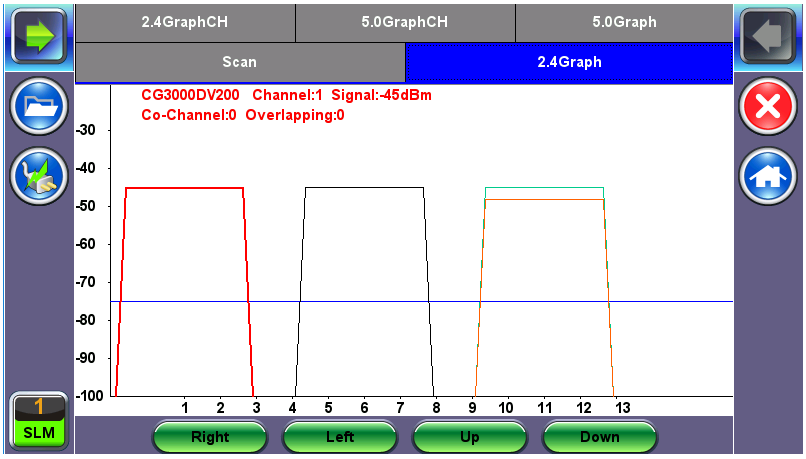
4. Tap the **Graph** tab of the respective Channel to view the results in a graphical presentation.



Graph

5. Use the Right/Left/Up/Down function keys or the arrow keys on the unit's keypad to navigate the graph and get additional information for the access points. Detailed information for each Access Point includes:

    - SSID: name of the AP
    - AP's radio Channel number
    - Signal strength (dBm)
    - Number of co-channel: Number of APs using the same radio channel
    - Number of Overlapping APs: Number of APs using channels whose frequency band overlaps with the AP

OTDR Viewer

This built-in application allows the test platform to view previously saved .sor trace results and edit events, as needed. If an OPX-BOXe is connected to the platform via direct USB connection, Wi-Fi, or Bluetooth®, this built-in application can also be used to control all OTDR test functions.

To access the OTDR Viewer from the Platform Screen, select **Tools** > **OTDR Viewer**.

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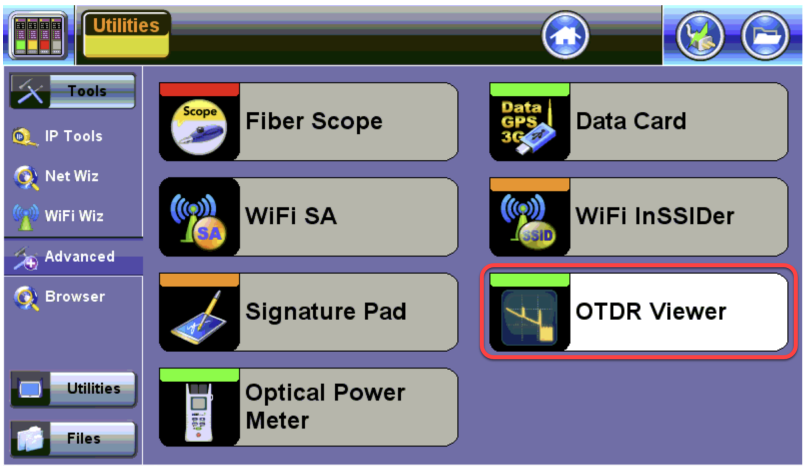

Once paired or connected to the micro OTDR, the test set displays a virtual OTDR user interface that is used to control the OPX-BOXe and perform measurements.

- Traces and Events table view
- Loss calculations
- Compatible with Fiberizer Cloud (upload and download)
- Controls external OPX-BOXe OTDR

Since fibers are commonly placed in access, metro, and transport networks, having a companion add-on OTDR to inspect drop fiber reduces dependence on specialized fiber construction crews troubleshooting fiber related problems.

Refer to the OPX-BOXe User Manual and OTDR Series User Manual for further details about OTDR operations.

GNSS/GPS & Sky View

GNSS Receiver Settings and Operation

This section explains the GNSS Receiver configuration and basic settings required to quickly verify proper module installation and operation. Refer to the tables at the end of this document for application-oriented settings.

1. Install the portable antenna facing up, on a stable surface or mounting, with a wide unobstructed view to the sky or use a professionally-installed in-building roof-top antenna feed.
2. Connect the active GPS or antenna to the GNSS Receiver module's SMA connector. If a BNC-to-SMA or TNC-to-SMA adapters is required, use flexible adapter cables (not rigid adapters) to prevent

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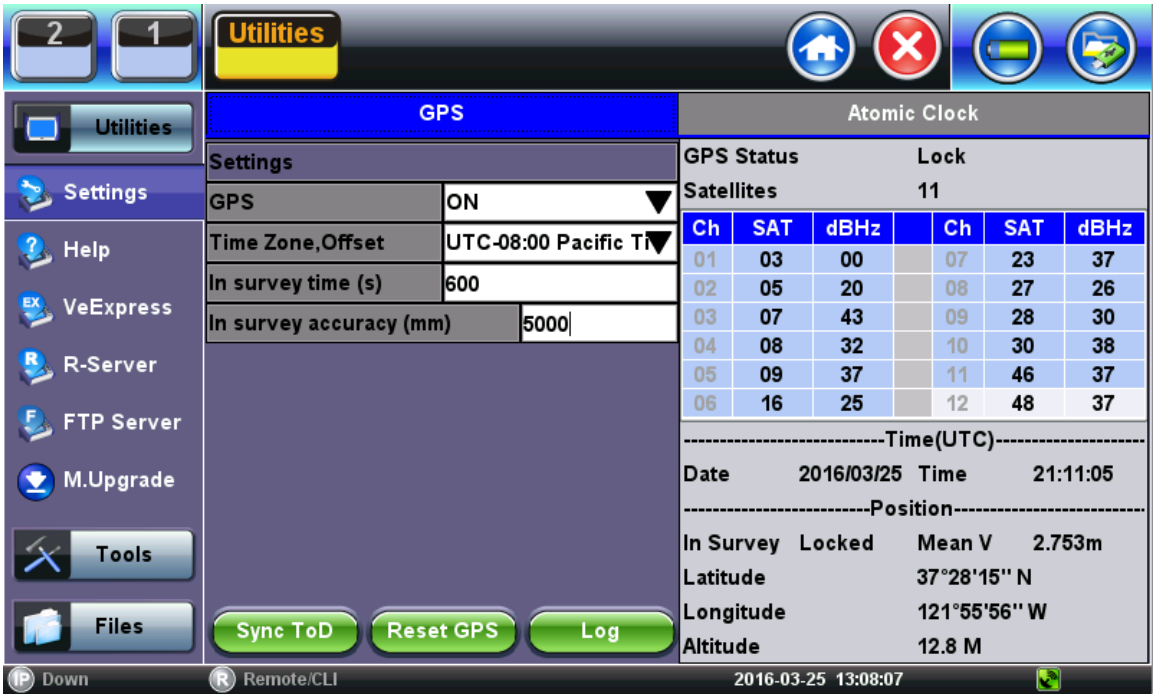
any mechanical stress.

3. Turn the **GNSS Receiver = ON**.



GNSS Receiver On

4. Go to **>Utilities >Settings >More >High Precision Clock >GNSS**.
5. Set the **Satellite System = GPS**
6. Set **In-survey time (s) = 600**, which is the time window used by the GNSS Receiver to assess stable location, using the specified accuracy (below). Having an accurate tri-dimensional location is required to calculate accurate time.
7. Set **In-survey accuracy (m) = 5**, which is a target of <5m for the Mean V accuracy reading. Smaller values tighten the location accuracy requirements, but the site survey process may take longer. It is possible to get better than 1.5m location accuracy when using professionally-installed roof-top antennas.
8. Enter any antenna cable delay that needs to be compensated for (velocity of propagation is cable dependent, their values are around 5ns/m or 1.2ns/ft). Enter **20ns** if using the 5m portable antenna.

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9. Select the **Time Zone Offset** (it is used to calculate the local time of day).
10. Wait for GPS Status on top to show Lock and the icon at the bottom of the screen turns green. It indicates that it is successfully tracking enough GPS and GLONASS satellites.
11. Wait for about 15 to 30 minutes for the **Mean V** value to be below **5.00m** and until the **In Survey** status also shows **Locked**. This indicates that the GPS position has reached the required accuracy (site survey finished) and that it has switched into Timing Mode.
12. At this point, the GPS Module should be providing accurate Time and Timing (1PPS).
13. Tap the **Sync ToD** button to synchronize the test set's (system) real-time clock.

