

TestPoint 10Gbps



Highlights

Automatic testing with minimum script development time

- Tests all 10G related rates with one module – 10 GigE LAN and WAN, 8G and 10G Fibre Channel
- Comprehensively supports OTN-related rates – ODU2, OTU2, 11.049G, 11.095G, 11.270G, and 11.317G
- Supports EFEC (ITU-T G.975.1 I.4)
- Maps GFP-F directly into OTU2 and SONET / SDH (STS-192c / VC-4-64c)
- Maps 10GigE LAN with preambles into OTU2 using GFP-F into extended payload (ITU-T G.Sup.43 7.3)
- Runs framed and unframed PRBS at all supported rates
- Captures MAC traffic and line codes (64B / 66B for 10 GigE and 10GFC, 8B / 10B for 8GFC)
- Edits and plays back 64B / 66B 10 GigE PCS codes
- Generates up to 4096 unique traffic streams in ExStreams mode (MAC / stacked VLAN, MPLS, IPv4, IPv6)

Applications

- Facilitates both 10 Gbps line and client testing
- Tests Ethernet and Fibre Channel transport
- Provides 8.5-11.3 Gbps 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 10Gbps Module supports a comprehensive set of line rates and protocols in the 10 Gbps range. Its applications include the testing of 10 Gigabit Ethernet (LAN / WAN) and SONET / SDH. Also offered are licensed options for 8 & 10 Gigabit Fibre Channel (8/10GFC), several Generic Framing Procedure (GFP) flavours, and Cisco high level data link control (HDLC)

A factory installed hardware option provides forward error correction (FEC) and Enhanced FEC (EFEC) support at the following rates: ODU2 (10.037 Gbps), OTU2 (10.709 Gbps), OTU1e (11.049 Gbps), OTU2e (11.095 Gbps), OTU1f (11.270 Gbps), and OTU2f (11.317 Gbps). The test interface uses a 10 Gigabit small form-factor plug-gable (XFP) socket which supports optical and electrical connectivity options.

The 10Gbps module can be inserted into multiple scalable chassis options, including the highly compact TS-10 configuration. Additional highlights of the 10 Gbps module include a strong focus on lower-layer testing and an RFC 2544 test suite for 10 GigE and 8 / 10GFC.

Note: The TestPoint 10Gbps 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.

2

INTERFACE SPECIFICATIONS**Optical XFP**

Optical connector	LC	LC	LC
Wavelength	850 nm	1310 nm	1550 nm
Optical output power (Rx power read)	-4 to -1.1 dBm	-6 to -1 dBm	-1 to +2 dBm
Optical overload (min)	-1 dBm	0.5 dBm	2 dBm
Sensitivity (min)	-11.1 dBm	-11 dBm	-13.5 dBm

Differential Electrical XFP

Connector	Note		
Impedance single-ended	50 Ohm		
Cable length	14 inches		
Type	SMA		
Transmitter			
Minimum single-ended amplitude	150 mV		
Maximum single-ended amplitude	385 mV	Level set to low	
	560 mV	Level set to high	

Receiver

Sensitivity with PRBS23 @BER10 ¹² (single-ended peak-to-peak)	100 mV	Optimized RX equalizer
--	--------	------------------------

Clock Output

Output level	LVPECL, AC coupled
Connector	SMA/50 Ohm

Management Ports

10/100Base-T LAN (Ethernet)	via RJ45
Operator port	via 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
XFP information display

Electrical

Receive equalization setting
Transmit level high/low

LINE RATES**Reports PPM offset on receive interface**

8.500 G (8GFC)
9.953 Gbps (10GigE WAN and OC-192 / STM-64 BERT)
10.037 Gbps (ODU2)
10.3125 Gbps (10 GigE LAN)
10.51875 Gbps (10GFC)
10.709 Gbps (OTU2)
11.049 Gbps (OTU1e, 10 GigE LAN with FEC, no fixed stuff bytes)
11.095 Gbps (OTU2e, 10 GigE LAN with FEC, with fixed stuff bytes)
11.270 Gbps (OTU1f, 10GFC with FEC, no fixed stuff bytes)
11.317 Gbps (OTU2f, 10GFC with FEC, with fixed stuff bytes)

CLOCKING

Internal (± 4.6 ppm accuracy)
Recovered from line
External via group controller (TS-30 / 170)
Clock rate variations
± 30 ppm: 10 GigE WAN, SONET / SDH, OTU2
± 110 ppm: 10 GigE LAN, 8 / 10GFC, 11.X G rates
Clock output

LOGGING

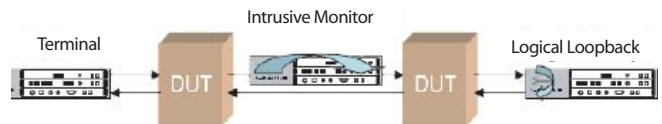
Event log
Log injections

CONNECTIVITY

Transparent monitor: Transparently monitors signal and retransmits unaltered (all supported line rates)

Intrusive monitor: Can inject layer 1 errors and pass traffic unaltered (OTN related rates, SONET / SDH)

Logical loopback: Used to switch MAC and IP addresses to loop traffic back (10 GigE LAN)

**APPLICATIONS****Description of the applications:****10 GigE**

10 GigE LAN: 10 GigE directly on the line
10 GigE WAN: 10 GigE into SONET / SDH

SONET / SDH

OC-192 / STM-64 (channelized down to STS-1 / VC-3)

