VIAVI Solutions

VIAVI
T-BERD/MTS-5800–100G, MAP-2100 and 100G Module (OneAdvisor 1000)

Specifications for 100G Handheld Network and Fiber Tester and matching centralized rackmount unit

T-BERD/MTS-5800–100G Platform

Platform Attributes
The unit is small and portable
The mainframe is expandable with modules
The product is field upgradeable
Operating system is Linux to ensure optimum stability and offer high security

Display
Display size 7 inches with 1200x600 resolution
Screen Saver support
Physical screen protector provided
Mode that 'locks' the touchscreen for use without a password

Power/Battery
Supports battery operation with seemless swapping between AC and DC
Built-in battery charger
Battery is field replaceable
Can perform two 100GE tests for at least 1 hour on battery power
Can perform one 100GE test for at least 1:30 hours on battery power
Can perform two 10G tests for at least 2:00 hours on battery power
Unit power input 19VDC, 150 Watt Power supply input 100 to 240 VAC, 50/60 Hz, auto-sensing

Field Operation
Portable, AC or battery operated, switches without disruption, and is rugged for field operations
Protected by bumpers

Weight and Size
Weight of 2.45kg while supporting dual 100G rates Size of 17.78 x 24.13 x 8cm

Expansion Modules	
T-BERD/MTS-5800-100G supports all 2000 modules in addition to the Timing Expansion Module and DEM. List includes, but is not limited, to:	
TEM (Timing Expansion Module) with Rubidium oscillator and TEM2 which offers dual-frequency support	
DEM (Datacom Expansion Module) to support legacy interfaces such as RS-232/V.28, V.11, and V.35	
Multiple OTDRs	· Multimode · Quad · Last Mile · Metro Access · Metro PON · CWDM · DWDM · FiberComplete: bi-directional testing of ORL, IL, OTDR
CWDM and DWDM Channel Checker	
MPO Switch	
Full-band nano-OSA	

Included Items
User manual
AC power source
AC power cords
Soft carrying case for unit and pluggable optics

MAP-2100 Platform

Platform Attributes

A thin 1RU Rackmount unit with the same UI as T-BERD/MTS-5800-100G

The product is field upgradeable

Operating system is Linux to ensure optimum stability and offer high security

Recessed reset button for factory reset

Power/Battery

Supports AC operation; may consume up to a maximum of 150W

Equipped with toggle power switch and soft power button

Power input 100 to 240 VAC, 50/60 Hz, auto-sensing

Fan Support

Field replaceable fan tray

Equipped with replaceable fan filter
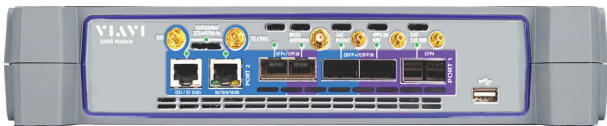
Optical Switch Support

Optionally equipped with an optical switch supporting dual 1x4 port switching

LC connectors

Weight and Size

Weight: 5.9kg
Size: 4.4 x 44.2 x 37.5cm

100G Module (OneAdvisor 1000)

Module Attributes

The 100G Module is for the OneAdvisor 1000 platform

It has its own storage system and processor

The 100G Module has its own onboard processor as the 5800-100G/MAP-2100

It has its own USB port

The 100G Module runs the same software applications as the 5800-100G/MAP-2100

See the OneAdvisor 1000 datasheet for more s summary information

T-BERD/MTS-5800–100G, MAP-2100 and 100G Module (OneAdvisor 1000) Platforms

Industry Standards and Compliance

Safety: UL, CE

EMC: CE compliant, FCC part 15 subpart A, Class A; EN 61326-1 and ETSI EN 301 489-1

FCC Part 15 Compliant

Physical and Environment Specifications

Temperature range:

    Operating, with dual 100GE: 0°C to +40°C

    Operating, with dual 10GE: 0°C to +50°C

    Storage: - 20°C to +60°C (-4°F to +140°F)

Storage Humidity: 10-95% without condensing.

Operating Humidity: 10-90% without condensing.

Drop Test - Shock

per IEC 68-2-27 and 68-2-29 Ed. 2.0

Drop Test - Durability

per IEC 721-3-7 2nd Ed./IEC 61010-1

Vibration

per IEC 68-2-6 and MIL-PRF-28800F (Class 2)

Operation

Can be turned on and operational in 3 minutes or less

Accepts operations on display screen or with an external keyboard

Boots to a simplified launch page allowing the user to select previous test configurations and/or favorite test configurations

I/O's

Includes the following I/O interfaces

    VT100 (RJ-45)

    2 x USB

    RJ-45 (Ethernet/IP)

    Serial

    WiFi (T-BERD/MTS-5800-100G only)

Bluetooth (T-BERD/MTS-5800-100G only)	Comments: · Bluetooth headset support for VoIP and PRI calls · Bluetooth tethering to iOS devices for file transfer

GNSS (Global Navigation Satellite System)

Can download data to PC, Android device, IOS device or compatible device via standard interface or protocol

Internal Reference: ±1.5 ppm

Clock

Internal Reference: ±1.5 ppm

T-BERD/MTS-5800–100G, MAP-2100 and 100G Module (OneAdvisor 1000) Platforms (Continued)

Built-in GNSS

Results	Event log
	Date and Time
	Sky Plot
	Signal Strength per satellite
	Carrier to Noise Density (CNO) Table
	Carrier to Noise Density (CNO)
Spectrogram	Number of Satellites: up to 72
	Longitude, latitude, altitude
	GNSS types: GPS, GLONASS, BeiDou, SBAS, Galileo, QZSS
SBAS	Settings:
	Time type: GPS, UTC
	Antenna power: 0, 3.3, 5 volts
	Antenna Time Bias (nsec)
	Survey Mode: Quick, Fast, Typical
Extended, Manual	Assign fixed position
	Timed test

Test, Files and Data Storage

Report Generation: HTML, PDF, TXT, CSV, XML

Ability to create a customized name structure

Supports screen capture

Internal storage capacity shall of at least 3GBbytes. 5800-100G is expandable to 128GBytes via C5EXTSTOR Option.

Job Manager to push common job information into multiple test applications

Ability to create summary reports including all tests performed in a job with pass/fail verdict of each

Job Manager

Workflow tool to support:
· Execution and uploading of user defined test plan
· Maintaining of live status including reporting of individual tests results based on pass/fail
· Reporting of single test report for multiple tests

Remote Operation

Can be remotely controlled via VNC and/or SmartAccess Anywhere (Android, IOS, Windows)

Access via SSH encryption or local tether with SmartAccess Anywhere application. Use MobileTech to get a SmartAccess Anywhere code for the application.

Can control the UI and transfer files concurrently with SmartAccess Anywhere application

Unit supports a high security firewall mode with only port 22 open coupled with encryption of at least 192 bits

Unit supports a password composed of at least 16 characters including special characters

Calibration

Calibration interval of 3 years

Warranty

1 year warranty

Saved Configurations

Can save test configurations for future recall

Can transfer pre-defined test configurations between test sets

25G, 40G, 50G, 100G Ethernet

Test Interfaces/Bit Rates (All dual-port capable)

4x10GE LAN on QSFP+ (up to 8x10GE with dual-port)

25GigE (25.78125Gb/s) RS-FEC and bypass

40GigE (41.25Gb/s)

50GigE (53.125Gb/s) with KP4 RS-FEC

100GigE (103.125Gb/s)

100GigE with KR4 RS-FEC (103.125Gb/s)

100GigE with KP4 RS-FEC (106.25Gb/s)

Interface Type

SFP28	**Applications:** · 25G
QSFP+	**Applications:** · 40G
QSFP28	**Applications:** · 100G, 50G
CFP4	**Applications:** · 100G

General

Line Rate Traffic Tx and RX for all Interfaces

Single Stream Generation/Analysis

Up to 16 Streams Generation/Analysis	**Comments:** · With VIAVI (Acterna) test frame pattern (ATP)
Power Level (aggregate)	**Comments:** · Provided by optics
Tx/Rx Power Level (per lambda)	**Comments:** · Provided by optics

Modes Of Operation

Terminate

Monitor/Thru	**Comments:** · Monitoring on Rx while keeping Tx up via idles
Logical Loopback	**Comments:** · Manual and Loop up/down; switching of addresses at Layer 2 and Layer 3

Timing

Recovered from Rx	**Comments:** · Synchronous Ethernet Applications
Internal (Stratum 3)	
Recovered from External (BITs/SETs)	**Comments:** · BITS / SETS / 2.048MHz / 10MHz
Frequency Offset Transmit/Receive	**Comments:** · Required for Synchronous Ethernet Applications, +/- 150ppm range

25G, 40G, 50G, 100G Ethernet (Continued)

Ethernet Features

Layer 1 (Unframed) Patterns

Scrambled idle PCS BERT pattern
Unframed BERT per lane: 4x10G, 4x11G, 4x25G, 4x28G

Framed Pattern Test

PRBS 2^{31-1} and inverse
User defined Digital Word
PRBS Payload Patterns
2^{31-1}, 2^{31-1} Inverse

MAC Frame Payload

PRBS Pattern; Payload threshold pass/fail with user settable BER and/or bit error count, applicable to rates without FEC
ATPv2 and ATPv3 can run concurrently with PRBS

Flow Control

Emulation On/Off

Pause Frames

Tx Insert	
Pause Quanta - Definable	
Pause Frame Analysis (counts etc)	
Loop Protection	**Comments:** Protects a test between 2 ports. Prevents a remotely initiated test in progress from being interruption from loop up/down or test connection.

Ethernet Generator

Skew injection per Virtual Lane:

100GE: 0 to 32000 (6206 ns) bits per lane
40GE: 0 to 32000 (3103 ns) bits per lane

Skew alarm (Rx) threshold settings	**Compliance:** · Defaults to 180 ns
	Comments: · Up to 6206 ns for 40GE; Up to 12412 ns for 100GE

Skew reporting per virtual lane

Tx/Rx Decoupling Mode (for Service Disruption Measurements)	**Comments:** · On incoming alarms such as LOF or Remote Fault, traffic generator is not affected (no alarm response)

Frame Type

802.3
DIX (Type II)
VLAN / Q-in-Q
MPLS (1 or 2 labels)
Ethertype editing

MAC Addressing

Destination MAC Address - Unicast
Destination MAC Address - Broadcast
Destination MAC Address - Multicast
Destination MAC Address - ARP Support (IPv4)
Source MAC Address - User Defined

Source MAC Address - Auto-increment MAC	**Comments:** · For LAG testing, No. of MACs in sequence, disable OOS

MAC Frame Size

64, 128, 256, 512, 1024, 1280, 1518
User defined
Jumbo (up to 16000 bytes)
EMIX
Random

VLAN (802.1q)

VLAN Tag Editable Fields
VLAN ID
User Priority

VLAN Stacking (Q-in-Q)

SVLAN Tag Editable Fields
SVLAN ID
SVLAN User Priority
SVLAN DEI Bit
SVLAN TPID
CVLAN Tag Editable Fields
VLAN ID
User Priority

MPLS

Single and Dual Label Support
MPLS Unicast
MPLS Multicast
MPLS Editable Parameters
MPLS Label
MPLS Priority
MPLS TTL

Y.1731 Service OAM and 802.1ag CFM

CCM Messages
Programmable CCM Rate
CCM Type - Unicast, Multicast
MEG ID End Point
Maintenance Domain Level
AIS Tx/Rx
RDI Tx/Rx
LBR/LBM (Ping) - Unicast, MultiCast
LTM/LTR (Trace)

MEP Discovery	**Comments** · Auto discovery of all MEPs on the Network

IP Packet Generator

IP

IPv4 Frame Format
IPv6 Frame Format

25G, 40G, 50G, 100G Ethernet (Continued)

TCP Port Number	Comments · Source & Destination Port
UDP Port Number	Comments · Source & Destination Port

IP Addressing

Destination IP Address - User Defined

Source IP Address - User Defined and auto-increment

IPv4 Editable Fields

    ToS

    DSCP

    Flags

    Protocol

    TTL

IPv6 Editable Fields

    Traffic Class

    Flow Label

    Next Header

    Hop Limit

IP Ping

Fast Ping

IP TraceRoute

Traffic Generator

Traffic Profiles

    Traffic generation in Mbit/s and % utilization

    Constant B/W

    Burst B/W (duty cycle, bytes/frames/burst up to 33.6 Mbytes, continuous/no. of bursts)

    Ramp B/W (timed step, load step %, stop increment on errors/dropped)

Flood B/W	Comments: · Full line rate

Constant B/w

Bit Rate	Comments: · 0.1 Mbps granularity
Percentage	Comments: · 0.001% granularity

Burst B/w

    Bytes and Information Rate (IR)

        Information Rate (Mbps)

        Burst kBytes

    Continuous or fixed (up to 65535) bursts

    Burst Time and Information Rate (IR)

        Information Rate (Mbps)

        Burst Time

    Continuous or fixed (up to 65535) bursts

    Bytes and Gap Time

        Gap/Idle Time

        Burst kBytes

    Continuous or fixed (up to 65535) bursts

    Burst Time and Gap Time

        Burst Time

        Gap/Idle Time

    Continuous or fixed (up to 65535) bursts

    Frames and Duty Cycle

        Duty Cycle (%)

        Frames/Burst (up to 2M)

    Continuous or fixed (up to 65535) bursts

Ramp B/w

    Timed Step (0.1 sec granularity)

    Load Step (0.001% granularity)

    Stop load incr conditions

        Errored Frames (count parameter)

        Dropped Frames (count parameter)

        Pause Frames (count parameter)

RS-FEC Settings

Incoming FEC

    Find and fix errors (default)

    Find but don't fix errors

    Ignore

Disable HI SER Alarms

    Off (default)

    On

KP4 FEC Correctable RS-FEC BER Threshold alarm, defaults to 2.4×10^{-4}

TCP Throughput

100GigE Linerate Stateful Emulation

Configurable Src and Dest IP address

Packet length

TCP/UDP Traffic Modes

Source Port

Destination Port

Listen Port

Configurable TCP Window Size

Measures TCP Efficiency

Measures Buffer Delay

TCP Client Emulation

TCP Server Emulation

Up to 64 TCP Stateful Sessions Simultaneously

Supports 4 Background Streams

Compatible with IPERF, including version 3

RFC2544/RFC 5180 (IPv6)

    Asymmetric Testing

    Symmetric Testing

    Throughput

    Frame Loss

    Out of sequence frames

    Errored Frames

    Delay

25G, 40G, 50G, 100G Ethernet (Continued)

Back to Back	
Committed Burst Size (CBS)	
Policer Test	
Jitter	
Master/Slave	
Pass/Fail Thresholds per MEF 23.1	
Connectivity QuickCheck	**Comments:** · Enables quick verification of end to end connectivity before executing an RFC test
Parallel Testing	**Comments:** · Reduces test times by 50% by performing Latency, Throughput and Jitter tests simultaneously
Optional Testing with line rate LBM frames	
Definable Frame Size	
LAG Support	
Sequential MAC Addresses	
Suppression of OOS Frames	
Report formats	
Graphical Results	
Total Test Time Display	

ITU-T Y.1564

- Up to 16 Traffic Streams
- Service Configuration Test
- Service Performance Test
- Committed Information Rate (CIR)
- Extended IR (EIR)
- Maximum Ir (MIR)
- Frame Loss Rate (FLR)
- Frame Delay (FD)
- Frame Delay Variation
- Committed Burst Size (CBS)
- Policer Test
- Round Trip Testing

Concurrent Bi-directional Testing	**Comments:** · Enables each test set to perform and collect 1564 results for bi-directional analysis.

- Configurable VLAN, Priority, Addressing and Pass/Fail Thresholds
- Programmable Pass/Fail Thresholds
- Graphical Results
- Screenshot Support
- Auto-Negotiation Check
- Saved Test Profiles
- Saved Reports
- Configurable DEI, TPID, TOS/DSCP
- Inclusive of L2 Ethernet, IPv4, and IPv6
- Integrated TrueSpeed TCP traffic stream with background streams
- Optional Testing with line rate LBM frames

- Asymmetric Testing
- LAG Support
  - Sequential MAC Addresses
  - Suppression of OOS Frames

IETF RFC 6349

- Supported on 100GigE Interfaces
- Automated TCP Throughput test per RFC 6349
- IPv4 and IPv6 Support
- Path MTU Detection Test
- Round Trip TimeTest
- Walk the Window Test
- TCP Throughput Test
- Traffic Shaping Test
- TCP Efficiency Metric
- Buffer Delay Metric
- Up to 64 TCP Stateful Sessions Simultaneously
- 1 KB TCP Window Size Granularity
- Jumbo Frame Support
- Graphical Results and Report Generation
- Configurable File Sizes and Window Sizes
- Total Test Time Display
- Configurable Saturation Window Test
- Compatible with the following endpoints:
- T-BERD/MTS instruments
- QT-600 Ethenet Probes
- TrueSpeed VNF Server
- RFC 6349 application to interwork with
- Fusion/TrueSpeed VNF

Layer 2 Transparency Testing

Verifies Transparent forwarding of Control Plane traffic through Ethernet switch fabrics.

- Send/Receive Ethernet Control Plane Traffic
- Encapsulation Supported - VLAN
- Encapsulation Supported - QinQ
- Encapsulation Supported - Spanning Tree
- Encapsulation Supported - Cisco Protocols (Discovery etc.)
- Encapsulation Supported - IEEE
- Send/Receive Ethernet Control Plane Traffic
  - Spanning Tree Protocol (STP)
  - Rapid Spanning Tree Protocol (RSTP)
  - Multiple Spanning Tree Protocol (MSTP)
  - Link Layer Discovery (LLDP)
  - Generic Multicast Registration (GMRP)
  - Generic VLAN Registration (GVRP)
  - Cisco Discovery Protocol (CDP)
  - Link Aggregation Control Protocol (LACP)
  - Port Aggregate Protocol (PAgP)
  - Unidirection Link Detection (UDLD)

25G, 40G, 50G, 100G Ethernet (Continued)

	Dynamic Trunking Protocol (DTP)
	Inter-Switch Link (ISL)
	Per VLAN Spanning Tree (PVST-PVST+)
	STP-ULFAST
	VLAN-BRDGS
	802.1d
	VLAN Trunking (VTP)
	Custom Frame Builder

Loopback

Manual (LLB)
Automatic
Local
Far End

Class of Service Measurements

Throughput (Tx/Rx)

Frame Loss (Rate and Ratio)

OoS Frames	**Comments:** · Out-of-sequence

Round-trip Delay

Acterna Test Protocol Version 3 (default) (RTD)

For 100GE, high-accuracy of +/- 65 nsec or better using a hard loopback with 10 nsec resolution

Acterna Test Protocol Version 2

One-Way Delay (OWD)

Acterna Test Protocol Version 3

For 100GE: +/- 100 nsec accuracy with 10 nsec resolution.
Use GNSS with accurate position survey, used matched cable lengths with matching antenna time bias. Error may increase with very large distances.