Atomic Clock Settings and Operation

This section explains the different disciplining parameters for the optional chip-scale Atomic Clock and provides the settings required to quickly verify its proper operation. For application-oriented configurations, please refer to the suggested configurations table at the end of this document.

Free Running Stage (Frequency only)

By default, the built-in Atomic Clock oscillator starts in free-running mode, providing a calibrated Atomic 10MHz frequency reference. (Its exact frequency could vary over time due to ageing, temperature, storage and other factors.) It also produces an arbitrary (non-traceable) 1PPS timing signal that is not aligned to the standard UTC second. Disciplining must be used in order to make the necessary frequency and timing corrections.

Oscillator Disciplining Process (Frequency & Phase)

The disciplining process acts as a continuous "soft calibration" that corrects any frequency deviation in the oscillator and aligns the timing pulse (1PPS) to the standard UTC second. The chip-scale atomic oscillator can be disciplined by:

1. The built-in precision GNSS Receiver (GNSS 1PPS).
2. An external traceable 1PPS signal from a primary reference time clock (PRTC) or time standard (Cs or Rb).

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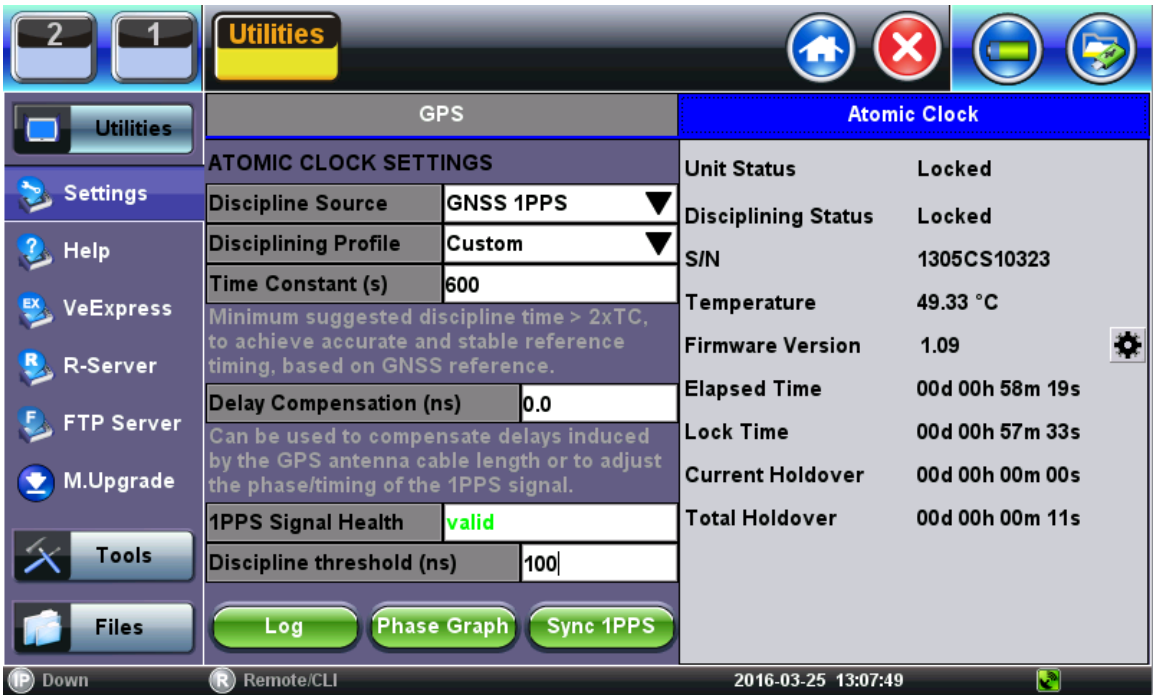
Clock Disciplining - Using the built-in GNSS 1PPS

1. With the GNSS module already locked, go to **>Utilities >Settings >More >High Precision Clock >Atomic Clock**.
2. Set **Discipline Source = GNSS 1PPS**, to use the traceable (UTC aligned) 1PPS timing signal from the GNSS receiver.



Discipline Source

3. Verify that **1PPS Signal Health = Valid**, to confirm that the one-pulse-per-second signal is being detected.
4. Set **Discipline Profile = Custom**.
5. Set Time **Constant (s) = 60** (this small window is only used to expedite the initial phase alignment process).
6. Set **Discipline Threshold (ns) = 100** (a more stringent 50ns could also be tried, if applicable. Use the Phase Graph to determine the stability range).

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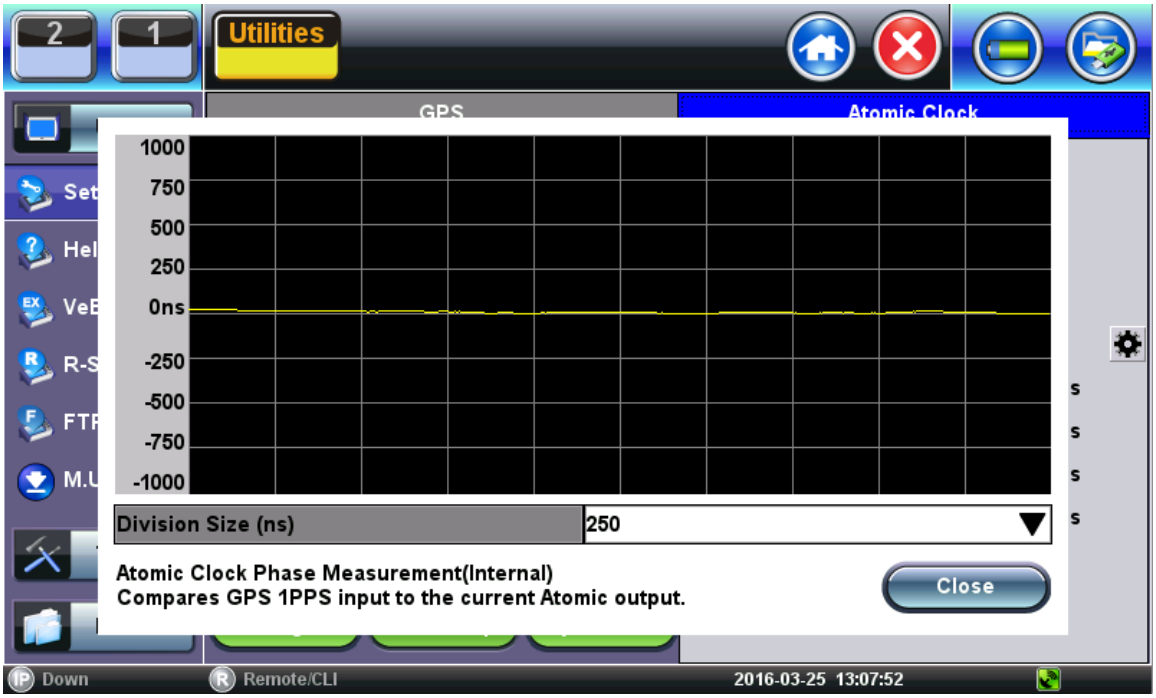
7. Verify that **Disciplining Status = Acquiring**. This indicates that the disciplining process is in progress.
8. Tap on the **Phase Graph** to monitor the relative phase error until it becomes a horizontal line close to 0ns. The time required for this may vary (it should take less than 15 minutes)
9. Close the Phase Graph and set the **Time Constant (s) = 900**. You can also experiment with larger time constants (e.g. 1800s, 3600s, 5400s). The larger the constant the more stringent the disciplining process becomes and the longer it takes to achieve disciplining lock. To declare lock, the Atomic Clock verifies that the relative phase stays within the defined Disciplining Threshold for about 2x Time Constant (to confirm its stability). You can use the Phase Graph to monitor the actual phase variations on your current GNSS environment for the past 600s.



Discipline Source Phase Measurement

10. Open the **Phase Graph** again to monitor the time error. Once it stabilizes again around 0ns, wait for about 60 minutes. The line should stay flat and very close to 0ns. If not stable, please check the GPS satellites and antenna installation.

