



MX300 e-Manual



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1.0 Product Introduction

VeEX™ MX300 Ethernet Transport Expert is the next generation of Core Transport and Carrier Ethernet field test equipment for Ethernet Networks carrying Voice, Data and Video. The unit is lightweight, rugged and weather resistant, featuring 10Gigabit Ethernet LAN/WAN, Gigabit Ethernet and Fast Ethernet test ports complete with advanced Triple Play verification capabilities.

Test Interfaces: The MX300 is part of the MX product family and can be configured for;

- **Single port operation**

- Single port 10GE
- Single Copper port 1GE
- Single Fiber port 1G

- **Dual Port operation**

When the dual port interfaces and software options are enabled, the test set can operate a combination of two ports at the same time with the following physical port operation combinations:

- Dual port - 10GE and Copper 1GE
- Dual port - 10GE and Fiber 1GE
- Dual Copper port 1GE
- Dual Fiber port 1GE
- Dual Copper Fiber port 1GE

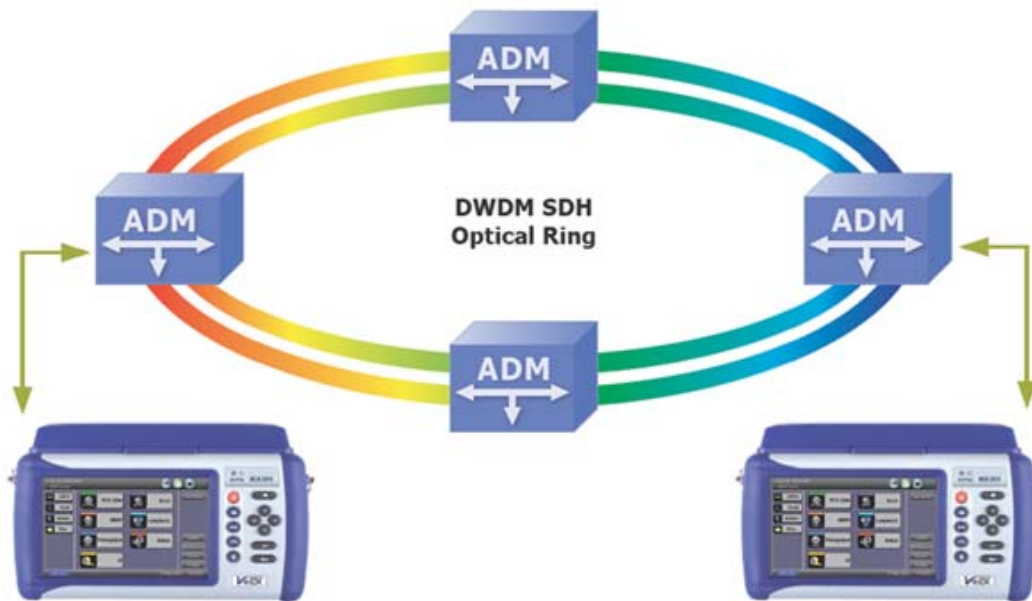
Note: The configuration parameters (header, bandwidth, etc) for each application (on each of the ports) are completely independent from one another. This is a summary of the possible port/application configurations:

- Port 1 (RFC 2544) and Port 2 (RFC 2544) - Dual copper and dual fiber ports
 - Port 1 (BERT) and Port 2 (BERT) - Dual copper and dual fiber ports
 - Port 1 (Throughput) and Port 2 (Throughput) - Dual copper and dual fiber ports
 - Port 1 (Loopback) and Port 2 (any application) - 10GE and single port copper or fiber
 - Port 1 (any application) and Port 2 (Loopback) - 10GE and single port copper or fiber
 - Port 1 (Loopback) and Port 2 (Loopback) - 10GE and single port copper or fiber
- **Pass through monitor operation**

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

Test Applications: When the unit is operating in any of the physical port combinations above, each port will be enabled to run the same test application.

- **BERT** - Unframed / Framed Layer 1, and Framed Layer 2/3 Ethernet traffic generation with user selectable test pattern for Bit Error Rate analysis.
- **RFC 2544** - Throughput, Back-to-Back, Frame Loss and Latency conformance tests in accordance with RFC 2544 specifications.
- **Throughput** - Ethernet traffic generation and analysis with multiple-streams to verify network throughput and jitter
- **Loopback** - Loop back the transmitted data while swapping the source and destination addresses of the MAC, IP and UDP layers.



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2.0 About this User Manual

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

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This user manual is suitable for novice, intermediate, and experienced users and is intended to help you successfully use the features and capabilities of the VePAL MX300 test set. It is assumed that you have basic computer experience and skills, and are familiar with IP and telecommunication concepts, terminology, and safety.

For more technical resources, visit VeEX Inc web site at www.veexinc.com.

If you need assistance or have questions related to the use of this product, call or email our customer care department for customer support. Before contacting our customer care department, you must have your product serial number and software version ready. Please go to [Basic Operations](#) section for details on locating your unit serial number in the menus or locate the serial number on the back of the chassis. Please provide this number when contacting VeEX customer service.

Customer Care:

Phone: + 1 408 970 9090

Email: customers@veexinc.com

Website: www.veexinc.com

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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.

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4.0 Basic operation

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 by more than 10 seconds will force the unit to switch off.
- **Save** key: Saves test results in the unit's memory. If the measurement is still running, it will provide a snap shot 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 [files](#).

- **History** key: The history key resets any blinking LED due to a history condition. For more details on the LED, please go to [LEDs](#).
- **Help** key: The help key brings the user to the online help, regardless of the current user interface location of the unit.
- **Lock** key: Locks the keypad
- **Home** key: Bring the unit to its home menu regardless of its location on the user interface.
- **Arrow** key: The arrow key moves the cursor in any of the four supported directions (left, right, up, down). The arrow key works in conjunction with the Enter and Escape keys.
- **Enter** key: The enter key provides an enter sequence to the user interface. It is used in non touch screen operation mode to enter menus and functions.
- **Escape** key: The escape key provides an escape sequence to the user interface. It is used in non touch screen operation mode to escape menus and functions.

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4.2 Touch Screen Display

The LCD supports touch screen operation. To operate the touch screen, use the stylus located in the top cover to navigate the menus and tabs. The unit can also be used in a non touch screen mode i.e. use the arrow, enter, and escape keys to navigate. The location of the cursor on the screen is indicated by a focus state. The focus state varies depending on the function or section of the test set. 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

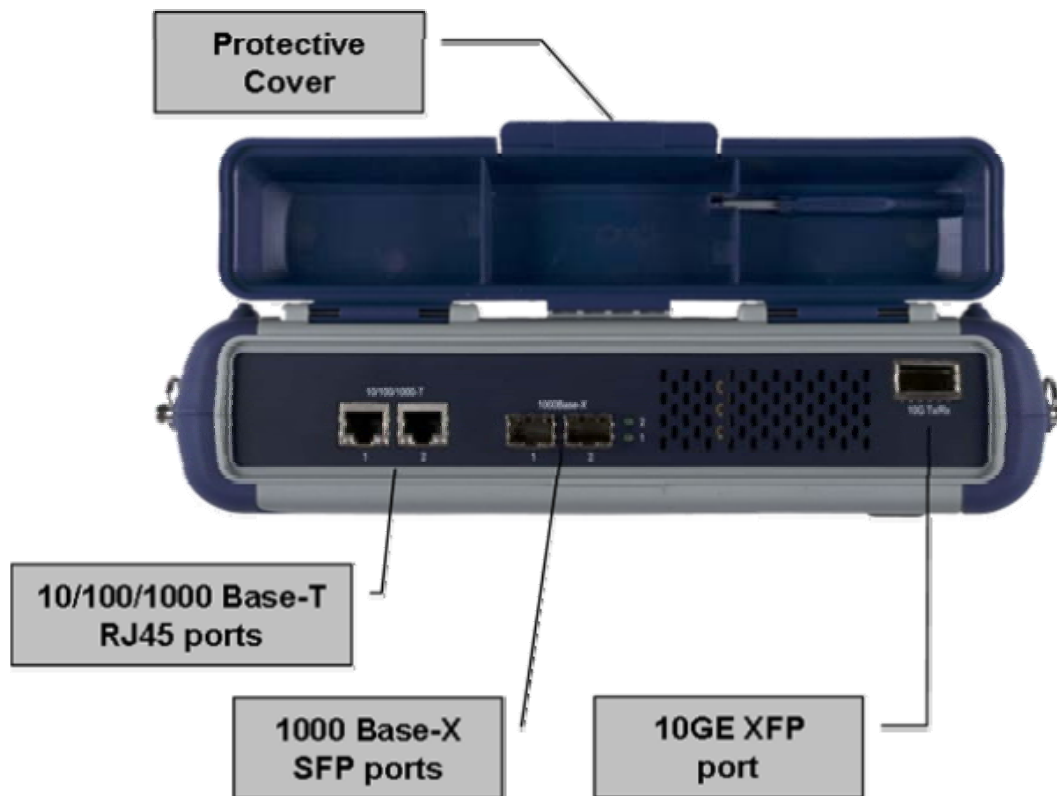
The VPAL300 chassis is equipped with an intelligent Lilon rechargeable battery pack which is located in the rear of the unit. The battery will be partially charged upon delivery, so it is recommended to charge the battery fully before use. Please charge the battery at room temperature to preserve its 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 adapter. Removing the battery, while the unit is powered on is not recommended - this may result in damage. Remove the rubber cover on the left side to connect the AC Main adapter to the unit.



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4.4 Connectors and Panels

The connector panel located at the top of the unit comprises the following test ports:



4.4.1 Test Ports:

- **Electrical Ethernet Interfaces**
 - Dual 10/100/1000Base-T Ports, RJ45 connector, IEEE 802.3 compliant
 - A green LED on the RJ45 connector flashes when there is activity on the network.
 - The green LED is On when there is a valid Ethernet link with the network and off when there is no link.
- **Optical Ethernet Interface options**
 - **Single 10GE XFP Port, LC connector**
 - 10GBASE-SR 850nm, serially encoded (64B/66B); 10.3 Gb/s rate not SDH/ SONET compatible (LAN PHY)
 - 10GBASE-LR 1310nm, serially encoded (64B/66B); 10.3 Gb/s rate not SDH/ SONET compatible (LAN PHY)
 - 10GBASE-ER 1550nm, serially encoded (64B/66B); 10.3 Gb/s rate not SDH/ SONET compatible (LAN PHY)
 - 10GBASE-SW 850nm, serially encoded (64B/66B); compatible with SDH/SONET standards for a 10 Gb/s (WAN PHY)
 - 10GBASE-LW 1310nm, serially encoded (64B/66B); compatible with SDH/SONET standards for a 10 Gb/s (WAN PHY)
 - 10GBASE-EW 1550nm, serially encoded (64B/66B); compatible with SDH/SONET standards for a 10 Gb/s (WAN PHY)
 - **Dual 1000Base-X SFP Ports, LC connector**
 - 1000Base-SX (850nm)
 - 1000Base-LX (1300nm)
 - 1000Base-ZX (1550nm)

4.4.2 Utility Ports:

The Ethernet and USB ports are located on the left and right side of the unit.

- **RJ45, 10/100Base-T port:**

To access the Ethernet port, remove the protective rubber cover on the right hand side of the unit to expose the connector. Ethernet applications include;

 - IP connectivity testing
 - Net Wiz testing

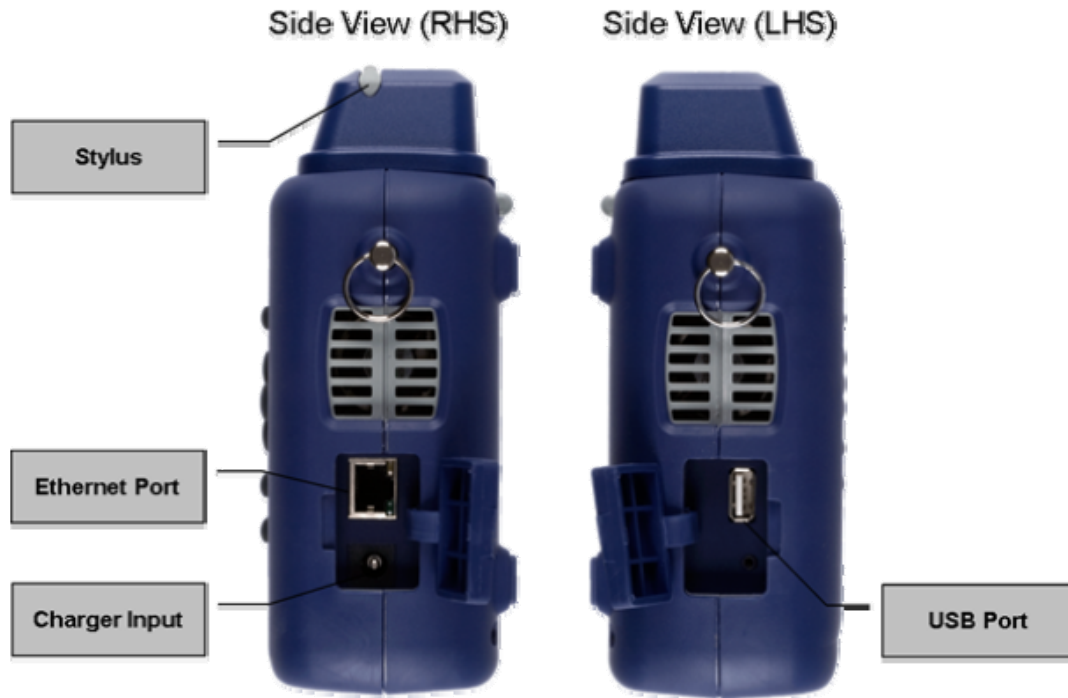
- WiFi Wiz testing
- Voice over IP (VoIP) testing
- IPTV testing
- Transfer measurement results and test profiles between the instrument and a computer using Reveal MX software
- Upload/download channel tables between the instrument and a computer using Reveal MX software
- Upgrade the instrument software using Reveal MX software
- Remote control of the instrument using Reveal MX software (optional)

- **USB Port:**

To access the USB port, remove the protective rubber cover on the left hand side of the unit to expose the connector.

The USB port supports;

- Memory drives
- WiFi adaptor for WiFi testing application



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4.5 LEDs

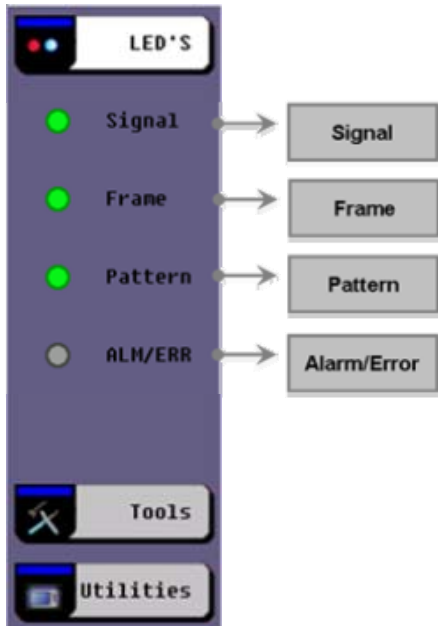
The MX300 is equipped with the following LEDs;

- **Fixed 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 Main and powered off.
- **Soft LEDs:** The Graphical User Interface (GUI) supports several "soft" LED functions depending on test mode.
 - Signal LED - indicates presence of a valid input signal
 - Frame LED - indicates presence of valid framing on the input signal
 - Pattern LED - indicates test pattern synchronization in BERT, RFC and Throughput modes
 - Alarm / Error LED - indicates the presence of alarms or errors

Note: Each soft LED is equipped with a History function.

- **Green LED** - indicates that no alarm/error has occurred
- **Red LED** - indicates that at least one alarm/error has occurred during the test
- **Red flashing LED** - indicates any alarms/errors that have occurred
- **Grey LED** - indicates that no condition or a test that has not begun yet

MX300 Soft LED functions



Note: The **History** key on the rubber keyboard (O -> O) resets the soft LEDs on the GUI.

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5.0 Home Screen and Menu

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

- **Left:**
 - **LEDs:** Displays soft LEDs associated with Errors and Alarms
 - **Tools:** IP connection status, Advanced IP features (Net Wiz, WiFi Wiz, VoIP, and IPTV applications)
 - **Utilities:** Applications (Help, Settings, Files) which are common to all VePAL handheld test sets.
- **Middle:**
 - Test Applications specific to the test set (RFC2544, BERT, Throughput, IP, Scan, Loopback and Netwiz)
 - Port Setup to configure test interfaces
- **Right:**
 - **Test mode:** Selects to the test interface/s
 - **Laser On/Off:** Enables/Disables the Laser transmitter on optical ports (SFP or XFP)
 - **Control:** Selects loopback devices
 - **Profiles:** Recalls profiles saved in memory

MX300 Home Menu

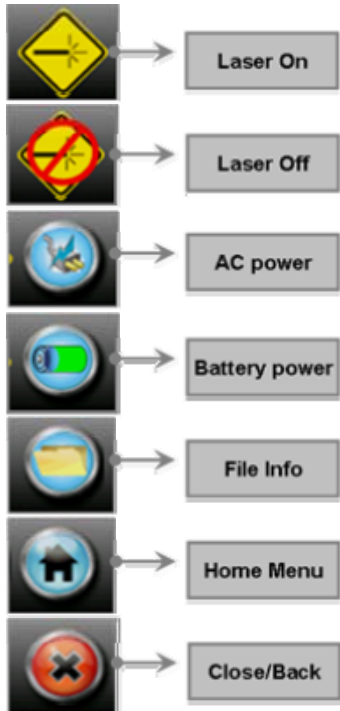


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Screen icons: The following icons are located at the top right hand corner of the screen;

- **Laser icon** - Indicates if the optical transmitter in the SFP or XFP transceiver is switched On or Off.
- **Power icon** - Indicates if the unit is being powered by the internal Lilion battery or external AC power. Tap the icon for battery status If running on battery.
- **File icon** - Provides File Storage Information
- **Home icon** - Provides instant navigation back to the main Home menu screen
- **Close icon** - Closes screen and returns user to the previous screen

VPAL 300 Screen Icons



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6.0 Setup

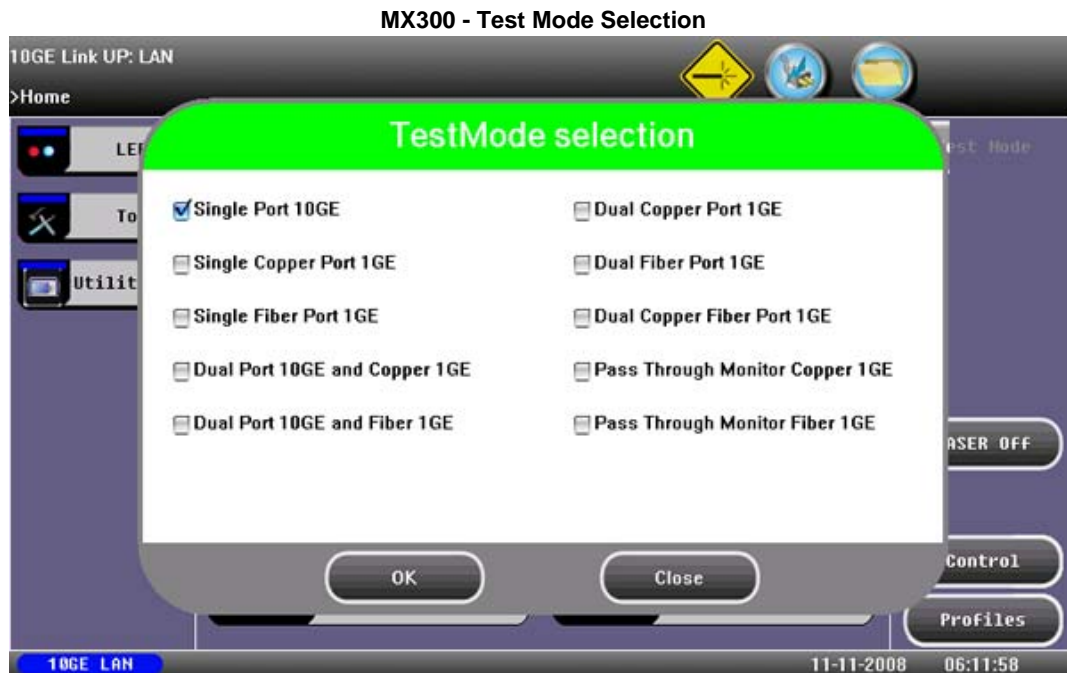
Test mode, test port/s and network settings are required prior to performing any measurements or applications.

6.1 Test Mode Selection

This menu is accessed via the Test Mode button located at the top right hand side of the screen. Depending on interface options purchased, the following selections are possible;

- Single port 10GE
- Single Copper port 1GE
- Single Fiber port 1GE
- Dual port 10GE and Copper 1GE
- Dual port 10GE and Fiber 1GE
- Dual Copper port 1GE
- Dual Fiber port 1GE
- Dual Copper Fiber port 1GE
- Pass Through Monitor Copper 1GE
- Pass Through Monitor Fiber 1GE

After selecting the test interface click OK button located at the bottom of the pop-up window.



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6.2 Port setup

Port setup or test interface configuration are accessed via the Setup menu located on the Home page. The configuration capabilities depends on the interface selected in the Test Mode selection.

Port Tab:

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

Operation Modes:

- Single Port - Applies to 10GE interface or low rate Ethernet interfaces purchased without dual port option
- Dual Port - Applies to 10/100/1000 Base-T and 1000Base-X interfaces only and if the Dual Port software option is enabled
- Flow control - On or Off.
 - When flow control is enabled, the test set will respond to pause frames received by the link partner by adjusting the transmit rate.
 - When flow control is disabled, the test set ignores all incoming pause frames from the link partner and continues transmitting at the configured transmit rate.



