

The MTS-8000 Transport Module

SDH, PDH, and Ethernet Test Module for the MTS-8000



Key Features

- Optical testing at 155 Mb/s, 622 Mb/s, 2.5 Gb/s, and 10 Gb/s SDH/SONET
- PDH and T-Carrier testing at T1, E1, E3, DS3, and E4 interfaces and mappings
- Optical GigE and 10 GigE LAN and WAN PHY testing at 850 nm, 1310 nm, and 1550 nm wavelengths
- Ethernet testing with 10/100/1000 Mb/s electrical RJ-45 interfaces
- Reduce CAPEX with a stackable design that allows for a cost effective upgrade path
- Identify Fiber Optics problems quicker with the User Interfaces optical power source, high accuracy power meter, Visual Fault Locator, and Fiber Microscope
- The only integrated field SDH, PDH, and Ethernet solution available to the market, weighing less than 7 kg

As providers expand their offerings into new data and wavelength services, test responsibilities are expanding beyond traditional SDH and PDH needs into Data and Optical layer technologies. These users now have the responsibility to install and maintain new network elements and service types that were not present in yesterday's legacy networks. The Transport Module addresses these trends by providing the necessary test functionality to support all these services in one integrated module.

Weighing less than 7 kg and operating on battery power for two hours at 10 Gb/s rates, the MTS-8000 is conveniently sized and packaged for mobile applications.

In addition, advanced applications such as measuring Round trip delay, identifying dropped packets, and verifying automatic protection switch times enable providers to quickly and accurately resolve problems, speed network deployment, and enjoy the convenience of a truly field solution.

For productivity enhancements, the easy to use graphical interface enables users with limited test experience to verify performance parameters and ensure that services meet desired quality metrics. In addition, the user interface is based on the industry standard TestPad and MTS product families, allowing existing customers to migrate to the MTS-8000 platform. In combination with saved setups and remote operation, this solution enables time efficient deployment and maintenance of revenue generating services. However, in contrast to today's test solutions, the Transport Module doesn't sacrifice scalability or feature depth for convenience.

Module Overview

One integrated solution

As new service offerings arise, Multi-Service Provisioning Platforms (MSPPs) are combining Data and Transport technologies on the same linecards. These network elements give providers the flexibility to configure new services quickly in support of customer demand. The Transport Module replicates this design by providing Ethernet and SDH/SONET test functionality in one module. Enabling providers to deploy and commission these new services quickly, efficiently and conveniently. Users no longer need to carry, manage, or maintain multiple modules or test sets in support of today's service offerings.

Remote operation

Increase efficiency by testing remotely, the MTS-8000 Transport Module's remote operation functionality allows technicians to operate the test set, perform test routines, analyze and download results. Remote operation is supported by a variety of connectivity interfaces including both Ethernet and Modem interfaces. Remote operation turns what used to be two-person testing into one-person testing, increasing efficiency by 50%. Many other network elements and test solutions require the installation of application-specific software clients. By allowing the use of any standard Web browser, the MTS-8000 Transport Module gives users maximum convenience and flexibility to test when they need to, where they need to.



Module overview

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Flexibility and configurability

The MTS-8000 Transport Module demonstrates unparalleled technological integration, providing SDH, PDH, 10GigE, GigE, and Optical functionality in one briefcase-sized unit. Recognizing that customers don't need or can't always buy all of this functionality, the Transport Module gives customers the flexibility to buy SDH or Ethernet only configurations and upgrade them as new needs arise. This features gives customers the flexibility to meet current needs without sacrificing the scalability of the module. Supported configurations of the MTS-8000 Transport Module include STM-64 only, 10 GigE only, and E1 to STM-64 – just to name a few.

Field exchangeable optical connectors

The emergence of new LC interfaces has caused yet another optical connector in today's work environment. Most networks have a combination of ST, SC, FC, DIN, and now LC connector types. Test equipment has typically had fixed connector types, forcing users to find adapter cables and connectors before testing can occur. These field removable connectors give users maximum flexibility to adapt their test set to different connector types in just seconds. Never lose time again trying to find the correct crossover cable or adapter when turning up a customer circuit or troubleshooting a service effecting fault.

Real time Histogram and Event Log

Visually analyze and monitor error alarms and events in real time. Correlate specific errored conditions to time of day and other conditions present in the network. Efficiently and effectively troubleshooting your network by correlating results quickly and easily.

850 nm, 1310 nm, and 1550 nm wavelength support for all optical interfaces

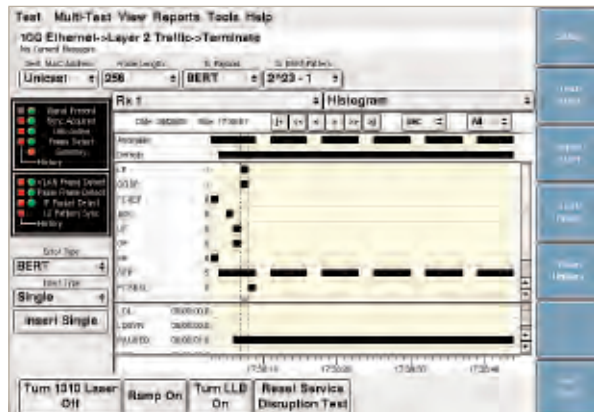
The design of the Transport Module allows users to install 850 nm, 1310 nm, and 1550 nm transmitters and receivers all in one package. This eliminates the need to purchase and manage separate test modules, GBICs, or SFPs to support additional wavelength types ensuring that users always have the proper test equipment to test the service.

Battery operation

Taking battery operation to another level, the MTS-8000 Transport Module is configurable with up to two batteries. It can function at a line rate up to 10 Gb/s for up to two hours on battery power.



Field exchangeable optical connectors



Histogram

SDH/SONET

E1 to STM-64 BER testing

Perform BER testing on all line interfaces in end-to-end or loopback applications. Insert errors and alarms to verify network element conformance and connectivity. Measure bit error rates to ensure quality of service.

Muxed payload and bulk payload generation and analysis from 10 Gb/s to 2Mb/s

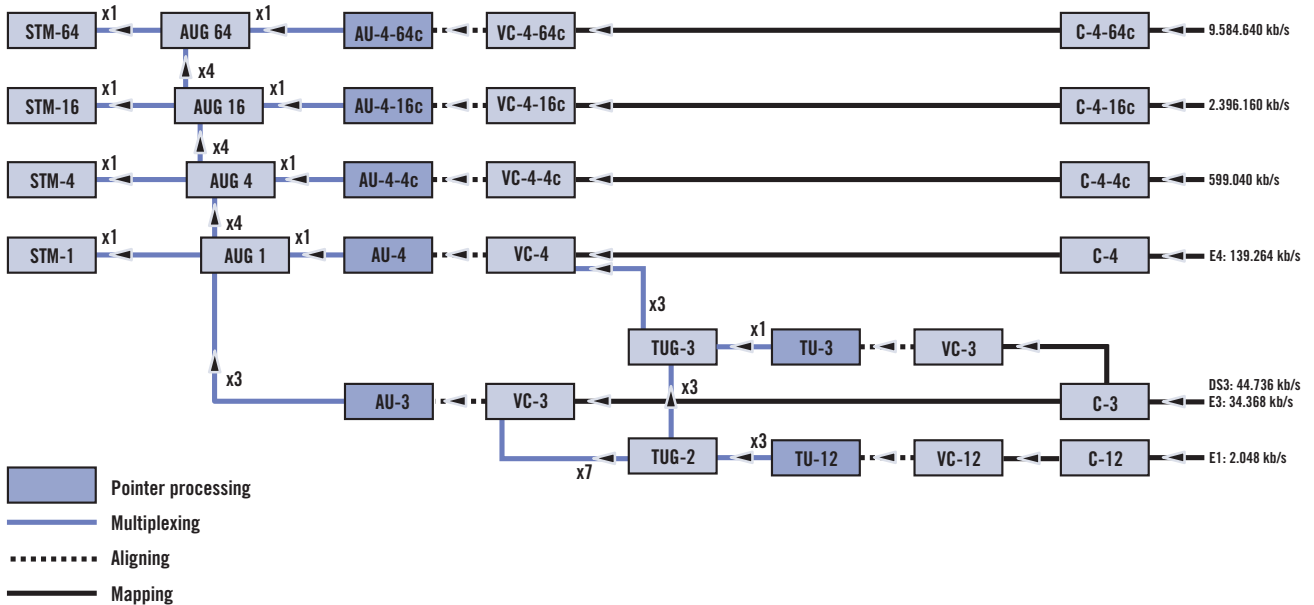
Muxed and bulk signals can be analyzed with a full array of mapping support. As an example, 2 Mb/s channels can be monitored from a STM-64 interface.

SDH/SONET overhead byte manipulation and analysis

Using the overhead byte manipulation and analysis capability of the MTS-8000 Transport Module, users can modify K1 and K2 bytes to test Automatic Protection Switching (APS); specify and identify user configurable path trace messages and payloads.

APS measurements

Measure the protection switch times of SDH/SONET rings and their effects on tributaries. By measuring various error and alarm conditions on the tributaries, providers can verify that their transport network is providing adequate redundancy to guarantee Service Level Agreements (SLAs). In addition, when operating on the SDH ring itself, capture APS sequences via the K1/K2 bytes and decode the definition of these messages per the selected network architecture.



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Round Trip Delay

Immediately identify network latency with the round trip delay pattern at all linerates.