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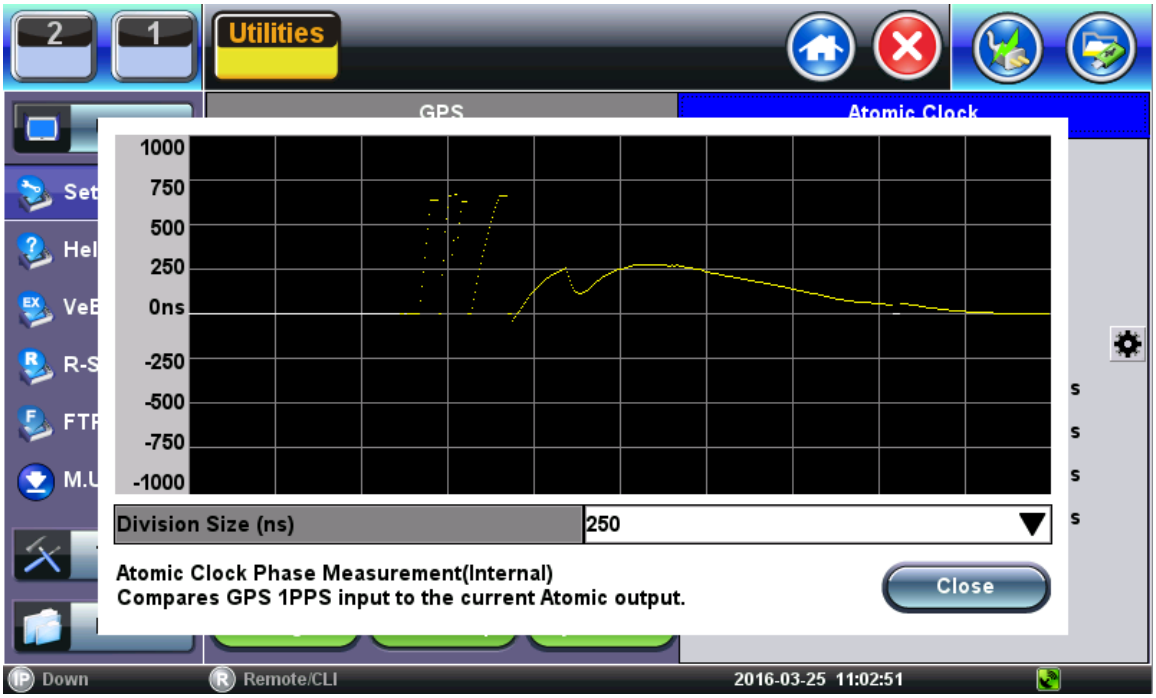

Discipline Source Phase Measurement

11. Close the Phase Graph and verify that the **Disciplining Status** gets into **Locked** mode.

At this point the test set's internal "Atomic 10MHz" frequency and "Atomic 1PPS" timing reference signals can be considered accurate and stable.

The Phase Graph (above) can be used to monitor the short-term stability of the raw GPS clock, which can be used to determine the Discipline Threshold for a particular site or scenario. Zoom in to the 50ns grid and estimate how disperse the 1PPS samples are (in ns), then use a larger value as a threshold. A vertical variation of <30ns is OK.

Verifying the Antenna Field of View

Not many of us would be tempted to get on the roof or climb to the top of a tower to perform a 360° visual inspection to identify any potential satellite signal obstructions. But even if you do, you won't be able to "see" interference, multi-path or other RF effects.

As all "visible" GNSS satellites move around their orbits, the directional vectors pointing at them form dome above the antenna. Their received signal qualities change over time, depending on their elevation angles, obstructions, reflections and other factors.

To track this, you need a tool that records the C/No of every satellite as they pass by the antenna's aperture (field of view), to create a flat (2D) projection of a 360° color-coded dome-shaped "heat" map representing the

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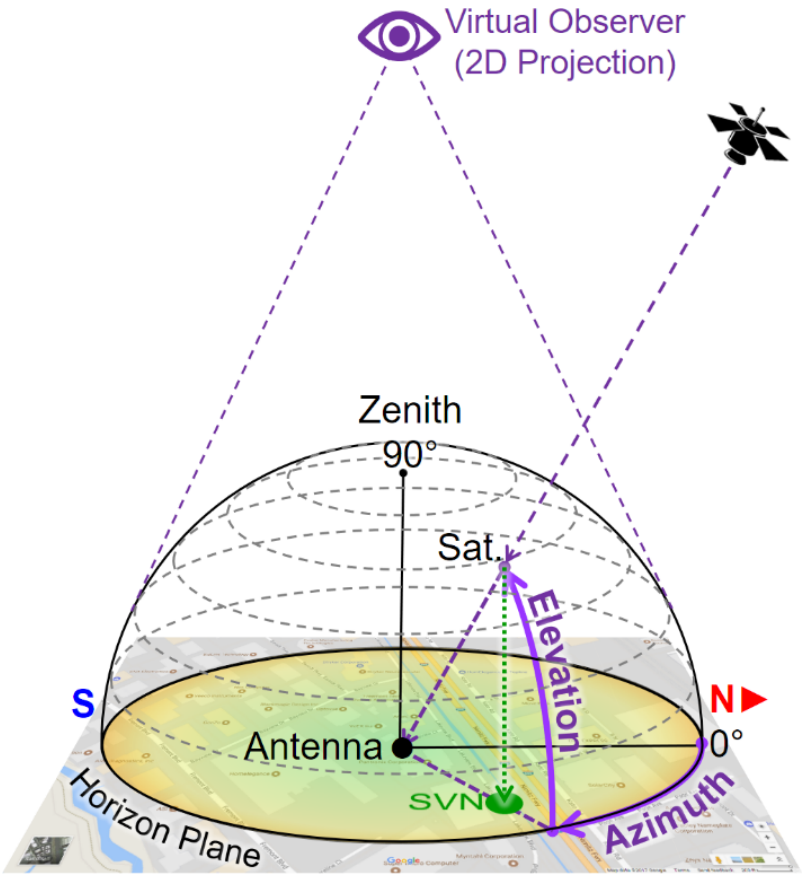
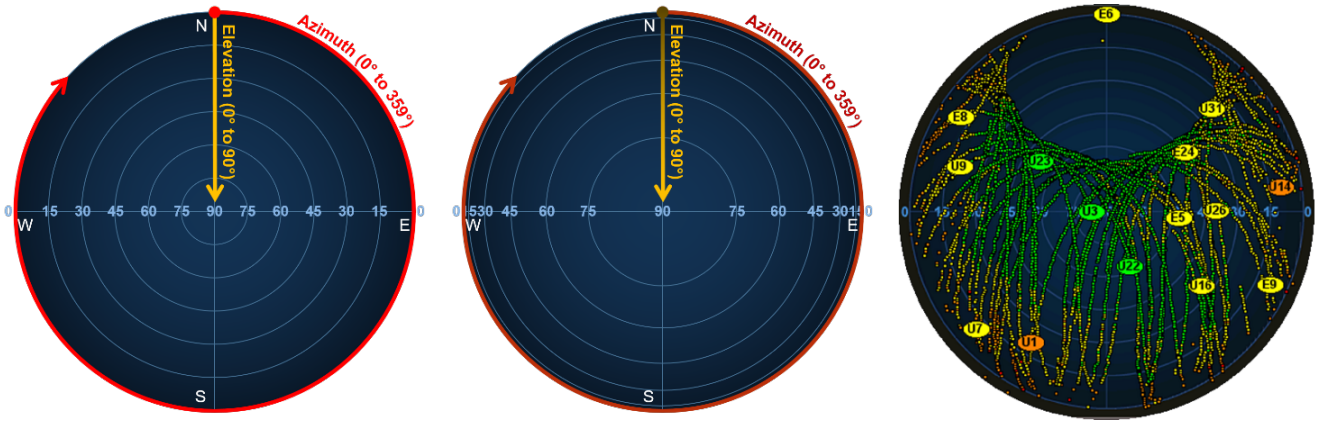
field of view of the antenna and the signal quality from every direction. These azimuthal graphs allow you to identify areas (directions) with degraded signal quality.



Building such maps usually takes >**24 hours**, to allow each satellite to complete one cycle over the antenna (not to be confused with their ~12-hour orbital cycles).



