USER MANUAL

10G Test Module

for the VePAL UX400

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1.0 About This User Manual

The purpose of this manual is to help users successfully use the features of VePAL UX400 test platform.

This manual is intended for novice, intermediate, and experienced users. It is assumed that users have basic computer experience and skills, and are familiar with basic telecommunication concepts, terminology, and safety. For more technical resources, visit VeEX Inc. website at www.veexinc.com.

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

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

If any assistance is needed or there are any questions related to the use of this product, call or e-mail our Customer Care department for customer support. Before contacting our Customer Care department, have the serial number ready. Please refer to the Basic Operations section of this manual for details on locating the unit serial number.

Customer Care:

Phone: +1 510 651 0500

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2.0 Introduction to UX400

VeEX® UX400 is the industry's most flexible, compact, and future-proof test solution for OTN, SDH, SONET, PDH, T-Carrier, Carrier Ethernet, Mobile Backhaul, Core, and Storage Area Networks. VeEX UX400 is the first truly robust portable platform to offer test capabilities ranging from DS1/E1 to 100GE and beyond, allowing any combination of test modules tailored for each particular application or set of requirements. Its versatile and flexible hardware and software architecture optimize configurations to meet users' specific needs; from transport applications at rates ranging from DS1/E1 to OC-768/ STM-256, OTU3 and OTU4 to Carrier and Ethernet Transport applications from 10M to 40GE/100GE and beyond.

Its modular architecture allows for up to six independent test modules and up to six concurrent tests or combination of tests. It also allows simultaneous local and remote users to share the platform and run independent tests, maximizing the use of resources.

Key Features of UX400:

- Industry's smallest and most powerful 1.5Mbps to 100G test platform
  - Supports OTU4/OTU3, 40/100GE, 10GE, 1000Base-X, 10/100/1000Base-T, SDH/SONET up to STM-256/OC-768, and PDH/DSn test interfaces without having to change modules
- Large high resolution 10.4" color touch screen VGA monitor port, microphone/headset, built-in speaker
- Built-in GPS timing and Atomic (Rubidium) clock
  - Provide accurate and stable timing reference when an office clock is not available (e.g. Mobile Station)
  - Verify the accuracy of a received network clock
- Intel Atom 1.6GHz Processor
  - 2GB DDR, 8GB SDD (up to 32GB)
- High capacity Li-ion battery pack
  - >1 hour @ 40G, >8 hours @ 1GE
  - Battery operation at all rates
- 1000Base-T management port
- Dual USB 2.0 ports
  - WiFi, 3G UMTS modem, Bluetooth, Memory stick
- VFL and OPM hardware options
- Weighs <15kg fully loaded including battery
- Dual ports to monitor network bi-directionally
  - PDH/DSn/SDH/SONET from E1/T1 to 40G
  - OTN from OTU1 to OTU4
  - Ethernet from 10Base-T to 100GE
- Generate +/- 150ppm clock offset to stress both Ethernet and SDH networks
- Jitter and Wander analysis up to STM-1e rates
- SyncE and IEEE 1588v2 support with Wander analysis
- Pulse mask analysis on PDH/DSn signals
- Multiple remote and local users able to share platform for simultaneous testing

Multiple Test Applications and Users

- Independent configuration and operation of modules allows multiple users to share platform
- Up to 6 test applications can be configured and operated simultaneously, locally and remotely
- SCPI remote control interface via IP connection for multiple user/applications

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3.0 Safety Information

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

Optical Connectors

The UX400 displays a laser warning icon when the laser source is active to alert the user about a potentially dangerous situation. It is recommended to:

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

ESD: Electrostatic Discharge Sensitive Equipment

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

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

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-swapable. The platform must be turned off and unplugged from VAC mains when removing or inserting test modules.
- For safety and EMC (Electromagnetic Compatibility), empty module slots must be properly covered with blank panel covers.
- Prevent foreign objects from entering the UX400, before, during and after module exchange or re-configuration process. They could create short circuits or damage internal fans.
- Always store test modules by themselves in individual ESD protected packaging (with no loose elements, like screws or tools).

Lithium-ion Battery Precautions

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

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

UX400 battery pack is also fitted with a safety connector to prevent accidental short circuits and reverse polarity.

- Always charge the UX400 battery pack inside the UX400 battery bay using the UX400 AC/DC adapter supplied by VeEX.
- Do not charge or use the battery pack if any mechanical damage is suspected (shock, impact, puncture, crack, etc).
- Do not continue charging the battery if it does not recharge within the expected charging time
- Storage: For long term storage, the battery pack should be stored at 20°C/68°F (room temperature), charged to about 30 to 50% of its capacity. Spare battery packs should be charged and used at least once a year to prevent over-discharge (rotate them regularly).
- It is recommended to charge and use battery packs at least every three months. Battery packs shall not go without recharging (reconditioning) for more than six months.
- After extended storage, battery packs may reach a deep discharge state or enter into sleep mode. For safety reasons, Li-ion batteries in deep discharge state may limit the initial charging current (pre-recharge) before starting their regular fast charging cycle. The pre-charging state may take several hours.
- Air transportation of Li-ion batteries is regulated by United Nations' International Air Transportation Association (IATA) Dangerous Goods Regulations and by country-specific regulations. Please check local regulations and with common carriers before shipping Li-ion battery packs or products containing relatively large Li-ion battery packs.

Electrical Connectors

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

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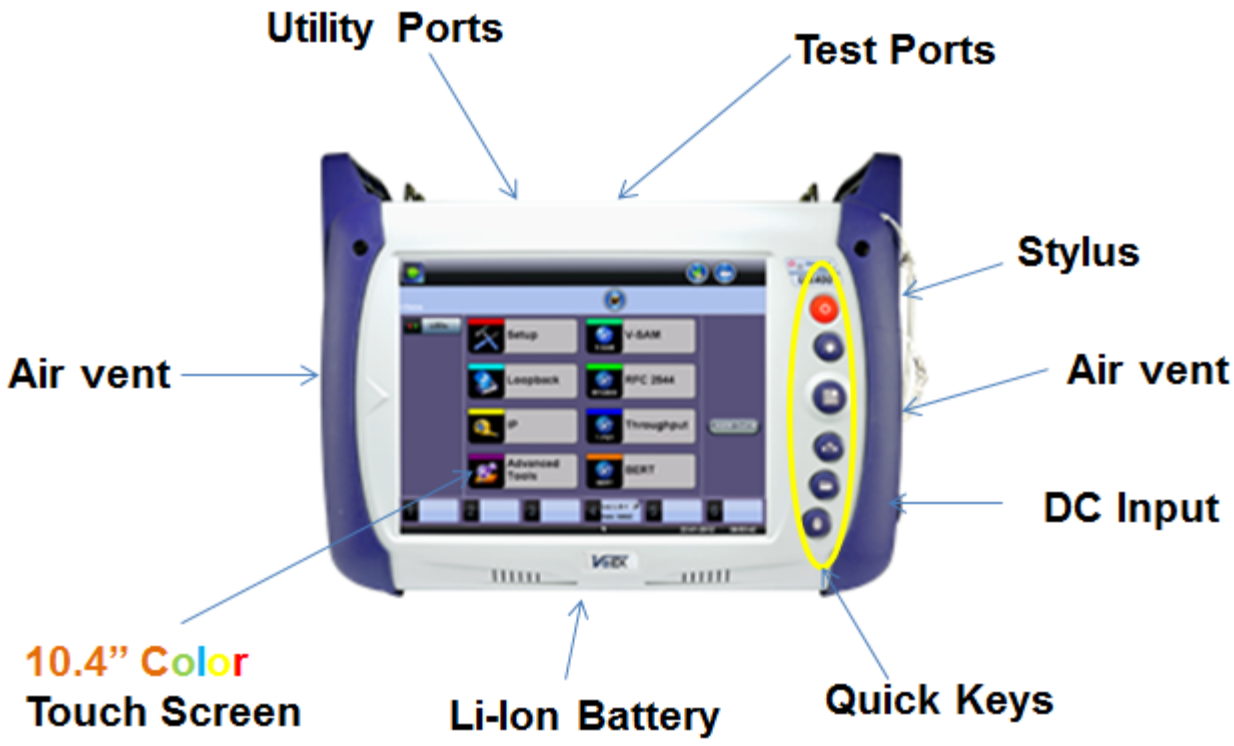
4.0 Platform Overview

The unit is powered on and off from the red key on the keypad area. To power on the unit, hold the Power key down until a beep is heard. In order to turn off the unit, press the Power key for at least 2 seconds. If the unit is not responding, holding the Power key down for more than 10 seconds will force the unit to power down.

Note: *No results or configurations are saved during the emergency shut down.*



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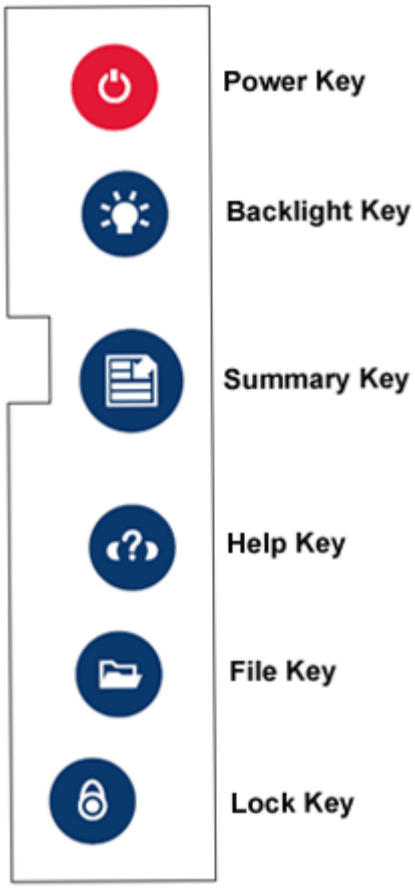
4.1 Keypad

The keypad comprises the following keys:



- **Power** key: The unit is powered on and off from the red key on the keypad. The button is recessed to prevent accidental power on. Press the key for 3-5 seconds to turn the unit on. To turn off the unit, press the Power key for at least 2 seconds. If the unit does not respond, holding the Power key down for more than 10 seconds will force the unit to switch off.
- **Backlight** key: Press the key to turn the backlight off and on. If the backlight is on a timer, the backlight will restart the timer.
- **Summary** key: Brings on a screen showing a summary of all interfaces/tests. When pressed a second time, it closes the summary screen and returns to previous screen. This key does not interrupt operations or tests in progress.
- **Help** key: Brings the user to online help, regardless of the current user interface location of the unit. When pressed a second time, it closes the help screen. This key does not interrupt operations or tests in the progress.
- **File** key: Saves test results in the unit's memory. If the measurement is still running, it will provide a snapshot the moment the key is pressed. The Save function provides automatic storage with automatic naming and time stamping function. To process a stored file, please go to **7.0 Files** in the **V300 Common Functions manual**. Press the key again to cancel the save operation.
- **Lock** key: Can be configured to lock the keypad or capture the current screenshot.

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4.2 Touch Screen Display

The LCD supports touch screen operation. To operate the touch screen to navigate the menus and tabs, use the stylus located on the right side of the unit. 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.

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4.3 Battery

The UX400 chassis is equipped with an intelligent Li-ion rechargeable battery pack, which is located in 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 adaptor. 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 Main adaptor to the unit.

Note: *Make sure that the key is aligned while plugging in the AC adaptor to the unit. If it is not aligned, the plug will not connect to the unit and using force will damage the connector.*

Battery Charging time
The total charging time depends on the remaining battery capacity percentage and the actual current load in the UX400. An idle UX400 (no test modules selected or tests running) 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 UX400 is being used while charging and a full charge (100% capacity) can not be achieved within three hours, the charging will automatically stop.
- To resume charging, unplug the AC/DC adapter and let the UX400 work on battery power for a minute or two and plug the AC/DC back in. This would reset the charging circuity.

Warning! DO NOT disconnect the AC/DC power supply when the UX400 is running under heavy load conditions (greater than the battery's current ratings), such us certain multi-module multi-test applications.
- If the current required is too high, but still within the battery's limits, a warning message would be displayed, when the AC/DC adapter is unplugged, while all the tests are properly closed and the UX400 shuts down.
- Under overload conditions, the battery may not be able to supply enough current to keep such test scenario running and its safety mechanisms may shut the battery down without warning and test results may be lost.

Battery Safety precautions
Refer to section 3.0 Safety Information.

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4.3.1 Using the Built-in Battery Backup System

An internal battery pack option is available for the UX400 system to provide uninterrupted operation during short power outages or as a time-saving convenience when moving the test set from one point to another, without having to cycle power. Under certain conditions it can also provide hours of untethered testing autonomy (extended battery operation).

△Use caution when planning to rely on battery operation or backup power availability. Due to its flexibility and scalability, the capacity of the UX400 system may exceed its battery rating. Independent of how many modules or module combinations are loaded in the UX400, if the total power required by the active test modules exceeds 95W, the battery operation would be disabled for safety reasons and to protect the battery pack. Use the tables below to calculate the maximum power consumption for any desired test scenario.

Release any unused test modules before entering extended battery operation to assure that total power consumption is less than 95W. Use the power gauge information (battery icon) to get an estimate on the autonomy time, which based on the actual power consumption. Make sure battery is fully charged.

If moving the UX400 from one place to another (e.g. between workstations, benches, racks or equipment rooms) release test modules as their test cables are disconnected, to reduce the power consumption below 95W and assure a hitless transition. Modules can then be quickly reactivated by assigning them to a test application and recalling its previous configuration (profile) as test cables are reconnected. Time is saved by not having to reboot the test system.

Battery Power Capacity

Total Battery Power: 115 Watts

- UX400 Platform: 20 Watts
- Up to 95 Watts are available to any combination of active test modules (below).

Note: *The sum of active test modules cannot exceed the 95W power budget available.*

Test Modules' maximum power requirements (active modules only)

- UX400-100GE module: 58 Watts

- UX400-40G module: 32 Watts
- UX400-10G module: 29 Watts
- UX400-2.5G module: 20 Watts
- UX400-1GE module: 15 Watts

Note: *Test Modules become active when one of its test ports is assigned to a Test Application; otherwise they remain inactive with little or no power consumption.*

Total AC/DC Power: 250 Watts

- 220 Watts available to support any combination of active test modules

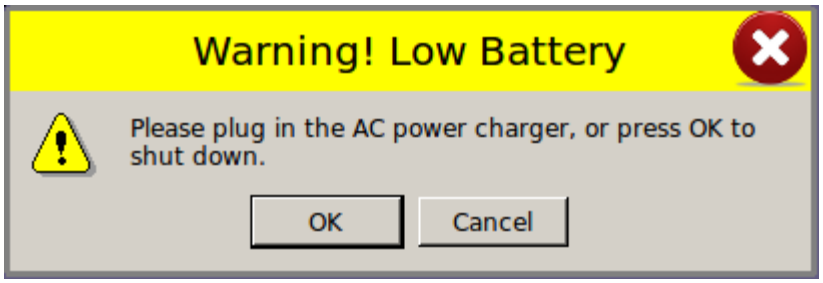
Actual power consumption (per module) may vary depending on configuration/settings and optic modules being used. Values listed are maximum estimated ratings for the most demanding conditions.

Inactive modules (not assigned to a test application) do not consume power.

When working on battery-only mode, the UX400 notifies users when the maximum battery capacity has been reached or it is not enough to support the new module user is trying to activate.

4.3.2 Battery Overdraw Protection

- On battery power, when the capacity reaches 10%, the UX400 notifies users with a pop-up warning message and an intermittent audible alarm.



- If the previous message is ignored and the total capacity falls under 5% the UX400 immediately initiates the emergency shutdown procedure for safety and to protect its battery from damage. Once in this mode all power to modules is immediately cut and test files are not saved.
- In the event that the load exceeds the 95W battery limit when the AC power is interrupted or AC/DC adapter is unplugged, the UX400 would immediately initiate the emergency shutdown procedure to protect its battery from damage or any other safety issues. Once in this mode all power to modules is immediately cut and test files are not saved.

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4.4 Connectors and Panels

4.4.1 Test Modules

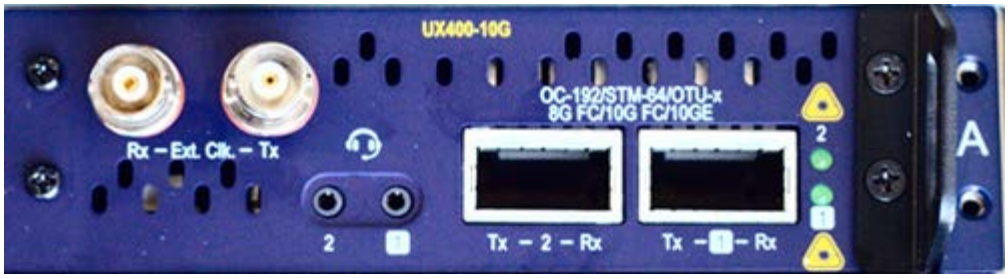
1G Test Module:

- Single slot (up to 6 modules per UX400 > 12 ports)
- Test Interfaces/Applications
  - 10/100/1000Base-T
  - 100Base-FX/1000Base-X
  - 1/2/4G Fiber Channel
- Test modes
  - Single and Dual Port
  - Bi-directional Passthrough monitoring
  - RFC2544, V-SAM per ITU-T Y.1564
  - Throughput with multiple streams, MPLS, VLAN tags
  - Loopback
- External clock interface (input and output)
- Audio headset for VoIP application

2.5G Test Module:

- Dual 2.5 G ports
  - Single BERT, Dual BERT, Bi-directional line/payload through & monitor
- Test rates supported
  - STM-0e/STM-0/STM-1/STM-1e/STM-4/STM-16:
    - VC-11,VC12,VC-3, VC-4, VC-4-4c,VC-4-16c
  - STS-1/OC-1/OC-3/OC-12/OC-48:
    - VT-1.5, VT-2, STS-1 SPE,STS-3c SPE, STS-12c SPE,STS-48c SPE
  - PDH/DSn:E1, E2, E3. DS1, DS3, E4
- Audio headset for ISDN PRI and VF applications
- Jitter wander to STM-1 rate

10G Test Module:



- Single Slot (Up to 6 x 10G modules per UX400 i.e. 12 test ports)
- Dual 10G ports
  - Dual Port, Single Port, Bi-directional line/payload through & monitor
- Applications (same as TX300e)
  - STM-64: VC-4-64c down to VC12
  - OC-192: STS-192c SPE
  - 10GE (LAN/WAN)
  - OTN: OTU2, OTU1e, OTU2e
  - 8GFC, 10GFC
- External clock RX and TX
- Audio headset (VF)

40G Test Module:

- SDH/SONET testing
  - Generation/evaluation of STM-256 signal according to ITU-T G.707
  - Generation/evaluation of OC-768 signal according to ANSI T1.105
- SDH Mapping
  - VC-4-256c, VC-4-64c, VC-4-16c, VC-4-4c, VC-4, to VT1.5/VT2.0
- PDH Analysis internal E3/E1 analysis
- Full ITU-T performance monitoring, APS testing
- Test pattern and Alarm generation, Error Insertion
- Overhead display, decode and generation
- Trace identifier
- Pointer Analysis
- Tandem analysis

40/100G Test Module:

- CFP Modules & Interfaces

    - 40GE (40GBase-LR4)
    - 100GE (100GBase-LR4)
    - External clock input (BNC)
    - Eye clock output (SMA)
    - SD card
- 40GE LR4 CFP Module
    - 2 SMF: 1 fiber in each direction with 4x10G wavelengths
- 100GE LR4 CFP Module
    - 2 SMF: 1 fiber in each direction with 4x25G wavelengths

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4.4.2 RJ-45 Interface

Balanced, Tx and Rx electrical interfaces for T1 and E1 signals. The port is 120 ohm for E1 signals and 100 ohm for T1 signals.