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6.3 Profiles

Profiles Tab:

Previously stored profiles can be viewed, deleted and loaded from this screen. When the user loads a profile, the screen will change automatically to the application that the profile corresponds to. See [Profiles](#) regarding how to store and recall profiles.

MX300 - 10GE Profile Setup



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6.4 Measurement settings

Measurement Tab:

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

- **Mode:** Manual, timed, or auto mode are available.
 - Manual mode - User starts and stops the measurements manually.
 - Timed mode - User defines the duration of the test; after the test is started, the test will run for the configured duration and stop automatically.
 - Auto mode - User configures the start and end time of the test, selects the type of test to run, and a profile if one has been previously stored.
The test set must be powered on to carry out and automatic test.
- **Event Log:** Circular or Blocked. Up to 1000 event logs can be stored.
 - Circular - only the latest events will be stored if there are over 1000 event logs. The oldest event will be deleted so that the new event can be added.
 - Blocked event - only the maximum number of events will be stored; any event that occurs after the 1000th event will not be stored. Event logs consist of a log of the start of test, end of test, errors, alarms, frames loss, etc. The log will have a timestamp, type of event, and count (number of errors occurring in that instant).
- **TX Start:** Tx & Rx, or Tx Separate. Configure how the measurements are started when in BERT and Multiple Streams test modes
 - Tx & Rx - Transmitter and receiver are turned on at the same time, and the Tx and Rx measurements start at the same time at the start of the test.
 - Tx Separate - independent control (Start/Stop) of the transmitter is enabled. At the start of the test only the receiver is turned on - the user must start the transmitter manually.
- **OAM Enable:** On / Off.
 - When OAM is enabled, the MX300 supports the IEEE 802.3ah EFM standard for discovery and loopback control of OAM-enabled devices.



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7.0 Test Applications

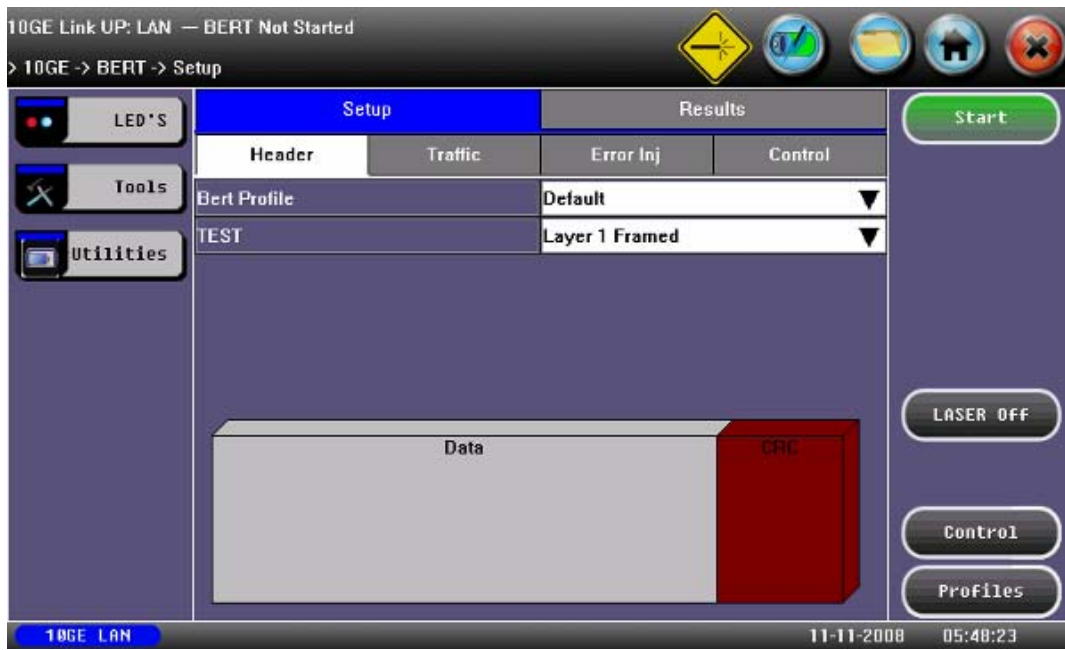
7.1 BERT

Overview:

BER testing at layer 1, 2, and 3 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. All patterns are encapsulated into an Ethernet frame to verify bit-per-bit performance of the circuit under test.

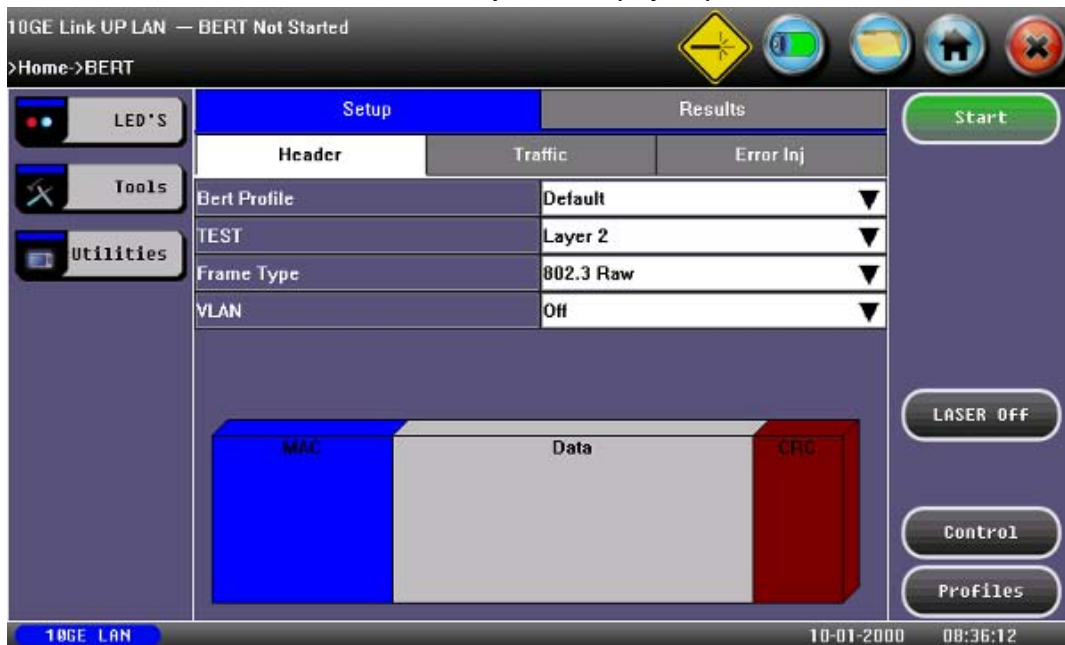
- **Layer 1:** Unframed mode (fiber ports only) or Framed mode.
 - Unframed mode - Test traffic consists of a bit stream of the selected test pattern.
 - Framed mode - Test pattern is encapsulated into a valid Ethernet frame with SOF, Preamble and CRC field.

BERT Setup -Header (Layer 1)

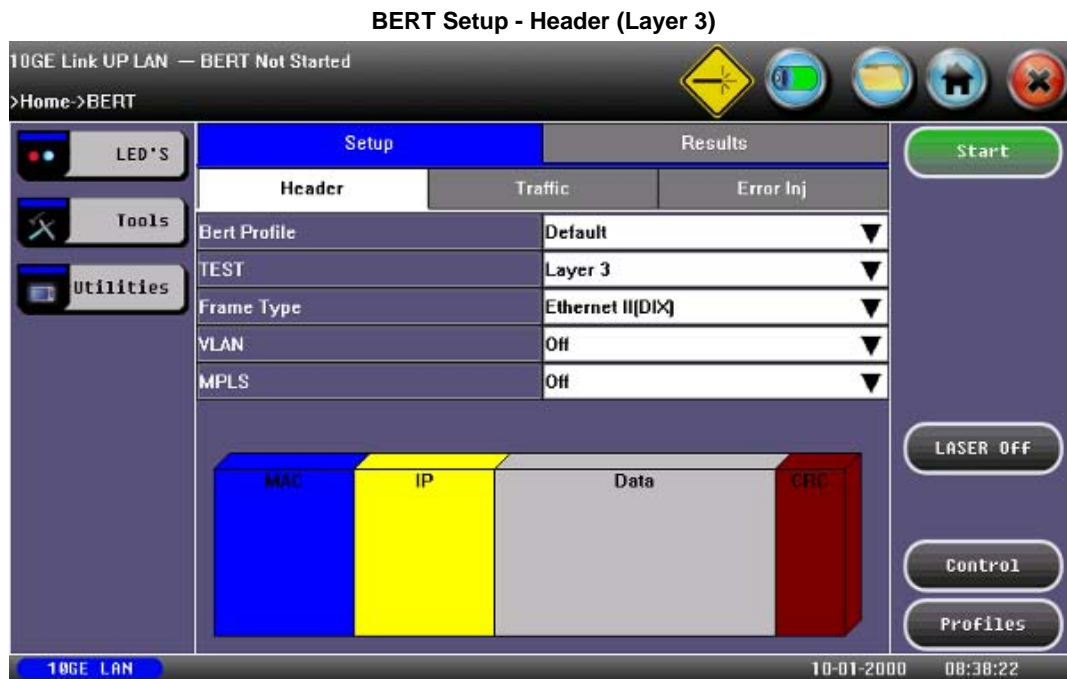


- **Layer 2: Framed BERT (same as Layer 1 Framed)**
 - **MAC Address:** A default or user configured Media Access Control (MAC) address is added to the frame. This MAC address is used as the source MAC address for all streams (Throughput Testing mode).

BERT Setup - Header (Layer 2)



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



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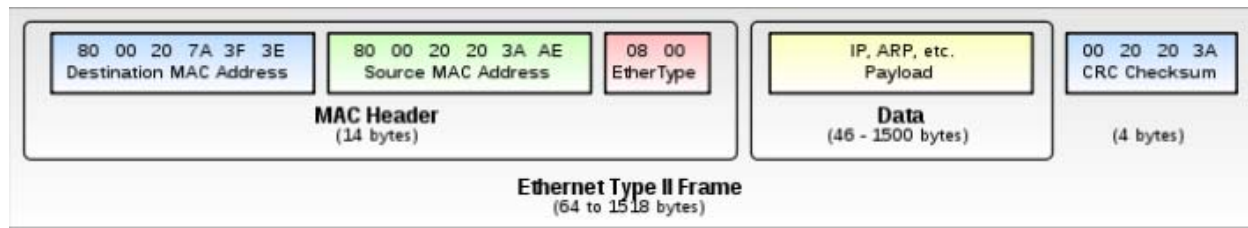
7.1.1 Setup

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.

7.1.1.1 Header Settings

- **BERT Profile:** Load a previously configured test profile or create a new profile from existing settings. See [Profiles](#) for more details on how to create new profiles.
- **Test:** Select the test layer to perform the BERT.
 - Options are Layer 1 Unframed, Layer 1 Framed, Layer 2, and Layer 3.
- **Frame Type:** Select the Ethernet frame type for Layer 2 or Layer 3.
 - 802.3 Raw (IEEE 802.3 frame without LLC) - Not available when Layer 3 is selected
 - 802.3 LLC (IEEE 802.3 frame with LLC header)
 - 802.3 SNAP (IEEE 802.3 frame with SNAP header)
 - Ethernet II (DIX) (named after DEC, Intel, and Xerox, this is the most common frame type today)
- **MAC/IP:** Tap the MAC and IP blocks on the Frame image to access the setup menus
 - Set the Source and Destination MAC address for Layer 2
 - Set the Source and Destination MAC and IP addresses for Layer 3
- **VLAN:** Off, 1 tag, 2 tags, 3 tags.
 - The user is able to configure up to 3 VLAN tags (VLAN stacking, for Q-in-Q applications)
Note: VLAN stacking is an option.
- **MPLS:** Off, 1 tag, 2 tags, 3 tags.
 - The user is able to configure up to 3 MPLS tags.
Note: MPLS tag configuration is only available when the MPLS option is purchased.

The most common Ethernet Frame format, Type II



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

To configure the MAC addresses, IP addresses, VLAN tag/s, MPLS tag/s, and test pattern, tap on the frame image displayed on the screen. This brings you to 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.
- **Ethernet Type** - For Layer 3 testing, the user can also configure the Ethertype;
 - 0800-IP (Internet Protocol Version 4, IPv4)
 - 0600-Xerox
 - 0801-X.75 (X.75 Internet)
 - 0805-X.25 (X.25 Level 3)
 - 0806-ARP (Address Resolution Protocol (ARP))
 - 8035-RARP (Reverse Address Resolution Protocol (RARP))
 - 8137-IPX (Novell IPX)
 - 814C-SNMP
 - 8847-MPLS unicast
 - 8848-MPLS multicast
 - 86DD (Internet Protocol, Version 6 (IPv6)) - Future Release

BERT Setup - MAC address settings (Layer 3)

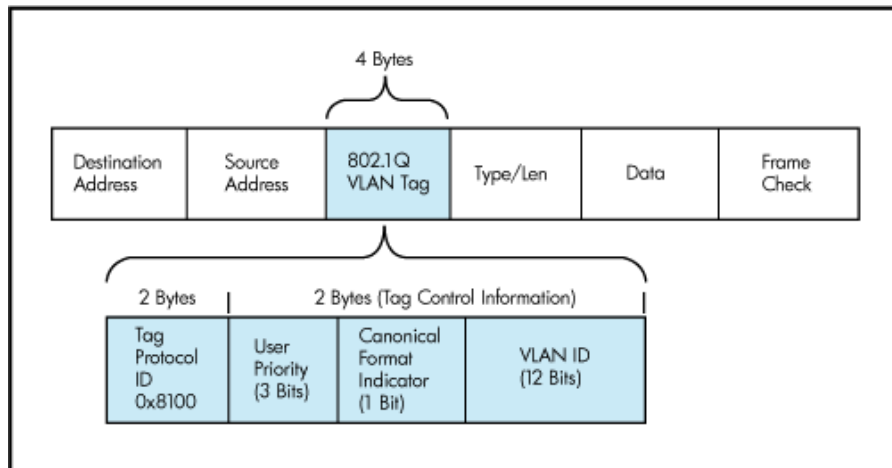


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- **VLAN Tab:** In the VLAN tab the following parameters are configured;
- **VLAN ID:** Settable in the range 1 to 4094
 - VLAN ID is the identification of the VLAN, which is basically used by the standard 802.1Q.
 - It has 12 bits which allows the 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:** Settable in the range 0 to 7
 - 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)

IEEE 802.1Q VLAN Tag in an Ethernet Frame



BERT Setup - VLAN Tag configuration (Layer 3)

The screenshot shows the BERT Setup - VLAN Tag configuration (Layer 3) interface. The interface is titled "10GE Link UP LAN — BERT Not Started" and includes a "Data Pattern" section with tabs for LED'S, Tools, and Utilities. The main configuration area is divided into several sections:

- MAC**: Tab selected.
- VLAN**: Tab selected.
- MPLS**: Tab.
- IP**: Tab.
- DATA**: Tab.
- Rx Filter**: Tab.

The configuration area shows three VLAN entries:

- VLAN #1**: ID 12, Priority 3, Type 8100.
- VLAN #2**: ID 12, Priority 3, Type 8100. Drop Eligible.
- VLAN #3**: ID 12, Priority 3, Type 8100. Drop Eligible.

On the right side, there are buttons for "Start", "LASER OFF", "Control", and "Profiles". The bottom status bar shows "10GE LAN", "10-01-2000", and "10:52:20".

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- **MPLS Tab:** In the MPLS tab the following parameters are configured;
- **MPLS label:** Settable 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:** Settable in the range 0 to 7
Note: This field is three bits in length and maps directly to IP Precedence TOS bits to provide class of service (COS).
- **S-bit:** Settable 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:** Settable in the range 0 to 255. The default setting is 128 hops
Note: Used to decrement the time-to-live counter.

BERT Setup - MPLS label configuration

MAC	VLAN	MPLS	IP	DATA	Rx Filter
MPLS #1	Label=	5	S=	0	
	CoS=	0	TTL=	128	
MPLS #2	Label=	4	S=	0	
	CoS=	0	TTL=	128	
MPLS #3	Label=	7	S=	0	
	CoS=	0	TTL=	128	

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- **IP Tab:** In the IP tab the user must configure the destination IP address and source address. The user may also configure the following IP header fields;
- **IP TOS (for quality of service testing);**
 - **Legacy TOS (Precedence)** - The first three bits of the IP TOS field can be edited;
 - 000 - Best Effort
 - 001 - Bulk Data
 - 010 - Transactional
 - 011 - Call Signalling
 - 100 - Streaming Video
 - 101 - Voice
 - 110 - Routing
 - 111 - Reserve
 - **DSCP (Differentiated Services Code Point)** - The first six bits of the IP TOS can be edited to provide more granular service classification.
For more information on the definition of DSCP field in IPv4 and IPv6 headers, refer to [RFC2474](#)
 - **Time To Live (TTL):** Settable in the range 0 to 255
 - **Fragment offset byte:** Settable in the range 0 to 65.528
Note: The fragment offset field, measured in units of eight-byte blocks, is 13 bits long and specifies the offset of a particular fragment relative to the beginning of the original unfragmented IP datagram.

- **Protocol field:** UDP (0x11) or TCP (0x06)

BERT Setup - IP Address settings (Layer 3)

MAC	VLAN	MPLS	IP	DATA	Rx Filter
source IP address			192.168.0.10		
destination IP address			192.168.2.200		
IP TOS			DSCP		
DSCP	011001	ECT	0	CE	0
TTL			128		
Frag. Offset			0		
Protocol			UDP - 0x11		

10GE LAN 10-01-2000 10:54:31

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- **Data Tab:** User selects a test pattern that will be encapsulated in the Ethernet frame payload (for framed mode). Depending on the test layer, different test pattern options are available;
 - **Layer 1 test patterns**
 - CRPAT - Compliant Random Pattern provides broad spectral content and minimal peaking for the measurement of jitter at component or system level.
 - CJTPAT - Compliant Jitter Test Pattern is a Jitter Tolerance Pattern that stresses a receiver by exposing it to extreme phase jumps thereby stressing the clock data recovery (CDR) circuitry. The pattern alternates between repeating low transition density patterns and repeating high transition density patterns.

BERT Setup - Data selection (Layer 1 Framed)

10GE Link UP LAN — BERT Not Started

Data Pattern

LED'S Tools Utilities

DATA

CRPAT

CJPAT

Start

LASER OFF

Control

Profiles

10GE LAN 10-01-2000 10:58:19

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- **Layer 2 & 3 test patterns**

- **PRBS:**
 - $2^{31} - 1$ (147 483 647-bit pattern used for special measurement tasks, e.g. delay measurements at higher bit rates)
 - $2^{23} - 1$ (8 388 607 bit pattern primarily intended for error and jitter measurements at bit rates of 34 368 and 139 264 kbit/s)
 - $2^{15} - 1$ (32 767 bit pattern primarily intended for error and jitter measurements at bit rates of 1544, 2048, 6312, 8448, 32 064 and 44 736 kbit/s)
 - $2^{11} - 1$ (2047 bit pattern primarily intended for error and jitter measurements on circuits operating at bit rates of 64 kbit/s and $N \cdot 64$ kbit/s)
- **Fixed:** All 0s or All 1s
- **User Defined pattern:** Length depends on size of frame
- **Inversion:** Normal or inverted



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- **RX Filter Tab:** Allows the user to filter incoming streams by;
 - MAC Destination address
 - MAC Source address
 - VLAN ID
 - IP Destination address
 - IP Source address

BERT Setup - RX Filter selection



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7.1.1.2 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 stair case profile according to user selectable step time, number of steps, and maximum bandwidth
- **Frame Size:** Enter the frame size when a Layer 2 or Layer 3 BERT is selected.
 - Frame size configuration is not available for Layer 1 BERT.
 - Frame sizes can be from 64bytes to 1518bytes, in addition to jumbo frames up to 9000 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

The screenshot shows the BERT Setup window for a 10GE LAN. The window title is "10GE Link UP: LAN — BERT Not Started". The breadcrumb path is "> 10GE -> BERT -> Setup". The interface is divided into several sections:

- Left Panel:** Contains buttons for "LED'S", "Tools", and "Utilities".
- Setup Tab:**
 - Header:** "Setup" (selected) and "Results".
 - Traffic Tab:**
 - Traffic Flow: Constant
 - Frame Size: Fixed
 - Frame Size: 1518
 - Const BW: 100.00 %
- Graph:** A line graph showing "BW%" at 100.00% over "Time".
- Right Panel:** Contains buttons for "Start", "LASER OFF", "Control", and "Profiles".
- Bottom Bar:** Shows "10GE LAN" on the left and "11-11-2008 05:54:11" on the right.