Packet Jitter (Frame Delay Variation)

Capture/Decode

Wirespeed Capture

Integrated Wireshark on the TestSet	**Comments:** · Viewing capture files can be performed directly on the test set and not require a separate laptop/PC.

256MB Capture Buffer

Triggers and filters

Tx and Rx Capture	**Comments:** · Captures traffic on the test interface receiver and transmitter.

Frame Slicing

Expert Decode/Analysis

Decode/Analysis Capture Files

Detect Half-Duflex Ports

Detect ICMP Layer Issues

Identify Top Talkers

TCP Layer Diagnosis - ex. Retransmissions

Traffic Filtering

Ethernet (Layer 2) Traffic Filtering

MAC destination address

MAC source address

VLAN (Layer 2.5) Tag

VLAN ID

VLAN User Priority

Q-in-Q VLAN (Layer 2.5) Tags

SVLAN Fields

SVLAN ID

SVLAN User Priority

SVLAN DEI Bit

SVLAN TPID

CVLAN Fields

VLAN ID

User Priority

IPv6 5G NR Discovery

Discover MAC Address, VLAN ID, IPv6 addresses over 10 GE and 2 5 GE interfaces

MPLS

MPLS Label

MPLS Priority

IP (Layer 3) Traffic Filtering

Destination address

Source address

Source Subnet mask

TOS/DSCP fields (IPv4)

Protocol (IPv4)

IPv6 Traffic Class

IPv6 Next Header

Payload analysis on/off

Errors Tx/Rx

Errors

Code Violation	**Comments:** · Per lane/all lanes; Single/Burst (up to 128)/Rate (10^{-3} to 10^{-10})
Alignment Marker	**Comments:** · Per lane/all lanes; Single/Burst (up to 8)/Rate (10^{-3} to 10^{-10})
BIP-8	**Comments:** · Per lane/all lanes; Single/Burst (up to 128)/Rate (10^{-3} to 10^{-10})
Undersized	**Comments:** · Single/Burst (up to 16)
Runt	**Comments:** · Single/Burst (up to 16)
FCS	**Comments:** · Single/Burst (up to 32767)
Acterna Payload	**Comments:** · Single/Burst (up to 32767)
IPv4 Checksum	**Comments:** · Single/Burst (up to 32767)

25G, 40G, 50G, 100G Ethernet (Continued)

Bit Error (PRBS)	**Comments:** · Single/Rate (10^{-3} to 10^{-10})
RS-FEC Correctable	**Comments:** · Single/Continuous
RS-FEC Uncorrectable	**Comments:** · Single/Continuous

Alarms Tx/Rx

Alarms

HI BER	**Comments:** · High Bit Error Rate (from Sync Header Bits)
LOBL	**Comments:** · Per lane/all lanes; Loss of Block Lock
LOAML	**Comments:** · Per lane/all lanes; Loss of Alignment Marker Lock
LOAMPS	**Comments:** · Loss of Alignment Marker Payload Sequence
RS-FEC LOCWMS (25GE)	
RS-FEC LOAMP	
RS-FEC HI SER	

Faults

Local Fault
Remote Fault

Service Disruption Measurements

Measurement Parameters	Separation Time
	Threshold Time
Triggers	Signal Loss
	Sync Loss
	Local Fault
	Remote Fault
	Errored Blocks (PCS)
	Code Violation
	Interframe Gap with threshold
	Interframe Gap for ATP frames with threshold
	FCS

Results

Custom results

Histogram and Graphical Results Script

LEDS

Signal Present
Sync Acquired
Link Active
Marker Lock
Loss of Alignment
HI BER
Frame Detect
ATP Detect

Pattern Sync	
VLAN Frame Detect	
SVLAN Frame Detect	
Local Fault	
Remote Fault	
RS-FEC LOCWMS (25GE)	**Comments:** · Loss of Codeword Marker Sync
RS-FEC LOAMP	**Comments:** · Loss of Alignment Marker Payload
RS-FEC LOA	**Comments:** · Loss of Alignment
RS-FEC HI SER	**Comments:** · High Symbol Error Rate

Time Source

ToD Sync
1PPS Sync

SLA/KPI

Throughput Current	
Rx & Tx Mbps L1	
Rx & Tx Mbps L2	
Frame Loss (count & ratio)	
Round Trip Delay/FD (average, current, maximum)	
One Way Delay (average, current, maximum)	
Packet Jitter/FDV (average, max avg, peak, instantaneous)	
Service Disruption Summary Table	
Service Disruption Details	
Service Disruption Statistics	Longest
	Shortest
	Last
	Average
	Number of Disruptions

Interface

Signal Losses
Signal Loss Seconds
Sync Loss Seconds
Link Loss Seconds
CFP2 Optical Rx Overload
Optical Rx Level (dBm)
Rx Frequency (Hz)
Rx Frequency Deviation (ppm)
Rx Frequency Max Deviation (ppm)
Tx Clock Source
Tx Frequency (Hz)
Tx Frequency Deviation (ppm)
Tx Freq Max Deviation (ppm)
Local Fault Seconds
Remote Fault Seconds

25G, 40G, 50G, 100G Ethernet (Continued)

Per lambda Rx power	**Comments:** · Optics dependent

L2 Link counts/statistics (most stats also per stream)

Bandwidth utilization % (avg, current, min, peak)

Bandwidth utilization Mbps (Rx, Tx, L1, L2)

Current utilization % (unicast, multicast, broadcast)

Rx Pause Length (ms) (current, min, max)

Frame rate (avg, current, min, peak)

Frame size (avg, min, max)

Round Trip Delay/FD (average, current, max, min)

Packet Jitter/FDV (average, max avg, peak, instantaneous)

VLAN (ID, User Priority)

SVLAN (ID, User Priority, DEI)

Peak IFG Gap (usec)

One Way Delay (average, current, max, min)

Received frames

Transmitted frames

Tx Acterna frames

Pause frames

Rx VLAN frames

Rx Q-in-Q frames

Unicast frames

Multicast frames

Broadcast frames

Rx Frame Bytes

Tx Frame Bytes

Span Tree Frames

64 Byte Frames

65-127 Byte Frames

128-255 Byte Frames

256-511 Byte Frames

512-1023 Byte Frames

1024-<Jumbo Frames

Jumbo Frames	**Comments:** · Measures longest gap between frames

L3 Link counts/statistics (most stats also per stream)

Bandwidth utilization % (avg, current, min, peak)

Packet rate (avg, current, min, peak)

Packet size (avg, min, max)

Bandwidth utilization Mbps (Rx, Tx, L3)

TOS

Received Packets

Transmitted Packets

Unicast Packets

Multicast Packets

Broadcast Packets

20-45 Byte Packets

46-63 Byte Packets

64-127 Byte Packets

128-255 Byte Packets

256-511 Byte Packets

512-1023 Byte Packets

1024-1500 Packets

>1500 Packets

IPv6 Tx Router Solicitations

IPv6 Rx Router Advertisements

L2 Filtered counts/statistics

L3 Filtered counts/statistics

BERT

Pattern Losses

Pattern Loss Seconds

Bit Errors

Bit Error Rate

Bit Error Seconds

Bit Error-Free Seconds

Bit Error-Free Seconds, %

PCS Stats

invalid Alignment Markers

invalid Alignment Marker Rate

invalid Alignment Marker Seconds

Alignment Marker Lock

Alignment Marker Lock History

Alignment Marker Loss Seconds

BIP-8 AM Bit Errors

BIP-8 AM Bit Error Rate

BIP-8 AM Bit Error Seconds

BIP-8 AM Block Errors

BIP-8 AM Block Error Rate

BIP-8 AM Block Error Seconds

Max Skew (Bits)

Current Max Skew (Bits)

Max Skew (ns)

Current Max Skew (ns)

Max Virtual Lane Skew (VLID)

Min Virtual Lane Skew (VLID)

Loss of Alignment

HI BER

HI BER History

HI BER Seconds

PCS Block Errors	**Comments:** · List similar to L2 Link counts/statistics
PCS Block Error Seconds	**Comments:** · List similar to L3 Link counts/statistics

25G, 40G, 50G, 100G Ethernet (Continued)

Per Lane

    Lane #

    Virtual Lane ID

    Skew (Bits, nsec)

    Sync Acquired

    Marker Lock

    Code Violations

    Invalid Alignment Markers

    BIP-8 AM Bit Errors

    BIP-8 AM Block Errors

RS-FEC

    LOCWMS Alarm (25GE)

    LOCWMS Seconds (25GE)

    LOAMPS Alarm

    LOAMPS Seconds

    LOA Alarm

    LOA Seconds

    HI SER Alarm

    HI SER Seconds

    RS-FEC Correctable Count

    RS-FEC Correctable Rate

    RS-FEC Uncorrectable Count

    RS-FEC Uncorrectable Rate

    Error Distribution 1 to 15 Symbols for KP4 RS-FEC

Capture	Comments: · Up to 256 Mbytes
Packets processed	
Capture progress %	

J-Proof Results

    Name

    Tx

    Rx

    Status

Error Statistics

    Code Violations

    Code Violation Rate

    Code Violation Seconds

    Runts/Undersized

    Jabbers

    FCS errored frames

    Errored Frames

    IP Checksum Errors (IPv4)

    IP Packet Length Errors

    Acterna Payload Errors

    Packet Error Rate

    Lost Frames

    Frame Loss Ratio

    OoS Frames

    Errored Second

    Severely Errored Seconds

    Unavailable Seconds

    Errored Second Ratio

    Severely Errored Second Ratio

Event Log

    Event, Date, Start Time, Stop Time, Duration, Value

Real Time Histogram

    Seconds, Minutes, Hours, Days

Time

    Current Date, Current Time, Test Elapsed Time

Graphical Displays

Errors versus Time

Frame Loss versus Time

Packet Jitter versus Time

Latency versus Time

Throughput versus Time

IEEE 1588v2 PTP

25GE PTP and 100GE PTP are available. See under 1G, 10G Ethernet for PTP coverage.

1G, 10G Ethernet

Test Interfaces/Bit Rates (All dual-port capable)
10/100/1000M Electrical
100Base-FX (Optical)
GigE (Optical)
10GEBASE-T Electrical
10GigE WAN Phy (9.9G)
10GigE LAN Phy (10.3G)
2.5GBase-T/5GBase-T/10GBase-T (requires specific SFP+)

Interface Type
RJ-45
SFP
SFP+
SFP28

General	
Line Rate Traffic Tx and RX for all Interfaces	
Single Stream Generation/Analysis	
Up to 16 Streams Generation/Analysis	
Auto Discovery of Test Sets	**Comments:** · Automatically discovers additional test sets on the network for loopback/end to end testing
Power Level	**Comments:** · Provided by SFP/SFP+

Modes Of Operation
Terminate
Monitor
Thru (Intrusive)
Loopback
Half Duplex
Full Duplex

Timing	
Recovered from Rx	**Comments:** · Required for Synchronous Ethernet Applications
Internal (Stratum 3)	
Recovered from External (BITs/SETs)	
Freq Offset Transmit/Receive	**Comments:** · Required for Synchronous Ethernet Applications

Ethernet Features	
GE Layer 1 (Unframed) Bit Error Testing Patterns	
High Frequency test pattern	**Comments:** · Per IEEE 802.3, 2000 Edition, Annex 36A:
Low frequency test pattern	**Comments:** · Per IEEE 802.3, 2000 Edition, Annex 36A:
Mixed frequency test pattern	**Comments:** · Per IEEE 802.3, 2000 Edition, Annex 36A:

Random Data Pattern (RPAT)	**Comments:** · Per NCITS TF-25-1999
Jitter Tolerance Test Pattern (JTPAT)	**Comments:** · Per NCITS TF-25-1999
Supply Noise Test Sequence (SPAT)	**Comments:** · Per NCITS TF-25-1999

Unframed BERT on SFP: 1x10G, 1x25G

GE Layer 2 (Framed) Bit Error Testing Patterns
Compliant Random Data Pattern (CRPAT)
Compliant Jitter Tolerance Pattern (CJPAT)
Compliant Supply Noise Pattern (CSPAT)

10 GE Layer 1 (Unframed) Bit Error Testing Patterns
A Seed
B Seed
PRBS 31

Framed Pattern Test
PRBS (2^{11-1}, 2^{15-1}, 2^{20-1}, 2^{23-1}, 2^{31-1} and inverse)
All 1s
All 0s
1:3
1:7
3:1
7:1
2 in 8
User defined

MAC Frame Payload
PRBS Pattern; Payload threshold pass/fail with user settable BER and/or bit error count
Editable Digital Word
ATPv2 and ATPv3, can run concurrently with PRBS

Flow Control
Emulation On/Off

Pause Frames	
Tx Insert	
Pause Quanta - Definable	
Pause Frame Analysis (counts etc)	
Loop Protection	**Comments:** Protects a test between 2 ports. Prevents a remotely initiated test in progress from being interruption from loop up/down or test connection.

Ethernet Generator	
10GE Tx/Rx Decoupling Mode (for Service Disruption Measurements)	**Comments:** · On incoming alarms such as LOF or Remote Fault, traffic generator is not affected (no alarm response)

Frame Type
802.3
DIX
VPLS with inner and outer MAC
MAC in MAC 802.1ah
EtherType Field - Editable

1G, 10G Ethernet (Continued)

MAC Addressing

Destination MAC Address - Unicast

Destination MAC Address - Broadcast

Destination MAC Address - Multicast

Destination MAC Address - ARP Support (IPv4)

Source MAC Address - User Defined

Source MAC Address - Auto Increment	Comments: · Automatically increments the source MAC address to replicate multiple source MACs.

MAC Frame Size

64, 128, 256, 512, 1024, 1280, 1518

User defined

Jumbo (to 16000)

EMIX

Random

VLAN

VLAN Tagging 802.1q

VLAN Tag Editable Fields

Priority

VID

VLAN Scan

VLAN Stacking (Q-in-Q)

SVLAN Tag Editable Fields

SVLAN ID

SVLAN Priority

SVLAN DEI

SVLAN TPID

CVLAN ID

CVLAN Priority

Support up to 8 stacked VLAN Tags

VPLS

VPLS Parameters - MAC Addresses

VPLS Parameters - Frame Type

VPLS Parameters - Ethertype

VPLS Tunnel and VC Label - Lavel, CoS, TTL

VPLS Control Word - Reserved Bits, Sequence Number

MAC in MAC/PBT/PBB

Parameters - MAC Address

B-Tag - TPI, VID, Priority, DEI

I-Tag - TPI, SID, Priority, DEI, NCA, Res1, Res2

MPLS

Single Label Support

Stacked Label Support - Up to 2	Comments: · Supports up to 2 MPLS tags

Editable Parameters/Results - Label

Editable Parameters/Results - CoS

Editable Parameters/Results - TTL

MPLS-TP

MPLS-TP Label Support (Tunnel and VC)

VLAN Tag Support

Linerate Traffic Generation

Traffic Analysis

Editable Parameters/Results - Label

Editable Parameters/Results - Priority

Editable Parameters/Results - TTL

Rx Filters

GAL (Label 13) + ACH from ITU-T G.8113.1

Common Header Label - PW, LSP, Section

CCM Generation and Analysis

LBM/LBR Generate and Analysis

AIS Generate and Analysis

OAM Alert Label (Label 14) from ITU-T G.8114

Common Header Label - PW, LSP, Section

CCM Generation and Analysis

LBM/LBR Generate and Analysis

AIS Generate and Analysis

OAM Alert Label (Label 14) from ITU-T Y.1711

Common Header Label - PW, LSP, Section

CCM Generation and Analysis

FFD Generation and Analysis

BDI Generation and Analysis

FDI Generation and Analysis

Simultaneous OAM and background traffic generation

Ethernet OAM

Y.1731 Service OAM and 802.1ag CFM

CCM Messages

Programmable CCM Rate

CCM Type - Unicast, MultiCast

MEG ID End Point

Maintenance Domain Level

AIS Tx/Rx

RDI Tx/Rx

LBR/LBM (Ping) - Unicast, MultiCast

LTM/LTR (Trace)

MEP Discovery	Comments: · Autodiscovery of all MEPs on the Network

802.3ah Link OAM

Mode - Passive/Active

Vendor OUI

Vendor Specific Info

Max PDU Size

Unidirectional Links

Remote Loopback

Link Events

Variable Retrieval

1G, 10G Ethernet (Continued)

Dying Gasp	
Link Fault	
Critical Event	
Errored Symbol Period Event	
Errored Frame Event	
Errored Frame Period Event	
Errored Frame Second Summary Event	

IP Packet Generator

IP

IPv4 Frame Format	
IPv6 Frame Format	
TCP Port Number	**Comments:** · Source & Destination Port
UDP Port Number	**Comments:** · Source & Destination Port

IP Addressing

Destination IP Address - User Defined
Source IP Address - User Defined and auto-increment

IPv4 Editable Fields

ToS
DSCP
Flags
Protocol
TTL

IPv6 Editable Fields

Traffic Class
Flow Label
Next Header
Hop Limit

IP Ping

Fast Ping

IP TraceRoute

Traffic Generator

Number of Traffic Engines	**Comments:** · Many concurrent streams can be generated with different frame sizes and bandwidths
Bandwidth Controlled	**Comments:** · User can specify bandwidth by directly specifying the bandwidth setting
Bandwidth Specification in Mbps or kbps	
Bandwidth Granularity	
Bandwidth Specification in %	
Bandwidth Utilization Accuracy - 0.1%	
Burst Mode - Burst Size - 1 to 2M frames	
Bandwidth Specified - Definable	
Continuous Tx	**Comments:** · Ongoing traffic as defined
Once Tx - Definable frames/burst	

Traffic generation in LBM frames at line rate	
Analysis of LBR frames at line rate	

Traffic Profiles

Constant B/W
Ramp B/W
Bursty B/W
Flood B/W
Traffic generation in Mbps, kbps, or % utilization
B/W configurable based on L1 or L2

TCP Throughput

10/100/1000M Linerate Stateful Emulation
1GigE Linerate Stateful Emulation
10GigE Linerate Stateful Emulation
Configurable Src and Dest IP address
Packet length
TCP/UDP Traffic Modes
Source Port
Destination Port
Listen Port
Configurable TCP Window Size
Measures TCP Efficiency
Measures Buffer Delay
TCP Client Emulation
TCP Server Emulation
Up to 64 TCP Stateful Sessions Simultaneously
Supports 4 Background Streams
Compatible with IPERF, including version 3