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4.4.3 Bantam Interface

Balanced, Tx and Rx interfaces for DS1 and E1 signals.

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4.4.4 BNC Interface

Unbalanced, 75 ohm Tx and Rx interfaces for DS3 and E1, E2, E3, E4 and STM-0/STS-1 (51M), STS-3/STM-1E.

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4.4.5 XFP/SFP Transceiver Interface

Optical Transceivers (Tx/Rx) conforming to Multi Source Agreement (MSA) recommendations are supported. Various SFPs are available for different wavelengths and dynamic range requirements. Check the ordering options for more details. The standard optical connector type used on SFP transceivers is LC. Please use appropriate low reflectance patchcords (Ultra Physical Contact [UPC]) and note the damage level associated with each Transceiver. Customers opting to use or provide their own SFPs should ensure that the transceivers are multi-rate and that digital diagnostics are supported – this enables the optical power and other measurements when in SDH optical test mode. Furthermore, only SFPs with low jitter and good optical extinction ratio should be used. To comply with ROHS and other local government requirements, only compliant SFP transceivers should be used.

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4.4.6 SMA Interface

- Unbalanced, NRZ electrical clock input
- For DS1/T1: 1.544Mbps or 1.544 MHz
- For E1: 2.048Mbps or 2.048MHz

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4.4.7 Utility Ports

The Ethernet and USB ports are located on the top of the unit.

RJ45, 10/100/1000Base-T Port

Ethernet applications include:

- IP connectivity testing
- Net Wiz testing
- Transfer measurement results and test profiles between the instrument and a computer using ReVeal UX400 software

Upload/download configurable tables between the instrument and a computer using ReVeal UX400 software
- Upgrade the instrument software using ReVeal UX400 software
- Remote control of the instrument using ReVeal UX400 software (optional)

USB Port

The USB port supports:

- Memory drives
- WiFi adaptor for connectivity and WiFi testing application

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4.5 LEDs

Fixed (Power) LED: A single LED indicates the power state of the unit.

- The LED is off when the unit is powered off
- The LED is green when the unit is powered on
- The LED is orange when the unit is connected to the AC Mains and powered off

Soft LEDs: Each tests module offers detailed soft LEDs and indicators in its test application. Refer to individual modules manuals for details.

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4.6 Software Upgrade

There are two methods of updating the test set software: via USB port or ReVeal UX400 software.

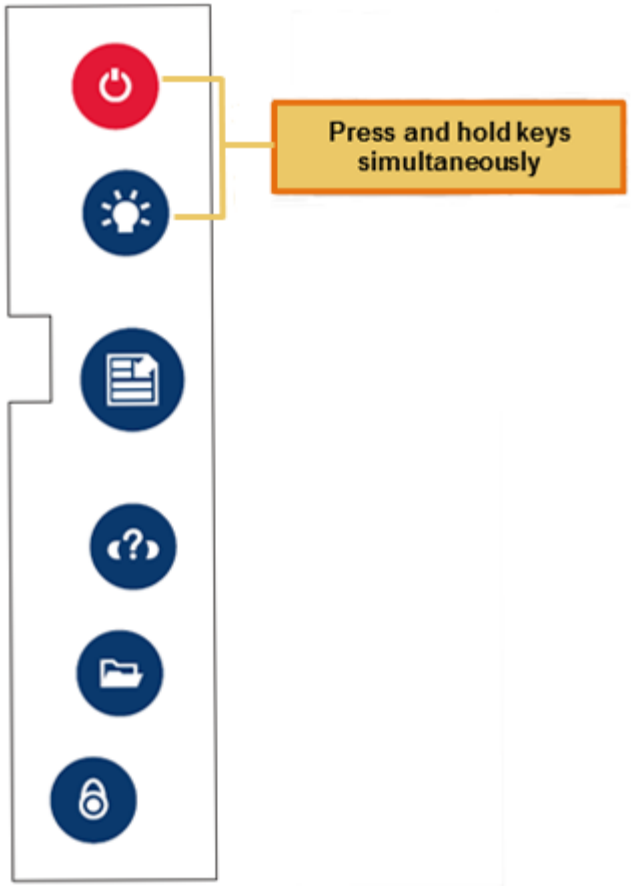
Downloading UX400 Software from the VeEX website

- Enter Username and Password under **Customers Login**.
- Click on the **Customers** tab at the top of the screen after successfully logging in.
- Click on **Software**, located in the **Functions** toolbar on the left side of the screen.
- Search for and download the latest UX400 software onto the PC.

Installing New UX400 Software via USB

- Unzip the original/downloaded upgrade package file.
- Search for a compressed file with the phrase veex-arm.tar.gz, (e.g., "UX400-veex-arm.tar.gz") and copy it onto a USB stick formatted in the FAT32 file format.
  Note: *Make sure the new software image is the only file on the USB stick.*

- Verify that the UX400 unit is powered off and that the DC adaptor connected to the unit is charging the battery. Insert the USB stick on the top left side of the unit.
- Press and hold the **Power** and the **Backlight** keys simultaneously.



- Release the **Power** key when the unit starts to boot up.
- Keep the **Backlight** key pressed down until one beep is heard.
- The unit should now show all the new software packages on the USB. Select the ones that apply.
- A message will appear on screen stating the upgrade is in progress. Installing the software will take a few minutes.

***Note**: Do not remove the USB memory stick until upgrade is complete. Doing so will interrupt the software upgrade and corrupt the upgrade progress.*

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5.0 Basic Set up and Common Tasks

When the UX400 unit is powered on, its system boots up and the first screen displayed shows an image of all the modules installed in the unit. Up to six tests can be assigned at any given time to be run on the unit.

Main Modules Screen

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5.1 Home Screen Tabs

 - On the top left hand side of the screen; to enter the system settings and tools screen

 - Go back to the screen displaying the installed test modules

 - Go to the home screen of a Test Application assigned to one of the tabs on the bottom of the screen

 - Displays the power status of the unit - on AC Power, battery status

 - Save to files

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5.2 Common Tasks

5.2.1 Assigning Test Modules

UX400 can simultaneously run up to six tests. There are six test tabs on the bottom of the unit's screen. A different test module can be assigned to each of these tabs.

Test Tabs

1. Click on a free test tab.

An arrow in the top right corner of the tab indicates the selected tab.

2. Select a test module from those displayed on the screen.

All the test technology options available through that module will be displayed.

Test Module Selection

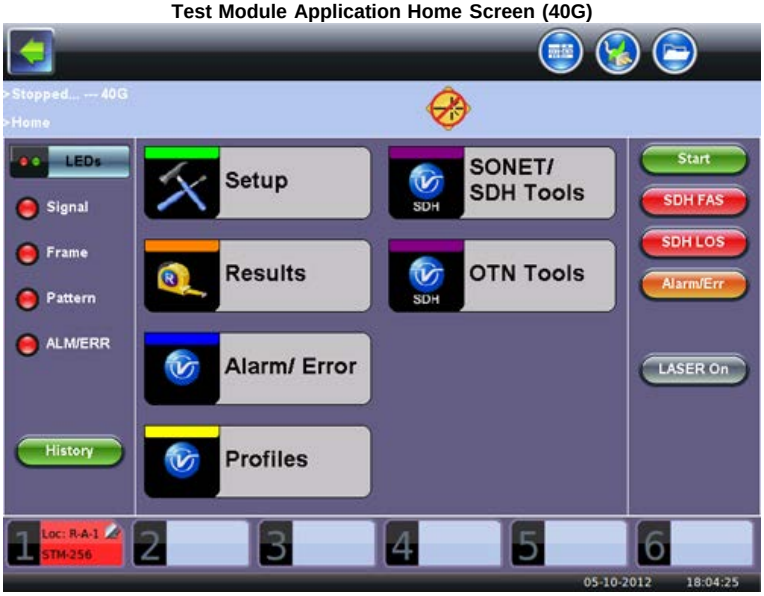
3. Select the technology option best suited for the test you wish to run and then click Accept.

The screen will show the progress as the unit is configured for the selected test module.

Test Module Application Loading

When the configuration is complete, the home screen of that test module will be displayed on the screen. The user will be ready to set up the parameters for different tests possible for that module.

Test Module Application Home Screen (40G)



The test tab to which the application was assigned will change color and the details of the test module's location on the unit and the technology selected will be displayed in the tab. The test tab color indicates the status of the respective test:

- Red: Indicates that at least one alarm/error has occurred during the test
- Yellow: History - Use the History button on the left side of the screen to acknowledge the status and reset the history indication.
- Green: Indicates no condition or a test that has not begun yet

To return to main modules screen:

Either click an unassigned tab on the bottom of the screen;

Or click the  button on the top panel of the screen.

To free up an already assigned tab:

1. Click on the tab that needs to be made free.
2. Return to the main modules screen.
3. Click on the "Release" button on the right side of the module location illustration. A pop-up window will ask for confirmation of the action.

Releasing a Test Tab

4. Click "Yes" to confirm and release the tab. The tab is now free to be assigned for another test application.

To assign more test applications:

1. Return to the main modules screen. Make sure an empty tab is selected.

Note: *Look for the arrow in the right corner of the tab to ensure that the correct tab is selected.*

Select Another Test Tab

2. Follow the same steps as when assigning the first test tab to a test application.

Select Module and Technology

System Configuring

Test Module Application Home Screen (100GE)

Note:

- *Depending on the type of test module (single or dual port) one or two test tabs can be assigned to a test module.*

Dual port test modules usually allow two fully independent tests (e.g. one 10GE test in port 1 and another SONET/SDH test on port 2) or dual port applications.

- *Test ports are identified by their position nomenclature. For example, L-C-2 identifies the port 2 of the test module located on the left column and C row.*

- *To switch between different module application screens, click on the respective test tab on the bottom of the screen.*

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5.3 Platform Settings

Test ports and network settings are required prior to performing any measurements or applications.

The platform settings screen can be entered by clicking the arrow button on the top left corner of the main screen.

The following options are available:

- Tools
- Utilities
- Files

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5.3.1 Tools

Tap the Tools button to enter the Tools screen. The following can be configured or viewed under the tools tab:

- IP Tools:
  - Setup: Network, Port
  - Status
  - Ping: Setup, Result
- Advanced:
  - VFL
  - OPM
  - GPS

IP Tools Setup

Advanced Tools

The Home menu can be accessed at anytime during operation by pressing the **Home** key.

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5.3.2 Utilities

The Utilities tab on the settings home screen offers the following options:

- Settings
- Backlight

Utilities Menu

Settings

The following options are available under settings:

- About
- Backlight
- Global
- Date & Time
- Remote Access
- Power

Utilities Settings

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About:

Gives information about the unit - the serial number, the version of the software running on the unit, customer care number, Management MAC address, options installed on the unit, and also information about the different modules installed on the unit.

Utilities Settings - About Page 1 **Utilities Settings - About Page 2**

Utilities Settings - About Page 3

Utilities Settings - About Page 4

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Backlight:

The Backlight tab, which can also be accessed directly from the Utilities menu on the left side of the screen, shows information about the Battery Power, AC Power, and Brightness adjustment tool.

Utilities Backlight Battery Power

Utilities Backlight AC Power

Utilities Backlight Brightness

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Global:

The Global tab offers the following options to configure:

- **General Settings:** Language, Unit, Audible Alarm, Show Password
- **Storage Setting:** How the system should work while performing operations that deal with storage of files and data: File Name Prefix, Profile Deleting, Profile Saving, Result Saving, Advanced Saving.
- **Save Screen:** This utility helps in configuring the Lock button on the keypad to either lock the screen or take a screenshot. Select "Save Screen" to configure the Lock button to take a screenshot. Then the following settings can be configured:
  - Save Screen Compression Level - The saved screen shot can be compressed to keep the size of the captured file small
  - Save Screen Current Number - The number of screen shots already captured
  - Save Screen Maximum Number - The total number of screen shots that may be taken can be configured here

Utilities - General Settings **Utilities - Storage Settings**

Utilities - Save Screen

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Date & Time:

The date and time settings for the unit can be set through this tab.

Date & Time Configuration

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Remote Access:

Remote Access Configuration

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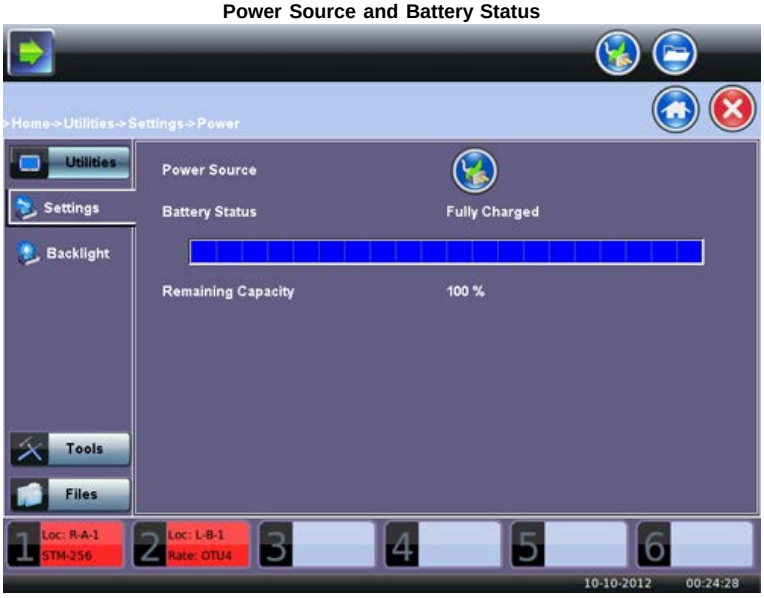
Power:

The Power tab displays the source of the power to the unit and status of the battery.

Power Source and Battery Status



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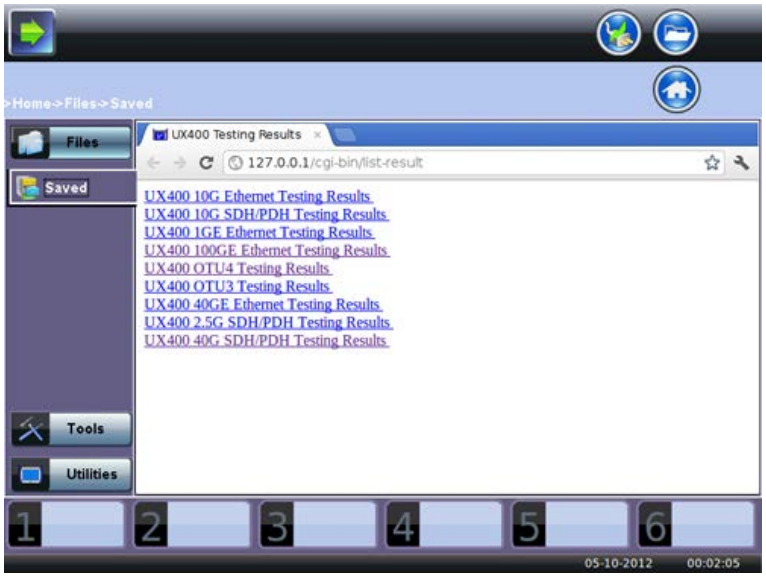
5.3.3 Files

The Files tab shows all the test results files saved on the unit.



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6.0 10G Ethernet Test Application

Follow the steps to assign the test module to a test tab as described in Chapter 5 of this manual.

Select the 10G Ethernet Testing Application (Single Port or Dual Port) and click "Accept".

10GE Ethernet Testing App Selection

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

System Configuring

The 10GE home page will be displayed with links to all possible tests. 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.

10GE Test App Home Screen (Single Port)

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.

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

Ready for Testing Tasks

10GE Test App Home Screen (Dual Port)

Ethernet Dual Port Operation

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

Note: *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, V-SAM) in dual port operation. However, some advanced tools like VoIP, IPTV, VLAN scan, Packet Capture are only available in single port testing mode. The User Interface will provide an error message when a feature is not available in dual port operation.*

Start All: The Start All button is located on the right side of the dual port operation mode screen. Tapping this button will simultaneously start a test on both ports.

Stop All: Once the test starts on both ports, the Start All button will change to Stop All. Tapping on this button will simultaneously stop the test on both ports.

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6.1 Setup

6.1.1 Port Setup

Port setup configuration is accessed from the Setup menu located on the home page of 10GE Test App.

UX400 10G Ethernet Test App Setup

The following configurations are available:

- **10G port profile**: Default
- **10GE Mode**: LAN / WAN
- **WIS Mode (for WAN):** SDH / SONET
- **Flow Control**: Enable
- **Clock Offset (ppm)**: Can be configured; range is +/- 150ppm

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6.1.2 Measurement Setup

The measurement settings are configured on this screen.

