VePAL UX400

Universal Test Platform

Next Generation Modular Platform for Transport, Carrier Ethernet, Mobile Backhaul, and Legacy Testing

VeEX® UX400 is the industry's most flexible, compact, and future-proof test solution for OTN, SDH, SONET, PDH, T-Carrier, Carrier Ethernet, Mobile Backhaul, Core, and Storage Area Networks[1].

VeEX UX400 is the first truly robust portable chassis to offer test capabilities ranging from DS1/E1 to 100GE and beyond, allowing any combination of test modules tailored for each particular application or set of requirements.

Its versatile and flexible hardware and software architecture optimize configurations to meet users' specific needs; from transport applications at rates ranging from DS1/E1 to OC-768/STM-256/OTU3 to Carrier and Ethernet Transport applications from 10M to 40GE/100GE and beyond[1].

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

A large bright 10.4" TFT color LCD with touch panel offers enhanced viewing and operation, while an intuitive graphical user interface simplifies menu navigation, accelerates test setup, and enhances presentation of results.

[1] *Test interfaces, data rates, mappings, transmission protocols, and features depend on the availability of individual test modules*

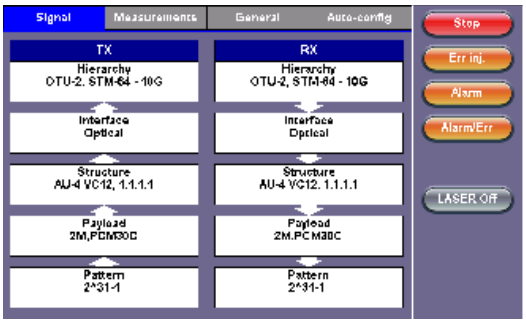
Platform Highlights

- Intuitive Multi-user graphical user interface (GUI) with touch screen control
- Field exchangeable test modules
- Robust, portable chassis packed with powerful and flexible features for demanding environments and test conditions
- CLI/SCPI remote control
- Fast and efficient test result transfer to USB memory stick or FTP upload
- Built-in optical power meter and visual fault locator
- Built-in GPS receiver for system clock synchronization
- Built-in Atomic clock which can be disciplined and calibrated by the GPS signal
- Industrial grade SSD (Solid State Disk) with up to 32GB of storage space
- High-capacity Li-ion battery pack for uninterrupted testing and added portability
- Portable with weight less than 10 kg including battery pack
- Rack mount version available
- Built-in VGA monitor port for external monitor or projector connection
- Operate with USB mouse and keyboard
- Maintain instrument software, manage test configurations, process measurement results and generate customized test reports using included ReVeal™ software

OTN Features

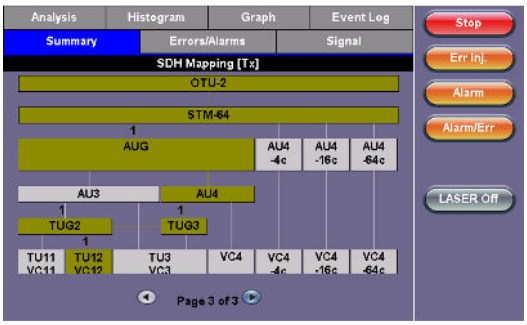
Intuitive Test Signal Setup

Transmitting and receiving ITU-T G.709 compliant OTN signals is quick and simple. The transmitter and receiver can operate independently, or they can be coupled depending on test scenario. Framed signals can be equipped with unstructured or structured payloads – a user-selected test pattern fills the entire payload (Bulk) or a structured payload (SDH/SONET framed client signal) is used. Scrambling and Forward Error Correction (FEC) can be enabled or disabled to verify applicable circuitry. Depending on test modules and options, the UX400 supports OTN rates from OTU1 to OTU4, including Ethernet payload verification such as DU0 and ODU flex mapped to higher OTU rates.



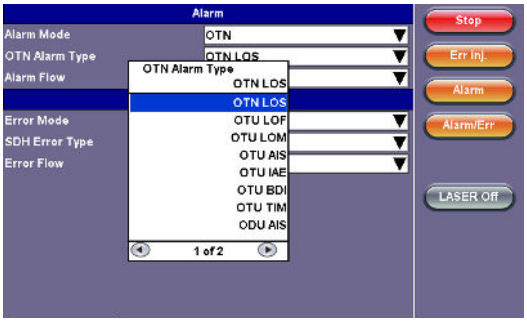
Advanced Mapping Capability

SDH/SONET client signals can be mapped using bit-synchronous or asynchronous modes. In synchronous mode, the Optical Payload Unit (OPU) clock is derived from the mapped client signal while in Asynchronous mode, the OPU clock is independent. The mapping structure can be easily viewed and verified in the Signal summary tab.



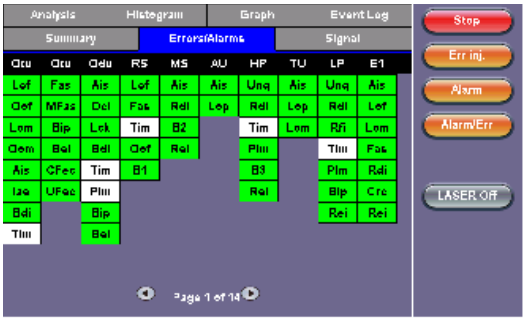
Error Insertion and Alarm Generation

Alarms and Errors can be applied to the OTN signal or to the payload itself. A full range of PDH/DSn and SDH/SONET anomalies and alarms are supported depending on payload setup. Single errors, preset rates or user-defined error rates are supported. The selected error and alarm insertion type are shown to the right of the user interface, which can be accessed at any time in the same test session.



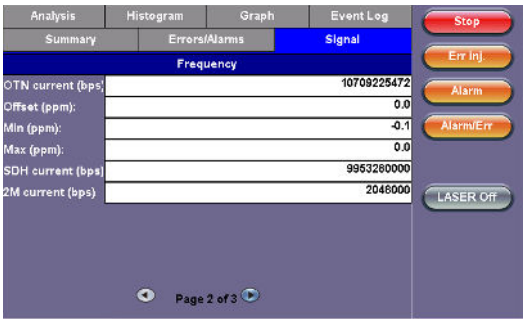
Monitoring Errors and Alarms

It is possible to monitor OTN anomalies and the errors in the SDH/SONET payload signals. Similarly, bit errors are monitored when the OTN signal payload is a test signal. Soft LEDs display event status continuously while a test is running – errors and alarms are color coded to show present and historical conditions.



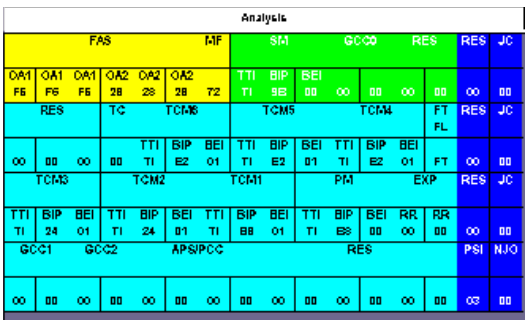
Line and Payload Frequency Analysis

Frequency offset present in the Optical Transport Unit (OTU) line frequency or Optical Payload Unit (OPU) are measured accurately. Furthermore, frequency offset applied to the signal by the user regardless of the clock source can also be analyzed.



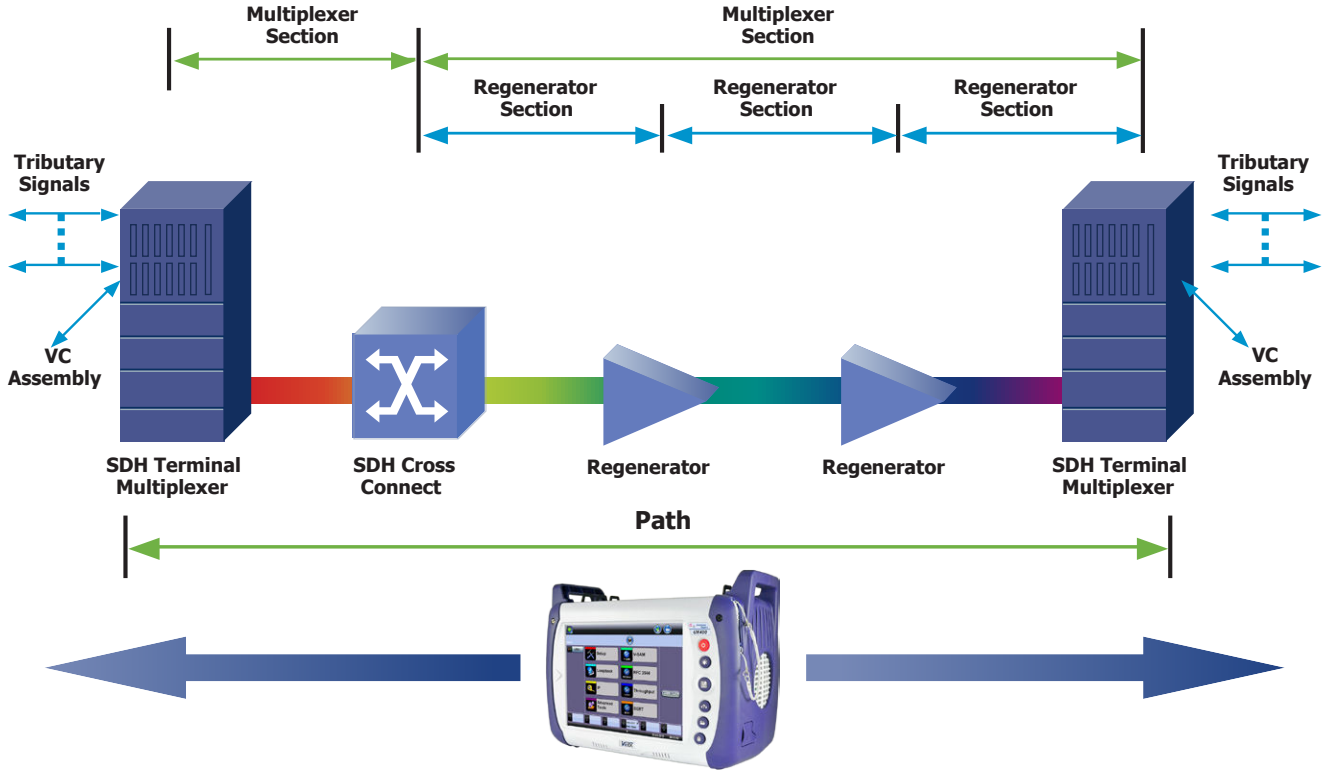
Overhead Byte Analysis

All overhead bytes in the OTU are captured and displayed in hexadecimal format. Direct access to overhead bytes ensures that the DUT performs termination and pass-through operations accurately, giving you confidence in your network design. On-screen decodes can easily be done by tapping the desired byte location where detailed information will then be shown in a pop-up box.



SDH/SONET Applications

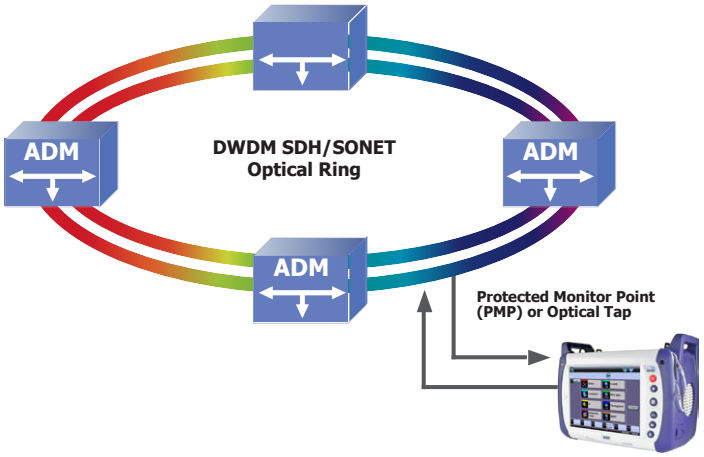
Installation, commissioning, monitoring and maintenance of SDH/SONET networks is simplified thanks to a combination of intuitive features and powerful test functions. SDH/SONET signals are often compromised by various impairments in the multiplexing process therefore defining the type of anomaly or defect to isolate the network element or signal path causing the problem is crucial. Fast troubleshooting and comprehensive analysis of transmission problems can be performed using intrusive, non-intrusive and monitoring test modes. Novice users will benefit from the easy-to-use Auto-configuration and Tributary Scan test modes, while experienced users will appreciate the array of advanced features such as Overhead Monitoring and Byte Control, Pointer Test Sequences, Path Trace Generation, Tandem Connection Monitoring and lots more.