RFC2544/RFC 5180 (IPv6)

Asymmetric Testing	
Symmetric Testing	
Throughput	
Frame Loss	
Out of sequence frames	
Errored Frames	
Delay	
Back to Back	
Committed Burst Size (CBS)	
Policer Test	
Jitter	
Master/Slave	
Pass/Fail Thresholds per MEF 23.1	
Connectivity QuickCheck	**Comments:** · Enables quick verification of end to end connectivity before executing an RFC test
Parallel Testing	**Comments:** · Reduces test times by 50% by performing Latency, Throughput and Jitter tests simultaneously
Optional Testing with line rate LBM frames	

1G, 10G Ethernet (Continued)

Definable Frame Size	
LAG Support	
Sequential MAC Addresses	
Suppression of OOS Frames	
Report formats	
Graphical Results	
Total Test Time Display	
One Way Delay with GPS or CDMA receiver	**Comments:** · GPS receiver is Spectrum Instruments TM-4M; CDMA receiver is Precious

ITU-T Y.1564

Up to 16 Traffic Streams	
Service Configuration Test	
Service Performance Test	
Committed Information Rate (CIR)	
Extended IR (EIR)	
Maximum Ir (MIR)	
Frame Loss Rate (FLR)	
Frame Delay (FD)	
Frame Delay Variation	
Committed Burst Size (CBS)	
Policer Test	
Round Trip Testing	
Concurrent Bi-directional Testing	**Comments:** · Enables each test set to perform and collect 1564 results for bi-directional analysis.
Configurable VLAN, Priority, Addressing and Pass/Fail Thresholds	
Programmable Pass/Fail Thresholds	
Graphical Results	
Screenshot Support	
Auto-Negotiation Check	
Saved Test Profiles	
Saved Reports	
Configurable DEI, TPID, TOS/DSCP	
Inclusive of L2 Ethernet, IPv4, and IPv6	
Integrated TrueSpeed TCP traffic stream with background streams	
Optional Testing with line rate LBM frames	
Asymmetric Testing	
LAG Support	
Sequential MAC Addresses	
Suppression of OOS Frames	
One Way Delay with GPS or CDMA receiver	**Comments:** · GPS receiver is Spectrum Instruments TM-4M; CDMA receiver is Praecis II Receiver

IETF RFC 6349

Supported on 10/100/1000 M Electrical and 1/10 G Optical Interfaces	

Automated TCP Throughput test per RFC 6349	
IPv4 and IPv6 support	
Path MTU Detection Test	
Round Trip Time Test	
Walk the Window Test	
TCP Throughput Test	
Traffic Shaping Test	
TCP Efficiency Metric	
Buffer Delay Metric	
Up to 64 TCP Stateful Sessions Simultaneously	
1 KB TCP Window Size Granularity	
Jumbo Frame Support	
Graphical Results and Report Generation	
Configurable File Sizes and Window Sizes	
Total Test Time Display	
Configurable Saturation Window Test	
Compatible with the following endpoints:	
T-BERD/MTS instruments	
QT-600 Ethenet Probes	
TrueSpeed VNF Server	
RFC 6349 application to interwork with Fusion/TrueSpeed VNF	

Layer 2 Transparency Testing

Verifies Transparent forwarding of Control Plane traffic through Ethernet switch fabrics.	
Send/Receive Ethernet Control Plane Traffic	
Encapsulation Supported - VLAN	
Encapsulation Supported - QinQ	
Encapsulation Supported - Spanning Tree	
Encapsulation Supported - Cisco Protocols (Discovery etc.)	
Encapsulation Supported - IEEE	
Send/Receive Ethernet Control Plane Traffic	
Spanning Tree Protocol (STP)	
Rapid Spanning Tree Protocol (RSTP)	
Multiple Spanning Tree Protocol (MSTP)	
Link Layer Discovery (LLDP)	
Generic Multicast Registration (GMRP)	
Generic VLAN Registration (GVRP)	
Cisco Discovery Protocol (CDP)	
Link Aggregation Control Protocol (LACP)	
Port Aggregate Protocol (PAgP)	
Unidirection Link Detection (UDLD)	
Dynamic Trunking Protocol (DTP)	
Inter-Switch Link (ISL)	
Per VLAN Spanning Tree (PVST-PVST+)	
STP-ULFAST	
VLAN-BRDGS	
802.1d	
VLAN Trunking (VTP)	
Custom Frame Builder	

1G, 10G Ethernet (Continued)

Synchronous Ethernet

10GigE Tx/Rx	
1000M/100M/10M Electrical Tx/Rx	**Comments:** · Electrical SycnE PIM required
100M/1000M Optical Tx/Rx	
G.826x Compliant	
Frequency offsets ± 100 ppm in 1 or 10 ppm increments	
Recovered Interface Timing	
4.6ppm Frequency Accuracy	
SSM Message Decode	
ESMC Message Transmit & Capture	
Quality Message Decode	
Definable SSM PDU Rate (pps)	
Background Dataplane traffic generation	

Masks
· MTIE/TDEV: SSU Type I (G.812)
· MTIE/TDEV: SSU Type II, III (G.812)
· MTIE: SSU Type IV (G.812)
· MTIE/TDEV: EEC-1 Noise Gen (G.8262 constant temp.)
· MTIE: EEC-1 Noise Gen (G.8262 with temp. effects)
· MTIE/TDEV: EEC-2 Noise Gen (G.8262 constant temp.)
· MTIE/TDEV: EEC-1 Noise Tolerance (G.8262)
· TDEV: EEC-2 Noise Tolerance (G.8262)
· MTIE/TDEV: EEC-1 Noise Gen (G.8262.1 constant temp.)
· MTIE/TDEV: EEC-1 Noise Gen (G.8261)
· TDEV: EEC-2 Network Limit for Wander (G.8261)
· MTIE/TDEV: Noise Generation (G.811)

IEEE 1588v2 PTP

1G, 10G, 25G, and 100G Tx/Rx	
Dual Monitor 1588 at 1G and 10G Ethernet	
IPv4 and IPv6	
1588v2 Master Emulation 1-step and 2-step	
1588v2 Slave Emulation	
1 G Dual Monitor	
Encapsulations supported: None, VLAN, and Q-in-Q	
Packet Delay Variation Measurements on Control Plane Traffic	**Compliance:** · Add ipdv add per message type
Generate up to 4 streams of Background Dataplane traffic	**Comments:** · To see the effect of dataplane network traffic on PTP PDV.
Frame/Packet Capture and Decode via Wireshark	**Comments:** · Message rates for annonce request sync
Layer 2 1588v2 Messaging	
Layer 4 1588v2 Messaging	
Message rates Multicast: fastest 2/16/64/64 (DelayResponse/Announce/Sync/DelayRequest) ; slowest one message every 16 seconds	
Message rates Unicast: fastest 2/16/16/16 (DelayResponse/Announce/Sync/DelayRequest); slowest one message every 16 seconds	
Support for Unicast and Multicast Address Mode	
Support for Forwardable and Non-forwardable Address	

Static unicast message negotiation: ON or OFF	
Thresholds for Delay, PDV and Time Error	
Single- & Dual Step operation in both slave and master modes	
Master Mode Clock Classes Supported	
Primary	
Primary Holdover	
Arbitrary	
Arbitrary Holdover	
Primary A	
Arbitrary A	
1588v2 Delay Measurements (Master/Slave)	**Comments:** · Requires Precision Timing Reference Module
One-way (Master to Slave and Slave to Master) Delay	**Comments:** · Requires Precision Timing Reference Module
Differential Delay and Delay Asymmetry Measurements	
Time Error Measurements (1ns resolution)	
max |TE| Measurement	
cTE Measurement	
Wander Analysis of Time Error Measurement	
Automated Time Error Measurement workflow.	

Enhanced PTP analysis
· Floor packet analysis
· Extended runtime
· Noise Floor Reduction
· User Specified Ethernet Cable Delay
· cTE Calculation

PTP Check
· Support of a workflow to automate getting PTP Time Error results
· PTP Check available for G.8275.1 layer 2 and layer 4
· 1GE, 10GE, and 25GE

Testing can be performed as per G.8265.1, G.8275.1, G.8275.2

Masks
· Low-Pass: G.8271.1 Network (BC/T-TSC) 0.1Hz
· Low-Pass: G.8273.2 (BC/T-TSC) 0.1Hz
· Low-Pass: G.8273.3 (BC/T-TSC) 0.1Hz
· Avg of N Samples: G.8271.1 Network (PRTC)
· Avg of N Samples: G.8272 (PRTC)
· MTIE: DTE Network Limit (G.8271.1)
· MTIE/TDEV: Noise Generation (G.811)
· MTIE/TDEV: Wander Generation (G.8272-A and G.8272-B)
· MTIE/TDEV: G.8272.1 (ePRTC)
· MTIE/TDEV: DTE Noise Gen. (G.8273.2-A/B constant temp.)
· MTIE: DTE Noise Gen. (G.8273.2-C constant temp.)
· MTIE: DTE Noise Gen. (G.8273.2-A/B variable temp.)
· MTIE: DTE Noise Gen. (G.8273.3-A/B constant temp.)
· MTIE/TDEV: DTE Noise Gen. (G.8273.3-C constant temp.)
· MTIE: DTE Noise Gen. (G.8273.3-A/B variable temp.)
· MTIE: DTE Noise Gen. (G.8273.3-C constant temp.)

Loopback

Manual (LLB)	
Automatic	
Local	
Far End	**Comments:** · Can you send a loop command to another test set?

1G, 10G Ethernet (Continued)

Auto Discovery of Test Sets	Comments: · Automatically discovers additional test sets on the network for loopback/end to end testing

Class of Service Measurements

Throughput (Tx/Rx)	
Frame Loss (Rate and Ratio)	
OoS Frames	Comments: · Out-of-sequence
Round-trip Delay	
Acterna Test Protocol Version 3 (default) (RTD)	
For 10GE, high-accuracy of +/- 80 nsec or better using a hard loopback with 10 nsec resolution	
Acterna Test Protocol Version 2	
One Way Delay Support	
Packet Jitter (Frame Delay Variation)	

CAT-5 Testing

Link speed
Link status
Cable status
Crossover/straight (MDI/MDIX)
Distance to fault
Pin mapping
Pair length
Polarity
Skew

Capture/Decode

Wirespeed Capture	
Integrated Wireshark on the TestSet	Comments: · Viewing capture files can be performed directly on the test set and not require a separate laptop/PC.
256MB Capture Buffer per port	
Triggers and filters	
Tx and Rx Capture	Comments: · Captures traffic on the test interface receiver and transmitter.
Frame Slicing	

Expert Decode/Analysis

Decode/Analysis Capture Files
Detect Half-Duflex Ports
Detect ICMP Layer Issues
Identify Top Talkers
TCP Layer Diagnosis - ex. Retransmissions

Traffic Profiling

Detect and display up to 128 streams of live traffic
Specify Filters for stream detection

Stream Classification	Comments: · Organize streams by VLAN, MAC, IP Address etc for analysis

Network Discovery

Automatically detect networks, domains, devices, and hosts

Traffic Filtering

Ethernet (Layer 2) Traffic Filtering

MAC source and destination address
Frame Type/Length
VLAN ID
VLAN Priority
VLAN Discovery

VLAN (Layer 2.5) Tags - 802.1q

TPI
Priority
CFI/DEI
VID

VLAN (Layer 2.5) Tags - QnQ, 802.1ah

SVLAN ID
SVLAN Priority
SVLAN TPI
CVLAN ID
CVLAN Priority

IPv6 5G NR Discovery

Discover MAC Address, VLAN ID, IPv6 addresses over 10 GE and 25 GE interfaces

MPLS

MPLS Label
MPLS Priority

IP (Layer 3) Traffic Filtering

Source and destination IP address
Subnet mask
IPv6 Traffic Class
TOS/DSCP fields

TCP/UDP (Layer 4) Traffic Filtering

ATP Listen Port

Protocol Analysis

CDP and LLDP Frame Discovery and Decode

CDP Analysis

Device Identifier
Port Identifier
VLAN ID
Source MAC Address
IP Subnet Addresses

LLDP Analysis

Chassis Identifier
Port Identifier
Time To Live

1G, 10G Ethernet (Continued)

Source MAC address and optional VLAN ID	
Management IP Address	
MAU Type Information	

Errors Tx/Rx

Code Error Tx/Rx	**Comments:** · Single/Burst (up to 16)/Rate $(10^{-3}$ to $10^{-9})$
FCS Error Tx/Rx	**Comments:** · Single/Burst (up to 32767)
Acterna Payload	**Comments:** · Single/Burst (up to 32767)
IP Checksum Tx/Rx	**Comments:** · Single/Burst (up to 32767)
Bit Error Tx/Rx	**Comments:** · Single/Rate $(10^{-3}$ to $10^{-9})$
Insertion Profile - Once	
Insertion Profile - Rate	
Insertion Profile - Burst	
Alarms Tx/Rx	

Faults

Local Fault Tx/Rx

Remote Fault Tx/Rx

Service Disruption Measurements

Measurement Parameters

    Separation Time

    Threshold Time

Triggers

    Signal Loss

    Sync Loss

    Local Fault

    Remote Fault

    Errored Blocks (PCS)

    Code Violation

    Interframe Gap with threshold

    Interframe Gap for ATP frames with threshold

FCS

Results

Custom results

Histogram and Graphical Results Script

LEDS

    Signal Present

    Sync Acquired

    Link Active

    Frame Detect

    IP Packet Detect

    Pattern Sync

    VLAN Frame Detect

    SVLAN Frame Detect

    Local Fault

    Remote Fault

Time Source

    ToD Sync

    1PPS Sync

SLA/KPI

    Throughput Current

        Rx & Tx Mbps L1

        Rx & Tx Mbps L2

        Rx & Tx Mbps L3

    Frame Loss (count & ratio)

    Round Trip Delay/FD (average, current, maximum)

    Packet Jitter/FDV (average, max avg, peak, instantaneous)

    One Way Delay (average, current, maximum)

Time

Current Date, Current Time, Test Elapsed Time

Auto-negotiation status

    Link configuration ack

    Link advertisement status

    Pause capable

    Remote fault

    Destination MAC address when using ARP

    Service Disruption Summary Table

    Service Disruption Details

    Service Disruption Statistics

        Longest

        Shortest

        Last

        Average

        Number of Disruptions

Interface

    Signal Losses

    Signal Loss Seconds

    Sync Loss Seconds

    Link Loss Seconds

    Optical Rx Overload

    Optical Rx Level (dBm)

    Rx Frequency (Hz)

    Rx Frequency Deviation (ppm)

    Rx Frequency Max Deviation (ppm)

    Tx Clock Source

    Tx Frequency (Hz)

    Tx Frequency Deviation (ppm)

    Tx Freq Max Deviation (ppm)

    Local Fault Seconds

    Remote Fault Seconds

1G, 10G Ethernet (Continued)

L2 Link counts/statistics (most stats also per stream)

Total utilization % (avg, current, min, peak)

Current utilization % (unicast, multicast, broadcast)

Rx Pause Length (ms) (current, min, max)

Frame rate (avg, current, min, peak)

Frame size (avg, min, max)

Bandwidth utilization Mbps (Rx, Tx, L1, L2)

Round Trip Delay/FD (average, current, max, min)

One Way Delay (average, current, max, min)

One Way Delay % Valid

Packet Jitter/FDV (average, max avg, peak, instantaneous)

VLAN (ID, User Priority)

SVLAN (ID, User Priority, DEI)

Peak IFG Gap (usec)

Received frames

Transmitted frames

Rx Acterna frames

Tx Acterna frames

Pause frames

Rx VLAN frames

Rx Q-in-Q frames

Unicast frames

Multicast frames

Broadcast frames

Rx Frame Bytes

Tx Frame Bytes

Span Tree Frames

64 Byte Frames

65-127 Byte Frames

128-255 Byte Frames

256-511 Byte Frames

512-1023 Byte Frames

1024-<Jumbo Frames

Jumbo Frames

L3 Link counts/statistics/Config Status (most stats also per stream)

Total utilization % (avg, current, min, peak)

Packet rate (avg, current, min, peak)

Packet size (avg, min, max)

Bandwidth utilization Mbps (Rx, Tx, L3)

TOS

Received Packets

Transmitted Packets

Unicast Packets

Multicast Packets

Broadcast Packets

20-45 Byte Packets

46-63 Byte Packets

64-127 Byte Packets

128-255 Byte Packets

256-511 Byte Packets

512-1023 Byte Packets

1024-1500 Packets

>1500 Packets

IPv6 Tx Router Solicitations

IPv6 Rx Router Advertisements

Source IP Address

IP Gateway

IP Subnet Mask

Destination IP Address

Destination MAC Address

L2 Filtered counts/statistics

L3 Filtered counts/statistics

L4 Link counts/statistics (many stats also per stream)

Rx Source Port

Rx Destination Port

Rx/Tx Mbps, current L4

Rx Mbps, current TCP

Rx Mbps, current UDP

TCP Packets

UDP Packets

BERT

Pattern Losses

Pattern Loss Seconds

Bit Errors

Bit Error Rate

Bit Error Seconds

Bit Error-Free Seconds

Bit Error-Free Seconds, %

Capture	Comments:
	· Up to 256 Mbytes
Packet Processed	
Capture Progress %	

Sync Status Messages

CDMA/GPS Receiver

Event, Time

J-Proof Results

Name

Tx

Rx

Status

Error Statistics

Code Violations

Code Violation Rate

Code Violation Seconds

Undersized Frames

1G, 10G Ethernet (Continued)

- Runts
- Jabbers
- FCS errored frames
- Errored Frames
- Errored Blocks (PCS)
- Errored Block Losses (PCS)
- IP Checksum Errors (IPv4)
- IP Packet Length Errors
- Acterna Payload Errors
- Packet Error Rate
- Lost Frames
- Frame Loss Ratio
- OoS Frames
- TCP/UDP Checksum Errors
- Errored Second
- Severely Errored Seconds
- Unavailable Seconds
- Errored Second Ratio
- Severely Errored Second Ratio

Event Log

- Event, Date, Start Time, Stop Time, Duration, Value

Real Time Histogram

- Seconds, Minutes, Hours, Days

Time

- Current Date, Current Time, Test Elapsed Time

Graphical Displays

Errors versus Time

Frame Loss versus Time

Packet Jitter versus Time

Latency versus Time

Throughput versus Time

Application Testing

Walk the Window

FTP Throughput

HTTP Throughput

Optics Self-Test

Purpose

A workflow tool to validate the performance of pluggable optics in the field

Coverage

10GE LAN SFP+

25GE SFP28

40GE QSFP+

OTU3 QSFP+

50GE QSFP28

100GE QSFP28 and CFP4

OTU4 QSFP28 and CFP4

Functions

Test Duration

- User defined test times in seconds, minutes, hours
- Auto-calculated recommended test time based on bit error rate theory, uses the Bit Error Rate threshold as key parameter