- **Mode**: Manual, Timed
  - Manual mode: User manually starts and stops the measurements.
  - 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**: Separated and Coupled. Configure how the measurements are started when in BERT and Multiple Streams test modes.
  - Separated: Independent control (Start/Stop) of the transmitter is enabled. At the start of the test only the receiver is turned on -- the user must start the transmitter manually.
  - Coupled: Transmitter and receiver are turned on at the same time, and the Tx and Rx measurements start at the same time at the start of the test.

Measurement Setup

Measurement Mode **Measurement TX Start**

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6.1 Setup

6.1.1 Port Setup

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UX400 10G Ethernet Test App Setup

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- **10G port profile**: Default
- **10GE Mode**: LAN / WAN
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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.

Measurement Setup

Measurement Mode

Measurement TX Start

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6.2 BERT

6.2.1 BERT Setup

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

BERT Setup - Header (Layer 2)

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

BERT Setup - Header (Layer 3)

- **Layer 4:** Framed BERT (same as Layer 2 & 3 Framed)
  - **MAC Address:** A default or user configured Media Access Control (MAC) address is added to the frame
  - **IP Address:** A default or user configured IP address is added to the frame
  - **UDP Address:** A user defined source and destination port address is added to the frame

BERT Setup - Header (Layer 4)

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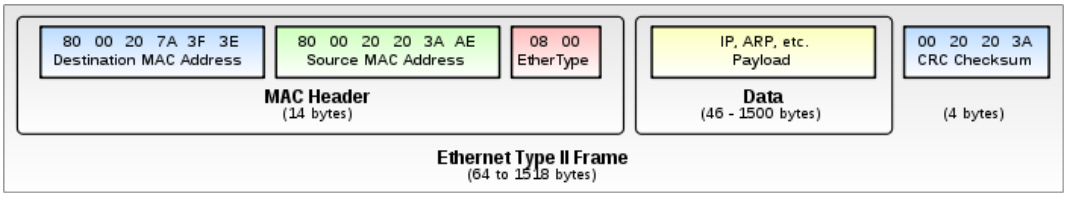
6.2.1.1 Header Settings

- **BERT Profile:** Load a previously configured test profile or create a new profile from existing settings. Currently its set to "Default".
- **Test Layer:** Select the test layer to perform the BERT
  - Options are Layer 2, Layer 3 and Layer 4
- **Frame Type:**
  - Layer 2: 802.3 Raw (IEEE 802.3 frame without LLC) and Ethernet II (DIX) (named after DEC, Intel, and Xerox, this is the most common frame type today)
  - Layer 3: Ethernet II (DIX)
  - No Frame Type for Layer 4
- **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 4
- **VLAN:** Off, 1 tag, 2 tags, 3 tags
  - The user is able to configure up to 3 VLAN tags (VLAN stacking, for Q-in-Q applications)
    Note: *VLAN stacking is an option*
- **MPLS:** (For Layer 3 and 4 only) Off, 1 tag, 2 tags, 3 tags
  - The user is able to configure up to 3 MPLS tags
    Note: *MPLS tag configuration is only available when the MPLS option is purchased*
- **PROTOCOL (Layer 4 only)**: UDP or TCP

The most common Ethernet Frame format, Type II



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

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

- **MAC Header Tab:**
  - **MAC Source:** Use the default source address of the test set or configure a new or different address.
  - **MAC Destination**: Configure the destination MAC address of the far-end partner test set or use the ARP or ARP GW keys to determine the MAC address of the destination IP address (ARP) or the Gateway (ARP GW). Note that a valid IP connection needs to be up to use these functions. Refer to **9.1 IP** in the **V300 Common Functions manual** for details on IP connection.
  - **Ethernet Type:** For Layer 3 & 4 testing, the Ethertype is set to 0800-IP. For Layer 2, it can be typed in.

BERT Setup MAC Layer 2 **BERT Setup MAC Layer 3 & 4**

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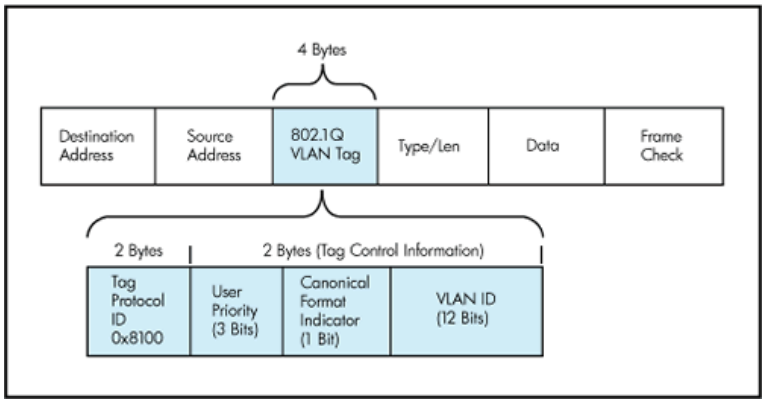
- **VLAN Tab:** In the VLAN tab the following parameters are configured:
  - **VLAN ID:** Configurable in the range 1 to 4094.
    - VLAN ID is the identification of the VLAN, which is basically used by the standard 802.1Q.
    - It has 12 bits which allows the identification of 4096 (2^12) VLANs.
 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

IEEE 802.1Q VLAN Tag in an Ethernet Frame



BERT Setup - VLAN Tag configuration

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- **MPLS Tab (Only for Layer 3 & 4):** In the MPLS tab the following parameters are configured:
  - **MPLS label:** Configurable in the range 16 through 1,048,575 (labels 0 to 15 are reserved).
    Note: *Composed of 20 bits which allows for the creation of over one million labels.*
  - **CoS:** Configurable in the range 0 to 6.
    Note: *This field is three bits in length and maps directly to IP Precedence TOS bits to provide Class of Service (COS).*
  - **S-bit:** Configurable 0 or 1.
    Note: *The S field is one bit in length and is used for stacking labels. This is important as it is used to indicate the last label in the label stack.*
  - **TTL:** Configurable in the range 0 to 255. The default setting is 128 hops.
    Note: *Used to decrement the time-to-live counter.*

BERT Setup - MPLS configuration (Layer 3 & 4)

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- **IP Tab (only for Layer 3 & 4):** In the IP tab the user must configure the destination IP address and source address. The user may also configure the following IP header fields:
  - **IP Type:** IPv4
  - **IP Source and IP Destination:** For IP Source, if the IP connection is up, refer to section **9.1 IP** in the **V300 Common Functions manual**. The source address is fixed to the IP address from the IP setup menu.
  - **IP TOS (for Quality of Service testing):** Legacy TOS or DSCP
    - **Legacy TOS :** The first three bits of the IP TOS field can be edited:
      - **Precedence:**
        - 000 - Routine
        - 001 - Priority
        - 010 - Immediate
        - 011 - Flash
        - 100 - Flash Override
        - 101 - Critical
        - 110 - Internetwork Control
        - 111 - Network Control
      - **TOS Values:**

- 1000 - Minimize Delay
- 0100 - Maximize Throughput
- 0010 - Maximize Reliability
- 001 - Minimize Monetary Cost
- 0000 - Normal Service

- **DSCP (Differentiated Services Code Point):** The first six bits of the IP TOS can be edited to provide more granular service classification.
- **Time To Live (TTL):** Configurable in the range 0 to 255.
- **Do Not Fragment Flag:** 0 or 1
- **Protocol field:**
  - **Layer 3:** Preset to OXFF,
  - **Layer 4:** UDP-0x11 or TCP-0x06 (Defined on the Header Settings main screen)

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

BERT Setup - IP Address Setting Layer 3 (IPv4 DSCP)

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- **Data Tab:** User selects a test pattern that will be encapsulated in the Ethernet frame payload (for framed mode).
  - **Layer 2, 3, & 4 test patterns**
    - **PRBS:**
      - 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)
    - **Fixed:** All 0s or All 1s
    - **User Defined pattern:** Length depends on size of frame
    - **Inversion:** Normal or inverted

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

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

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

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- **RX Filter Tab:** Allows the user to filter incoming streams. When checked, the incoming traffic flows not matching these criteria will not be considered for these results.
  - MAC Destination address
  - MAC Source address
  - VLAN
  - DSCP (for Layer 3 & 4)
  - Protocol Type (for Layer 3 & 4)
  - IP Destination (for Layer 3 & 4)
  - IP Source (for Layer 3 & 4)
  - Destination Port (for Layer 4)
  - Source Port (for Layer 4)

BERT Setup RX Filter (Layer 2)

BERT Setup RX Filter (Layer 3)

BERT Setup RX Filter (Layer 4)

- **UDP/TCP (Layer 4 only):** Input Source Port and Destination Port.

BERT Setup - UDP/TCP (Layer 4)

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6.2.1.2 Traffic Settings

Traffic tab:

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

- **Traffic Flow:** Select from the following traffic flows:
  - **Constant:** The selected frame is transmitted continuously according to the selected bandwidth %.
  - **Ramp:** The selected frame is transmitted at maximum bandwidth according to the selected duty cycle and burst period.
  - **Burst:** The selected frame is transmitted in a staircase profile according to user selectable step time, number of steps, and maximum bandwidth.
  - **Single Burst:** Configure the number of frames to be transmitted in the burst along with the bandwidth. For example, if 100000 frames are transmitted at 12.5% of bandwidth, on a 1Gbps line, 100000 frames will transmit at a rate of 125Mbps and then the burst will stop.
- **Frame Size Type:** Fixed or Uniform min and max frame length values. Uniform traffic is traffic generated with a uniform distribution of frame lengths.
- **Frame Size (bytes):**
  - Frame sizes can be from 64 bytes to 1518 bytes, in addition to jumbo frames up to 10000 bytes
- **BW (Transmit Bandwidth):** Configure the transmit rate for the test
  - When traffic flow is equal to Burst, two burst bandwidths are configured with burst time
  - When traffic flow is equal to Ramp, starting and an ending bandwidth are configured along with the bandwidth step size and duration

BERT Setup - Constant Traffic **BERT Setup - Ramp Traffic**

BERT Setup - Burst Traffic

BERT Setup - Single Burst

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6.2.1.3 Error Injection

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

- **Error type:**
  - CRC
  - PCS Errored Block
  - Bit
  - IP Checksum (Layer 3 & 4 only)
  - TCP/UDP Checksum (Layer 4 only)
- **Injection Flow:** The error injection flow determines how the selected errors will be injected.
  - Single
  - Count: Configures the error count via a numeric keypad
  - Rate: 1E-3, 5E-4, 2E-4, 1E-4, 5E-5, 2E-5, 1E-5, 5E-6, 2E-6, 1E-6, 5E-7, 2E-7, 1E-7, 5E-8, 2E-8, 1E-8, 5E-9, 2E-9, 1E-9 or User Defined. The user may configure the desired rate using the on screen keypad.

BERT Setup - Error Injection **Keypad**

Error Injection

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

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6.2.1.4 Alarm Injection Settings

Alarm injection can be performed during a 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 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 Conitnue (continuous) can be selected.
- **Alarm Length:** 1s, 10s, or 100s.

BERT Setup - Alarm Injection

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6.2.1.5 Starting/Stopping a BERT

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

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

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

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

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6.3.2 BERT Results

6.3.2.1 Summary

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

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

BERT Results - Summary

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6.3.2.2 Signal

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

BERT Results - Signal (Page 1) **BERT Results - Signal (Page 2)**

BERT Results - Signal (Page 3)

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6.2.2.2 Errors

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

- **PCS Errored Block**
- **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 & 4 only)
- **IP Checksum Rate** (Layer 3 & 4 only)
- **TCP/UDP Checksum** (Layer 4 only)
- **TCP/UDP Checksum Rate** (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

BERT Results - Errors

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6.2.2.3 Alarms

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

- **LOS (ms):** Loss of Signal
- **LOSync:** Loss synchronization
- **Pattern Loss:** Indicates errors related to test pattern
- **Service disruption** (ms) associated with loss of signal:
  - **Current:** Duration of the current service disruption
  - **Total:** Total accumulated duration of the service disruptions
  - **Last**
  - **Min/Max:** Minimum and maximum duration of the service disruption events
  - **No. of Occurrences:** Counter of service disruption events
  - **Local Fault**
  - **Remote Fault**
- **PCS-HI-BER:** High bit error rate of sync header
- **PCS-LOBL**: Loss of block lock

BERT Results - Alarms (Page 1)

BERT Results - Alarms (Page 2)

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6.2.2.5 Events

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

BERT Results - Events

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6.2.2.6 Traffic

Traffic tab: The following Traffic statistics are displayed:

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

Tap on the graph for detailed screens.

BERT Results - Traffic

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

- **Received (RX) frames:**
  - Total frames
  - Test frames
  - VLAN tagged frames
  - VLAN stacked frames
  - MPLS (Layer 3 and 4 only)
  - MPLS Stack (Layer 3 and 4 only)
  - Non-test frames
- **Transmitted (TX) frames:**
  - Total frame - Total # frames transmitted
- **Pause frames:** Total number of transmitted and received Ethernet pause flow-control frames

BERT Results - Frames

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Traffic Type: 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.
- **Layer 3 Unicast** (For Layer 3 & 4)
- **Layer 3 Broadcast** (For Layer 3 & 4)
- **Layer 3 Multicast** (For Layer 3 & 4)

BERT Results - Traffic Type

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

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

BERT Results - Frame Size

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6.2.2.7 Delay

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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6.2.2.8 Rates

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

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

BERT Results - Rates

BERT Results - Rate Details

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6.3.3 Saving BERT Results

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

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

BERT Results Save

Once the results are saved, they can be viewed or renamed by going to **Tools / System Settings screen> Files**. Please see Chapter 5.3.3 Files section.

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6.3 RFC2544

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

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

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

RFC2544 Header Setup (Layer 2)

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6.3.1 Setup

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

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6.3.1.1 Header Settings

Profile: Load a previously configured test profile or create a new profile from existing settings. Currently its set to "Default".

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

Frame Type: Select the Ethernet frame type for Layer 2 or Layer 3.

- Layer 2:
  - Ethernet II (DIX) (named after DEC, Intel, and Xerox, this is the most common frame type today),
  - 802.3 Raw (IEEE 802.3 frame without LLC) - Not available when Layer 3 is selected
- Layer 3: Ethernet II (DIX)

VLAN: Off, 1 tag, 2 tags, 3 tags

- Up to three VLAN tags (VLAN stacking for Q-in-Q applications) can be configured.
  Note: *VLAN stacking is an option.*

MPLS (only for Layer 3 & 4)**:** Off, 1 tag, 2 tags, 3 tags

- Up to three MPLS tags can be configured.
  Note: *MPLS tag configuration is only available when the MPLS option is purchased.*

PROTOCOL (Only for Layer 4)**:** UDP or TCP

RFC2544 Header Setup Layer 3 **RFC2544 Header Setup Layer 4**

Layer 2

The following can be configured for Layer 2:

MAC: Tap the MAC block on the Frame image to access the setup menu.

- **MAC Source:** Use the default source address of the test set or configure a new or different address. See MAC address editing screen shot below.
- **MAC Destination**: Configure the destination MAC address of the far-end partner test set. See MAC address editing screen shot below.
- **Ethernet Type:** Can be configured for Layer 2

RFC2544 Setup MAC Layer 2

RFC2544 MAC Editing

Data: No payload selection is possible for Layer 2.
The payload area is populated with a VeEX signature field and other proprietary data.

RFC2544 Data Layer 2

RX Filter: Allows to filter streams by:

- MAC Destination address
- MAC Source address

RFC2544 Setup RX Filter Layer 2

VLAN: If VLAN tag was selected on the setup main screen for Layer 2, then the VLAN Frame will be visible on the Frames figure. Tap on the VLAN frame to configure the following:

- **VLAN ID**
- **Priority**
- **Tag Type** (Ethernet Type)**:** 8100, 88a8 or User Defined
- **Drop Eligible:** If enabled, drop eligibility flag will be set.

RFC2544 Setup VLAN Layer 2

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Layer 3

MAC/IP: Tap the MAC or IP block on the Frame image to access the setup menus.

- **MAC Source:** Use the default source address of the test set or configure a new or different address. See MAC address editing screen shot above.
- **MAC Destination**: Configure the destination MAC address of the far-end partner test set. See MAC address editing screen shot above.
- **Ethernet Type:** 8847-MPLS unicast or 8848-MPLS multicast

RFC2544 Setup MAC Layer 3

IP: Configure the source and destination IP addresses. The following IP header fields can be configured:

- IP Type: IPv4
- Source IP Address
- Destination IP Address
- IP TOS (for quality of service testing): Legacy TOS, DSCP
  - If Legacy TOS is selected, then the parameters that can be configured are: Precedence and TOS Values
  - If DSCP is selected, then the parameters that can be configured are: DSCP, ECT and CE
- TTL
- Do Not Fragment Flag: 0, 1
- Protocol: 0XFF

RFC2544 IP Configuration Layer 3

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

RX Filter Tab: Allows to filter streams by:

- MAC Destination address
- MAC Source address
- VLAN
- DSCP
- Protocol Type
- IP Destination
- IP Source

RFC2544 RX Filter Layer 3

MPLS: If MPLS tag was selected on the setup main screen for Layer 3, then the MPLS Frame will be visible on the Frames figure. Tap on the MPLS frame to configure the flollowing:

- MPLS label
- CoS priority settings
- TTL
- S-bit

RFC2544 Setup MPLS Layer 3

VLAN: If VLAN tag was selected on the setup main screen for Layer 3, then the VLAN Frame will be visible on the Frames figure. Tap on the VLAN frame to configure the following:

- VLAN ID
- Priority
- Tag Type (Ethernet Type)

RFC2544 VLAN Setup Layer 3

Note: *Please refer to the BERT application for more details.*

Layer 4: Same as Layer 3, except for following possible configurations:

UDP/ TCS: Source Port, Destination Port

RX Filter has filters for Destination Port and Source Port

RFC2544 UDP/TCS Layer 4

RFC 2544 Header Setups

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

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6.3.1.2 Frames Settings

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

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

RFC2544 Frames Setup

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6.3.1.3 Threshold Settings

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

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

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

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

RFC2544 Thresholds Setup

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6.3.1.4 Throughput, Latency, Frame Loss, and Burst Settings

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

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

Throughput:

- **Max Rate:** Up to 100% of the negotiated line rate. The default value is 100%.
  - This is the maximum transmit rate to perform the throughput test for each test frame size.
  - This rate may be configured as a % of the total line rate or in Mbps. For example the Max Rate is configured to be 90% and the negotiated line rate of the link is 100Mbps, then the maximum transmit rate will be 90Mbps or 90% of the line rate.
- **Resolution:** Input any value between 0.001% and 1%. The default value is 1%. Resolution refers to the resolution in searching for the throughput rate. If 1% is selected, the throughput rate will be searched with ±1% accuracy.
- **Duration:** 5 to 999 seconds. The default value is 20 seconds.
  - The duration is the amount of time the throughput test is run for, for each frame size at a given rate.