In-Service Monitoring

Applications include:

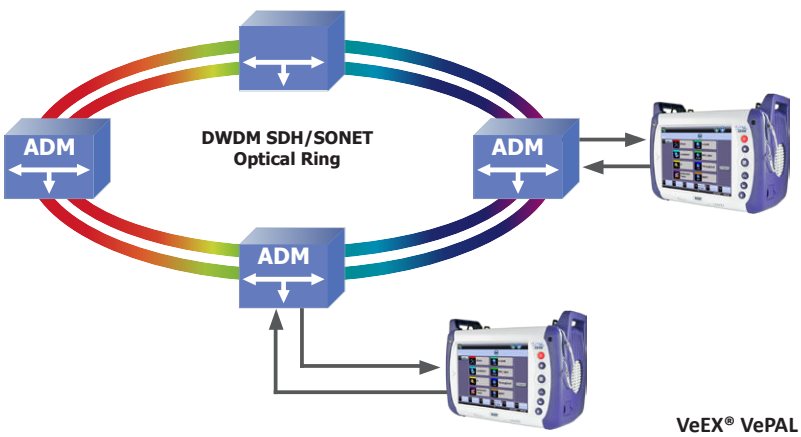
- Optical Power and Frequency
- Tributary Scanning
- Performance Analysis per G.826, G.828, G.829, M.2101, GR-253
- Pointer Analysis and Generation
- APS Measurement
- Tandem Connection Monitoring
- Overhead Byte Control and Decode



Out-of-Service Testing

Applications include:

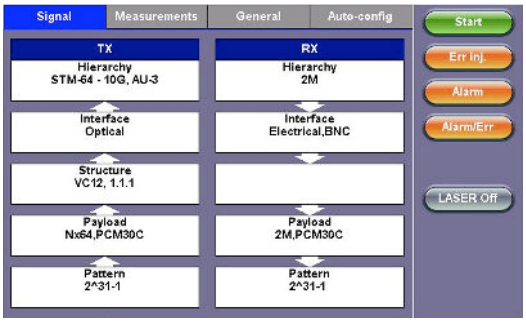
- BERT
- Tributary Mapping/de-Mapping
- Path/Section Trace Generation
- Bringing Into Service (M.2100)
- Mux Testing
- Round Trip Delay
- Pointer Test Sequences



SDH/SONET Features

Quick and Easy Graphical Setup

Complex daily tasks are common in today's network environment, therefore technicians and network engineers need a test set that is quick and easy to configure. Intuitive graphics, drop down menus and touch-screen operation greatly simplify test interface, signal structure, payload mapping and test pattern setup.

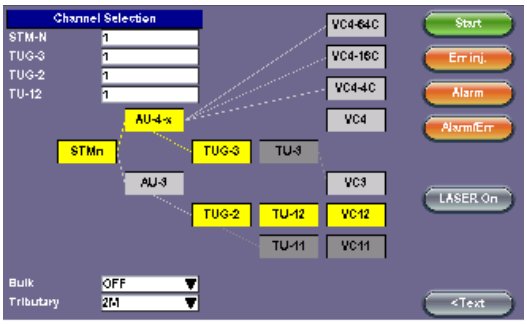


Physical Layer Testing

Verifying analog parameters are within prescribed specifications and limits is recommended prior to performing framing and payload analysis. High optical power levels can saturate receiver equipment, while low power levels are susceptible to noise which result in false defects or anomalies. Clock tolerances for each individual signal hierarchy is clearly defined by ITU-T/ Telcordia recommendations and should be verified as part of any acceptance/conformance test.

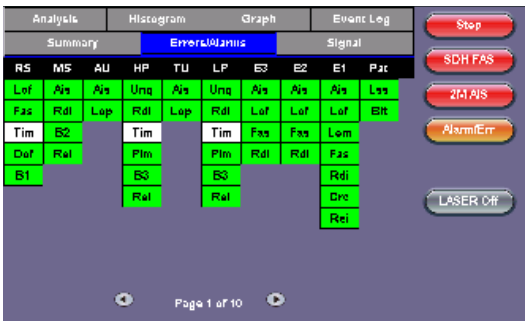
Payload Mappings

Test the operation of Add/Drop Multiplexers, Digital Cross Connects and other Network Elements (NE) by verifying the mapping and de-mapping of different tributaries and payloads into SDH/SONET containers and monitor anomalies and defects according to ITU-T G.707 and GR-253 recommendations.



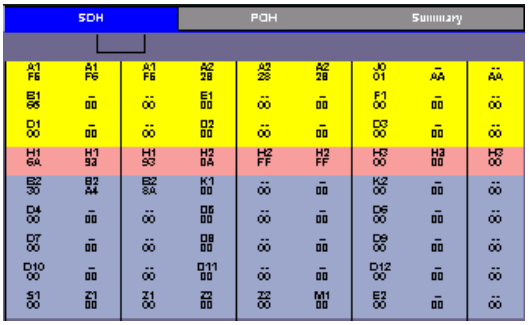
Performance Analysis Summary

Performance of each hierarchy is based on Byte Interleaved Parity (BIP) checksums which are calculated on a frame by frame basis. These BIP checks are inserted into the Regenerator, Multiplexer and Path Overhead, all of which form an integral part of the performance monitoring capabilities of an SDH/SONET network. The UX400 analysis screens present Pass/Fail criteria for each performance parameter according to ITU-T/Telcordia recommendations.



Overhead Analysis

Binary and hexadecimal decode of all Section and Path overhead bytes are performed and a summary of the most important bytes is displayed.



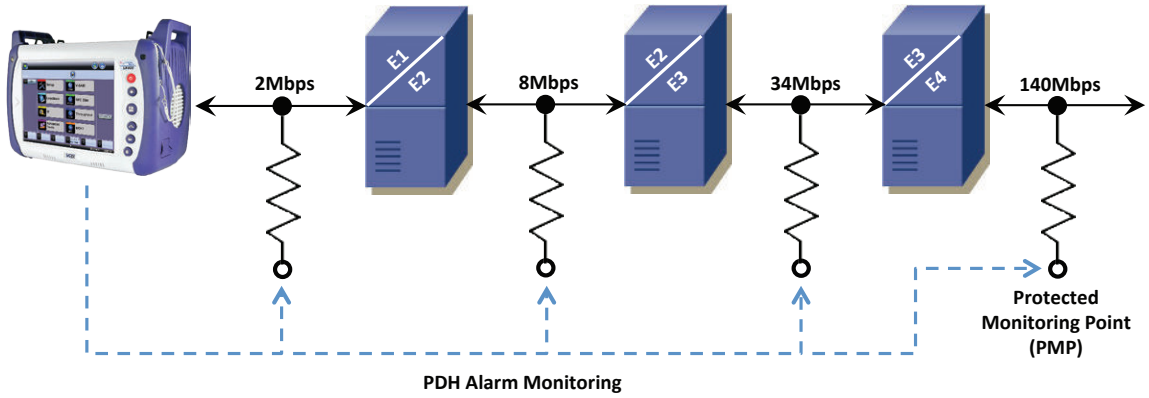
Overhead Byte Control

Manipulation of transmitted overhead bytes in both signal and payload through modes enables the user to stress the network's response to various conditions.

PDH Applications

PDH multiplexing and transmission systems developed in the 1960s and 1970s comprise the first generation of digital telecommunications network technology. While these networks have subsequently evolved to include long-distance, high-capacity trunks and OTN/SDH/SONET rings, PDH network segments are frequently retained for access, service delivery, and economic reasons. As such, testing PDH networks will continue for several years to come.

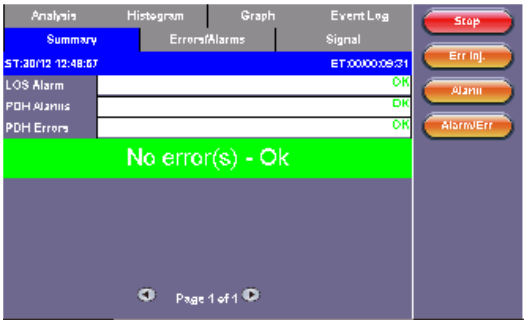
The UX400 provides PDH test capabilities and sub-rates from 140 Mbps (E4), 34 Mbps (E3), 8 Mbps (E2), 2 Mbps, down to N/M × 64 kbps. Additional PDH test features include simultaneous multilayer G.821, G.826, M.2100 results, Pulse Mask analysis and Round Trip Delay. The test rates also empower the mapping and de-mapping of E1, E3, and E4 payloads in virtual containers and testing of TU-12, TU-3 and AU-4 overheads, making it ideal for testing hybrid PDH/SDH/SONET networks.



PDH Features

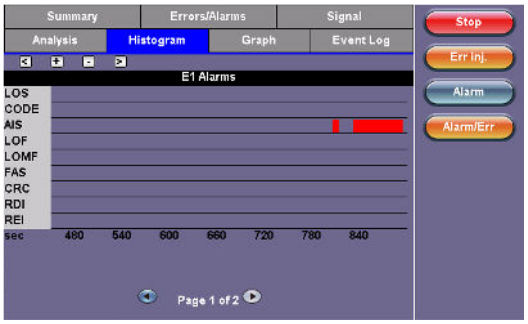
Intuitive Test Results

A summary screen quickly reports signal status and critical Error and Alarm parameters with easy-to-read Pass/Fail indicators. Additional screens accessed via a simple tab system display signal levels, anomalies and events.



Powerful Measurement Histograms

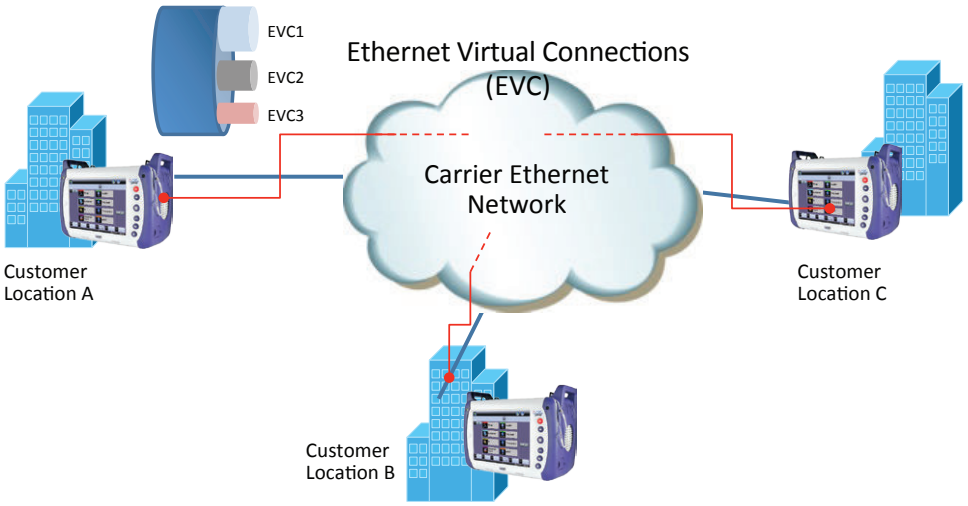
Visual presentation of simultaneous measurement results with 1-second resolution simplifies correlation of alarms and errors.



Ethernet Applications

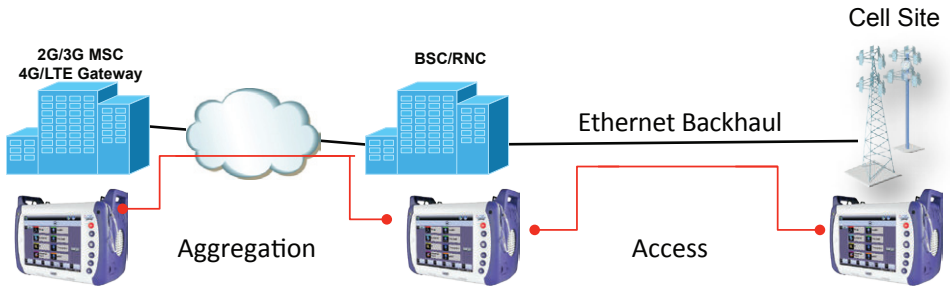
Carrier Ethernet Testing

Reliability, Scalability and Quality of Service are the attributes needed for Ethernet to turn into Carrier-grade Ethernet. With standard features including RFC2544, Y.1564 Service Activation Methodology and Ethernet OAM, MPLS and VLAN support, the UX400 has all the tools necessary to truly ensure end-to-end carrier-grade Ethernet services.