BER Threshold Type

Pre-FEC or Post-FEC if FEC is used

Bit Error Rate Threshold

- 10^{-5} to 10^{-15}

PPM Max Offset

- 0 to +/-100 PPM

Stop on Error option

Results Overview

Optics type

- Signal Presence
- Optical Signal Level Test
- Excessive Skew Test
- Current PPM Offset
- BER Threshold Test
- Current BER or both pre-FEC BER and post-FEC BER

Report generation with pass/fail and recorded pluggable information

Expert Mode

QSFP

- Rx Auto-Equalization
- Ignore LOS
- CDR Bypass
- High Power mode
- Peek/Poke of any register

SFP

- Rx Auto-Equalization
- Ignore LOS
- Rate Select pins
- Peek/Poke of any register

FlexE

Test Interfaces/Bit Rates

Single or Dual-port FlexE on 100GigE (103.125Gb/s) as per OIF v2.0

Single or Dual-port FlexE on 50GigE (53.125Gb/s)

Optical power in dBm per port and per lambda

Dual switchable calendar configurations A and B

Alarm in case of excessive incoming optical power

Skew injection on each port per Virtual Lane
· Report excessive skew above 180 nsec

Timing

Recovered from Rx For Synchronous Ethernet Applications

Internal (Stratum 3)

FlexE (Continued)

Recovered from External (BITs/SETs) clock	**Comments:** · BITS / SETS / 2.048MHz / 10MHz
Frequency Offset Transmit/Receive in PPM	
Adjust transmit with PPM offset up to +/-150ppm	
Report FlexE skew between ports	

Ethernet Client Support

Dual independent Clients
FlexE client size settable between 5Gbps and 100Gbps
Client size granularity of 5Gbps
Calendar slot can also be set to Unused or Unavailable
Usage of ATP payload signatures (latency, frame loss)
802.3 and DIX (type II) Ethernet framing
VLAN and Q-in-Q with support of VLAN p-bit
Undersized frame error injection below 64 bytes
Jumbo frame sizes up to 10000 bytes
Random frame sizes
EMIX frame size distribution
Client traffic with bandwidth settings: · Constant bandwidth · Burst with settable burst size, number of bursts and duty cycle Up to 65535 or continuous · Ramp
Peak IFG measurement to display the service disruption time on each client
Per client statistics: · Round-trip delay measurements · Packet jitter measurements · Frame loss count and ratio · Out of sequence measurements

Ethernet Error and Alarm Injections

Error and alarm injections:

Loss of Block Lock Per Port	
Loss of Alignment Marker Lock Per Port	
Alignment Marker errors Per Port	**Comment:** · Single/Burst (up to 128)/Rate (10-3 to 10-10).
BIP-8 errors Per Port	**Comment:** · Per lane/all lanes; Single/Burst (up to 128)/Rate (10-3 to 10-10)
Undersized frames Per Client	**Comment:** · Single/Burst (up to 16)
Runt frames per Client	**Comment:** · Single/Burst (up to 16)
Coding Errors Per Port	**Comment:** · Single/Burst (up to 128)/Rate (10-3 to 10-10).
FCS Errors Per Client	**Comment:** · Single/Burst (at least up to 32767)
Local Fault	
Remote Fault	

FlexE Alarms and Errors

Alarms
· Loss of Group Alignment (LOGA)
· Group Number Mismatch (GNM)
· Loss of Frame (LOF)
· Out of Frame (OOF)
· Loss of Multiframe (LOM)
· Out of Multirame (OOM)
· Remote PHY Fault (RPF)
· PHY Number Mismatch (PNM)
· PHY Map Mismatch (PMM)
· Calendar Mismatch (CM)

Errors
· Overhead Block Errors
· CRC Errors
· CBIT Errors

LED Results

Summary
· Per Port Laser
· Per Client Traffic

Physical
· Per Port Signal Present
· Per Port Sync Acquired

FlexE
· Per Port LOF
· Per Port Remote PHY Fault
· Per Port PHY Number Mismatch
· Loss of Group Alignment
· Group Number Mismatch

Ethernet Client
· Per Client Link Up
· Per Client ATP Detect
· Per Client VLAN Frame Detect
· Per Client SVLAN Frame Detect
· Per Client OAM

Dark Fiber Qual™

LED Results

Provide automatic detection using specific SFPs supporting T2MOD(TM) and FlexTune™
10G BiDi and 25G Duplex support
Auto detection of channel wavelength and bidirectional insertion loss
Built-in Channel Performance Test feature

SONET SDH

Test Interfaces/Bit Rates	
STS-1(e) (51.84 Mbps)	
Dual Port Capable	
STM-1(e) (155.52Mb/s)	
Dual Port Capable	
STM-1(o) (155.52Mb/s)	
Dual Port Capable	
OC-3 (155.52Mb/s)	
Dual Port Capable	
OC-12 (622.08Mb/s)	
Dual Port Capable	
STM-4 (622.08Mb/s)	
Dual Port Capable	
OC-48 (2.488Gb/s)	
Dual Port Capable	
STM-16 (2.488Gb/s)	
Dual Port Capable	
OC-192 (9.953Gb/s)	
Dual Port Capable	
STM-64 (9.953Gb/s)	
Dual Port Capable	
Interface Type	
SFP	
SFP+	
SFP+ Tunable	
Modes Of Operation	
Terminate	
Monitor	
Thru (Intrusive)	
Tributary Scan	
Drop and Insert	
Timing	
Recovered from Rx	
Internal (Stratum 3)	
Recovered from External (BITs/SETs)	
Recovered from 10MHz clock	
Frequency Offset Transmit/Receive	

Traffic Mappings	
SONET/SDH Bulk BERT	**Comments:** · PRBS as payload in SONET/SDH frames
J-Scan	**Comments:** · Tributary scan monitor tool
SONET Mappings	
VT1.5 DS1 and Bulk BERT	**Comments:** · OC-3/12/48/192
VT2 E1 and Bulk BERT	**Comments:** · OC-3/12/48/192

STS-1 DS3 and Bulk BERT	**Comments:** · OC-3/12/48/192
STS-1 E3 and Bulk BERT	**Comments:** · OC-3/12/48/192
STS-3c Bulk BERT	**Comments:** · OC-3/12/48/192
STS-12c Bulk BERT	**Comments:** · OC-12/48/192
STS-48c Bulk BERT	**Comments:** · OC-48/192
STS-192c Bulk BERT	**Comments:** · OC-192
SDH Mappings	
AU-3|VC-11 DS1 BERT	**Comments:** · STM-1/4/16/64
AU-3 | VC-12 E1 and Bulk BERT	**Comments:** · STM-1/4/16/64
AU-3 | VC-3 DS3, E3, and Bulk BERT	**Comments:** · STM-1/4/16/64
AU-4 | VC-12 E1 and Bulk BERT	**Comments:** · STM-1/4/16/64
AU-4|VC-11 DS1 BERT	**Comments:** · STM-1/4/16/64
AU-4 | VC-3 DS3, E3 and Bulk BERT	**Comments:** · STM-1/4/16/64
AU-4 | VC-4 E4 and Bulk BERT	**Comments:** · STM-1/4/16/64
AU-4 | VC-4-4c Bulk BERT	**Comments:** · STM-4/16/64
AU-4 | VC-4-16c Bulk BERT	**Comments:** · STM-16/64
AU-4 | VC-4-64c Bulk BERT	**Comments:** · STM-64
PRBS Patterns	
2^{15-1}, 2^{15-1} Inverse	
2^{20-1}, 2^{20-1} Inverse	
2^{23-1}, 2^{23-1} Inverse	
2^{31-1}, 2^{31-1} Inverse	**Comments:** · OC-48/129 STM-16/64
Digital Word	
Delay pattern	
Rx Live	
SONET/SDH Injection/Detection	
Alarms/Defects	
Signal Present / LOS	**Comments:** · Terminate & Thru
LOF	**Comments:** · Terminate & Thru
TIM-S / RS-TIM	**Comments:** · Terminate & Thru
AIS-L / MS-AIS	**Comments:** · Terminate
RDI-L / MS-RDI	**Comments:** · Terminate
AIS-P / AU-AIS	**Comments:** · Terminate

SONET SDH (Continued)

LOP-P / AU-LOP	**Comments:** · Terminate
RDI-P / HP-RDI	**Comments:** · Terminate
TIM-P / HP-TIM	**Comments:** · Terminate & Thru
PLM-P / HP-PLM	**Comments:** · Terminate & Thru
UNEQ-P / HP-UNEQ	**Comments:** · Terminate & Thru
AIS-V/TU-AIS	**Comments:** · Terminate
LOP-V/TU-LOP	**Comments:** · Terminate
LOM-V/TU-LOM	**Comments:** · Terminate
RDI-V/LP-RDI	**Comments:** · Terminate
RFI-V/LP-RFI	**Comments:** · Terminate
UNEQ-V/LP-UNEQ	**Comments:** · Terminate & Thru
TIM-V/LP-TIM	**Comments:** · Terminate & Thru
PLM-V/LP-PLM	**Comments:** · Terminate & Thru

Errors/Anomalies

Frame Word	**Comments:** · Burst (1 to 32) Terminate & Thru
B1	**Comments:** · Single/Rate (10^{-6} to 10^{-9}) Terminate
B2	**Comments:** · Single/Rate (10^{-4} to 10^{-9}) Terminate
REI-L /MS-REI	**Comments:** · Single/Rate (10^{-4} to 10^{-9}) Terminate
B3	**Comments:** · Single/Rate (10^{-6} to 10^{-9}) Terminate & Thru
REI-P / HP-REI	**Comments:** · Single/Rate (10^{-6} to 10^{-9}) Terminate
Bit/TSE	**Comments:** · Single/Rate (10^{-4} to 10^{-9}) Terminate
BIP-V/LP-BIP	**Comments:** · Terminate
REI-V/LP-REI	**Comments:** · Terminate

Pointers

- Increment
- Decrement
- +2 NDF
- -2 NDF
- Sequence

SONET/SDH Overhead

Overhead Manipulation/Analysis

- Overhead viewing & editor for TOH/SOH and POH bytes
- User can set TOH/SOH Tx & Rx Channels
- POH Byte Capture (manual trigger)

Set STS-N/STM-N Channel

Section/RS Trace Message Editor (J0)

- Tx Edit and Rx Display functionality
- Unformatted, Single Byte, CR/LF Terminated, ITU-T G.707
- TIM-S / RS-TIM alarms on mismatch

Path/Trace Message Editor (J1)

- Tx Edit and Rx Display functionality
- Unformatted, Single Byte, CR/LF Terminated, ITU-T G.707
- TIM-P / HP-TIM alarms on mismatch

APS (K1/K2)

- Set based on Ring or Linear Topology
- Set Bridge Request Code, Dest Node ID, Src Node ID, Path Code, Status

Set Sync Status (S1) based on message

Signal Label generation/display (C2)

- Tx Edit and Rx Display functionality
- PLM-P / HP-PLM alarms on mismatch

TCM (N1) Monitoring / Generation

Pointer Movements

Set Pointer Movements

- +/- Single pointers of opposite polarity
- +/- Regular pointers plus one double pointer
- +/- Regular pointers with one missing
- +/- Double pointers of opposite polarity
- +/- Single
- +/- Burst
- +/- Periodic - 87-3 pattern
- +/- with add: Periodic - 87-3 pattern
- +/- with cancel Periodic - 87-3 pattern
- +/- Periodic - continuous pattern
- +/- with add: Periodic - continuous pattern
- +/- with cancel: Periodic - continuous pattern
- +/- Periodic - 26-1 pattern
- +/- with add: Periodic - 26-1 pattern
- +/- with cancel Periodic - 26-1 pattern
- +/- Phase transient

Service Disruption Measurements

Measurement Parameters

SD Separation/Debounce Time Setting	**Comments:** · Mandatory for handling debounce of the NE's Tx.
SD Threshold Time Settings	

SONET SDH (Continued)

Triggers	
Signal Loss	
Bit/TSE Error	**Comments:** · For PRBS errors
Frame Sync Loss / LOF	
SEF / OOF	
Frame Word Error	
AIS-L / MS-AIS	
RDI-L / MS-RDI	
AIS-P / HP-AIS	
LOP-P / AU-LOP	
P-RDI / HP-RDI	
B1 error	
B2 error	
REI-L / MS-REI Error	
B3 error	
REI-P / HP-REI	
AIS-V/TU-AIS	
LOP-V/TU-LOP	
LOM-V/TU-LOM	
RDI-V/LP-RDI	
BIP-V/LP-BIP	
REI-V/LP-REI	
Performance Monitoring	
G.828 Path Allocation % Setting	
G.828 Enable UAS Limit on/off	**Compliance:** · 10 to 100000
G.826 Path Allocation % Setting	
G.828 Enable UAS Limit on/off	**Compliance:** · 10 to 100000
M.2101	**Compliance:** · MS/HP Setups
See Results section	
J-Scan	
Tributary Scan with STS/STM reporting	**Compliance:** · High Path Scan
Results	
Custom results	
LEDS	
Signal Present / LOS	
Frame Sync / LOF	
Path Pointer Present / AU Pointer Present	
Pattern Sync / LSS	
Summary Status	
Event Log (Event, Date, Start & Stop time, Duration/Value)	
Histogram (multiple alarms & errors)	
Service Disruption Summary Table	
Service Disruption Details	

Service Disruption Statistics
Longest
Shortest
Last
Average
Number of Disruptions
Time
Current Date, Current Time, Test Elapsed Time
Interface
Invalid Rx Signal Seconds
Signal Losses / LOS
Signal Losses Seconds / LOS Seconds
Optical Rx Overload
Optical Rx Level (dBm)
Rx Frequency (Hz)
Rx Frequency Deviation (ppm)
Rx Frequency Max Deviation (ppm)
Tx Clock Source
Tx Frequency (Hz)
Tx Frequency Deviation (ppm)
Tx Freq Max Deviation (ppm)
Round-Trip Delay Current, Avg, Min, Max (100 nsec res.)
Section / RSOH
Frame Sync Losses
Frame Sync Loss Seconds / LOF Seconds
OOFs / SEFs
OOF / SEF Seconds
Frame Word Errors
Frame Word Error Rate
B1 Errors
B1 Error Rate
Section/RS Trace Format (J0)
Section/RS Trace (J0)
Line / MSOH
AIS-L / MS-AIS Seconds
RDI-L / MS-RDI Seconds
B2 Errors
B2 Error Rate
REI-L / MS-REI Errors
REI-L / MS-REI Rate
APS Messages
APS K1 Bridge Request Code (Ring)
APS K1 Destination Node ID (Ring)
APS 2 Source Node ID (Ring)
APS K2 Path Code (Ring)
APS K2 Status (Ring)
Sync Status (S1)

SONET SDH (Continued)

Path / HP
- AIS-P / AU-AIS Seconds
- LOP-L / AU-LOP Seconds
- Path/AU Pointer Loss Seconds
- P-RDI / HP-RDI Seconds
- Path/AU Pointer Adjustments
- Path/AU Pointer Increments
- Path/AU Pointer Decrements
- Path/AU New Pointer
- Path/AU Pointer Value
- Path/AU Pointer Size
- Tx Path Pointer Value
- Tx Path Pointer Size
- B3 Errors
- B3 Error Rate
- REI-P / HP-REI Errors
- REI-P / HP-REI Rate
- Path/HP Trace Format (J1)
- Path/HP Trace (J1)
- Signal Label (C2)
- UNEQ-P / HP-UNEQ Seconds

VT / LP
- AIS-V/TU-AIS Seconds
- LOP-V/TU-LOP Seconds
- VT/TU Pointer Loss Seconds
- LOM-V/TU-LOM Seconds
- RDI-V/LP-RDI Seconds
- Multiple Pointer stats
- BIP-V/LP-BIP Errors/Error Rate
- REI-V/LP-REI Errors/Error Rate
- VT/LP Trace Format and Trace (J2)
- VT/LP Signal label (V5)
- UNEQ-V/LP-UNEQ Seconds

TCM (Forward)
- TC-UNEQ
- TC-UNEQ Seconds
- TC-LTC
- TC-LTC Seconds
- TC-AIS
- TC-AIS Seconds
- B3 Errors
- TC-IEC
- TC-DIFF
- TC-APId Label

TCM (Backward)
- TC-RDI
- TC-RDI Seconds
- TC-ODI

TC-ODI Seconds
- TC-REI
- TC-REI Seconds
- TC-OEI
- TC-OEI Seconds
- TC-REIs
- TC-OEIs
- TC-APId Label

K1/K2 Log (Linear)

K1/K2 Log (Ring)

Payload
- Pattern Sync Losses
- Pattern Sync Loss Seconds
- Bit/TSE Errors
- Bit/TSE Error Rate

G.829 RS ISM
- BBE (NE)
- ES (NE)
- SES (NE)
- UAS (NE)
- BBER (NE)
- ESR (NE)
- SESR (NE)

G.829 MS ISM
- BBE (NE & FE)
- ES (NE & FE)
- SES (NE & FE)
- UAS (NE & FE)
- BBER (NE & FE)
- ESR (NE & FE)
- SESR (NE & FE)

G.828 HP ISM
- Verdict (NE & FE)
- BBE (NE & FE)
- ES (NE & FE)
- SES (NE & FE)
- UAS (NE & FE)
- SEP (NE & FE)
- BBER (NE & FE)
- ESR (NE & FE)
- SESR (NE & FE)
- SEPI (NE & FE)

G.828 HP OOS
- Verdict
- BBE
- ES
- SES
- UAS

SONET SDH (Continued)