RFC2544 Throughput Settings

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Latency: The following parameters can be configured:

- **Test Rate:** Throughput Rate or Custom Rate. The default value is Throughput.
  - **Throughput rate**: Latency test will be performed at the Throughput rate found for each of the tested frame sizes.
  - **Custom rate:** A custom rate in % or Mbps can be configured.
- **Rate:** Only available if Custom Rate is selected. Enter up to 100% of the negotiated line rate or enter the rate in Mbps.
- **Duration:** 5 to 999 seconds. The default value is 20 seconds.
  This is the amount of time that the latency test will be performed for each test frame size.
- **Repetitions:** 1 to 100. The default value is 1.
  This is the amount of times that the latency test will be repeated for each test frame size.

RFC2544 Latency Settings

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Frame Loss: The following parameters can be configured:

- **Max Rate:** Up to 100% of the negotiated line rate. The default value is 100%.
  This is the maximum transmit rate to perform the frame loss test for each test frame size. The user may configure this rate as a % of the total line rate or in Mbps. For example if the user configures the Max Rate to be 90% and the negotiated line rate of the link is 100Mbps, then the maximum transmit rate will be 90Mbps or 90% of the line rate.
- **Step Size:** 1 to 10%. The default value is 10%.
  The step size is the rate % that the frame loss test will be reduced by in the event of any frame loss. For example if the Max Rate is 100Mbps (or 100%) and frames are lost at this rate, then the transmit rate will be reduced to 90Mbps (or 90%). The frame loss test will now be performed at the new rate until there is zero frame loss at two consecutive rate settings. This means that the test will have to be performed at 80% (assuming that there was zero frame loss at 90%).
- **Duration:** Selectable in the range 5 to 999 seconds. The default value is 20 seconds.
  The duration is the amount of time the throughput test is run for, for each frame size at a given rate.

RFC2544 Frame Loss Settings

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

- **Max Rate:** The default value is 100%.
  In the burst test, frames are always transmitted at the maximum rate for a given minimum and maximum burst duration.
- **Minimum Duration:** Selectable in the range 2 to 999 seconds. Default value is 2 seconds.
  This is the duration of the first burst.
- **Maximum Duration:** Selectable up to 999 seconds. The default value is 20 seconds.
  This is the duration of the second burst, which must be greater than the minimum burst.
- **Repetitions:** Selectable in the range 1 to 100. The default value is 1.
  This is the amount of times that the burst test will be repeated for each test frame size.

RFC2544 Burst Settings

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6.3.1.5 Starting/Stopping a RFC 2544 Measurement

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

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

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

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6.3.2 Results

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

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

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

RFC2544 Results Status

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

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

RFC 2544 Results Summary

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6.3.2.3 Signal: The Signal tab displays the optical level measured by the SFP or XFP transceiver.

RFC2544 Results Signal Page 1

RFC2544 Results Signal Page 2

RFC2544 Results Signal Page 3

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

RFC 2544 Results Events

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

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

RFC2544 Results Throughput Summary

RFC2544 Results Throughput Tx Graphical

RFC2544 Results Throughput Rx Graphical

RFC2544 Results Throughput Test Log

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6.3.2.6 Latency and Jitter

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

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

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

RFC2544 Latency Results Graphical

RFC2544 Latency Results Summary

RFC2544 Latency Results Test Log

RFC2544 Jitter Results Graphical

RFC2544 Jitter Results Summary

RFC2544 Jitter Results Test Log

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6.3.2.7 Frame Loss

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

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

RFC2544 Results - Frame Loss Graphical

RFC2544 Results - Graph Legend

RFC2544 Results - Frame Loss Summary

RFC2544 Results - Frame Loss Test Log

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6.3.2.8 Burst

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

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

RFC2544 Results - Burst Summary

RFC2544 Results - Burst Test Log

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6.3.3 Saving RFC 2544 Results

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

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

RFC2544 Results Save

Once the results are saved, they can be viewed or renamed by going to **Tools / System Settings screen> Files**. Please see Chapter 5.3.3 Files section.

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6.4 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.

Comparison of RFC 2544 and Y.1564

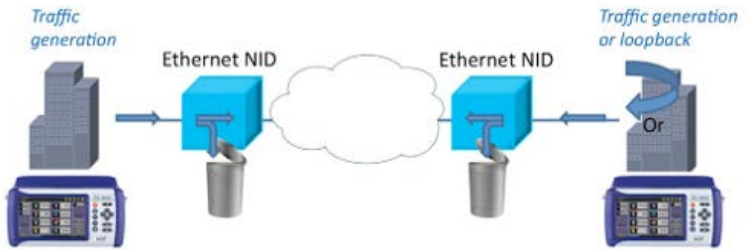
	RFC2544	Y.1564
Key Test Objective	Device performance	Network Service verification/activation
Service validation	One service at a time	Multiple services simultaneously
Throughput	Yes	Yes
Latency	Yes	Yes
Frame Loss	Yes	Yes
Burstability	Yes	Yes
Packet Jitter	No	Yes
Multiple Streams	No	Yes
Test Duration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

Test Methodology

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

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

Test Application

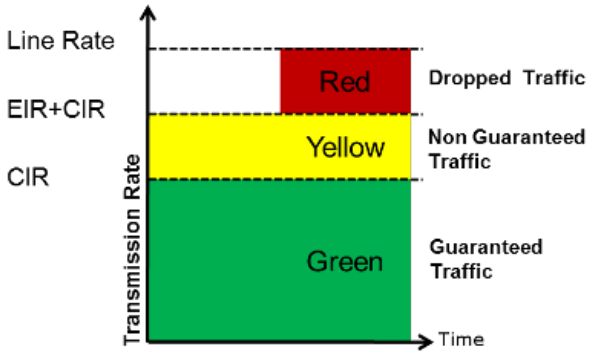


Phase 1: Service Configuration Test

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

- **Step 1: Committed Information Rate (CIR) Test**: Traffic is transmitted at the CIR for a short period of time and the received traffic is evaluated against the Service Acceptance Criteria (FLR, FTD, FDV) measured simultaneously. The CIR test passes if the measurements on the received traffic stay below the performance objectives.
- **Step 2: Excess Information Rate (EIR) Test**: Traffic is transmitted at the CIR+EIR rate for a short period of time; the EIR test passes if the received traffic rate is between the CIR (minus the margin allowed by the FLR) and CIR+EIR.
- **Step 3: Traffic Policing (Overshoot Test)**: The purpose of the Traffic Policing Test is to ensure that when transmitting at a rate higher than the allowed CIR+EIR, the excess traffic will be appropriately blocked to avoid interference with other services. For this test, traffic is transmitted at 25% higher than the CIR+EIR for a short period of time. The test passes if the received traffic rate is at least at the CIR (minus the margin allowed by the FLR) but does not exceed the allowed CIR+EIR.
- At this time the **Committed Burst Size (CBS)** and **Excess Burst Size (EBS)** tests are considered experimental and not an integral part of the standard.

Service Bandwidth Profile



Phase 2: Service Performance Test

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

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6.4.1 V-SAM Setup

General (Page 1 and 2)

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

Enabling/Disabling Tests

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

V-SAM - Setup - General (Page 1)

V-SAM - Setup - General (Page 2)

CIR Test Configuration

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

CIR Test Config

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6.4.1.1 Header Settings

- **Service #:** Select a service to configure
- **Service Name:** Assign a name to the service if desired.
- **Frame Type:** 802.3 Raw or Ethernet II (DIX)
- **Frame Size Type:** A fixed frame size is chosen as default
- **Frame Size:** Input a fixed frame size within the range of 64-10000 bytes.

Please see 6.3.1 RFC 2544 Setup and follow the setup procedure to configure the remaining Header Settings for V-SAM.

V-SAM Setup - Services - Header Settings

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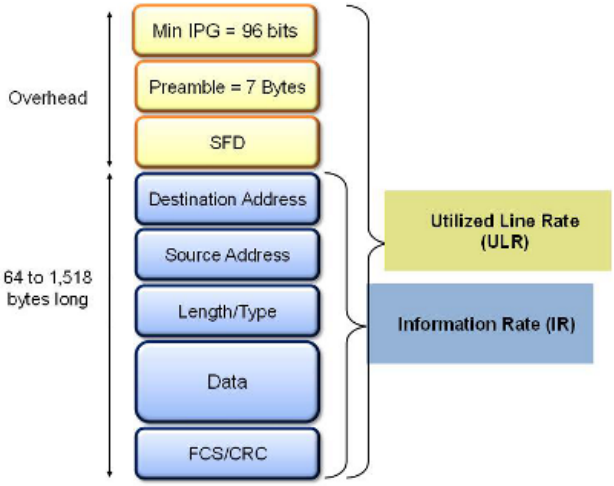
6.4.1.2 Service Attributes

Bandwidth Profile Parameters

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

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

V-SAM Services - Header



- **Excess Information Rate (EIR):** Maximum rate above the CIR at which the customer can send frames that will be forwarded on a best effort basis, but may be dropped in the event of congestion within the network. The combined CIR and EIR must not exceed the line bandwidth. Traffic beyond CIR + EIR will be dropped when it enters the carrier's network. Tap on the box to enter a rate. EIR is expressed in terms **IR Mbps**, **IR Gbps**, **ULR Mbps** or **ULR Gbps**. 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 Service:** Enable or Disable
  Note: *A VLAN Tag must be enabled for Color Aware Service to be enabled.*
- **CBS** and **EBS** are currently not supported with this release.

V-SAM Setup - Services - Service Attributes

Enabling/Disabling Tests

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

Service Acceptance Parameters

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

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

Copying Services

Copying Services

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

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6.4.2 Results

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

6.4.2.1 Configuration Tests

Results - Config. Tests - Service 1

The **Config. Tests** tab lists the Pass/Fail status of each service and test.

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

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

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

CIR Test - Service 1

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

CIR/EIR 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.

Policing Test - Service 1

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

Results - Config. Tests - Summary

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6.4.2.2 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.

Perf. Test - Service 1

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

Perf. Tests - Summary

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6.4.2.3 Signal

The Signal tab displays the optical level measured by the SFP or XFP transceiver.

Signal Page 1

Signal Page 2

Signal Page 3

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6.4.2.4 Event Log

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

Event Log

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6.5 Throughput Testing

Overview:

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

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

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6.5.1 Setup

Unless otherwise noted, the Frame Header and related setups are the same as the ones described in section 6.3 RFC 2544 and 6.2 BERT. 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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6.5.1.1 General Throughput Settings (Global Configuration)

- **# of Streams:** Up to 10 streams are available.
- **Stream #:** Allocated Bandwidth per Stream: The total bandwidth for all streams cannot exceed 100%.
- **Total (%):** Sum of all stream rates in %.
- **RTD Measurement:** Enable/disable the round trip delay measurement. It should only be enabled when running the test to a remote loopback.

Throughput General Setup

Multiple Streams

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

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6.5.1.2 Header Settings

The configurable parameters and procedure for the Header settings in Layer 2, 3 and 4 are the same as for RFC2544 - Chapter 6.4 and BERT - Chapter 6.2.

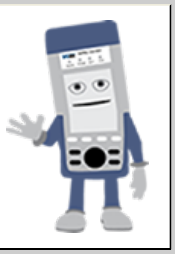
Throughput MAC Settings Layer 2

DATA:

The Data tab can be accessed by tapping the frames diagram on the Header settings screen.

Throughput DATA Setup Page 1

Throughput DATA Setup Page 2



Multiple Streams - MAC/IP Address Setup

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

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

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6.5.1.3 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:** Only Constant is available
- **Frame Size (Type):** Fixed
- **Frame Size (bytes):** Enter the frame size. Frame sizes can be from 64bytes to 1518bytes, in addition to jumbo frames up to 9k bytes.
- **Bandwidth:** Configure the transmit rate for the stream

Note: *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 6.2.1.2 BERT Traffic Settings.

Throughput Traffic Settings

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6.5.1.4 Error Injection Settings (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 or PCS Errored Block.
- **Injection Flow:** The error injection flow determines how the selected errors will be injected.
  - **Single**
  - **Count:** Set a count using the numeric keypad.
  - **Rate:** 1E-3, 5E-4, 2E-4, 1E-4, 5E-5, 2E-5, 1E-5, 5E-6, 2E-6, 1E-6, 5E-7, 2E-7, 1E-7, 5E-8, 2E-8, 1E-8, 5E-9, 2E-9, 1E-9 or User Defined. The user may configure the desired rate using the on screen keypad.

Throughput Error Injection Setup

Keypad

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6.5.1.5 Alarm Injection Settings

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

- **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.

Throughput Alarm Injection Setup

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6.5.1.6 Summary

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

Throughput Setup Summary MAC List

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6.5.1.7 Starting/Stopping a Throughput Test

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

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

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

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6.5.2 Throughput Results

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

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6.5.2.1 Global Results

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

The **Global Stream Summary** screen displays:

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

Throughput Results - Global Stream Summary

QoS

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

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

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

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

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The **Aggregate** screen displays these parameters:

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

Throughput Results - Global Aggregate

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

Throughput Results - Global Signal Page 1 **Throughput Results - Global Signal Page 2**

Throughput Results - Global Signal Page 3

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

- **PCS Errored Block**
- **FCS/CRC:** Number of received frames with an invalid Frame Check Sequence (FCS)
- **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

Throughtput Results - Global Errors

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

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

Throughput Results - Global Alarms Page 1

Throughput Results - Global Alarms Page 2

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

Throughput Results - Global Events

The **Global Traffic** screen displays:

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

Throughtput Results - Global Traffic

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Tap on the graph to view the details for Frames distribution, Traffic Type and Frame Size.

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

- **Received (RX) frames:**
  - Total frames
  - Test frames
  - VLAN tagged frames
  - VLAN stacked frames
  - MPLS (Layer 3 and 4 only)
  - MPLS Stack (Layer 3 and 4 only)
  - 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

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Traffic Type: 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.
- **Layer 3 Unicast** (For Layer 3 & 4)
- **Layer 3 Broadcast** (For Layer 3 & 4)
- **Layer 3 Multicast** (For Layer 3 & 4)

Throughput Results - Traffic Type

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

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

Throughput Results - Frame Size

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

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

Throughtput Results - Global Delay

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6.5.2.2 Per Stream Results

The **Per Stream** tab displays the same type of statistics as seen in Global Results, but for each stream. For descriptions of the parameters in each tab, with the exception of **Rates**, please refer back to the corresponding section in 6.5.2.1 Global/Aggregate Results.

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

Throughtput Results - Per Stream Summary

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

- **Bit:** Indicates errors related to test pattern (Bit Error or LSS [Pattern Loss])
- **BER:** Bit Error Ratio
- **FCS/CRC:** Number of received frames with an invalid Frame Check Sequence (FCS)
- **FCS/CRC Rate**
- **IP Checksum** (Layer 3 and 4 only)**:** Invalid IP Frame Check sequence
- **TCP/UDP Checksum** (Layer 4 only)
- **Jabber frames:** Number of received frames larger than 1518 bytes containing an invalid FCS
- **Runt frames:** Number of received frames smaller than 64 bytes containing an invalid FCS
- **Frame Loss**
- **Frame Loss %**
- **OOS**

Throughput Results - Per Stream Errors Page 1

Throughput Results - Per Stream Errors Page 2

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

Throughput Results - Per Stream Events

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

Throughtput Results - Per Stream Traffic

Tap on the graph to see details for Frames (RX and TX) and Frame Size distribution.

Throughtput Results - Per Stream Traffic Frames

Throughtput Results - Per Stream Traffic Frame Size

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

Throughtput Results - Per Stream Delay

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

Throughtput Results - Per Stream Rates

Tap on the graph to see Rate Details.

Throughtput Results - Per Stream Rate Details

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6.5.3 Saving Throughput Results

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

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

Throughput Results Save

Once the results are saved, they can be viewed or renamed by going to **Tools / System Settings screen> Files**. Please see Chapter 5.3.3 Files section.

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6.6 Loopback

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

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

- **Layer 1**: All incoming traffic to the Rx loopback interface will be sent out unaltered to the Tx loopback interface.
- **Layer 2, 3, & 4**: In a Layer 2 or 3 loopback all incoming test traffic will be looped back.
  - The loopback function will swap the MAC destination and MAC Source addresses (for Layer 2) or MAC and IP destination and source addresses (for Layer 3).
  - All incoming frames with CRC errors will be dropped, similar to what an Ethernet switch does.
  - All broadcast and multicast frames will be dropped including any incoming unicast frames that have the MAC Source address equal to the MAC Destination address.

6.6.1 Setup

Loopback Parameters: The following parameters are available on Layer 2, 3 and 4. For more information on the parameters, please see 6.2.1.1 BERT Header Settings in the BERT section. It is possible to enable any of these parameters to create a customer loopback filter. For example, enabling a filter with VLAN 64, Priority 7, will only loop back traffic corresponding to these values.

- VLAN ID
- VLAN Priority
- MAC Source
- MAC Destination
- IP Source Address (Layer 3 & 4 only)
- IP Destination (Layer 3 & 4 only)
- Precedence (Layer 3 & 4 only)
- TOS Value (Layer 3 & 4 only)
- UDP SPort (Layer 4 only)
- UDP DPort (Layer 4 only)

Loopback Setup Layer 2

Loopback Setup Layer 3

Loopback Setup Layer 4

Press Start to begin loopback.  indicates that loopback is in progress.

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6.6.2 Results

The Results tab displays current test results.