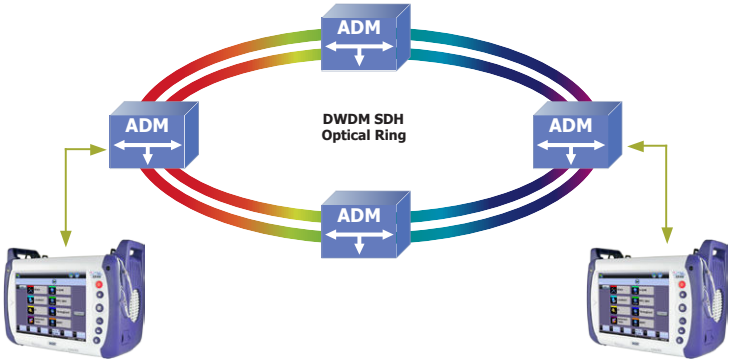
Mobile Backhaul Testing

With the rapid roll out of 3G and 4G/LTE networks and the growing demand for high bandwidth services, Mobile Ethernet Backhaul deployments are accelerating. Network performance evaluation is a critical step for carriers who must transition from highly reliable legacy TDM networks to packet based services. With the UX400 all services Key Performance Indicators like bandwidth, delay, and jitter can be measured and quickly evaluated for suitable service deployment.



10/40/100GE DWDM-based Service Testing

- Perform Layer 1 Unframed BERT to verify the physical layer
- Perform Layer 2 BERT/Throughput test with valid Ethernet frames to verify end-to-end transport
- Verify end-to-end QoS parameters: throughput, frame loss, round trip delay, frame arrival delay, frame delay variation (jitter), out-of-sequence frames

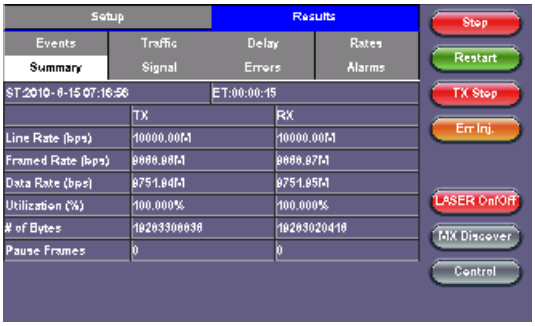


Ethernet Features

BERT

Layer 1 unframed (optical ports only), Layer 1, 2, 3, and Layer 4 BER testing are supported. The BER test can be configured to use regular PRBS test patterns, IEEE stress patterns for 1GE and 10GE LAN unframed modes, or user defined test patterns to simulate various conditions.

One traffic stream is transmitted across the network under test and bit-per-bit error checking is then performed on the received traffic. Service disruption measurements as well as CRC error checking are also performed. The BER test can be performed with a physical loop (or plug) at the far end (for a layer 1 circuit), or a second test unit or intelligent loopback device in Smart Loop or in Peer-to-Peer mode.

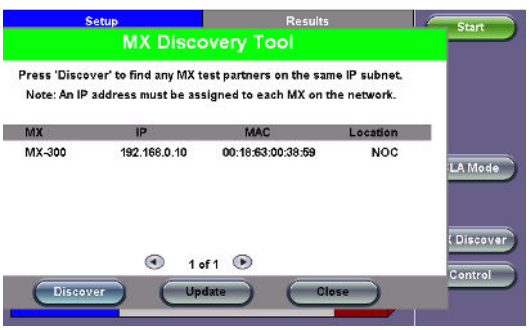


Q-in-Q (VLAN stacking)

VLAN stacking, also known as Q-in-Q, makes a provision for carrier/service provider assigned VLANs (SP-VLAN), but also retains the VLAN of customer traffic (CE-VLAN). Up to three layers of VLAN tagging are supported on RFC2544, V-SAM, BERT, and Multi-streams throughput test, with configurable VLAN ID, Priority, and VLAN type.

Intelligent Network/Device Discovery

Easily discover and select another VeEX Ethernet tester or loopback device on the network under test for loopback testing applications. The local device will control the operation of the far end device, in either loopback or peer-to-peer mode (or symmetrical or asymmetrical traffic generation mode). This feature greatly simplifies field testing since there is no need for a second technician to be at the far end configuring the test partner device.

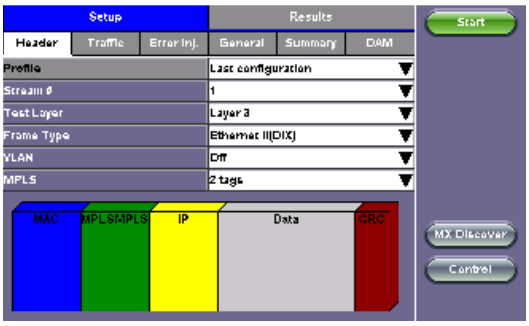


Delay and Jitter Measurements

Frame delay and frame delay variation - Jitter measurements are performed on the test traffic during BER tests, V-SAM, RFC 2544 multi-streams, or throughput tests.

MPLS Measurements

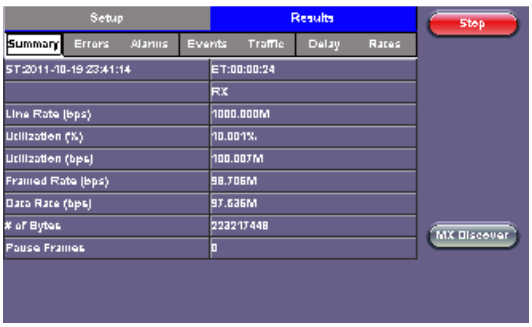
Multiple Protocol Label Switching is a technology that allows for a more efficient routing of Ethernet/IP packets via the use of MPLS routers in the network. MPLS labels reside between the MAC (Layer 2) and IP layers (Layer 3). Up to three MPLS tags can be configured in the traffic stream with user configurable Label, CoS, and TTL fields.



Smart Loopbacks

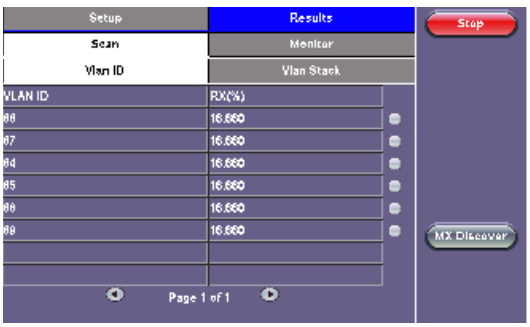
Four modes are available for looping back test traffic. At Layer 1, all incoming traffic is looped back unaltered. At Layer 2, all incoming unicast traffic is looped back with the MAC source and destination addresses swapped. At Layer 3, all incoming unicast traffic is looped back with the MAC and IP source and destination addresses swapped, and at Layer 4, all incoming unicast traffic is looped back with the MAC, IP, and UDP/TCP ports swapped.

Configurable traffic filters are supported on all MAC, IP, and VLAN fields to allow full control over looped traffic. Traffic is monitored while being looped and key traffic metrics such as frame type, rate, and error/alarms are displayed on screen. These can be compared to results at the far end to pinpoint issues more easily.



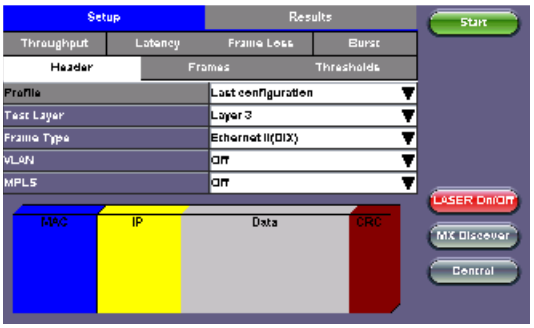
VLAN Scan and Traffic Monitor

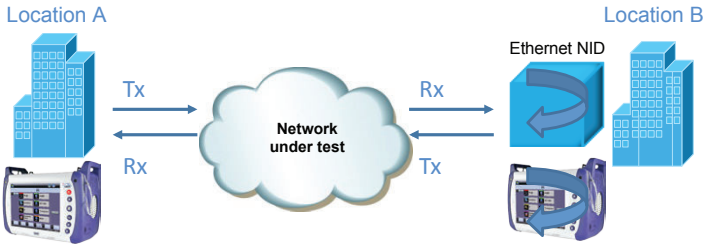
Scan up to 4096 VLAN IDs for switch configuration verification. Verify which VLAN IDs are the top bandwidth users and monitor up to eight live traffic streams (in terminate mode).



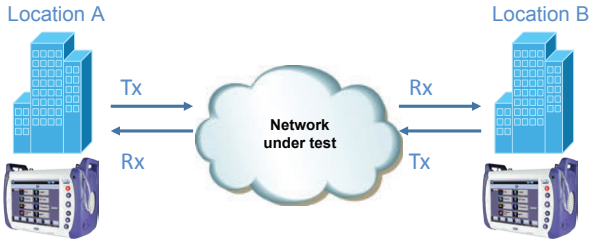
RFC2544 Compliance Testing

Performs the RFC2544 automated test suite at all recommended frame sizes as well as user configurable frame sizes and up to full line rate. The test suite can be performed with the far end test partner in loopback mode or peer-to-peer mode - the latter allowing for symmetrical/asymmetrical testing. Thresholds may be configured for accurate SLA assurance and verification. The automated tests supported are throughput, latency, frame loss, and back-to-back frames.





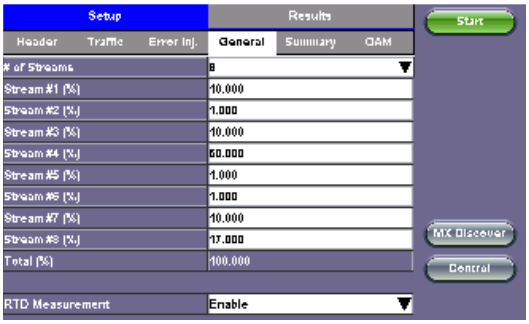
Remote Loopback to VeEX Ethernet tester or Ethernet Network Interface Device



Peer to peer test: Symmetrical or Asymmetrical traffic generation
Remote control from a single unit; Test results available for each direction

Multiple Streams Generation - Throughput

Up to ten traffic streams can be independently configured with CoS (VLAN priority) and QoS (TOS/DSCP) prioritization. This traffic feature simulates multiple service conditions (e.g. Triple Play), and facilitates end-to-end QoS performance verification. The multiple stream throughput test may be performed with a second test unit at the far end in Smart Loop mode or Peer-to-Peer mode.

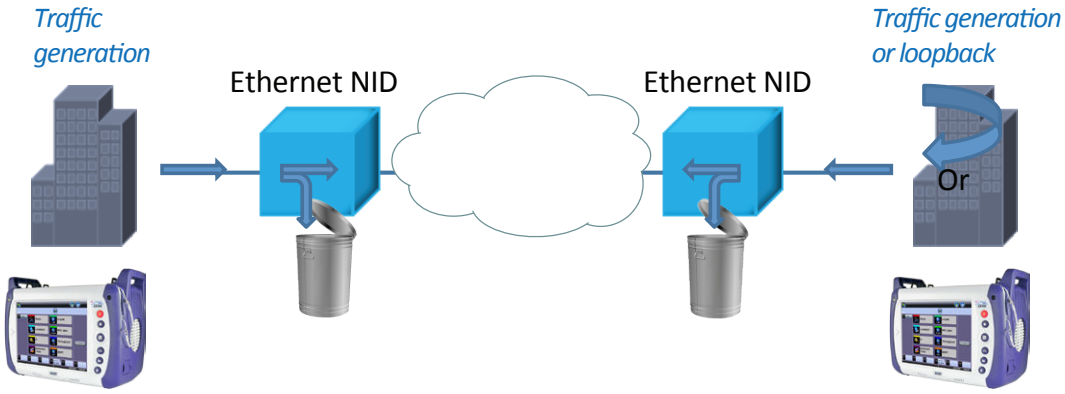


Y.1564 V-SAM Test

VeEX's V-SAM test suite is fully compliant with ITU-T Y.1564 and offers an efficient method to qualify and troubleshoot Ethernet Services. V-SAM addresses some of RFC2544 limitations by testing multiple services at once and providing simultaneous measurements of key SLA parameters.