Optical and electrical signal level measurements

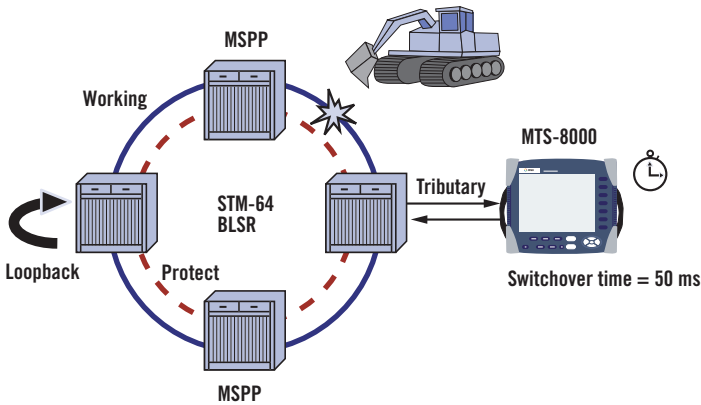
Optical power and frequency offset testing ensures that received signals are within acceptable limits and network elements thresholds are within specifications.

Performance measures including T1.231, T1.510, T1.514, G.821, G.826, G.828, G.829, M.2100, and M.2101 for circuit acceptance

Bit error measurements are used to measure the quality of a circuit. The ITU-T and ANSI recommend various Pseudo Random Bit Sequence (PRBS) test patterns that simulate real traffic and stress the network. In addition to these patterns, different measurement methods are used to analyze the circuit performance. These measurements and test patterns are used as the basis for Service Level agreements. The Transport Module performs conformance analysis in accordance with ITU-T and ANSI recommendations.

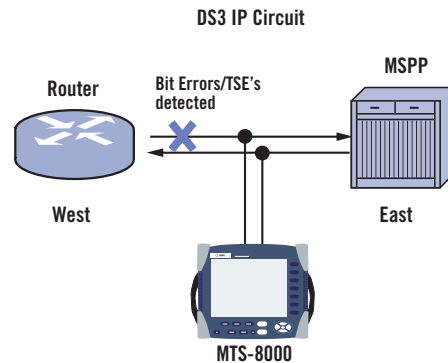
Dual-Direction E1*, T1, and DS3 receivers

Reduce test time by up to 50%, two electrical receivers allows users to simultaneously monitor two directions of a circuit under test, allowing users to quickly determine the source of errors (East versus West). Especially valuable when intermittent problem are present and monitoring one direction doesn't guarantee trouble isolation. Alternate solutions with a single receiver, requires the use of two test sets, which may not always be present or cost effective. With this functionality, sectionalize the network and focus on fixing the source of errors as opposed to spending time finding the problem.



APS and service disruption

* Dual E1 receivers are only supported for 70 Ohm applications



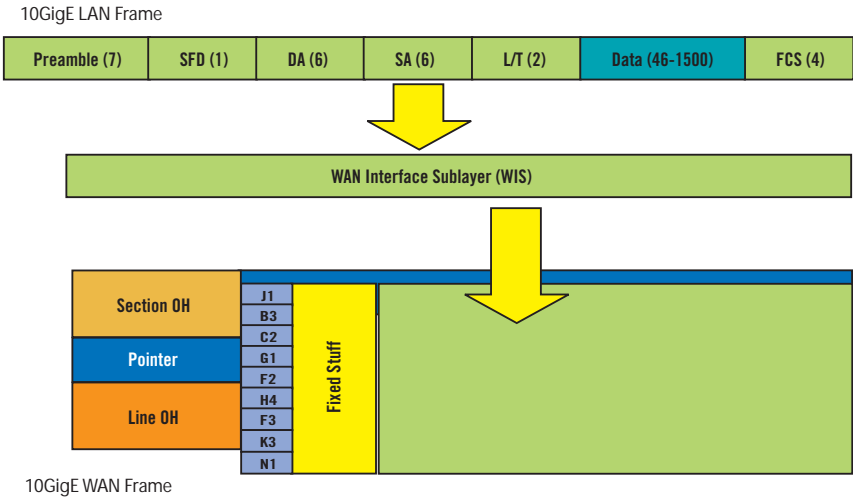
Dual-direction PDH receivers

Ethernet

The MTS-8000 Transport Module supports all optical Ethernet interfaces at all three wavelengths – 850 nm, 1310 nm, and 1550 nm. By supporting all three wavelengths simultaneously, the MTS-8000 Transport Module eliminates both the need to carry multiple GBIC, SFP and/or XFP modules, and the need to manage multiple optical interfaces to perform testing.

10 GigE LAN PHY

10GBASE-R (LAN PHY) interfaces offer a 10-fold performance improvement in comparison to Gigabit Ethernet interfaces. The effective line rate achieved by this interfaces is 10.3125 Gb/s, which translates into 10 Gb/s of data traffic at Layer 2, encoded in 64B/66B protocol. Moreover, 10 GigE technology is positioned to revolutionize network architectures by providing 8x cost efficiencies over existing 10 Gb/s SDH/SONET interfaces. Service Providers and Operators are rapidly deploying 10 GigE LAN circuits to offer higher bandwidth speeds at a minimal cost and network complexity, while preserving many of the same characteristics of other Ethernet technologies, such as 10/100/1000 Mb/s and GigE.



	10 Gigabit Ethernet Interface	Data Rate	Nominal Operating Wavelength	Fiber Interface	Operating Transmission Range
10GigE LAN	10GBASE-SR	10.3125 Gb/s	850 nm	Multimode (50 μm)	2 to 300 m
	Multimode (62.5 μm)			2 to 33 m	
	10GBASE-LR		1310 nm	Singlemode	2 m to 10 km
	10GBASE-ER		1550 nm	Singlemode	2 m to 30 km
10GigE WAN	10GBASE-SW	9.95328 Gb/s	850 nm	Multimode (50 μm)	2 to 300 m
	Multimode (62.5 μm)			2 to 33 m	
	10GBASE-LW		1310 nm	Singlemode	2 m to 10 km
	10GBASE-EW		1550 nm	Singlemode	2 m to 40 km

10GigE WAN PHY

10GigE WAN PHY offers an Ethernet interface that is compatible with the existing SDH network and adaptable to the growing Ethernet market. The 10GigE WAN standard uses a concatenated STM-64 signal operating at 9.9Gb/s with a SDH framing structure. Standard Ethernet frames are mapped directly into the payload of the SDH frame, using a WAN Interface Sublayer (WIS). In addition, since SDH framing is used, users also have sectionalization capability for their Ethernet services (regenerator, multiplexer, and path layers). Most importantly, the 10GigE WAN standard allows providers to manage Ethernet services in their already existing SDH networks. With the transport module, troubleshoot both Ethernet and SDH layer issues in one single 10GigE WAN test application, speeding trouble recognition and isolation times.

10/100/1000 Mb/s Ethernet and GigE

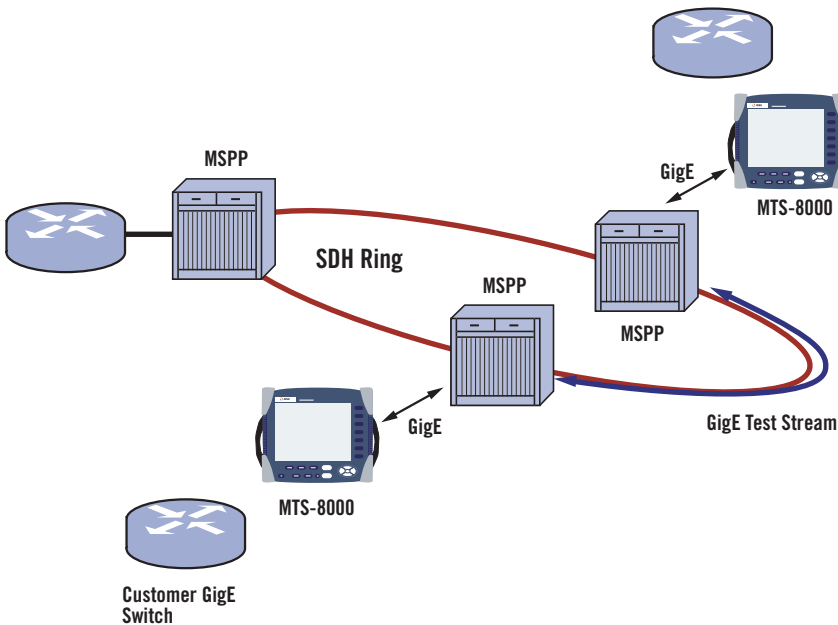
With Ethernet services dominating metro data services landscape, the Transport Module has been designed to meet the needs of Service Providers and Operators offering various Ethernet and IP services. Test capability ranges from BER testing and verifying end-to-end Connectivity to determining Throughput, Utilization, Frame Loss, and Round Trip Delay for Ethernet and IP service deployment. The Transport Module supports testing 10/100/1000 Mb/s electrical interfaces, as well as GigE optical interfaces at all three wavelengths.

Connectivity and loopback testing

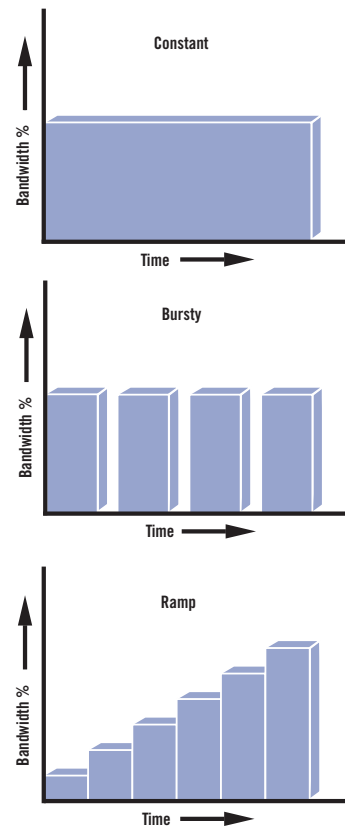
Ensure physical layer integrity and verify end to end connectivity of the Ethernet circuit by establishing an end to end link. The user configurable auto negotiation capability of the module makes this instrument compatible with any installed Ethernet interface.