Examples of 2D Linear and Cosine projection (polar) grids, as well as actual satellite trails recorded

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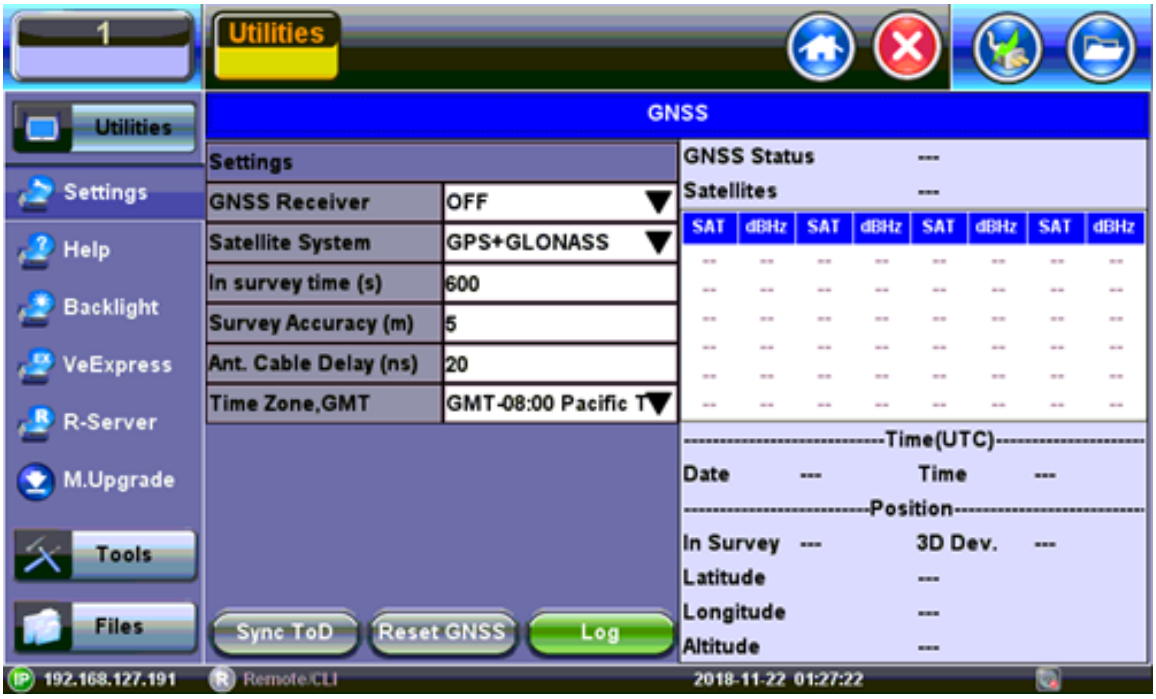
This type of tool can also be used to evaluate and benchmark different antennas in real life and under the same conditions. The areas in yellow indicate the directions with degraded satellite signals are, such as RF “shadows” cast bet trees and buildings. They can also indicate interference. As the signal degrade even more they turn orange and red. The example below shows the correlation between the sky view map and a map of the area around the antenna.

1. Go to **>Utilities >Settings >More >High Precision Clock**.

2. Turn the **GNSS Receiver = OFF** and close the screen.



GNSS Receiver Off

3. Go to **>Tools>Advanced>More>GNSS**.

4. Select the **Time Zone** from the **Time Zone Offset:** drop-down list box.

5. Enter a **Test Name** from the **File Name**: drop-down list box.

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6. Select the **Duration** of the test from the **Duration**: drop-down list box.

GNSS Setup

7. Tap on the **Arrow** to open the menu and tap on **Start**.

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GNSS Start Menu

GNSS Start

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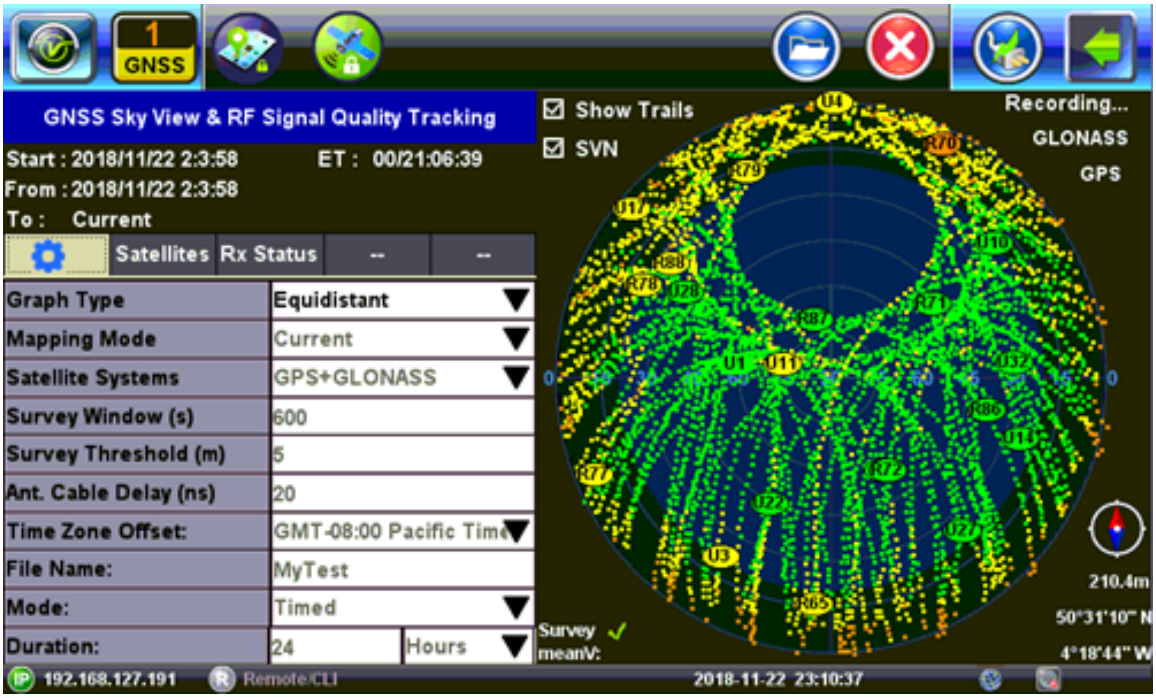
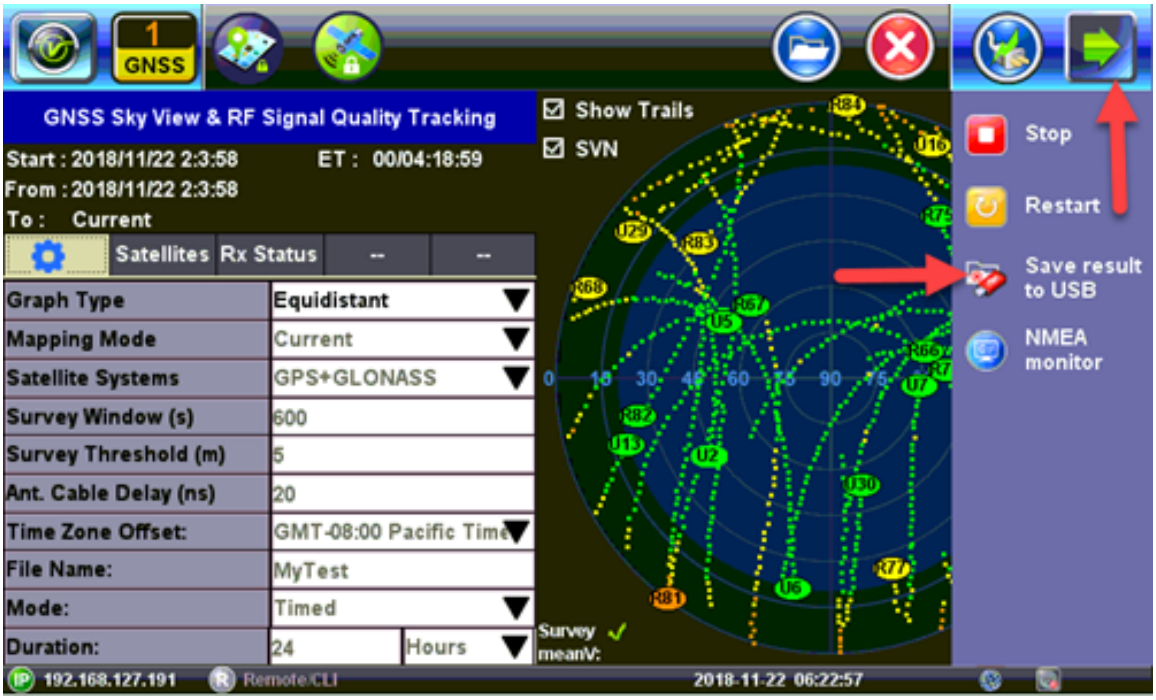


GNSS Results

8. To save **Results to USB** tap on the **Arrow** and then tap on **Save Results To USB**.



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Web Browser

A web browser is available in the **Tools > Browser** menu and can be used to quickly verify Internet connectivity.