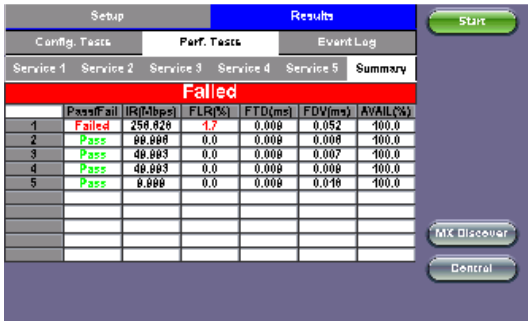
The purpose of the SAM test suite is to verify that the service is compliant to its Bandwidth Profile and Service Acceptance Criteria. The test is broken down into two phases:

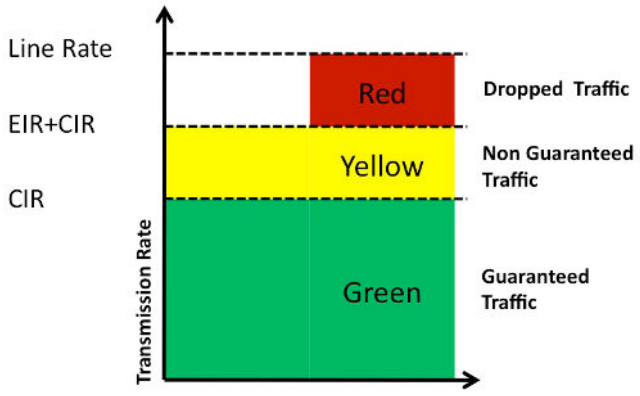
- Phase 1: Service Configuration test. The services running on the same line are tested one by one to verify the correct service profile provisioning.
- Phase 2: Service Performance test. The services running on the same line are tested simultaneously over an extended period of time, to verify network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



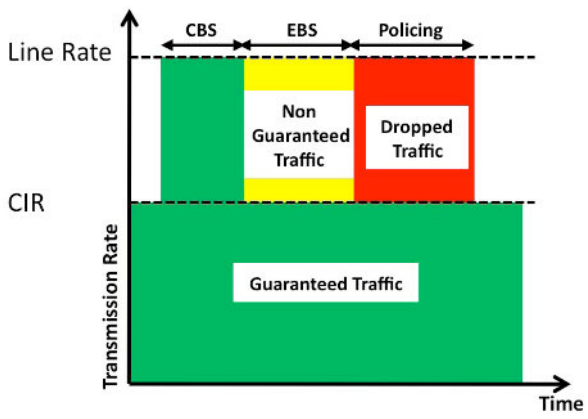
This test suite was designed with the end user in mind and allows for quick provisioning, execution and analysis of the test results, even without prior detailed knowledge of the standard:

- Test profiles can be stored and recalled, and even created offline on a PC and loaded on the test set, to facilitate quick setup.
- A visual Pass/Fail banner and summary tables provides a quick overview of the status of all services.
- Color highlighting the failing parameters facilitates a quick understanding of the problem if troubleshooting is required.





Service Information Rate



Service Burst Rate

Dual 1GE Module Key Features

- Single Slot test module
- Dual 10/100/1000Base-T RJ45 ports, Dual 100Base-FX/1000Base-X SFP ports
- Each port can be independently operated
- Dual Traffic generation or Loop thru monitoring
- Q-in-Q (VLAN stacking) and multiple MPLS tag support
- Throughput, latency, frame loss, and back to back measurement per RFC2544 and V-SAM (per ITU-T Y.1564)
- BERT testing at Layer 1, 2, 3 and 4
- Multiple stream traffic generation and analysis for end-to-end QoS verification of multiple services
- Port 1 to Port 2 one-way latency measurement
- Service disruption measurement
- Transmit frequency offset to stress the network up to ± 150 ppm

Specifications

Ethernet

Electrical Interfaces

Dual 10/100/1000Base-T Port: RJ45 connector
Ethernet Classification: Per IEEE 802.3

Optical Interfaces*

Dual 1000Base-X/100Base-FX SFP Port: LC connector
ROHS compliant and Lead Free per Directive 2002/95/EC
Eye Safety: Class 1, per FDA/CDRH, EN (IEC) 60825

Ethernet Features

Auto Negotiation, Full and Half Duplex, Flow Control

Modes of Operation

Terminate, Pass Through Monitor, Loopback

Traffic Generation

Layer 1 Unframed (optical ports only)/Framed (BERT only), Layer 2, Layer 3, Layer 4
Test Frame Header:

- IEEE 802.3 and Ethernet II (DIX) frames
- Configurable Source and Destination MAC and Ethernet Type
- VLAN stacking up to 3 VLAN tags w/configurable priority & type
- Fully configurable IPv4 or IPv6 header
- MPLS up to 3 labels with configurable Label/S/CoS and TTL fields (optional)
- UDP/TCP header with configurable Source & Destination ports

Frame size 64 to 1518 bytes and jumbo frame up to 10000 bytes
Traffic Pattern (Throughput Test and BERT only): Constant, Ramp, Multi Bursts, Single Burst
Error Injection (Throughput Test and BERT only): Bit, CRC, IP Checksum, TCP/UDP checksum, Pause, Symbol (Layer 1 Unframed)
MAC flooding feature generates test frames with up to 4096 incremental Source and/or Destination MAC addresses (optional)
VLAN flooding feature generates test frames with up to 4096 incremental VLAN IDs (optional)

ITU-T Y.1564 V-SAM Test

V-SAM test suite compliant with ITU-T Y.1564 standard
Support for Multi-stream traffic generation, Service Configuration and Service Performance tests
Independently configurable for each stream: Bandwidth profile parameters (CIR, EIR, Traffic Policing) and Service Acceptance criteria (FLR, FTD, IFDV, AVAIL)
Simple summary Pass/Fail results tables and drill down capability with detailed measurements (Frame Loss, Frame Transfer Delay, Frame Delay Variation, Availability) for each service

Transceiver	SFP				
Data rate	1000Base-X			100Base-FX	
Part No.	301-01-001G	301-01-002G	301-01-003G	301-01-013G	301-01-014G
Wavelength (nm)	850	1310	1550	1310	1310
Range	300m	10km	80km	2km	15km
Connector	LC	LC	LC	LC	LC
Line coding	NRZ	NRZ	NRZ	NRZ	NRZ
Tx Laser	VCSEL	DFB	DFB	LED	FP
Tx Spectral width (nm)	0.85	1	1	175	7.7
Tx Power (dBm)	-9 to -3	-6 to -1	0 to +5	-20 to -15	-15 to -8
Rx Detector	PIN	PIN	APD	PIN	PIN
Rx Sensitivity					
1.25 Gbps	-20 to 0	-22 to 0	-22 to 0	n/a	n/a
125 Mbps	n/a	n/a	n/a	-31 to -14	-28 to -8

**Data rates, performance, and supported transmission protocols are only guaranteed for SFPs and XFPs supplied by VeEX Inc. If selecting or using other vendors, users should exercise caution.*

RFC2544 Compliance Testing

Automated tests compliant with RFC2544 with configurable threshold values and maximum transmit bandwidth settings
Throughput, Latency, Frame Loss, and Back-to-Back (burst) tests
Frame sizes: 64, 128, 256, 512, 1024, 1280, and 1518 bytes including 2 user configurable frames
Test can be done to a remote loopback or to a remote test set with remote control of traffic generation and measurements at each end (requires asymmetric test option)

Bit Error Rate Testing

Single Stream test with test pattern PRBS: 2^{31}-1, 2^{23}-1, 2^{20}-1, 2^{15}-1, 2^{11}-1, normal and inverted patterns, All 0s, All 1s and User Defined
Layer 1 Framed: CRPAT, CSPAT, CRTPAT
1GE Layer 1 Unframed: HFPAT, LFPAT, MFPAT
10GE Layer 1 Unframed: PRBS Seed A and B

Multiple Streams Throughput Testing

Up to 8 independent traffic streams generation and analysis, with configurable filters on 1 GE interface
Each stream can be set with independent frame size, bandwidth, traffic profile, and QoS levels

Ethernet *cont'd*

Smart Loopback Mode

Layer 1: loops back all incoming traffic
Layer 2: all incoming unicast traffic is looped back with MAC source and destination addresses swapped
Layer 3: all incoming unicast traffic is looped back with MAC and IP source and destination addresses swapped
Layer 4: all incoming unicast traffic is looped back with MAC, IP, and UDP/TCP ports swapped
All key measurements on received traffic provided on loopback unit

Key Measurements

Error Measurements: Bit/BER (BERT and single stream Throughput Test), CRC, symbol, IP checksum, TCP/UDP checksum, jabber frames, runt frames, Frame loss (count and %), OSS
Alarm Detection: LOS, pattern loss, service disruption
Frame/Packet Statistics: Multicast, broadcast, unicast, pause frames, frame size distribution
Rates (min, max, average and current): frame rate, bandwidth utilization, frame rate, line rate, data rate
Delay (min, max, average and current): round trip delay, inter frame gap, jitter, one-way delay between two ports of the same module
Port 1 to Port 2 one-way latency measurement

VLAN Scan and Monitor

Scans incoming traffic and discovers all VLAN flows including Q-in-Q tagging
Key statistics on traffic rates, alarms and errors are reported for monitored streams (up to 8)

Pass Through Monitor Mode

Pass through monitoring function between 2x 1GE Copper ports or 2x 1GE fiber ports
Key statistics on traffic rates, alarms and errors are reported as well as configurable performance thresholds

IPv6

IPv6 compliant test traffic generation and analysis for all test applications (Y.1564 V-SAM, RFC2544, BERT and Multi-stream Throughput)
IPv6 Loopback capability
IPv6 Static or Stateless Auto Configuration, Ping and Trace Route functions

VePAL Discovery Function and Remote Control

Discovery function to all VeEX VePAL devices within subnet or manual control of VeEX VePAL devices in routed network
Remote Control of Loopback capability
Remote Control of Asymmetric test capability for end-to end RFC2544 test (optional)

Ordering Information

Z22-00-001P	UX400 1GE Test Module Dual 10/100/1000Base-T (RJ45) ports Dual 100Base-FX/1000Base-X (SFP) ports

Software Options

499-05-013	Multi Stream Test
499-05-014	MPLS Tags
499-05-058	MAC Flooding
499-05-059	Asymmetric Testing
499-05-093	VLAN Flooding

10G Module Key Features

SDH/SONET

- Single Slot test module
- Dual XFP optical ports
- Single or Dual BERT
- External clock interface
- Optical SDH/SONET testing for STM-64/OC-192
- OTN testing for OTU-2, OTU-1e/2e, ODU0, ODUflex
- Optical power and frequency measurement
- Round trip and port 1 to port 2 one way delay measurement
- Path trace and pointer generation and analysis
- Overhead monitoring and byte decoding
- Full SDH/SONET mapping down to VT2 and VT1.5
- PDH (E1, E3), DS1, DS3 payload analysis
- Transmit frequency offset to stress the network up to ± 150 ppm
- Bi-directional payload thru or monitoring

Ethernet

- 10GE-LAN and 10GE-WAN testing
- Throughput, latency, frame loss, and back to back measurement per RFC2544 and V-SAM (per ITU-T Y.1564)
- BERT testing at Layer 1, 2, 3 and 4
- Multiple stream traffic generation and analysis for end-to-end QoS verification of multiple services
- Port 1 to Port 2 one-way latency measurement
- Service disruption measurement
- Transmit frequency offset to stress the network up to ± 150 ppm
- MPLS tagging
- MAC flooding and VLAN flooding
- VLAN stacking/Q-in-Q

SDH/SONET Interfaces

Optical*

XFP transceivers conforming to Multi Source Agreement (MSA) specifications; LC connectors
ROHS compliant and Lead Free per Directive 2002/95/EC
Operating temperature range: -10˚C to 70˚C
Safety: Class 1, per FDA/CDRH, EN (IEC) 60825 eye safety regulations
Compliant to ITU-T G.957/G.691 Optical interfaces and systems relating to SDH
Optical Power Measurement: ± 2dB accuracy, 1dB resolution

Transceiver	XFP		
Data rate	OC-192; STM-64 (9.953 Gbps) OTU-2 (10.7 Gbps) OTU-1e (11.049 Gbps) OTU-2e (11.095 Gbps)		
Part No.	301-04-002G	301-04-003G	301-04-004G
Wavelength (nm)	1310	1550	1550
Range (km)	10	40	80
Connector	LC	LC	LC
Line coding	NRZ	NRZ	NRZ
Tx Laser	DFB	DFB	DFB
Tx Spectral width (nm)	1	1	1
Tx Power (dBm)	-6 to -1	-1 to +2	0 to +4
Rx Detector	PIN	PIN	APD
Rx Sensitivity			
9.953 Gbps	-14.4 to +0.5	-16 to -1	-24 to -7
10.7 Gbps	-14.4 to +0.5	-16 to -1	-24 to -7
11.049 Gbps	-13.4 to +0.5	-15 to -1	-22 to -7
11.095 Gbps	-13.4 to +0.5	-15 to -1	-22 to -7