Note: Frame Size Limitations

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

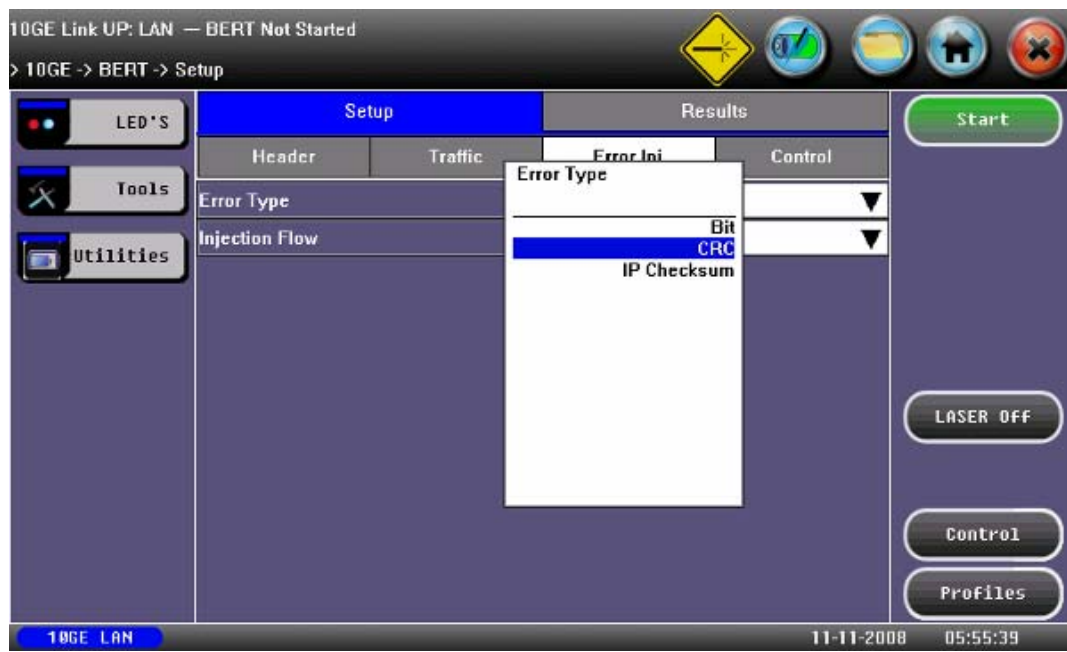
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7.1.1.3 Error Injection

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

- **Error type:** Select from Bit, CRC, IP Checksum (layer 3 only).
- **Injection Flow:** The error injection flow determines how the selected errors will be injected.
 - The user can select a single error injection, a specific count, or error rate.
- **Rate and Count:** The user will be able to configure the error rate and error count via a numeric keypad

BERT Setup - Error Injection



	<p>Note: Error Injection Once a test is running, error injection can be enabled by selection the "Error Injection " icon from the action pull down menu at the top of the screen. Press the "error inject" button to start injecting errors.</p>
---	---

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7.1.1.4 Control Settings

In the Control settings tab, the user configures the loop-up and loop-down commands necessary to control a far end unit. The user is able to configure the control commands manually or automatically.

Three modes are available for looping back test traffic;

- **Layer 1:** All incoming traffic is looped back unaltered.
- **Layer 2:** All incoming unicast traffic is looped back with the MAC source and destination addresses swapped.
- **Layer 3:** All incoming unicast traffic is looped back with MAC and IP source and destination addresses swapped.

BERT Setup - Control



Manual: User must input the destination MAC/IP address of the far end device along with the type of command.


- MAC Destination: MAC address of the far end test set that is to be looped up/down.
- IP Destination: IP address of the far end test set that is to be looped up/down.

Automatic: User selects from a list of discovered devices to loop-up/down.

Note: In automatic mode no configuration is necessary - user simply selects the discovered far end device to control.

Control Mode:

Manual - This mode is not to be confused with the manual and automatic configuration modes mentioned above. When manual is selected the user must manually send the loop up command before the start of the test, and must manually send a loop down at the end of the test.

	<p>Note: OAM Devices If OAM is enabled, any link partner that supports the IEEE 802.3ah protocol, will be discovered automatically and be displayed under the "OAM Discover" tab.</p>
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7.1.1.5 Starting/Stopping a BERT

Once all the necessary configurations have been completed the user can start the test. The Start icon is located in the top right corner of the screen. Once selected, the test will start immediately and the icon will change to a Stop indication. To stop the test, simply tap the Stop icon. If the testing on any of the fiber ports, ensure the LASER is switched ON before starting the test.

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7.1.2 BERT Results

7.1.2.1 Summary

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

- Line rate
- Framed rate
- Data rate
- Utilization

- Number of bytes
- Optical power - optical level measured by the SFP or XFP transceiver

BERT Results - Summary

Setup		Results	
Summary	Errors	Events	Rates
ST:05:56:32		ET:00:00:07	
	Tx		Rx
Line Rate	10000.00M		10000.00M
Framed Rate	9870.21M		9870.74M
Data Rate	9573.20M		9573.20M
Utilization	100.00%		100.00%
# of Bytes	8214117136		8213856190
Opt Power	N/A		N/A

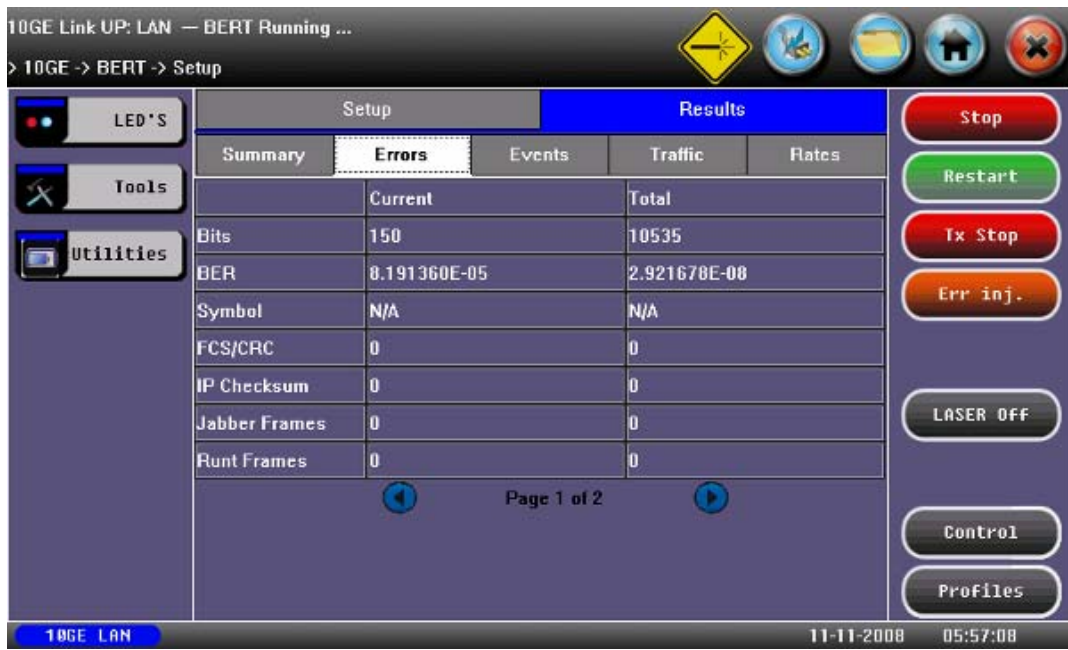
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7.1.2.2 Errors

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

- Bits - Indicates errors related to test pattern (Bit Error or LSS (Pattern Loss)).
- BER - Bit error ratio
- Symbol - declared when an invalid code-group in the transmission code is detected
- FCS/CRC - number of received frames with an invalid FCS
- IP Checksum (Layer 3 only)
- Jabber frames - number of received frames larger than 1518 bytes containing an invalid FCS.
- Runt frames - number of received frames smaller than 64 bytes containing an invalid FCS.
- Giant frames - number of received frames larger than 1522 bytes containing an invalid FCS.

BERT Results - Errors



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7.1.2.3 Events

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

BERT Results - Events



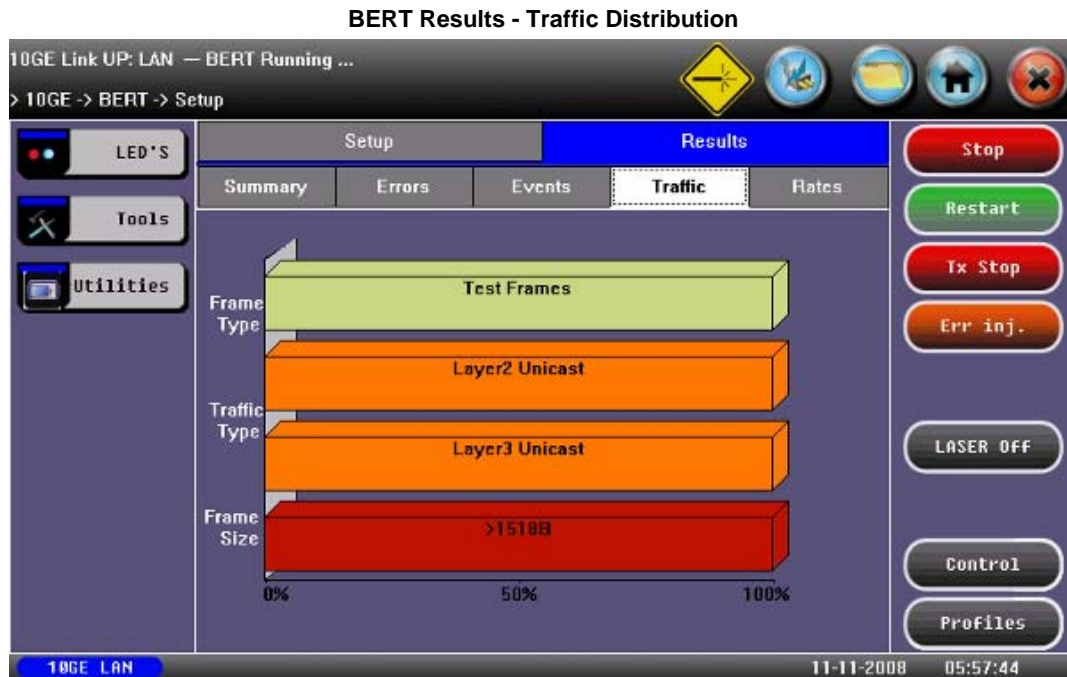
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7.1.2.4 Traffic

Traffic tab: The following Traffic statistics are displayed;

- Frame Type - Test and non-test frames

- Traffic type - Layer 2 and Layer 3 Unicast, Broadcast and Multicast frame percentage
- Frame size distribution
- Pause frames



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

- **Received (RX) frames:**
 - Total frames
 - Test frames
 - VLAN tagged frames
 - VLAN stacked frames
 - MPLS labeled frames
 - MPLS stacked frames
 - Non-test frame
- **Transmitted (TX) frames:**
 - Total frame
- **Paused frames:** Transmitted and Received

BERT Results - Frames

Frames	Traffic Type	Frame Size
Rx Frames	#	%
Total	111141020	100
Test	111141008	99.999989
VLAN	111140818	99.999818
VLAN Stack	111140818	99.999818
MPLS	0	0.000000
MPLS Stack	0	0.000000
Non-Test	12	0.000011
Tx Frames	#	
Total	111141185	
Pause Frame	Tx	Rx
Total	0	0

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

- Layer 2 Unicast frames - number of Unicast frames received without FCS errors.
- Layer 2 Broadcast frames - number of Broadcast frames received without FCS errors. Broadcast frames have a MAC address equal to FF-FF-FF-FF-FF-FF.
- Layer 2 Multicast frames - number of Multicast frames received without FCS errors.
- Pause frames - number of valid flow-control frames received. Frames having a type/length field equal to 8808h are counted as pause frames.
- Layer 3 Unicast frames - number of Unicast frames received without FCS errors.
- Layer 3 Broadcast frames - number of Broadcast frames received without FCS errors. Broadcast frames have a MAC address equal to FF-FF-FF-FF-FF-FF.
- Layer 3 Multicast frames - number of Multicast frames received without FCS errors.

BERT Results - Traffic Type

Frames	Traffic Type	Frame Size
Distribution	#	%
L2 Unicast	126862266	99.999700
L2 Broadcast	141	0.000111
L2 Multicast	239	0.000188
Pause	0	0.000000
L3 Unicast	126862268	99.999882
L3 Broadcast	134	0.000106
L3 Multicast	16	0.000013

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Frame Size tab: The following Frame distribution statistics are displayed in count (#) and percentage (%);

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



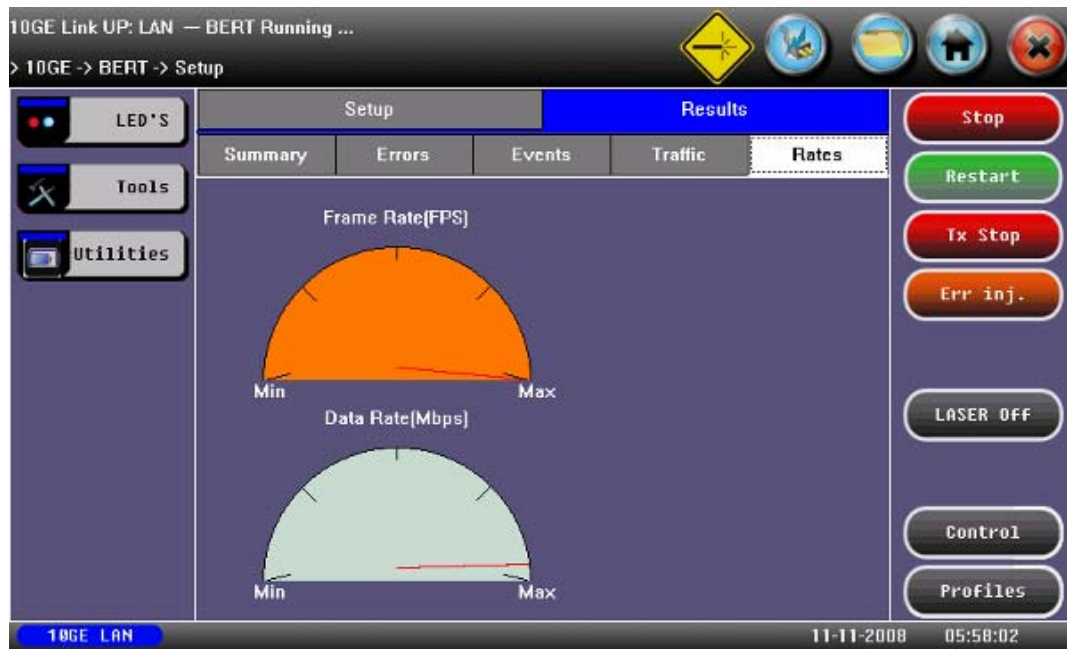
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7.1.2.5 Rates

Rates tab: The following Rate statistics are displayed graphically;

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

BERT Results - Rates



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7.2 RFC2544 Conformance Testing

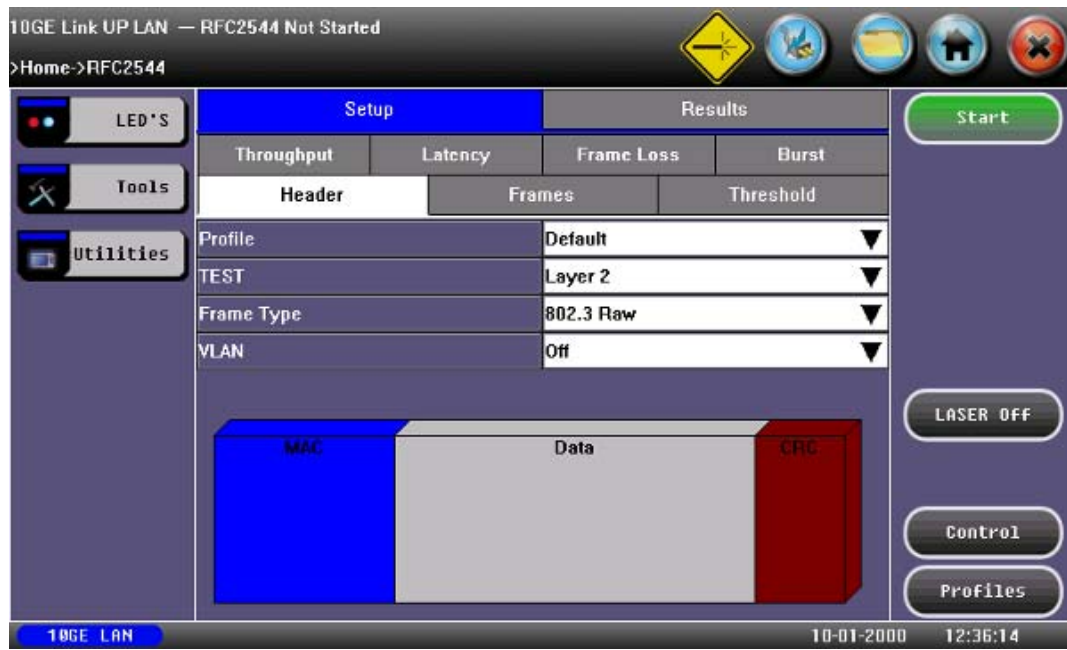
Overview:

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

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

- Test layer
- Frame header
- Test frames selection
- Pass/fail thresholds (optional)
- Far end unit loop control
- Throughput
- Latency
- Frame loss
- Burst (back-to-back)

RFC2544 Setup - Layer 2 parameters



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7.2.1 Setup

Unless otherwise noted, the Frame Header and related setups are identical to the setups described in the BERT Application above. A summary of the RFC2544 setup options are outlined below.

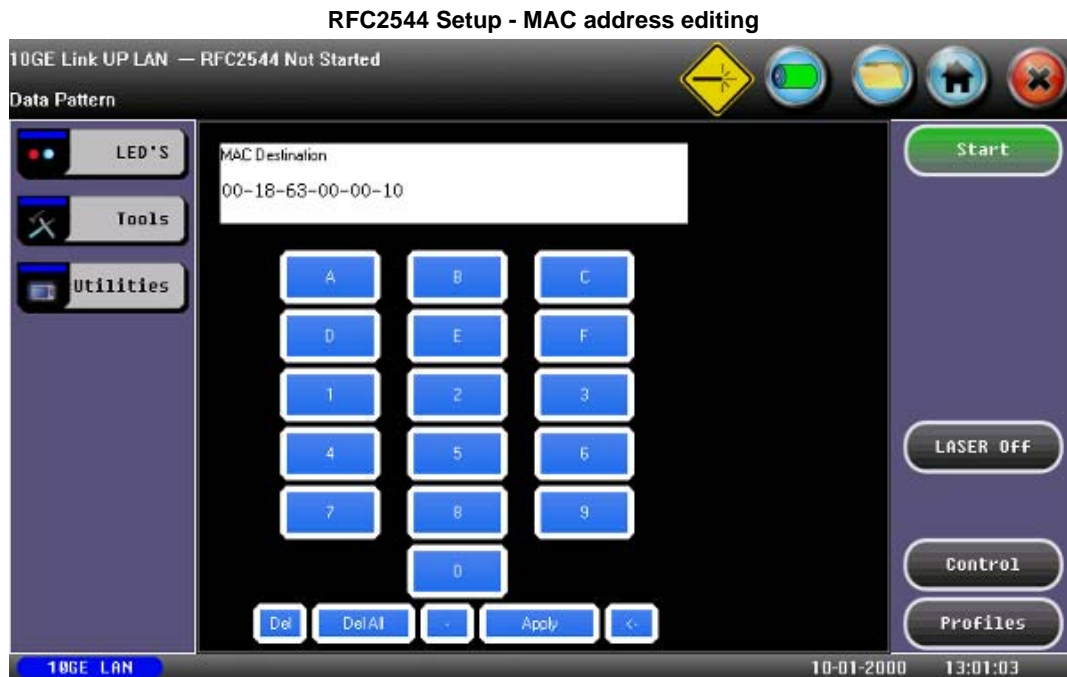
7.2.1.1 Header Settings

- **BERT Profile:** Load a previously configured test profile or create a new profile from existing settings. See [Profiles](#) for more details on how to create new profiles.
- **Test:** Select the test layer to perform the BERT.
 - Options are Layer 1 Unframed, Layer 1 Framed, Layer 2, and Layer 3.
- **Frame Type:** Select the Ethernet frame type for Layer 2 or Layer 3.
 - 802.3 Raw (IEEE 802.3 frame without LLC) - Not available when Layer 3 is selected
 - 802.3 LLC (IEEE 802.3 frame with LLC header)
 - 802.3 SNAP (IEEE 802.3 frame with SNAP header)
 - Ethernet II (DIX) (named after DEC, Intel, and Xerox, this is the most common frame type today)
- **MAC/IP:** Tap the MAC and IP blocks on the Frame image to access the setup menus
 - Set the Source and Destination MAC address for Layer 2
 - Set the Source and Destination MAC and IP addresses for Layer 3
- **VLAN:** Off, 1 tag, 2 tags, 3 tags.
 - The user is able to configure up to 3 VLAN tags (VLAN stacking, for Q-in-Q applications)
Note: VLAN stacking is an option.
- **MPLS:** Off, 1 tag, 2 tags, 3 tags.
 - The user is able to configure up to 3 MPLS tags.
Note: MPLS tag configuration is only available when the MPLS option is purchased.
- **MAC, VLAN, MPLS, IP, and Test Pattern Configurations:**

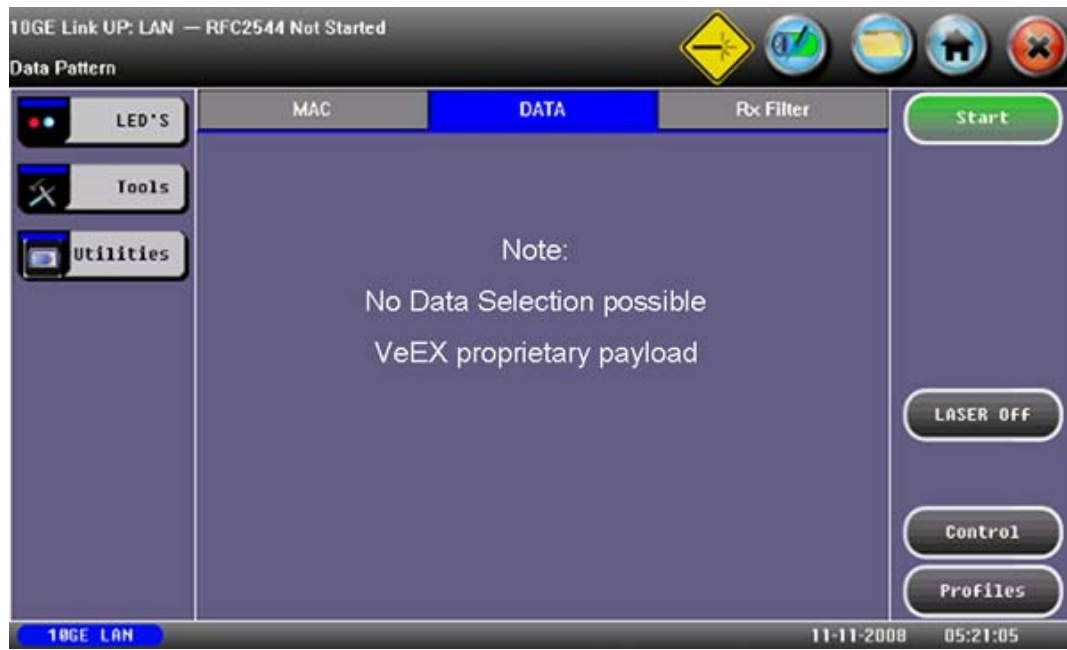
Tap on the Frame image displayed on the screen to configure the MAC addresses, IP addresses, VLAN tag/s, MPLS tag/s, and test pattern. This brings you to the configuration screens for all the header fields.

