

## TestPoint Multi-Rate



### Highlights

#### Highest integration of line rates for multi-protocol testing

- Tests the following protocols with one module – OC-3 / 12 / 48, STM-1 / 4 / 16, OTN, Ethernet, 1 / 2G Fibre Channel (FC)
- Comprehensive support for OTN related rates – OTU1 (2.666 G) and ODU1 (2.498 G)
- Maps GFP-F and ATM into SONET / SDH
- Unique capability of Ethernet over PDH (ITU-T G.7043)
- Supports a wide variety of Ethernet interfaces: 1000BASE-X, 10 / 100 / 1000BASE-T, 100BASE-FX



### Applications

- Facilitates both line and client testing
- Tests Ethernet and Fibre Channel transport
- Provides 2.7 Gbps and below traffic blasting

### Compliance

- CSA Certificate of Compliance to CAN/CSA C22.2 No.60950-1 (2003) and ANSI/UL 60950-1 (2003) with CSA Mark for Canada and USA
- CSA CB Certificate of Compliance to EN60950-1, IEC 60950-1, and National Deviations with CE Marking
- Class 1 Laser Product in compliance with EN 60825, IEC 60825, and FDA/CDRH requirements

The TestPoint Multi-Rate Module is a single-slot, customizable module with three physical ports: OC-48/STM-16 (option for G.709 OTN), OC-3 / 12 / STM-1/4, and Ethernet / Fibre Channel.

One physical port can be active at a time for testing and at least one synchronous optical network technologies / synchronous digital hierarchy (SONET / SDH) port must be licensed. For the convenience of changing wavelengths and protocols, pluggable SFP optical / electrical interfaces are used. Traffic generation of up to 128 streams is provided on all supported Ethernet rates.

A hardware option provides OTU1 support on the OC-48/STM-16 port. Both SONET / SDH ports support licensed options for Ethernet over SONET / SDH (VCAT and GFP-F) and asynchronous transfer mode (ATM). Additional options include Ethernet over PDH (EoPDH) (DS1 / E1 / DS3 / E3 into SONET / SDH with GFP-F / HDLC payload), RPR Intrusive Monitor Mode on OC-48 / STM-16, and ODU1 line rate (2.499 G). The Multi-Rate Module can be inserted into multiple scalable TestPoint chassis including the highly compact TestPoint TS-10. Up to sixteen Multi-Rate modules can be inserted into the TS-170 for a high-density, rack-mounted test solution.

NOTE: The TestPoint Multi-Rate is available as a module for multi-slot systems (TestPoint TS-30 and TS-170) or in a static, self-contained configuration (TestPoint TS-10). The term module is used in this document.

**INTERFACE SPECIFICATIONS**

OC-48 / STM-16 (SFP)			
Optical connector	LC		LC
Wavelength	1310 nm		1550 nm
Optical output power (Rx power read)	-9.5 to -3 dBm		-5 to 0 dBm
Optical overload (min)	-3 dBm		0 dBm
Sensitivity (min)	-18 dBm		-19 dBm
OC-12 / 3 / STM-4 / 1 (SFP)			
Optical connector	LC		LC
Wavelength	1310 nm		1550 nm
Optical output power (Rx power read)	-15 to -8 dBm		-15 to -8 dBm
Optical overload (min)	-7 dBm		0 dBm
Sensitivity (min)	-34 dBm		-28 dBm
Ethernet / FC (SFP)			
Optical connector	LC	LC	LC
Wavelength	850 nm	1310 nm	1550 nm
Optical output power (Rx power read)	-9.5 to -3.5 dBm	-9.5 to -3 dBm	-5 to 0 dBm
Optical overload (min)	-3.5 dBm	-3 dBm	0 dBm
Sensitivity (min)	-20 dBm	-22 dBm	-23 dBm
Electrical connector	RJ45; supports full-duplex 1BASE-T, 10BASE-TX, 100BASE-T		
Clock out	LVPECL signal, AC coupled on SMA connector		
LAN (Ethernet) port	RJ45 (10 / 100BASE-T)		
Operator port	RJ12 into RS-232 serial cable		
LAN management port	Supports simple network time protocol (SNTP) configurable for static IP address or DHCP		

**OPTICAL**

- Receive power measurement
- Transmit laser on / off
- SFP information display

**LINE RATES**

- 10 / 100 / 1000 Mbps (BASE-T)
- 125 Mbps (100BASE-FX)
- 155.52 Mbps (OC-3 / STM-1)
- 622.08 Mbps (OC-12 / STM-4)
- 1.0625 Gbps (1GFc)
- 1.25 Gbps (GigE)
- 2.125 Gbps (2GFc)
- 2.488 Gbps (OC-48 / STM-16)
- 2.498 Gbps (ODU1)
- 2.666 Gbps (OTU1)

**CLOCKING**

- Internal (± 4.6 ppm accuracy)
- Recovered from line
- External via group controller (TS-30 / TS-170)
- Clock rate variations
- ± 30 ppm: SONET / SDH, OTU1
- ± 110 ppm: Ethernet, FC
- Clock out (LVPECL, AC coupled on SMA)

**LOGGING**

- Event log
- Log injections

**CONNECTIVITY**

- Terminal: Source and sink traffic (all rates)
- Transparent Monitor: Transparently monitors signal and retransmits unaltered (all SONET / SDH rates and OTU1)
- Intrusive Monitor: Intrusively injects errors while forwarding incoming traffic (RPR option only)

**APPLICATIONS**

**Description of the applications**

**SONET / SDH:**

OC-3 / 12 / 48 and STM-1 / 4 / 16

**Digital Wrapper and FEC**

OTU1: Client can be PRBS or OC-48 / STM-16  
 ODU1: OTU1 frame structure without FEC

**Ethernet**

Optical GigE and / or 10 / 100 / 1000BASE-T and / or 100BASE-FX

**Fibre Channel**

1 and 2GFC point-to-point

**Ethernet over PDH**

DS1 / E1 and DS3 / E3 into OC-3 / 12 / 48 / STM-1 / 4 / 16  
 PDH VCAT / LCAS is available on DS1 / E1  
 MAC traffic on GFP-F / bit-HDLC / byte-HDLC (on DS1 / E1 only)

**Ethernet over SONET / SDH**

GFP-F on OC-3 / 12 / 48 or STM-1 / 4 / 16  
 Higher-Order VCAT on OC-48 / STM-16

**RPR**

Intrusive monitor mode on OC-48 / STM-16  
 (STS-48c / VC-4-16c)