The built-in web browser uses the management port IP connection. An active IP connection can be established either through Ethernet or Wi-Fi. The web browser defaults to VeEX's test website. Use the Web browser's navigation bar to enter the name of the website you wish to reach. Navigation capabilities may be limited.

Browser

Files

File Manager: Working with Saved Results, Profiles, Images

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Access the File Manager by selecting **Files**> **Saved** in the left panel of the platform menu. Files can be viewed, edited, or exported to a USB dongle or a PDF file (using a FAT32 USB Memory stick). Use the check box ☑ to select the desired file(s) or choose all files by selecting the check box in the top header row.

Table Sorting

Tap a column header to sort the table in ascending or descending order by the column selected.

Tap the filter icon in the column header row to filter for specific test results stored on the unit.

At the top of the screen, tap the green buttons for view options.

Displays full filename.

Search for specific file(s) using advanced search terms.

Displays all records.

Select columns to make visible.

Opens the selected test report (one).

Closes the current test report and returns to File Manager.

Exits the File Manager.

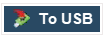
Deletes all unlocked test reports that are selected with checkmarks.

Renames the selected test report (one).

Unlocks or Locks test reports. Locked reports are identified by a red padlock icon. Locked test reports cannot be deleted or renamed.

Generates a PDF copy of the test report and stores it in an attached USB memory stick (required) for distribution (e.g., via email).

Imports (restores) all test results, test profiles and screenshots stored in an attached USB Memory Stick. The included On-The-Go (OTG) micro-B USB to USB-A adapter cable is required for the USB memory stick.



Exports (backup) all selected test results, test profiles and screenshots stored to an attached USB Memory Stick. The included On-The-Go (OTG) micro-B USB to USB-A adapter cable is required for the USB memory stick.

Transfers selected test results, test profiles and screenshot files to a paired Bluetooth® smartphone, tablet or PC.

Loads the selected test profile, if supported.

Loads the selected test profile and runs the test, if supported.

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Enabling To USB and From USB Functions

1. Insert a USB Memory stick (FAT32 file format) into a USB port on the side of the unit.
2. Wait for the USB memory to be detected (the folder icon at the top-right corner will change to a green USB memory icon). After the unit detects the USB memory stick, files can be downloaded to or restored from USB. See "USB Memory Browser" on the next page for details about using a USB memory stick with the test set.

Downloading Files To USB

1. Select the test results, test profiles, or screen capture files to be saved. For a full backup, tap the check box in the top header row to select all files.
2. At the bottom of the screen, tap the **To USB** button

to initiate the file transfer procedure and wait for the progress bar to finish. Original files won't be deleted from the test set. Each file is saved into its own folder using the "MyVeEX" tree directory format.
3. When all files have been copied to the USB, tap the folder icon (top-right corner) and select **Remove USB Drive** to make sure all cached data is transferred to the USB drive, especially when transferring small files.

Exporting Files to Mobile Devices via Bluetooth

Applies to test sets with compatible Bluetooth USB dongle attached.

1. Select the test results, test profiles, and/or screen capture files to be exported. For a full backup, tap the check box in the top header row to select all files.
2. At the bottom of the screen, tap **BT**

. The test set scans for Bluetooth devices automatically.
3. After pairing the device, tap **Send** to export the selected files. Original files won't be deleted from the test set. Each file is saved into its own folder using the "MyVeEX" tree directory format.

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Exporting Results to PDF

1. Select the test result files to be exported.
2. At the bottom of the screen, tap **PDF** PDF. A "PDF file will be generated to USB disk" message appears.
3. Tap **Yes**.

USB Memory Browser

Use an USB-A OTG cable (optional with purchase) to connect a USB to the micro-B USB port. The port supports memory drives and USB add-on devices such as fiberscopes.

The File Manager (**Files** > **USB**) provides basic USB memory stick management tools to browse and manage files without the need of a PC. If needed, use the micro-B USB to USB-A adapter to connect to the USB memory stick.

Import OTDR	When an OTDR module is used, OTDR test results (SOR files) can be imported.
Reload	Refreshes the USB stick info.
Delete	Erases the selected files or folders.
Up	Exits the current folder and moves up to a higher folder in the file tree hierarchy. The current folder structure is shown in the top bar.
Open	Opens certain file types.

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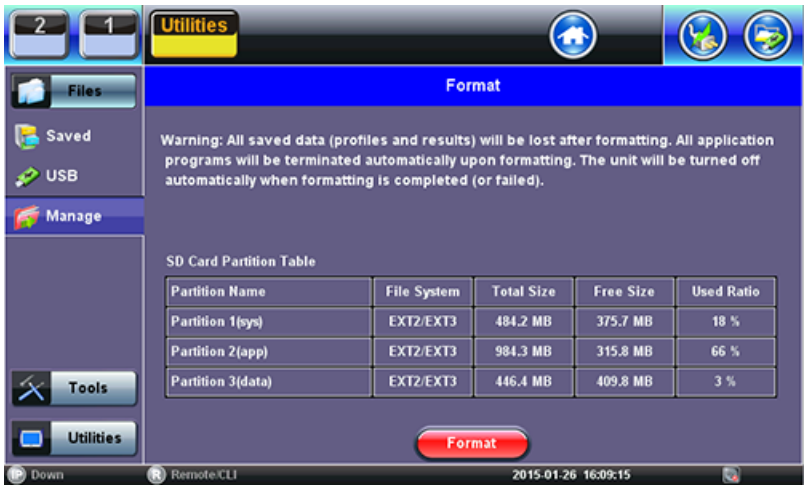
The USB tool supports one USB memory stick. If more than one memory stick is available, it shows the first USB memory stick recognized from any of the two ports.

The following file types are supported:

- **HTML:** Launches the browser to display its content (test results and OPM results)
- **TXT:** Launches a basic text viewer to display its content (test results and OPM results)
- **PCAP:** Launches the built-in Wireshark® protocol analyzer
- **MTIE:** Launches the optional built-in Wander Analysis tool
- **SOR**: Supported with OTDR module or built-in test set only.
- **PNG**: Screenshots (Fiberscope images)

Manage Internal SD Card



The SD card tool provides Internal SD card's partition capacity information.

All saved files, such as profiles, test results, and screen shots, are stored in the Data partition 3(data).

If the data partition is nearly full, use the **File Manager** to backup files to USB, then delete selected files.

The **Format** function is exclusively a maintenance tool. Use **ONLY** when instructed by a VeEX Customer Care representative. **It erases all the information stored in the test set!**

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- *The internal SD Card contains the System OS, all the Test Applications (Apps) and user's data.*
- *Only the Data partition is accessible to users, through the test set's functions.*
- *Do not remove or reformat the SD Card outside of the test set.*
- *The SD card can only be accessed by opening the test set.*

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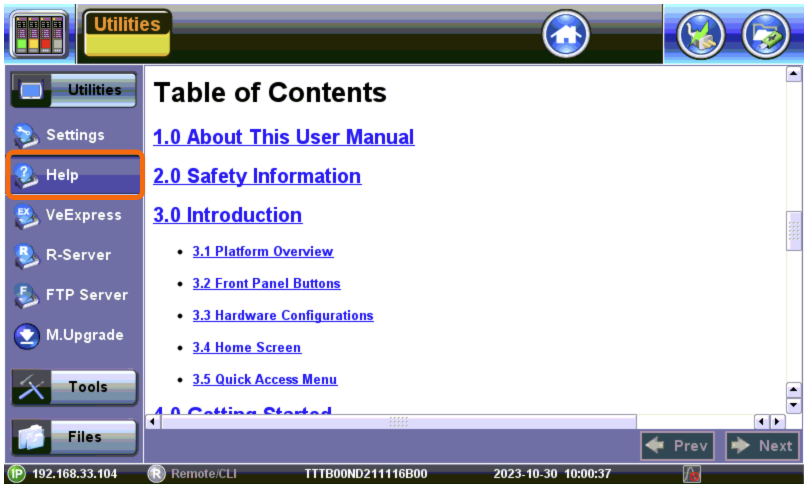
Help

The **Help** option opens up the user manual. Use the scroll bars, table of contents, and hyperlinks to navigate the content.