- **MAC Header Tab:**

- **MAC Source** - Use the default source address of the test set or configure a new or different address. See MAC address editing screen shot below.
- **MAC Destination** - Configure the destination MAC address of the far end partner test set. See MAC address editing screen shot below.
- **Ethernet Type** - For Layer 3 testing, the user can also configure the Ethernet type;
 - 0800-IP (Internet Protocol Version 4, IPv4)
 - 0600-Xerox
 - 0801-X.75 (X.75 Internet)
 - 0805-X.25 (X.25 Level 3)
 - 0806-ARP (Address Resolution Protocol (ARP))
 - 8035-RARP (Reverse Address Resolution Protocol (RARP))
 - 8137-IPX (Novell IPX)
 - 814C-SNMP
 - 8847-MPLS unicast
 - 8848-MPLS multicast
 - 86DD (Internet Protocol, Version 6 (IPv6)) - Future Release



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




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

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

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

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

	<p>Note: RFC2544 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.</p>
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7.2.1.2 Frames Settings

Frames tab: User Configures;

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

- **Add frame:** The user can add two additional user configurable test frames of any size ranging from 64 bytes to 9000 bytes.
 - To add additional test frames, tap the 'Add Frame' button.
 - Enter the frame size using the numeric keypad and click apply.
 - Press the back button to return to the frames screen.
 - The new custom frame size is displayed - it can be enabled or disabled as needed.



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7.2.1.3 Threshold Settings

Threshold tab:

- User enables or disables threshold settings for the throughput and latency tests.
 - When enabled, threshold settings can be configured for all of the test frames selected in the frame settings tab.
- A Pass/Fail criteria will be applied when the threshold settings are enabled.
 - For example - If the throughput threshold value for a 64 byte frame is configured for 80%, then a Pass criteria is assigned if the throughput rate is 80% or better.

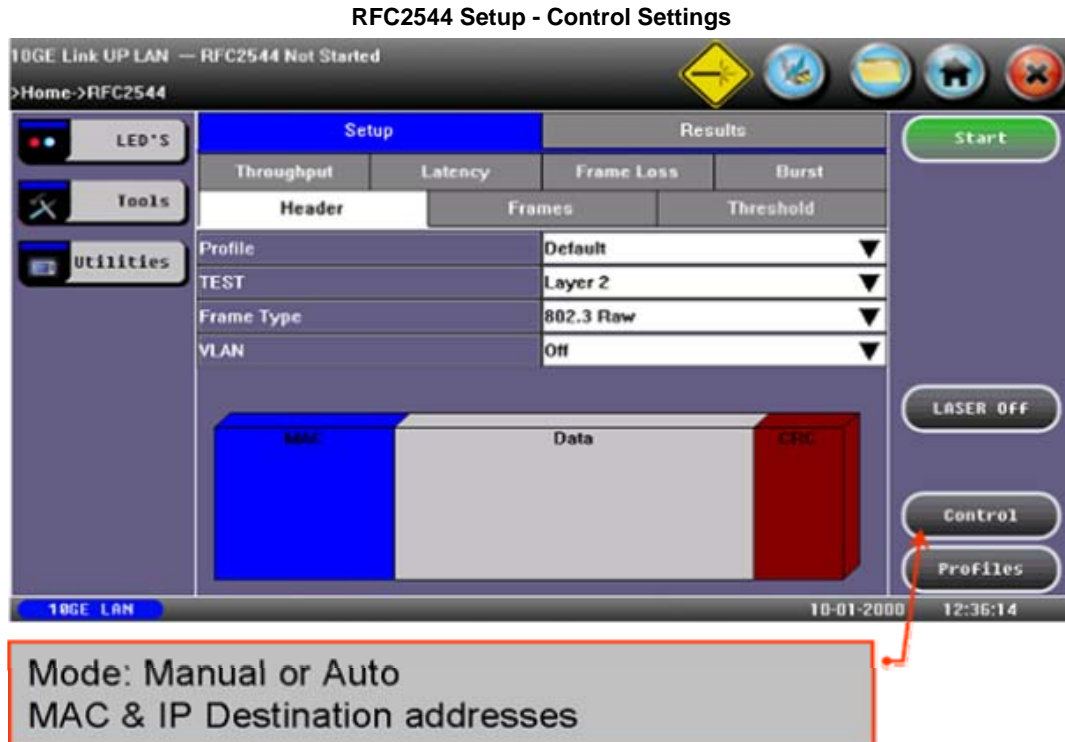


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7.2.1.4 Control Settings

Control button:

- **Overview:** Configures the loop-up and loop-down commands necessary to control the far end unit. The user is allowed to configure the commands manually or automatically.
 - **Manual selection:** user must input the destination MAC/IP address of the far end device including the command type
 - **Automatic selection:** User must select from a list of discovered devices to loop-up/down.
 - In automatic mode no configuration is necessary - user only has to select the "discovered" far end device to control.



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7.2.1.5 Throughput, Latency, Frame Loss, and Burst Settings

The RFC 2544 test suite allows the user to run all of the 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 of the four tests are enabled.

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

Throughput tab:

- **Max Rate:** Up to 100% of the negotiated line rate. The default value is 100%.
 - This is the maximum transmit rate to perform the throughput test for each test frame size.
 - The user may configure this rate as a % of the total line rate or in Mbps. For example if the user configures the Max Rate to be 90% and the negotiated line rate of the link is 100Mbps, then the maximum transmit rate will be 90Mbps or 90% of the line rate
- **Resolution:** 1% to 0.001%. The default value is 1%.
- **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 Setup - Throughput Settings

10GE Link UP LAN — RFC2544 Not Started

>Home->RFC2544

	Setup		Results	
	Header	Frames	Threshold	
Throughput	Latency	Frame Loss	Burst	
MAX Rate	100.00		%	
Resolution	1.00			
Duration	20			
<input checked="" type="checkbox"/> Enable Test				

10GE LAN 10-01-2000 12:37:03

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Latency tab: User configures;

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

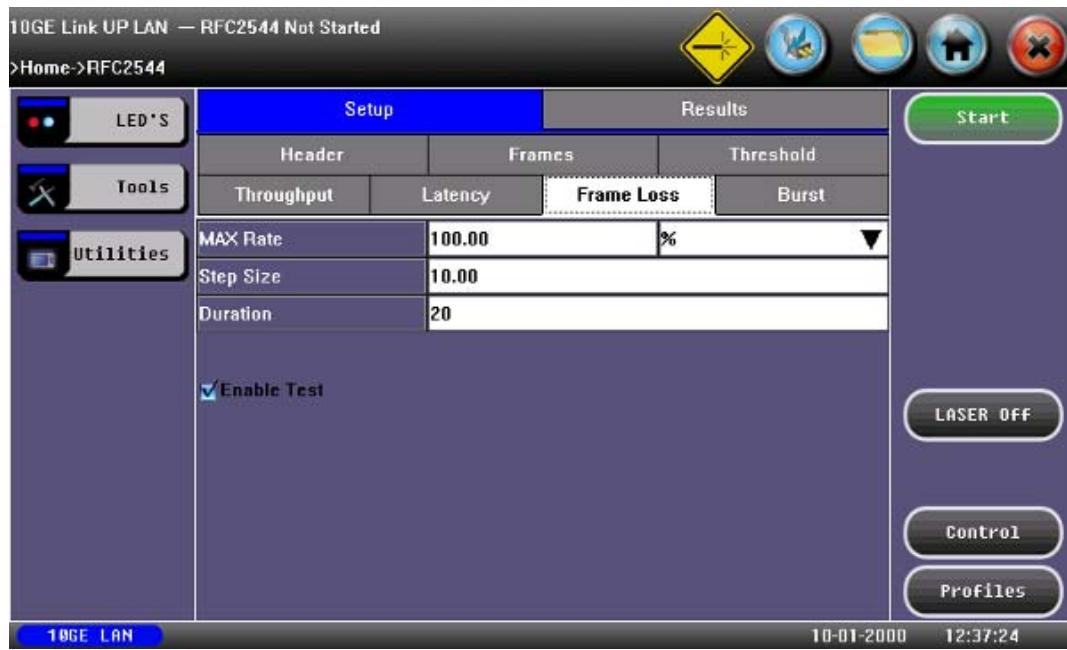


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Frame Loss tab:

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

RFC2544 Setup - Frame Loss Settings

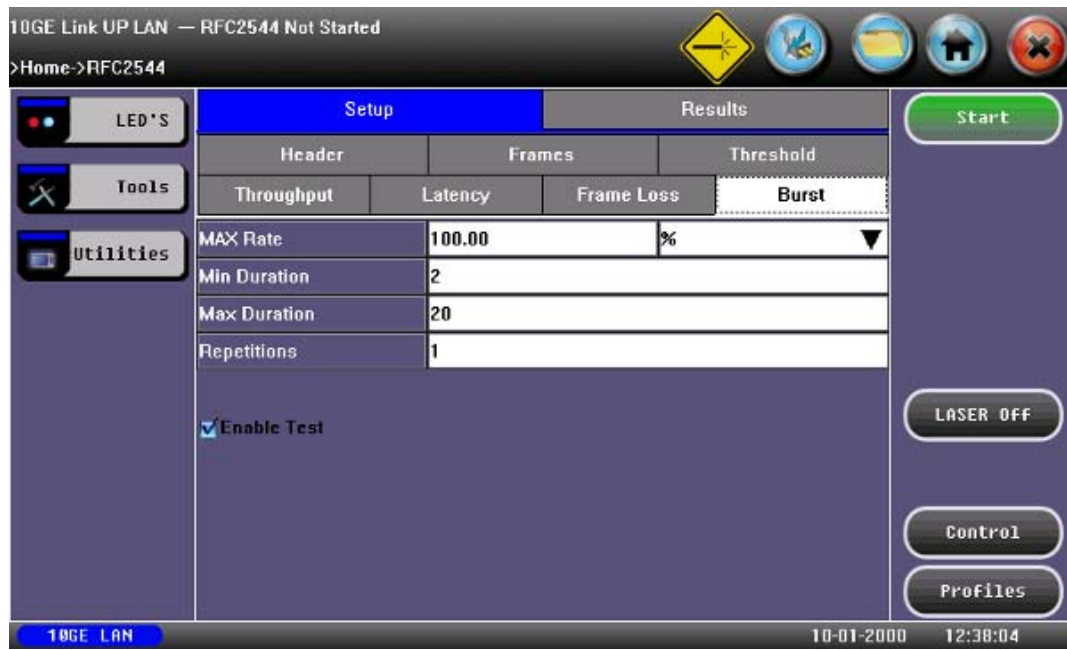


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Burst (Back-to-Back) tab:

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

RFC2544 Setup - Burst Settings



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7.2.1.6 Starting/Stopping a RFC 2544 Test

Once all configurations have been made, the user can start the RFC 2544 test. The following are three scenarios of how to prepare and start the unit for RFC 2544 testing.

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

- **Far End Unit in Manual Loopback Mode:**

- If the far end unit (another MX) is already in a manual loopback mode, the user must make sure that the control settings mode is set to manual. Do not send a loop up command, since it is not necessary.
- Once the correct control settings are configured, the user can start the test

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

- **Far End Unit Controlled with Manual Mode Loop Up/Down Commands**

- If the far end unit is not manually looped back, then it must first receive a loop up command from the control unit before the RFC 2544 test suite can be started.
- To loop up the far end unit with the manual mode loop up/down commands, configure the control settings mode to manual.
- Enter the MAC and/or IP address of the far end unit.
- Send the loop up command by pressing 'Loop Up'

Once the far end unit has been looped back, start the test by pressing the Start button. When the all of the selected test are completed, the RFC 2544 test suite will stop automatically. Once all tests have been completed and there is no need to test again, go back to the Control tab, and press the 'Loop Down' button. This will send a loop down command to the far end unit to remove the loopback that is in place.

- **Far End Unit Controlled with Automatic Mode Loop Up/Down Commands**

- If the far end unit is not manually looped back, then it must first receive a loop up command from the control unit before the RFC 2544 test suite is started.
- To loop up the far end unit with the automatic mode loop up/down commands, configure the control settings mode to automatic.
- Enter the MAC and/or IP address of the far end unit.
- Press Start to automatically loop up the far end unit

Start the RFC 2544 test, and loop down the far end unit when all tests have been completed.

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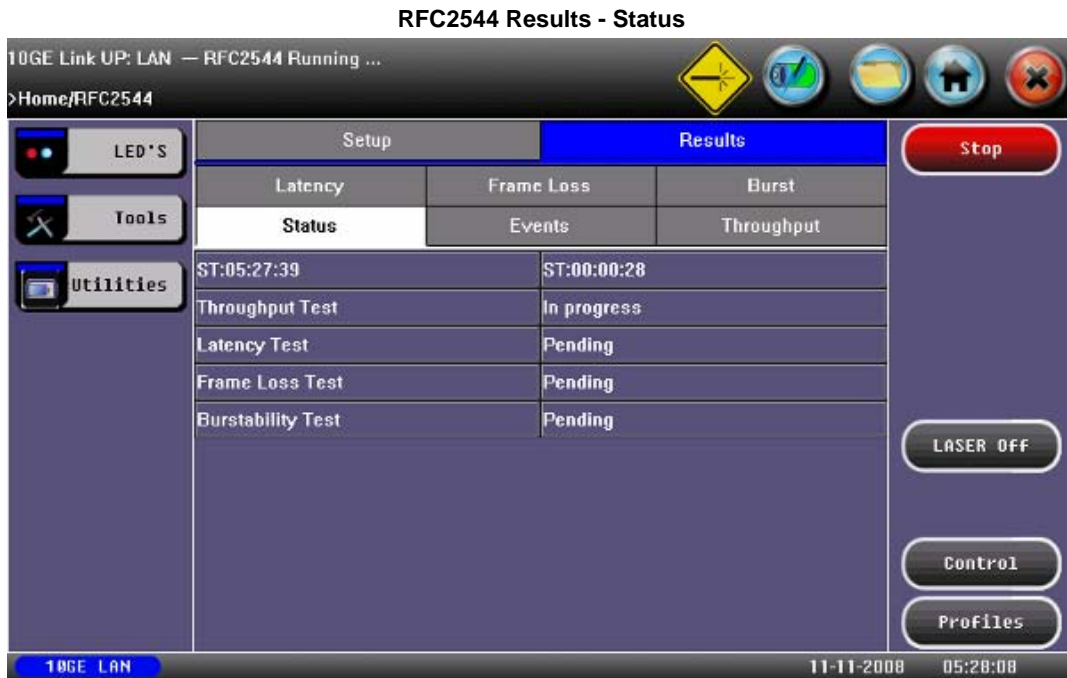
7.2.2 RFC 2544 Results

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

Results tab:

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

Status tab: The status of each test is displayed.



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

RFC2544 Results - Events

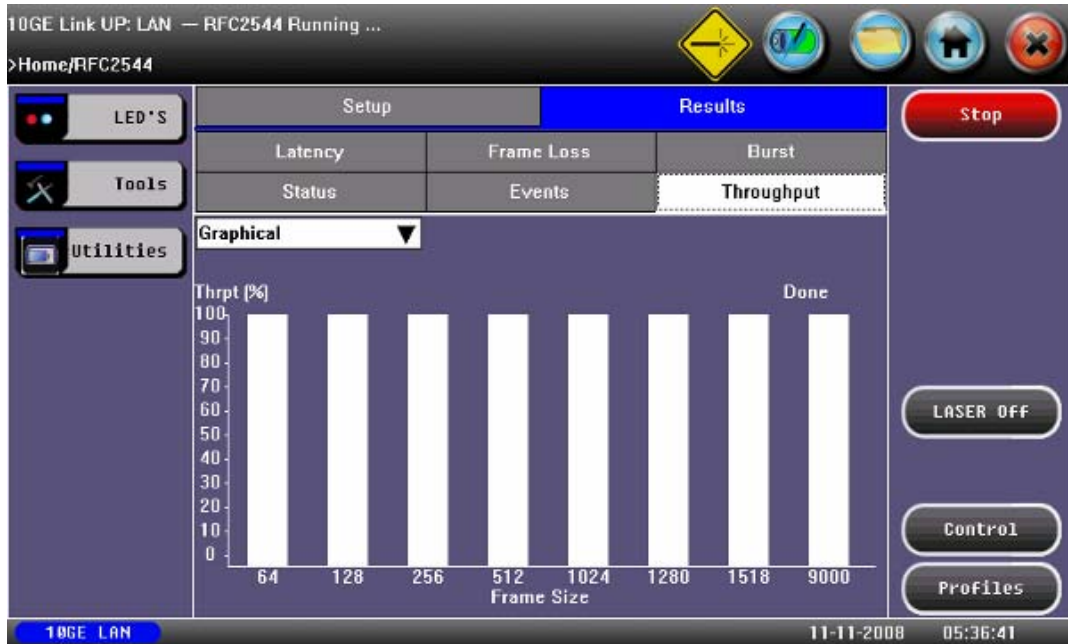


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Throughput tab: Throughput results are displayed in the following formats;

- Graphical
- Summary table
- Test log table

RFC2544 Results - Throughput (Graphical)

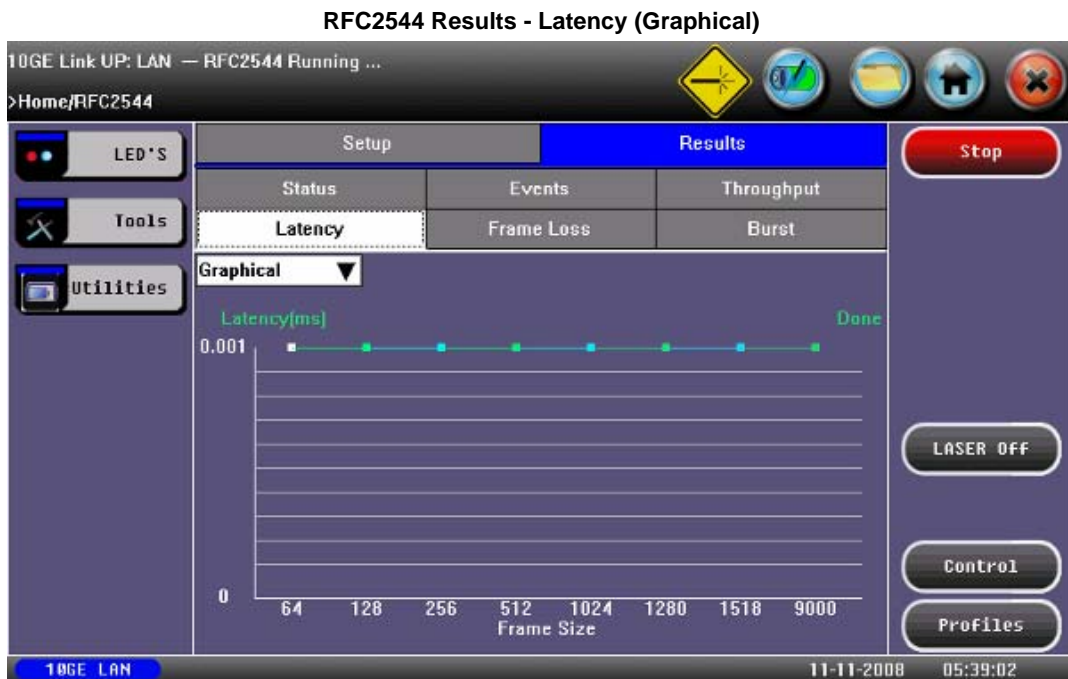
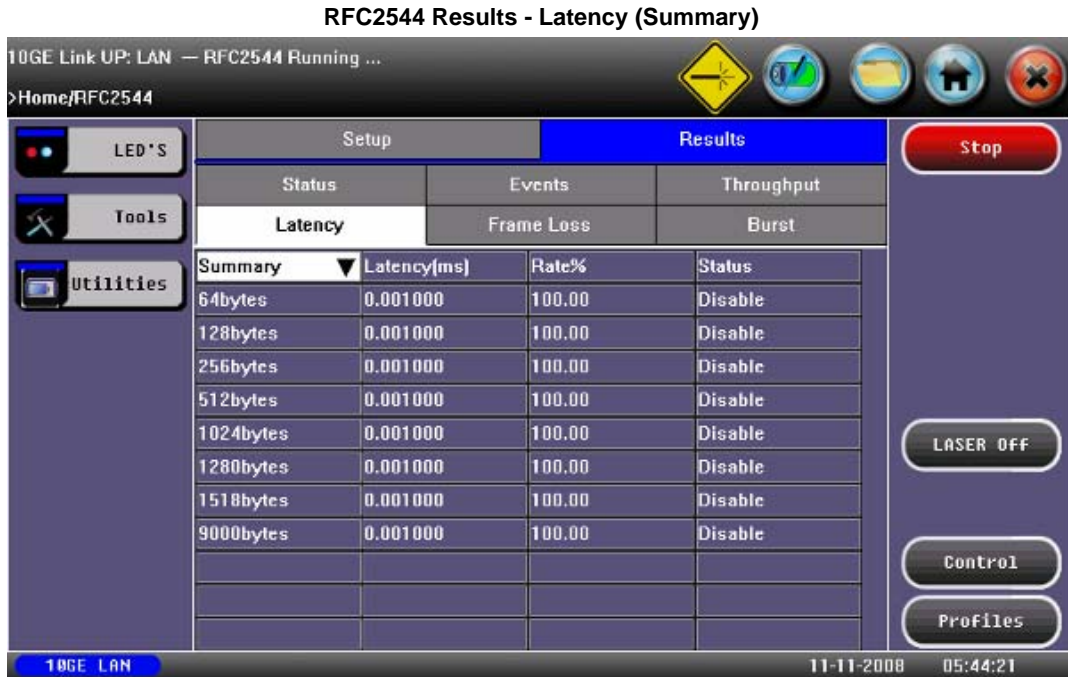


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Latency tab: Latency results are displayed in the following formats;

- Graphical
- Summary table

- Test log table



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Frame Loss tab: Frame loss results are displayed in the following formats;

- Graphical
- Summary table
- Test log table

RFC2544 Results - Frame Loss (Summary)

Setup		Results	
Status	Events	Throughput	
Latency	Frame Loss	Burst	
Summary	▼ Frameloss%	Rate%	
64bytes	0.000000	100.000000	
128bytes	0.000000	100.000000	
256bytes	0.000000	100.000000	
512bytes	0.000000	100.000000	
1024bytes	0.000000	100.000000	
1280bytes	0.000000	100.000000	
1518bytes	0.000000	100.000000	
9000bytes	0.000000	100.000000	

RFC2544 Results - Frame Loss (Graphical)

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Burst tab: Burstability (back-back) results are displayed in the following formats;

- Graphical
- Summary table
- Test log table

RFC2544 Results - Burstability (Summary)



RFC2544 Results - Burstability (Test Log)



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7.2.3 Saving RFC 2544 Results

Once the test has been stopped the results can be saved by pressing the save key on the keypad. The results will be saved and named automatically. Once the results are saved, the user may view or rename the results file by going to the results folder of the files menu.