**ATM**

On OC-3 / 12 / 48, STM-1 / 4 / 16

**SONET / SDH**

**CHANNELIZATION**

- OC-3: STS-3c / STS-1
- STM-1: VC-4 / VC-3 (AU-3)
- OC-12: STS-12c / STS-3c / STS-1
- STM-4: VC-4-4c / VC-4 / VC-3 (AU-3)
- OC-48: STS-48c / STS-24c / STS-12c / STS-3c / STS-1
- STM-16: VC-4-16c / VC-4-8c / VC-4-4c / VC-4 / VC-3 (AU-3) / VC-3 (TUG-3)

**ALARMS**

Monitoring is performed on all paths concurrently in the event log

Errors & Status			
Sonet			
		Count	Ratio
LOS	AIS-P	B1	0 0.0000E00
LOF	LOP-P	B2	0 0.0000E00
OOF	RDI-P	B3	0 0.0000E00
AIS-L	ERDI-P Payload	RE-L	0 0.0000E00
RDI-L	ERDI-P Server	RE-P	0 0.0000E00
	ERDI-P Connectivity		
	UNEQ-P		

LOS / LOF / OOF / AIS-L / MS-AIS / RDI-L / MS-RDI / LOP-P / AU-L  
 OP / AIS-P / AU-AIS / ERDI-P / HP-ERDI / UNEQ-P / HP-UNEQ  
 VC-3 (TUG-3): TU-AIS / TU-LOP / LP-RDI / LP-UNEQ

**ERRORS**

Monitoring is performed on all paths concurrently in the event log

Single / Rates for LOF / AIS-L / MS-AIS / RDI-L / MS-RDI / RE-L  
 / MSREI / RE-P / HP-REI / B1 / B2 / B3  
 VC-3 (TUG-3): Single / Rates for LP-REI / LP-BIP  
 Duration (in ms) for LOF / [AIS-L/MS-AIS] / [RDI-L/MS-RDI]

**ENLARGED VIEW OF ERRORS & ALARMS REPORT**



Up to 4 indicators of errors and alarms detected by the TestPoint. Object of each indicator can be chosen by user from the above list of alarms and errors.

**TRAFFIC**

PRBS 23 or 31 / 4-Byte Sequence / Pattern Invert

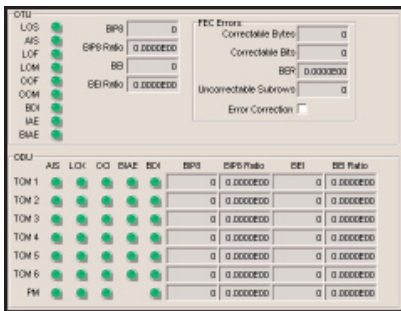
**TRIGGER SIGNAL**

OC-48 / STM-16: Output pulse either on received / transmitted A2 byte

**DIGITAL WRAPPER AND FEC**

Covers OTU1, ODU1. FEC does not apply to ODU1

**ALARMS**



LOS / OOF / LOF / OOM / LOM / OTU-AIS (PN-11) / OTU-IAE / OTU-BDI / OTU-BIAE / ODU-AIS (PM / TCM1-6) / ODU-LCK (PM / TCM1-6) / ODU-OCI (PM / TCM1-6) / ODU-BDI (PM / TCM1-6) / ODU-BIAE (TCM1-6)

**ERRORS**

Single / rates for OTU-BIP8 / OTU-BEI / ODU-BIP8 (PM / TCM1-6) / ODU-BEI (PM / TCM1-6)

**OVERHEADS**

Multi Frame Structures: OTU-TTI / ODU-TTI (PM / TCM1-6) / ODU-FTFL / PSI  
 Justification events: Sync (line-client locked) / async (range ± 70 ppm). Reporting of justification event ratio and line client ppm offset  
 Byte diagram: User editable overhead fields / MFAS invert.  
 Injection count in frames / continuous injection  
 Overhead PRBS: 3 independent PRBS 15 engines for GCCO-2 / RES (OTU, ODU, OPU) / TCM1-6 (TCM / ACT) EXP  
 Error suppression: To optionally suppress incoming errors / alarms: FEC / TCM1-6 errors / PM errors / client errors

**CAPTURES**

FAS	MFAS	SM	GCCO	RES	RES	TCM/ACT	TCM6
FE FE FE 28 28 28	00	00 32 01	00 00	00 00	00 00 00	00	00 32 01
FE FE FE 28 28 28	0A	00 56 01	00 00	00 00	00 00 00	00	00 56 01
FE FE FE 28 28 28	0C	00 40 01	00 00	00 00	00 00 00	00	00 40 01
FE FE FE 28 28 28	0D	00 4B 01	00 00	00 00	00 00 00	00	00 4B 01

Triggers: Manual / OOF / LOF / OOM / LOM / OTU-IAE / OTU-BDI / OTU-BIAE / OTU-BIP8 / OTU-BEI / ODU-AIS (PM / TCM1-6) / ODU-LCK (PM / TCM1-6) / ODU-OCI (PM / TCM1-6) / ODU-BDI (PM / TCM1-6) / ODU-BIP8 (PM / TCM1-6) / ODU-BEI (PM / TCM1-6) / ODU-BIAE (TCM1-6) / positive justification / negative justification / overhead PRBS bit error / pattern match (equal, not equal) with bit-mask

Pattern Match Fields: FAS / MFAS / GCCO-2 / OTU RES / SM TTI / ODU RES1-3(TCM / ACT) FTFL / EXP / APS / PCC / TCM1-6 TTI / PM TTI / OPU RES1-3

Trigger point: Start / middle / end  
 Display: Trigger point / Hex values for all overhead fields  
 Size: Overhead of 256 frames  
 File type: ASCII (csv)

**CLIENT**

OC-48 / STM-16  
 PRBS 23, 31 & 4-byte user pattern

**FEC**

Settings: Standard FEC / All-Zeros FEC. Enable / Disable error correction  
 Injection: Single and rates. Control of errored sub-row (including all) / errored bytes per sub-row / errored bits per byte. Skipped rows between errors. Up to 16 symbol errors.  
 Detection: Number of correctable byte errors / number of correctable bit errors / bit error rate / number of uncorrectable sub-rows