Help

The **VeEX Inc. Knowledge Base** provides further assistance and answers frequently asked questions regarding VeEX Inc. products.

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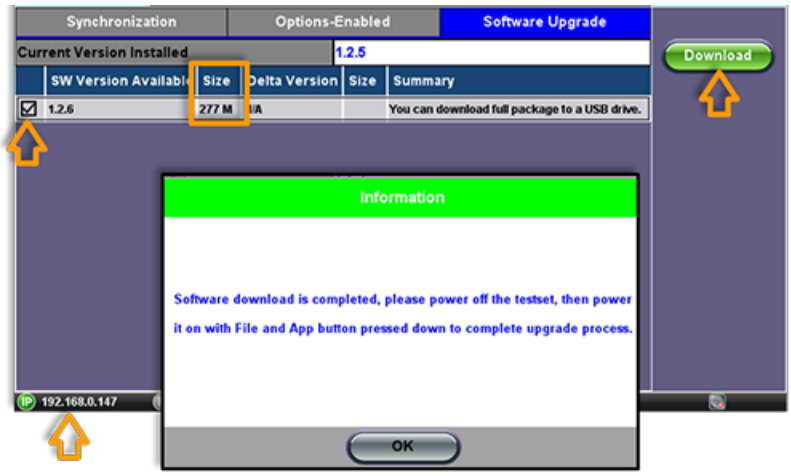
Software Upgrade

The RXT-1200 includes the bootloader, OS and system-wide (common) features. Its software update package can be identified as RXT-1200-veex.tar.gz. The software upgrade packages can be downloaded from www.veexinc.com, or using the test set's built-in "VeExpress™" on page 576 client.

Platform Software Upgrade Procedure

1. Obtain the RXT-1200-veex.tar.gz system upgrade package.
   a. Download it from www.veexinc.com, www.v-express.com, a link provided or by using the built-in VeExpress client.
   b. Unzip the file and copy to the root of a FAT32 USB memory stick if necessary.
2. Insert the memory stick to the USB port located on the left-side of the unit.
3. Simultaneously press the Alternate Function, the Enter, and **Power** buttons, until it beeps.

   The update process may take a few minutes. Once it is complete, the test set reboots automatically.



Software Download

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Buttons to be pushed simultaneously

After the System upgrade, the following pop-up message may appear if a module upgrade is required. Follow the module update procedure.

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Module Software Upgrade Procedure

1. Obtain the required RXT-1200-300sm.tar.gz, RXT-1200-320sm.tar.gz and/or RXT-1200-OTDR.tar.gz, upgrade files.
    a. Download them from www.veexinc.com, www.v-express.com, a link provided or by using the built-in VeExpress client.
    b. Unzip the files and copy to the root of a FAT32 USB memory stick if necessary.
2. Insert the memory stick to the USB port located on the left-side of the unit.
3. Initiate Software Upgrade process.
    a. Open the Utilities section Go to **>Utilities >M.Upgrade**.
    b. Select new version and press **Upgrade**. The test set turns itself **OFF** at the end.

The built-in VeExpress client downloads the uncompressed RXT-1200-xxxx.tar.gz upgrade packages directly to the root of the memory stick attached to the test set, so the M.Upgrade process can be started right away

The process may need to be repeated if two different blade types are loaded.

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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

RoHS ComplianceVeEX QUALITY AND ENVIRONMENTAL POLICY

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

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

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RoHS and WEEE Position Statement

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

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

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

For more information about RoHS as it relates to VeEX Inc, go to www.veexinc.-com/company/rohscompliance.

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About VeEX

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

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

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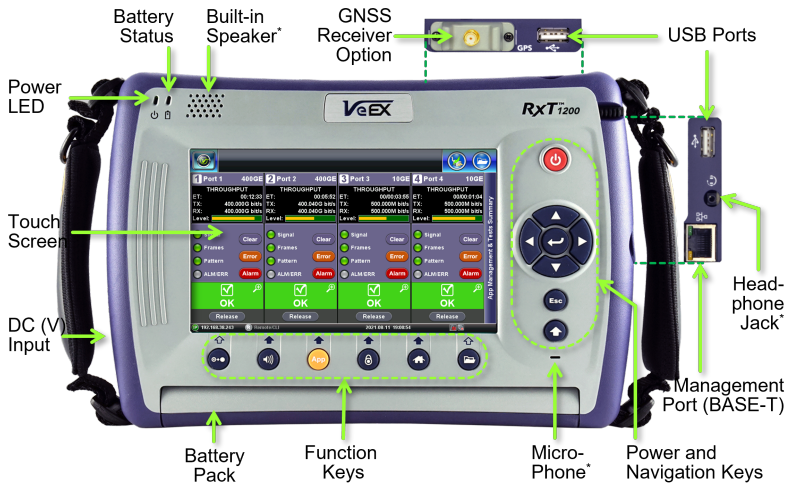
RXT-1200 Quick Guide

The RXT® Test Platform is a family of modular telecommunication test and measurement equipment. It comprises of a common Test Platform (host or chassis) and different interchangeable test modules (each geared toward specific applications and/or technologies).



Some versions of the RXT-12xx platform may not offer microphone, speaker or headset jack (optional). However, some of the features requiring audio access may still be supported by dedicated audio jacks on the test module's connector panel.

Accessories & Hardware Options

- One AC/DC Adapter and Power Cord.
- Optional carrying case (if ordered).
- Optional USB Wi-Fi 802.11a/b/g/n/ac dual-band dongle (if ordered).
- Optional USB Wi-Fi 802.11b/g/n + Bluetooth 4.0 dongle (if ordered).
- Optional USB Bluetooth dongle (if ordered).
- Optional Optical Transceivers (if ordered from VeEX).

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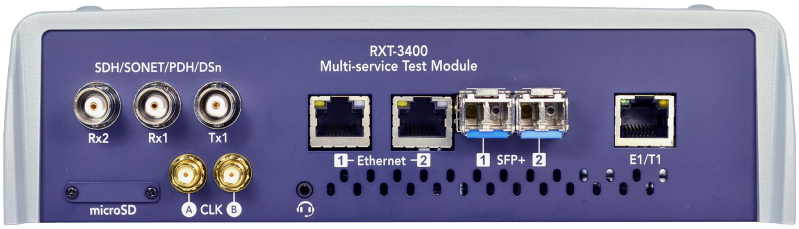
- Optional GNSS or Multiband GNSS receiver (comes pre-installed, if ordered).
- Optional GPS or Multiband GNSS antenna (if ordered).
- Optional Atomic Clock hardware option (built-in, not visible from the outside).

RXT Test Modules

RXT-3400 Advanced 16G Multi-Service Test Module

The RXT-3400 multi-service test module for the versatile RXT® test platform offers state-of-the-art support for Access, Metro, Core, Transport, Carrier Ethernet, Backhaul, Fronthaul and SAN technologies up to 16GFC. VeEX RXT® is the industry's most flexible, compact, complete and future-proof hand-held test solution, from 64k to 400GE, including Fiber Optics and WDM.



RXT-4100+ OTDR Module

Features a range of Optical test functions including OTDR, OPM, Light Source and VFL. Physical link for OTN, SDH/SONET, Ethernet, Fibre Channel and Synchronous Packet Networks utilizing optical fibers can easily be verified as well as OSA testing on CWDM/DWDM network with a single test platform ensuring maximum test productivity.

RXT-4113+ Tunable xWDM OTDR Module

The industry's first combined CWDM/DWDM OTDR in a single test module. CWDM and DWDM (C-band) wavelength tuning with up to 500,000 data point sampling resolution offers unprecedented network characterization.

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RXT-4500/4510 Series OSA Modules

The RXT-4500/4510 OSA modules are practical Optical Spectrum/Channel Analyzers for CWDM and DWDM networks. Using superior micro-optic design and MEMS tuning technology, the modules measure key optical parameters such as wavelength, channel power, and OSNR.