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SDH/SONET Functions

Operating Modes

Terminate and Monitor modes
Payload Through mode (Intrusive)
- Modification of selected SOH bytes
- Alarm Generation/Error Insertion of selectable defects/anomalies

Line Through mode (transparent)
- Passes entire signal through without modifying overhead bytes

Signal Structure

STM-64 VC-n container equipped with:
- Framed or Unframed PDH test pattern per ITU-T O.150
- Bulk TSS per ITU-T O.181

SDH Mappings (According to ITU-T G.707)

C-12 (unstructured or framed E1, asynchronous or byte synchronous)
C-3 (unstructured or framed E3 or DS3) via AU-3 or AU-4
C-4 (unstructured or framed E4)
C-4-4c (STM-4 and STM-16)
C-4-16c (STM-16)
C-4-64c (STM-64)
C-11 (unstructured or framed DS1)

SONET Mappings (According to Telcordia GR-253/ANSI T1.105)

VT-1.5 (unstructured or framed DS1, asynchronous or float byte synchronous)
STS-1 SPE (unstructured or framed E3 or DS3)
STS-3c SPE (unstructured or framed E4)
STS-12c SPE (Bulk)
STS-48c SPE (Bulk)
STS-192c SPE (Bulk)
VT-2 (unstructured or framed DS1)

Patterns

The following test patterns can be generated
- PRBS: 2^{31}-1 , 2^{23}-1, 2^{20}-1, 2^{15}-1, 2^{11}-1: normal or inverted
- Fixed: 0000, 1111, 1010, 1000 and 1100
- 10 User programmable words up to 32 bits each

Errors

Insertion
- FAS, B1, B2, MS-REI, B3, HP-REI, LP-REI, LP-BIP, and bit errors
- Mode: Single and rate (1 x 10^{-3} to 5 x 10^{-6})

Detection
- FAS, B1, B2, MS-REI, B3, HP-REI, LP-BIP, LP-REI, slips and bit errors

SDH/SONET Functions *cont'd*

Alarms

Generation

- LOS, LOF, MS-AIS, MS-RDI, RS-TIM, AU-LOP, AU-AIS, HP-UNEQ, HP-PLM, HP-RDI, HP-TIM, TU-LOM, TU-LOP, TU-AIS, LP-UNEQ, LP-PLM, LP-RDI, LP-RFI, LP-TIM, 2M AIS, 2M LOF, 2M RDI
- Mode: Static (Enable/Disable)

Monitoring and Detection

- LOS, LOF, OOF, RS-TIM, MS-AIS, MS-RDI, AU-AIS, AU-LOP, HP-UNEQ, HP-PLM, HP-TIM, HP-RDI, TU-LOM, TU-AIS, TU-LOP, LP-UNEQ, LP-PLM, LP-TIM, LP-RDI, LP-RFI

Pointer Analysis and Generation

Analysis

- Current value, increments, decrements, sum, difference
- New Data Flags (NDF)
- Tributary frequency offset (ppm of AU/TU)

Generation

- Single pointer, increment, decrement, or increment/decrement
- Programming of SS bits
- Pointer Sequences (ITU-T G.783, Telcordia GR-253)
  - Single, Double Alternating
  - Regular Add, Regular Cancel
  - Burst, Trans. Burst
  - 87/3, 87/3 Add, 87/3 Cancel
  - Periodic Add, Periodic Cancel

Tributary Scan

Automatically scans VC-12/VC-11 for errors, alarms and events using a sequential BER tests

Overhead Analysis and Generation

Network Architectures supported

- Linear (per ITU-T G.783)
- Ring (per ITU-T G.841)

Analysis – Decode and Display

SOH/POH bytes in hexadecimal, binary or ASCII formats

- S1 synchronization status
- C2 HP signal label
- J0 trace identifier (16 bytes) in ASCII format
- J1 trace identifier (16 or 64 bytes) in ASCII format
- J2 trace identifier (16 or 64 bytes) in ASCII format
- K1, K2 APS Control
- V5 LP signal label

Generation - Programmable Bytes

RSOH

- J0 trace: 1 byte hexadecimal or 16 byte ASCII sequence with CRC-7

MSOH

- K1, K2 APS bytes per ITU-T G.783 and G.841
- S1 synchronization status message

HO-POH (VC-4, VC-3)

- J1 trace: 16 byte ASCII with CRC-7 or 64 byte ASCII sequence
- C2 signal label
- H4 Sequence/Multiframe Indicator
- G1 (bit 5): End-to-end path status (RDI generation)
- K3 (bits 1-4) APS signaling

LO-POH (VC-3)

- J1 trace: 16 byte ASCII with CRC-7 or 64 byte ASCII sequence
- C2 signal label
- G1 (bit 5): End-to-end path status (RDI generation)
- K3 (bits 1-4) APS signaling

LO-POH (VC-12, VC-11)

- V5 (bits 5-7) LP signal label
- J2 trace: 16 byte ASCII with CRC-7 or 64 byte ASCII sequence
- K4 (bits 3-4) LP APS signaling

OTN Functions

- OTU1 (2.7 Gbps) and OTU2 (10.7 Gbps) bit rates
- OTU1e (11.049 Gbps) and OTU2e (11.095 Gbps) over-clocked bit rates
- Frequency offset generation of bit rates by ± 50 ppm
- EoOTN testing - internally generated 10 GigE LAN signal mapped into OTU1e and OTU2e
- Synchronous and asynchronous mapping of SONET/SDH signals within OTN
- Forward error correction (FEC) testing
- OTU, ODU, OPU overhead manipulation and monitoring
- OTU, ODU and OPU layer alarms/errors generation and analysis
- OTU, ODU trace messages
- ODU multiplexing alarm-generation and analysis

OTN

Standards: ITU-T G.709, ITU-T G.798, ITU-T G.872

Test rates: OTU1 (2.7 Gbps), OTU2 (10.7 Gbps); Optional OTU1e (11.0491 Gbps), OTU2e (11.0957 Gbps)

Signal types

- All SONET/SDH mappings supported
- Optional ODU0 into OTU2 and ODU0 into ODU1 multiplexing, with Ethernet or PRBS (CBR) payloads
- Optional ODUflex into OTU2, with Ethernet or PRBS (CBR) payload

OTU Layer

Errors: OTU-FAS, OTU-MFAS, OTU-BEI, OTU-BIP-8

Alarms: LOF, OOF, LOM, OOM, OTU-AIS, OTU-TIM, OTU-BDI, OTU-IAE, OTU-BIAE

Trace Generation: 64-byte Trail Trace Identifier (TTI)

ODU Layer

Errors: ODU-BIP-8, ODU-BEI

Alarms: ODU-AIS, ODU-OCI, ODU-LCK, ODU-TIM, ODU-BDI, ODU-FSF, ODU-BSF, ODU-FSD, ODU-BSD

Trace Generation: 64-byte Trail Trace Identifier (TTI)

ODU Multiplexing

Alarms: OPU-MSIM, ODU-LOFLOM

OPU Layer

Alarms: OPU-PLM

Payload Type (PT): Generates and displays received PT value

Forward Error Correction (FEC)

Errors: FEC-Correctable, FEC-Uncorrectable

Ethernet over OTN (EoOTN)

Mapping: Direct mapping into OTU1e or OTU2e

BERT: Framed Layer 2 supported with or without VLAN

Test Pattern (payload)

- Fixed: 1s and 0s
- PRBS: 2^{9}-1 , 2^{11}-1, 2^{15}-1, 2^{20}-1, 2^{23}-1, 2^{31}-1 with inversion

Error Insertion: FCS, code violations, bit

Error Measurement: Jabber/giant, runt, undersize, oversize, FCS

Error Measurement (BERT): Bit error

Ethernet Statistics: Multicast, broadcast, unicast, frame size distribution, bandwidth, utilization, frame rate

Ethernet

Optical Interfaces (10G XFP)*

Dual 10G XFP Port, 10GE LAN and 10GE WAN PHY, LC connector
XFP transceivers per Multi Source Agreement (MSA)
ROHS compliant and Lead Free per Directive 2002/95/EC
Operating temperature range: -10˚C to 70˚C
Eye Safety: Class 1, per FDA/CDRH, EN (IEC) 60825
Power Measurement: ± 2dB accuracy, 1dB resolution

Transceiver	XFP			
Data rate	10GE LAN and WAN			
Part No.	301-04-001G	301-04-002G	301-04-003G	301-04-004G
Wavelength (nm)	850	1310	1550	1550
Range	300m	10km	40km	80km
Connector	LC	LC	LC	LC
Line coding	NRZ	NRZ	NRZ	NRZ
Tx Laser	VCSEL	DFB	EML	EML
Tx Spectral width (nm)	0.4	1	1	1
Tx Power (dBm)	-5 to -1	-6 to -1	-1 to +2	0 to +4
Rx Detector	PIN	PIN	PIN	APD
Rx Sensitivity				
9.53 Gbps (10GE WAN)	-11.1 to +0.5	-14.4 to 0.5	-16 to -1	-24 to -7
10.3 Gbps (10GE LAN)	-11.1 to +0.5	-14.4 to +0.5	-16 to -1	-24 to -7

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Clock Synchronization

Internal: ± 3.5 ppm stability per ITU-T G.812
Recovered: from the incoming signal
External reference via SMA connector
- Clock: 2.048 MHz, 1.544 MHz (sine wave or TTL)
- Signal: 2.048 Mbps (HDB3), 1.544 Mbps (B8ZS)
- 64 kbps co-directional

Tx Frequency Offset: Up to 50 ppm (25,000 ppm for E1) in steps of 0.1 ppm for both optical and electrical interfaces

Ethernet Features

Auto Negotiation, Flow Control

Modes of Operation

Terminate, Pass Through Monitor, Loopback

Traffic Generation

Layer 1 Unframed/Framed (BERT only), Layer 2, Layer 3, Layer 4
Test Frame Header:
- IEEE 802.3 and Ethernet II (DIX) frames
- Configurable Source and Destination MAC and Ethernet Type
- VLAN stacking up to 3 VLAN tags w/configurable priority & type
- Fully configurable IPv4 or IPv6 header
- MPLS up to 3 labels with configurable Label/S/CoS and TTL fields (optional)
- UDP/TCP header with configurable Source & Destination ports

Frame size 64 to 1518 bytes and jumbo frame up to 10000 bytes
Traffic Pattern (Throughput Test and BERT only): Constant, Ramp, Multi Bursts, Single Burst
Error Injection (Throughput Test and BERT only): Bit, CRC, IP Checksum, TCP/UDP checksum, Pause, Symbol (Layer 1 Unframed)
MAC flooding feature generates test frames with up to 4096 incremental Source and/or Destination MAC addresses (optional)
VLAN flooding feature generates test frames with up to 4096 incremental VLAN IDs (optional)

ITU-T Y.1564 V-SAM Test

V-SAM test suite compliant with ITU-T Y.1564 standard
Support for Multi-stream traffic generation, Service Configuration and Service Performance tests
Independently configurable for each stream: Bandwidth profile parameters (CIR, EIR, Traffic Policing) and Service Acceptance criteria (FLR, FTD, IFDV, AVAIL)
Simple summary Pass/Fail results tables and drill down capability with detailed measurements (Frame Loss, Frame Transfer Delay, Frame Delay Variation, Availability) for each service

RFC2544 Compliance Testing

Automated tests compliant with RFC2544 with configurable threshold values and maximum transmit bandwidth settings
Throughput, Latency, Frame Loss, and Back-to-Back (burst) tests
Frame sizes: 64, 128, 256, 512, 1024, 1280, and 1518 bytes including 2 user configurable frames
Test can be done to a remote loopback or to a remote test set with remote control of traffic generation and measurements at each end (requires asymmetric test option)

Bit Error Rate Testing

Single Stream test with test pattern PRBS: 2^{31}-1, 2^{23}-1, 2^{20}-1, 2^{15}-1, 2^{11}-1, normal and inverted patterns, All 0s, All 1s and User Defined
Layer 1 Framed: CRPAT, CSPAT, CRTPAT
1GE Layer 1 Unframed: HFPAT, LFPAT, MFPAT
10GE Layer1 Unframed: PRBS Seed A and B

Multiple Streams Throughput Testing

Up to 10 independent traffic streams generation and analysis, with configurable filters 10GE interface
Each stream can be set with independent frame size, bandwidth, traffic profile, and QoS levels