Throughput Verification

The Transport Module can verify error-free throughput of the Ethernet link by generating respective traffic (Constant, Bursty, or Ramp) at a specified bandwidth. With the functionality to loop back frames at the far end, the instrument enables the qualification of the link in both directions.



Connectivity and loopback testing



Throughput verification

Quality of Service measurements

The RTD measurement is a critical parameter for delay sensitive Triple Play applications such as Video and Voice over IP (VoIP). Round trip delay measurements are a critical measure of a networks capability to transport delay sensitive applications. Use the Transport Module to verify links RTD for Ethernet and IP services and ensure that it conforms to SLA parameters.

Optical Power Measurements

To ensure that Ethernet interfaces and spans are operating within the correct optical signal power levels, the Transport Module allows users to measure the optical signal level on the Ethernet test interface, enabling a user to qualify a circuit without needing a separate handheld power meter.

RFC2544 Conformance Testing

RFC2544 addresses the need of Service Providers to perform the QoS measurements in Ethernet and IP networks. It represents a benchmarking methodology for performing these measurements. As such, the Transport Module enables the users to perform automated RFC2544 testing, and turn-up Ethernet and IP service by performing: Throughput, Frame Loss, Round Trip Delay, and Burstability tests. Such automated testing removes possibility for error and ensures that technicians will run the tests uniformly and obtain reliable results every time.

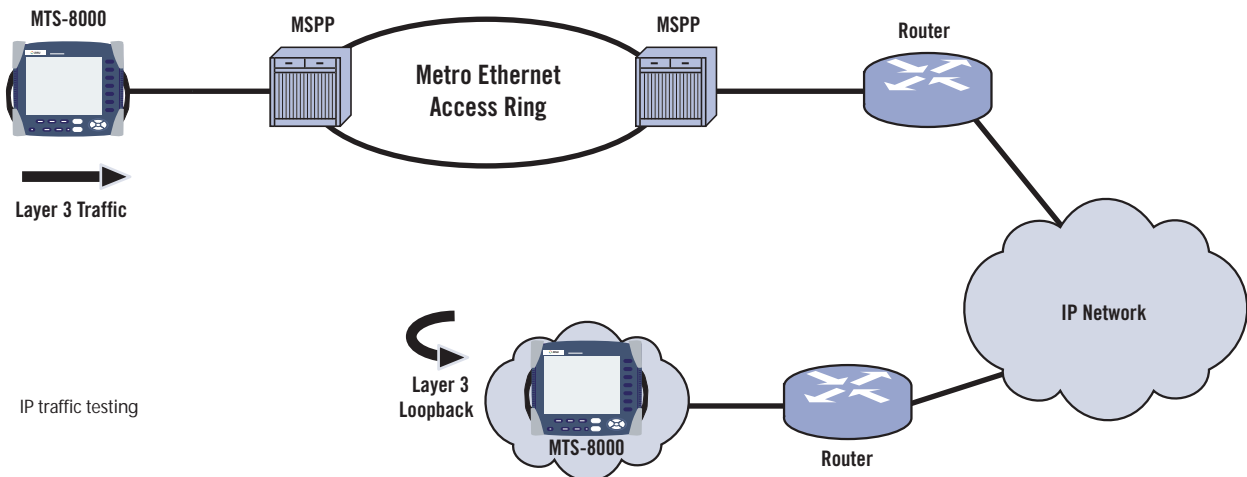
Dual Port Operation

In addition to generating two separate traffic streams up to full-bandwidth of the test interfaces, the support for dual port 10/100/1000 Mb/s and GigE interfaces on the Transport Module enables technicians to gain access to circuits under test to perform in service monitoring in both directions. The test instrument allows for unobtrusive monitoring of 10/100/1000 Mb/s Ethernet

circuits to verify the capability of network elements to support reliable communications. Moreover, the through mode allows for monitoring of the traffic in lieu of using a splitter, and allows the service providers to solve finger pointing situations.

IP Testing

Prior to testing throughput in a routed network, technicians may need to verify if the provisioned path in the network will carry IP traffic to its destination. The first step in verifying this end-to-end connectivity will be to perform an IP Ping. Once connectivity is verified, the feature enables users to generate IP traffic at the line rate specified for the service. While verifying end to end connectivity and throughput, user can also verify QoS by ensuring that no data has been errored and/or dropped during transit. In addition, for troubleshooting applications, users can localize network congestion locations by using the IP Traceroute application.



Fiber Optics

One of the most common problems in today's Transport networks is faulty fibers and connectors. Even the smallest problem with the fiber plant can adversely affect high speed transmission services. The MTS user interface module provides fiber test functionality without adding excess size or weight. Eliminating the need to carry and manage separate test sets or additional modules. Never lose time again due to faulty patch cords or optical connectors when turning up services.

Loss Test Set

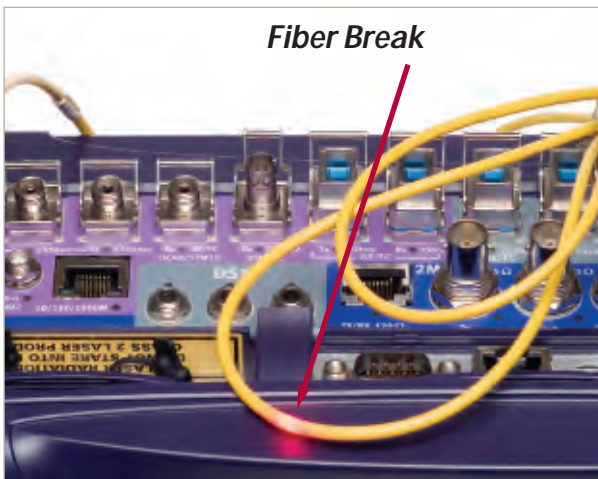
Using the MTS-8000's Stable power source and high accuracy power meter, users can measure power at any point of an active network, measure the insertion loss of a link between transmitter and receiver and verify the loss characteristics of patch cords before turning up services. Providing this high accuracy loss test set eliminates the need for a separate handheld instruments or additional test modules.

Visual Fault Locator (VFL)

Considered a mandatory tool for any technician dealing with fiber patch cords, the built-in visible light source allows for quick fiber continuity checks and visual break locations.

Fiber Optic Video Microscope

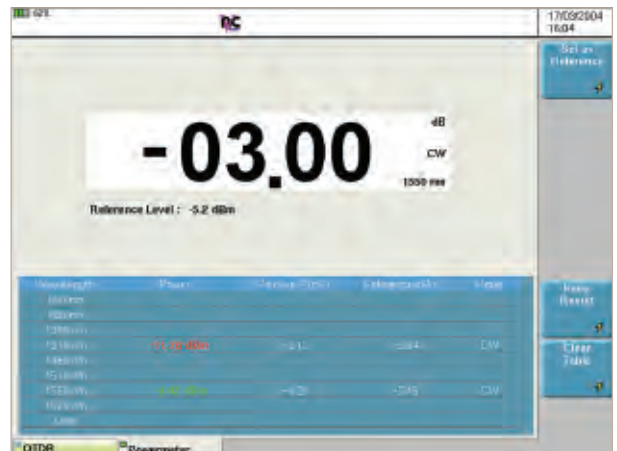
Upon installation and maintenance of transmission systems, the optical inspection scope allows for the quality verification of the front optical connector, when problems occur during measurement or system turn-up. The use of the video probe allows for visualization of the connector in a safe environment, even if the fiber is active.



Visual fault locator



Connector surface inspection



Jumper loss measurement

Physical Characteristics

Primary Port Bank

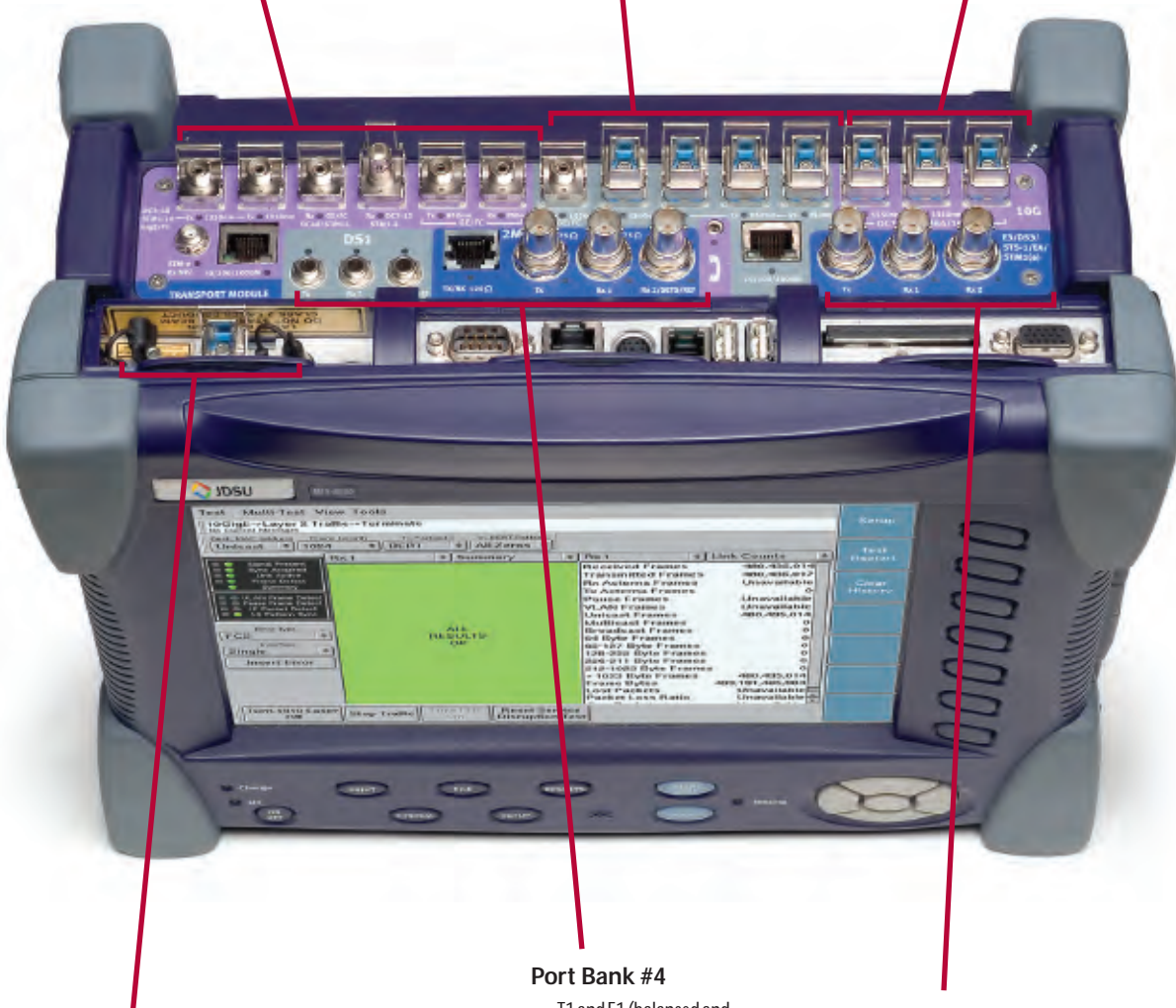
- Includes 2.5 Gb/s, 622 Mb/s, and 155 Mb/s SDH/SONET Tx/Rx, GigE Tx/Rx at 850 nm, 1310 nm, and 1550 nm; and 10/100/1000 Mb/s Ethernet