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7.3 Throughput (Multiple Streams)

Overview: The throughput application (or the multiple streams application) performs the following measurements: throughput performance, frame loss analysis, delay analysis, frame/packet arrival analysis, received traffic type analysis, and received traffic frame size analysis. On the transmit side, the throughput application allows for the configuration of up to 8 traffic streams with their own MAC and IP addresses, VLAN tags (up to 3 per stream), bandwidth/rate, frame size, and L2 and/or L3 quality of service (QoS) parameters. On the receiver end the traffic is analyzed on a per stream (up to 8 streams) basis as well as a global or aggregate measurement.

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

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7.3.1 Setup

Unless otherwise noted, the Frame Header and related setups are the same as the ones described in the [BERT](#) and [RFC2544](#) Applications above. 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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7.3.1.1 General Throughput Settings (Global Configuration)

- **Profile:** Load a previously configured test profile or create a new profile from the existing settings.
- **# of Streams:** From 1 to 8 streams.
- **Stream #:** Allocated Bandwidth per Stream: The total bandwidth for all streams cannot exceed 100%.

Throughput Setup - General Settings



	<p>Note: Multiple Streams All streams are configured for the same test layer - if layer 2 is selected, all streams will be layer 2 traffic</p>
---	---

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7.3.1.2 Control

Control button:

- **Overview:** Configures the loop-up and loop-down commands necessary to control the far end unit. The user is allowed to configure the commands manually or automatically.
 - **Manual selection:** user must input the destination MAC/IP address of the far end device including the command type
 - **Automatic selection:** User must select from a list of discovered devices to loop-up/down.
 - In automatic mode no configuration is necessary - user only has to select the "discovered" far end device to control.

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7.3.1.3 Per Stream Configurations

Please note that for any of the per stream configurations (Header, Traffic, and Error Injection), a stream number will be displayed. The user must select each stream number separately to configure the respective parameters.

Header Settings (Per Stream Configurations)

- **Profile:** Load a previously configured test profile or create a new profile from the existing settings.
- **Test:** Select the test layer. Options Layer 2 and Layer 3.
- **Frame Type:** Select the Ethernet frame type. The options are 802.3 Raw (IEEE 802.3 frame without LLC), 802.3 LLC (IEEE 802.3 frame with LLC header), 802.3 SNAP (IEEE 802.3 frame with SNAP header), and Ethernet II (Dix). Note: The 802.3 Raw frame type is not available when Layer 3 is selected.

- **VLAN:** Off, 1 tag, 2 tags, or 3 tags. The user will be able to configured up to 3 VLAN tags (VLAN stacking, for Q-in-Q applications).
- **MPLS:** Off, 1 tag, 2 tags, or 3 tags. MPLS tag configuration is only available when the MPLS option is purchased.
- **MAC, VLAN, MPLS, and IP:** To configure the MAC addresses, VLAN ID/priority, MPLS label/CoS/etc, IP addresses and header, tap on the 3-D image of the frame on the screen. This will bring you to the configuration screens for all the header fields.
- **MAC Header Tab:** In the MAC tab the user must configure the destination MAC address of the far end partner test set. For the source address use the default source address of the test set or configure a different one. Depending on the type of frame the user may also configure an Ethernet Type field (Ethernet II frame), LLC header fields (802.3 LLC frame), or SNAP header fields (802.3 SNAP frame).
- **VLAN Tab:** In the VLAN tab the, the VLAN ID, priority, and Tag Type (or Ethernet Type) can be configured for all available VLANs.
- **MPLS Tab:** In the MPLS tab the MPLS label, CoS priority settings, TTL, and S-bit fields are configured for all available MPLS tags.
- **IP Tab:** In the IP tab the user must configure the destination IP address and source address. The user may also configure the following IP header fields; IP TOS (for quality of service testing), TTL, fragment offset byte, and the protocol field.
- **RX Filter:** Filter traffic by MAC or IP source and destination addresses or VLAN tag.

Throughput Setup - Header Settings per Stream


10GE Link UP LAN — THROUGHPUT Not Started

>Home->ThroughPut

Setup		Results	
Header	Traffic	Error Inj	General
Profile		Default	
TEST		Layer 3	
Frame Type		Ethernet II(DIX)	
VLAN		1 tag	
MPLS		1 tag	

MAC VLAN MPLS IP Data CRC

10GE LAN 10-01-2000 12:41:32



Note: Multiple Streams - MAC/IP address setups

- 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.

7.3.1.4 Traffic Settings (Per Stream Configuration)

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

- **Frame Size:** Enter the frame size when a Layer 2 or Layer 3 BERT is selected. Frame size configuration is not available for Layer 1 BERT. Frame sizes can be from 64bytes to 1518bytes, in addition to jumbo frames up to 9k bytes.
- **Traffic Flow:** Select from Constant, Ramp, or Burst traffic flow.
- **BW (Transmit Bandwidth):** Configure the transmit rate for the stream.
Note: the bandwidth allocation per stream is already configured in the General Settings tab, but can be modified in this screen as well.

Throughput Setup - Traffic Settings per Stream

Setup		Results	
Header	Traffic	Error Inj	General
Traffic Flow	Constant		
Frame Size	Fixed		
Frame Size	68		
Const BW	100.00	%	

Graph: BW% 100.00% vs Time

Buttons: Start, LASER OFF, Control, Profiles

Status: 10GE LAN | 10-01-2000 | 12:42:07

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7.3.1.5 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.

- **Error type:** Select from CRC or IP Checksum (layer 3 only)
- **Injection Flow:** The error injection flow determines how the selected errors will be injected. The user can select a single error or a specific count.
- **Count:** The user will be able to configure the error count via numeric keypad.

Throughput Test - Error Injection Settings per Stream



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7.3.1.6 Starting/Stopping a Throughput (Multiple Streams) Test

Once all the necessary configurations have been made, the user can now start the Throughput test. The following are three scenarios of how to prepare and start the unit for Throughput testing.

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

- **Far End Unit in Manual Loopback Mode:**
 - If the far end unit (another MX) is already in a manual loopback mode, the user must make sure that the control settings mode is set to manual. Do not send a loop up command, since it is not necessary.
 - Once the correct control settings are configured, the user can start the test

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

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

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

- **Far End Unit Controlled with Automatic Mode Loop Up/Down Commands**
 - If the far end unit is not manually looped back, then it must first receive a loop up command from the control unit before the Throughput test is started.
 - To loop up the far end unit with the automatic mode loop up/down commands, configure the control settings mode to automatic.
 - Enter the MAC and/or IP address of the far end unit.
 - Press Start to automatically loop up the far end unit

Start the Throughput test, and loop down the far end unit when all tests have been completed.

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7.3.2 Throughput Results

7.3.2.1 Viewing Throughput (Multiple Streams) Test Results

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

7.3.2.2 Global/Aggregate Results

The aggregate results screen displays;

- Line rate
- Framed rate
- Total data rate
- Total utilization
- Total # of frames
- Total number of bad frames
- Optical power measurement (if applicable).

Throughput Results - Global Aggregate

Setup		Results	
Global		Per Stream	
Events	Traffic	Stream Summary	
Aggregate		Errors	
ST:06:04:29		ET:00:00:11	
	Tx	Rx	
Line Rate	10000.00M	10000.00M	
Framed Rate	9870.76M	9870.76M	
Data Rate	9573.20M	9573.21M	
Utilization	100.00%	100.00%	
Total Frames	8517058	8516892	
Bad Frames	0	0	
Opt Power	N/A	N/A	

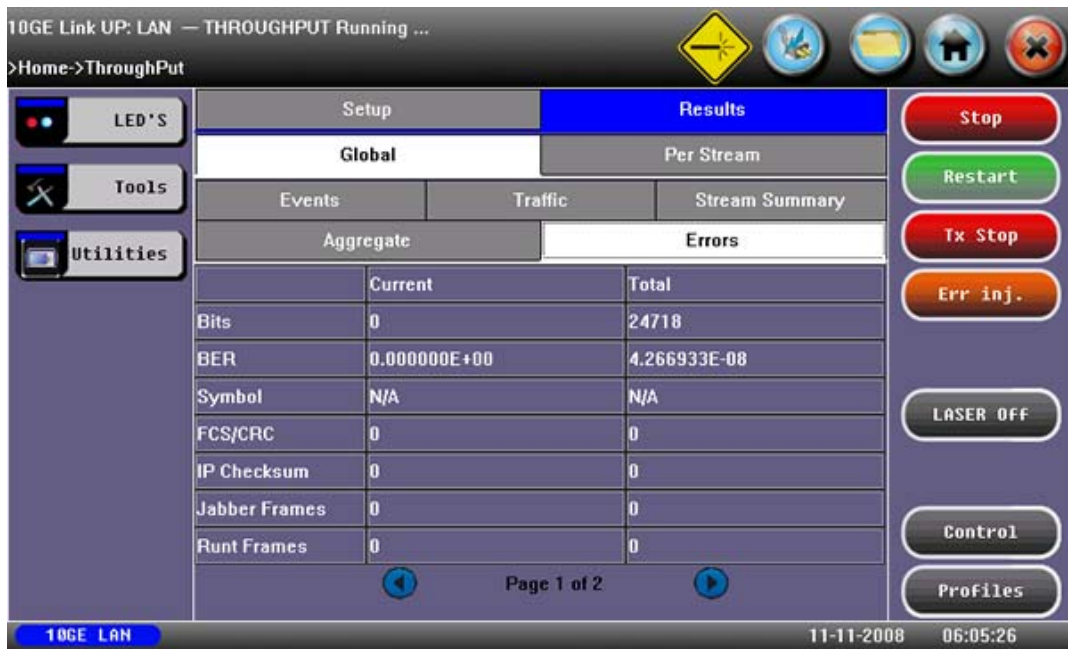
10GE LAN 11-11-2008 06:04:39

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The Global 'Errors' screen displays the Current and Total error count of all streams;

- Bits
- BER
- Symbol
- FCS/CRC
- IP Checksum
- Jabber Frames
- Runt Frames

Throughput Results - Global Errors



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The Global 'Stream Summary' screen displays;

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

Throughput Results - Global Stream Summary

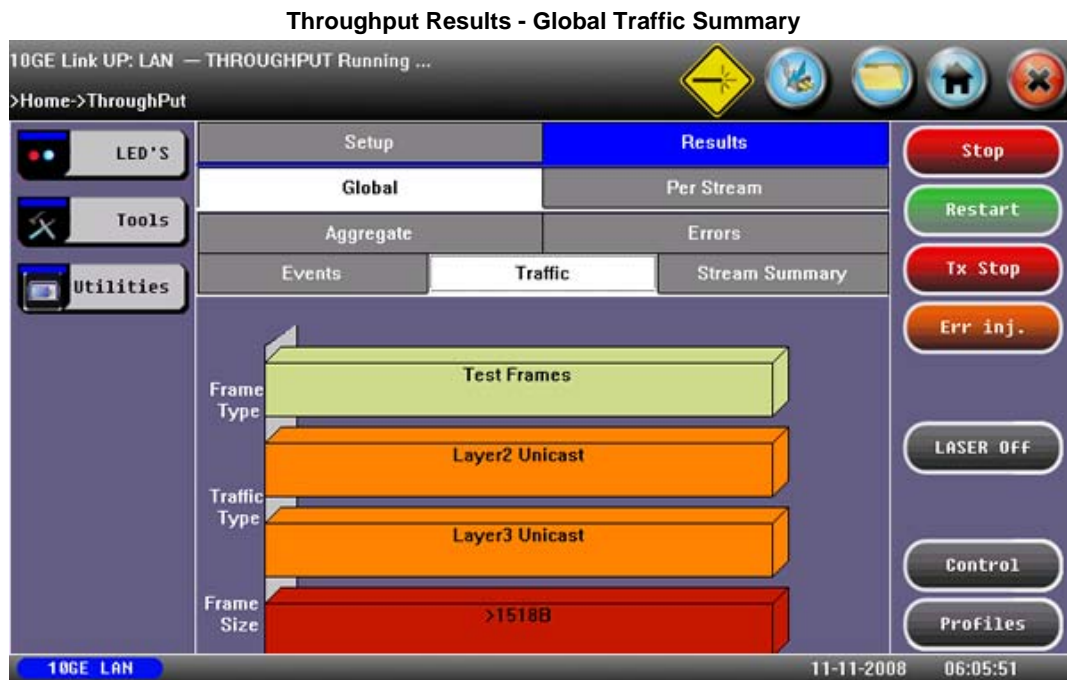


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The Global 'Traffic' screen displays;

- Frame Type of all streams

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



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7.3.2.3 Per Stream Results

In the 'Per Stream' tab the following measurements are available;

- 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
- Rates - Rates information associated with each stream

Throughput Results - Summary per Stream

10GE Link UP: LAN — THROUGHPUT Running ...

>Home->ThroughPut

Setup		Results	
Global		Per Stream	
Summary	Errors	Traffic	Delay
ST:06:04:29		ET:00:02:24	
	Tx		Rx
Framed Rate	9870.76M		9870.77M
Data Rate	9573.22M		9573.22M
# of Bytes	170762996792		170762731258
Total Frames	111902352		111902183
Bad Frames	0		0
Opt Power	N/A		N/A

10GE LAN 11-11-2008 06:06:42

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The Per Stream 'Errors' screen displays the Current and Total error count of each stream;

- Bits
- BER
- FCS/CRC
- IP Checksum
- Jabber Frames
- Runt Frames
- Giant Frames

Throughput Results - Errors per Stream

10GE Link UP: LAN — THROUGHPUT Running ...

>Home->ThroughPut

Setup		Results	
Global		Per Stream	
Summary	Errors	Traffic	Delay
	Current		Total
Bits	0		37019
BER	0.000000E+00		2.142743E-08
FCS/CRC	0		0
IP Checksum	0		0
Jabber Frames	0		0
Runt Frames	0		0
Giant Frames	772023		142289494

Page 1 of 2

10GE LAN 11-11-2008 06:07:19

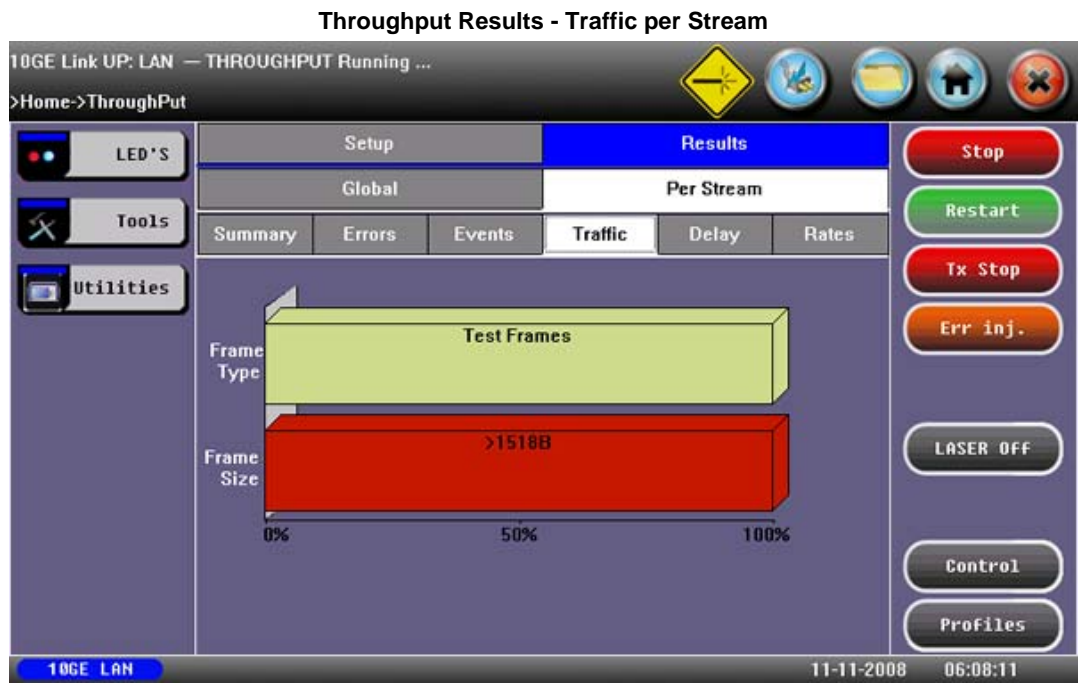
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The Per Stream 'Events' screen displays a Date and Time stamped record of bit errors, alarms and other anomalies pertaining to each stream.



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



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

Throughput Results - Delay per Stream



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

Throughput Results - Rates per Stream



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7.3.2.4 Saving Throughput (Multiple Streams) Results

Once the test has been stopped the results can be saved by pressing the save function key on the VePAL's keypad. The results will be saved and named automatically. Once the results are saved, the user may view or rename the results file by going to the results folder of the files menu.

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7.4 Monitor (Pass Through)

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

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

- First connect to both 1000Base-X fiber ports (port 1 and port 2) or both 10/100/1000T copper ports (port 1 and port 2), depending on the interfaces to be monitored.
- Once the cable/interface connections are in place, press start.

To switch between port 1 and port 2 results select "P1 Monitor" and "P2 Monitor" respectively.

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7.5 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, Layer 2, or Layer 3. Layer 1:

- In a Layer 1 loopback all incoming traffic to the Rx loopback interface will be sent out unaltered to the Tx loopback interface.
- Layer 2/3: 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

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8.0 IP Tools

8.1 IP Connection

8.1.1 Setup

Setup tab:

Enter a Static IP address or use DHCP to connect to the network.

If DHCP is selected, an IP address will be automatically assigned to the test set. The user can also turn the DNS server option On or Off.

IP Connection - DHCP mode



If a Static connection mode is selected, the user is required to enter a Local IP, Subnet, Gateway, and DNS IP (if the DNS server option is turned on).

IP Connection - Static mode



A DNS IP address is required when using URL format as a destination address.

The user needs to establish an IP connection and address prior to Ping, Trace Route, Web/FTP, ARP Wiz, VoIP, and IPTV testing.

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8.1.2 IP Status

Status tab:

IP Connection Status:

- Ensure the Status is PASS before continuing with any IP tests
- If the status fails, go back to the setup screen to verify that the parameters are entered correctly
- Ensure that the ethernet cable is connected properly before trying to reconnect
- Check the status LED on the Ethernet connector (on the right side of the unit) to look for port and network activity

IP Connection - Status Indication

Tools	Setup	Status	Ping	Trace Route	WEB/FTP	ARPWiz
IP Tools	DHCP server		192.168.0.1:0			
	DHCP Lease Time		86400			
Net Wiz	Local IP		192.168.0.93			
	Subnet Mask		255.255.255.0			
Wifi Wiz	Gateway		192.168.0.1			
	DNS IP		206.13.28.12			
LED'S	Second DNS		206.13.31.12			
	DHCP:		PASS			
Utilities	IP:		PASS			
	Gateway:		PASS			
DNS:		PASS				
Disconnect						

10GE LAN 09-01-2000 08:31:32

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8.2 Advanced IP Tests

An IP test will verify that the IP network is configured properly and connected to the Internet. Depending on the IP options purchased, the following tests are possible;

8.2.1 Ping Test**Ping tab:**

PING is a popular computer network tool used to test whether a particular host is reachable across an IP network. A Ping is performed by sending an "echo request" or ICMP (Internet Control Message Protocol) to the target host and listening for "echo response" replies. The following setup selections are available;

- **Profile** - Recall a Ping profile from memory or create a new test setup
- **Destination** - Enter the destination IP address or URL to Ping
- **Number of Pings** - Enter the number of Ping attempts that will be performed to reach the network device
- **Length** - Enter the buffer size that will be sent to the network device to be detected
- **Pings/second** - Enter the Ping repetition rate
- **Time-out** - Enter the maximum time allowed between an ICMP ping and echo response.