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6.6.2.1 Summary

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

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

Results Summary

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6.6.2.2 Signal

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

Results Signal Page 1 **Results Signal Page 2**

Results Signal Page 3

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6.6.2.3 Errors

The following errors (Current and Total) are displayed:

- **FCS/CRC:** Number of received frames with an invalid FCS
- **IP Checksum** (Layer 3 & 4 only)
- **TCP/UDP Checks** (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

Results Errors

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6.6.2.4 Alarms

The following alarms (Current and Total) are displayed:

- **LOS (ms):** Loss of Signal
- **LOSync:**
- **Pattern Loss:** Indicates errors related to test pattern
- **Service Disruption (ms)** associated with loss of signal:
  - **Current:** Duration of the current service disruption
  - **Total:** Total accumulated duration of the service disruptions
  - **Last:**
  - **Min/Max:** Minimum and maximum duration of the service disruption events
  - **No. of Occurances:** Counter of service disruption events

Results Alarms

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6.6.2.5 Events

The Events tab gives a time stamped record or log of anomalies, alarms, test status (start/stop) and test application.

Results Events

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6.6.2.6 Traffic

The following Traffic statistics are displayed:

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

Tap on the graph for detailed screens.

Traffic Type: 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.

Results Traffic

Traffic Type (Layer 2)

Traffic Type (Layer 3 & 4)

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

- Received (RX) frames:
  - Total frames
  - VLAN tagged frames
  - VLAN stacked frames
  - Pause frames: RX
  - Total number of received Ethernet pause flow-control frames

Traffic Frames Type

Frame Size

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

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

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6.6.2.7 Delay

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

- Current
- Average
- Minimum
- Maximum
- Frame Delay Variation:
  - Current

Results Delay

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6.6.2.8 Rates

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

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

Results Rates

Rate Details

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6.7 Advanced Tools

Advanced Tools

The UX400 platform features two Advanced Tools menus--one that offers test applications common to all modules across the platform and one specific to different test applications.

Please note the IPTV, Net Wiz, and Packet Capture functions are not supported in this release.

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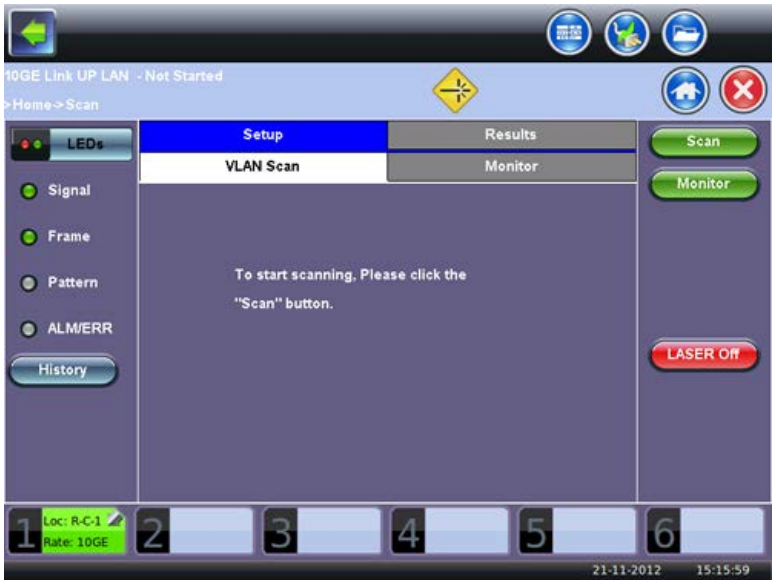
Scan

VLAN Scan Setup



VLAN Scan scans up to 4096 VLAN IDs for switch configuration and displays VLAN ID bandwidth rates, useful for identifying top bandwidth users based on VLAN ID. Monitor mode monitors up to eight live traffic streams (in terminate mode) and filters them based on VLAN ID configuration, providing key traffic metrics such as frame type, rates, and errors and alarms.

VLAN Scan

- While traffic is being received, press **Scan**. The Results tab displays a list of detected VLAN IDs and the percentage of traffic marked with those IDs. Check up to 8 streams to monitor.

VLAN ID

- The VLAN Stack tab displays detected SP and CE VLAN tags (if stack VLAN tags are used).

VLAN Stack

Monitoring Traffic

- To only receive traffic streams meeting specific criteria, stop the scan and go to the Monitor tab to configure filter criteria.
- Tap on a parameter box to configure it. Place a check next to a parameter to only receive traffic that matches this criteria. For descriptions of each parameter, please see, 6.5.1 Setup for Throughput Testing (Multiple Streams).
- Press **Monitor** to monitor selected traffic. For a description of traffic parameters from Global and Per Stream Results tabs, please see 6.5.2 Throughput Results.

Monitor Setup

Monitor Global Results Aggregate

Monitor Global Results Stream Summary

Monitor Per Stream Results Summary

Monitor Per Stream Results Errors

Note: *If no stream information is displayed in the* ***Per Stream*** *tab, return to the VLAN ID tab (****Results*** *>* ***Scan*** *>* ***VLAN ID****) and verify that the VLAN ID boxes are checked.*

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7.0 OTN/ SDH/ SONET (OTU2/STM-64/OC-192) Test App

Follow the steps to assign the test module to a test tab as described in Chapter 5 of this manual.

Select the OTU2/STM-64/OC-192 Testing Application (Single or Dual Port) and click "Accept".

OTU2/STM-64/OC-192 Test App Selection

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

System Configuring

The OTU2/STM-64/OC-192 Testing home page will be displayed with links to Setup, Results, Alarm/Error, Profiles, SONET/SDH Tools, PDH Tools 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.

OTU2/STM-64/OC-192 Testing 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.

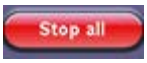
Note: *For Dual Port testing the Laser On step needs to be performed for both ports. The ports can be switched by tapping on the respective buttons on the left side of the screen (10G Port 1 / 10G Port2).*

Ready for Testing Tasks

Dual Port Operation

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

Start All: The Start All button is located on the right side of the dual port operation mode screen. Tapping this button will simultaneously start a test on both ports.



Stop All: Once the test starts on both ports, the Start All button will change to Stop All. Tapping on this button will simultaneously stop the test on both ports.

OTU2/STM-64/OC-192 Testing Dual Port

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7.1 Setup

The Setup tab allows the user to select SDH, SONET, OTN and PDH and all the other related configurations under the following menus:

- **Signal**
- **Measurements**
- **General**

Setup Home

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7.1.1 Signal Overview

Signal tab is the default tab that opens up when Setup screen is entered. Signal allows setting up the Transmitter and Receiver interfaces and associated test parameters prior to running a test.

TX and RX Configurations

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

Coupling TX and RX

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

Accessing the Copy Menu

Copy Menu Options

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

- **Rx=Tx:** Rx blocks will copy the settings made in the Tx blocks

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

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

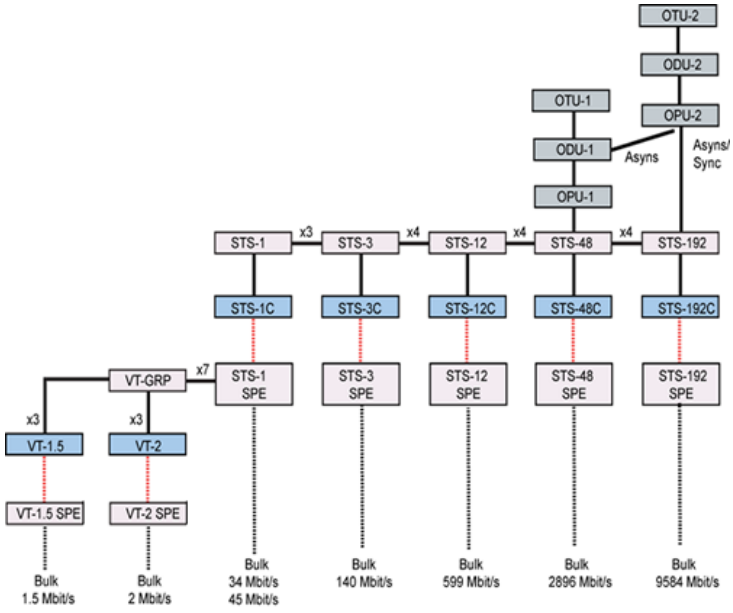
7.1.1.1 Hierarchy: Allows the user to configure the following:

- **Operating Mode:**
  - **Normal:** Unit working as normal mode.
  - **Payload:** Overhead overwrite Editing Thru mode allows for some intrusive error and alarm injection through overhead manipulation. Applies to both SDH/SONET and PDH signals and allows the user to configure low rate signal (if applicable) and associated framing.
  - **Transparent:** 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.

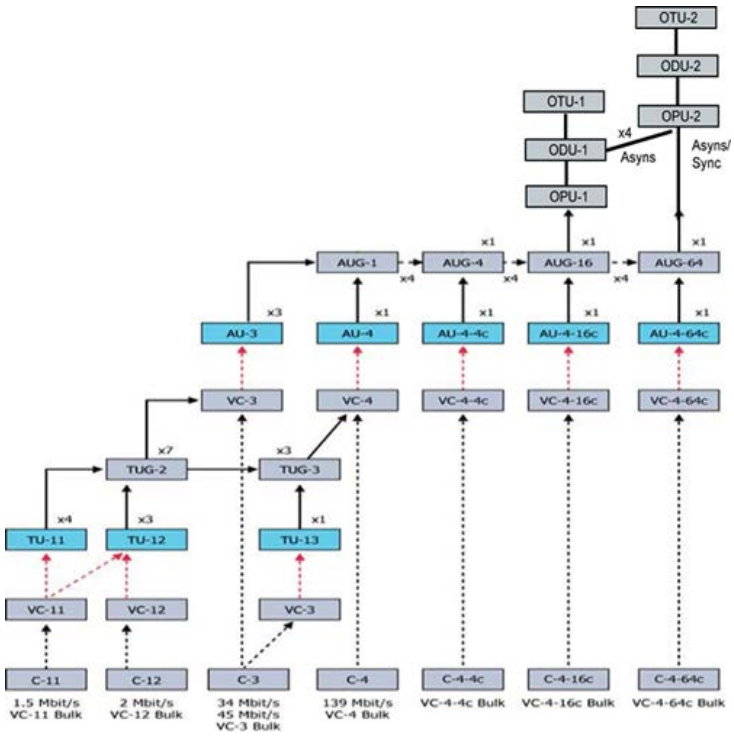
  Note: *Through modes are used to test network behavior under certain conditions, such as alarms and APS. To select Payload Through, the payload has to be the same for the relevant ports.*
- **Network Type:** SONET/ SDH or OTN
  Note: *The choice between SDH and SONET Network Type is based on the selection made in the menu under General tab.*
- **Test Rate:** OC-192-10G (for SONET), STM-64 - 10G (for SDH), OTU-2 (for OTN)
- **OTN Mapping** (for OTN only)**:** PRBS, OC192 SYNC, OC192 ASYNC, STM-64 SYNC, STM-64 ASYNC

  Note: *ITU-T G.709 and STS mappings per Bellcore GR-253 and ANSI T1.105 recommendations are supported. ITU-T G.709 and both AU-4 and AU-3 signal mappings per G.707 recommendations are supported. The multiplexing structures are shown below.*

OTN SONET Mapping Structure



OTN SDH Mapping Structure



- **Scrambler** (for OTN only)**:** ON / OFF
- **FEC** (for OTN only)**:** ON / OFF

Heirarchy Menu SDH / SONET

Heirarchy Menu OTN

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7.1.1.2 Interface: Allows the user to select the following:

- **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.
  - **External:** 2MHz, 2Mbit/s
    - **Termination:** Terminated, Monitor, Bridge
    - **Line code:** HDB3, AMI
  - **RX** (**Received):** The clock for the transmitter is derived from the received signal and the jitter of the incoming signal is suppressed.
  - **Offset:** The clock for the transmitter is derived from internal clock generator. It can change the offset while measurements are running. Use the numeric key to increase and decrease the frequency shift, up to 0.01ppm. Frequency offset: ± 50ppm with 1, 0.1, 0.01ppm resolution.

Interface Menu

Interface External Clock

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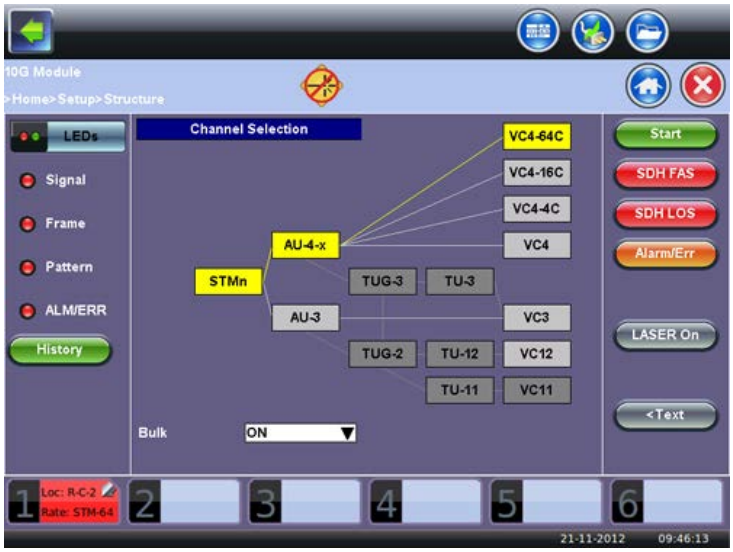
7.1.1.3 Structure: Allows the user to configure lower order mapping and the channel number.

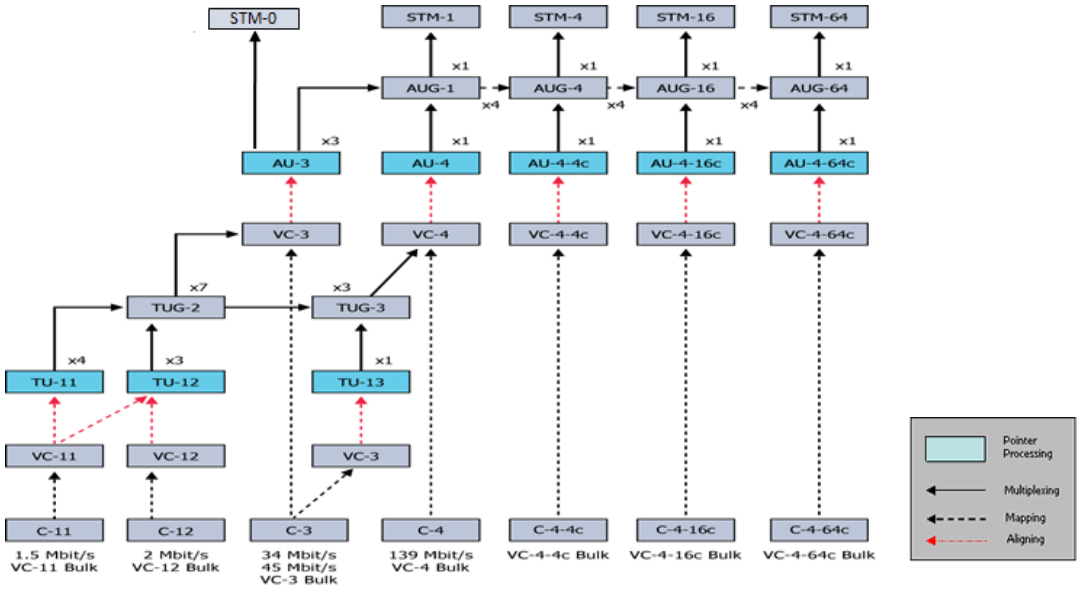
Structure Menu



For SDH:

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

SDH Multiplexing Structure



AU4 Mapping: VC4-64C, VC4-16C, VC4-4C, VC4, VC3, and VC12 are available.

AU3 Mapping: VC3,VC12, and TU11/VC11 are available.

Bulk: Tap the check box to enable the setting. In bulk mode, the entire VT container is filled with a test pattern per ITU-T 0.181 recommendations.

Tributary: Preset to DS1, E1, DS3, and E3 depending upon the options and mapping.

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

Note:

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

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

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

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

Thus the naming convention per SDH rate is as follows:

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

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

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

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

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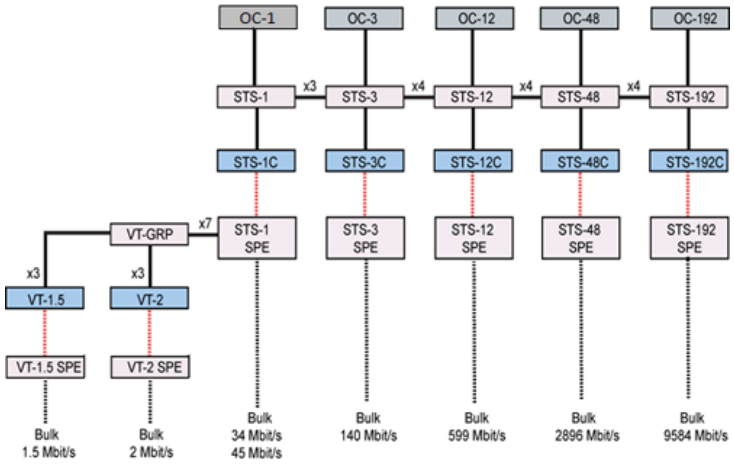
For SONET:

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.

SONET Mapping Structure



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7.1.1.4 Payload: Depends on Mapping Selected.

Tapping the Tx or Rx Payload box opens the respective Payload Setup screen.

Payload Setup

Rate: Depends on mapping selected.

SDH:

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

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

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

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

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

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

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

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

SONET:

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

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

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

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

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

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

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

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

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

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

Framing: Depends on low rate selected:

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

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7.1.1.5 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.

Pattern Setup

Note: *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.*

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7.1.2 Measurements Setup

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

Measurements tab

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7.1.2.1 Timer Setup

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

Mode: Manual, Timed, and Auto selections are available

- **Manual**
- **Timed:** The test duration can be set by the user. The test duration can be set in seconds, minutes, hours or days.
- **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.