Secondary Port Bank

- Includes GigE Tx/Rx at 850 nm, 1310 nm, and 1550 nm; and 10/100/1000 Mb/s Ethernet

10 Gb/s Port Bank

- 10 Gb/s SDH/SONET and 10 GigE LAN/WAN Phy at 850 nm, 1310 nm, and 1550 nm



Optical Connection Check Interfaces

- High accuracy Power Meter
- Continuous Wave Power Source
- Visual Fault Locator

Port Bank #4

- T1 and E1 (balanced and unbalanced Tx/Rx)

Port Bank #5

- E3, DS3, STS-1, E4, and STM-1 (e) Tx/Rx BNCs

Technical specifications

Display

High visibility touchscreen TFT color display, 10.4 inches, LCD 800 x 600

Storage

Internal memory	8 Mb
Hard disk	Min 6 GB
Floppy disk drive (optional)	3.5 inches
CD read/write (optional)	
Input/output interfaces	RS232C, 2 x USB, VGA, RJ-11 modem (optional), RJ-45 Ethernet, DIN external switch, compact flash*

* Compact flash receptacle is used for the Transport Module application card

Optional Interfaces

Power meter (optional)	+ 10 to -50 dBm (-45 dBm from 800 nm to 1250 nm)
Talk set (optional)	45 dB range
VFL (optional)	1 mW, Class 2 Laser, universal push/pull connector video
Video microscope (optional)	250x, 400x, through USB port

Power Supply, Battery

Battery type	Internal standard removable Li-Ion batteries
Operation time	Up to 1.5 hours at 10 Gb/s rates with one battery (two batteries possible)

Internal charger

Power supply, AC/DC	Transport Module power adapter: 100-240 V, 50-60 Hz, 2A, Output: 24 V, 6.25 A To be used when operating a MTS-8000 with the Transport Module.
Charging Time	One battery, unit non operating: 3 hours One battery, unit in operation: up to 9 hours
Trickle charge	Yes

General specifications

Module physical specifications

Height	2.13 inches/5.41 cm
Width	12.16 inches/30.88 cm
Depth	9.96 inches/25.3 cm
Weight	5.5 lbs/2.5 kg

Combined physical specifications

for Transport Module when attached to the base unit a battery module with one battery installed.

Height	5.8 inches/14.73 cm
Width	12.16 inches/30.89 cm
Depth	9.96 inches/25.3 cm
Weight	14.69 lbs/6.6 kg

Operating Temperature

Operational temperature	0° C to +40° C
Storage temperature	-20° C to +60° C
Humidity	5% to 95% without condensation

Shock/Drop Height

Shock - Per IEC 60068-2-27 & 29: The unit resists the following test:
 - Three shocks per axis along each of the three axes, with power off
 - Impacts of 15 G, 1/2 sine, duration 11 ms, at 10 second intervals

Bumps - Per IEC 60068-2-27 & 29: The unit resists the following test:

- 1,000 jolts per axis along each of the three axes, with power off
- Jolts of 15 G, 1/2 sine, duration 6 ms, at 1 second intervals

Drop - Meets requirements as specified in IEC 721-3-7:

- Total of six (6) impacts dropped from a height of 50 cm (20"). One (1) impact on each of its' six sides onto a flat plywood surface.

EMI/ESD	CE Mark Class A
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Ethernet

10 GigE LAN/WAN* PHY

Connector Type

FC, SC, ST, LC, DIN
 10 GigE LAN/WAN Phy Rates 10.3 Gbps, 10 Gbps
 * For 10 Gbps WAN, SONET/SDH capability can be located in the SONET/SDH section of this datasheet.

Flow Control

Supported

Modes of Operation

Terminate, Monitor, Loopback

Configurations

Single and Dual Port*
 *Dual Port testing for 10 GigE requires two Transport Modules

Layer 2 (Ethernet) Traffic Generation

Constant, Bursty, Ramp, Flood Configurable Source and Destination Address, Frame Format, Type Field (for DIX), Frame Length (including Jumbo and Undersized), VLAN Tag, Pause Frames, Payload, Utilization %

Layer 3 (IP) Traffic Generation

Configurable Source and Destination IP Address, DNS Server Type, Tx Payload, TOS/DSCP/TTL, Packet Size Length (34 – 1500 bytes), Ping, Traceroute

Layer 2 (Ethernet) Traffic Filtering

MAC Source and Destination Address, Frame Type/Length, VLAN Tagged or Untagged Frames

Layer 3 (IP) Traffic Filtering

Source and Destination IP Address, TOS Type (TOS/DSCP)

Bit Error Rate Testing Patterns

Layer 1 (Unframed) Bit Error Testing Patterns

Pattern Segments	<i>Per 802.3ae-2002, Section 52.9.1</i>
An	0x3C8B44DCAB6804F
Bn	0x34906BB85A38884
Patterns	<i>Per 802.3ae-2002, Section 52.9.1</i>

BnBiBnBi

AnAiAnAi

PRBS31(B)*

*(B) This is the test pattern checker defined in 49.2.12 of 802.3ae-2002

Layer 2 (Framed) Bit Error Testing Patterns

PRBS (2²³-1, 2³¹-1 and inverted selections)

- All 1s
- All 0s
- User defined (32 bits)

Error Insertion

Code Errors	Single, Burst, Rate
Bit Errors	Single, Rate
FCS Errors	Single, Burst
IP Checksum	Single, Burst
ATP Payload	Single, Burst

Key Results

LEDs

- Signal Status
- Sync Acquired
- Link Active
- Frame Detected
- VLAN Tagged Frame Detected
- Pause Frame Detect
- Acterna Frame Detect
- IP Packet Detect

Signal

- Optical Receive Level (dBm)
- Remote Fault Seconds
- Local Fault Seconds

L1 Errored Stats

- Code Violation Rate, Code Violation Seconds, Code Violations, Pattern Errors, Pattern Error Rate, Pattern Error Free Seconds, Pattern Error Free Seconds %, Pattern Errored Seconds, Bit Error Rate, Bit Errors

L2 Link Stats

- Delay, Frame Rate, Frame Size, Service Disruption (micro seconds), Total Utilization, Tx/Rx Mbps, Tx/Rx Mbps Data

L2 Link Counts

- Frame Lengths (Binning), Pause Frames, Rx/Tx Frames, Tx/Rx Acterna Frames, Tx/Rx Frame Bytes, Span Tree Frames, Unicast Frames, VLAN Frames, VLAN ID, VLAN Priority, Broadcast Frames, Multicast Frames

L2 Errored Stats

- Code Violation Rate, Code Violation Seconds, Code Violations, Errored Blocks (PCS), Errored Frames, FCS Errored Frames, Frame Loss Ratio, Jabbers, Lost Frames, Oos Frames, Runts, Undersized Frames

L2 BER Stats

Bit Error Count, Bit Error Rate, Error Free Seconds, Total Bits

L3 Errored Stats

Acterna Payload, Errored Frames, FCS Errored Frames, Frame Loss Ratio, IP Checksum, IP Packet Length, Jabbers, Lost Frames, Oos Frames, Runts, Undersized Frames

L3 Link Stats

IP Delay, Packet Rate, Packet Size, Tx/Rx Mbps, Total Utilization %

L3 Link Counts

Packet Length (Bins), Broadcast Packets, Multicast Packets, Tx/Rx Packets, Unicast Packets

L3/IP Config Status

Destination IP address, Destination MAC Address, DNS alternate server, DNS Server Type, IP Gateway, IP Subnet Mask, Source IP address

Ping/Traceroute

IP Delay, Lost Pings, Lost Pings %, Requests Rx, Requests Tx, Replies Rx, Traceroute map

10/100/1000 Mb/s and Gig Ethernet

Connector Type

RJ-45 - 10/100/1000 Mb/s Electrical
FC, SC, ST, LC, DIN - 1 GigE Optical

Rates

10/100/1000 Mb/s and 1 GigE

Duplex Modes

Full/Half

Flow Control

Supported

Modes of Operation

Terminate, Monitor, Loopback

Configurations

Single and Dual Port

Layer 2 (Ethernet) Traffic Generation

Constant, Bursty, Ramp, Flood, Configurable Source and Destination Address, Frame Format, Type Field (for DIX), Frame Length (including Jumbo and Undersized), VLAN Tag, Frame Payload, Utilization %, Pause Frames