Ping Test Setup



Ping Result tab:

The following results are displayed;

- Ping status - Pass or Fail
- Destination IP address
- Number of Pings Sent
- Number of Pings Received
- Unreachable and Missing Pings
- PING also estimates the round-trip time, in milliseconds
 - Current - the current time for a Ping request to be answered.
 - Minimum - the minimum time recorded for a Ping request to be answered.
 - Maximum - the maximum time recorded for a Ping request to be answered.
 - Average - the average time required for a Ping request to be answered.

Ping Test Result



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8.2.2 Trace Route

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

Trace Route setup tab:

The following setup selections are available;

- **Profile** - Recall a trace route pfile or create a new test
- **Destination** - Enter the IP address or URL of the network device to be detected.
- **Time-out** - Enter the maximum time allowed between an ICMP echo and response at each hop
- **Max Hop** - Enter the maximum number of network devices the packet is allowed to transit.

Once the parameters are configured, click 'Trace' to start.



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Trace Route results tab:

The following results are displayed;

- Number of hops to destination
- Time To Live (TTL)
- and addresses up to the destination.

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

Trace Route Result

The screenshot shows the '10GE Link UP LAN' web interface. The breadcrumb path is '>Home->Tools->IP Tools'. The 'Trace Route' tab is selected. The interface displays a table with the following data:

Setup			Result
TRACEROUTE: Over			
Hop	TTL(ms)	Address	
1	0.440	192.168.0.1	
2	1.119	71.159.222.70	
3	10.859	151.164.184.72	
4	9.654	76.246.22.2	
5	10.114	151.164.93.237	
6	11.641	151.164.190.14	

At the bottom of the table, it says 'Page 1 of 2' and there is a 'Trace' button. The status bar at the bottom shows '10GE LAN' on the left and '09-01-2000 08:58:34' on the right.

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8.2.3 FTP Test

The File Transfer Protocol is used to verify the actual throughput of upstream or downstream data rate by sending or receiving files of known size.

FTP tab:

For FTP download or upload, the user needs to configure;

- **Mode** - select between FTP or Web mode
- **FTP mode** - displayed when FTP is selected. Select either Upload or Download
- **Profile** - Recall a FTP profile or create a new FTP test session
- **Address** - Enter IP Address of the FTP server
- **File/Path** - Enter any file path if applicable
- **User name** - Enter user name needed to login into server
- **Password** - Enter password needed to login and authenticate access to the FTP server.
- Press 'Start' to initiate the download or upload process.

Note: For FTP upload, the user can also set the file size to be transmitted.

FTP Download Setup



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FTP Result tab:

The FTP download or upload results screen indicates;

- Pass or Fail status
- Time to login into Rx server (Download)
- Data transfer in Mbps
- Total Transfer time
- Average Throughput according to the download or upload.

FTP Download Result



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8.2.4 Web Test

Web Test is used to verify that the internet is properly provisioned at the service point. Web Mode can be set to either Web Test or Web Browser.

Web Test Setup tab:

To perform a Web Test, follow the procedure below;

- **Mode** - Select Web Test from Mode selection
- **Web mode** - Select Test from the Web mode selection
- **Profile** - Recall a known profile or enter the desired IP address or URL destination
- Press 'Start.'



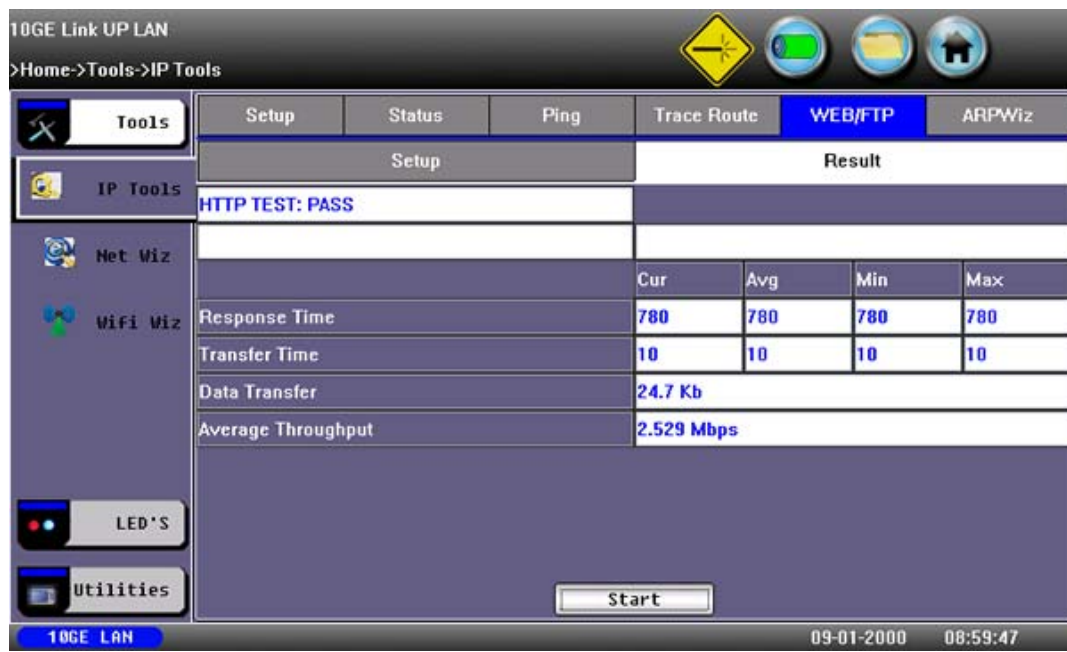
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Web Test Result tab:

The following results are displayed;

- Status - Pass / Fail indication of HTTP traffic
- Response time - Current, Average, Minimum and Maximum values
- Transfer time - Current, Average, Minimum and Maximum values
- Data transfer
- Average Throughput

Web Test Result



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Web Browser:

- Select Browser from Web Mode
- Enter or select the desired IP address or URL destination, and encoding, and then press 'Start.'
- The screen will turn blank while launching the spider web browser engine.
- The web page is divided into quadrants. Use the slide keys to navigate up/down and left/right.
- It is possible to navigate links within the screen.
- Click the close button in the Top right hand corner to exit.

Note: If a DNS server is not detected, an error message will be displayed.

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8.2.5 ARP Wiz

ARP Wiz uses the Address Resolution Protocol (ARP) to verify the status of each IP address in a user selectable IP range. ARP is the standard method for finding a host's hardware address when only its network layer address is known. In other words, ARP is used primarily to translate IP addresses to Ethernet MAC addresses. ARP is defined in [RFC 826](#)

Setup tab:

- Profile - Recall an address stored as a Profile or enter a desired IP address
- Source address - Enter the IP address range
- Destination address - Enter the IP address range
- Time-out
- Press 'Start'

ARP Wiz Setup




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Result tab:

The MAC addresses associated with active IP addresses in the range are displayed.

ARP Wiz Result

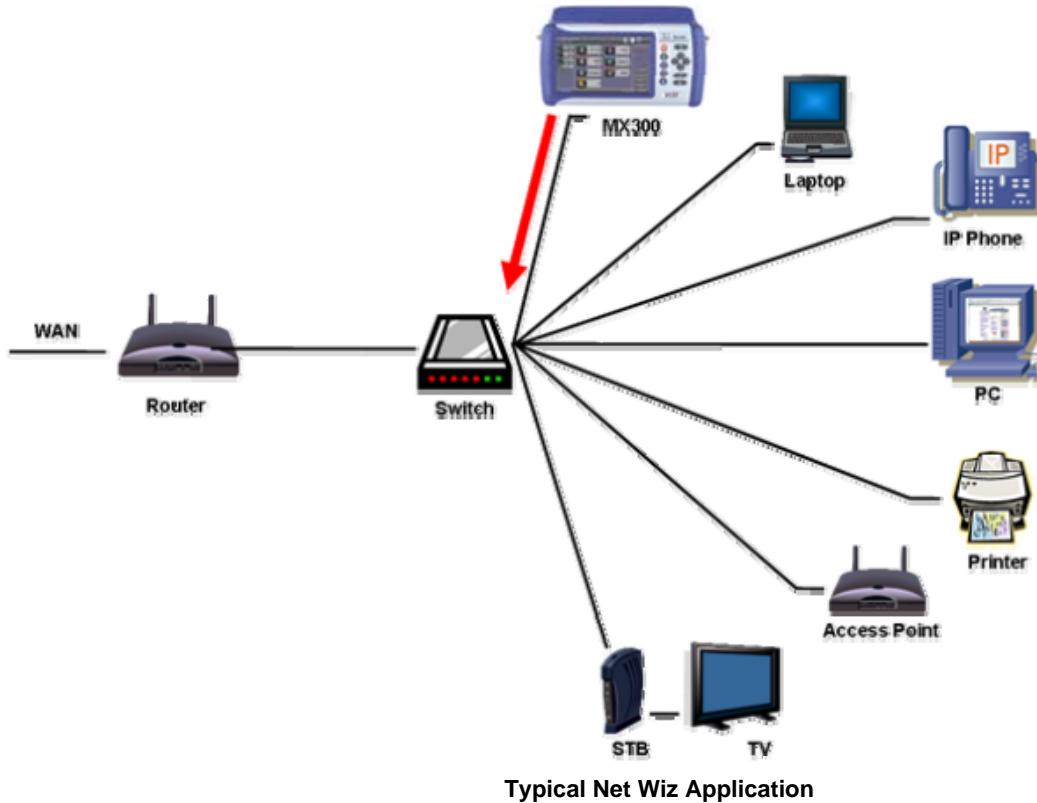


	<p>Note: ARP The ARP protocol only works within the same subnet as the IP address provided to the testset in IP Status.</p>
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8.3 Net Wiz

The Net Wiz function allows you to test the ethernet cable and associated network environment. A typical application is shown below;



Netwiz Test functionalities include;

- Cable Analysis with distance
 - to switch with MDI mode (Straight or Crossover)
 - to fault, type of fault (Open, Short, Impedance Mismatch)
- Analyze the network and automatically report
 - Stations
 - Routers/Gateway
 - Printers
- Provide MAC and IP addresses of each device
- PING each device and verify the device is active
- Provide detected networks (NetBIOS, IPX, etc)

Status

- Press 'Start' to begin the test.
- The test set will report the connection type (Straight or Cross Over) if connected to an end point device.
- If a fault is detected (Open or Short), the fault will be indicated including the distance to the fault.

Discovery

- Before proceeding with the discovery function, please go to IP Tools to establish a connection.
- Enter the desired IP address range and press 'Start'

Discovery Result:

- **Summary** tab reports;
 - Total transmitted and received frames
 - Received frames in error
 - Speed advertized
 - Duplex mode advertised
 - Number of devices and networks found

Discovery Result:

- **Devices** tab indicates;
 - Total number of devices found
 - Number of devices i.e. routers, servers or hosts.
 - Attribute of each device discovered including Ping test result.

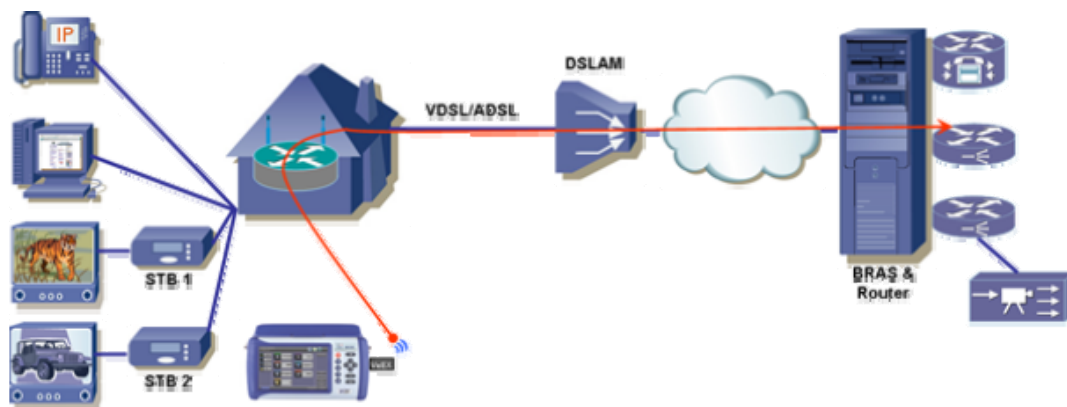
Discovery Result:

- **Networks** tab indicates;
 - Number of IP Subnets, Hosts, Domain, and Named Hosts Found.

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8.4 WiFi Wiz

The function allows you to test wireless WiFi 802.11b and 802.11g networks. A typical application is shown below.



Typical WiFi Wiz Application

The WiFi Wiz function supports;

- WEP Encryption
- Scanning
- SSID broadcasting and report
- Signal Strength
- Mode (AP, IF) and Security
- IP Connection and Ping Test

Setup:

- Plug the WiFi adaptor into the USB port. Allow at least 30-45 seconds for the unit to detect the wireless adaptor and for the software driver to load.
- VPAL products support Linksys USB wireless adaptors only and have the necessary software driver built into the Linux operational system. Do not use other wireless adaptors as this may damage the unit.
- Tap on the pull down menu to turn the wireless USB adapter on. An information box will display the initiation process of the USB and this process will take about 90 seconds.
- Ensure the USB wireless adapter is connected before turning it on.

Scan - Tap on the Scan tab once the test set has detected the wireless USB adapter. Press Scan on the bottom to start

scanning the site. When scan is completed, the test set will show the number of SSIDs, Channels, and the number of SSIDs in Infrastructures mode and Ad-Hoc mode.

SSID - Tap on the SSID tab after the scan is completed. Select one of the SSIDs to start a connection. If the SSID is locked, a network key is required to complete the connection. The WiFi function supports WEP encryption. The key can either be 10 characters or 26 characters. Note: If the user entered the wrong network key the test set will still connect to the Access Point, however, it will not be able to connect to the web or to perform the Ping test.

Note: Select the manual selection to enter the parameters manually if the SSID did not detect the AP that the user is searching for.

Connection

Once connected, the connection screen will display the following information on the connection;

- SSID
- BSSID MAC address
- Channel number
- Encryption type - WEP, WPA, Disabled
- Type - Adhoc, Infrastructure
- Signal strength is constantly updated so the value varies.
- Link Quality is constantly updated so the value varies.

Note: Signal versus Link Quality

Link quality - Fundamentally, the best way to measure link quality is to derive the Signal to Noise Ratio (SNR) of the desired received signal. For that to happen, a demodulator in the receive chain needs to provide information about the confidence of the detected symbol - also known as soft detection. However, with modern CMOS transceivers used in WiFi type products, soft detection is not provided. Instead, in a typical application, there are two measures of the Rx signal quality: Received Signal Strength Indication (RSSI) and integrity check of the demodulated data by either Cyclic Redundancy Check (CRC) or PN code correlation strength.

Signal quality - The RSSI can be used as a measure of signal quality when there is no interference. But, in the case where the receiver experiences interference, the RSSI may falsely indicate sufficient signal strength even if the desired signal is completely jammed by the interfering signal. This is because the RSSI cannot distinguish the desired signal from the interfering signal. In this situation, a data integrity check can be used to detect if the demodulated data is corrupted, and then subsequently adjust the transmit power. Using a CRC check as a measure of link quality implies that a few bit errors occur in the data or voice transmission before the transmit power can be increased. There is a lot of controversy about the term signal quality used in WLAN networks but the most likely definition of "signal quality," or "PN code correlation strength" is that it is some metric of the correlation between the correct symbol-stream and the actual symbol-stream received. For example, the PHY might count the average number of "wrong" bit positions over a window of some number of symbols, where zero "wrong" bit positions equals 100% signal quality and more "wrong" bit positions results in lower signal quality.

Signal strength and RSSI - In reality, there are four units of measurements used to represent RF Signal Strength namely mW(milliwatts), dBm ("dB"-milliwatts), RSSI (Received Signal Strength Indicator), and a percentage measurement. Signal strength defined in the IEEE 802.11 recommendation for WiFi type devices is based on the Received Signal Strength Indicator (RSSI) and is intended to be used as a 'relative value' within the WiFi chipset. The 1-byte value can have values ranging from 0 to 255, but vendors prefer to use arbitrary scales from 0 to RSSI_Max but in fact no vendor actually measures the 256 different signal level values so each adopts and uses their own specific maximum RSSI value (RSSI_Max). For example on the WiFi adaptor we use, Linksys (Cisco) chooses to measure 101 separate values for RF energy so their RSSI_Max is 100. Note that the RSSI value is not associated with any particular power scale (e.g. mW) and it is also not required to be of any particular accuracy. The RSSI value is used internally by the microcode in the adapter and by the device driver and this is why vendors are not forced to use a compatible standard. As a result, the signal strength numbers reported by an 802.11 device or adaptor will not be consistent between two vendors, and should not be assumed to be particularly accurate or precise.

Ping - Before performing the Ping test, ensure the WiFi connection is Up and the WiFi icon (on the top of the screen) has turned green.

Note: WiFi Ping Test

The signal level might change depending on the distance between the Access Point and the test set causing the WiFi connection to drop. Furthermore, if the link quality is below 60%, the connection might



drop too.

If the connection drops the test set will automatically search for the connection and re-connect. Always ensure the connection is active before performing the Ping test.

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8.5 VoIP Testing

8.5.1 VoIP Check

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8.5.2 VoIP Expert

Setup: Select the VoIP tab to proceed with VoIP Expert setup. There are three modes or applications;

- **Client** - To use the test set as a Client, the user needs to input the Server's IP address and set a Test Duration. The File Name and Encoding are preset in the test set for the current release. Press 'Start' when the parameters are all entered
- **Server** - To use test set as a server, select Server then press 'Start.' The test set then waits for the connection from the Client to perform the test. The IP address of the server is the one entered or obtained in the IP Status

Note: Client and Server mode simulate a VoIP call between two test sets or one test set and a server, and measure the VoIP quality parameters.

- **IP Phone** - For IP Phone or VoIP Call Expert mode, go to VoIP - IP Phone Section

For Client mode, the user needs to input the Server's IP and Test Duration. The File Name and Encoding are preset in the test set for the current release. Press 'Start' when the parameters are all entered.

Server Status

There are 4 stages in Server test mode:

- **Wait for Client or Server** - Wait for the Client to connect with the server or vice versa
- **Connecting** - Once client is connected to the server, the downstream test will be performed.
- **Downstream** - As soon as the downstream is completed the upstream test will be performed.
- **Upstream** - As soon as the upstream is completed, a Pass or Fail result will be indicated
- **File Pass** - File Pass will be displayed when the test is completed.

Note: Loss, Dup, and DV can be generated at any time, however, these functions are only available when the test set transmits the file.

- **LOSS** - Packet Loss
- **DUP** - Duplicate Packet
- **DV** - Delay Variation (DV)

Client Status:

There are 3 stages in Client mode:

- **Upstream** - Stream the voice file to the Server.
- **Downstream** - Once the upstream is completed the downstream test will be performed.
- **VOIP Test Complete** - VOIP Test Complete will be displayed when the test is completed.

Status:

Status tab indicates;


- **ST** - Start Time

- ET - Elapsed Time
- Test progress

MOS/R tab indicates;

The Mean Opinion Score (MOS) and R-factor measurements performed by the **Telchemy™ VQmon®** VoIP quality measurement engine which is integrated into the test set. **VQmon/SA** supports;

- Listening and conversational quality metrics
- MOS scores and R factors
- Detailed packet/RTP statistics
- Jitter buffer emulation



Note: Call Quality

Listening Quality (LQ) - Refers to how the users rate what they “hear” during a call

Conversational Quality (CQ) - Refers to how the users rate the overall quality of a call based on the listening quality and their ability to converse during a call. This includes any echo or delay related difficulties that may affect the conversation

Transmission Quality - Refers to the quality of the network connection used to carry the voice signal.

Call Quality Rating and Mean Opinion Score (MOS)		
User Opinion	R Factor	MOS (ITU)
Maximum obtainable for G.711	93	4.1
Very Satisfied	90 - 100	4.1 - 5.0
Satisfied	80 - 90	3.7 - 4.1
Some users satisfied	70 - 80	3.4 - 3.7
Many users dissatisfied	60 - 70	2.9 - 3.4
Nearly all users dissatisfied	50 - 60	2.4 - 2.9
Not recommended	0 - 50	1.0 - 2.4

Packets tab indicates;

- Analysis on packet loss
- Duplicated packets
- Out of sequence packets
- Packet rate
- Packet jitter

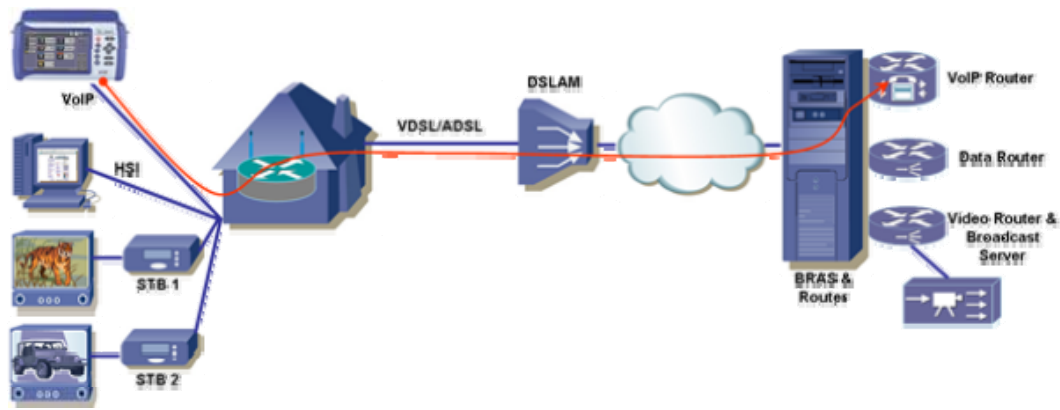
Events tab indicates;

- A time stamped log of the various test steps with Pass/Fail criteria

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8.5.2 VoIP Call Expert

The function allows you to place a VoIP call over an IP and PSTN network.



Typical VoIP Call Expert Application - DSL Triple Play Network

Setup:

Select the VoIP tab to proceed with the IP Phone setup.