**ETHERNET**

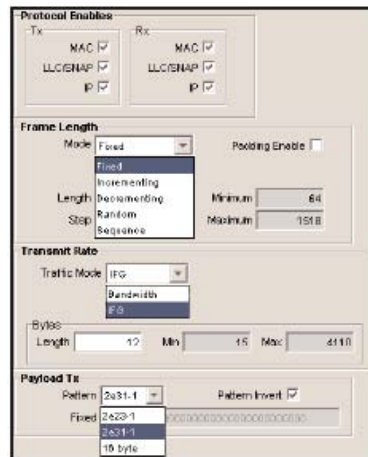
Covers optical GigE, 10 / 100 / 1000BASE-T, and 100BASE-FX depending on the SFP used

**TRAFFIC SETTINGS**

Two modes: Single stream, multiple stream

**Single Stream**

Used for BERT testing at PCS (optical GigE only), MAC, single / stacked VLAN, and IPv4 layers



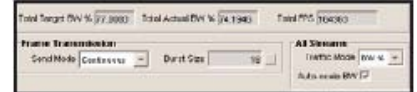
Send mode: Continuous / burst of frames

Protocol support: MAC (single / stacked VLAN) LLC / SNAP / IPv4. User can set header values. For destination / source MAC addresses and VLAN IDs, support of single / incrementing value over a range  
 Frame size: Range of 19 to 65,535 bytes (19 to 9,600 bytes for 10 / 100 / 1000BASE-T). Size can be: Fixed / incrementing / decrementing / random / user sequence (up to 8)  
 Transmission rate: Specified as bandwidth (%/Mbps, frame/s) or number of inter frame gap (IFG) bytes (fixed / random / sequence up to 8; range 4 to 16,777,215 bytes). IFG does not apply to 10 / 100 / 1000BASE-T  
 Frame payload: PRBS 23 or 31 / 16-byte sequence / pattern invert

**Multiple Streams**

Used for traffic simulation and multi-protocol support

N	Enable	Frame Length	Frame Count	VLAN VID	Destination Address	Source Address	BW % Target	BW % Actual
1	✓	1024	1	27	02:00:00:00:00:00	08:00:20:20:20:20	10.0000	10.0000
2	✓	2048	1	28	02:00:00:00:00:00	08:00:20:20:20:20	20.0000	20.0000
3	✓	4096	1	29	02:00:00:00:00:00	08:00:20:20:20:20	30.0000	30.0000
4	✓	8192	1	30	02:00:00:00:00:00	08:00:20:20:20:20	40.0000	40.0000
5	✓	16384	1	31	02:00:00:00:00:00	08:00:20:20:20:20	50.0000	50.0000



Maximum number of streams: 128  
 Send mode: Continuous / burst of frames  
 Protocol support: MAC (single / stacked VLAN) MPLS / IPv4 / IPv6 / TCP / UDP. User can set header values per stream.  
 Frame size: Range of 27 to 9,600 bytes. Size is fixed within a stream.  
 Transmission Rate: BW % / IFG size in bytes / frames/s. IFG does not apply to 10 / 100 / 1000BASE-T  
 Auto-scale BW: Scales bandwidth when total exceeds 100%.  
 Frame Payload: Fill byte / random / custom (user defined byte-by-byte)

Stream signature: Used for receive auto-detection

**AUTO-NEGOTIATION**

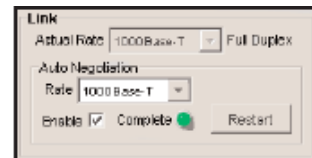
Different implementation for optical GigE and 10 / 100 / 1000BASE-T; does not apply to 100BASE-FX

**Optical GigE**



Settings: Enable / disable. Remote fault (offline, link failure, auto-neg error) / pause encoding / duplex settings  
 Reporting: Auto-negotiation complete indicator. Remote fault (offline, link failure, auto-neg error)  
 Capture: Using 8B / 10B PCS capture

**10 / 100 / 1000BASE-T**



Settings: Enable / disable. Full duplex only support. Rate to negotiate / pause encoding  
 Reporting: Auto-negotiation complete indicator

# 4

## CONTROL PLANE

Pause frames: Single / continuous with interval. Pause timer. Receiver throttles

**ARP:**  
 ARP request sent for each unique destination IP address; Timeout, Retry Period and Count support  
 ARP Reply sent on port MAC address match  
 Gateway and Subnet Mask Settings

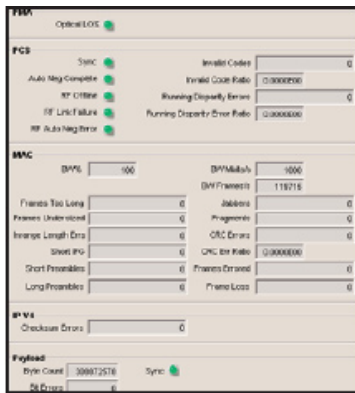
## Ping

Send mode: Continuous / packet count  
 Transmission period: 1000 to 4,294,967,295 ms  
 Protocol support: IPv4 with no VLAN, single VLAN and stacked VLAN  
 Data size: 0 to 9,572 bytes  
 Replies: Issued on port IP address match

## ERROR INJECTIONS

PCS / PMA sublayer:  
 Optical GigE: LOS / running disparity error (single, rates) / (8B / 10B) coding error (single, rates) / random bit corruption  
 100BASE-FX: LOS / Sync / far end fault / invalid code  
 MAC sublayer: Short preambles (single stream) / long preambles (single stream) / CRC (single, rates in single stream; per-stream in multiple streams)

## ERROR MONITORING



PCS / PMA sublayer:  
 Optical GigE: LOS / PCS synchronization / running disparity errors / invalid 8B / 10B code groups  
 100BASE-FX: LOS / sync / far end fault / invalid codes  
 MAC sublayer: Frames too long (>jumbo) / jabbers / under-sized / fragments / CRC errors / in-range length errors (802.3 frames) / short IFGs (adjustable threshold, does not apply to 10 / 100 / 1000BASE-T)  
 IPv4: Checksum errors (single stream)

## STATISTICS

MAC: bandwidth (%Mbps, frames/s) / frame count / octet count / unicast frames / multicast frames / broadcast frames / single / stacked VLAN tagged frames / number of pause frames / ARP frames / MPLS tagged frames / frame length bins (including jumbo) / CRC counts (total and lengths bins) / short preamble count / long preamble count  
 IPv4: Packet count / ICMP packets  
 IPv6: Packet count / ICMP packets  
 Per-stream statistics: Bandwidth (Mbps, %, frames/s) / frame count / octet count