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

Measurements Auto Mode

Measurements Timed Mode

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7.1.2.2 Performance Analysis

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

Analysis

The recommendations are briefly defined as follows:

- **G.821:** Error performance of an international digital connection operating at a bit rate below the primary rate and forming part of an Integrated Service Digital Network (ISDN)
  - Long term error performance conducted Out of Service (OOS)
  - Based on measuring bit errors
  - Evaluation period of 30 days
  - Since there is no overhead structure at these bit rates, in-service measurements are extremely difficult
- **G.826:** End-to-end error performance parameters and objectives for international, constant bit rate digital paths and connections
  - Long term error performance for Out of Service (OOS) and In-Service Measurement (ISM)
  - Based on measuring bit errors for connections and block errors for paths
  - Evaluation period of 30 days
- **G.828 Analysis**: Error performance parameters and objectives for international constant bit rate synchronous digital paths
  - Deals exclusively with SDH paths
  - Long term error performance for Out of Service (OOS) and In-Service
  - Based on measuring block errors
  - Evaluation period of 30 days
- **G.829 Analysis:** Error performance events for SDH Regenerator and Multiplexer sections
  - Deals exclusively with SDH sections
  - Error event definition
  - Based on measuring block errors
- **M.2100:** Performance limits for bringing into service and maintenance of international multi-operator PDH paths and connections
  - Deals exclusively with PDH paths, sections and systems
  - Based on measuring bit errors and block errors
  - BIS limits for OOS/ISM
  - Evaluation periods of 15 minutes, 2 hours and 24 hours
  - First step is a continuity test for 15 minutes
  - PDH paths are composed of sub-elements of different lengths each with its own set Reference Performance Objectives (RPO)
- **M.2101 Analysis:** Performance limits and objectives for maintenance and bringing into service SDH paths and multiplex sections.
  - Deals exclusively with SDH paths and sections
  - Based on measuring block errors
  - BIS limits for OOS/ISM
  - Evaluation periods of 15 minutes, 2 hours, 24 hours and 7 days
  - First step is a continuity test for 15 minutes

Note: 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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7.1.3 General

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

General tab

- **APS Protocol:** Linear or Ring architectures are selectable. This determines how the APS bytes (K1/K2) are decoded in the SDH Overhead Analyzer or how they are generated in the SDH Overhead Generator. It also determines how the APS measurement will be made.
- **SDH/SONET:** SDH or SONET modes are available options.
- **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**
  - **External:** 2MHz, 2Mbit/s

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7.2 Results

Accessing Results

To access measurements for SDH, SONET, and OTN, tap on **Start**, which starts testing and takes the user to the Results screen, or tap on **Results** on the home screen.

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7.2.1 Summary

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

Results Summary - SDH

Results Summary - OTN

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7.2.2 Errors and Alarms

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

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

- **Green:** No error or alarm is present
- **Red:** An error or alarm condition is detected and is currently present
- **Yellow:** Indicates a history condition. An error or alarm was detected during the measurement interval but it is no longer present or active

Errors/Alarms (SDH Page 1)

Errors/Alarms (OTN Page 1)

Note: *Tapping the individual box in the table will bring up the applicable result screen with detailed 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 - SDH (Page 2)

Errors/Alarms - OTN (Page 2)

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Errors/Alarms (Page 3 & 4)

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.

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

Errors/Alarms - SDH (Page 3)

Errors/Alarms - SDH (Page 4)

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

Errors/Alarms - OTN (Page 3 - OTU Alarms)

Errors/Alarms - OTN (Page 4 - OTU Alarms)

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Errors/Alarms (Page 5)

For SDH and SONET Page 5 lists the Bit Error Performance (BERT) associated with the signal under test.

Errors/Alarms - BERT (SDH/ SONET Page 5)

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

Errors/Alarms - OTN Page 5

Errors/Alarms - OTN Page 6

Errors/Alarms (Page 7) - (For OTN Only)

For OTN the Error/ Alarms tab has 7 pages. Page 7 lists the Bit Error Performance (BERT) associated with the signal under test.

Errors/Alarms - OTN Page 7

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7.2.3 Event Log

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

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

Event Log

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7.2.4 Signal

The signal tab displays the Level and Frequency screen.

Page 1: Displays **Level** measurements in electrical units (volts) for SDH and SONET, and in dBm for OTN. Loss of Signal (LOS) and the Saturation levels is shown both graphically and in dBm.

SDH: Measurements for STM-1, STM-4, STM-16 and STM-64 signals.

SONET: Measurements for OC-3, OC-12, OC-48 and OC-192 signals.

OTN: Measurements for OTU-1 and OTU-2 signals.

Signal Page 1

Page 2: The received signal **frequency** and offset is measured and displayed.

- **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 2

For SDH and SONET signals, the measurement is performed on the optical interfaces (XFP).

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 UX400 unit must be connected to a Protected Monitoring Point (PMP). The frequency of the signal is normally reported in Hz, while the deviation is reported in ppm. Tolerances for the various clock frequencies of SDH hierarchies are presented in the table below.

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

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

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Signal Page 3: Optical Information

Page 3 displays the Optical Transceiver (SFP or XFP) information including Vendor name, Part #, Firmware revision #, Optical Wavelength and Min/Max bit rates supported.

Signal Page 3

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7.2.5 Histogram

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 (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 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).

Page 1:

For SDH: Displays the Alarms associated with the Section Overhead (SOH) Alarm

For SONET: Displays the Alarms associated with the SONET Alarm

For OTN: OTU Alarms

Page 2:

For SDH: Displays the Errors associated with the Section Overhead (SOH)

For SONET: Displays the Errors associated with the SONET Errors

For OTN: OTU Errors

Page 3:

For SDH: 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)

For SONET: The Alarms and Errors associated with the STS PATH. The measured parameters are:

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

For OTN: ODU Alarms (AIS, OCI, LCK, BDI, TIM, PLM)

Page 4:

For SDH: 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)

For SONET: 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)

For OTN: ODU Errors (BIP, BIE)

Page 5: Displays BERT Alarms / Errors. LSS (Loss of Sequence Synchronization) and BIT errors.

Histogram - BERT Alarms/Errors (Page 5)

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7.2.6 Graph

The Graph tab brings up 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.

The following error types are covered:

For SDH:

- FAS
- B1
- B2
- MS-REI
- B3
- HP-REI
- Bit

For SONET:

- FAS
- S-BIP
- L-BIP
- REI-L
- P-BIP
- REI-P
- Bit

For OTN:

- OTU FAS
- OTU MFAS
- OTU BIP
- OTU BEI
- COR FEC
- UNCOR FE
- ODU BIP
- ODU BEI
- Bit

Results Graph

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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7.2.7 Performance Analysis

The Analysis tab displays measured objectives from ITU-T performance tests selected from the Measurements tab (**Setup** > **Measurements**). For a brief description of supported G-Series and M-Series performance tests as well as setup instructions, please see 7.1.2.2 Performance Analysis.

7.2.7.1 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%

Note: 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.821 Analysis

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7.2.7.2 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.

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

G.826 Analysis

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7.2.7.3 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)

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

G.828 Performance Analysis

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7.2.7.4 Evaluation According to ITU-T G.829

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

ES, SES, BBE and UAS are evaluated.

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

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

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

Bit errors can be evaluated for:

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

G.829 Analysis

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7.2.7.5 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.

M.2100 Analysis

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7.2.7.6 Evaluation According to ITU-T M.2101

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

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

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

Settings for S1 and S2:

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

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

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

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

Bit errors can be evaluated for:

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

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

M.2101 Analysis

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7.2.8 Alarm Error Definitions for SDH, SONET and OTN

7.2.8.1 SDH:

The SDH LED headers are described in the table below:

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

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

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

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

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

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

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

High Order Path – Alarm Definitions	
HP-UNEQ	HO path unequipped - Declared when the C2 byte contains "00H" in five consecutive frames
HP-RDI	HO path Remote Defect Indication - Alarm is declared when bits 5,6,7 of the G1 byte contain 100 or 111 in five consecutive frames
HP-TIM	HO path Trace Identifier Mismatch - Indicates that the J1 path trace does not match the expected message value. The TIM function must be enabled for this alarm to be active
HP-PLM	HO path Payload Mismatch - Declared after receiving five consecutive frames with mismatched VC signal labels
B3	HO path error monitoring of VC-3, VC-4 - Parity errors evaluated by the B3 byte (BIP-8) of a VC-N (N = 3, 4). If any of the eight parity checks fail, the corresponding block is assumed to be in error.
HP-REI	HO path Remote Error Indication - Declared when bits 1-4 of the G1 byte contain 0001 to 1000 pattern

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

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

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7.2.8.2 SONET:

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

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

Abbreviation	Name	OH byte
LOS	Loss of Signal	
TSE	Test Sequence Error(bit error)	
LSS	Loss of Sequence Synchronizartion	
AIS	Alarm Indication Signal	
SECTION		
OOF	Out of Frame	A1,A2
LOF	Loss of Frame	A1,A2
B1(8bits)	Regenerator Section Error Monitoring	B1
TIM-S	Trace Identifier Mismatch	J0
LINE		
AIS-L	Line AIS	K2
RDI-L	Line Remote Defect Indication	K2
REI-L	Line Remote Error Indication	M1
B2(24bits)	Error Monitoring	B2
STS-PATH		
LOP-P	Loss of STS Pointer	H1,H2
AIS-P	Administrative Unit AIS	STS-1 SPE include. H1,H2,H3
RDI-P	STS path Remote Defect Indication	G1
REI-P	STS path Remote Error Indication	G1
TIM-P	STS path Trace Identifier Mismatch	J1
PLM-P	STS path Payload Label Mismatch	C2
B3(8bits)	Error Monitoring	B3
UNEQ-P	STS path Unequipped	C2
VIRTUAL TRIBURTARY PATH (VT)		
LOP-V	Loss of TU Pointer	V1,V2
AIS-V	TU Alarm Indication Signal	VT incl. V1 to V4
LOM	TU Loss of Multiframe	H4
UNEQ-V	VT Path Unequipped	V5
RDI-V	VT Path Remote Defect Indication	V5
REI-V	VT Path Remote Error Indication	V5
RFI-V	VT Path Remote Failure Indication	V5
TIM-V	VT Path Trace Identifier Mismatch	J2
PLM-V	VT Path Payload Label Mismatch	V5
BIP-2	VT Path Error	V5

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

	Anomalies/Defect	Detection Criteria	Bellcore ANSI
Section/Line Layer			
LOS	Loss of Signal	All-zero pattern for 2,3 us≤ T ≤ 100us	GR-253 T1.231
LOF	Loss of Frame	A1, A2 No valid framing pattern for 3 ms (24 frames)	GR-253 T1.231
B1	Section BIP error	Mismatch of the recovered and computed BIP-8 covers the whole STS-N frame	GR-253 T1.105
B2	Line BIP error	Mismatch of the recovered and computed NxBIP-8 covers the whole STS-N frame	GR-253 T1.105
AIS-L	Line-AIS	K2(bits 6, 7, 8) = 111 for 5 frame	GR-253 T1.231
REI-L	Line Remote Error Indication	Number of detected B2 errors in the sink side encoded in the byte M0 or M1 of source side	GR-253 T1.105
RDI-L	Line Remote Defect Indication	K2(bits 6, 7, 8) = 110 for z frame (z= 5 – 10)	GR-253 T1.231

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

	Anomalies/Defect	Detection Criteria	Bellcore ANSI
VT Path Layer			
LOM	Loss of Multiframe	Loss of synchronization on H4 (bits 7, 8) superframe sequence	GR-253 T1.105
AIS-V	VT Path AIS	All "1" in the VT pointer bytes V1, V2 for ≥ 3 frames	GR-253 T1.231
LOP-V	VT Path Loss of Pointer	8 – 10 NDF enable, 8 – 10 invalid pointers	GR-253 T1.231
BIP-2	VT Path BIP Error	Mismatch of the recovered and computed BIP-2 (V5 bits 1, 2) covers entire VT	GR-253 T1.105
UNEQ-V	VT Path Unequipped	V5 (bits 5, 6, 7) = 000 for ≥ 5 (≥ 3 as per T1.231) superframes	GR-253 T1.231
TIM-V	VT Path Trace Identifier Mismatch	Mismatch of the accepted and expected Trace Identifier in byte J2	
REI-V	VT Path Remote Error Indication	If one or more BIP-2 errors detected in the sink side, byte V5 (bit 3) = 1 on the source side	GR-253 T1.105
RDI-V	VT Path Remote Defect Indication	V5 (bit 5) = 1 for 10super frames	GR-253 T1.231
PLM-V	VT Path Payload Label Mismatch	Mismatch of the accepted and expected Payload Label in bye V5 (bits 5, 6, 7) for ≥ 5 (≥ 3 as per T1.231) superframes	GR-253 T1.231

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7.2.8.3 OTN:

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

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

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

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

ODU Alarm/Error Definitions Detection criteria according to G.709 and G.798	
ODU-BEI	Backward error indication -PM byte 3, bit 1 to 4: value 0 to 8: SM BIP-8 error count value 9 to 15: no SM BIP-8 errors
ODU-AIS	Alarm Indication Signal - PM byte 3, bit 6 to 8: " 111" ≥ 3 frames
ODU-OCI	Open connection indication - PM byte 3, bit 6 to 8: " 110" ≥ 3 frames
ODU-LCK	Locked - PM byte 3, bit 6 to 8: " 101" ≥ 3 frames
ODU-BDI	Backward Defect Indication - PM byte 3, bit 5 = 1 ≥ 5 frames
ODU-PLM	Payload mismatch - Declared if the accepted payload type is not equal to the expected payload type(s) as defined by the specific adaptation function.
ODU-TIM	Trail Trace Identifier Mismatch

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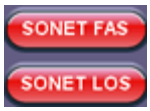
7.3 Alarm / Error Injection

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

To access the setup for the alarms and errors, tap the button on the right side of the screen. The following buttons are there for SDH, SONET and OTN respectively:

SDH	SONET	OTN
		

The type of Alarm/Error can be set by tapping the  tab.

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7.3.1 Setup Alarm and Error Injection

The Alarm and Error screen will reflect the alarm and error types based on the test type settings selected in the Setup. For instance the below screen shot is for SDH mode selected in Setup.

Setup Alarm and Error Injection

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7.3.2 Alarm Generation

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

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

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7.3.2.1 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

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7.3.2.2 SONET Alarms

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

- **OC-1/3/12/48/192 (depends on signal structure):** LOS, LOF, Line AIS, Line RDI, Section TIM, Path LOP, Path AIS, Path UNEQ, Path PLM, Path RDI, Path TIM

SONET Alarm Type

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7.3.2.3 OTN Alarms

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

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

OTN Alarm Type

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7.3.3 Error Generation

OTN, SDH, and SONET errors can be generated.

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7.3.3.1 SDH Errors

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

- **STM-1/4/16/64 signals:** FAS, B1, B2, MS-REI, B3, HP-REI

SDH Error Type

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7.3.3.2 SONET Errors

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

- FAS, Section BIP, Line BIP, Line REI, Path BIP, Path REI

SONET Error Type

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7.3.3.3 OTN Errors

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

OTN Error Type

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7.3.4 Error Flow

OTN, SDH, SONET signals

Injects different anomalies into the transmit signal. Error insertion flow modes include:

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

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

Error Flow

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7.3.4 Pattern Error

Errors can also be inserted in Pattern mode.

Pattern Error Type: BIT

Pattern Mode

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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.

Note: *Please refer to the tables in Chapter 7.2.8 for Alarm and Error Definitions.*

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7.4 SONET Tools

SONET Tools can be accessed by tapping the SONET/SDH Tools tab on the home screen. SONET test type will need to be selected in Setup to view SONET parameters under the Tools.

SONET Tools Menu

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

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7.4.1 Overhead Analyzer

Tap the Overhead Analyzer icon to display the OH screens. 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

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

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7.4.1.1 Section Overhead (SOH)

SOH

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

Section Layer

Framing Bytes (A1/A2)

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

A1 (Framing) Byte

Path Trace Byte (J0)

- Regenerator section trace
- Used to transmit a 16-byte identifier (trace) (15-byte string and a CRC-7 byte) repeatedly so that all regenerators can verify their connection. 64-byte strings are also available. It contains up to 62 characters plus carry return (CR) and line feed (LF), any unused characters are filled with blanks (00h)
- Used for continuity testing between regenerators

B1 Byte (RS-BIP)

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

B1 (Section-BIP) Byte

Order Wire Byte (E1)

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

F1 Byte

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

Data Communications Channel Bytes (D1/D2/D3)

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

D1 Byte

Pointers

H1/H2/H3 Bytes (STS Pointers)

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

H1 Pointer Byte

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Line Layer

B2 Byte

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

B2 Byte

K1 Byte (APS-Linear)

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

- 1111 Extra traffic channels

K1 Byte (APS-Linear)

K1 Byte (APS-Ring)

- Used to activate and deactivate the switching between the main and protection paths on a multiplexer section
- APS message type conforms to ITU-T G.841/ Bellcore GR.253 Ring Network architectures
  - Bits 1-4 are the condition
    - 1111 Lockout of protection
    - 1110 Forced switch (span)
    - 1101 Forced switch (ring)
    - 1100 Signal fail (span)
    - 1011 Signal fail (ring)
    - 1010 Signal degrade (protection)
    - 1001 Signal degrade (span)
    - 1000 Signal degrade (ring)
    - 0111 Manual switch (span)
    - 0110 Manual switch (ring)
    - 0101 Wait to restore
    - 0100 Exercise (span)
    - 0011 Exercise (ring)
    - 0010 Reverse request (span)
    - 0001 Reverse request (ring)
    - 0000 No request
  - Bits 5-8 are the destination node ID
    - 0000 Null channel
    - 0001 to 1110 Channels 1 thru 14
    - 1111 Extra traffic channel

K2 Byte (APS-Linear)

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

K2 Byte (APS-Ring)

- Conforms to and follows ITU-T G.841 Bellcore GR.253 recommendations
- Used to activate and deactivate the switching between the main and protection paths on a multiplexer section
- Used to communicate Alarm Indication Signal (AIS) and Remote Defect Indication (RDI) conditions
  - Bits 1-4 are the source node ID
  - Bit 5 is the path code
    - 0 Short path
    - 1 Long path
  - Bits 6-8
    - 000 Idle
    - 001 Bridged
    - 010 Bridged and switched
    - 110 RDI-L

111 AIS-L
- Others Not used

K2 Byte (APS-Linear)

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

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

S1 Byte (Synchronization Status)

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

S1 Byte (Synchronization Status)

Order Wire Byte (E2)

- A 64 kbps voice communication channel between multiplexers.
- It's a channel used by craft persons and will be ignored as it passes through regenerators.