Layer 3 (IP) Traffic Generation

Configurable Source and Destination IP Address, DNS Type, Preferred DNS Server, Alternate DNS Server, Tx Payload (Acterna or Fill), TOS, TTL, Packet Length (34 – 1500 bytes), Ping, Traceroute

Layer 2 (Ethernet) Traffic Filtering

MAC Source and Destination address, Frame Type/length, VLAN Tagged or Untagged Frames

Layer 3 (IP) Traffic Filtering

Source and Destination IP Address, TOS Type (TOS/DSCP)

Bit Error Rate Testing Patterns

Layer 1 (Unframed) Bit Error Testing Patterns

Per IEE 802.3, 2000 Edition, Annex 36A:

High Frequency Test Pattern
Low Frequency Test Pattern
Mixed Frequency Test Pattern

Per NCITS TF-25-1999

Random Data Pattern (RPAT)
Jitter Tolerance Test Pattern (JTPAT)
Supply Noise Test Sequence (SPAT)

Layer 2 (Framed) Bit Error Testing Patterns

PRBS ($2^{23}-1$, $2^{31}-1$ and inverted selections)

All 1s

All 0s

User defined

Framed Pattern Test Per NCITS TF-25 1999

Long Continuous Random Test Pattern
Long Contiguous Jitter Test Pattern
Long Compliant Supply Noise Pattern (CSPAT)

Error Insertion

Code Errors	Single, Rate
Bit Payload Errors	Single, Rate
FCS Errors	Single, Burst
IP Checksum	Single, Burst
ATP Payload	Single, Burst

Key Results

LEDs

Signal Status
Sync Acquired
Link Active
Frame Detected
VLAN Tagged Frame Detected
Pause Frame Detect
Acterna Frame Detect
IP Packet Detect

Signal

Optical Receive Level (dBm)

L1 Errored Stats

Code Violation Rate, Code Violation Seconds, Code Violations, Pattern Errors, Pattern Error Rate, Pattern Error Free Seconds, Pattern Error Free Seconds %, Pattern Errored Seconds, Bit Error Rate, Bit Errors

L2 Link Stats

Delay, Frame Rate, Frame Size, Service Disruption (micro seconds), Total Utilization, Tx/Rx Mbps, Tx/Rx Mbps Data

L2 Link Counts

Frame Lengths (Binning), Pause Frames, Rx/Tx Frames, Tx/Rx Acterna Frames, Tx/Rx Frame Bytes, Span Tree Frames, Unicast Frames, VLAN Frames, VLAN ID, VLAN Priority, Broadcast Frames, Multicast Frames

L2 Errored Stats

Code Violation Rate, Code Violation Seconds, Code Violations, Errored Blocks (PCS), Errored Frames, FCS Errored Frames, Frame Loss Ratio, Jabbers, Lost Frames, Oos Frames, Runts, Undersized Frames

L2 BER Stats

Bit Error Count, Bit Error Rate, Error Free Seconds, Total Bits

L3 Errored Stats

Acterna Payload, Errored Frames, FCS Errored Frames, Frame Loss Ratio, IP Checksum, IP Packet Length, Jabbers, Lost Frames, Oos Frames, Runts, Undersized Frames

L3 Link Stats

IP Delay, Packet Rate, Packet Size, Tx/Rx Mbps, Total Utilization %

L3 Link Counts

Packet Length (Bins), Broadcast Packets, Multicast Packets, Tx/Rx Packets, Unicast Packets

L3/IP Config Status

Destination IP Address, Destination MAC Address, DNS Alternate Server, DNS Server Type, IP Gateway, IP Subnet Mask, Source IP Address

Ping/Traceroute

IP Delay, Lost Pings, Lost Pings %, Requests Rx, Requests Tx, Replies Rx, Traceroute map

SONET/SDH

Connector Type

FC, SC, ST, LC, DIN

Rates

51Mbps, 155Mbps, 622Mbps, 2.5Gbps, 10Gbps

Modes of Operation

Terminate, Monitor, Loopback

Transmit Timing Source

Internal, Recovered, External (BITs, SETs*)

*Reference Clock and Sine Wave are for 2.048MHz

Frequency Offset Tx

+/- 50ppm

Mappings

SDH

VC4 Bulk, AU-4-4c, AU-4-16c, AU-4-64c

VC4

VC3

VC12

E4

DS3

E3

E1

SONET

STS-1, STS-3c, STS-12c, STS-48c, STS-192c

VT1.5

DS3

T1

Test Patterns

PRBS

215⁻¹*, 215⁻¹ Inverse*, 2[^]20⁻¹*, 2[^]20⁻¹ Inverse*, 2[^]23⁻¹*, 2[^]23⁻¹ Inverse*, 2[^]31⁻¹*, 2[^]31⁻¹ Inverse*

Round Trip Delay

Programmable – 32 bit

*ANSI and ITU implementations are supported

Anomaly/Errors Generation and Analysis

B1 Single, Rate

B2 Single, Rate

B3 Single, Rate

HP-REI/REI-P, LP-REI/REI-V Single, Rate

MS-REI/REI-L, LP-BIP/BIP-V Single, Rate

FAS/Frame Word Count (1-32)

Defects/Alarms Generation and Analysis (SDH)

LOS, LOF, RS-TIM, MS-AIS, MS-RDI, AU-LOP, AU-AIS, HP-UNEQ,

HP-RDI, HP-TIM, HP-PLM, TU-LOP, TU-AIS, TU-LOM, LP-UNEQ,

LP-RDI, LP-TIM, LP-PLM, LP-RFI

Defects/Alarms Generation and Analysis (SONET)

LOS, LOF, TIM, AIS-L, RDI-L, LOP-P, AIS-P, UNEQ-P, RDI-P, TIM-P,

PLM-P, LOP-V, AIS-V, LOM-V, UNEQ-V, RDI-V, TIM-V, PLM-V, RFI-V

Key Results

Signal Category

LOS Count, LOS Seconds, Rx Frequency, Tx Frequency, Tx Timing

Source, Optical Rx Level (dBm), Optical Rx Overload, APS

Switchover Time (ms), Delay

RSOH/Section Overhead Category

LOF Count, LOF Seconds, OOF Count, OOF Seconds, FAS Word

Errors, FAS/Frame Word Error Rate, B1 Errors, B1 Error Rate, RS

Trace (J0)

MSOH/Line Overhead Category

MS/Line-AIS Seconds, MS-RDI Seconds, B2 Errors, B2 Error Rate,

MS/Line-REI Errors, MS/Line-REI Rate, APS Message Count, ASP

K1 Bridge Request Code (Ring), APS K1 Destination Node ID

(Ring), APS K2 Source Node ID (Ring), APS K2 Path Code (Ring),

APS K2 Status (Ring), Sync Status (S1)

HP (High Path) Category

AU/Path-LOP Seconds, AU/Path-AIS Seconds, AU/Path Pointer

Adjustments, AU/Path Pointer Increments, AU/Path Pointer

Decrements, AU/Path-NDF Count, AU/Path Pointer Value, Tx

AU/Path Pointer Value, Tx AU/Path Pointer Size, B3 Errors, B3

Error Rate, HP/Path-REI Errors, HP/Path-REI Rate, HP/Path Trace

(J1), Signal Label (C2), HP/Path-UNEQ Seconds

LP (Low Path) Category

TU/VT-LOP Seconds, TU/VT-AIS Seconds, LP-RDI Seconds, TU/VT

Pointer Adjustments, TU/VT Pointer Increments, TU/VT-NDF

Count, TU/VT Pointer Size, Tx TU/VT Pointer Size, BIP-V Errors,

BIP-V Error Rate, LP-REI Errors, LP-REI Error Rate, LP-RFI

Seconds, TU/VT-LOM Seconds, LP Trace (J2), LP Signal Label

(V5), LP-UNEQ Seconds

SOH and POH Viewing and Manipulation (HP)

A1, A2, J0, J1, B1, E1, F1, B3, D1, D2, D3, C2, H1, H2, H3, G1, B2,

K1, K2, F2, D4, D5, D6, H4, D7, D8, D9, F3, D10, D11, D12, K3, S1,

Z1, Z2, E2, N1

BERT Category

LSS/Pattern Sync Loss Count, TSE/Bit Errors, TSE/Bit Error Rate

Tandem Connection Monitoring HP (Forward/Backward)

TC-UNEQ, TC-LTC, TC-AIS, B3 Errors, TC-IEC, TC-DIFF, TC-APId Label

K1/K2 Event Log

Date, Time, K1 Value, Code, Channel, K2, Bridge, MSP, Status

APS Event Log

Date, Time, Trigger Type, Switchover Time

Performance Measures

G.826 (ISM/OOS), G.828 (ISM/OOS), G.829 (ISM/OOS), M.2101,

T1.231, T1.514

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

E4

Connector Type

BNC

Rates

140Mbps

Modes of Operation

Terminate, Monitor

Framing

Unframed, Framed

Test Patterns

215⁻¹*, 215⁻¹ Inverse*, 2[^]20⁻¹*, 2[^]20⁻¹ Inverse*, 2[^]23⁻¹*, 2[^]23⁻¹ Inverse*, 2[^]31⁻¹*, 2[^]31⁻¹ Inverse*

Round Trip Delay

Programmable – 32 bit

*ANSI and ITU implementations are supported

Mappings

E4

E3

E1

Anomaly/Error Insert

FAS

Single, 2, 3, 4

TSE/Bit Error

Single, Rate

Defect/Alarm Insert

LOS, LOF, AIS, RDI

Frequency Offset Tx

+/- 100ppm

National Bit Support

On, Off

Results

Signal Category

Receive Frequency, Receive Frequency Deviation, Receive

Frequency Maximum Deviation, Transmit Signal Loss Count,

Signal Loss Seconds, Rx Frequency, Rx Frequency Deviation

(ppm), Rx Frequency Maximum Deviation (ppm), Tx Frequency,

Tx Timing Source, Rx Level (Vpp)