## LATENCY AND SEQUENCING

In single-stream mode



Sequencing: Frame loss / out-of-order / duplicates. Can inject errors on transmit  
 Time stamping: Latency (min, max, avg over test period and 0.5 s window; bit forwarding / store and forward) / packet jitter

## FILTERS

MAC: 8 MAC / VLAN filters with accept / discard criteria  
 Pattern filter: Up to 6 bytes with offset from start of frame

## CAPTURES

Two modes: 8B / 10B (optical GigE only), and MAC level

## PCS

	Raw Data	Code Group Names
21	1101101000 1010100101 1010100101 1010100101 1010100101 1010100101 1010100101 1010100101	327.7 321.2 021.2 321.2
22	1101010101 0010100101 1101010101 0010100101 0010100101 0010100101 0010100101 0010100101	34.2 34.2 34.2 34.2
23	1101010101 0010100101 1101010101 0010100101 0010100101 0010100101 0010100101 0010100101	34 34 34 34

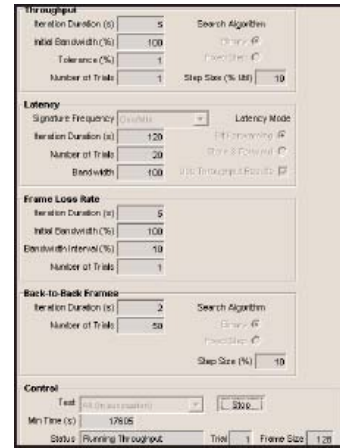
Triggers: Manual / PCS sync loss / invalid 8B / 10B code group / running disparity error / code group pattern match (up to 6 bytes)  
 Trigger point: Start / middle / end  
 Display: Trigger point / 8B / 10B code group and decode (D / K codes and hex)  
 Size: 8,250,000 8B / 10B code groups  
 File type: Binary / ASCII

## MAC

	T3 (µs)	Len	Dest Addr	Src Addr	VLAN	T/L
22	1.8	128	44-44-44-44-44-44	22-22-22-22-22-22	01 00 01 11	00 5A AA AF
23	0.8	128	44-44-44-44-44-44	22-22-22-22-22-22	01 00 01 11	00 5A AA AF
24						
25	1.2	128	44-44-44-44-44-44	22-22-22-22-22-22	01 00 01 11	00 5A AA AF

Triggers: Manual / CRC error / undersized frame / frame too long / in-range length error  
 Trigger point: Start / middle / end  
 Filters: MAC filters / pattern filter  
 Display: Trigger point / time stamp / MAC layer decode  
 Size: 400,000 Frames / 32.4 Mbytes / full frame or slicing (first 64 bytes)  
 File type: Binary (snoop compatible with Ethereal)

## RFC2544



Provides throughput, latency, frame loss, and back-to-back measurements in single-stream mode. Up to 10 frame sizes. Supports function to run all tests in succession. Logs results to file and generates graphics.

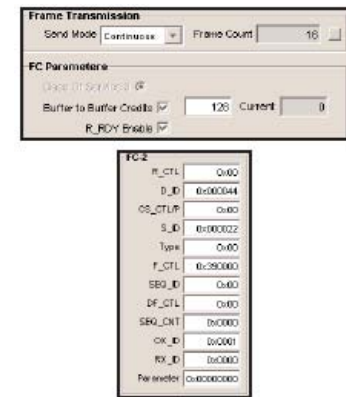
## TEST REPORT

Contains Ethernet settings, errors, and statistics

## FIBRE CHANNEL

This covers 1 and 2G Fibre Channel point-to-point. Used for BERT testing at the FC-1 and FC-2 layers.

## TRAFFIC SETTINGS



Send mode: Continuous / burst of frames  
 Frame size: Range of 12 to 4,104 bytes (multiple of 4, includes SOF & EOF). Size can be: Fixed / incrementing / decrementing / random / user sequence (up to 8)  
 Transmission rate: Specified as bandwidth (%Mbps, frame/s) / number of inter frame gap (IFG) bytes (fixed / random / sequence up to 8; range 8 to 65,535 bytes)  
 FC-2 framing: User can set the 24-byte header values  
 Class support: Class 3  
 Flow control: Manual buffer-to-buffer credit setting; range 1 to 4,095. Sending of R\_RDY may be enabled / disabled  
 Frame payload: PRBS 23 or 31 / 16-byte sequence / pattern Invert



**LINK INITIALIZATION**

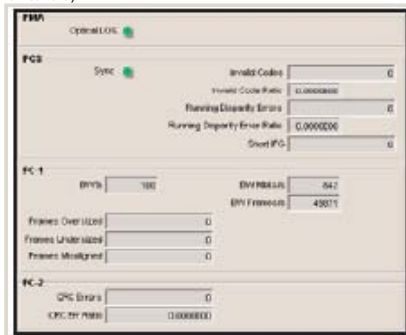
Settings: Enable/disable. LF1/LF2 state force  
 Reporting: Active state indicator/LF1 report/LF2 report/primitive sequence protocol error count/loss of sync count/link fail count  
 Capture: Using 8B/10B PCS capture

**ERROR INJECTIONS**

PCS sublayer: LOS / running disparity error (single, rates) / 8B / 10B coding error (single, rates) / random bit corruption  
 FC-1: Misaligned frames (non-multiple of 4 bytes size)  
 FC-2: CRC (single, rates)

**ERROR MONITORING**

PCS sublayer: LOS / PCS synchronization / running disparity errors / invalid 8B / 10B code groups / short IFGs (adjustable threshold)



FC-1: Frames oversized (>2,148 bytes) / frames undersized (<36 bytes) / frames misaligned (non-multiple of 4 bytes)  
 FC-2: CRC errors

**STATISTICS**

FC-1: Bandwidth (%/Mbps, frames/s) / frame count / octet count / number of R\_RDY

**LATENCY AND SEQUENCING**

Sequencing: Frame loss / out-of-order / duplicates. Can inject errors on transmit.  
 Time stamping: Latency (min, max, avg over test period and 0.5 s window) / packet jitter

**CAPTURES**

At the 8B / 10B PCS level  
 Triggers: Manual / PCS sync loss / invalid 8B / 10B character / running disparity error / character pattern match (up to 6 bytes)  
 Trigger point: Start / middle / end  
 Display: Trigger point / 8B / 10B character and decode (D / K codes and hex)  
 Size: 8,250,000 8B / 10B characters  
 File type: Binary / ASCII