RXT-6000e 100G Multi-Service Module

The RXT-6000e is a complete and flexible portable 100G test set. Equipped with most common transceiver form-factor ports and optional legacy test interfaces, this module is a perfect complement to the RXT® Platform, extending its testing range to 100 Gbps, with CFP2 or QSFP28 transceivers. It features 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 Universal Module

VeEX® RXT is the industry's most flexible, compact, and future- proof hand-held test solution for core, metro, edge, and access networks. The RXT-6200 module adds Ethernet, 5G/4G Mobile Backhaul and Fronthaul, Storage Area Networks, OTN, as well as legacy SDH/SONET, PDH/T-Carrier links and services testing, from 1.5/2 Mbps up to 100 Gbps.

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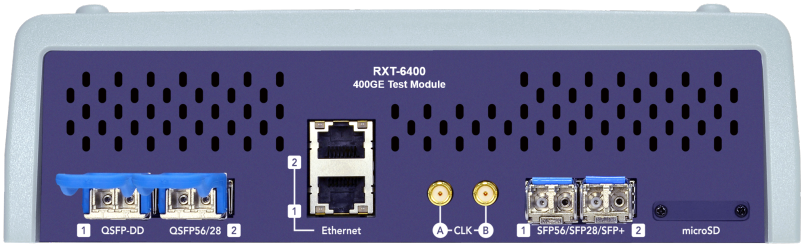
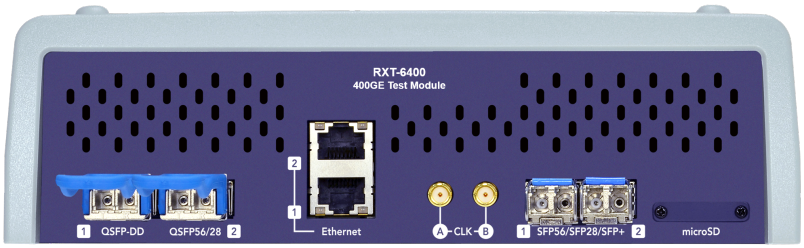


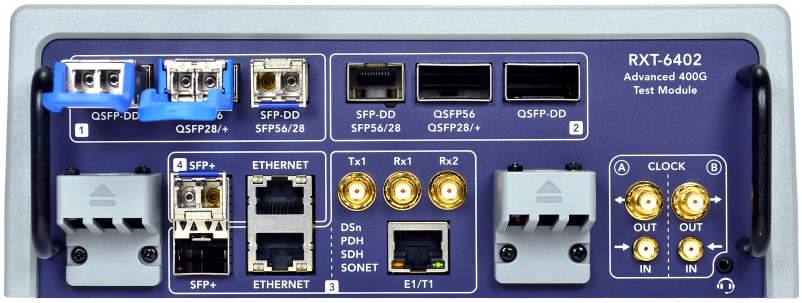
RXT-6400 Advanced 400G Test Module

The RXT-6400 was introduced as the first truly portable 400G test set supporting native PAM4 QSFP-DD and OSFP. Equipped to support all common transceiver form-factors, this module is a perfect complement to the RXT Platform, extending its testing range to 400 Gbps and offering all-in-one 1GE-to-400GE testing capabilities. It features an array of advanced layer 1-to-4 features, such as FEC codeword Error distribution analysis, PAM4 pre-emphasis, skew, transceiver check and stress, Lane BERT, Throughput test, IPv4/IPv6, transceiver testing and much more.



RXT-6402 Advanced Dual 400G Multi-service Test Module

The RXT-6402 Dual 400G Multi-Service test module offers the flexibility of testing current interfaces and supporting future expandability for applications including Transport, Metro, Edge, Aggregation, cross-connect, 5G x-haul, and NEMs field support.



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Basic Operations

- Power – Turns the test set ON and OFF.
- Clear History – Removes Error/Alarm reminders (blinking LEDs). Doesn't clear results.
- Volume Control – For applications with voice (VF) channels.
- Application Switcher – Allows users to quickly toggle between active test applications.
- Lock/Screenshot – Locks touch screen (can be configured to take pictures of the screen).
- Home – Goes back to the current test application's Main Menu.
- Save Results – Press it to manually save current test results.
- Cursor and Navigation buttons' functionality depends on individual test applications.

Software Upgrades

To perform an RXT-1200™ platform (system) software upgrade, insert a FAT32 USB memory stick, with the installer package, into one of the test set's USB ports and simultaneously press the **Alternate Function**, **Enter**, and **Power** buttons, until it beeps.

Platform and Module software upgrades can also be performed by pointing any standard web browser to the test set's IP address and selecting Platform Upgrade and Module Upgrade from the menu. The software upgrade packages can be downloaded from www.veexinc.com, or using the test set's built-in VeExpress client software.

Module Upgrades

To upgrade module software, insert a FAT32 USB memory stick, with the installer package, into one of the test set's USB ports. Then, attach the DC charger to the test set, power it on and go to **Utilities>M.Upgrade**. Once the upgrade image is recognized, confirm the versions and tap on the **Upgrade** button.

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DO NOT downgrade the software version currently installed in your test platform or module, unless specifically instructed by a VeEX Customer Care/Support agent. Your new test set may have been shipped with a newer version. For software upgrades, please check the current version(s) on your test set to confirm that the software posted here is a newer version and carefully read the **Release Notes** for the recommended platform versions. To find the Release Notes, go to the **Resources** tab of the module page on www.veexinc.com.

Turning the Test Set ON and OFF

- **Turn ON:** Press and hold the red **Power** button for two seconds, until a confirmation tone is heard, and the power LED turns green (in noisy environments, refer to the power LED).
- **Turn OFF:** Press and hold the red **Power** button for about two seconds, until two confirmation tones are heard. Then the shutdown process will start.
- **Forced Shut Down:** In the rare case of a malfunction, our Customer Support team may instruct to press and hold the Power button for approximately four seconds, until the screen turns off. Results, data or configurations are not saved.

Power LED

A single LED indicates the power state of the unit.

- **OFF** : The LED is off when the unit is powered off.
- **GREEN**: The LED is green when the unit is powered on and fully charged.
- **ORANGE**: The AC/DC adapter is plugged in and the battery is charging.

Audible Beeps

Low Battery status is indicated by a periodic beeping sound, every four seconds, and displaying a warning pop-up message on the screen.

When working on battery power, once the charge capacity reaches about 10%, the test set will start beeping to notify users to plug in the AC/DC adapter. A pop-up message may also be presented on the screen. When the charge level reaches 5%, the test set automatically initiates the shutdown process, to protect the battery.

To get information about the amount of battery charge and autonomy estimate (under current usage condition) tap the battery icon displayed on the top-right corner of the screen.

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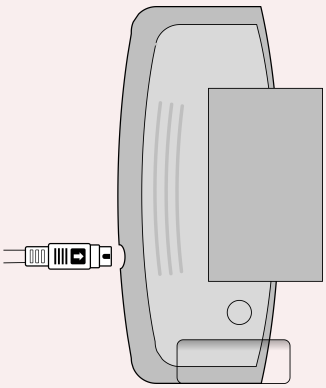
DC Power Jacks

Depending on the test modules ordered, users receive one of the following three RXT test platform models. They are very similar, with just a few differences, such as their power capacity, DC port types, and required AC/DC adapter (non-interchangeable).

Chassis	Voltage	Power	DC Plug Style	DC Jack	Use With
RXT-1200	15 VDC	140W			RXT-6200 RXT-3400 RXT-4xxx
RXT-1200+	15 VDC	180W			RXT-6400
RXT-1202	24 VDC	300W			RXT-6402 RXT-6802 RXT-6811

Attention: *For the* ***RXT-1202****, the flat part of the DC plug must be facing towards the front of the test set (as shown in the diagram), before plugging it in. Refer to the diagram embossed on the connector cover and the label on the power cord.*

Forcing it in any other orientation would trigger its protection circuit and disable it for several minutes (in some cases could cause permanent damage). If it happens by accident, disconnect the DC plug from the test set and wait for about one hour before trying again.



Inserting and Removing Test Modules

Turn the test set **OFF**.

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- **Remove:** Press the black RELEASE button on the back and pull the module out.
- **Insert:** Align the module with the metal guides and push it slowly until you hear the locking "click".