SEP	SEPI (Path NE)
BBER	**T1.514 OOS**
ESR	BBE (Path)
SESR	ES (Path)
SEPI	SES (Path)
M.2101 MS ISM	UAS (Path)
Verdict (NE & FE)	SEP (Path)
BBE (NE & FE)	% BBE (Path)
ES (NE & FE)	% ES (Path)
SES (NE & FE)	% SES (Path)
UAS (NE & FE)	SEPI (Path)
SEP (NE & FE)	**T1.231**
BBER (NE & FE)	ES (Section NE ISM)
ESR (NE & FE)	SES (Section NE ISM)
SESR (NE & FE)	UAS (Section NE ISM)
SEPI (NE & FE)	ES (Line NE ISM)
M.2101 HP ISM	SES (Line NE ISM)
Verdict (NE & FE)	UAS (Line NE ISM)
BBE (NE & FE)	ES (Path NE ISM)
ES (NE & FE)	SES (Path NE ISM)
SES (NE & FE)	UAS (Path NE ISM)
UAS (NE & FE)	
SEP (NE & FE)	
BBER (NE & FE)	
ESR (NE & FE)	
SESR (NE & FE)	
SEPI (NE & FE)	
M.2101 HP OOS	
Verdict	
BBE	
ES	
SES	
UAS	
SEP	
BBER	
ESR	
SESR	
SEPI	
T1.514 ISM	
BBE (Path NE)	
ES (Path NE)	
SES (Path NE)	
UAS (Path NE)	
SEP (Path NE)	
% BBE (Path NE)	
% ES (Path NE)	
% SES (Path NE)	

OTU4, OTU3

Test Interfaces/Bit Rates	
OTU3 (43.02Gb/s)	
Dual Port Capable	
OTU4 (111.8Gb/s)	
Dual Port Capable	

Interface Type	
QSFP+	**Compliance:** · 40G
QSFP28	**Compliance:** · 100G
CFP4	**Compliance:** · 100G

Modes Of Operation	
Terminate	
Monitor/Thru	**Comments:** · Monitoring on Rx with no Tx laser. Thru mode provides a full loopback with monitoring capabilities

Timing	
Recovered from Rx	
Internal (Stratum 3)	
Recovered from External (BITs/SETs)	**Comments:** · BITS / SETS / 2.048MHz / 10MHz
Frequency Offset Transmit/ Receive	**Comments:** · +/- 150ppm
Frequency Reporting	**Comments:** · Resolution in Hz, deviation in PPM

Traffic Mappings	
OTN Bulk BERT	**Comments:** · PRBS as payload in OTN frames
OTL BERT	**Comments:** · PRBS on OTL (with Lane Alignment)
OTU4 with 100GE Client using GMP	**Comments:** · Full Ethernet functionality at client level
OTU4 with ODU Multiplexing	**Comments:** · Full SONET/SDH functionality at client level (PRBS as per 40G SONET/SDH)
ODU3 with bulk. Direct into ODU4	
ODU2e with bulk. Direct into ODU4	
ODU2e with 10GE Transparent client (layer 1 and layer 2). Direct into ODU4	
ODU2 with bulk. Direct in ODU4	
ODU2 with 10GE client via GFP-F (G.7041 Sect 7.1) (layer 2 and layer 3). Direct in ODU4	
ODU2 with STS-192/VC-4-64 Client with various SONET/SDH channelization levels. Direct in ODU4.	
ODU1 with bulk. Direct in ODU4 and via ODU2	

ODU1 with STS-48/VC-4-16 Client with various SONET/SDH channelization levels. Direct in ODU4.	
ODU0 with bulk. Direct in ODU4, via ODU1, via ODU0	
ODU0 with GE client via GFP-T (layer 2 and layer 3). Direct in ODU4, via ODU1, via ODU0	
ODUFlex with bulk. Direct in ODU4	
ODUFlex with layer 2 MAC via GFP-F. Direct in ODU4	
OTU3 with OC-768/STM-256 Client	
OTU3 with 40GE Client transcoded	
OTU3 with ODU Multiplexing	
ODU2e with bulk. Direct into ODU3	
ODU2e with 10GE Transparent client (layer 1 and layer 2) Direct into ODU3	
ODU2 with bulk. Direct in ODU3	
ODU2 with 10GE client via GFP-F (G.7041 Sect 7.1) (layer 2 and 3). Direct into ODU3	
ODU2 with STS-192/VC-4-64 Client with various SONET/SDH channelization levels. Direct in ODU3.	
ODU1 with bulk. Direct in ODU3 and via ODU2	
ODU0 with bulk. Direct in ODU3, via ODU1, via ODU2	
DU1 with STS-48/VC-4-16 Client with various SONET/SDH channelization levels. Direct in ODU3.	
ODU0 with GE client via GFP-T (layer 2 and layer 3). Direct into ODU3, via ODU1, via ODU2	
ODUFlex with bulk. Direct in ODU3	**Comments:** · 1 to 8 Tributary Slots worth of bandwidth
ODUFlex with layer 2 MAC via GFP-F. Direct in ODU3	**Comments:** · 1 to 8 Tributary Slots worth of bandwidth
OTU3/4 Bulk PRBS Patterns	
2^{9-1}, 2^{9-1} Inverse	
2^{23-1}, 2^{23-1} Inverse	
2^{31-1}, 2^{31-1} Inverse	
Delay pattern	
Rx Live	

OTL/OTN Injection/Detection	
Set Tx Scramble on/off	
Set Rx Descramble on/off	
Skew injection per Virtual Lane:	
OTU4: 0 to 32000 (5724 ns) bits per lane	
OTU3: 0 to 32000 (2975.5 ns) bits per lane	
Skew alarm (Rx) threshold settings	**Compliance:** · Defaults to 180 ns
	Comments: · Up to 5951 ns for OTU3; Up to 11448 ns for OTU4
Skew reporting per virtual lane	
Transcoding HI BER Detection on/off	
Errors	
OTL FAS	**Comments:** · Per lane/all lanes; Single/Burst (up to 128)/Rate (10^{-3} to 10^{-10})

OTU4, OTU3 (Continued)

OTL MFAS	**Comments:** · Per lane/all lanes; Single/Burst (up to 128)/Rate (10^{-3} to 10^{-10})
OTL LLM (OTU4)	**Comments:** · Per lane/all lanes; Single/Burst (up to 128)/Rate (10^{-3} to 10^{-10})
FEC Uncorrectable	**Comments:** · Single/Rate (10^{-2} to 10^{-5})
FEC Correctable	**Comments:** · Single/Rate (10^{-2} to 10^{-5})
OOM	
SM-BIP	**Comments:** · Single/Rate (10^{-5} to 10^{-7})
SM-BEI	**Comments:** · Single/Rate (10^{-5} to 10^{-7})
PM-BIP	**Comments:** · Single/Rate (10^{-5} to 10^{-7})
PM-BEI	**Comments:** · Single/Rate (10^{-5} to 10^{-7})
TCM1-6 BIP	**Comments:** · Single/Rate (10^{-5} to 10^{-7})
TCM1-6 BEI	**Comments:** · Single/Rate (10^{-5} to 10^{-7})
Bit Error/TSE	**Comments:** · Single/Rate (10^{-3} to 10^{-10})
Additional Client Level Errors	

Transcoding Errors

LOBL (1027B)	
LOAML	**Comments:** · Per lane/all lanes
HI BERD (1027B)	

Alarms

OTL OOF	**Comments:** · Per lane/all lanes
OTL LOF	**Comments:** · Per lane/all lanes
LOM	
SM-IAE	
SM-TIM	
SM-BDI	
SM-BIAE	
ODU AIS	
ODU LCK	
ODU OCI	
PM-BDI	
PM-TIM	
Fwd Sig Fail	
Fwd Sig Degrade	
Bwd Sig Fail	
Bwd Sig Degrade	
TCM1-6 IAE	
TCM 1-6 BDI	

TCM1-6 BIAE	
TCM1-6 TIM	
PT Mismatch	
Client Loss	
Additional Client Level Alarms	

Transcoding Alarms

Flag Parity	**Comments:** · Single/Burst (up to 128)/Rate (10^{-3} to 10^{-10})
Marker Seq Violation	**Comments:** · Single/Burst (up to 128)/Rate (10^{-3} to 10^{-10})
OTN BIP-8	**Comments:** · Per lane/all lanes; Single/Burst (up to 128)/Rate (10^{-3} to 10^{-10})
Ingress BIP-8	**Comments:** · Per lane/all lanes; Single/Burst (up to 128)/Rate (10^{-3} to 10^{-10})
Code	**Comments:** · Per lane/all lanes; Single/Burst (up to 128)/Rate (10^{-3} to 10^{-10})

OTN alarm suppression	
	Setting to suppress low-rate FAS, MFAS, LLM, and correctable FEC reporting as errors. This is especially useful when there is an OTN interface using PAM4 such as OTL4.2

OTN Overhead

Support of AMP, GMP, BMP as per client mapping	**Comments:** · AMP client offset up to +/- 65 PPM for SONET/SDH Clients
GCC Transparency / encryption keys	**Comments:** · Selection of GCC0, GCC1, GCC2, GCC1+2. PRBS verification on Rx interface with bits, errors, and BER. Free running PRBS or reset PRBS every MFAS=0 · Per GCC byte testing
Round-Trip Delay (RTD) as per G.709 section 15.8 (100 nsec accuracy)	**Comments:** · Selection of PM or TCM1-6

Overhead Manipulation/Analysis

Overhead editor for OTU, ODU, OPU bytes	**Comments:** · Multiple ODU levels for ODU multiplexing
Full structured PSI editor	
Full PSI and MSI byte maps for each ODU multiplexed level	**Comments:** · Rx & Tx MSI with Byte value, ODU Type, and Tributary Port #
Can copy Rx MSI values to Tx MSI	

Full setting of Tx and Rx Tributary Ports	
Display of tributary slots and port for each ODU multiplexed level	

SM/PM and TCM1-6 Trace (TTI) messages

Tx and Rx SAPI/DAPI functionality	
TIM alarms on SAPI and/or DAPI mismatch or disable	

Fault Signaling (FTFL) processing

Forward and Backward messaging	

OTU4, OTU3 (Continued)

Payload Type (PT) Label generation/display	
Set transmitted and Display received PT value	
PLM alarms enable/disable	
Forward Error Correction	
Outgoing FEC: GFEC (G.709 FEC) or all-zeros	
Incoming FEC: ignore, correct errors, do not correct errors	

GMP Layer Injection/Detection

Tx Payload Mapping Type	
Expected Payload Mapping Type	
CM value overwrite	
Nominal and Effective CM Value	
Payload Offset (ppm)	**Comments:** · +/- 100ppm
Error Injections	
CRC-5	**Comments:** · Single/Burst (up to 16)
CRC-8	**Comments:** · Single/Burst (up to 16)
Ethernet	
As per Ethernet Injection/Detection	

GFP Layer Injection/Detection

With Ethernet Clients	
Set PFI	
Set EXI	
Set UPI	
Rx filter on CID	
Rx filter on UPI	
GFP-T Superblocks per frame	**Comments:** · 1 to 978

Service Disruption Measurement

Measurement Parameters	
SD Separation/Debounce Time Setting	**Comments:** · Mandatory for handling debounce of the NE's Tx. Up to 60000 msec
SD Threshold Time Settings	**Comments:** · Up to 60000 msec
Triggers	
Signal Loss / LOS	
Bit/TSE Error	**Comments:** · For PRBS errors
OTL LOF	
OTL FAS Error	
OTL MFAS Error	
OTL LLM (OTU4)	
OTU LOM	
OTU SM-IAE	
OTU SM-BIAE	
ODU AIS	
ODU LCK	

ODU OCI	
ODU PM-BDI	
OTU OOM	
ODU PM-BIP	
ODU PM-BEI	
SONET/SDH when present as a client	
Ethernet SD based on gap measurement when present as a client	

Results

Custom results	
LEDS	
Signal Present / LOS	
Frame Sync / LOF	
Marker Lock / LOR	
Lanes Aligned / LOL	
Pattern Sync / LSS	
GMP Sync	
GMP (Cm=0)	
GFP CSF-LCCS Alarm	
GFP CSF-LCS Alarm	
Client or muxed Level extra	
Summary Status	
Event Log (Event, Date, Start & Stop time, Duration/Value)	
Histogram (multiple alarms & errors)	
Service Disruption Summary Table	
Service Disruption Details	
Service Disruption Statistics	
Longest	
Shortest	
Last	
Average	
Number of Disruptions	
Time	
Current Date, Current Time, Test Elapsed Time	
Interface	
Invalid Rx Signal Seconds	
Signal Losses / LOS	
Signal Losses Seconds / LOS Seconds	
QSFP State	
CFP2 State	
CFP2 Optical Rx Overload	
Optical Rx Level (dBm)	
Rx Frequency (Hz)	
Rx Frequency Deviation (ppm)	
Rx Frequency Max Deviation (ppm)	
Tx Clock Source	
Tx Frequency (Hz)	
Tx Frequency Deviation (ppm)	

OTU4, OTU3 (Continued)

Tx Freq Max Deviation (ppm)	
Round-Trip Delay Current, Avg, Min, Max (100 nsec res.)	
Per lambda Rx power	**Comments:** · Optics dependent
Per lambda Tx power	**Comments:** · Optics dependent
OTL Stats	
Frame Sync Loss Seconds / LOF Seconds	
OOF Seconds	
OOMFAS Seconds	
Marker Lock Loss Seconds / LOR Seconds	**Comments:** · Loss of Recovery
OOR Errors	**Comments:** · Out of Recovery
Lane Aligned Loss Seconds / LOL Seconds	
OOL Seconds	
OOLLM Seconds	
FAS Errors	
FAS Error Rate	
FAS Error Seconds	
MFAS Errors	
MFAS Error Rate	
MFAS Error Seconds	
Logical Lane Marker Errors	
Logical Lane Marker Error Rate	
Logical Lane Marker Error Seconds	
Max Skew (Bits)	
Current Max Skew (Bits)	
Max Skew (ns)	
Current Max Skew (ns)	
Max Logical Lane Skew (LL ID)	
Min Logical Lane Skew (LL ID)	
OTL Per Lane	
Lane #	
Logical Lane ID	
Skew (Bits, nsec)	
Frame Sync / OTL LOF	
OTL OOF	
OOMFAS	
Marker Lock / OOLLM	
OTL LOR (OTU4)	**Comments:** · Out of Recovery
OTL OOR	
FAS Errors	
MFAS Errors	
Logical Lane Marker Errors (OTU4)	
Ethernet Virtual Lane ID	**Comments:** · For Ethernet in OTN

Sync Acquired	**Comments:** · For Ethernet in OTN
Eth Marker Lock	**Comments:** · For Ethernet in OTN
Code Violations	**Comments:** · For Ethernet in OTN
Invalid Alignment Markers	**Comments:** · For Ethernet in OTN
BIP-8 AM Bit Errors	**Comments:** · For Ethernet in OTN
BIP-8 AM Block Errors	**Comments:** · For Ethernet in OTN
FEC	
Uncorrected Word Errors	
Uncorrected Word Error Rate	
Uncorrected Word Errored Seconds	
Corrected Word Errors	
Corrected Word Errors Rate	
Corrected Word Errored Seconds	
Corrected Bit Errors	
Corrected Bit Errors Rate	
Corrected Bit Errored Seconds	
Framing	
OOM Seconds	
OTU	
AIS Seconds	
SM-IAE Seconds	
SM-BIP Errors	
SM-BIP Error Rate	
SM-BDI Seconds	
SM-BIAE Seconds	
SM-BEI Errors	
SM-BEI Error Rate	
SM-SAPI	
SM-DAPI	
SM-Operator Specific	
GCC BERT Bits	
GCC BERT Bit Errors	
GCC BERT Bit Error Rate	
ODU	
ODU-AIS Seconds	
ODU-LCK Seconds	
ODU-OCI Seconds	
PM-BIP Errors	
PM BIP Error Rate	
PM-BDI Seconds	
PM-BEI Errors	
PM-BEI Error Rate	
PM-SAPI	

OTU4, OTU3 (Continued)

PM-DAPI	GMP (under OTU when used to map payload)
PM-Operator Specific	Sync Status
GCC BERT Bits	Sync Loss Seconds
GCC BERT Bit Errors	OOS Status
GCC BERT Bit Error Rate	OOS Seconds
PM Round Trip Delay Recent	GMP Alarm (Cm=0)
PM Round Trip Delay Last	Effective CM
OPU	Minimum CM
Payload Type	Maximum CM
PT Mismatch Seconds	CM Offset (PPM)
FTFL	Unchanged CM Count
Forward-Fault Type	+1 CM Count
Forward-SF Seconds	+2 CM Count
Forward-SD Seconds	–1 CM Count
Forward-Operator Identifier	-2 CM Count
Forward-Operator Specific	New CM Count
Backward-Fault Type	CRC-5 Bit Errors
Backward-SF Seconds	CRC-5 Bit Error Rate
Backward-SD Seconds	CRC-5 Bit Seconds
Backward-Operator Identifier	CRC-8 Bit Errors
Backward-Operator Specific	CRC-8 Bit Error Rate
TCM 1-6	CRC-8 Bit Seconds
IAE Seconds	GFP
BIP Errors	Payload FCS Errors (count, seconds, ratio, rate)
BIP Error Rate	Core Header Single Bit Errors (count, seconds, ratio, rate)
BDI Seconds	Core Header Multi Bit Errors (count, seconds, ratio, rate)
BIAE Seconds	Type Header Single Bit Errors (count, seconds, ratio, rate)
BEI Errors	Type Header Multi Bit Errors (count, seconds, ratio, rate)
BEI Error Rate	Extension Header Single Bit Errors (count, seconds, ratio, rate)
SAPI	Extension Header Multi Bit Errors (count, seconds, ratio, rate)
DAPI	GFP-T CRC-16 Correctable Errors (count, seconds, ratio, rate)
Operator Specific	GFP-T CRC-16 Uncorrectable Errors (count, seconds, ratio, rate)
PM Round Trip Delay Recent	GFP-T 10B_ERR (count, seconds, ratio, rate)
PM Round Trip Delay Previous	Client
AMP	Client Rx Frequency (Hz)
Rx Offset (PPM)	Client Rx Freq Deviation (ppm)
Max Rx Offset (PPM)	Client Rx Freq Max Deviation (ppm)
PJO1 Count	Transcoding Stats
NJO1 Count	Sync Loss Seconds
Payload	HI BER Seconds
Pattern Sync Losses \ LSSs	1027B Flag Parity Err
Pattern Sync Loss Seconds \ LLS Seconds	1027B Flag Parity Err Rate
TSE/Bit Errors	513B Mkr Seq Vio Cnt
TSE/Bit Error Rate	513B Mkr Seq Vio Rate
TSE/Bit Error Seconds	513B Mkr Seq Vio Seconds
Bit Error-Free Seconds	Total OTN BIP-8 Err Cnt
Bit Error-Free Seconds, %	Total OTN BIP-8 Err Rate

OTU4, OTU3 (Continued)

Total Ingress BIP-8 Err Cnt	
Total Ingress BIP-8 Err Rate	
Transcoding Per Lane	
Lane #	
OTN BIP-8 Err Cnt	
OTN BIP-8 Err Rate	
Ingress BIP-8 Err Cnt	
Ingress BIP-8 Err Rate	
Ethernet Client	
As per Ethernet results	
SONET/SDH Client	
As per SONET/SDH results	