**RFC 2544**

Applies to FC as described under Ethernet

**TEST REPORT**

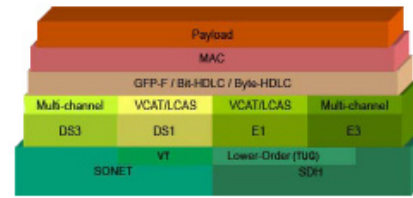
Contains FC settings, errors, and statistics

**TEST PATTERNS**

CJTPAT / CRPAT / CSPAT

**ETHERNET OVER PDH**

EoPDH is based on ITU-T G.7043 / 7042 and G.8040

**DS1**

Mapping onto SONET is via VT1.5. Supports PDH VCAT / LCAS



Independent channels: 336 on OC-12 / 48, 84 on OC-3 for VCG member selection

Format: ESF / SF

PPM offset: ± 130 ppm relative to line

ESF overheads: DL (data link) 6-bit programmable value / PRM (performance report message) 15-byte message injection and reporting

ESF errors: OOF / SEF / AIS / RAI / Idle / FPS bits (burst with mask, 10<sup>-3</sup> rate, error reporting) / CRC-6 (single, 10<sup>-3</sup> rate, error reporting)

SF errors: FT OOF / FT & FS OOF / SEF / AIS / RAI / Idle / FT & FS bits (burst with mask, 10<sup>-3</sup> rate, error reporting)

Payload: PRBS 15 or 23 / 4-byte sequence into GFP-F, byte-HDLC or bit-HDLC (RFC 1662 or LAPS) with MAC encapsulation

**E1**

Mapping onto SDH is via VC-12 using AU-3 or TU-3 VC-3 multiplexing. Supports PDH VCAT / LCAS



Independent channels: 252 E1 channels on STM-4 / 16, 63 E1 channels on STM-1 for VCG member selection

Format: PCM31CRC / PCM31

PPM Offset: ± 50 ppm relative to line

Overheads: Spare bits 5-bit programmable / Si 1-bit programmable (PCM31) / MDL (message-based data link) PRBS test  
 PCM31CRC errors: OOF / AIS / RAI / FAS bits (burst with mask, 10<sup>-3</sup> rate, error reporting) / Non-FAS Bit 2 (burst, continuous) / CRC-4 (burst, rates, error reporting) / REBE (single with mask, 10<sup>-3</sup> rate, error reporting)

PCM31 errors: OOF / AIS / RAI / FAS bits (burst with mask, 10<sup>-3</sup> rate, error reporting) / Non-FAS Bit 2 (burst, continuous)  
 Payload: PRBS 15 or 23 / 4-byte Sequence into GFP-F, byte-HDLC or bit-HDLC (RFC 1662 or LAPS) with MAC encapsulation

**DS3**

Mapping onto SONET is via STS-1

Independent engines: 12 on OC-3 / 12 / 48; for parallel independent testing on each engine

Format: C-bit parity / pseudo M23 / unframed

PPM Offset: ± 90 ppm relative to line

Overheads: MDL (maintenance data link) PRBS test

C-bit parity errors: OOF / AIS / SEF / Idle / RAI / F-bits (single with value, 10<sup>-3</sup> rate, error reporting) / M-bits (single with value, 10<sup>-3</sup> rate, error reporting) / C-bit parity errors (single with mask, 10<sup>-3</sup> rate, error reporting) / P-bit parity errors (single, 10<sup>-3</sup> rate, error reporting) / FEBE (single, 10<sup>-3</sup> rate, error reporting)

Payload: PRBS 15 or 23 / 4-byte sequence into GFP-F, or bit-HDLC (RFC 1662) with MAC encapsulation

**E3**

Mapping onto SDH is via VC-3 using AU-3 or TU-3 multiplexing

Independent engines: 12 on STS-1 / 4 / 16; for parallel independent testing on each engine

Format: G.832 (VL on / off) / G.751 / unframed

PPM Offset: ± 78 ppm relative to line

G.832 overheads: Trace message / MA payload type / MA SSM / network operator byte / GC PRBS test

G.751 overheads: National bit

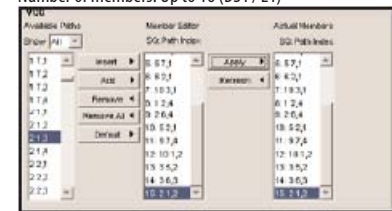
G.832 errors: OOF / RDI / AIS / FAS (single with value, 10<sup>-3</sup> rate, error reporting) / REI (single, 10<sup>-3</sup> rate, error reporting) / BIP-8 (single, 10<sup>-3</sup> rate, error reporting)

G.751 errors: OOF / AIS / RAI / FAS (single with value, 10<sup>-3</sup> rate, error reporting)

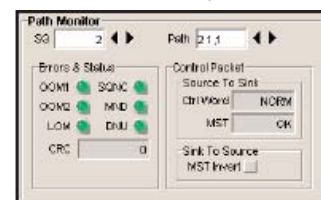
Payload: PRBS 15 or 23 / 4-byte sequence into GFP-F, or bit-HDLC (RFC 1662) with MAC encapsulation

**PDH VCAT / LCAS**

Number of members: Up to 16 (DS1 / E1)



Error injections: OOM1 / OOM2 / LOM (MF1, MF2) / SQ overwrite / CTRL overwrite / RS\_ACK toggle / suppress (LCAS) / MST invert (LCAS) / CRC (LCAS; single) / GID PRBS bit error (LCAS)



Error monitoring: OOM1 / OOM2 / LOM / SQM (VCAT; sequence indicator mismatch) / SQNC (LCAS; inconsistent sequence numbers) / LOA (VCAT; loss of alignment) / MND (LCAS; member not deskevable) / DNU (LCAS) / CRC error count (LCAS)

Error suppression: To optionally suppress non-member or noncandidate errors / alarms

LCAS status: Control word value / MST value

6

**LCAS sink Config:** User configures up to 32 candidate paths  
Monitoring of CTRL packets from this list provides sink side VCG information  
**LCAS statistics:** number of RS\_ACK toggles