- **Profile** - Recall an existing or save a new profile
- **Mode** - Select IP Phone from the Mode pull down menu.
- **Protocol** - SIP and H.323 are the only protocols supported at this time.
- **Registration** - Direct or Peer to Peer.
- **User name and Password** - for registering with the call authentication server
- **Codec** - select between G.711A, G.711U, G.728 or G.729
- **Headphone** - When the user turns on the headphone selection, an information box appears prompting you to plug-in the VeEX USB headphone adaptor. Ensure the headphone USB adaptor is properly connected to the test set before pressing 'OK'

Registration Status

- The status will show the registration progress and call activity if any
- Once the test set has completed the registration, the test set status will change to Online.
- If the test set fails to register, repeat the setup process and ensure all the parameters are entered correctly and register again.

Call Status:

To place a call;

- First enter a destination IP address - The address can be a phone number (phone number@sipserver) or an alias (bob@sipserver)
- Press 'Call' - The status will show the call progress e.g. 'Dialing in progress'
- The status changes to 'Call connected' when the destination end point answers the call

Receive Call Status:

- An information box appears on screen when there is an incoming call
- The user can choose to accept or to decline the call
- Once connected, you can use the USB headphone adaptor to talk and listen

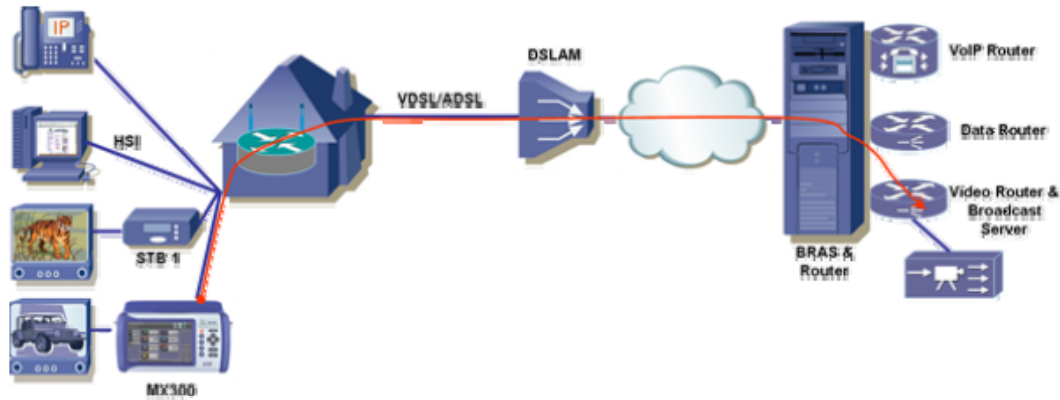
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8.6 IPTV

The function allows you to perform IPTV testing in a Triple Play network. The feature supports;

- Set Top Box (STB) emulation
- IGMP/RTSP signaling, MPEG2/4, H.264 encoding, RTP/VC1/MPEG-TS transport streams
- Packet Statistics: packet loss, jitter, delay, PID mapping
- Video/Audio stream rates

- Channel zapping for quick and complete installation check



Typical IPTV Test Application - DSL Triple Play Network

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The IPTV menu allows you to configure the following parameters;

8.6.1 Setup:

- **Channel Table** - Select the IPTV channel table to test. The IPTV channel table can be configured manually on the test set using the Editor function. Alternatively, the IPTV channel table can be created using the Reveal LX software which can subsequently be downloaded onto the test set.
- **Channel #** - Select and configure the channel to be analyzed. Up to three channels or streams (Multicast or Unicast) can be analyzed simultaneously. The channel can be in IP address or URL format.

Probe tab:

- Channel Name
- Channel Address

Editor tab: Allows you to edit;


- IPTV channel name
- IP address associated with the IPTV channel

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8.6.2 Results:


IPTV Summary tab displays;

- Status should indicate Streaming
- Line rate is the Ethernet line rate
- Total stream - packets associated with the video and audio content of the MPEG-2 Transport Stream (TS)
- Video stream - packets associated with the video content
- Audio stream - packets associated with the audio content

	<p>Note: IPTV Stream Analysis Up to three streams can be analyzed and the bandwidth associated with the whole TS is displayed. Video streams typically consume more bandwidth than audio streams, which in turn use more bandwidth than data streams. In this manual, MPEG-2 refers to the video transport stream defined in IEC13818 standard and not any compression technology used in the payload or transport packet. The MPEG-2 Transport stream contains seven packets of 188bytes each which transports either the MPEG-2, MPEG-4 or VC-1 encoded video.</p>
---	---

IPTV Result Video (Page #1) displays the following results;

- **Packet Rx** - is the (total number of packets received) - Packet loss (total number of packets lost)
- **Packet loss** - measured by analyzing video packet flows and determining the presence of a continuity error event. Because each video packet carries a sequence number, continuity errors can be determined easily. Missing, OOS and duplicate packets are counted as errors. Packet loss is typically seen on all channels arriving at the customer, because they are not source or content related problems. Analysis of the DSL or Ethernet physical layer normally determines the problem area. Packet loss impacts video quality and leads to highly visible errors. When lost packets contain I-frames, the impact will be more pronounced because the STB has to wait for the next I-frame to “reset” itself. H.264 encoding which uses a longer Group of Pictures (GOP) structure aggravates problems because higher compression contains more information. Consequently, the loss of a single H.264 frame will likely have a greater impact on picture quality.


	<p>Note: IPTV Network Performance</p> <p>Due to the real-time nature of IPTV, MPEG-2 is transported over UDP (IPv4/UDP), hence retransmission or re-ordering of packets is not intended. Video quality is largely determined by network performance parameters including Packet loss, Packet jitter and IGMP latency.</p>
---	--

IPTV Result Video (Page #2) - displays the **Stream Rate** results;

- Table provides individual bit rate statistics for each stream;
 - Total is the total number of bytes related to the Video, Audio and Data payloads
 - Video is the number of packets classified as video packets
 - Audio is the number of packets classified as audio packets
 - Data is the number of packets classified as data packets
 - Other is the number of packets classified as unknown packets


IPTV Result Video (Page #3) - displays the **Packet Jitter** results;

- Packet Jitter displayed in milliseconds.
- Current is the current jitter value
- Max is the maximum jitter value

	<p>Note: Packet Jitter</p> <p>This measurement is based on the data packet inter-arrival time which is a measure of packet arrival variance. Packet jitter affects packet arrival throughout the network. Variations lead to buffer under / overflows at the receiving equipment e.g. STB. Jitter impacts the way packets are handled at various network elements i.e. If the jitter is too high, packet loss will increase as queuing software tries to load balance traffic at network elements. Packet jitter should not be confused with PCR jitter (described below). When Packet jitter is present, the cause is normally related to the Ethernet physical layer. When PCR jitter is present, then the cause is most likely related to the program flow and could be related to an encoder not performing to specification.</p>
---	--

IPTV Result Video (Page #4) - displays the **Quality of Service (QOS)** results;

- **PCR Clock** - Presence of 27MHz Program Clock Reference
- **PCR Jitter** - PCR deviation in (ms)
- **MPEG Packet Loss** - continuity error (%)
- **Latency** - the time to complete a program change measured in milliseconds (ms)


	<p>Note: Program Clock Reference (PCR)</p> <p>MPEG TS normally contain a built-in timing packet known as the Program Clock Reference (PCR). Recovering the 27 MHz clock at the decoder end of the transmission system is necessary to re-create the video signal. The PCR values need to be correct at the signal origin and should not be distorted along the transmission path to a point where decoding the compressed signal becomes problematic. Measuring the interval between the arrival of PCR values, the accuracy of the expected values and also the jitter accumulated on those PCR values transmitted is necessary to assure that streams can be decoded. PCR jitter is a good indication of timing distortions due to poor encoding. Excessive PCR jitter results in visual impairments such as frame freezes, color loss and pixelization. The amount of PCR jitter that is considered excessive varies, and depends on various factors including STB buffer sizes and software architecture. However, in today's packetized video networks, PCR jitter should not exceed 10 ms. If PCR jitter is not constant, then a momentary problem from inserting local programming may be the cause.</p>
---	--

IPTV Result Video (Page #5) - displays the **Transport** results;

- MPEG Packet Loss
- Packets expected

IPTV Result Video (Page #6) - displays the **Media Delivery Index (MDI)** results;


- **MDI (Media Delivery Index)** - value in a ratio
- **DF (Delay Factor)** - Average, Minimum and Maximum values. Also defined as cumulative IP jitter, it represents the time it would take to drain an output buffer and ensure good video playback.
- **MLR (Media Loss Rate)** - Average, Minimum and Maximum values. Also defined as the packet loss rate due to dropped packets, bad/corrupted packets, or out-of-sequence packets.

	<p>Note: Media Delivery Index (MDI) Defined by RFC4445 is the only standardized video quality metric available today. MDI quantifies two IP transport impairments, namely Packet Jitter or Delay and Packet Loss. These test parameters are defined as Media Delay Factor (MDI-DF) and Media Loss Rate (MDI-MLR). The Delay Factor (DF) indicates how long a data stream must be buffered at its nominal bit rate to prevent packet loss. It gives a general idea of network jitter using the DF measurement. The MDI-DF can give a measure of congestion in a network, by showing utilization level, and detect if queuing is happening in network components, but it does not indicate how much of this is due to video packet bunching. The Media Loss Rate (MLR) is the number of packets lost during a 1 second period. MDI is expressed as a ratio namely; Delay Factor : Media Loss Rate, e.g. 70:15 The above ratio shows a delay factor of 70ms and 15 packets lost per second. MDI and MPEG packet loss together provides a good indication of IP transmission and non related IP issues.</p>
---	---

IPTV Result MAP:

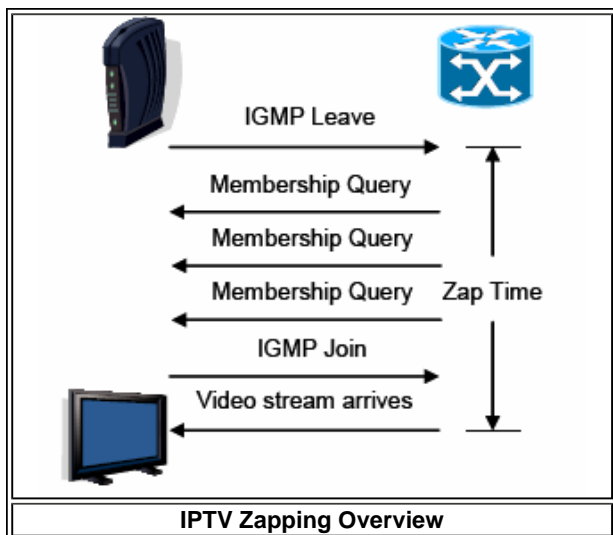
The MAP table provides a summary of the stream composition and the programming present.

- **Str** - Indicates stream number
- **PID** - Packet Identifier is a unique channel address identifier. PID enables identification and reconstruction of the programme and is used in conjunction with the Programme Service Identifier (PSI) packets. The decoder uses the PID and PSI to identify the Programme Association tables (PAT). PAT contain Program Map tables (PMT) that point the decoder to the packets associated with the channel or programme such as video, audio and data content in the transport stream.
- **Type:** Payload description
- **Description:** PID description on a per stream basis

	<p>Note: MPEG-2 Transport Stream (TS) A Packetized elementary stream (PES) is a continuous traffic stream of 188-byte packets carrying the digital signal. Since single/multiple programs can be carried per stream, a reference point from which the STB can synchronize and start the actual decoding from, must be provided. Each 188-byte packet consists of a 4-byte header containing this reference point which is a PAT table and a PID value equal to 0. The Packet Identifier (PID) contained within the 4-byte header, is a unique channel address identifier allowing identification and reconstruction of the program. The PID is used in conjunction with the Program Service Identifier (PSI) to identify Program Association Tables (PAT) which in turn hold Program Map Tables (PMT). The PAT table is also the table containing all program information ensuring the consumer receives updated program changes. The PAT table lists all the programs in the transport stream and associates each program with another PID, that holds a program map table (PMT) as its payload. PMT lists the Video, audio and eventual encryption information. The Payload Structure Identifier (PSI) table needs to be consistent with the PID table. PAT and PMT are inserted into the stream so that the decoder performs correctly. These two items should always be present.</p>
---	--

IPTV Scan - displays the **Scan** results;

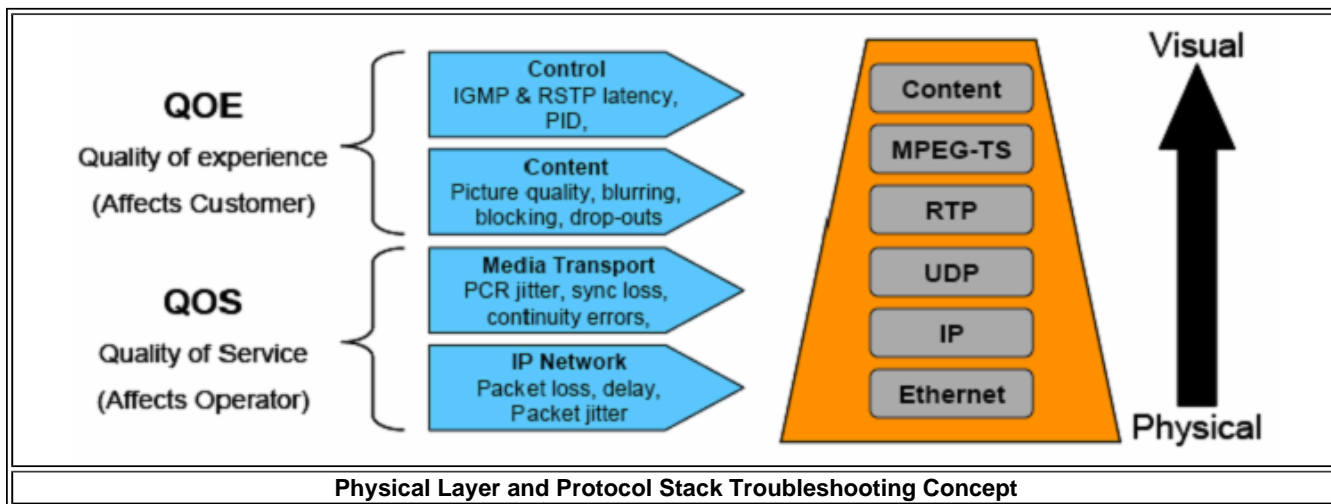
- **Channel** - Channel number (IP address:UDP port) being scanned
- **Zap time (ms)** - Also known as inter-channel change delay. Time between a channel leave request is sent and the receipt of the first byte of data from the new multicast channel. It is the IGMP Join Latency + Channel Switch Delay (STB dependent). Channel zapping should be < 700ms.
- **Status** - OK, no packet, Fail
- **Bandwidth** - bandwidth associated with the stream



Note: IGMP and Channel Zapping
 IGMP is a signaling protocol that enables each STB to obtain only the programming that the viewer is interested in watching, thus conserving bandwidth in the access network. STB's use the IGMP to change channels, by leaving and joining multicast groups representing channels.
 Key to IPTV QoE, is how fast and reliably end users can change TV channels, also known as "channel zapping". Essentially it is calculated as the time taken between sending a channel leave request and receiving the first video data of the new video stream.
Refer to DSL Forum TR-126 Triple Play Quality of Experience (QoE) requirements for more info.

IPTV Viewer - displays the Picture and is useful as a channel identifier.

- **Channel** - Unicast or Multicast including IP address and UDP port #
- **Status** – Decoding please wait. Please allow 20-30 seconds for buffering and decoding to occur.



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9.0 Utilities

Utility Settings - Home Menu



9.1 Help

Help provides a text based online help related to the operation of the test set and the measurements performed. The user can access the table of contents, hyperlinks or performing a search on keywords.

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9.2 Settings

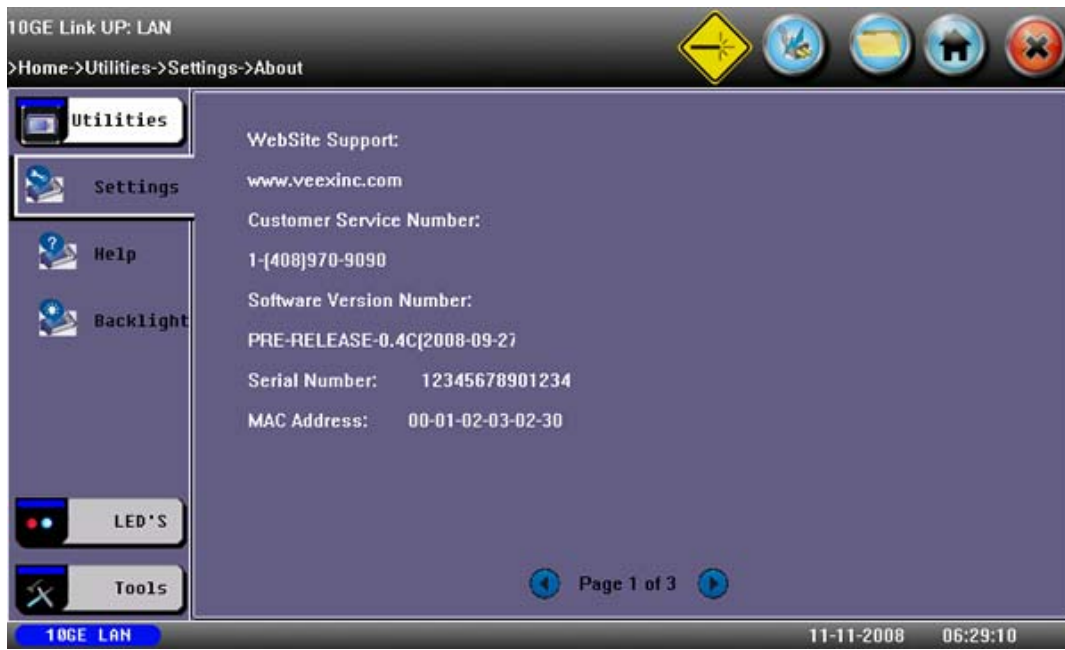
This section provides settings for the global parameters of the test set.

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9.2.1 About

Provides information about the software version, serial number and MAC address of the unit.

Utility Settings - About Menu (Page 1)



The **About** menu also allows the user to view installed options.

Utility Settings - About Menu (Page 2)



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9.2.2 Screen

Go to this section to change the screen theme. Also provides the utility to calibrate the touch screen when out of calibration.

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9.2.3 Selftest

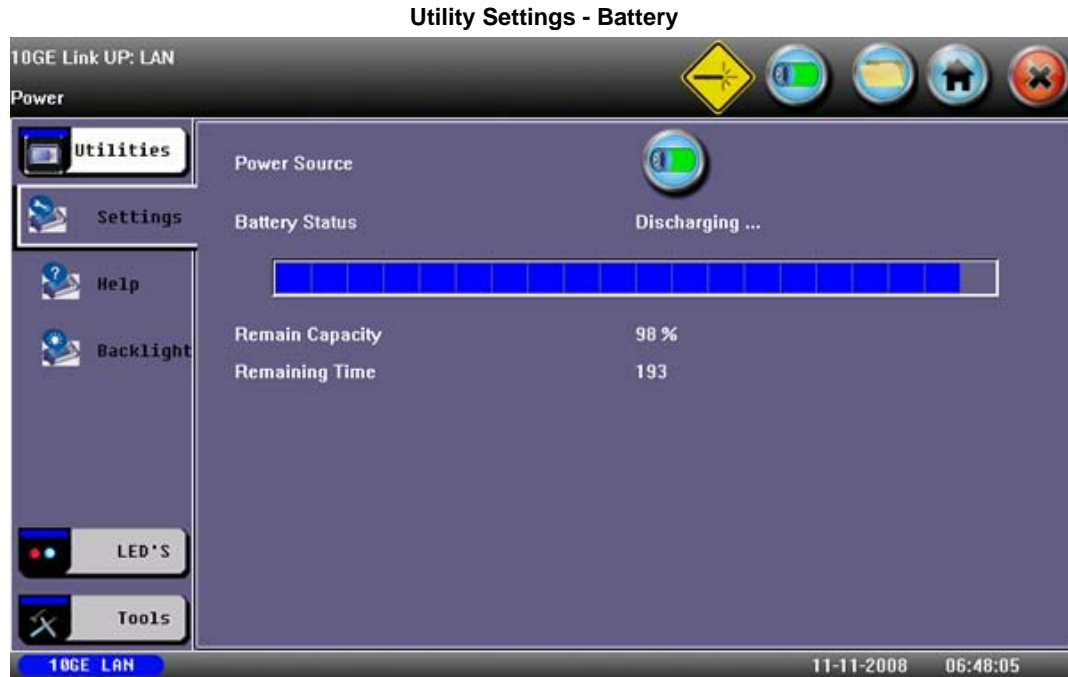
This utility provides a complete diagnostic of the test set. The report can be exported and provided to VeEX Inc Customer Care

Department.

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9.2.4 Power

Provides information about current power source, and information about the battery gauge.