OTN Check	
Automated workfolw is available at all OTN rates for OTN Bulk	**Comments:** · Key use case is OTN service activation
Set test duration based on Bit Error Rate Theory or actual time	
Bit Error Rate Theory parameters for test duration:	
Data Rate (e.g. OTU4)	
BER Threshold	
Confidence Level (% value)	**Comments:** · Statistical degree of certainty
Key automated tests	
Payload BERT	
PRBS pattern selection	
Pass/Fail BER Threshold	
Round Trip Delay	
Selection of applicable OH fields: PM, TCM1-6	
Measurement Frequency	
Pass/Fail Threshold (ms)	
GCC Transparency / encryption keys	

OTU1, OTU2, OTU1e, OTU2e

Test Interfaces/Bit Rates
OTU1 (2.7G)
Dual Port Capable
OTU2 (10.7G)
Dual Port Capable
OTU1e (11.045G)
Dual Port Capable
OTU2e (11.095G)
Dual Port Capable

Interface Type
SFP
SFP+
SFP+ - Tunable

Modes Of Operation
Terminate
Monitor/Thru

Selection of GCC0, GCC1, GCC2, GCC1+2	
Pass/Fail BER Threshold	
Far-end loopback auto-detect function	
Report generation and formats	

Timing	
Recovered from Rx	
Internal (Stratum 3)	
Recovered from External (BITs/SETs)	**Comments:** · BITS / SETS / 2.048MHz / 10MHz
Frequency Offset Transmit/ Receive	**Comments:** · +/- 50ppm
Frequency Reporting	**Comments:** · Resolution in Hz, deviation in PPM

Traffic Mappings	
OTN Bulk BERT	**Comments:** · PRBS as payload in OTU1/2/1e/2e frames
OTU2e with Layer 1 and Layer 2 Traffic	**Comments:** · Full Ethernet functionality at client level
OTU1e with Layer 1 and Layer 2 Traffic	**Comments:** · Full Ethernet functionality at client level
OTU2 with STS-192 Bulk BERT	**Comments:** · Full SONET functionality at client level
OTU2 with STM-64 Bulk BERT	**Comments:** · Full SDH functionality at client level
OTU2 with ODU Multiplexing	
ODU1 with bulk. Direct in ODU2	
ODU0 with bulk. Direct in ODU2	
ODU0 with GE client via GFP-T (layer 2 and layer 3). Direct in ODU2	
ODUFlex with bulk. Direct in ODU2	
ODUFlex with layer 2 MAC via GFP-F. Direct in ODU2	
OTU1 with STS-48 Bulk BERT	**Comments:** · Full SONET functionality at client level
OTU1 with STM-16 Bulk BERT	**Comments:** · Full SDH functionality at client level
OTU1 with ODU Multiplexing	
ODU0 with bulk. Direct in ODU1	
ODU0 with GE client via GFP-T (layer 2 and layer 3). Direct in ODU1	
OTN Bulk PRBS Patterns	**Comments:** · PRBS as payload in OTU1/2/1e/2e frames
2^{23-1}, 2^{23-1} Inverse	
2^{31-1}, 2^{31-1} Inverse	
Delay pattern	
Rx Live	
Digital Word	**Comments:** · 32 bits

OTU1, OTU2, OTU1e, OTU2e (Continued)

OTN Injection/Detection

Set Tx Scramble on/off

Set Rx Descramble on/off

Errors

FEC Uncorrectable	**Comments:** • Single/Rate (10^{-2} to 10^{-5})
FEC Correctable	**Comments:** • Single/Rate (10^{-2} to 10^{-5})
FAS	**Comments:** • Single/Burst (up to 300)
OOF	**Comments:** • Single
MFAS	**Comments:** • Single/Burst (up to 300)
OOM	**Comments:** • Single
SM-BIP	**Comments:** • Single/Rate (10^{-5} to 10^{-7})
SM-BEI	**Comments:** • Single/Rate (10^{-5} to 10^{-7})
PM-BIP	**Comments:** • Single/Rate (10^{-5} to 10^{-7})
PM-BEI	**Comments:** • Single/Rate (10^{-5} to 10^{-7})
TCM1 BIP	**Comments:** • Single/Rate (10^{-5} to 10^{-7})
TCM1 BEI	**Comments:** • Single/Rate (10^{-5} to 10^{-7})
Bit Error/TSE	**Comments:** • Single/Rate (10^{-4} to 10^{-9})

Additional Client Level Errors

Alarms

LOF

LOM

AIS

SM-IAE

SM-TIM

SM-BDI

SM-BIAE

ODU AIS

ODU LCK

ODU OCI

PM-BDI

PM-TIM

Fwd Sig Fail

Fwd Sig Degrade

Bwd Sig Fail

Bwd Sig Degrade

TCM1 IAE

TCM1 BDI

TCM1 BIAE

TCM1-6 TIM

PT Mismatch

Client Loss

Additional Client Level Alarms

OTN Overhead

Support of AMP, GMP, BMP as per client mapping	**Comments:** • AMP client offset up to +/- 65 PPM for SONET/SDH Clients
GCC Transparency / encryption keys	**Comments:** • Selection of GCC0, GCC1, GCC2, GCC1+2. PRBS verification on Rx interface with bits, errors, and BER. Free running PRBS or reset PRBS every MFAS=0
Round-Trip Delay (RTD) as per G.709 section 15.8 (100 nsec accuracy)	**Comments:** • Selection of PM or TCM1-6

Overhead Manipulation/Analysis

Overhead editor for OTU, ODU, OPU bytes	**Comments:** • Multiple ODU levels for ODU multiplexing

Full structured PSI editor

Full PSI and MSI byte maps for each ODU multiplexed level	**Comments:** • Rx & Tx MSI with Byte value, ODU Type, and Tributary Port #

Can copy Rx MSI values to Tx MSI

Full setting of Tx and Rx Tributary Ports

Display of tributary slots and port for each ODU multiplexed level

SM/PM and TCM1-6 Trace (TTI) messages

Tx and Rx SAPI/DAPI functionality

TIM alarms on SAPI and/or DAPI mismatch or disable

Fault Signaling (FTFL) processing

Forward and Backward messaging

Payload Type (PT) Label generation/display

Set transmitted and Display received PT value

PLM alarms enable/disable

Forward Error Correction

Outgoing FEC: GFEC (G.709 FEC) or all-zeros

Incoming FEC: ignore, correct errors, do not correct errors

Service Disruption Measurement

Measurement Parameters

SD Separation/Debounce Time Setting	**Comments:** • Mandatory for handling debounce of the NE's Tx. Up to 60000 msec
SD Threshold Time Settings	**Comments:** • Up to 60000 msec

Triggers

Signal Loss / LOS	**Comments:** • For PRBS errors

Bit/TSE Error

OTU LOM

OTU SM-IAE

OTU1, OTU2, OTU1e, OTU2e (Continued)

	OTU SM-BIAE
	ODU AIS
	ODU LCK
	ODU OCI
	ODU PM-BDI
	OTU OOM
	ODU PM-BIP
	ODU PM-BEI
	Ethernet SD based on gap measurement when present as a client
Results	
Custom results	
LEDS	
	Signal Present / LOS
	Frame Sync / LOF
	Marker Lock / LOR
	Lanes Aligned / LOL
	Pattern Sync / LSS
	GMP Sync
	GMP (Cm=0)
	Client or muxed Level extra
Summary Status	
Event Log (Event, Date, Start & Stop time, Duration/Value)	
Histogram (multiple alarms & errors)	
Service Disruption Summary Table	
Service Disruption Details	
Service Disruption Statistics	
	Longest
	Shortest
	Last
	Average
	Number of Disruptions
Time	
	Current Date, Current Time, Test Elapsed Time
Interface	
	Invalid Rx Signal Seconds
	Signal Losses / LOS
	Signal Losses Seconds / LOS Seconds
	Rx Frequency (Hz)
	Rx Frequency Deviation (ppm)
	Rx Frequency Max Deviation (ppm)
	Tx Clock Source
	Tx Frequency (Hz)
	Tx Frequency Deviation (ppm)
	Tx Freq Max Deviation (ppm)

FEC	
	Uncorrected Word Errors
	Uncorrected Word Error Rate
	Uncorrected Word Errored Seconds
	Corrected Word Errors
	Corrected Word Errors Rate
	Corrected Word Errored Seconds
	Corrected Bit Errors
	Corrected Bit Errors Rate
	Corrected Bit Errored Seconds
Framing	
	Frame Sync Losses
	Frame Sync Losses Seconds
	OOF Seconds
	FAS Errors
	FAS Error Rate
	Multiframe Sync Loss Seconds
	OOM Seconds
	MFAS Errors
	MFAS Error Rate
OTU	
	AIS Seconds
	SM-IAE Seconds
	SM-BIP Errors
	SM-BIP Error Rate
	SM-BDI Seconds
	SM-BIAE Seconds
	SM-BEI Errors
	SM-BEI Error Rate
	SM-SAPI
	SM-DAPI
	SM-Operator Specific
	GCC BERT Bits
	GCC BERT Bit Errors
	GCC BERT Bit Error Rate
ODU	
	ODU-AIS Seconds
	ODU-LCK Seconds
	ODU-OCI Seconds
	PM-BIP Errors
	PM BIP Error Rate
	PM-BDI Seconds
	PM-BEI Errors
	PM-BEI Error Rate
	PM-SAPI
	PM-DAPI

OTU1, OTU2, OTU1e, OTU2e (Continued)

PM-Operator Specific

GCC BERT Bits

GCC BERT Bit Errors

GCC BERT Bit Error Rate

PM Round Trip Delay Recent

PM Round Trip Delay Previous

OPU

Payload Type

PT Mismatch Seconds

FTFL

Forward-Fault Type

Forward-SF Seconds

Forward-SD Seconds

Forward-Operator Identifier

Forward-Operator Specific

Backward-Fault Type

Backward-SF Seconds

Backward-SD Seconds

Backward-Operator Identifier

Backward-Operator Specific

TCM 1-6

IAE Seconds

BIP Errors

BIP Error Rate

BDI Seconds

BIAE Seconds

BEI Errors

BEI Error Rate

SAPI

DAPI

Operator Specific

PM Round Trip Delay Recent

PM Round Trip Delay Previous

AMP

Rx Offset (PPM)

Max Rx Offset (PPM)

PJO1 Count

NJO1 Count

Payload

Pattern Sync Losses \ LSSs

Pattern Sync Loss Seconds \ LLS Seconds

TSE/Bit Errors

TSE/Bit Error Rate

Client

Client Rx Frequency (Hz)

Client Rx Freq Deviation (ppm)

Client Rx Freq Max Deviation (ppm)

Ethernet Client

As per Ethernet results

SONET/SDH Client

As per SONET/SDH results

Ethernet in OTN applications

Applicable to:

10GE in OTU2e/1e

40GE in OTU3

100GE in OTU4

Includes:

QuickCheck

RFC 2544 test suite

OTN Check

Automated workflow is available at all OTN rates for OTN Bulk	**Comments:** · Key use case is OTN service activation

Set test duration based on Bit Error Rate Theory or actual time

Bit Error Rate Theory parameters for test duration:

Data Rate (e.g. OTU4)

BER Threshold

Confidence Level (% value)	**Comments:** · Statistical degree of certainty

Key automated tests

Payload BERT

PRBS pattern selection

Pass/Fail BER Threshold

Round Trip Delay

Selection of applicable OH fields: PM, TCM1-6

Measurement Frequency

Pass/Fail Threshold (ms)

GCC Transparency / encryption keys

Selection of GCC0, GCC1, GCC2, GCC1+2

Pass/Fail BER Threshold

Far-end loopback auto-detect function

Report generation and formats

Fibre Channel

Test Interfaces/Bit Rates
1G FC (1.0625Gb/s)
Dual Port Capable
2G FC(2.125Gb/s)
Dual Port Capable
4G FC (4.25Gb/s)
Dual Port Capable
8G FC (8.5Gb/s)
Dual Port Capable
10G FC (10.5175Gb/s)
Dual Port Capable
16G FC (14.025Gb/s)
Dual Port Capable
32G FC (28.05Gb/s)
Dual Port Capable

Laser Type
SFP
SFP+
SFP28

Modes Of Operation
Terminate
Monitor
Thru
Loopback
Tx only mode

Timing	
Internal	
Frequency Offset Transmit/ Receive	**Comments:** · +/- 110ppm

Traffic Attributes	
Line Rate Traffic Tx and RX	
Layer 1 Test Patterns	
HFPAT	**Comments:** · 1G/2G/4G FC
LFPAT	**Comments:** · 1G/2G/4G FC
MFPAT	**Comments:** · 1G/2G/4G FC
RDPAT	**Comments:** · 1G/2G/4G FC
JTPAT	**Comments:** · 1G/2G/4G FC
SNPAT	**Comments:** · 1G/2G/4G FC
A seed	**Comments:** · 10G/16G FC
B seed	**Comments:** · 10G/16G FC

PRBS31	**Comments:** · 10G/16G FC
Layer 2 Test Patterns	
CRPAT	**Comments:** · 1G/2G/4G/8G FC
CJPAT	**Comments:** · 1G/2G/4G/8G FC
CSPAT	**Comments:** · 1G/2G/4G/8G FC
PRBS Payload Patterns	
2^{31-1}, 2^{23-1}, 2^{20-1}, All Ones, All Zeroes	
Scrambling (on/off)	**Comments:** · 8G FC In FC-1 on total frame
Emissions Lowering Protocol (on/off)	**Comments:** · 8G FC
Emissions Lowering Protocol Type (Idle-ARBff, ARBff-ARBff)	
Incoming FEC (32G)	**Comments:** · Find and fix errors, Find but don't fix errors, ignore
Disable Hi SER Alarm (32G)	**Comments:** · off, on

Fibre Channel Generator	
Frame Length	
28 (no payload), 32, 76 (ATP), 128, 256, 512, 1024, 1536, 2076, 2140 settings	
User defined (28 to 2140)	
Fibre Channel Fields	
Unicast or Broadcast	
Destination ID	
Source ID	
Sequence ID	
Originator ID	
Responder ID	
FC Frame Payload	
BERT/PRBS Pattern	
Acterna Test Protocol Version 2	
Auto-traffic start on laser on	

Traffic Generator	
Traffic Profiles	
Traffic generation in Mbit/s and % utilization	
Constant B/W	
Burst B/W	
Ramp B/W	
Flood B/W	**Comments:** · Full line rate
Constant B/w	
Bit Rate	
Percentage	
Burst B/w	

Fibre Channel (Continued)

Burst Time and Gap Time	
Burst Time	
Gap/Idle Time	
Continuous or fixed (up to 65535) bursts	
Frames and Duty Cycle	
Duty Cycle (%)	
Frames/Burst	
Continuous or fixed (up to 65535) bursts	

Ramp B/w

Timed Step (0.1 sec granularity)
Load Step (%)
Stop load incr conditions
Errored Frames (count parameter)
Dropped Frames (count parameter)

Flow Control Login

General

Flow Control (on/off)
Login
Implicit
Explicit (E-port)
Explicit (Fabric/N-port)
Buffer-to-Buffer Credits

MAC ID

Unit Identifier
Port Name

Fabric/N_Port Login

Topology (Fabric, Point-to-Point)
Source N-port Name
Source Node Name/Source ID
Dest N-port Name
Dest Node Name/Dest ID

TTS Speed Negotiation support for 32GFC fabrics

Traffic Filtering

Routing Control
Destination ID
Source ID
Data Type
Sequence Control
Data
BERT Rx=Tx
Payload Analysis
Rx BERT Pattern

Tx/Rx Decoupling Mode (for Service Disruption Measurements)	**Comments:** · On incoming alarms, traffic generator is not affected

Injection/Detection

Errors

Code	**Comments:** · Single/Rate (10^{-3} to 10^{-9})

CRC	**Comments:** · Single/Burst (up to 32767)
Bit Error (PRBS)	**Comments:** · Single/Rate (10^{-3} to 10^{-9})
RS-FEC Uncorr CW (32G)	**Comments:** · Single/Burst (up to 512)/Rate (10-2 to 10-9)
RS-FEC Corr CW (32G)	**Comments:** · Single/Burst (up to 512)/Rate (10-2 to 10-9)

Faults

Local Fault (10G)
Remote Fault (10G)

Alarms

HI SER (32G)

Results

Custom results

LEDS

Signal Present
RS-FEC LOCWS
RS-FEC HI SER (32G)
Sync Acquired
Link Active
ATP Detect
Pattern Sync
Local Fault (10G)
Remote Fault (10G)

SLA/KPI

Frame Loss (count & ratio)
Round Trip Delay/FD (average, current, maximum)

Event Log (Event, Date, Start & Stop time, Duration/Value)

Histogram

Optical Rx Overload
Signal Loss
Link Loss
Timing Src Loss
Sync Loss
Local Fault (10G/16G)
Remote Fault (10G/16G)
Code Violation
Runts
Jabbers
Undersized Frames
CRC errored frames
Errored Frames
Lost frames
OoS Frames
EB (PCS)
BSL (PCS)
Bit Errors (PRBS)
Acternal Payload Errors

Fibre Channel (Continued)

Time

Current Date, Current Time, Test Elapsed Time

Interface

Signal Losses

Signal Loss Seconds

Sync Loss Seconds

Link Loss Seconds

Optical Rx Overload

Tx Clock Source

Local Fault Seconds (10G/16G)

Remote Fault Seconds (10G/16G)

L2 Link Statistics

Total Utilization % (avg, current, min, peak)

Frame Rate (avg, current, min, peak)

Frame Size (Avg, Min, Max)

Rx Mbps (L1, L2)

Tx Mbps (L1, L2)

Round Trip Delay (us) (Avg, current, min, max)

Service Disruption (us)

ELP Mismatch Link Active

L2 Link Counts

Rx Frames

Tx Frames

Rx Acterna

Tx Acterna Frames

28-64 Byte Frames

68-124 Byte Frames

128-252 Byte Frames

256-508 Byte Frames

512-1020 Byte Frames

1024-2140 Byte Frames

Rx Frame Bytes

Tx Frame Bytes

Rx R_RDYs

Tx R_RDYs

Near-end B-B Credits

Tx Avail B-B Credit, Current

Class F Frames

Class 1 Frames

Class 2 Frames

Class 3 Frames

L2 Filtered counts/statistics

Bert Stats

Pattern Losses

Pattern Loss Seconds

Bit Error Rate

Bit Errors

Bit Errored Seconds

Bit Error-Free Seconds

Bit Error-Free Seconds (%)