Frame Category

Frame Sync Losses, Frame Sync Loss Seconds, FAS Bit Error

Count, FAS Bit Error Rate, FAS Bit Error Seconds, FAS Word Error

Count, FAS Word Error Rate, FAS Word Error Seconds, National

Bits

BERT Category

FAS TSE Count, FAS TSE Rate, FAS Word Error Count, FAS Word

Error Rate, Frame Synchronization Loss Pattern Sync Losses,

Pattern Sync Loss Seconds, TSE/Bit Error Count, TSE/Bit Error

Rate

Performance

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

DS3

Modes of Operation

Terminate, Monitor

Framing

Unframed, C-Bit, M13

Test Patterns

All 1s, All 0s, 2¹⁵-1* (Inverse), 2²⁰-1* (Inverse), 2²³-1* (Inverse), User Programmable (32 bits), Round Trip Delay, 100, 1100 (aka IDLE), 1010 (aka BLUE), Delay, User Bit (3 -32 bits), User Byte (2-129 Hex Digits)

*ANSI and ITU implementations are supported

Rx Input

Terminate, DSX-Monitor

LBO

High – 0 ft, Low - 900 ft, DSX – 450 ft

Mappings

T1

E1

Anomaly/Error Insert

DS3 BPV/Code Error Single

DS3 Frame/FAS Single, 2, 3

DS3 Parity Single

DS3 C-Bit Parity Single

DS3 TSE/Bit Error Single, Rate, Multiple

Defect/Alarm Insert and Detection

LOS, LOF, AIS, RAI

Frequency Offset

+/- 100 ppm

APS

Frame Synchronization

Results

Signal Category

Signal Loss/LOS Count, Signal Loss/LOS Seconds, Rx Frequency, Rx Frequency Deviation (ppm), Rx Freq Max Deviation (ppm), Tx Frequency, Tx Timing Source, Rx Level (Vp), Rx Level (dBdsx), BPVs, BPV Rate, BPV Error Second

Frame Category

LOF/Frame Sync Loss Count, LOF/Frame Sync Loss Seconds, Frame Error Count, Frame Error Rate, AIS Seconds, RAI Seconds, Near End OOF Seconds, Far End OOF Seconds, RX X-Bits, Tx X-Bits, FEAC Word, C-Bit Parity Error Count, C-Bit Parity Error Rate, C-Bit Parity Error Seconds, FEBE Count, FEBE Rate, FEBE Seconds, Parity Error Count, Parity Error Rate, Parity Error Seconds

BERT Category

LSS/Pattern Sync Loss/Count, LSS/Pattern Sync Loss Seconds, Bit/TSE Errors, Bit/TSE Error Rate, Pattern Slips, Pattern Slip Seconds

Performance Measures

G.821, G.826 (ISM/OOS), M.2100 (ISM/OOS), T1.231, T1.510 (ISM/OOS)

E3

Modes of Operation

Terminate, Monitor

Framing

Unframed, Framed

Test Patterns

All Ones, All Zeroes, 2¹¹-1 (inverse), 2¹⁵-1* (Inverse), 2²⁰-1* (Inverse), 2²³-1* (Inverse), Round Trip Delay, User Programmable Bit (3 to 32 bits), Programmable Byte (2-128 Hex Digits), 1:1, 1:3, 1:4, 1:7

*ANSI and ITU implementations are supported

Mappings

E1

Rx Input

Terminate, Monitor

LBO

0 dB, -6dB

National Bit Support

0, 1

Anomaly/Error Insert

TSE/Bit Error Single, Rate, Multiple

FAS Single, 2, 3, 4

Code Single

Defect/Alarm Insert

LOS, LOF, AIS, RDI

Frequency Offset

+/- 100 ppm

Code

HDB3

Results

Signal Category

LOS/Signal Loss Count, LOS/Signal Loss Seconds, Rx Frequency, Rx Frequency Deviation (ppm), Rx Freq Max Deviation (ppm), Tx Frequency, Tx Timing Source, Rx Level (Vp), Line Code Errors, Line Code Error Rate, Line Code Error Seconds.

Frame Category

LOF/Frame Sync Loss Count, LOF/Frame Sync Loss Seconds, FAS/Frame Bit Error Count, FAS/Frame Bit Error Rate, FAS/Frame Word Error Count, FAS/Frame Word Error Rate, National Bit

BERT Category

LSS/Pattern Sync Loss Count, LSS/Pattern Sync Loss Seconds, TSE/Bit Errors, TSE/Bit Error Rate

Performance Measures

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

2M (E1)

Modes of Operation

Terminate, Monitor

Framing

Unframed, PCM30, PCM30C, PCM31, PCM31C

Test Patterns

All 1s, All 0s, 2¹¹-1 (inverse), 2¹⁵-1* (Inverse), 2²⁰-1* (Inverse), 2²³-1* (Inverse), Round Trip Delay, 1:1, 1:3, 1:4, 1:7, User Bit (3 -32 bits), User Byte (2-128 Hex Digits)

*ANSI and ITU implementations are supported

Anomaly/Error Insert

Code Single

CRC Single

E-bit Single

FAS 1, 2, 3, 4

MFAS 1, 2

TSE/Bit Error Single, Rate, Multiple

Defect/Alarm Insert

LOS, LOF, AIS, MF-AIS, MF-RAIS, RDI, REBE

Frequency Offset

+/- 100ppm

Tx LBO

0 dB, -6.0 dB, -12.0 dB

Results

Signal Category

LOS/Signal Loss Count, LOS/Signal Loss Seconds, Rx Frequency, Rx Frequency Deviation (ppm), Rx Frequency Max Deviation (ppm), Tx Frequency, Tx Timing Source, Rx Level (Vp), Line Code Errors, Line Code Error Rate, Line Code Error Seconds

Frame Category

LOF Count, LOF Seconds, FAS Bit Error Count, FAS Bit Error Rate, FAS Word Error Rate, Non-Frame Alignment Word, AIS Alarm Losses, AIS Alarm Seconds, MFAS Word Error Count, MFAS Word Error Rate, MF-AID Seconds, MF-RAIS Seconds, CRC Error Count, CRC Error Rate, CRC Sync Loss Count, MFAS Sync Loss Count, Remote End Block Error (REBE), Sa Bit Monitor

Logic Category

LSS/Pattern Sync Loss Count, LSS/Pattern Sync Loss Seconds, TSE/Bit Error Count, TSE/Bit Error Rate, Pattern Slips, Pattern Slip Seconds, Pattern Synchronization Loss Count, Pattern Synchronization Loss Seconds

Performance Measures

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

1.5M (T1)

Modes of Operation

Terminate, Monitor

Framing

D4, ESF, SLC-96, Unframed

Test Patterns

All 1s, All 0s, $2^{15}-1^*$, $2^{20}-1^*$, QRSS, User Bit (3 -32 bits), User Byte (2-128 Hex Digits), Round Trip Delay, 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

*ANSI and ITU implementations are supported

Error Insert

Bit Error	Single, Rate, Multiple
CRC	Single
BPV	Single
Frame	Single, 2

Frequency Offset

+/- 100ppm

Tx LBO

0 dB, -7.5 dB, -15.0 dB, -22.5 dB

Results

Signal Category

LOS/Signal Loss Count, LOS/Signal Loss Seconds, Rx Frequency, Rx Frequency Deviation, Rx Frequency Max Deviation, Tx Frequency, Tx Timing Source, Rx Level (Vpp), Rx Level (dBdsx), BPVs, BPV Rate, BPV Error Seconds, Ones Density State Count

Frame Category

LOF/Frame Sync Losses, LOF/Frame Sync Loss Seconds, Frame Error Count, Frame Error Rate, AIS Seconds, RAI Seconds, CRC Error Count, CRC Errored Seconds, CRC Error Rate

Logic Category

LSS/Pattern Sync Losses, LSS/Pattern Sync Loss Seconds, Bit Error/TSE Count, Bit Error/TSE Rate

Performance Results

G.821, G.826 (ISM/OOS), M.2100, T1.231, T.510 (ISM/OOS)

Optical Specifications for 10 Gb/s Port Bank

Technologies Include - STM-64, OC-192, and 10 GigE LAN/WAN

Connectors

- 1 - 1550nm Tx
- 1 - 1310nm Tx
- 1 - 1310nm and 1550 nm Rx
- 1 - 850nm Tx
- 1 - 850nm Rx

Connector types - FC, SC, ST, LC, DIN

Transmitter (1550 nm and 1310 nm)

Clock frequency accuracy Tx +/- 1.5 ppm +/- 1 ppm/year

Receiver (1550 nm and 1310 nm)

Rx wavelength range (1310nm, 1550nm Rx) 1100 to 1600 nm
 Rx clock measurement accuracy +/- 1.5 ppm +/- 1 ppm/year
 Rx level accuracy (all wavelengths, all rates) +/- 3dB

Transmitter (850 nm)

Clock frequency accuracy Tx +/- 1.5 ppm +/- 1 ppm/year

Receiver (850 nm)

Rx wavelength range 840 - 860 nm
 Rx clock measurement accuracy +/- 1.5 ppm +/- 1 ppm/year
 Rx level accuracy +/- 3 dB

Optical Specifications for Primary Port Bank

Interfaces Include - 2.5 Gb/s, GigE, 622 Mb/s, and 155 Mb/s

Connectors

- 1 - 1310 nm 2.5 Gb/s, 1 Gb/s, 622 Mb/s, 155 Mb/s Tx
- 1 - 1550 nm 2.5 Gb/s, 1 Gb/s, 622 Mb/s, 155 Mb/s Tx
- 1 - 1310/1550 nm 2.5 Gb/s, 1 Gb/s Rx
- 1 - 1310/1550 nm 622 Mb/s, 155 Mb/s Rx
- 1 - 850 nm 1 Gb/s Tx
- 1 - 850 nm 1 Gb/s Rx