**GFP-F**

Support on EoPDH

**TRAFFICSETTINGS**

Send mode: Continuous / burst of frames  
Header settings: PLI (auto-calculate on / off) / PTI / EXI / UPI / pFCS (on / off) / linear extension header (on / off) / channel ID / spare  
cHEC error correction on / off on receive  
Scrambler: Core header scrambler (enable / disable); payload header scrambler (enable / disable)  
Frame size: Range of 9 to 65,535 bytes (GFP frame)  
Size can be: Fixed / incrementing / decrementing (DS1 / E1 only) / random (DS1 / E1 only)  
Transmission rate: Specified as bandwidth (Mbps) / number of GFP Idle Frames (fixed / random)

**ERROR INJECTIONS**

Loss of client signal (LCS) / loss of client character synchronization (LCCS) / short GFP frame / pFCS (single, rates on DS1 / E1 only) / Idle GFP frame (single, 16-bit x or mask) / core header (single, rates on DS1 / E1 only; 16-bit x or mask) / type header (single, rates on DS1 / E1 only; 16-bit x or mask) / extension header (DS1 / E1 only; single, rates)

**ERROR MONITORING**

Loss of frame delineation (LFD) / LCS count / LCCS count / short GFP frames / undefined fields (DS1 / E1 only: Client signal fail, PTI, EXI) / pFCS errors / single-bit cHEC errors / multi-bit cHEC errors / single-bit tHEC errors / multi-bit tHEC errors / single-bit eHEC errors (DS1 / E1 only) / multi-bit eHEC errors (DS1 / E1 only)

**Statistics**

Bandwidth (% ,Mbps, frames/s) / frame count / octet count / management frame count

**HDLC**

Bit-HDLC comes two ways: RFC 1662 and LAPS. RFC 1662 is supported on DS1 / E1 / DS3 / E3, and LAPS is supported on DS1 / E1. LAPS Byte-HDLC (ITU-T X.86) is supported on DS1 / E1

Byte-HDLC			
GM Fps	2016	Frame Too Short	0
FCS Errors	0	Frame Too Long	0
Invalid Bit Seq	0	Address Mismatch	0
Invalid Ctrl Seq	0	Control Mismatch	0
Rate Adapt Seq	0	SAR Mismatch	0

Settings: RFC 1662 bit-HDLC / LAPS bit-HDLC (DS1 / E1 only) / LAPS byte-HDLC (DS1 / E1 only)  
Send mode: Continuous / burst of frames  
Header settings: Address / control / protocol or SAPI  
Frame size: Range of 7 to 65,535 bytes  
Size can be: Fixed / incrementing  
Transmission rate: Specified as number of idle flags (fixed)  
Error injections: Abort (single) / FCS (single) / rate adaptation (byte-HDLC)  
Error monitoring: FCS errors / abort errors / frames too short (threshold) / frames too long (threshold) / address mismatches / control mismatches (byte-HDLC) / invalid control sequence (byte-HDLC) / invalid rate adaptation sequence (byte-HDLC)  
Statistics: Bandwidth (frames/s) / frame count / octet count

**MAC**

MAC maps into GFP-F or HDLC. On DS1 / E1, traffic maps on a VCG. On DS3 / E3, 12 independent traffic engines are available on 12 channels.  
Protocols: MAC / single VLAN (DS1 / E1 / DS3 / E3) / stacked VLAN with programmable Ethertype (DS3 / E3). User can set header values  
Error injections: CRC (DS1 / E1 only; single, rates)  
Error monitoring: CRC errors / DS1 / E1 only: (frames too long / jammers / undersized / fragments / in-range length errors)  
Statistics: Frame count / DS1 / E1 only: (octet count / unicast frames / multicast frames / broadcast frames / VLAN tagged Frames / frame length bins [HDLC only] / CRC error length bins [HDLC only])

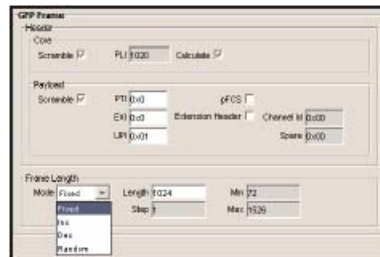
**ETHERNET OVER SONET / SDH**

**VCAT**

One VCAT group (VCG). Available on OC-48 / STM-16 port  
Channelization: STS-3c-nV (8 members) / VC-4-nV (8 members) / STS-1-nV (24 members) / VC-3-nV (AU-3 / TUG-3; 24 members)  
Error injections: LOM (using MF11 / MF12) / SQM / multi-frame (16-frame) control packet editor  
Error monitoring: LOM (per-member) / SQM (per-member) / LOA (adjustable threshold)  
Error suppression: To optionally suppress non-member errors / alarms  
Differential delay: Reporting of max differential delay in VCG.  
Injection on one VCG member of up to 256 ms.  
Capture: H4 Byte capture over 8 multi-frames (of 16 frames) for one VCG member

**GFP-F**

Available on Contiguously concatenated SONET / SDH (OC-3 / 12 / 48 STM-1 / 4 / 16) and VCAT (OC-48 / STM-16)



**TRAFFICSETTINGS**

Send mode: Continuous / burst of frames  
Header settings: PLI (auto-calculate on / off) / PTI / EXI / UPI / pFCS (on / off) / linear extension header (on / off) / channel ID spare. cHEC error correction on / off on receive  
Protocol support: MAC / single or stacked VLAN. User can set header values  
Scrambler: Core header scrambler (enable / disable); payload header scrambler (enable / disable)  
Frame size: Range of 9 to 65,535 bytes (GFP frame)  
Size can be: fixed / incrementing / decrementing / random  
Transmission rate: Specified as bandwidth (Mbps) / number of GFP Idle Frames (fixed / random; range 0 to 65,535 bytes)  
Frame payload: PRBS 23 or 31 / 4-byte sequence

**ERROR INJECTIONS**

GFP: Loss of client signal (LCS) / loss of client character synchronization (LCCS) / short GFP frame / pFCS (single, rates) / idle GFP frame (single, 16-bit x or mask) / core header (single, rates; 16-bit x or mask) / type header (single, rates; 16-bit x or mask) / extension header (single, rates; 16-bit x or mask)  
MAC: CRC (single, rate)

**ERROR MONITORING**



GFP: Loss of frame delineation (LFD) / LCS count / LCCS count / short GFP frames / undefined fields (client signal fail, PTI, EXI) / pFCS errors / single-bit cHEC errors / multi-bit cHEC errors / single-bit tHEC errors / multi-bit tHEC errors / single-bit eHEC errors / multi-bit eHEC errors  
MAC: Frames too long (>jumbo) / jammers / undersized / fragments / CRC errors / in-range length errors (802.3 frames)