Smart Loopback Mode

Layer 1: loops back all incoming traffic
Layer 2: all incoming unicast traffic is looped back with MAC source and destination addresses swapped
Layer 3: all incoming unicast traffic is looped back with MAC and IP source and destination addresses swapped
Layer 4: all incoming unicast traffic is looped back with MAC, IP, and UDP/TCP ports swapped
All key measurements on received traffic provided on loopback unit

Key Measurements

Error Measurements: Bit/BER (BERT and single stream Throughput Test), CRC, symbol, IP checksum, TCP/UDP checksum, jabber frames, runt frames, Frame loss (count and %), OSS
Alarm Detection: LOS, pattern loss, service disruption
Frame/Packet Statistics: Multicast, broadcast, unicast, pause frames, frame size distribution
Rates (min, max, average and current): frame rate, bandwidth utilization, frame rate, line rate, data rate
Delay (min, max, average and current): round trip delay, inter frame gap, jitter, one-way delay between two ports of the same module
Port 1 to Port 2 one-way latency measurement

Ordering Information

Z22-00-004P	UX400 10G Test Module Dual multiple rate 10G XFP ports

Software Options

499-05-060	10GE WAN
499-05-066	10GE Layer 1 Unframed BERT
499-05-109	10G APS
499-05-110	10G Tandem Connection Monitoring
499-05-111	10G ITU-T G.783 Pointer Test Sequences
499-05-122	10GE LAN
499-05-130	10GE Multiple Streams
499-05-131	10GE MPLS
499-05-133	10GE MAC Flooding
499-05-134	10GE VLAN Flooding
499-05-135	10GE Asymmetric Testing
499-05-221	UX400 10G SDH/SONET
499-05-222	UX400 OTU-2
499-05-223	UX400 OTU-1e
499-05-224	UX400 OTU-2e

Dual 2.5G Module Key Features

- Single Slot test module
- Dual SFP optical ports supporting STM-0/1/4/16 bit rates
- Dual Balanced ports (RJ48 or Bantam) for E1 or DS1
- Dual Unbalanced ports (BNC) for E1, E3, E4, STM-1e
- Each port can be independently operated
- Single or Dual BERT
- Full Rate E1, DS1, Fractional N/M x 64 kbps or 56 kbps testing
- PDH analysis with Sa bit generation
- Non-intrusive Pulse Mask Analysis at E1, E3, DS1, DS3 bit rates
- Flexible wavelength/bit rate options using industry standard SFPs conforming to the Multi Source Agreement (MSA)
- Optical Power, Level and Frequency measurements
- Payload Mapping according to ITU-T G.707 rec.
- Concatenated Payloads
- Bit Error and Performance Analysis per ITU standards
- Error and Alarm Generation and Analysis
- Path Trace Generation and Analysis
- Pointer Generation and Analysis
- Automatic Protection Switching/Service Disruption testing
- Histogram and Event analysis for errors and alarms
- Round Trip Delay on all interfaces and payload mappings
- Port 1 to Port 2 one-way delay measurement
- Section and Path Overhead Monitoring, Byte Decoding
- Tandem Connection Monitoring

Test Interfaces

Electrical

Dual RJ-48 (120Ω balanced)

Rates and line code

- 2.048 Mbps, HDB3 & AMI, 120Ω balanced
- 1.544 Mbps, AMI & B8ZS, 100Ω balanced (Optional)

BNC (75Ω unbalanced)

Rates and line code

- 2.048 Mbps, HDB3 & AMI
- 8.448 Mbps, HDB3
- 34.368 Mbps, HDB3
- 44.736 Mbps, B3ZS (Optional)
- 51.84 Mbps, B3ZS
- 139.264 Mbps, CMI (Optional)
- 155.520 Mbps, CMI (Optional)

Compliant to ITU-T G.703, G.823, G.824, G.772 and ANSI T1.102

Clock recovery (pulling range) per ITU-T G.703

Receiver Sensitivity

2.048 Mbps (E1)

- Terminate: ≤ 6 dB (cable loss only)
- Monitor (PMP): ≤ 26 dB (20 dB resistive, 6 dB cable loss)
- Bridge: ≤ 6 dB (cable loss only)

8.448 Mbps (E2)

- Terminate: ≤ 6 dB (cable loss only)
- Monitor (PMP): ≤ 26 dB (20 dB resistive, 6 dB cable loss)

34.368 Mbps (E3)

- Terminate: ≤ 12 dB (cable loss only)
- Monitor (PMP): ≤ 26 dB (20 dB resistive, 6 dB cable loss)

1.544 Mbps (DS1) (Optional)

- Terminate: ≤ 26 dB (cable loss only) at 0 dBdsx Tx
- Monitor (PMP): ≤ 26 dB (20 dB resistive, 6 dB cable loss)
- Bridge: ≤ 6 dB (cable loss only)

44.736 Mbps (DS3) and 51.84 Mbps (STS-1/STM-0E) (Optional)

- Terminate: ≤ 10 dB (cable loss only)
- Monitor (PMP): ≤ 26 dB (20 dB resistive, 6 dB cable loss)

139.264 Mbps (E4) and 155.520 Mbps (STM-1E) (Optional)

- Terminate: ≤ 12 dB (E4), 12.7 dB (STM-1E) (coaxial cable loss only)

Optical*

SFP and XFP transceivers conforming to Multi Source Agreement (MSA) specifications

ROHS compliant and Lead Free per Directive 2002/95/EC

Operating temperature range: -10˚C to 70˚C

Safety: Class 1, per FDA/CDRH, EN (IEC) 60825 eye safety regulations

Compliant to ITU-T G.957/G.691 Optical interfaces and systems relating to SDH

Optical Power Measurement: ± 2 dB accuracy, 1 dB resolution

Clock Synchronization

Internal: ± 3.5 ppm stability per ITU-T G.812

Recovered: from the incoming signal

Tx Frequency Offset: Up to 50 ppm (25,000 ppm for E1) in steps of 0.1 ppm for both optical and electrical interfaces

Transceiver	SFP					
Data rate	STM-0/1/4; OC-1/3/12 (51/155/622 Mbps)			STM-0/1/4/16; OC-1/3/12/48 (51/155/622/2488 Mbps) OTU-1 (2666 Mbps)		
Part No.	301-01-004G	301-01-005G	301-01-006G	301-01-007G	301-01-008G	301-01-009G
Wavelength (nm)	1310	1310	1550	1310	1310	1550
Range (km)	15	40	80	15	40	80
Connector	LC	LC	LC	LC	LC	LC
Line coding	NRZ	NRZ	NRZ	NRZ	NRZ	NRZ
Tx Laser	FP	DFB	DFB	DFB	DFB	DFB
Tx Spectral width (nm)	2.5	1	1	1	1	1
Tx Power (dBm)	-15 to -8	-3 to +2	-3 to +2	-5 to 0	-2 to +3	-2 to +3
Rx Detector	PIN	PIN	PIN	PIN	APD	APD
Rx Sensitivity						
155 Mbps	-28 to -8	-28 to -8	-28 to -8	-23 to -10	-30 to -15	-30 to -15
622 Mbps	-28 to -8	-28 to -8	-28 to -8	-22 to 0	-29 to -9	-29 to -9
2488 Mbps	n/a	n/a	n/a	-18 to 0	-27 to -9	-28 to -9
2666 Mbps	n/a	n/a	n/a	-18 to 0	-27 to -9	-28 to -9

**Data rates, performance, and supported transmission protocols are only guaranteed for SFPs and XFPs supplied by VeEX Inc. If selecting or using other vendors, users should exercise caution.*

SDH/SONET Functions

Operating Modes

Terminate mode
Monitor mode
Payload Through mode (Intrusive)
- Modification of selected SOH bytes
- Alarm Generation/Error Insertion of selectable defects/ anomalies

Line Through mode (transparent)
- Passes entire signal through without modifying overhead bytes

Signal Structure

STM-1, VC-n container equipped with:
- Framed or Unframed PDH test pattern per ITU-T O.150
- Test signal in N x 64 kbps, N x 56 kbps where N=1 to 24

STM-4/16/64, VC-n container equipped with:
- Framed or Unframed PDH test pattern per ITU-T O.150
- Bulk TSS per ITU-T O.181

SDH Mappings (According to ITU-T G.707)

C-12 (unstructured or framed E1, asynchronous or byte synchronous)
C-3 (unstructured or framed E3 or DS3) via AU-3 or AU-4
C-4 (unstructured or framed E4)
C-4-4c (STM-4 and STM-16)
C-4-16c (STM-16)
C-4-64c (STM-64)

Optional
C-11 (unstructured or framed DS1)

SONET Mappings (According to Telcordia GR-253/ANSI T1.105)

VT-1.5 (unstructured or framed DS1, asynchronous or float byte synchronous)
STS-1 SPE (unstructured or framed E3 or DS3)
STS-3c SPE (unstructured or framed E4)
STS-12c SPE (Bulk)
STS-48c SPE (Bulk)
STS-192c SPE (Bulk)

Optional
VT-2 (unstructured or framed DS1)

Patterns

The following test patterns can be generated
- PRBS: 2^{31}-1 , 2^{23}-1, 2^{20}-1, 2^{15}-1, 2^{11}-1: normal or inverted
- Fixed: 0000, 1111, 1010, 1000 and 1100
- 10 User programmable words up to 32 bits each

Errors

Insertion
- FAS, B1, B2, MS-REI, B3, HP-REI, LP-REI, LP-BIP, and bit errors
- Mode: Single and rate (1 x 10^{-3} to 5 x 10^{-6})

Detection
- FAS, B1, B2, MS-REI, B3, HP-REI, LP-BIP, LP-REI, slips and bit errors

Alarms

Generation
- LOS, LOF, MS-AIS, MS-RDI, RS-TIM, AU-LOP, AU-AIS, HP-UNEQ, HP-PLM, HP-RDI, HP-TIM, TU-LOM, TU-LOP, TU-AIS, LP-UNEQ, LP-PLM, LP-RDI, LP-RFI, LP-TIM, 2M AIS, 2M LOF, 2M RDI
- Mode: Static (Enable/Disable)

Monitoring and Detection
- LOS, LOF, OOF, RS-TIM, MS-AIS, MS-RDI, AU-AIS, AU-LOP, HP-UNEQ, HP-PLM, HP-TIM, HP-RDI, TU-LOM, TU-AIS, TU-LOP, LP-UNEQ, LP-PLM, LP-TIM, LP-RDI, LP-RFI

Overhead Analysis and Generation

Network Architectures supported
- Linear (per ITU-T G.783)
- Ring (per ITU-T G.841)

Analysis – Decode and Display
SOH/POH bytes in hexadecimal, binary or ASCII formats
- S1 synchronization status
- C2 HP signal label
- J0 trace identifier (16 bytes) in ASCII format
- J1 trace identifier (16 or 64 bytes) in ASCII format
- J2 trace identifier (16 or 64 bytes) in ASCII format
- K1, K2 APS Control
- V5 LP signal label

Generation - Programmable Bytes
RSOH
- J0 trace: 1 byte hexadecimal or 16 byte ASCII sequence with CRC-7

MSOH
- K1, K2 APS bytes per ITU-T G.783 and G.841
- S1 synchronization status message

HO-POH (VC-4, VC-3)
- J1 trace: 16 byte ASCII with CRC-7 or 64 byte ASCII sequence
- C2 signal label
- H4 Sequence/Multiframe Indicator
- G1 (bit 5): End-to-end path status (RDI generation)
- K3 (bits 1-4) APS signaling

LO-POH (VC-3)
- J1 trace: 16 byte ASCII with CRC-7 or 64 byte ASCII sequence
- C2 signal label
- G1 (bit 5): End-to-end path status (RDI generation)
- K3 (bits 1-4) APS signaling

LO-POH (VC-12, VC-11)
- V5 (bits 5-7) LP signal label
- J2 trace: 16 byte ASCII with CRC-7 or 64 byte ASCII sequence
- K4 (bits 3-4) LP APS signaling

DCC Overhead BERT

Generation and analysis of PRBS pattern in DCC channels (D1-D3 or D4-D12 bytes)
PRBS: 2^{11}-1, 2^{9}-1; inverted or non inverted)
Bit error counter and errored seconds

Pointer Analysis and Generation

Analysis
- Current value, increments, decrements, sum, difference
- New Data Flags (NDF)
- Tributary frequency offset (ppm of AU/TU)

Generation
- Single pointer, increment, decrement, or increment/ decrement
- Programming of SS bits
- Pointer Sequences (ITU-T G.783, Telcordia GR-253)
  – Single, Double Alternating
  – Regular Add, Regular Cancel
  – Burst, Trans. Burst
  – 87/3, 87/3 Add, 87/3 Cancel
  – Periodic Add, Periodic Cancel