Connector Types - FC, SC, ST, LC, DIN

Transmitter (1310 nm and 1550 nm)

Clock frequency accuracy Tx +/- 1.5 ppm +/- 1 ppm/year

Receiver (1310 nm and 1550 nm)

Rx wavelength range 1270 nm to 1600 nm range
 Rx clock measurement accuracy +/- 1.5 ppm +/- 1 ppm/year

Transmitter (850 nm)

Clock frequency accuracy +/- 1.5 ppm +/- 1 ppm/year

Receiver (850 nm)

Rx wavelength range 770 to 860 nm
 Rx clock measurement accuracy +/- 1.5 ppm +/- 1 ppm/year
 Rx level accuracy (all wavelengths, all rates) +/- 3 dB

Optical Specifications for Secondary Port Bank

Technologies Include - GigE

Connectors

- 1 - 1310 nm 1Gb/s Tx
- 1 - 1550 nm 1Gb/s Tx
- 1 - 1310/1550 nm 1G Rx
- 1 - 850 nm 1Gb/s Tx
- 1 - 850 nm 1Gb/s Rx

Connector Types - FC, SC, ST, LC, DIN

Transmitter (1310 nm and 1550 nm)

Clock frequency accuracy +/- 1.5 ppm +/- 1 ppm/year

Receiver (1310 nm and 1550nm)

Rx wavelength range 1100 nm to 1600 nm
 Rx clock measurement accuracy +/- 1.5 ppm +/- 1 ppm/year
 Rx level accuracy (1310 nm and 1550 nm) +/- 3dB

Transmitter (850 nm)

Clock frequency accuracy +/- 1.5 ppm +/- 1 ppm/year

Receiver (850 nm)

Rx wavelength range 770 nm to 860 nm
 Rx clock measurement accuracy +/- 1.5 ppm +/- 1 ppm/year
 Rx level accuracy (1310 nm and 1550 nm) +/- 3dB

Electrical Specifications

Electrical rates supported by the Transport Module

DS1	1.544
DS3	44.736
E1	2.048
E3	34.368
E4	139.264
STS-1	51.84
STM-1e	155.52
10Base-T Ethernet	10
100Base-T Ethernet	100
1000Base-T Ethernet	1000

Input/Output optical power levels for the Transport module	Primary Port Bank											
	Tx		Tx		Rx		Rx					
Connector Function	1550nm		1310nm		1310/1550nm		1310/1550nm					
Wavelength	1550nm		1310nm		1310/1550nm		850nm					
Applicable Rates (note that all rates listed are not applicable to all configurations)	2.5Gb/s, 1Gb/s, 622Mb/s		2.5Gb/s, 1Gb/s, 622Mb/s		2.5Gb/s, 1Gb/s		622Mb/s, 155Mb/s					
Model # Short Configuration Description	Max (dBm)	Min (dBm)	Max (dBm)	Min (dBm)	Max (dBm)	Min (dBm)	Max (dBm)	Min (dBm)				
SONET/SDH modules												
C8301 622M-T1/E1, 1550/1310nm @ 622M	2	-4	-8	-16	N/A	N/A	-8	-28	N/A	N/A	N/A	N/A
C8305 2.5G-T1/E1, 1550/1310nm @ 2.5G	0	-6	3	-3	-9	-27	-8	-28	N/A	N/A	N/A	N/A
C8310 10G SONET or SDH, 1550nm (IR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C8311 10G SONET or SDH, 1550nm (LR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C8312 10G SONET or SDH, 1550nm/1310nm (IR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C8313 10G SONET or SDH, 1550nm/1310nm (LR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C8314 10G SONET or SDH, 1310nm (SR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C8320 10G-T1/E1, 1550nm @ 10G (IR), 1550nm/1310nm @ 2.5G	0	-5	3	-2	-9	-27	-8	-28	N/A	N/A	N/A	N/A
C8321 10G-T1/E1, 1550/1310nm @ 10G (IR), 1550nm/1310nm @ 2.5G	0	-5	3	-2	-9	-27	-8	-28	N/A	N/A	N/A	N/A
C8325 10G-T1/E1, 1550nm @ 10G (LR), 1550nm/1310nm @ 2.5G	0	-5	3	-2	-9	-27	-8	-28	N/A	N/A	N/A	N/A
Ethernet modules												
C8401 GigE single port, 1310nm	N/A	N/A	-3	-12	-3	-19	N/A	N/A	N/A	N/A	N/A	N/A
C8402 GigE single port, 850nm	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	-12.5	0	-17
C8405 GigE single port, 1310/850nm	N/A	N/A	-3	-12	-3	-19	N/A	N/A	0	-12.5	0	-17
C8403 GigE single port, 1550nm	0	-6	N/A	N/A	-9	-27	N/A	N/A	N/A	N/A	N/A	N/A
C8406 GigE single port, 1310/1550nm	0	-6	-3	-12	-9	-27	N/A	N/A	N/A	N/A	N/A	N/A
C8408 GigE single port, 850/1310/1550nm	0	-6	-3	-12	-9	-27	N/A	N/A	0	-12.5	0	-17
C8415 GigE dual port, 1310/850nm	N/A	N/A	-3	-12	-3	-19	N/A	N/A	0	-12.5	0	-17
C8410 GigE dual port, 1310nm	N/A	N/A	-3	-12	-3	-19	N/A	N/A	N/A	N/A	N/A	N/A
C8411 GigE dual port, 850nm	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	-12.5	0	-17
C8418 GigE dual port, 850/1310/1550nm	0	-6	-3	-12	-9	-27	N/A	N/A	0	-12.5	0	-17
C8420 10GigE LAN, 1310nm	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C8421 10GigE LAN, 850nm	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C8422 10GigE LAN, 1550nm	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C8423 10GigE LAN, 850/1310nm	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C8424 10GigE LAN 1550/1310nm	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C8425 10GigE LAN 1550/1310/850nm	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C8430 10GigE LAN 1310nm, GigE (850/1310nm) single port, 10/100M (e)	N/A	N/A	-3	-11	-3	-19	N/A	N/A	0	-9.5	0	-17
C8431 10GigE LAN 850/1310nm, GigE (850/1310nm) single port, 10/100M (e)	N/A	N/A	-3	-11	-3	-19	N/A	N/A	0	-9.5	0	-17
C8432 10GigE LAN 1550/1310nm, GigE (850/1310nm) single port, 10/100M (e)	N/A	N/A	-3	-11	-3	-19	N/A	N/A	0	-9.5	0	-17
C8433 10GigE LAN 1550/1310/850nm, GigE (850/1310nm) single port, 10/100M (e)	N/A	N/A	-3	-11	-3	-19	N/A	N/A	0	-9.5	0	-17
C8435 10GigE LAN (1310nm), GigE (850/1310nm) dual port, 10/100M (e)	N/A	N/A	-3	-11	-3	-19	N/A	N/A	0	-9.5	0	-17
C8436 10GigE LAN (850/1310nm), GigE (850/1310nm) dual port, 10/100M (e)	N/A	N/A	-3	-11	-3	-19	N/A	N/A	0	-9.5	0	-17
C8437 10GigE LAN 1550/1310nm, GigE (850/1310nm) dual port, 10/100M (e)	N/A	N/A	-3	-11	-3	-19	N/A	N/A	0	-9.5	0	-17
C8438 10GigE LAN 1550/1310/850nm, GigE (850/1310nm) dual port, 10/100M (e)	N/A	N/A	-3	-11	-3	-19	N/A	N/A	0	-9.5	0	-17
C8540 10GigE LAN/WAN (10G-IR, 1310/1550nm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C8541 10GigE LAN/WAN (10G-IR, 850/1310/1550nm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C8542 10GigE LAN/WAN (10G-SR, 1310nm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C8545 10GigE LAN/WAN (10G-LR, 1310/1550nm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C8546 10GigE LAN/WAN (10G-IR, 1310/1550nm), 1xGigE-850/1310nm	N/A	N/A	-3	-11	-3	-19	N/A	N/A	0	-9.5	0	-17
C8547 10GigE LAN/WAN (10G-IR, 1310/1550nm), 2xGigE-850/1310nm	N/A	N/A	-3	-11	-3	-19	N/A	N/A	0	-9.5	0	-17
C8548 10GigE LAN/WAN (10G-IR, 850/1310/1550nm), 1xGigE-850/1310nm	N/A	N/A	-3	-11	-3	-19	N/A	N/A	0	-9.5	0	-17
SONET/SDH and Ethernet modules												
C8501 622M-T1/E1 and GigE SP (850/1310nm)	-8	-15	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8502 622M-T1/E1 and GigE DP (850/1310nm)	-8	-15	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8505 2.5G-T1/E1 and GigE SP (850/1310nm)	0	-5	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8506 2.5G-T1/E1 and GigE DP (850/1310nm)	0	-5	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8510 10G-T1/E1 and GigE SP (850/1310nm)	0	-5	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8511 10G-T1/E1 and GigE SP (1310/1550)	0	-5	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8515 10G-T1/E1 and GigE DP (850/1310nm)	0	-5	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8520 10G-T1/E1 (LR) and GigE SP (850/1310nm)	0	-5	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8521 10G-T1/E1 (LR) and GigE DP (850/1310nm)	0	-5	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8525 10G-T1/E1 Dual @ 10G/2.5G and GigE SP (850/1310nm)	0	-5	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8526 10G-T1/E1 Dual @ 10G/2.5G and GigE DP (850/1310nm)	0	-5	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8530 10G-T1/E1 and 10GigE LAN (10G-IR, 1310/1550nm) and GigE SP	0	-5	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8535 10G-T1/E1 and 10GigE LAN (10G-IR, 1310/1550nm) and GigE DP	0	-5	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8550 10G-T1/E1 and 10GigE LAN (10G-LR, 1310/1550nm) and GigE SP (850/1310)	0	-5	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8551 10G-T1/E1 and 10GigE LAN (10G-LR, 1310/1550nm) and GigE DP (850/1310)	0	-5	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8555 10G-T1/E1 and 10GigE LAN (10G-IR, 1310/1550nm) and GigE SP (850/1310)	0	-5	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8556 10G-T1/E1 and 10GigE LAN (10G-IR, 1310/1550nm) and GigE DP (850/1310)	0	-5	3	-3	-9	-27	-8	-28	0	-9.5	0	-17
C8557 10G-T1 or E1 and 10GigE LAN (10G-IR, 850/1310/1550nm)	0	-5	3	-3	-9	-27	-8	-28	N/A	N/A	N/A	N/A
C8581 2.5G-T1 or E1 (IR-Dual), 10GigE-SR/LR/ZR	0	-5	3	-3	-9	-27	-8	-28	N/A	N/A	N/A	N/A