**STATISTICS**

GFP: Bandwidth (Mbps, %, frames/s) / frame count / octet count / management frame count / GFP Idle Frame count  
MAC: Frame count / octet count / unicast frames / multicast frames / broadcast frames / single / stacked VLAN tagged frame

**FILTERS**

Pattern filter: Up to 6 bytes with offset from start of GFP frame

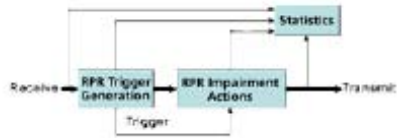
**CAPTURES**

TS	Len	GFP Core Header	GFP Payload Header	Dest A
128.9	1901	05 D9 A5 A1 00 01 10 21	00 01 10 21	aa aa aa aa
122.3	1902	05 DA 95 C2 00 01 10 21	00 01 10 21	aa aa aa aa
117.8	1903	05 DB 85 B3 00 01 10 21	00 01 10 21	aa aa aa aa

Triggers: Manual / GFP LFD / single-bit cHEC error / multi-bit cHEC error / tHEC error / eHEC error / pFCS error / management frame / large GFP frame (with threshold) / MAC CRC error  
Trigger point: Start / middle / end  
Filters: Pattern filter / exclude GFP Idle option  
Display: Trigger point / Time stamp / GFP and MAC layer decode  
Size: 700,000 frames / 32.4 Mbytes / full frame or slicing (first 64 bytes)  
File type: Binary (Snoop) / ASCII

**RPR**

Intrusive monitor mode only on OC-48 / STM-16 (STS-48c / VC-4-16c). RPR frames are encapsulated in GFP. RPR impairments are created based on triggering criteria applied to incoming frames



**TRIGGERING**

An AND relation applies between the frame fields selected as available triggers for one specific frame type.



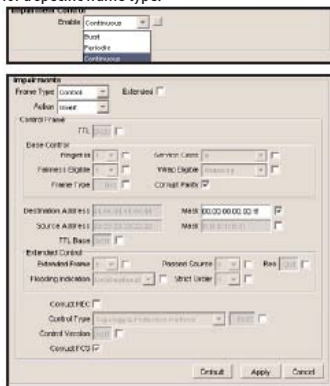
Frame type: 1 choice from: Data (regular, extended) / control / fairness / idle

Trigger condition: Equal / not equal

Frame fields: TTL (all) / ringlet ID (all) / fairness eligible (all) / service class (all) / wrap eligible (all) / parity (all) / destination address (data, control; with mask) / source address (data, control; with mask) / TTL BASE- (data, control) / flooding indication (data, control) / passed source (data, control) / strict order (data, control) / res (data, control, fairness) / HEC (data, control) / protocol type (data) / DA extended (data; with mask) / SA extended (data; with mask) / control type (control) / control version (control) / SA compact (fairness, idle; with mask) / fairness frame type (fairness) / fairness rate (fairness)

**IMPAIRMENTS**

For the frames matching the triggering criteria, an impairment control engine narrows down the number of frames to impair. An AND relation applies between the selected fields to impair for a specific frame type.



Impairment control: Continuous / periodic (on / off periods) / burst

Frame type: 1 choice from: Data (regular, extended) / control / fairness / idle

Impairment action: Overwrite / invert / increment (TTL) / decrement (TTL)

Frame fields: TTL (all) / ringlet ID (all) / fairness eligible (all) / service class (all) / wrap eligible (all) / corrupt parity (all) / destination address (data, control; with mask) / source address (data, control; with mask) / TTL BASE (data, control) / flooding indication (data, control) / passed source (data, control) / strict order (data, control) / res (data, control, fairness) / HEC (data, control) / protocol type (data) / DA extended (data; with mask) / SA extended (data; with mask) / control type (control) / control version (control) / SA compact (fairness, idle; with mask) / fairness frame type (fairness) / fairness rate (fairness) / corrupt FCS (all)

**ERROR MONITORING**

GFP: Loss of frame delineation (LFD) / LCS count / LCCS count / short GFP frames / undefined fields (client signal fail, PTI, EXI) / pFCS errors / single-bit CHEC errors / multi-bit CHEC errors / single-bit tHEC errors / multi-bit tHEC errors / single-bit eHEC errors / multi-bit eHEC errors

RPR: Frames too long (data, control) / undersized (data, control) / HEC error (data, control) / invalid length (fairness, idle) / parity errors / FCS errors

**STATISTICS**

Incoming GFP: Bandwidth (% ,Mbps, frames/s) / frame count / octet count / management frame count

Incoming RPR frames: Total bandwidth (Mbps, frames/s) / total frame count / total octet count / frame count & BW (data, control, fairness, idle) / octet count (data, control, fairness, idle) / per-class data frames & BW (class A A1, A A0, B CIR, B EIR, C) / unicast data frames / multicast & broadcast data frames / broadcast data frames / jumbo data frames

Outgoing RPR frames: Total frame count / total octet count / frame count (data, control, fairness, idle) / per-class data frames (Class A A1, A A0, B CIR, B EIR, C) / Unicast frames / multicast and broadcast data frames / broadcast data frames / jumbo data frames / triggered frame count / impaired frame count

**CAPTURES**

Frames are captured at the GFP level

Triggers: Manual / GFP LFD / single-bit CHEC error / multi-bit CHEC error / tHEC error / eHEC error / pFCS error / management frame / large GFP frame (with threshold) / MAC CRC error

Trigger point: Start / middle / end

Filters: Pattern filter up to 6 bytes with offset from start of GFP frame

Display: Trigger point / time stamp / GFP layer decode

Size: 700,000 frames / 32.4 Mbytes / full frame or slicing (first 64 bytes)

File type: Binary (Snoop) / ASCII

**ATM**

**TRAFFIC SETTINGS**

Two configuration options are available, based on engine lineups: File playback, PRBS, 0.191 or saturation engine, PRBS, 0.191

File playback: Plays cells as defined in a file. Two file types: ASCII / binary (Snoop; expects IP packets, will encapsulate with AALS)

Saturation engine: Provides AALO background traffic. Simulates multiple VCs. User programs a VPI / VCI range / GFC / PT / CLP / fill byte payload

0.191: Single VC with CRC, times tamp, sequence number for latency and sequencing. User programs a VPI / VCI / GFC / PT / CLP

PRBS: PRBS 23 or 31. User programs a VPI / VCI / GFP / PT / CLP

Idle cells: To control link bandwidth

Send mode: Continuous / buffer burst for file playback.