The relief byte is used for ring protection

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7.4.1.2 Path Overhead Layer (POH)

POH

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

- **J1 byte (STS Path Trace)**
  - High Order STS-N path trace byte
  - An unique message is assigned to each path in a SONET network – therefore the path trace can be used to check continuity between any location on a transmission path and the path source
  - This user programmable byte repeatedly transmits a 15-byte string plus 1 (CRC-7) byte so that a receiver can continually verify its connection with the transmitter
  - A 64-byte free-format string is also permitted. It contains up to 62 characters plus carry return (CR) and line feed (LF), any unused characters are filled with blanks (00h)
  - The message is transmitted one byte per STS-3 frame

J1 Byte

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

B3 Byte (STS Path BIP)

- **C2 byte (STS path signal label)**
  - Indicate the type of payload being transported in the STS, SPE, including the status of the mapped payloads.
  - The table below indicates the standard C2 binary values:

C2 Byte (STS Path signal label)

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

E9	STS-1 payload with 9 VT-x payload defects
EA	STS-1 payload with 10 VT-x payload defects
EB	STS-1 payload with 11 VT-x payload defects
EC	STS-1 payload with 12 VT-x payload defects
ED	STS-1 payload with 13 VT-x payload defects
EE	STS-1 payload with 14 VT-x payload defects
EF	STS-1 payload with 15 VT-x payload defects
F0	STS-1 payload with 16 VT-x payload defects
F1	STS-1 payload with 17 VT-x payload defects
F2	STS-1 payload with 18 VT-x payload defects
F3	STS-1 payload with 19 VT-x payload defects
F4	STS-1 payload with 20 VT-x payload defects
F5	STS-1 payload with 21 VT-x payload defects
F6	STS-1 payload with 22 VT-x payload defects
F7	STS-1 payload with 23 VT-x payload defects
F8	STS-1 payload with 24 VT-x payload defects
F9	STS-1 payload with 25 VT-x payload defects
FA	STS-1 payload with 26 VT-x payload defects
FB	STS-1 payload with 27 VT-x payload defects
FC	STS-1 payload with 28 VT-x payload defects, or STS-1, STS-3C, etc., with a non-VT payload defect (DS3, FDDI, etc.)

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

G1 Byte (HP Status)

- **F2 byte (Path user channel)**
  - STS Path user channel
  - STS-3# path user channel used for communication between path elements

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

H4 Byte (VT Indicator)

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

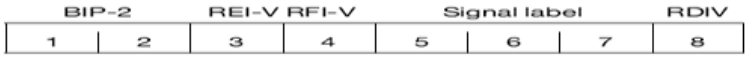
Z5 byte structure

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

Z5 Byte (Path TCM)

- **V5 byte (VT path overhead)**
  - The first byte of a VT SPE provides the functions of error checking, signal label and path status.
  - Continuous monitoring of anomalies or defects and payload composition at the path end or along the path
    - Bits 1-2 provides error checking (BIP-2)
    - Bit 3 is the REI-V (0 = no error, 1 = errors), that is sent back towards an originating VT PTE if errors were detected by the BIP-2.
    - Bit 4 is reserved for mapping-specific functions.

    - Bits 5-7 provide the VT signal label
        - 000 Unequipped
        - 001 Equipped (non-specific)
        - 010 Asynchronous mapping for DS1
        - 011 Bit synchronous mapping for DS1
        - 100 Byte synchronous mapping for DS1
    - Bit 8 is the VT path RDI-V normally set to zero unless there is an error condition (AIS)



Bits 1 and 2: Performance monitoring
Bit 3: REI-V (remote error indication) for VT path
Bit 4: RFI-V (remote failure indication) for VT path
Bits 5 to 7: Allocated for a VT path signal label
Bit 8: RDI-V (remote defect indication) for VT path

- **J2 byte (VT path trace)**
    - Used to transmit a configurable 16-byte or 64-byte identifier that enables the receiving path to continuously verify its connection with the transmitter
    - Uses the same byte structure as the J0 and J1 bytes

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

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

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	

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

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7.4.1.3 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)

Note:

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

Summary

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7.4.2 Overhead Generator

SOH

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

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

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

S1 Byte from SOH

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

C2 Byte from POH

Overhead Generator

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

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

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7.4.3 Pointer Tasks

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

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7.4.3.1 Pointer Analysis

Pointers keep SONET signals synchronous by compensating for timing differences without having to use stuffing bits. Pointers are allowed to move up or down every three

frames however the actual rate should be slower. The Administrative Unit (AU) and the Tributary Unit (TU) each has its own pointer and the unit has two tabs for displaying the values and measurements.

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

Pointer Tasks - Analysis STS

Pointer Tasks - Analysis VT

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7.4.3.2 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.
- **For VT pointers**
  - VT Pointer value: Set value in a range of 0 to 109 (VT-1.5) and 0 to 139 (VT-2)
  - Increment (INC) or Decrement (DEC) pointer value by 1 byte is single steps

Generator > STS tab

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7.4.3.3 Pointer Sequences

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

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

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

G.873 **G.873 Sequences**

Pointer Sequence Testing

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

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7.4.4 Trace Identifier

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

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7.4.4.1 Transmitted Traces (TX)

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

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

Trace Identifier TX

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7.4.4.2 Received Traces (RX)

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

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

RX - JO [S]

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7.4.5 Payload Labels

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

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

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

Payload Label TX

Payload Label RX

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

Payload Label RX VT

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7.4.6 APS Tasks

APS Timing

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

- **APS Standards**
  The principles and protocols of APS in SONET networks are defined in ITU-T G.783 and G.841 and Bellcore GR-253 recommendations for Linear and Ring network architectures respectively. According to these recommendations, the re-routing of the signal has to occur within 50ms. Protection switching is initiated as a result of one of the following conditions:
  - “Hard” Failure (SF) condition – Loss of Signal (LOS), MS-AIS, BER >1 x 10^{-3}.
  - “Soft” Failure (SD) condition – Signal degradation when BER exceeds a predetermined threshold. Normally over a provisioned range of 1 x 10^{-5} to 1 x 10^{-9}.

Tap the APS Tasks icon to display the APS testing screens shown below.

- **Sensor:** Select the trigger that will initiate the APS measurement.
  - The selections are: LOS, LOF, SONET FAS, S-BIP, AIS-L, RDI-L, REI-L, L-BIP, AIS-P, LOP-P, P-BIP, RDI-P, REI-P, LSS and None
- **Switch Time Limit:** Configurable in the range from 15ms to 200ms.
  - Typically 50ms according to ITU-T recommendations.
- **Gate Time**: Configurable in the range from 200ms to 4 seconds.
  - Used to measure total service disruption when multiple switches or micro interrupts occur.
- **Repeat**: ON/OFF
  - Configurable to measure on a continuous basis.
- **Start**: Press to begin the test.

APS Timing Setup

APS Test Procedure:

- The UX400 unit should be connected to a tributary port of network element or transmission system to ensure that the switching time is measured for the service transported by the SONET network.
- Ensure that no errors or alarms are present on the transmission system because this will impact the measurement.
- The measurement will be triggered by an Alarm Indication Signal (AIS)
- The UX400 measures how long the AIS event remains present after the event is first recognized and will continue to measure the total disruption time in the event of multiple disruptions.

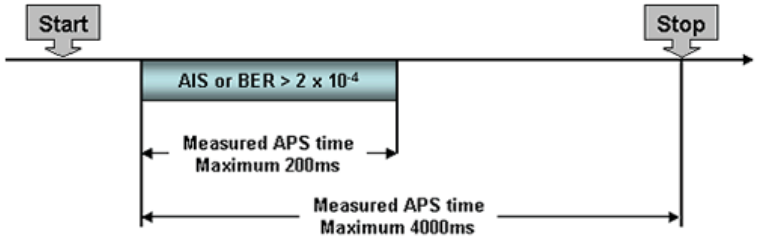

Figure 1: Perfect service disruption

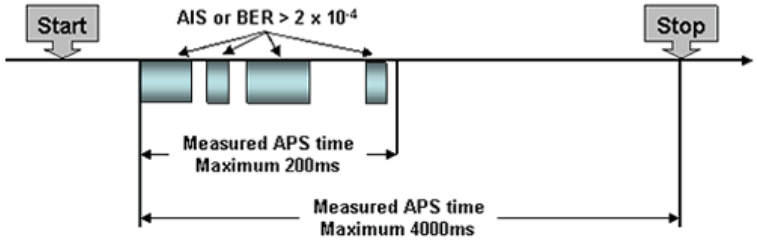

Figure 2: Multiple service disruption or micro interrupts

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7.4.7 Tandem Connection Monitoring (TCM)

HP Setup

TCM Standards
The Tandem paths are defined in ITU recommendation G.707 Annex D and Annex E. ITU-T recommendation G.707 defines a tandem connection source and sink and describes the responses of each when defect (alarm) and error conditions are detected. Tandem connection maintenance signals are carried in the Z5 byte for STS-N and in the Z6 byte for VT's. These two bytes are structured similarly, but their functions are not identical.

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7.4.8 Tributary Scan

This SDH/SONET monitoring function requires VC12/VC11 or VT-1.5/VT-2 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/STS-3 contains 63 x VC-12's and a STM-4/STS-48 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/SONET tributary (C12 channel) - mapping can be either via AU-4 or AU-3 to assess the health of each channel. The unit checks for error, alarms or status indicators in each channel of the received signal., the SDH structure, and if a test pattern is found in the payload, matching the unit's settings, pattern sync is achieved and a quick BER test is performed for synchronization of the selected test pattern in all channels.

The result for each channel is entered in a table:

- **K.L.M.:** Shows the ITU-T Tributary numbering scheme
- **Report:** Summary assessment of each channel
- **Pass (OK)** if the payload contains a test sequence (pattern) matching the one set in the Setup menu.
- **BIT** if a test pattern was found and bit errors were detected
- **LSS (Live)** if no test pattern was found inside the payload
- Any **SDH/SONET error, alarm or status** indicators detected on each tributary
- **J2 trace:** Corresponds to the VT or VC trace identifier being transmitted in each channel
- **Payload Label:** Corresponds to the V5 byte signal label being transmitted

Tapping on any of the table rows brings up an Event Details window.

Tributary Scan

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7.4.9 Round Trip Delay

Round Trip Delay Results

The Round Trip Delay (Propagation Delay) measurement works by sending a test pattern. An error 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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7.4.10 One Way Delay

Available with Dual Port Testing Application. It measures the delay between two local ports, in each direction.

One Way Delay

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7.5 SDH Tools

SDH Tools can be accessed by tapping the SDH/SONET Tools tab on the home screen. SDH test type will need to be selected in Setup to view SDH parameters under the Tools.

SDH Tools Menu

- **Overhead Analyzer:** Displays the Section Overhead (SOH) and Path Overhead (POH) bytes of the received channel.
- **Overhead Generator:** SDH mode. Used to edit Section Overhead (SOH) and Path Overhead (POH) bytes of the transmitted channel.
- **Pointer Tasks:** Displays both AU and TU pointer values and generates AU and TU pointer movements.
  - Pointer sequences according to ITU-T G.783 recommendations are also possible.
- **Trace Identifier:** Used to generate and edit J0, J1 and J2 path traces and set expected trace for received channel according to G.831 recommendations.
- **Payload Labels:** Used to set the C2 and V5 Path Signal Labels which indicate the content of the High order/STS path and Low order VCs/ VTs.
- **APS Testing:** Used to measure Automatic Protection Switching limits. Using selectable triggers, the drop out times of tributary connections are measured and compared with preset values.
- **Tributary Scan:** Used to scan individual or multiple tributaries to verify routing and error free operation. Only available in VC-12 or VC-11mode
- **TCM Tasks:** Used to analyze or edit the sequence of N1 and N2 TCM bytes by generating alarms and errors in the Tandem connection sub-layer.
- **Round Trip Delay (Propagation Delay):** Measurement works by sending a test pattern. Bit errors are transmitted in the pattern. The time it takes for the error to reach the receiver is the propagation time through the network.

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7.5.1 Overhead Analyzer

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

- SOH RX, which displays the bytes associated with the Section/LINE Overhead
- POH RX, which displays the bytes associated with the Path Overhead
- Summary, which displays the Path Traces (J0, J1, J2), APS (K1, K2), Synchronization status (S1), STS Path (C2), and VT Path (v5) Signal Label bytes

SOH

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

7.5.1.1 Section Overhead

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

Section Layer

Framing Bytes (A1/A2)

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

A1 [Framing] Byte

Path Trace Byte (J0)

- Regenerator section trace
- Used to transmit a 16-byte identifier (trace) (15-byte string and a CRC-7 byte) repeatedly so that all regenerators can verify their connection. 64-byte strings are also available. It contains up to 62 characters plus carry return (CR) and line feed (LF), any unused characters are filled with blanks (00h)
- Used for continuity testing between regenerators

B1 Byte (RS-BIP)

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

Path Trace Byte (J0)

Order Wire Byte (E1)

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

F1 Byte

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

Data Communications Channel Bytes (D1/D2/D3)

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

Pointers

AU Pointers Bytes (H1/H2/H3)

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

AU Pointer Byte

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Line Layer / Multiplexer Section

B2 Byte (MS-BIP)

- A 24-bit interleaved even parity code used to determine if transmission errors have occurred over the Multiplexer Section
- Its calculated over all the bits of the STM-1 frame except those in the Regenerator Section overhead
- The computed checksum is placed in the MSOH of the following STM-1 frame

K1 Byte (APS-Linear)

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

K1 Byte (APS-Linear)

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K1 Byte (APS-Ring)

- Used to activate and deactivate the switching between the main and protection paths on a multiplexer section
- APS message type conforms to ITU-T G.841/ Bellcore GR.253 Ring Network architectures
  - Bits 1-4 are the condition
    - 1111 Lockout of protection
    - 1110 Forced switch (span)
    - 1101 Forced switch (ring)
    - 1100 Signal fail (span)
    - 1011 Signal fail (ring)
    - 1010 Signal degrade (protection)
    - 1001 Signal degrade (span)
    - 1000 Signal degrade (ring)
    - 0111 Manual switch (span)
    - 0110 Manual switch (ring)
    - 0101 Wait to restore
    - 0100 Exercise (span)
    - 0011 Exercise (ring)
    - 0010 Reverse request (span)
    - 0001 Reverse request (ring)
    - 0000 No request
  - Bits 5-8 are the destination node ID
    - 0000 Null channel
    - 0001 to 1110 Channels 1 thru 14
    - 1111 Extra traffic channel

K2 Byte (APS-Linear)

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

K2 Byte (APS-Ring)

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

K2 Byte (APS-Linear)

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

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

S1 Byte (Synchronization Status)

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

S1 Byte (Synchronization Status)

Order Wire Byte (E2)

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

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7.5.1.2 Path Overhead Layer

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

- **J1 byte (STS Path Trace)**
  - High Order VC-N path trace byte
  - A unique message is assigned to each path in 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. It contains up to 62 characters plus carry return (CR) and line feed (LF), any unused characters are filled with blanks (00h)
  - The message is transmitted one byte per VC-4 frame

J1 Byte (HP Path Trace)

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

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

C2 Byte (HP signal label)

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

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

G1 Byte (HP Status)

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- **F2 byte (HP user channel)**
  - High Order Path user channel
  - VC-4 path user channel used for communication between path elements
- **H4 byte (TU Indicator)**
  - Position or Sequence Indicator
  - Multiframe phase indicator used for tributary structured payloads
- **F3 byte (LP) user channel**
  - Used for communication between path elements and is payload dependent.
- **K3 byte (HP APS)**
  - Bits 1-4 are used for protection switching of VC-3 & 4 paths.
  - Bits 5-8 are a currently not used
- **N1 byte (HP)**

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

N1 byte structure per ITU-T G.707 recommendations							
Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8
IEC coding				TC-REI	OEI	TC-API, TC-RDI, ODI, Reserved	

- **V5 byte (LP signal label)**
  - Byte contains error analysis, signal label and path status information
  - Continuous monitoring of anomalies or defects and payload composition at the path end or along the path
    - Bits 1-2 provides error checking (BIP-2)
    - Bit 3 is the LP-REI (0 = no error, 1 = errors)
    - Bit 4 is the LP-RFI (0 = no error, 1 = errors)
    - Bits 5-7 provide the VC-12 signal label
      - 000 Unequipped
      - 001 Equipped (non-specific)
      - 010 Asynchronous
      - 011 Bit synchronous
      - 100 Byte synchronous
      - 101 Extended
      - 110 0.181 test signal (TSS4)
      - 111 VC-AIS
    - Bit 8 is the VC12 path LP-RDI normally set to zero unless there is an error condition (AIS)

V5 byte 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		LP-REI	LP-RFI	Signal Label			LP-RDI

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- **J2 byte (LP)**
  - Used to transmit a configurable 16-byte or 64-byte identifier that enables the receiving path to continuously verify its connection with the transmitter
  - Uses the same byte structure as the J0 and J1 bytes

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

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

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

K4 multiframe structure per ITU-T G.707 recommendations																															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	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

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7.5.1.3 Summary

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

Summary

Path Traces

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

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7.5.2 Overhead Generator

SOH

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

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

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

S1 Byte from SOH

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

C2 Byte from POH

Overhead Generator

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

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7.5.3 Pointer Tasks

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

7.5.3.1 Pointer Analysis

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

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

Analysis - AU

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

Analysis - TU

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7.5.3.2 Pointer Generation

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

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

Generator - AU

- **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

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7.5.3.3 Pointer Sequences

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

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

G.873 - AU

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

Pointer Sequence Testing

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

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7.5.4 Trace Identifier

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

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

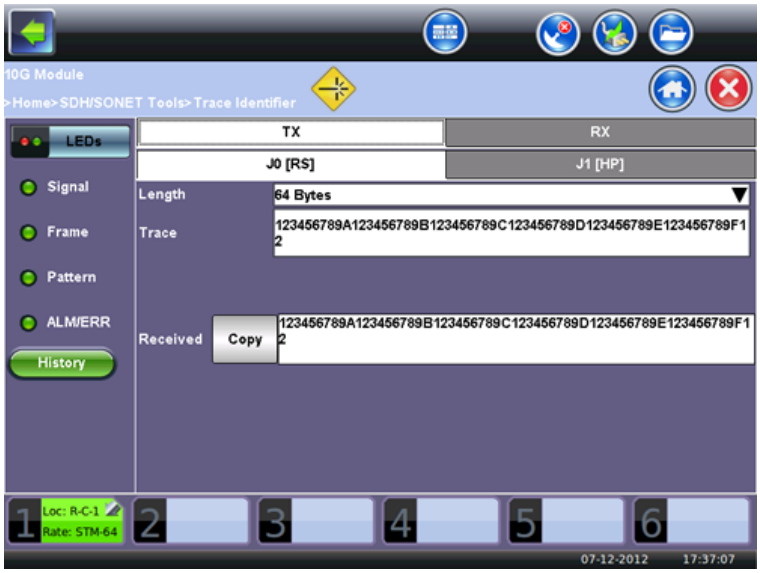
7.5.4.1 Transmitted Traces (TX)

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

Copy: This function allows copying the received trace identifier from RX, making it easier on the user, specially for the longer strings, to minimize typos.