Login status

Login Status

Tx/Rx ELP Request

Tx/Rx ELP Accept

Tx/Rx ELP Ack1

Fabric Present

Fabric Login Status

F Port Name

Fabric Name

N Port Login Status

Dest N Port ID

Dest N Port Name

Dest Node Name

Source N Port ID

Source N Port Name

Source Node Name

RS-FEC

LOCWS Alarms

LOCWS Seconds

HI SER Alarm

HI SER Seconds

Corr. CW Errors

Corr. CW Error Rate

Corr. Bit Errors

Corr. Bit Error Rate

Uncorr. CW Errors

Uncorr. CW Error Rate

Corr+Uncorr Bit Error Rate

Error Stats

Symbol Errors

CRC Errored Frames

Fiber Runts

Fiber Jabbers

Undersized Frames

Errored Frames

Code Violations

Code Violation Rate

Code Violation Seconds

Graphical Displays

Throughput versus Time

Frame Loss versus Time

Latency/FD (RTD) versus Time

Errors versus Time

CRC Errored Frames

Fiber Runts

Fibre Channel (Continued)

	Fiber Jabbers
	Bit Errors
	OoS Frames
FC RFC2544	
Symmetric, Loopback	
Loopback	
Set addresses, Loop Type, IDs	
Tests	
	Throughput
	Zeroing-in: RFC 2544 standard or VIAVI enhanced
	Bandwidth Granularity
	Test Duration and Number of Trials
	Pass/Fail Threshold
	Latency (RTD)
	Pass/Fail Threshold
	Frame Loss
	Test Duration and Number of Trials
	Pass/Fail Threshold
	Back-to-back
	Max Burst Duration
	Burst Granularity
	Buffer Credit
	Flow control Login Type (Implicit, Explicit)
	Max Buffer Size
	Buffer Credit Throughput
	Throughput Steps
Traffic in Mbps or %	
Up to 10 frame/packet sizes (max 2140 bytes)	
Can run multiple tests concurrently for speed	
Report generation and formats	
Graphical Results	
Total Test Time Display	

PDH

Test Interfaces
E4 (140Mbps)
DS3 (44.736Mbps)
E3 (34Mbps)
E1 Balanced (2.048Mbps)
E1 Unbalanced (2.048Mbps)
DS1 (1.544Mbps)
Interface Type
BNC
Bantam
RJ-48
Modes Of Operation
Terminate
Monitor
Thru (Intrusive)
Timing
Recovered from Rx
Recovered Internal (Stratum 3)
Recovered from External (BITs/SETs)
Framing
Framed
Unframed
Test Patterns
2^{15-1}* (Inverse)
2^{20-1}* (Inverse)
2^{23-1}* (Inverse)
User Programmable
Round Trip Delay
ANSI and ITU
Mappings
E3
E1
64k
Anomaly/Error Insert/Analysis
Frame Errors
TSE/Bit Error
Single
Rate
Defect/Alarm Insert/Analysis
AIS
RDI/FAS Distant
General
Frequency Offset +/- 100ppm
National Bit Support
Performance Measures
G.821 (OOS)
G.826 (ISM/OOS)
M.2100 (ISM/OOS)

PDH (Continued)

Results
Signal Category
Receive Frequency
Receive Frequency Deviation
Receive Frequency Max Deviation
Transmit Frequency
Round Trip Delay
Frame Category
FAS TSE Count
FAS TSE Rate
FAS Word Error Count
FAS Word Error Rate
Frame Synchronization Loss Count
Frame Synchronization Loss Seconds
Logic Category
TSE/Bit Error Count
TSE/Bit Error Rate
Pattern Slips
Pattern Slip Seconds
Pattern Synchronization Loss Count
Pattern Synchronization Loss Seconds

DS3
Modes Of Operation
Terminate
Monitor
Thru (Intrusive)
Timing
Recovered from Rx
Internal (Stratum 3)
Recovered from External (BITs/SETs)
Framing
M13
Cbit
Unframed
Test Patterns
All 1s
All 0s
2^{15-1}* (Inverse)
2^{20-1}* (Inverse)
2^{23-1}* (Inverse)
Round Trip Delay
User Programmable (3,,,,32 bits)
User Byte
100
1100 (aka IDLE)
1010 (aka BLUE)
ANSI and ITU

Mappings		
E1		
T1		
64k		
Anomaly/Error Insert/Analysis		
BPV/Code Error		
Frame		
Parity		
C-Bit Parity		
TSE/Bit Error		
Single		
Rate		
Multiple		
Defect/Alarm Insert/Analysis		
AIS		
RDI/FAS Distant		
REBE		
TS-16 AIS		
TS-16 RDI/MFAC Distant		
General		
Frequency Offset +/- 100ppm		
Loop Codes Tx NIU, CSU, Line	**Comments:** · FEAC Loopcodes	
Rx Compensation - High - 0 ft		
Rx Compensation - Low - 450 ft		
Rx Compensation - Low - 900 ft		
Service Disruption	**Comments:** · Frame Sync	
Performance Measures		
G.826 (ISM/OOS)		
G.821		
M.2100		
M.2101		
T1.231		
T1.510		
Results		
Signal Category		
Receive Frequency		
Receive Frequency Deviation		
Receive Frequency Maximum Deviation		
Transmit Frequency		
BPV/Code Rate		
BPV/Code Count		
Electrical Input Level		
Round Trip Delay (ms)		

PDH (Continued)

Frame

- Frame Error Count
- Frame Error Rate
- Frame Error Seconds
- Frame Synchronization Loss Count
- Near End Out of Frame Seconds
- Far-End Out of Frame Seconds
- C-Bit Format
- RX X-Bits
- FEAC Word
- Parity Error Count
- Parity Error Rate
- Parity Error Seconds
- C-Bit Parity Error Count
- C-Bit Parity Error Rate
- C-Bit Error Seconds
- FEBEs
- DS2 Frame Synchronization Loss Count

Logic

- Bit Error/TSE Count
- Bit Error/TSE Rate
- Pattern Slips
- Pattern Slip Seconds
- Pattern Synchronization Loss Count
- Pattern Synchronization Loss Seconds
- Pattern Synchronization Status

E3

Modes Of Operation

- Terminate
- Monitor
- Thru (Intrusive)

Timing

Recovered from Rx

Internal (Stratum 3)

Recovered from External (BITs/SETs)

Framing

Framed

Unframed

Test Patterns

All 1s

All 0s

2047

2^{11-1}* (Inverse)

2^{15-1}* (Inverse)

2^{20-1}* (Inverse)

2^{23-1}* (Inverse)

User Programmable (3,,,,32 bits)

User Byte

Round Trip Delay

1:1

1:3

1:4

1:7

ANSI and ITU

Mappings

E1

64k

Anomaly/Error Insert/Analysis

Code Error

FAS Error

TSE/Bit Error

Single

Rate

Defect/Alarm Insert/Analysis

AIS

RDI/FAS Distant

General

Frequency Offset Tx +/- 100ppm

Tx LBO - 0 dB Loss

Tx LBO - 6 dB Loss

National Bit Support - On/Off

Service Disruption

Performance Measures

- G.826 (ISM/OOS)
- G.821
- M.2100

Results

Signal Category

- Transmit Frequency
- Receive Frequency
- Receive Frequency Maximum Deviation
- Electrical Input Level
- Code Error Count
- Code Error Rate
- Round Trip Delay (ms)
- APS Switch Time (ms)

Frame Category

- FAS Bit Error Count
- FAS Bit Error Rate
- FAS Word Error Count
- FAS Word Error Rate
- Frame Synchronization Loss Count
- 8M FAS Word Error Rate
- 8M FAS Bit Error Count

PDH (Continued)

8M FAS Bit Error Rate	
8M FAS Word Error Count	
8M FAS Word Error Rate	
Logic Category	
TSE/Bit Error Count	
TSE/Bit Error Rate	
Pattern Slips	
Pattern Slip Seconds	
Pattern Synchronization Loss Count	
Pattern Synchronization Loss Seconds	
Pattern Synchronization Status	
E1	
Modes Of Operation	
Terminate	
Monitor	
Thru (Intrusive)	
Timing	
Recovered from Rx	
Internal (Stratum 3)	
Recovered from External (BITs/SETs)	
Framing	
Unframed	
PCM30	
PCM30C	
PCM31	
PCM31C	
Test Patterns	
All 1s	
All 0s	
2^{15-1}* (Inverse)	
2^{20-1}* (Inverse)	
2^{23-1}* (Inverse)	
QRSS	
User Programmable (32 bits)	
Round Trip Delay	
1:1	
1:3	
1:4	
1:7	
ANSI and ITU	
Mappings	
64k	
Anomaly/Error Insert/Analysis	
Code Error	
FAS Error	
MFAS Error	
TSE/Bit Error	
Single	

Multiple	
Rate	
Defect/Alarm Insert/Analysis	
AIS	
REBE	
TS-16 AIS	
TS-16 RDI/MFAS Distant	
General	
Frequency Offset Tx +/- 100ppm	
Service Disruption	**Comments:** · Frame Sync
Performance Measures	
G.826 (ISM/OOS)	
G.821	
G.829 (ISM/OOS)	
M.2100	
Results	
Signal Category	
2M Receive Frequency	
2M Reference Frequency	
2M Receive Frequency Deviation	
2M Receive Frequency Maximum Deviation	
2M Transmit Frequency	
Electrical Input Level	
Code Error Count	
Code Error Rate	
Round Trip Delay (ms)	
Timing Slips	
Frame Slips	
APS Switch Time	
Logic Category	
TSE/Bit Error Count	
TSE/Bit Error Rate	
Pattern Slips	
Pattern Slip Seconds	
Pattern Synchronization Loss Count	
Pattern Synchronization Status	
Alarm Category	
FAS/Frame Synchronization	
MFAS Synchronization	
CRC Synchronization	
AIS	
RDI	
Power Loss Count	
2M Alarm	

PDH (Continued)

Frame Category	
FAS Bit Error Count	
FAS Bit Error Rate	
FAS Word Error Count	
FAS Word Error Rate	
Non-Frame Alignment Word	
MFAS Word Error Count	
MFAS Word Error Rate	
Time Slot Rx Byte	
CRC Error Count	
CRC Error Rate	
CRC Synchronization Loss Count	
FAS Synchronization Loss Count	
MFAS Synchronization Loss Count	
Remote End Block Error (REBE)	

T1	
Modes Of Operation	
Terminate	
Monitor	
Thru (Intrusive)	
Timing	
Recovered from Rx	
Internal (Stratum 3)	
Recovered from External (BITs/SETs)	
Framing	
Unframed	
SF	
ESF	
SLC-96	
Test Patterns	
63	
511	
511 QRSS	
2047 QRSS	
2047	
All 1s	
All 0s	
2^{15-1}* (Inverse)	
2^{20-1}* (Inverse)	
2^{23-1}* (Inverse)	
QRSS	
User Programmable (3,,,,32 bits)	
User Byte	
BridgeTap	
MultiPat	
Round Trip Delay	
1:1	

1:3	
1:4	
1:7	
2 in 8	
3 in 24	
MIN/MAX	
T1 DALY	
55 OCTET	
T1-2/96	
T1-3/54	
T1-4/120	
T1-5/53	
Mappings	
64k	
56k	
Anomaly/Error Insert/Analysis	
Frame Errors	
BPV Errors	
TSE/Bit Error	
Single	
Rate	
Multiple	
Defect/Alarm Insert/Analysis	
AIS	
REBE	
General	
Frequency Offset Tx +/- 100ppm	
Performance Measures	
G.826 (ISM/OOS)	
G.828 (ISM/OOS)	
G.829 (ISM/OOS)	
M.2100	
T1.231	
Tx LBO - 0 dB Loss	
Tx LBO - 7.5 dB Loss	
Tx LBO - 15 dB Loss	
Tx LBO - 22.5 dB Loss	
Service Disruption	
Loop Codes	
Loop Code Tx - NIU	
Loop Code Tx - CSU	
Loop Code Tx - Repeater	
Loop Code Emulation - NIU	
Loop Code Emulation - CSU	
HDSL Loopcode Tx	
CO to Customer direction	
Customer to CO direction	
User Defined Loopcode Support	

PDH (Continued)

Results
Signal Category
Receive Frequency
Reference Frequency
Receive Frequency Deviation
Receive Frequency Maximum Deviation
Transmit Frequency
Simplex Current
Receive Level (Vp)
Receive Level (dBdsx)
Receive Level (dBm)
BPV Error Count
BPV Error Rate
Frame Slip Count
Signal Loss Count
Signal Loss Seconds
Round Trip Delay (ms)
Timing Slips
Frame Slips
APS Switch Time
Frame Category
Frame Error Count
Frame Error Rate
Frame Error Seconds
Frame Loss Count
Frame Loss Seconds
Severely Errored Seconds
CRC Error Count
CRC Error Rate
CRC Errored Seconds
CRC Severely Errored Seconds
Logic Category
Bit Error/TSE Count
Bit Error/TSE Rate
Bit Error/TSE Seconds
Pattern Slips
Pattern Slip Seconds
Pattern Synchronization Loss Count
Pattern Synchronization Loss Seconds

Channel	
DSO Channel Payload View	**Comments:** · View the data in all 24 embedded channels.
ABCD Bit Signaling View	

DS1 Dual HDLC Monitor and PPP Ping
Modes of Operation
Bridge
Terminate
DSX Monitor
Line Code
B8ZS
AMI
Clock Source (PPP Ping Only)
Internal
Recovered
External
Selectable Clock Offset
Transmit LBO (PPP Ping Only)
0 dB
-7.5 dB
–15.0 dB
–22.5 dB
Framing
Unframed
ESF
D4 (SF)
SLC–96
Payload
Bulk
Fractional Rate
HDLC
Normal or Inverted HDLC Mode
CRC16 or CRC32
PPP (PPP Ping Only)
PPP Mode (Client or Server)
IP Mode (Static or Auto)
Optional Authentication
IP (PPP Ping Only)
IPv4 Frame Format
Local IP
Remote IP
Destination IP Address – User Defined
Subnet Mask
Preferred & Alternate DNS Server
IPv4 Editable Fields
ToS
DSCP
TTL

PDH (Continued)

IP Ping

Editable Packet Length (46 - 1500 bytes)

Single

Multiple

Continuous

Fast

Alarms/Errors Generation and Analysis (PPP Ping Only)

LOS

LOF

AIS

RAI

BPV

Frame

Results

Interface

Signal Losses

Signal Loss Seconds

Rx Level (Vpp)

Rx Level (dBsx)

Rx/Tx Frequency (Hz)

Rx/Tx Frequency Deviation (ppm)

Rx/Tx Frequency Max Deviation (ppm)

Bi-Polar Violations (BPVs)

BPV Rate

Excess Zeros State Count

Ones Density State Count

DS1

Frame Sync Losses

Frame Sync Loss Seconds

AIS Alarms

AIS Seconds

T1 Alarm Seconds

Frame Errors

Frame Error Rate

Frame Error Seconds

Excess Zeros

Maximum Consecutive Zeros

HDLC

Rx/Tx Frame Count

Rx/Tx Octet Count

Frame Aborts

Short Frames

FCS Errored Frames

Percent Utilization (Average, Current, Maximum)

Throughput (Average, Current, Maximum)

Average Fame Rate (frames/sec)

Average Frame Size (octets)

PPP (PPP Ping Only)

PPP Status

Local IP

IP Subnet Mask

Remote IP

Preferred & Alternate DNS Server

Destination IP Address

Resolved Host Name

Ping (PPP Ping Only)

Ping Requests Tx

Ping Replies Rx

Lost Pings

Lost Ping %

Delay (ms)

Ping Requests Rx

Ping Replies Tx

Capture/Decode

Wirespeed Capture

Integrated Wireshark on the TestSet

256MB Capture Buffer

Triggers

Frame Slicing

DS3 HDLC Dual Monitor

Modes of Operation

DSX-MON

Terminate

Framing

Unframed

M13

C-Bit

HDLC

Normal or Inverted HDLC Mode

CRC16 or CRC32

Results

Interface

Signal Losses

Signal Loss Seconds

Rx Level (Vpeak)

Rx Level (dBdsx)

Rx Frequency (Hz)

Rx Frequency Deviation (ppm)

Rx Frequency Max Deviation (ppm)

Bi-Polar Violations (BPVs)

BPV Rate

BPV Error Seconds

Excess Zeros Count

Excess Zeros Seconds

PDH (Continued)

DS3

- Frame Sync Losses
- Frame Sync Loss Seconds
- Near End OOF Seconds
- Far End OOF Seconds
- AIS Seconds
- RAI Seconds
- FEAC Word
- Frame Errors
- Frame Error Rate
- Parity Errors
- Parity Error Bit Rate
- C-Bit Errors
- C-Bit Error Rate
- C-Bit Error Seconds
- C-Bit Frame Mismatch Seconds
- C-Bit Sync Loss Seconds
- FEBEs
- FEBE Rate
- FEBE Seconds
- Rx X-Bits

HDLC

- Rx Frame Count
- Rx Octet Count
- Frame Aborts
- Short Frames
- FCS Errored Frames
- Percent Utilization (Average, Current, Maximum)
- Throughput (Average, Current, Maximum)
- Average Fame Rate (frames/sec)
- Average Frame Size (octets)

eCPRI

Test Interfaces/Bit Rates (All dual-port capable)

- 10GigE LAN Phy (10.3G)
- 25GigE (25.78125Gb), RS-FEC and bypass

Interface Type

SFP28	Applications: 25G eCPRI
SFP+	Applications: 10G eCPRI
General	

- A lot of commonality with 10GE and 25GE Ethernet features
- Line Rate Traffic Tx and RX for all Interfaces
- Report Tx/Rx optical power levels
- Support of Service Disruption
- Ethernet and eCPRI capture (10GE)
- Ethernet/eCPRI error injection and reporting

Modes of Operation

Terminate	
Monitor/Thru Comments: Monitoring on Rx while keeping Tx up via idles	
Logical Loopback	**Comments:** · Manual and Loop up/down; switching of addresses at Layer 2 and Layer 3

Timing

Recovered from Rx	**Comments:** · Synchronous Ethernet Applications Internal (Stratum 3)
Recovered from External (BITs/SETs)	**Comments:** · Required for Synchronous Ethernet applications, +/- 150ppm range

Ethernet Features

- Frame type: 802.3 and DIX (type II)
- VLAN and Q-in-Q
- Framed Pattern Tests: PRBS and ATP traffic
- Traffic: constant BW, ramp BW, burst BW
- eCPRI subheaders in Ethernet
- Frame Loss, Frame Loss Ratio, and Out of Sequence measurements
- 10 streams for traffic generation