Continuous / burst for 0.191. Continuous for saturation engine, PRBS

Transmission rate: Specified as Mbps / Quants (back-to-back cells for file playback / saturation engine / PRBS) / %

**ERROR INJECTIONS**

HEC: Continuous (single bit / multiple bits)

**ERROR MONITORING**

HEC: Single-bit correctable / single-bit uncorrectable / multi-bit; HEC error. Error correction enable / disable option

**STATISTICS**

VC	VPI	VCI	Lech	PRBS	0.191	Capture
10	10					
100	101					
101	100					
101	101					
100	100					

Port: ATM sync / bandwidth (% ,Mbps, cells / s) / cell count

Per connection: Up to 256 auto-detected connections.

Bandwidth (% ,Mbps, cells / s), cell count / CLP=1 Cells / F5 OAM cells / congestion cells / cell inter-arrival (min, max, avg)

**LATENCY AND SEQUENCING**

Uses 0.191 cells

Sequencing: Cell Loss / misinserted Cell (out-of-order). Can inject errors on transmit.

Times tamping: Latency (min, max, avg over test period) / peak-to-peak CDV (one point)

CRC: Errored cells. Can inject errors on transmit

**CAPTURES**

Triggers: Manual

Filters: All / Per-VC

Display: Hex

Size: 20,000 cells

File type: Binary (Snoop for IP packets) / ASCII

**SERVICE DISRUPTION TIME**

Measurement: us resolution

Statistics: Current / Previous / Minimum / Maximum / Average / Count

Event Logging

Automatic re-triggering

Triggers: Ethernet and Fibre Channel: LOS / PCS Sync / PRBS Sync SONET/SDH: LOS / LOF / PRBS Sync

Disruption Time Measurement	
Configuration	
Trigger	Sonet LOF
Debounce (ms)	300.000
Measurement	
Current (ms)	3.250
Previous (ms)	175.750
Minimum (ms)	3.250
Maximum (ms)	175.750
Average (ms)	100.375
Disruption Count	5

**ORDERING INFORMATION**
**TS-30/170**
**Multi-Rate Module**

N530-0130 Multi-Rate Module

N530-0131 Multi-Rate Module with Digital Wrapper/FEC

**Options**
**SONET/SDH ports**

OPT 0130-01 OC-3/12 STM-1/4

OPT 0130-03 OC-48/STM-16

OPT 0130-40 OC-3/12 STM-1/4 &amp; OC-48/STM-16

OPT 0130-18 ODU1 2.498Gbps Digital Wrapper

OPT 0130-08 ATM for SONET/SDH ports

OPT 0130-09 Ethernet over SONET/SDH for SONET/SDH ports

OPT 0130-30 Ethernet over PDH for SONET/SDH ports

OPT 0130-32 RPR for SONET/SDH ports

**GigE/Ethernet & FC port**

OPT 0130-10 GigE/Ethernet

OPT 0130-11 1/2GFC

OPT 0130-42 OC-3/12/48 STM-1/4/16 &amp; GigE/Ethernet

OPT 0130-43 OC-3/12/48 STM-1/4/16 &amp; GigE/Ethernet &amp; 1/2GFC

OPT 0130-44 OC-3/12/48 STM-1/4/16 &amp; 1/2GFC

**SFP Optical interfaces for SONET/SDH ports**

OPT 0130-26 OC-3/12 STM-1/4 1310 nm SFP optics

OPT 0130-27 OC-3/12 STM-1/4 1550 nm SFP optics

OPT 0130-16 OC-48/STM-16 1310 nm SFP optics

OPT 0130-17 OC-48/STM-16 1550 nm SFP optics

**SFP Optical interfaces for GigE/Ethernet/FC port**

OPT 0130-05 GigE/FC 1310 nm SFP optics

OPT 0130-06 GigE/FC 1550 nm SFP optics

OPT 0130-07 GigE/FC 850 nm SFP optics

OPT 0130-12 10/100/1000BASE-T electrical SFP

OPT 0130-13 100BASE-FX 1310 nm SFP optics

**Accessories**

OPT 022x-10 Wheeled hard travel case accepting TS-10 or TS-30 chassis

**TS-10**
**Multi-Rate configuration**

N550-0222 TS-10 with multi-rate configuration

N550-0223 TS-10 with multi-rate configuration with Digital Wrapper/FEC

**Options**
**SONET/SDH ports**

OPT 0222-01 OC-3/12 STM-1/4

OPT 0222-03 OC-48/STM-16

OPT 0222-40 OC-3/12 STM-1/4 &amp; OC-48/STM-16

OPT 0222-18 ODU1 2.498Gbps Digital Wrapper

OPT 0222-08 ATM for SONET/SDH ports

OPT 0222-09 Ethernet over SONET/SDH for SONET/SDH ports

OPT 0222-30 Ethernet over PDH for SONET/SDH ports

OPT 0222-32 RPR for SONET/SDH ports

**GigE/Ethernet/FC port**

OPT 0222-10 GigE/Ethernet

OPT 0222-11 1/2GFC

OPT 0222-42 OC-3/12/48 STM-1/4/16 &amp; GigE/Ethernet

OPT 0222-43 OC-3/12/48 STM-1/4/16 &amp; GigE/Ethernet &amp; 1/2GFC

OPT 0222-44 OC-3/12/48 STM-1/4/16 &amp; 1/2GFC

**SFP Optical interfaces for SONET/SDH ports**

OPT 0222-26 OC-3/12 STM-1/4 1310 nm SFP optics

OPT 0222-27 OC-3/12 STM-1/4 1550 nm SFP optics

OPT 0222-16 OC-48/STM-16 1310 nm SFP optics

OPT 0222-17 OC-48/STM-16 1550 nm SFP optics

**SFP Optical interfaces for GigE/Ethernet/FC port**

OPT 0222-05 GigE/FC 1310 nm SFP optics

OPT 0222-06 GE/FC 1550 nm SFP optics

OPT 0222-07 GE/FC 850 nm SFP optics

OPT 0222-12 10/100/1000BASE-T electrical SFP

OPT 0222-13 100BASE-FX 1310 nm SFP optics

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