Tributary Scan

Automatically scans VC-12/VC-11 for errors, alarms and events using a sequential BER tests

PDH Functions

Operating Modes

Terminate, Monitor; Bridge (E1 & DS1)

Signal Structure

2.048 Mbps (E1)

- Unframed or Framed with/without CRC per ITU-T G.704 (PCM30, PCM30C, PCM31, PCM31C)
- Test signal in N/M x 64 kbps, N x 56 kbps where N=1 to 30/31

8.448 Mbps (E2)

- Unframed or Framed according to ITU-T G.742

34.368 Mbps (E3)

- Unframed or Framed according to ITU-T G.751

Optional

1.544 Mbps (DS1)

- Unframed or Framed SF (D4), ESF per ANSI/Telcordia standards
- Test signal in N x 64 kbps, N x 56 kbps where N=1 to 24

44.736 Mbps (DS3)

- Unframed or Framed M13 & C-Bit Parity per ITU-T G.752/G.704

139.264 Mbps (E4)

- Unframed or Framed per ITU-T G.751

Patterns

The following test patterns can be generated

- PRBS: 2^{31}-1, 2^{23}-1, 2^{20}-1, 2^{15}-1, 2^{11}-1, 2^{9}-1, 2^{7}-1, QRSS
- Fixed: 0000, 1111, 1010, 1100, 1in8, 2in8, 3in24, DALY, NET55, and OCT55
- 10 user programmable words: up to 32 bits; normal or inverted generation

Errors

Insertion

- 2.048 Mbps (E1): Code, FAS, CRC, EBIT, Bit errors
- 8.448 Mbps (E2): Code, 8M FAS, 2M FAS, 2M CRC, 2M RDI, Bit errors
- 34.368 Mbps (E3): Code, 34M FAS, 8M FAS, 2M FAS, 2M CRC, 2M RDI, Bit errors
- Single or continuous rate (1 x 10^{-3} to 5 x 10^{-6})

Optional

- 1.544 Mbps (DS1): Code, FAS, Bit, Frame, CRC
- 44.736 Mbps (DS3): Code, FAS, MFAS, P/C-Parity, Bit errors
- 139.264 Mbps (E4): Code, FAS, Bit errors

Measurement

- 2.048 Mbps (E1): Code, FAS, CRC, EBIT and Bit errors
- 8.448 Mbps (E2): Code, FAS, Bit errors
- 34.368 Mbps (E3): Code, FAS, Bit errors

Optional (DS1, DS3, E4) – where applicable

- Code, FAS, MFAS, 2M CRC, P/C-Parity, Bit errors

Alarms

Generation

- 2.048 Mbps (E1): LOS, AIS, LOF, RDI
- 8.448 Mbps (E2): 8M AIS, 8M LOF, 8M RDI, 2M AIS, 2M LOF, 2M RDI
- 34.368 Mbps (E3): 34M LOS, 34M AIS, 34M LOF, 34M RDI, 8M AIS, 8M LOF, 8M RDI, 2M AIS, 2M LOF, 2M RDI
- Mode: Static (Enable/Disable)

Optional

- 1.544 Mbps (DS1): AIS, yellow, idle, LOS, LOF
- 44.736 Mbps (DS3): LOS, LOF, OOF, AIS, Parity
- 139.264 Mbps (E4): AIS, FAS RDI

Measurement

- 2.048 Mbps (E1): LOS, AIS, LOF, LOMF, RDI, and LSS
- 8.448 Mbps (E2): LOS, AIS, LOF, RDI, and LSS
- 34.368 Mbps (E3): LOS, AIS, LOF, RDI, and LSS

Optional (T-Carrier DS1/DS3)

- LOS, AIS, LOF, OOF, idle, yellow, and LSS

Measurement Functions

Test Results

Error count, ES, %ES, SES, %SES, UAS, %UAS, EFS, %EFS, AS, %AS, and rate for all events: errors, alarms and pointer events

Performance Analysis

Measurements according to:

- ITU-T G.821: ES, EFS, SES and UAS with HRP 1% to 100%
- ITU-T G.826: EB, BBE, ES, EFS, SES, UAS; HRP of 1% to 100%
- In Service Measurement (ISM) using B1, B2, B3, FAS, CRC or Code (E1)
- Out of Service measurement (OOS) using bit errors (Test Sequence Error)
- ITU-T G.828: ES, EFS, SES, BBE, SEP, UAS with HRP 1% to 100%
- ITU-T G.829: ES, EFS, SES, BBE, UAS on RSOH (B1), MSOH (B2) or TSE
- ITU-T M.2100: ES, EFS, SES, UAS with HRP 1% to 100%
- User defined thresholds for Maintenance (MTCE) and Bringing into Service (BIS) objectives
- ITU-T M.2101: ES, EFS, SES, BBE, SEP, UAS with HRP 1% to 100%
- User defined thresholds for Maintenance (MTCE) and Bringing into Service (BIS) objectives. In service measurements on both near and far ends of path using TSE, HP-BIP (B3), MS-BIP (B2), RS-BIP (B1) and LP-BIP (V5)

SDH/SONET/PDH Measurement Options

Automatic Protection Switching (APS)

Measurement of disruption time on SDH & PDH interfaces
Tributaries: PDH (E1), SDH
Pass/Fail range: 15 ms to 10 seconds
Resolution: 1 ms
Triggers: LOS, LOF, SDH FAS, B1, MS-AIS, MS-RDI, MS-REI, B2, AU-AIS, AU-LOP, B3, HP-RDI, HP-REI, TU-AIS, 2M-AIS, 2M-LOF, LSS
APS Byte (K1/K2) capture and decode

Pointer Analysis and Generation

Generation: ITU-T G.783 pointer sequences

Tandem Connection Monitoring (TCM)

Generation and analysis of N1 and N2 bytes
Errors generated: TC-IEC, TC-BIP, TC-REI, OEI
Alarms generated: TC-RDI, TC-UNEQ, TC-LTC, TC-AIS, TC-ODI
Detection, display, analysis and storage of events:

- TC-IEC, TC-AIS, TC-REI, TC-RDI, TC-OEI, TC-LTC, TC-UNEQ, TC-ODI, TC-TIM
- Analysis and generation of APId (Access Point Identifier)

SDH/SONET/PDH
Common Functions & Measurements

Frequency Measurement
Optical and Electrical Interfaces: Hz and ppm
Resolution: 1 Hz
TIE measurement on Pointer Justification Events

Round Trip Delay (available on all interfaces & mappings)
Measurement Range: 1 µS to 10 seconds
Resolution: ±1 µs or 1 U.I.

Event Logging
Date and time stamped events in tabular format

Histograms (available for all interfaces)
Display of Errors and Alarms versus time
Resolution: Seconds, minutes, hours and days

LED Indicators
Fixed LEDs for Signal, Framing, Pattern and Errors/Alarms
Soft LEDs for alarms/Errors displaying historical events and conditions

Ordering Information

Z22-00-002P	UX400 2.5G Test Module (Bantam) Dual port 2.5G, supports DS1 to OC48
Z22-00-003P	UX400 2.5G Test Module (RJ45) Dual port 2.5G, supports E1 to STM-16

Software Options

499-05-100	2.048 Mbps (E1) Testing with VT-2 Mapping
499-05-101	34 Mbps (E3) Testing
499-05-040	1.544 Mbps (DS1) and C-11 Mapping
499-05-041	45 Mbps (DS3) Testing
499-05-042	155 Mbps Electrical Testing
499-05-046	APS
499-05-047	Tandem Connection Monitoring
499-05-048	ITU-T G.783 Pointer Test Sequences
499-05-052	139 Mbps Testing

40G Module Key Features

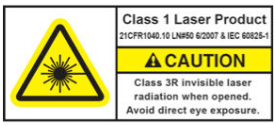
- Single Slot test module
- System is able to support two UX400-40G module operating simultaneously
- High speed optical OTN, SDH, SONET testing at 39.8, 43.0 Gbps
- Optical Power and Frequency measurements
- External clock interface and Eye diagram output port
- Concatenated Payloads and lower rate client mappings
- Path Trace and Pointer Generation and Analysis
- Automatic Protection Switching
- Round Trip Delay and payload mappings
- Histogram analysis
- Transmit frequency offset to stress clock recovery circuits
- Overhead Monitoring and Byte decoding
- Tandem Connection Monitoring
- Lower rate payload mapping down to VT1.5 and VT2
- Error and alarm injection
- G.821, G.826, G.828, G.829, M.2101 performance analysis

Specifications

The 40G NRZ SFF Test Module supports 39.8, 43.0 Gbps bit rates for short reach (VSR) optical link lengths of up to 2 km

OTN/SDH/SONET (single test port)
OTUk: OTU-3
STM-256 SYNC, STM-64 ASYNC, STS-768 SYNC, STS-768 ASYNC, PRBS/Bulk
STM-N: STM-256
VC-4-256c, VC-4-64c, VC-4-16c, VC-4-4c, VC-4, VC-3, VC-12, VC-11, PRBS/Bulk
OC-x: OC-768
STS-768c SPE, STS-192c SPE, STS-48c SPE, STS-12c SPE, STS-3c SPE, STS-1 SPE, VT-2, VT-1.5, PRBS/Bulk

Test Ports
Single test port (Tx and Rx)
Connectors: LC-UPC with safety latch
Line coding: NRZ

Transmitter


Wavelength: 1550 nm
Output Power: 0 to 3 dBm
Eye Diagram: ITU-T G.693 compliant
Laser Safety: Class 1 Laser product, IEC 60825-1 Edition 1.2, FDA/CDRH, 21 CFR 1040
Jitter Output: ITU-T G.8251

Receiver
Wavelength: 1290 to 1610 nm
Max Input Power: 3 dBm
Sensitivity: -7 dBm
Jitter Tolerance: ITU-T G.8251 compliant

Clock Synchronization
Internal: ± 3.5 ppm stability per ITU-T G.812
Recovered: from the incoming signal
External: 1.5 MHz, 2 MHz, 1.5 Mbps, 2 Mbps (SMF)
Tx Frequency Offset: Up to ± 50 ppm (in steps of 0.01 ppm)

SONET/SDH Functions

Operating Modes
Terminate mode
Payload Through mode (Intrusive)
- Modification of selected TOH bytes
- Alarm Generation/Error Insertion of selectable defects/anomalies

Line Through mode (transparent)
- Passes entire signal through without modifying overhead bytes

SONET Mappings (According to Telcordia GR-253/ANSI T1.105)
VT-1.5 (unstructured or framed DS1, asynchronous or float byte synchronous)
STS-1 SPE (Bulk)
STS-3c SPE (Bulk)
STS-12c SPE (Bulk)
STS-48c SPE (Bulk)
STS-192c SPE (Bulk)
STS-768c SPE (Bulk)

SDH Mappings (According to ITU-T G.707)
C-12 (unstructured or framed E1, asynchronous or byte synchronous)
C-3 (unstructured or framed E3 or DS3) via AU-3 or AU-4
C-4 (unstructured or framed E4)
C-4-4c (STM-4 and STM-16)
C-4-16c (STM-16)
C-4-64c (STM-64)
C-4-256c (STM-256)

Patterns
The following test patterns can be generated
- PRBS: 2^{31}-1 , 2^{23}-1, 2^{20}-1, 2^{15}-1, 2^{11}-1: normal or inverted
- Fixed: 0000, 1111, 1010, 1000 and 1100
- 10 User programmable words up to 32 bits each

Errors
Insertion
- FAS, B1, B2, REI-L, B3, REI-P, REI-V, BIP-V, and bit errors
- Mode: Single and rate (1×10^{-3} to 5×10^{-6})

Detection
- FAS, B1, B2, REI-L, B3, REI-P, REI-V, BIP-V, slips and bit errors

Alarms
Generation
- LOS, LOF, AIS-S, RDI-S, TIM-P, LOP-P, AIS-P, UNEQ-P, PLM-P, RDI-P, LOM-V, LOP-V, AIS-V, UNEQ-V, PLM-V, RDI-V, RFI-V, TIM-V
- Mode: Static (Enable/Disable)

Monitoring and Detection
- LOS, LOF, OOF, AIS-S, RDI-S, TIM-P, LOP-P, AIS-P, UNEQ-P, PLM-P, RDI-P, LOM-V, LOP-V, AIS-V, UNEQ-V, PLM-V, RDI-V, RFI-V, TIM-V

SONET/SDH Functions *cont'd*

Overhead Analysis and Generation

Network Architectures supported
- Linear (per ITU-T G.783)
- Ring (per ITU-T G.841)