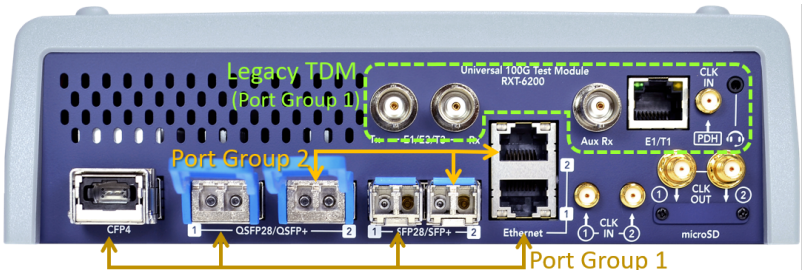
If adding a new module, download the test module's software from its web page and install it using the **M.Upgrade** function, before using it. To find the Release Notes, go to the **Resources** tab of the module page on www.veexinc.com.

Identifying Test Ports and Port Groups

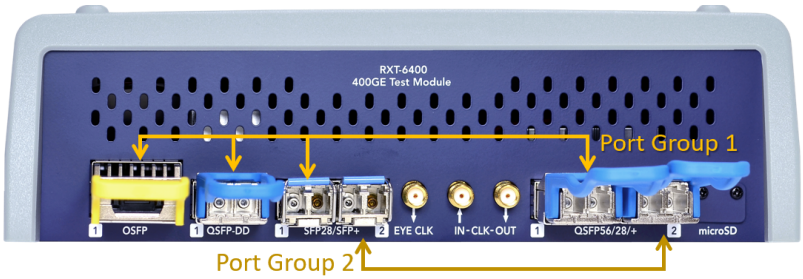
On the module's connector panel, test ports are identified by group numbers in white rounded squares. In multi-port test modules, each group can run one independent test. These groups may also be referred as P1, P2, P3, P4, etc.

Consider the test port groups as 'Test Resources' or 'Test heads'. Each one can run one test.

RXT-6200 Test Port Groups



RXT-6400 Test Port Groups



RXT-6402 Test Port Groups

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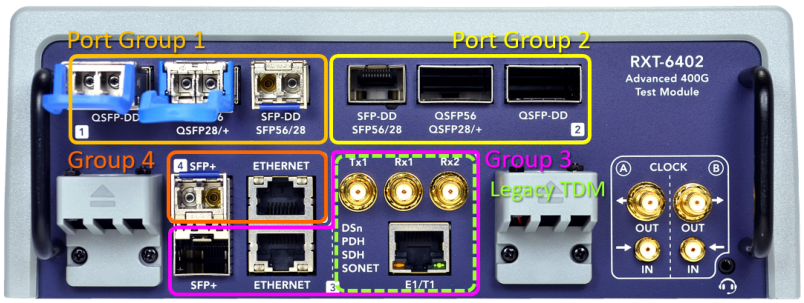
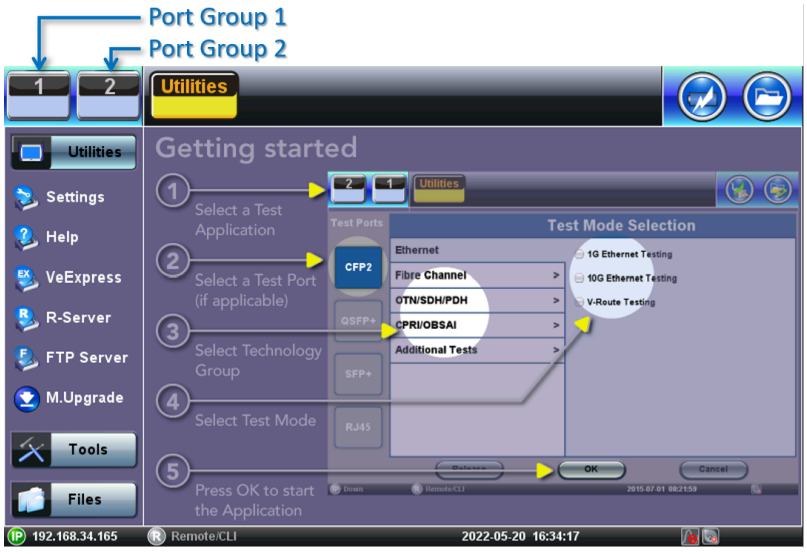


Selecting the Test Port Group

1. Identify the type of interface being used by the link or device to be tested.
2. On the test module, identify a test port group with an available port or transceiver type that matches the link or device under test. (Note: If you need to use a QSFP28 transceiver for 100GE, but Group 1 is already running a 25GE test with SFP28, even if the P1 QSFP28 slot is available, it can't be used. Then you must select a port from Group 2. Each group can only run one test.)
3. From the GUI, select the test port group. Depending on the test module type, number of supported concurrent tests, and software version, tap on:
    a. One of the available Test Port Group buttons, 1 or 2, on the top-left corner of the screen. (If a Port Group is already being used, it will display the test type on the bottom-half of the button, with either yellow/idle, green/good or red/alarm background color indication.)



--OR--

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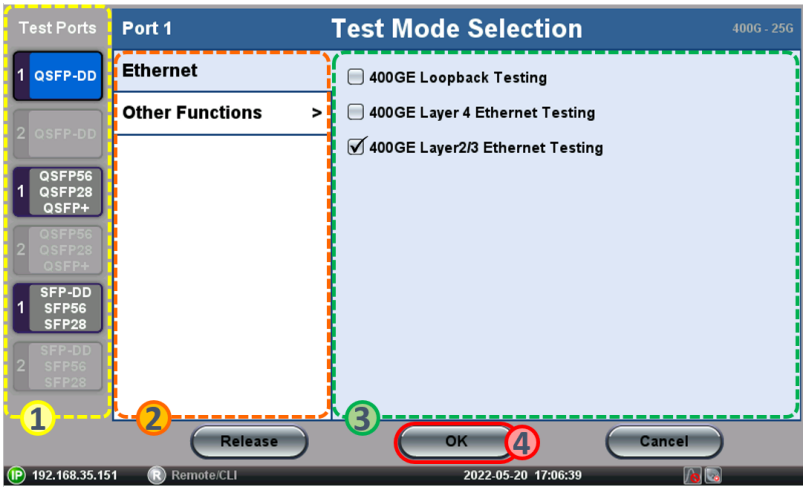
b. The New button on one of the available Test Cards, according to the test interface required for the application. Depending on each individual test module and/or hardware configuration, the screen may display two, three or four test cards.

The test set will display the Test Mode Selection menu.

Test Modes - Launching Test Applications



From the Test Mode Selection menu, select the:

1. **Test port**, using the buttons on the left. (The available selection will change based on the capabilities of the selected port group.)

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2. **Protocol** (technology or link type), using the vertical tabs. (The available selection will depend on the capabilities of the selected port type.)
3. **Test Application**, using the check boxes. (The available test functions will depend on the of the selected protocol and purchased licenses.)
4. Press **OK** to launch the Test Application.

The selected test application will start to launch (it may take several seconds).

Insert the required optical transceiver (if applicable) and connect the selected test port to the Fiber, Link, Line Card and/or Device Under Test (DUT), to set up the test scenario and start testing.

Use the buttons on the left of the top bar to navigate between the different functions (System Tools/Utilities, Test Card Summary/Test Selector, Current Test/Change Test Mode).

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Refer to the individual test module and test function manual for more details on the application.

Remote Access & Control

When connected to a network, the platform's management IP address (from LAN, Wi-Fi or Cellular Modem) is displayed on the bottom-left corner of the screen. Users on the same LAN environment (or through VPN) can type the IP address on a browser's URL field, to gain remote access to the test set.

Other Features

System Tools (Utilities)

or Tap to access to the test platform (system) related settings, test results, utilities and certain tools (Fiber Scope, OTDR Viewer), including connectivity (LAN, Wi-Fi, Bluetooth) and cloud-related applications like EZ-Remote, VeExpress, FTP, R-Server, etc.

Test Cards Summary / Application Switching

Tap to access the Test Cards Summary, which shows an overview of all active tests and test resource availability. Test applications can be terminated/released or new ones can be assigned.

Active Test Application

This button indicates the current Port (1) on Module (2) is being currently presented on the screen. Tap this button to change the Test Mode or Test Application for this port.

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