Latency Measurements

- Round-Trip Delay latency using ATPv4 for high-accuracy in the low nsec range
- 25GE One-Way Delay using eCPRI Message 5
  · 25GE RS-FEC with TEM, port to port: accuracy <40ns, with typical precision of <10ns. (Precision is OWD Max − OWD Min) and 1ns resolution
  · 25GE bypass with TEM, port to port: accuracy <10ns, with typical precision of <10ns and 1ns resolution
- 10GE One-Way Delay using eCPRI Message 5
  · 10GE with TEM, port to port: accuracy <10ns, with typical precision of <10ns and 1ns resolution

RFC2544

- Asymmetric Testing
- Symmetric Testing
- Throughput
- Frame Loss
- Out of sequence frames
- Errored Frames
- Delay
- Back to Back
- Committed Burst Size (CBS)
- Policer Test
- Jitter
- Master/Slave
- Pass/Fail Thresholds per MEF 23.1

eCPRI (Continued)

Connectivity QuickCheck	**Comments:** · Enables quick verification of end to end connectivity executing an RFC test
Parallel Testing	**Comments:** · Reduces test times by 50% by performing Latency, Throughput and Jitter tests simultaneously
Optional Testing with line rate LBM frames	
Definable Frame Size	
Report formats	
Graphical Results	
Total Test Time Display	
ITU-T Y.1564	
10 Traffic Streams	
Service Configuration Test	
Service Performance Test	
Committed Information Rate (CIR)	
Extended IR (EIR)	
Maximum Ir (MIR)	
Frame Loss Rate (FLR)	
Frame Delay (FD)	
Frame Delay Variation	
Committed Burst Size (CBS)	
Policer Test	
Round Trip Testing	
Concurrent Bi-directional Testing	**Comments:** · Enables each test to perform and collect 1564 results for bi-directional analysis
Asymmetric Testing	
Configurable VLAN, Priority, Addressing and Pass/Fail Thresholds	
Programmable Pass/Fail Thresholds	
Graphical Results	
Screenshot Support	
Saved Test Profiles	
Saved Reports	
Configurable DEI, TPID, TOS/DSCP	

CPRI

Test Interfaces/Bit Rates
614 Mbps Optical - Option 1
Dual Port Capable
1.2 Gbps Optical - Option 2
Dual Port Capable
2.4 Gbps Optical - Option 3
Dual Port Capable
3.1 Gbps Optical - Option 4
Dual Port Capable

4.9 Gbps Optical - Option 5
Dual Port Capable
6.1 Gbps Optical - Option 6
Dual Port Capable
9.8 Gbps Optical - Option 7
Dual Port Capable
10.137 Gbps Optical - Option 8
Dual Port Capable
24.33 Gbps Optical - Option 10 with RS-FEC and bypass
Dual Port Capable
Laser Type
SFP
SFP+
SFP+ Tuneable
SFP28
Modes Of Operation
Terminate
Monitor/Thru
Timing
Recovered from Rx (Slave)
Internal (Stratum 3) (Master)
Recovered from External (BITs/SETs) (Master)
Recovered from 10MHz clock (Master)
CPRI Features
Optical/Electrical Power Level
Freq Offset Transmit/Receive
CPRI Startup Sequence - Normal or Bypass
Signal Generation and Monitoring
L2 - PRBS Pattern Inserted in CPRI Basic Frame I/Q area
Interface Type
Master
Slave
Selectable CPRI Protocol Version
Control and Management (C&M) Channel
Ethernet
HDLC
Selectable C&M Channel Rate
Service Disruption Measurements
SD Separation/Debounce Time Setting
SD Threshold Time Settings
Round Trip Delay Measurement
PRBS Patterns
2^{15-1}, 2^{15-1} Inverse
2^{20-1}, 2^{20-1} Inverse
2^{23-1}, 2^{23-1} Inverse
2^{31-1}, 2^{31-1} Inverse
Delay

CPRI (Continued)

Live

Digital Word

ANSI and ITU implementations

Anomaly/Errors generation

Bit/TSE

Code

K30.7

RS-FEC Uncorr. CW (CPRI 10)

RS-FEC Corr CW (CPRI 10)

Running Disparity

Insert - Single

Insert - Rate

Defects/Alarms generation/analysis

LOS

LOF

SDI

RAI

RF analysis over CPRI

Detect PIM

Up to 4 graphs

CPRI Overhead Transparency Tests

Test Slow C&M, Fast C&M, Ctrl, AxC and VSD

User test pattern on overhead

Test with Ethernet frames in Fast C&M

User Plane Tests

Bulk BERT

Channelized PRBS BERT

Analog Waveform

AxC up to 8 concurrent antennas payload test

CPRI Capture

Fast C&M pcap

Full hyperframe capture (.csv)

RF over CPRI

Available on CPRI rates 1 through 8

Results

RTD Accuracy

15 ns for CPRI 1-8

1 ns for CPRI 10

Signal Category

Signal Losses

Sync Loss Seconds

Optical Rx Overload

Optical Rx Level (dBm)

Receive Frequency

Receive Frequency Deviation

Receive Frequency Maximum Deviation

Transmit Frequency

Tx Frequency Deviation (Hz)

Tx Frequency Deviation (ppm)

Tx Frequency Max Deviation (ppm)

CPRI CPRI Inband Protocol

Tx/Rx Protocol Version

Tx/Rx C&M HDLC Rate

Tx/Rx C&M Ethernet Subchannel Number

Port Type (Master/Slave)

Start-up State

CPRI Counts

Code Word Count Tx/Rx

Frame Count Tx/Rx

Error Stats

Word Sync Loss Events

Word Sync Loss Seconds

Code Violations

Code Violation Rate

Code Violation Seconds

K30.7 Words

Frame Sync Loss Events

Frame Sync Loss Seconds

Pattern Sync Losses

Pattern Sync Loss Seconds

Bit Error Rate

Bit Errors

Errored Seconds

Error-Free Seconds

Error Free Seconds, %

Total bits Received

Round Trip Delay Current (ms)

Round Trip Delay Average (ms)

Round Trip Delay Minimum (ms)

Round Trip Delay Maximum (ms)

Remote LOS

Remote LOS Seconds

Remote LOF

Remote LOF Seconds

RAI

RAI Seconds

SDI

SDI Seconds

Running Disparity Errors

Running Disparity Error Rate

RS-FEC Stats (CPRI 10)

CPRI Check

Automated workflow for CPRI transport testing with the following functions:

SFP is within optical and rate specifications

Run tests at the interface level (layer 1)

CPRI (Continued)

Run tests at layer 2
Round Trip Delay Measurement
Test report

Jitter

General Features
Measure Jitter
on electrical interfaces: DS1, DS3, and E1
Automatic Measurement Sequences
Measure Intrinsic Jitter
Support different Measurement Bands
High Band
Wide Band
Extended Band
Ability to set user definable band

Results
Jitter Results per measurement band
Current peak to peak jitter [UI]
Peak to peak jitter [UI]
Positive peak jitter [UI]
Negative peak jitter [UI]
Maximum peak to peak jitter [UI]
Peak to peak jitter [UI]
Positive peak jitter [UI]
Negative peak jitter [UI]
Phase Hits
RMS Jitter [UI]
Jitter Graphs

OBSAI

Test Interfaces/Bit Rates (Dual-port for all)
768 Mbps Optical
1.5 Gbps Optical
3.1 Gbps Optical
6.1 Gbps Optical
Interface Type
SFP+/SFP dual-port

Modes of Operation
Terminate
Monitor/Thru Mode

Timing
Recovered from Rx (slave)
Internal (Stratum 3)
Recovered from External (BITs/SETs)
Frequency Offset Transmit/Receive in PPM

OBSAI Features
Optical power in dBm
Port Type Master · Slave
LOS Enable (On or Off)
Force Tx Idle (On or Off)
Definable RP3 Address
Selectable RP3 Type (WCDMA/FDD, GSM/EDGE, WiMAX 802.16, LTE)
RP3 Address
FCB Message Generation
Service Disruption Measurements
- SD Separation/Debounce Time Setting
- SD Threshold Time Settings
Round Trip Delay Measurements

OBSAI Patterns
PRBS Patterns
2^{15-1}, 2^{15-1} Inverse
2^{20-1}, 2^{20-1} Inverse
2^{23-1}, 2^{23-1} Inverse
2^{31-1}, 2^{31-1} Inverse
Delay
Live
Digital Word
ANSI and ITU implementations

OBSAI Check
Automated workflow for OBSAI transport testing with the following functions: · SFP is within optical and rate specifications · Run tests at the interface level (layer 1) · Start-up sequence · Test report

Errors and Alarm Injections
Alarm injections
Bit/TSE
Code
K30.7
Insert - Single
Insert - Rate

Results
LED results
LOS
Sync Acquired
Frame Sync
Pattern Sync

Results
Optical Rx Overload
Optical Rx Level (dBm)
Rx Frequency (Hz)

OBSAI (Continued)

Rx Frequency Deviation (ppm)	
Rx Frequency Max Deviation (ppm)	
Tx Frequency (Hz)	
Tx Frequency Deviation (ppm)	
Tx Frequency Max Deviation (ppm)	

OBSAI Counts

Code Word Count Tx/Rx	
Message Group Count Tx/Rx	
Rx Message Counts (multiple types)	

Error Stats

Word Sync Loss Events	
Code Violations	
K30.7 Words	
Frame Sync Loss Events	
Pattern Sync Losses	
Bit/TSE Errors	
Round Trip Delay (current, avg, min, max)	
Tx/Rx OBSAI state	

Wander

General Features

Measure Wander on 1PPS Signal	**Comments:** · Use Ext Clk input and Multi Access timing adapter 22035030 or Precision Timing Reference Module
Measure Wander on 100/1000Base-T, 1GE optical, 10GE LAN, and 25GE	
Measure Wander on T1, E1, & unframed 2.048 MHz Signals	**Comments:** · O.171
Measure Wander on 10 MHz Signal	
Selectable Peak Time Offset Threshold	
Resolution 1 ns	
Sample Rate 1, 30, 60 samples per second	
Internal Data Storage - 256M	
External Data Storage on USB stick	
Start Stop via key	

Results

Time Interval Error (TIE)	
Current TIE [s]	
Maximum TIE [s]	
Minimum TIE [s]	
Maximum Peak-to-Peak TIE (MTIE) [s]	
Offset Between Test Signal and Reference	
Current Offset [µs]	
Minimum Offset [µs]	
Maximum Offset [µs]	
Pass/Fail Result	
TIE Graph	

Reference Clock for 1pps wander: 1pps reference signal	**Comments:** · Use Ext Clk input and Multi Access timing adapter 22035030 or Precision Timing Reference Module
Reference Clock for 1G SyncE Optical, T1, E1, 2 MHz, & 10 MHz wander: 2MHz or 10 MHz reference signal	**Comments:** · Use Ext Clk input and Multi Access timing adapter 22035030 or Precision Timing Reference Module
Cables for 1pps Wander	

Wander Analysis Tool

Offline analysis of captured/imported TIE measurements	
Maximum Peak-to-Peak TIE (MTIE) [s]	
TDEV (Time Deviation)	**Comments:** · Compliant to 0.174, Available in wander analysis tool; not available on 1PPS signal
Frequency Offset (ppm)	
Drift Rate (ppm/s)	

Masks

ANSI	SMC Holdover (T1.105.109)
ETSI	SEC (ETS 300 462-5-1) SEC Netw. IF (ETS 300 462-3-1) SSU (ETS 300 462-4-1) SSU Netw. IF (ETS 300 462-3-1)
GR253	SMC Transient
ITU	G.8261 SEC Netw. IF (G.832, G.825) SEC Opt. 1 (G.813) SEC Opt. 2 (G.813) SEC Hold. Opt. 2 (G.813) SEC Trans. Opt. 2 (G.813) SSU Netw. IF (G.823, G.825) SSU Type I (G.812) SSU Type II, III (G.812) SSU Type IV (G.812) PRC (G.811) EEC-1 Noise Generation (G.8262 constant temp.) EEC-1 Noise Generation (G.8262 with temp. effects) EEC-2 Noise Generation (G.8262 constant temp.) EEC-1 Noise Tolerance (G.8261) EEC-1 Noise Tolerance (G.8262) PRC (G.811) dTE Network Limit (G.8271.1) Wander Generation (G.8272) DTE Noise Generation (G.8273.2 constant temp.) DTE Noise Generation (G.8273.2 variable temp.) DTE Noise Generation (G.8273.3 constant temp.) DTE Noise Generation (G.8273.3 variable temp.)
PRC/SSU/SEC: Masks for G.811/G.812/G.813 clocks (ETS 300 462-2)	
Networks: According to G.823/G.824	
SyncE: According to G.8261, G.8262, G.8262.1	
ANSI-Standard: DS1 masks	

Services

VoIP Testing

10/100/1000M Electrical Ethernet Interfaces

1GigE Optical Ethernet Interface

10GigE Optical Ethernet Interface

SIP, Cisco SCCP and H.323 Fast Connect

Supported SIP Parameters

Dial by phone/URL/e-mail

Nortel & Huawei SIP emulation

Proxy login and proxyless operation

Supported SCCP Parameters

Selectable Cisco Phone emulation supporting at least 15 models

Configurable device name

Supported H.323 Parameters

H.323 ID

Bearer Capability including Unrestricted Digital, Speech & 3.1K Audio

Configurable Calling & Called Party Number Plans and Number Types

Static, auto-discoverable and no gatekeeper operation

Configurable Local and Gatekeeper RAS port and Call Control Port

Configurable Time Zone

Configurable RTP port range

General Parameters

Auto answer on/off

Codecs:
-G.711 A Law
-G.711 U Law
-G.723 5.3 K
-G.723 6.3 K
-G.729A
-G.726
-G.722

Configurable Call Manager port

Selectable silence suppression

Configurable jitter buffer and speech per frame parameters

ACR or G.107 MOS Scoring

Configurable Jitter, Loss, Delay and Content Threshold pass/fail

Mean Opinion Score Results (MOS)

Graphical Summary Results including Ethernet, transport & Content

Transaction Log including call log and protocol signaling

Phone book of last 10 numbers and IP addresses called

DTMF Digits

Triple Play Automated Test Script

10/100/1000M Electrical Ethernet Interfaces

1GigE Optical Ethernet Interface

10GigE Optical Ethernet Interface

Over 11,000 simulated calls with configurable Codec and sampling rate

Configurable voice call or tone with configurable silence suppression, sampling rate and jitter buffer

Up to 250 simulated SDTV channels with configurable frame size and MPEG-2/4 compression

Up to 52 simulated HDTV channels with configurable frame size and MPEG-2/4 compression

2 configurable data streams with individual constant or ramp traffic and configurable frame sizes including random frames

IPTV

1GigE Optical Ethernet Interface

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Single Program Transport Stream (SPTS) and Multiple Program Transport Stream (MPTS) formats

Video explorer capable of detecting 512 SPTS and 32 MPTS and a video analyzer that supports 16 SPTS and 1 MPTS

Supported measurements include bandwidth utilization, packet loss, packet jitter, PCR jitter, continuity error bit and error bit indicator

TR 101 290 priority 1 errors such as program identification (PID), program association table (PAT) and program map table (PMT)

Loss distance and period errors per RFC3357, results per transport stream and per PID

Measure ICC latency and R-UDP latency

Internet Group Management Protocol (IGMP) support. IGMP control plane signaling available at 1GE.

Primary Rate T1 ISDN

Test Access - T1

TE Emulation

NT Emulation

D-Channel Signaling Decodes

Call Control - National

Call Control - 5ESS

Call Control - NI-1

D-Channel Rate - 64k

D-Channel Rate - 56k

Call Type - Data

Call Type - Voice

Call Type - 3.1k Audio

Channel Number - 1 to 24

D-Channel Rate - 56k

DTMF Digits

Primary Rate E1 ISDN

Test Access - E1

TE Emulation

NT Emulation

Codec μ-law, A-law
Dual PRI Call support

Call Controls - 1TR6, 1TR67, EDSS-1, VN3, VN4, VN6, TPH1962, Q.SIG, Q.931, TN-1R6, SwissNet-3, CorNet-N, CorNet-NQ, DREX, Alcatel QSIG

D-Channel Signaling Decodes

Services - Speech, 3.1 KHz, Data, Fax G4, Teletex, Videotex, Speech BC, Data BC, Data 56Kb, Fax 2/3

Channel Number - 1 to 31

DTMF Digits

Services (Continued)

Signaling - Place/Receive Call
Test Access - T1
E&M Signaling
Loop Start Signaling
Ground Start Signaling
Audio Drop/Insert
Signaling Bits
Place Call
Receive Call
MF Digits
DTMF Digits
Event Log
VF Tone Insertion

Fractional T1/E1
Test Access - T1
Fractional T1 - n x 64k
Fractional T1 - n x 56k
Contiguous Channels
Non Contiguous Channels
V.54 Loop Codes Support

Voice Frequency
Test Access - T1
Listed to an Audio Call
Insert VF Tones
404 Hz
1004 Hz
1804 Hz
2713 Hz
2804 Hz
User Frequency
Quiet Tone
Holding Tone
Three Tone
Frequency Sweep
Impulse Noise
Rx Frequency
Level (dBm)
DC Offset mV

Cable Test

AOC/DAC/Breakout Cable Test
Cable testing functionality in data centers for:
AOC (Active Optical Cable)
DAC (Direct Attach Copper)
Breakout cables (QSFP at one end and multiple SFP at the other)

Capabilities:
Calculate recommended test times based on Bit Error Rate theory using the Bit Error Rate Threshold and Confidence Level
Utilize a pattern with a Bit Error Rate result to evaluate cable performance – For 25GE/100GE with RS-FEC: provide pre-FEC and post-FEC BER results
Provide a test report indicating pass/fail result and the serial number of the cable
Cover for AOC/DAC:
10GE SFP+
25GE SFP28
40GE QSFP+
50GE QSFP28
100GE QSFP28
Cover for breakout cables
QSFP+ to multiple SFP+ (10GE)
QSFP28 to multiple SFP28 (25GE)
QSFP28 to dual QSFP28 (2x50GE)

Fiber Inspection

Optical Fiber Microscope
Supports an optical video microscope with autofocus capability
Microscope connector image displayed on the Test Equipment and saved into a .JPEG file format.
Microscope offer a switchable 200/400x magnification capabilities
Microscope provided with the dedicated tips to connect to the patch panel or directly to the connector ferrule
Capable of automatically centering the fiber image
Capable of performing on-board Pass/Fail analysis
Compatible with Android tablets/smartphones
Microscope supports MPO connectors
Supports FiberChek microscope via USB connection