Input/Output optical power levels for the Transport module		10Gb/s Port Bank				
		Tx 1550nm 10.3Gb/s, 10Gb/s	Tx 1310nm 10.3Gb/s, 10Gb/s	Rx 1310/1550nm 10.3Gb/s, 10Gb/s	Tx 850nm 10.3Gb/s, 10Gb/s	Rx 850nm 10.3Gb/s, 10Gb/s
Connector Function	Wavelength	Max (dBm)	Min (dBm)	Max (dBm)	Min (dBm)	Max (dBm)
Applicable Rates (note that all rates listed are not applicable to all configurations)						
Model # Short Configuration Description		Max (dBm)	Min (dBm)	Max (dBm)	Min (dBm)	Max (dBm)
SONET/SDH modules						
C8301	622M-T1/E1, 1550/1310nm @ 622M	N/A	N/A	N/A	N/A	N/A
C8305	2.5G-T1/E1, 1550/1310nm @ 2.5G	N/A	N/A	N/A	N/A	N/A
C8310	10G SONET or SDH, 1550nm (IR)	2	-1	N/A	N/A	-1 -14
C8311	10G SONET or SDH, 1550nm (LR)	2	-1	N/A	N/A	-9 -24
C8312	10G SONET or SDH, 1550nm/1310nm (IR)	2	-1	-1 -6	-1 -14	N/A N/A
C8313	10G SONET or SDH, 1550nm/1310nm (LR)	2	-1	-1 -6	-9 -24	N/A N/A
C8314	10G SONET or SDH, 1310nm (SR)	N/A	N/A	-1 -6	-1.0 -11	N/A N/A
C8320	10G-T1/E1, 1550nm @ 10G (IR), 1550nm/1310nm @ 2.5G	2	-1	N/A	N/A	-1 -14
C8321	10G-T1/E1, 1550/1310nm @ 10G (IR), 1550nm/1310nm @ 2.5G	2	-1	-1 -6	-1 -14	N/A N/A
C8325	10G-T1/E1, 1550nm @ 10G (LR), 1550nm/1310nm @ 2.5G	2	-1	N/A	N/A	-9 -24
Ethernet modules						
C8401	GigE single port, 1310nm	N/A	N/A	N/A	N/A	N/A
C8402	GigE single port, 850nm	N/A	N/A	N/A	N/A	N/A
C8405	GigE single port, 1310/850nm	N/A	N/A	N/A	N/A	N/A
C8403	GigE single port, 1550nm	N/A	N/A	N/A	N/A	N/A
C8406	GigE single port, 1310/1550nm	N/A	N/A	N/A	N/A	N/A
C8408	GigE single port, 850/1310/1550nm	N/A	N/A	N/A	N/A	N/A
C8415	GigE dual port, 1310/850nm	N/A	N/A	N/A	N/A	N/A
C8410	GigE dual port, 1310nm	N/A	N/A	N/A	N/A	N/A
C8411	GigE dual port, 850nm	N/A	N/A	N/A	N/A	N/A
C8418	GigE dual port, 850/1310/1550nm	N/A	N/A	N/A	N/A	N/A
C8420	10GigE LAN, 1310nm	N/A	N/A	-1 -6	-1.0 -11	N/A N/A
C8421	10GigE LAN, 850nm	N/A	N/A	N/A	N/A	-1 -7.3
C8422	10GigE LAN, 1550nm	2	-1	N/A	N/A	-1 -14
C8423	10GigE LAN, 850/1310nm	N/A	N/A	-1 -6	-1 -11	-1 -7.3
C8424	10GigE LAN 1550/1310nm	2	-1	-1 -6	-1 -14	N/A N/A
C8425	10GigE LAN 1550/1310/850nm	2	-1	-1 -6	-1 -14	-1 -7.3
C8430	10GigE LAN 1310nm, GigE (850/1310nm) single port, 10/100M (e)	N/A	N/A	-1 -6	-1 -11	N/A N/A
C8431	10GigE LAN 850/1310nm, GigE (850/1310nm) single port, 10/100M (e)	N/A	N/A	-1 -6	-1 -11	-1 -7.3
C8432	10GigE LAN 1550/1310nm, GigE (850/1310nm) single port, 10/100M (e)	2	-1	-1 -6	-1 -14	N/A N/A
C8433	10GigE LAN 1550/1310/850nm, GigE (850/1310nm) single port, 10/100M (e)	2	-1	-1 -6	-1 -14	-1 -7.3
C8435	10GigE LAN (1310nm), GigE (850/1310nm) dual port, 10/100M (e)	N/A	N/A	-1 -6	-1 -11	N/A N/A
C8436	10GigE LAN (850/1310nm), GigE (850/1310nm) dual port, 10/100M (e)	N/A	N/A	-1 -6	-1 -11	-1 -7.3
C8437	10GigE LAN 1550/1310nm, GigE (850/1310nm) dual port, 10/100M (e)	2	-1	-1 -6	-1 -14	N/A N/A
C8438	10GigE LAN 1550/1310/850nm, GigE (850/1310nm) dual port, 10/100M (e)	2	-1	-1 -6	-1 -14	-1 -7.3
C8540	10GigE LAN/WAN (10G-IR, 1310/1550nm)	2	-1	-1 -6	-1 -14	N/A N/A
C8541	10GigE LAN/WAN (10G-IR, 850/1310/1550nm)	2	-1	-1 -6	-1 -14	N/A N/A
C8542	10GigE LAN/WAN (10G-SR, 1310nm)	N/A	N/A	-1 -6	-1 -11	N/A N/A
C8545	10GigE LAN/WAN (10G-LR, 1310/1550nm)	2	-1	-1 -6	-9 -23	N/A N/A
C8546	10GigE LAN/WAN (10G-IR, 1310/1550nm), 1xGigE-850/1310nm	2	-1	-1 -6	-1 -14	N/A N/A
C8547	10GigE LAN/WAN (10G-IR, 1310/1550nm), 2xGigE-850/1310nm	2	-1	-1 -6	-1 -14	N/A N/A
C8548	10GigE LAN/WAN (10G-IR, 850/1310/1550nm), 1xGigE-850/1310nm	2	-1	-1 -6	-1 -14	-1 -7.3
SONET/SDH and Ethernet modules						
C8501	622M-T1/E1 and GigE SP (850/1310nm)	N/A	N/A	N/A	N/A	N/A
C8502	622M-T1/E1 and GigE DP (850/1310nm)	N/A	N/A	N/A	N/A	N/A
C8505	2.5G-T1/E1 and GigE SP (850/1310nm)	N/A	N/A	N/A	N/A	N/A
C8506	2.5G-T1/E1 and GigE DP (850/1310nm)	N/A	N/A	N/A	N/A	N/A
C8510	10G-T1/E1 and GigE SP (850/1310nm)	2	-1	N/A	N/A	-1 -14
C8511	10G-T1/E1 and GigE SP (1310/1550)	2	-1	N/A	N/A	-1 -14
C8515	10G-T1/E1 and GigE DP (850/1310nm)	2	-1	N/A	N/A	-1 -14
C8520	10G-T1/E1 (LR) and GigE SP (850/1310nm)	2	-1	N/A	N/A	-9 -23
C8521	10G-T1/E1 (LR) and GigE DP (850/1310nm)	2	-1	N/A	N/A	-9 -23
C8525	10G-T1/E1 Dual @ 10G/2.5G and GigE SP (850/1310nm)	2	-1	-1 -6	-1 -14	N/A N/A
C8526	10G-T1/E1 Dual @ 10G/2.5G and GigE DP (850/1310nm)	2	-1	-1 -6	-1 -14	N/A N/A
C8530	10G-T1/E1 and 10GigE LAN (10G-IR, 1310/1550nm) and GigE SP	2	-1	-1 -6	-1 -14	N/A N/A
C8535	10G-T1/E1 and 10GigE LAN (10G-IR, 1310/1550nm) and GigE DP	2	-1	-1 -6	-1 -14	N/A N/A
C8550	10G-T1/E1 and 10GigE LAN (10G-LR, 1310/1550nm) and GigE SP (850/1310)	2	-1	-1 -6	-9 -23	N/A N/A
C8551	10G-T1/E1 and 10GigE LAN (10G-LR, 1310/1550nm) and GigE DP (850/1310)	2	-1	-1 -6	-9 -23	N/A N/A
C8555	10G-T1/E1 and 10GigE LAN (10G-IR, 1310/1550nm) and GigE SP (850/1310)	2	-1	-1 -6	-1 -14	N/A N/A
C8556	10G-T1/E1 and 10GigE LAN (10G-IR, 1310/1550nm) and GigE DP (850/1310)	2	-1	-1 -6	-1 -14	N/A N/A
C8557	10G-T1 or E1 and 10GigE LAN (10G-IR, 850/1310/1550nm)	2	-1	-1 -6	-1 -14	-1 -7.3
C8581	2.5G-T1 or E1 (IR-Dual), 10GigE-SR/LR/ZR	2	-1	-1 -6	-1 -14	-1 -7.3

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