Analysis – Decode and Display

TOH/POH bytes in hexadecimal, binary or ASCII formats
- S1 synchronization status
- C2 STS path signal label
- J0 trace identifier (16 bytes) in ASCII format
- J1 trace identifier (16 or 64 bytes) in ASCII format
- J2 trace identifier (16 or 64 bytes) in ASCII format
- K1, K2 APS Control
- V5 VT path signal label

Generation - Programmable Bytes

Section Overhead
- J0 trace: 1 byte hexadecimal or 16 byte ASCII sequence with CRC-7

Line Overhead
- K1, K2 APS bytes per ITU-T G.783 and G.841
- S1 synchronization status message

STS-POH (STS-N SPE, STS-1 SPE)
- J1 trace: 16 byte ASCII with CRC-7 or 64 byte ASCII sequence
- C2 signal label
- H4 Sequence/Multiframe Indicator
- G1 (bit 5): End-to-end path status (RDI generation)
- K3 (bits 1-4) APS signaling

STS-POH (STS-1 SPE)
- J1 trace: 16 byte ASCII with CRC-7 or 64 byte ASCII sequence
- C2 signal label
- G1 (bit 5): End-to-end path status (RDI generation)
- K3 (bits 1-4) APS signaling

VT-POH (VT-1.5, VT-2)
- V5 (bits 5-7) VT signal label
- J2 trace: 16 byte ASCII with CRC-7 or 64 byte ASCII sequence
- K4 (bits 3-4) VT APS signaling

Pointer Analysis and Generation

Analysis
- Current value, increments, decrements, sum, difference
- New Data Flags (NDF)
- Tributary frequency offset (ppm of STS/VT)

Generation
- Single pointer, increment, decrement, or increment/decrement
- Programming of SS bits
- Pointer Sequences (ITU-T G.783, Telcordia GR-253)
  - Single, Double Alternating
  - Regular Add, Regular Cancel
  - Burst, Trans. Burst
  - 87/3, 87/3 Add, 87/3 Cancel
  - Periodic Add, Periodic Cancel

Measurement Functions

Test Results

Error count, ES, %ES, SES, %SES, UAS, %UAS, EFS, %EFS, AS, %AS, and rate for all events: errors, alarms and pointer events

Performance Analysis

Measurements according to:
- ITU-T G.821: ES, EFS, SES and UAS with HRP 1% to 100%
- ITU-T G.826: EB, BBE, ES, EFS, SES, UAS; HRP of 1% to 100%
- In Service Measurement (ISM) using B1, B2, B3
- Out of Service measurement (OOS) using bit errors (Test Sequence Error)
- ITU-T G.828: ES, EFS, SES, BBE, SEP, UAS with HRP 1% to 100%
- ITU-T G.829: ES, EFS, SES, BBE, UAS on TOH (B1), (B2) or TSE
- ITU-T M.2100: ES, EFS, SES, UAS with HRP 1% to 100%
- User defined thresholds for Maintenance (MTCE) and Bringing into Service (BIS) objectives
- ITU-T M.2101: ES, EFS, SES, BBE, SEP, UAS with HRP 1% to 100%
- User defined thresholds for Maintenance (MTCE) and Bringing into Service (BIS) objectives. In service measurements on both near and far ends of path using TSE, P-BIP (B3), L-BIP (B2), S-BIP (B1) and V-BIP (V5)

SONET/SDH Measurement Options

Automatic Protection Switching (APS)

Measurement of disruption time on SONET, SDH interfaces
Tributaries: SONET, SDH
Pass/Fail range: 15 ms to 10 seconds
Resolution: 1 ms
Triggers: LOS, LOF, SONET FAS, B1, B2, B3, AIS-L, RDI-L, REI-L, AIS-P, LOP-P, RDI-P, REI-P, AIS-V, LSS
APS Byte (K1/K2) capture and decode

Pointer Analysis and Generation

Generation: ITU-T G.783 pointer sequences

Tandem Connection Monitoring (TCM)

Generation and analysis of Z5 and Z6 bytes
Errors generated: TC-IEC, TC-BIP, TC-REI, OEI
Alarms generated: TC-RDI, TC-UNEQ, TC-LTC, TC-AIS, TC-ODI
Detection, display, analysis and storage of events:
- TC-IEC, TC-AIS, TC-REI, TC-RDI, TC-OEI, TC-LTC, TC-UNEQ, TC-ODI, TC-TIM
- Analysis and generation of APId (Access Point Identifier)

OTN Functions

- OTU3 (43.0 Gbps) bit rate
- Frequency offset generation of bit rates by ± 50 ppm
- Synchronous and asynchronous mapping of SONET/SDH signals within OTN
- Forward error correction (FEC) testing
- OTU, ODU, OPU overhead manipulation and monitoring
- OTU, ODU and OPU layer alarms/errors generation and analysis
- OTU, ODU trace messages
- ODU multiplexing alarm-generation and analysis

OTN

Standards: ITU-T G.709, ITU-T G.798, ITU-T G.872
Test rates: OTU3 (43.0 Gbps)
Signal types: All SONET/SDH mappings supported

OTU Layer

Errors: OTU-FAS, OTU-MFAS, OTU-BEI, OTU-BIP-8
Alarms: LOF, OOF, LOM, OOM, OTU-AIS, OTU-TIM, OTU-BDI, OTU-IAE, OTU-BIAE
Trace Generation: 64-byte Trail Trace Identifier (TTI)

ODU Layer

Errors: ODU-BIP-8, ODU-BEI
Alarms: ODU-AIS, ODU-OCI, ODU-LCK, ODU-TIM, ODU-BDI, ODU-FSF, ODU-BSF, ODU-FSD, ODU-BSD
Trace Generation: 64-byte Trail Trace Identifier (TTI)

ODU Multiplexing

Alarms: OPU-MSIM, ODU-LOFLOM

OPU Layer

Alarms: OPU-PLM
Payload Type (PT): Generates and displays received PT value

Forward Error Correction (FEC)

Errors: FEC-Correctable, FEC-Uncorrectable

SONET/SDH/OTN Common Functions & Measurements

Frequency Measurement

Optical and Electrical Interfaces: Hz and ppm
Resolution: 1 Hz
TIE measurement on Pointer Justification Events

Round Trip Delay (available on all interfaces & mappings)

Measurement Range: 1 µS to 10 seconds
Resolution: ±1 µs or 1 U.I.

Event Logging

Date and time stamped events in tabular format

Histograms (available for all interfaces)

Display of Errors and Alarms versus time
Resolution: Seconds, minutes, hours and days

Ordering Information

Z22-00-005P	UX400 40G Test Module Single port, LC connector Internal mapping from 155 Mbps to 40G
Z22-00-008P	UX400 40G Test Module Single port, LC connector Internal mapping from 155 Mbps to 40G and OTU3e

Software Options

499-05-215	UX400 OTU-3
499-05-216	UX400 Low Rate Mapping support (from VT1.5/VT2 40G)
499-05-217	UX400 PDH (E3, E1, DS3, DS1) support (requires 499-05-216)
499-05-218	UX400 40G APS
499-05-219	UX400 40G Tandem Connection Monitoring
499-05-220	UX400 ITU-T G.783 Pointer Test Sequences

40/100GE Module Key Features

- Double Slot test module
- Single CFP port compliant to CFP MSA standards
- 40GE/100GE/OTU3/OTU4 test rates support (CFP dependant)
- OTU-3/4 ITU-T G.709 compliant
- 40GE/100GE framed and unframed BERT
- 256 multiple stream capability (100GE)
- Layer 2 and Layer 3 Ethernet BERT
- IPv4 and IPv6
- Flow control analysis
- External reference clock input
- Transmit frequency offset to stress the network up to ± 150 ppm
- OTU3 (43 Gbps) and OTU4 (112 Gbps) framed and unframed BERT

Specifications

Ethernet (100GE)

Modes of Operation
Terminate, Loopback

Traffic Generation
100G Ethernet traffic generation and reception > 100% wire speed
Layer 2, Layer 3
Test Frame Header:
- IEEE 802.3 and Ethernet II (DIX) frames
- Configurable Source and Destination MAC and Ethernet Type
- VLAN stacking up to 3 VLAN tags w/configurable priority & type
- Fully configurable IPv4 or IPv6 header
- MPLS up to 3 labels with configurable Label/S/CoS and TTL fields (optional)

Frame size 64 to 1518 bytes and jumbo frame up to 10000 bytes
Traffic Pattern (Throughput Test and BERT only): Constant, Ramp, Multi Bursts, Single Burst
Error Injection (Throughput Test and BERT only): Bit, CRC, IP Checksum, Pause

RFC2544 Compliance Testing
Automated tests compliant with RFC2544 with configurable threshold values and maximum transmit bandwidth settings
Throughput, Latency, Frame Loss, and Back-to-Back (burst) tests
Frame sizes: 64, 128, 256, 512, 1024, 1280, and 1518 bytes including 2 user configurable frames
Test can be done to a remote loopback

Bit Error Rate Testing
Single Stream test with test pattern PRBS: 2^{31}-1, normal & inverted

Smart Loopback Mode
Layer 2: all incoming unicast traffic is looped back with MAC source and destination addresses swapped
Layer 3: all incoming unicast traffic is looped back with MAC and IP source and destination addresses swapped
All key measurements on received traffic provided on loopback unit

Key Measurements
Error Measurements: Bit/BER (BERT and single stream Throughput Test), CRC, symbol, IP checksum, TCP/UDP checksum, jabber frames, runt frames, Frame loss (count and %), OSS
Alarm Detection: LOS, pattern loss, service disruption
Frame/Packet Statistics: Multicast, broadcast, unicast, pause frames, frame size distribution
Rates (min, max, average and current): frame rate, bandwidth utilization, frame rate, line rate, data rate
Delay (min, max, average and current): round trip delay, inter frame gap, jitter

IPv6
IPv6 compliant test traffic generation and analysis for all test applications (RFC2544, BERT and Throughput)

PCS
TX Lane Mapping: user configurable lane mapping
Skew generation (TX) per PCS lane pair: up to 16,000 per CAUI
Skew compensation (RX): 4000 bits
Skew Alarm Threshold settings
64/66B Alarm generation/detection: HI-BER
PCS Alarm generation/detection: Loss of Alignment Marker Lock (LOAML), Loss of Block Lock (LOBL)
PCS Error generation/detection: Invalid Sync Header (ISH), Invalid Align Marker (IAM), BIP 8
Error Injection Types: Single, Burst, Rate (1E-3 to 1E-9)
Alarm Injection Type: continuous

100GE CFP Module

Compliant to IEEE 802.3ba 100GBase-LR4 and 100GBase-LR10
103.125 Gbps Single Rate
Transmission length up to 10 km
1310 nm uncooled EA-DFB LD optical light source
PIN Photo detector optical receiver
Operating temperature: -5˚C to 70˚C

Ordering Information

Z22-00-006P	UX400 40GE Test Module Includes 40GE Test Protocol
Z22-00-007P	UX400 40GE/100GE Test Module Test protocol not included

Software Options

499-05-211	UX400 40GE Test Protocol
499-05-212	UX400 100GE Test Protocol
499-05-214	UX400 Multiple Stream

General

Display	TFT 10.4” full color touch-screen LCD
Interfaces	VFL - Visual Fault Locator (optional) OPM - Optical Power Meter (optional) 10/100/1000Base-T management port (RJ45) Wi-Fi 802.11b/g/n (optional USB dongle) Bluetooth 2.0 (optional USB dongle) 2x USB2.0; VGA monitor port
GPS	
Audio	Standard headphone/microphone jacks (3.5mm), Built-in speaker
Languages	Multiple languages can be supported
Battery	Li-ion smart battery; 8400 mAh 14.8VDC
AC Adaptor	Input: 100-240 VAC, 50-60 Hz Output: 19 VDC, 9.47 A
Size	360 x 270 x 180 mm (W x H x D) 14.2 x 10.6 x 7.1 in
Weight	Less than 10 kg (22 lb) with battery Less than 15 kg (33 lb) fully loaded with modules and battery
Operating Temperature	0˚C to 45˚C (32˚F to 113˚F)
Storage Temperature	-20˚C to 70˚C (-4˚F to 158˚F)
Humidity	5% to 95% non-condensing
Ruggedness	Survives 0.5 m drop to concrete on all sides
Certifications	CE

Ordering Information

Z08-00-001P	VePAL UX400 Universal Test Platform

Hardware

B02-12-001G	UX400 Battery Pack
Z66-00-038G	UX400 VFL
Z66-00-039G	UX400 GPS (antenna not included)
Z66-00-040G	UX400 Atomic Clock
Z66-00-077P	UX400 OPM

Software

Refer to individual Test Module pages.

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