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

TX - JO [RS]



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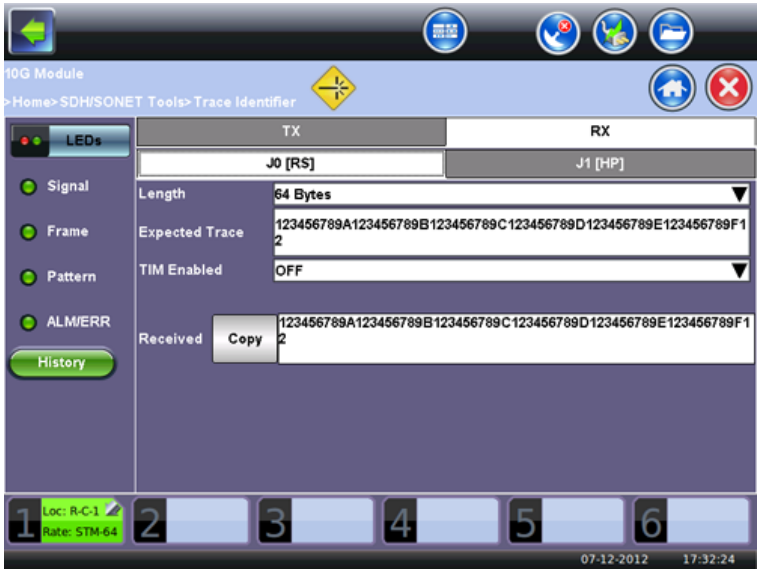
7.5.4.2 Received Traces (RX)

- J0 [RS]: Regenerator section trace
  - Program a 1, 16-byte or 64-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

Copy: This function allows copying the received trace identifier from RX, making it easier on the user, specially for the longer strings, to minimize typos. It is also a quick way to eliminate TIM alarms.

RX - JO [S]



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7.5.5 Payload Labels

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

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

- **C2 [HP Path]: 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]

RX 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

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7.5.6 APS Tasks

7.5.6.1 APS Timing

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

- **APS Standards**
  The principles and protocols of APS in SDH networks are defined in ITU-T G.783 and G.841 and Bellcore GR-253 recommendations for Linear and Ring network architectures respectively. According to recommendations, the re-routing of the signal has to occur within 50ms. Protection switching is initiated as a result of one of the following conditions:
  - “Hard” Failure (SF) condition – Loss of Signal (LOS), MS-AIS, BER > 1×10^{-3}.
  - “Soft” Failure (SD) condition – Signal degradation when BER exceeds a predetermined threshold. Normally over a provisioned range of 1×10^{-5} to 1×10^{-9}.

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

- **Sensor:** Select the trigger that will initiate the APS measurement
  - The selections are LOS, LOF, SDH FAS, B1, MS-AIS, MS-RDI, MS-REI, B2, AU-AIS, AU-LOP, B3, HP-RDI, HP-REI, LSS and None
- **Switch Time Limit**: Configurable in the range from 15ms to 200ms
  - Typically 50ms according to ITU-T recommendations
- **Gate Time**: Configurable in the range from 50ms to 4 seconds
  - Used to measure total service disruption when multiple switches or micro interrupts occur
- **Repeat**: ON/OFF
  - Configurable to measure on a continuous basis
- **Start**: Press to begin the test

APS Timing Setup

- **APS Test Procedure:**
  - The UX400 unit 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 UX400 unit measures how long the AIS event remains present after the event is first recognized and will continue to measure the total disruption time in the event of multiple disruptions

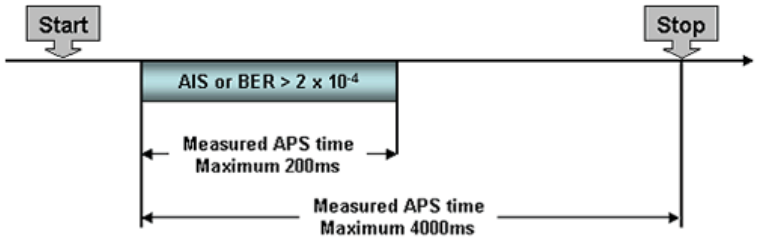

Figure 1: Perfect service disruption

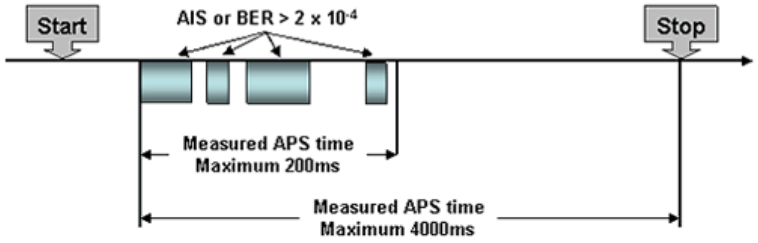

Figure 2: Multiple service disruption or micro interrupts

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7.5.7 Tandem Connection Monitoring (TCM)

HP Setup

- **TCM Standards**
  The Tandem paths are defined in ITU recommendation G.707 Annex D and Annex E
  - G.707 Annex D for VC4 and VC3
  - G.707 Annex E for VC2 and VC1
  - G.707 defines a tandem connection source and sink and describes the responses of each when defect (alarm) and error conditions are detected
  - Tandem connection maintenance signals are carried in:
    - N1 byte for VC4 and VC3
    - N2 byte for VC2 and VC
    - These two bytes are structured similarly, but their functions are not identical

N1 byte structure

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

N2 byte structure

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

IEC:	Incoming Error Count. Indicates IAIS when set to '1110' (see below)
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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7.5.8 Tributary Scan

This SDH/SONET monitoring function requires VC12/VC11 or VT-1.5/VT-2 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/STS-3 contains 63 x VC-12's and a STM-4/STS-48 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/SONET tributary (C12 channel) - mapping can be either via AU-4 or AU-3 to assess the health of each channel. The unit checks for error, alarms or status indicators in each channel of the received signal., the SDH structure, and if a test pattern is found in the payload, matching the unit's settings, pattern sync is achieved and a quick BER test is performed for synchronization of the selected test pattern in all channels.

The result for each channel is entered in a table:

- **K.L.M.:** Shows the ITU-T Tributary numbering scheme
- **Report:** Summary assessment of each channel
- **Pass (OK)** if the payload contains a test sequence (pattern) matching the one set in the Setup menu.
- **BIT** if a test pattern was found and bit errors were detected
- **LSS (Live)** if no test pattern was found inside the payload
- Any **SDH/SONET error, alarm or status** indicators detected on each tributary
- **J2 trace:** Corresponds to the VT or VC trace identifier being transmitted in each channel
- **Payload Label:** Corresponds to the V5 byte signal label being transmitted

Tapping on any of the table rows brings up an Event Details window.

Tributary Scan

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7.5.9 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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7.4.10 One Way Delay

Available with Dual Port Testing Application.

One Way Delay

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7.6 OTN Tools

OTN Tools Menu

- **Overhead Analyzer:**
  - Displays the Optical Channel Transport Unit (OTU)
  - Displays Optical Channel Data Unit (ODU)
  - Displays Optical channel Payload Unit (OPU) bytes of the received channel
- **Overhead Generator:**
  - Used to edit Optical channel Transport Unit (OTU)
  - Used to edit Optical Channel Data Unit (ODU)
  - Used to edit Optical Channel Payload Unit (OPU) bytes of the transmitted channel
- **Trace Identifier:**
  - Trace Identifier 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.
  - Trace Identifier contains the 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 Labels (Payload Structure Identifier):**
  - PSI field transports a 256-byte message aligned with the ODU multiframe.
  - PSI0 contains the Payload Type (PT) identifying the payload being transported.
    - The OPU Payload Type (PT) is a single byte defined within PSI to indicate the composition of the OPU signal, or in other words, the type of payload being carried in the OPU.
- **TCM Tasks:**
  - Used to analyze or edit the sequence of TCMi (i = 1 to 6) bytes by generating alarms and errors in the Tandem connection sub-layer.

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7.6.1 Overhead Analyzer & Generator

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

Overhead Analyzer **Overhead Generator**

OTU OPU ODU

The Overhead is color coded for simplified viewing.

Decoding Bytes

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

Byte Analyzer - Advanced Decode

7.6.1.1 OTN Frame Analysis

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

- **Frame Alignment Signal (FAS)**
  - Uses the first six bytes and, similar to SONET/SDH, it is used to provide framing for the entire signal
  - In order to provide enough 1/0 transitions for synchronization, scrambling is used over the entire OTU frame, except for the FAS bytes
- **MultiFrame Alignment Signal (MFAS)**
  - Byte is used to extend command and management functions over several frames
  - The MFAS counts from 0 to 255, providing a 256 multiframe structure

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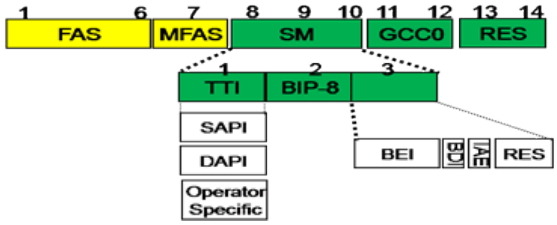
7.6.1.2 Optical Transport Unit (OTU) Analysis

The OTU overhead comprises the SM, GCC0, and RES bytes.



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

SM BIP8

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

GCCO Type

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

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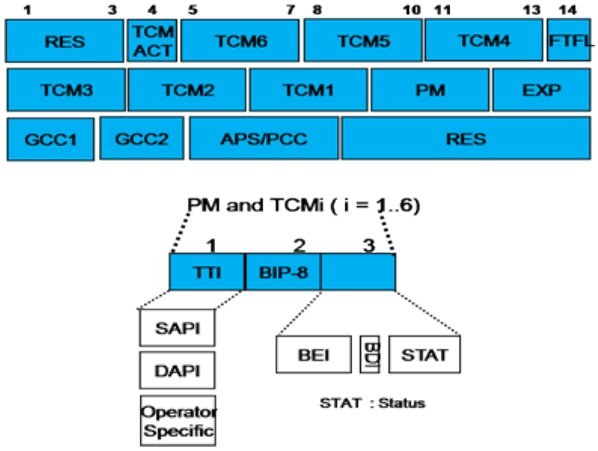
7.6.1.3 Optical Data Unit (ODU) Analysis

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



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

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

PM BIP8

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

TCM1 BEI Type

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

ITU-T G.709 Figure 15-20

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

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

ITU-T G.709 Figure 15-20

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

ITU-T G.709 Figure 15-21

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

ITU-T G.709 Figure 15-6

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

EXP Type

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

GCC1 Type

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

APS/PCC Type

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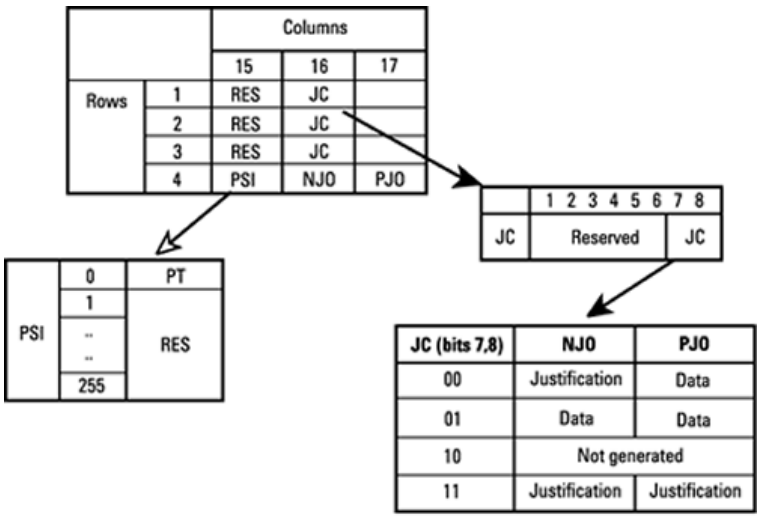
7.6.1.4 Optical Payload Unit (OPU) Analysis

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

OPU PSI Type

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



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

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7.6.2 Payload Label (Payload Structure Identifier)

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

Payload Label

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

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

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7.6.3 Trace Identifier (Trail Trace Identifier)

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

Expected SAPI: The received trace will be compared against this string, if they don't match a TIM alarm would be declared

Received SAPI: This field shows the trace being received. Users can use the COPY button to transfer the same string to the Expected SAPI and make them match.

TIM (Trace Identification Mismatch): TIM evaluation can be turned ON or OFF. If the evaluation is turned off, the receive trace would not be compared against the expected string and the TIM alarm would not be raised. If set to ON a TIM alarm will be declared if the expected and received strings don't match.

Trace Identifier (Trail Trace Identifier) TX & RX

Trail Trace Identifier

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

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7.6.4 TCM Tasks (Tandem Connection Monitoring)

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

TCM Tasks

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

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

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

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

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7.7 PDH Tools

Access to PDH Tools depends on the configuration selected under the Setup menu. Refer to the Setup section of this manual for more details.

PDH Menu

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7.7.1 E1 APS Testing

This function measures the Automatic Protection Switching (APS) limits of the network. APS applies the Multiple E1 Links and enables network elements to re-route traffic to a backup circuit in the event of network failure or problems.

APS Test Procedure:

- The UX400 unit should be connected to a transmission system to ensure that the switching time is measured for the service transported by the E1 links
- Ensure that no errors or alarms are present on the transmission system because this will impact the measurement
- The measurement will be triggered by an Alarm Indication Signal (AIS)
- The UX400 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

Repeat: When set to ON, the UX400 will continuously measure APS and keep a record of the Current, Maximum and Minimum disruption times measured.

E1 APS

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7.7.2 E1 Frame Words

This function requires the E1 signal to be framed. The NFAS word is used to carry information about the status of the link and to provide control signals for primary rate multiplexers.

Not Frame Alignment Signal (NFAS)								
Bit	1	2	3	4	5	6	7	8
Value	Si (M)	1	A	Sa4	Sa5	Sa6	Sa7	Sa8

- Bit 1: Reserved for International use (M is used to transmit the CRC multiframe signal in PCM30C and PCM31C)
- Bit 2: Set to “1” to prevent simulation of FAS
- Bit 3: "A" shows the remote alarm indication
- Bits 4 to 8: Sa4 to Sa8 are spare bits

TX: Bits Sa4 to Sa8 are used to send optional network messages. The Sa bits should be set to “1” when they are not used or when links cross International borders.
RX: Bit Sa4 can be used as a message based data link for operations, maintenance and performance monitoring.

E1 Framed RX

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7.7.3 E1 RX Data

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

E1 RX Data

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7.7.4 DS1 RX Data

DS1 RX Data

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7.8 Profiles

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

Profiles can be viewed and loaded in the Profiles folder located in the Files folder structure.

Accessing and Configuring Profiles

To access the Profiles menu from the **OTN/SDH/SONET** Testing main menu, tap on **Profiles**. To save a new profile select the **Save as** drop-down option. This will bring up an alphanumeric keypad to name the profile. When the profile is saved, all of the test configurations that apply to the particular application are saved. This allows for fast access to preconfigured test configurations.

Alphanumeric keypad

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8.0 Warranty and Software

Warranty Period: The warranty period for hardware, software and firmware is three (3) years from the date of shipment to the customer. The warranty period for battery pack, LCD, LCD touch panel, LCD protective cover, and accessories (including but not limited to patch cords, AC adaptor, SFP, USB adaptors, carrying case, carrying pouch) is limited to one (1) year.

Hardware Coverage: VeEX Inc. warrants hardware products against defects in materials and workmanship. During the warranty period, VeEX will, at its sole discretion, either

- Repair the products
- Replace hardware which proves to be defective

provided that the products that the customer elects to replace is returned to VeEX Inc. by the customer along with proof of purchase within thirty (30) days of the request by the customer, freight prepaid.

Software Coverage: VeEX Inc. warrants software and firmware materials against defects in materials and workmanship. During the warranty period, VeEX will, at its sole discretion, either

- Repair the products
- Replace the software and/or firmware which prove to be defective

provided that the products that the customer elects to replace is returned to VeEX Inc. by the customer along with proof of purchase within thirty (30) days of the request by the customer, freight prepaid.

Additionally, during the warranty period, VeEX Inc. will provide, without charge to the customer, all fixes, patches and enhancements to the purchased software, firmware and software options. VeEX Inc. does not warrant that all software or firmware defects will be corrected. New enhancements attached to a software option require the option to be purchased (at the time of order or the time of upgrade) in order to benefit from such enhancements.

Limitations: The warranty is only for the benefit of the customer and not for the benefit of any subsequent purchaser or licensee of any merchandise (hardware, software, firmware and/or accessories).

Revoking the warranty: VeEX Inc. does not guarantee or warrant that the operation of the hardware, software or firmware will be uninterrupted or error-free. The warranty will not apply in any of the following cases:

- Improper or inadequate maintenance by the customer
- Damage due to software installed by the customer on the unit without prior authorization (written) from VeEX Inc.
- Unauthorized alteration or misuse
- Damage occurred from operating the unit from outside of the environmental specifications for the product
- Improper installation by the customer

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9.0 Product Specifications

The UX400 product specifications are available for download in PDF format on the VeEX customer website. Please note that Adobe Reader version 9.0 or higher is needed to open and view the file.

To get the latest free version of Adobe Reader, click here.

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10.0 Certifications and Declarations

Declaration of Conformity

What is CE?

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

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

ROHS Statement

What is RoHS?

RoHS is the acronym for Restriction of Hazardous Substances. Also known as Directive 2002/95/EC, it originated in the European Union and restricts the use of specific hazardous materials found in electrical and electronic products. All applicable products imported into the EU market after **July 1, 2006** must pass RoHS compliance.

Click here for ROHS Statement relating to VeEX products

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11.0 About VeEX

VeEX Inc., the Verification EXperts, is an innovative designer and manufacturer of test and measurement solutions addressing numerous technologies. Global presence through a worldwide distribution channel provides uncompromised product support.

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

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