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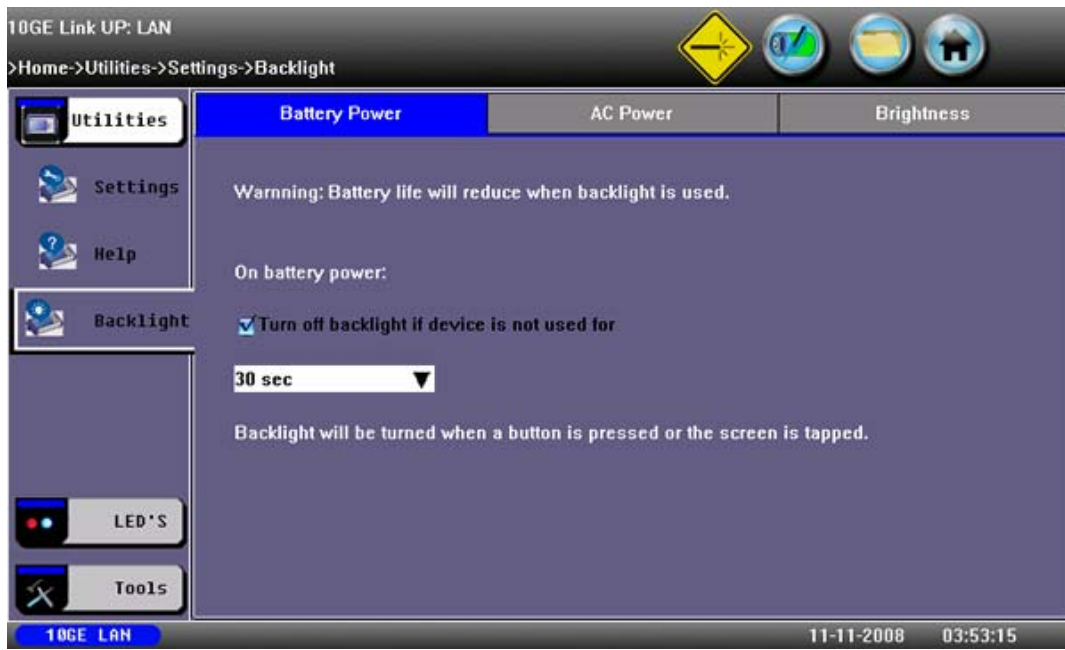
9.2.5 Backlight

Provides backlight control of the unit.

Power: There are two settings, one for Battery power and one for AC power.

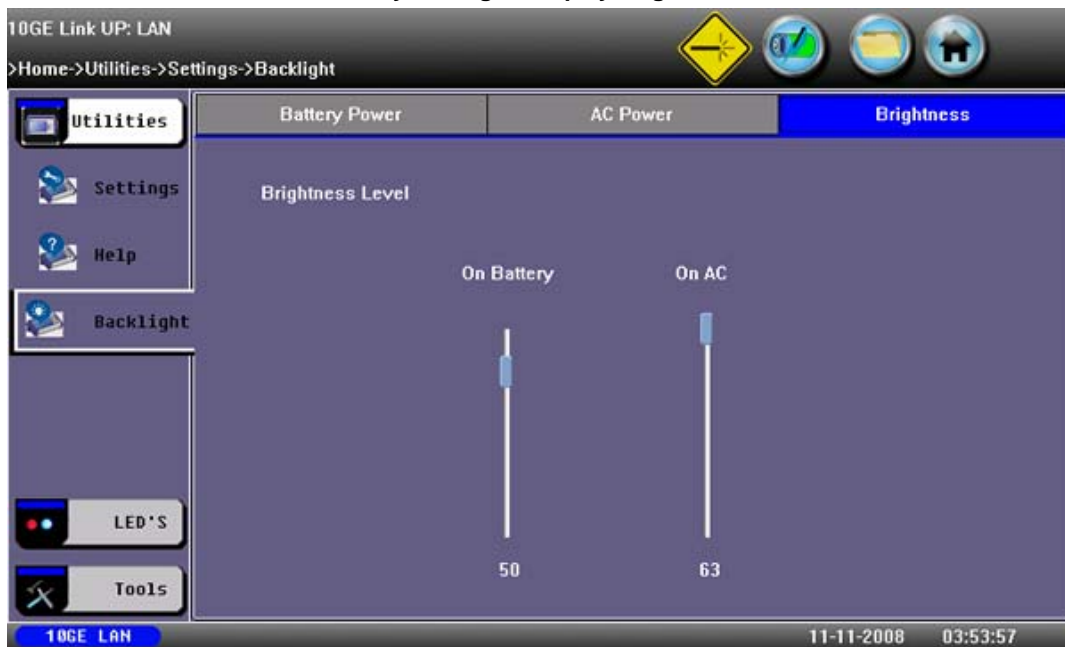
- The user has the option to select a timer to turn off the backlight if the unit is not used. This function helps improve the battery autonomy and preserve LCD life
- To enable the timer, check "Turn off backlight if device is not used for" and with the pull down menu adjust the duration of the idle time before the backlight is turned off.
- Once the timer is active, and the backlight turned off, any action on the test set (touch screen, keyboard) will turn on the backlight again.

Utility Settings - Backlight



Brightness: The user can select the brightness level for Battery and AC operation modes.

Utility Settings - Display Brightness



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9.2.6 Global Settings

This menu allows the user to select;

- **Language:** An alternative language for the user interface
- **Units:** Measurement system (English - feet or Metric - meter).
- **File Name Prefix:** Once entered the prefix will be added to any file exported from the test set.
- **Show Password:** Hides/unhides User Name and Password information associated with FTP and related IP functions
- **Management Port:** Sets LAN management port to Remote Control or IPTV mode
- **Lock/Save Screen:** Locks/unlocks touch screen to prevent accidental interruption during a long term test.

Utility Settings - Global Setup

Setting	Value
Language	English
Unit	Metric
Audible Alarm	Off
File Name Prefix	
Show Password	No
Management Port	Remote Control
Lock/Save Screen on lock key	Lock Screen

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9.2.7 Date and Time

Set the date and time accordingly to time zone or user requirement. Daylight savings are automatically enabled in the utility.

Utility Settings - Date and Time Setup

Setting	Value
Date:	
Month	November
Date	11
Year	2008
Time:	
Hour	06
Minute	30
Second	52

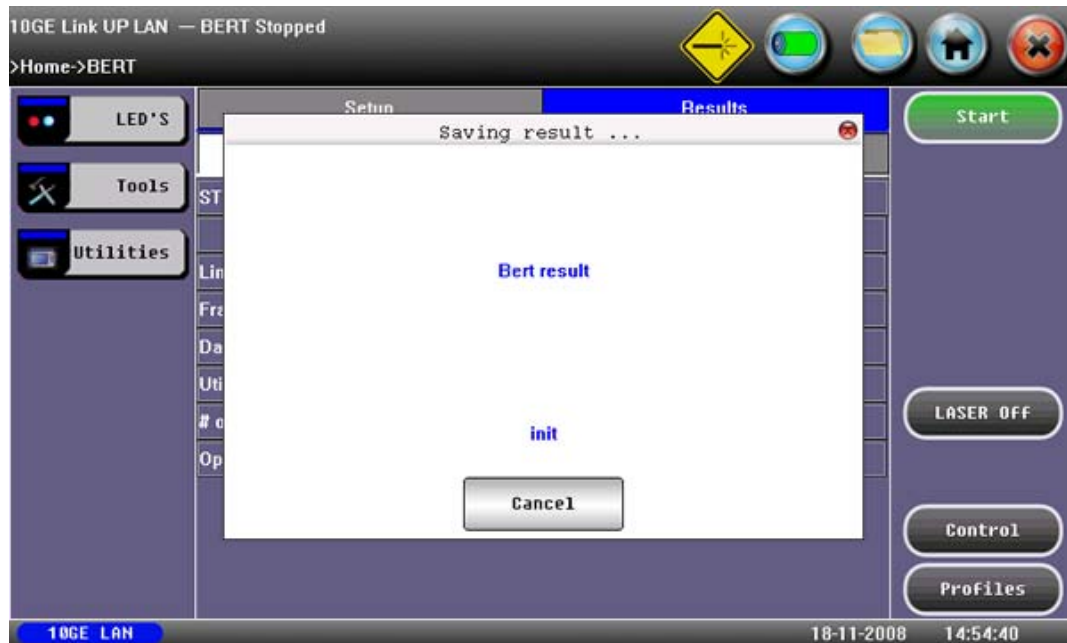
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9.3 Files

The MX300 saves the Files (Test results) in the unit's internal memory for recall and viewing.

9.3.1 Saving Files (Test Results):

- Press the File button on the rubber keypad. Refer to section 4.1 or click here
- The Test Result from the active Test Application is saved in non-volatile memory



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9.3.2 Recalling or Viewing Files or Test Results:

The Explorer screen allows you to View, Delete, or Rename files. File protection is provided using the Lock/Unlock button.

Memory Capacity: Tapping the File icon displays the Storage information screen which shows the current file capacity and current % memory utilization.



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9.3.3 File Transfer

The test result files are saved in a proprietary format. To archive, print or generate test reports, please export or transfer the files using one of the following methods.

- USB Memory Device via USB interface.
- FTP server Upload or Transfer via the unit's Ethernet interface.
- File transfer using Reveal software via the unit's Ethernet interface.

9.3.3.1 USB File Transfer

Setup:

- When the USB mode is selected, USB storage device (memory stick) detection starts. An information box appears providing information on the detection process.
- Input a File/Path once the USB storage device is detected. A "File/Path" is the name of the folder where the files will be stored on the USB device.
- Press 'Transfer' to start the file transfer - An information box appears indicating the transfer is in progress.
- Press 'OK' to exit or to abort the file transfer.
- During the transfer, a % progress message appears in the file transfer window.
- A "Transfer finished" message appears when the transfer is complete.

9.3.3.2 FTP File Transfer

Setup:

- Enter a valid FTP server address, File/Path, User name, and Password.
- Once the server parameters are entered, click 'Upload' to start uploading the files.
- During the transfer, a % progress message appears in the file transfer window.
- A "Transfer finished" message appears after the FTP file transfer is complete.

After the results are exported, please use ReVeal software to manage and process the files.

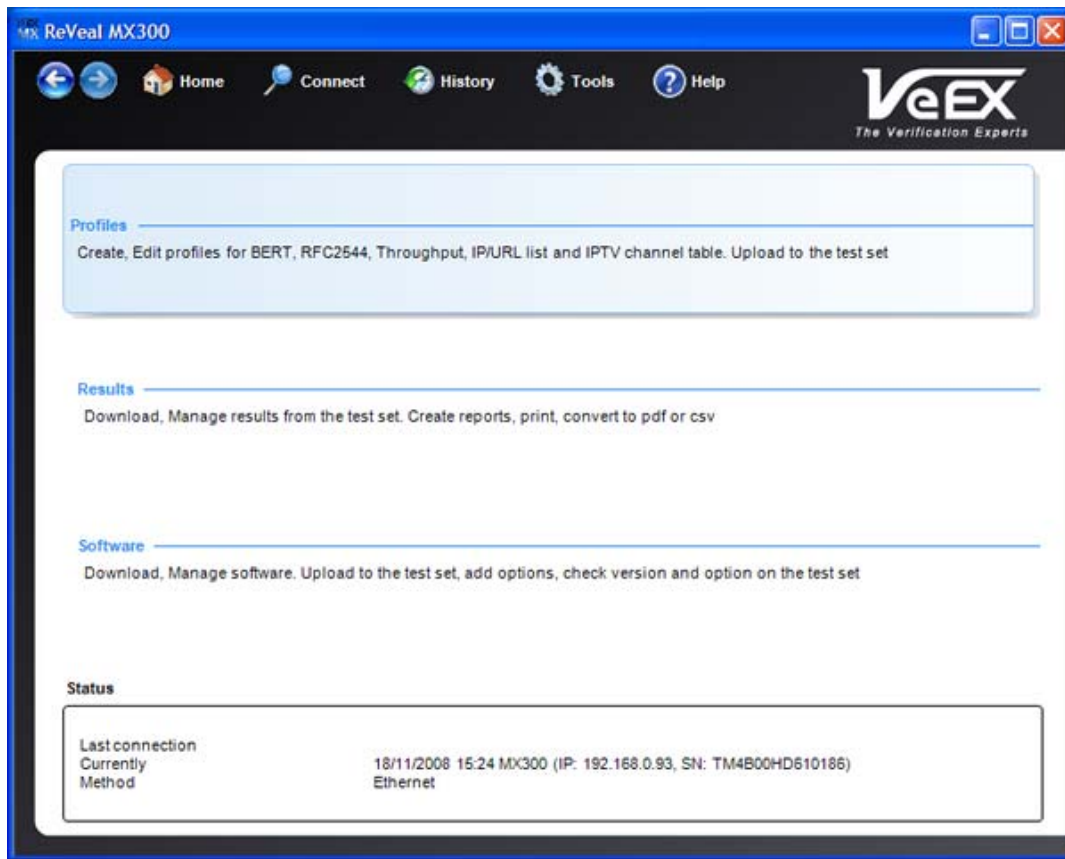
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9.4 ReVeal software

Please install the ReVeal MX300 software (supplied with the instrument) onto your PC. The ReVeal software offers the following functionality;

- **Profiles:** Create, Edit and Manage Test Profiles
- **Results:** Download and Manage test results, generate Test Reports
- **Software:** Download software, upgrade test set, add options and check instrument configuration
- **Tools:** Remote Control the instrument (optional)

ReVeal MX300 - Home Menu



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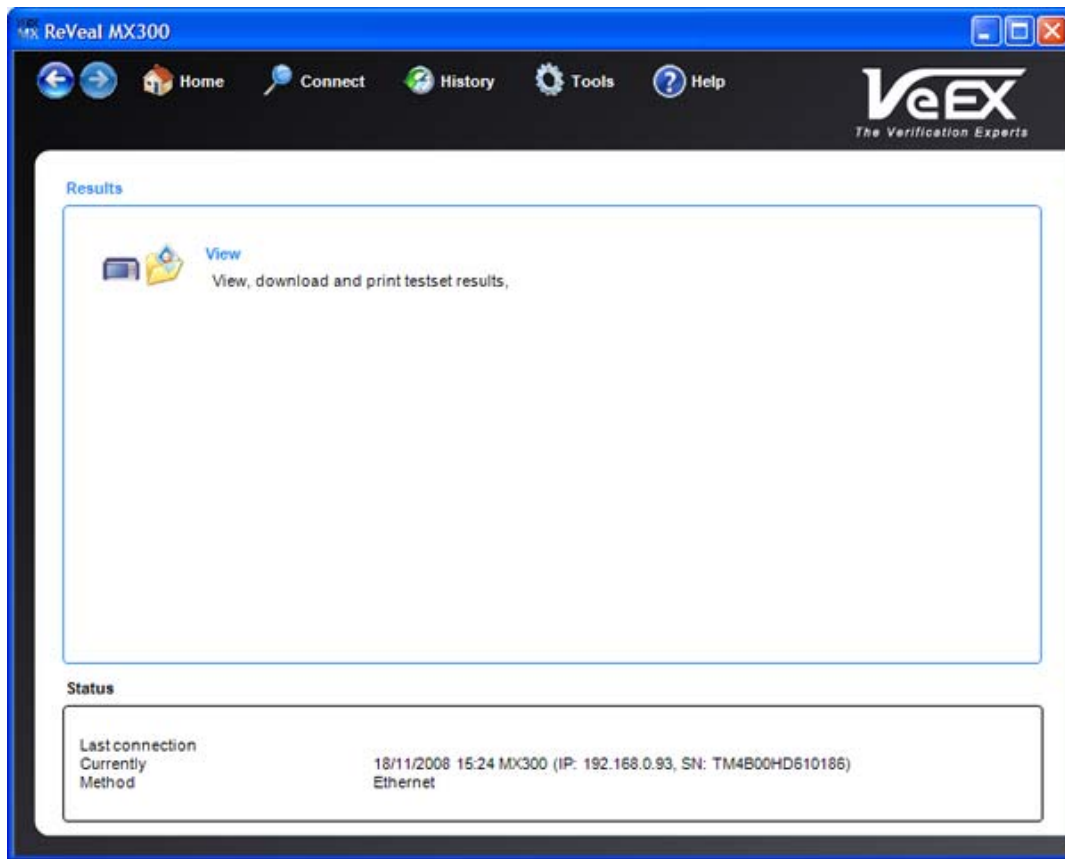
9.4.1 Profiles

9.4.2 Results

Results menu allows you to;

- Download Results
- Manage Results
- Create Reports
- Convert Results to PDF format
- Convert Results to CSV format
- Print Results

ReVeal MX300 - Results Menu



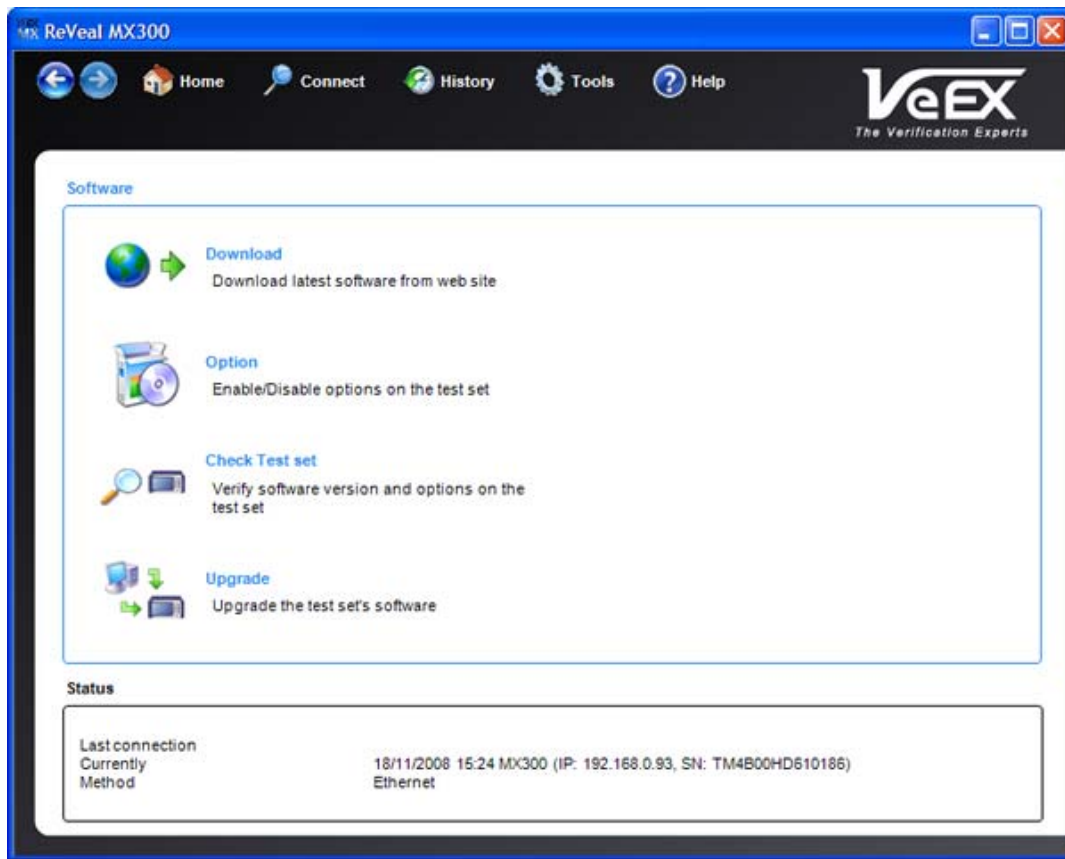
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9.4.3 Software

The **Software** menu allows you to;

- Download software from the VeEX website to upgrade the Testset
- Enable or Disable software options
- Check Testset configuration
- Upgrade Testset software

ReVeal MX300 - Software Menu



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9.4.4 Remote Control

- Launch ReVeal LX software on your PC to remote control the instrument.
- The test instrument must be connected to the PC via an IP connection.
- Select the remote control application located in the Tools menu.
- Start the remote control application

For detailed information, refer to the ReVeal MX300 user manual.

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10.0 Warranty and Software

Warranty Period: The warranty period for hardware, software and firmware are 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 the hardware 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.

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 guaranty 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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11.0 Product Specifications

MX300 Specification - [Click here](#)



VeEX

2008 Global Test & Measurement
Emerging Company of the Year Award

VePAL MX300
10GbE LAN/WAN and Gigabit Ethernet and Fast Ethernet Test Set

Next Generation of Metro and Carrier Ethernet Testing
VeEX™ MX300 Ethernet Transport Expert is the next generation of Core Transport and Carrier Ethernet field test equipment for Ethernet Networks carrying Voice, Data and Video.

Platform Highlights

- Intuitive presentation of measurements with test graphics
- High resolution color touch-screen viewable in any lighting conditions fitted with protective cover
- Robust, handheld chassis packed with powerful and flexible features for demanding environments and test conditions
- Optimized for field engineers or technicians installing and maintaining Ethernet networks enabling triple play services
- Ethernet connection for back office applications, workforce management and triple play service verification
- User defined test profiles and thresholds enable fast, efficient and consistent turn-up of services
- USB memory stick and FTP upload support for test result storage/file transfer
- Maintain instrument software, manage test configurations, process measurement results and generate customer test reports using the included ReVeal™ PC software
- Extend field testing time using interchangeable LiIon battery pack/s. Greater battery autonomy provided in standby mode

Key Features

- 10GbE LAN and WAN
- One 10GbE LAN/WAN XFP port, two 1000Base-X SFP ports, and two 10/100/1000T RJ45 ports
- All-in-one 10 Gigabit Ethernet LAN/WAN, Gigabit Ethernet, and Fast Ethernet testing
- Ideal for the lab testing and field testing environments
- Throughput, latency, frame loss, and back-to-back measurements per the industry-standard RFC 2544 tests
- Unframed BER testing to validate error free fiber connections
- BER testing at layer 1, layer 2, and layer 3, with or without VLAN and MPLS tags
- Q-in-Q (VLAN stacking) capability, with up to three VLAN tags
- Multiple stream traffic generation and analysis for end-to-end QoS verification of multiple services
- MPLS stacking capability, with up to three MPLS labels
- Intelligent device discovery mode; discover other MX300s on the network for quick and easy loopback control configuration
- Smart Loop mode for layer 1, layer 2, and layer 3
- Remote control capability through the ReVeal PC software

Metro Expert



Note: Product Specifications

The most recent product specifications can be downloaded from the VeEX website. For the most recent version, [click here](#)

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12.0 Certifications and Declarations

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 the unit conforms to requirements of European Union and European Free Trade Association (EFTA). EN61010-1

[Click here for CE Declaration of Conformity relating to VeEX products](#)

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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13.0 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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