DIGITAL WRAPPER & FEC

ODU2: OTU2 frame structure without FEC
OTU2: Client can be PRBS, 10 GigE WAN, SONET / SDH BERT or GFP
11.049G FEC: PRBS or 10 GigE LAN client, frame structure without fixed stuff bytes
11.095G FEC: PRBS or 10 GigE LAN client, frame structure with fixed stuff bytes
11.270G FEC: PRBS or 10GFC client, frame structure without fixed stuff bytes
11.317G FEC: PRBS or 10GFC LAN client, frame structure with fixed stuff bytes

FIBRE CHANNEL

8G and 10G
Point-to-point

GFP-F

All GFP-F modes feature a LAN client
GFP-F directly in OPU2
GFP-F in OC-192/STM-64 (STS-192c / VC-4-64c)
GFP-F in OC-192/STM-64 STM-64 wrapped in OTU2
GFP-F into ODU2 extended payload (ITU-T G.Sup43 7.3)

GFP-T

GFP-T with 8GFC client directly in OPU2

cHDLC

Cisco HDLC in OC-192 / STM-64 (STS-192c / VC-4-64c); or in OC-192 / STM-64 wrapped in OTU2

UNFRAMED

PRBS and user pattern on all supported line rates

10 GigE

Description covers 10 GigE LAN and WAN

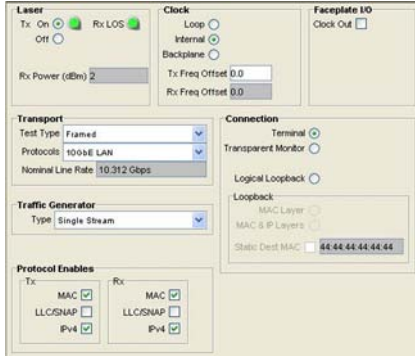
TRAFFIC SETTINGS

Four modes: Single stream, multiple streams (physical ports), multiple streams (logical ports ExStreams), PCS play from buffer
TestPoint allows for full bi-directional traffic testing

3

SINGLE STREAM

Used for BERT testing at PCS, MAC, single / stacked VLAN, and IPv4 layers

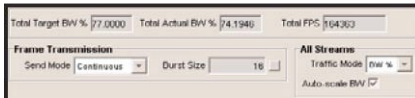


Send mode: Continuous / burst of frames
 Protocol support: MAC / single / stacked VLAN / LLC / SNAP / IPV4
 User can set header values. For destination / source MAC addresses and VLAN IDs, support of single / incrementing value over a range
 Frame size: Range of 19 to 65,535 bytes. Size can be: fixed / 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 8 to 16,777,215 bytes)
 Frame payload: PRBS 15, 23, or 31 / 16-byte sequence / pattern invert

MULTIPLE STREAMS

Used for traffic simulation and multi-protocol support

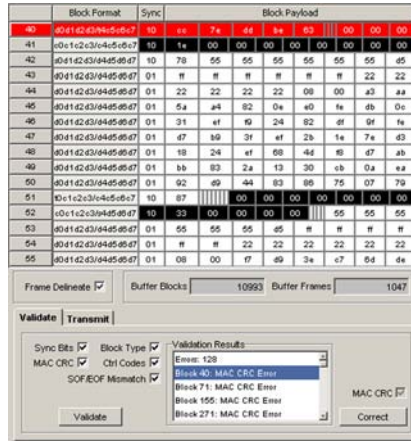
Id	Enable	Frame Length	Frame Count	VLAN VID	Destination Address	Source Address	BW % Target	BW % Actual
1	<input checked="" type="checkbox"/>	911	2	27540-40-40-40-40	20.20.20.20.20.20	11.00000	10.9270	
2	<input checked="" type="checkbox"/>	319	10	27440-40-40-40-40-40	20.20.20.20.20.21	24.00000	22.2890	
3	<input checked="" type="checkbox"/>	512	6	27540-40-40-40-40-42	20.20.20.20.20.22	22.00000	20.9890	
4	<input checked="" type="checkbox"/>	1500	1	64040-40-40-40-40-50	20.20.20.20.20.30	10.00000	9.9934	
5	<input checked="" type="checkbox"/>	1501	1	64040-40-40-40-40-51	20.20.20.20.20.31	10.00000	10.0000	



Maximum number of streams: 128 for physical ports / 4096 for logical ports (ExStreams)
 Number of logical ports (ExStreams): User setting to 1, 2, 4, 8, 16 or 32. Per transmit port, up to 4096/[# of logical ports] streams can be defined. Each receive port can detect up to 4096 streams
 Send mode: Continuous / burst of frames
 Protocol support: MAC / single / stacked VLAN / MPLS / IPv4 / IPv6 / TCP (logical port) / UDP (logical port). User can set header values per stream
 Frame size: Range of 27 to 6,600 bytes. Size can be: Fixed / random within a stream
 Transmission rate: BW % / IFG size in bytes / frames/s
 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

PCS PLAY FROM BUFFER

Used to edit PCS blocks, inject detailed errors, and create custom low-level patterns
 Send mode: Continuous / buffer burst



Protocol support: Raw blocks / PCS / MAC
 PCS editing: Load from PCS capture file (auto-delineates MAC frames) / manual from scratch
 Auto-validation: Sync header bits / PCS block type value / SOF and EOF mismatch / MAC CRC / control codes
 Auto-correction: MAC CRC
 File type: Binary / ASCII

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: 1,000 to 4,294,967,295 ms
 Protocol support: IPv4 with no VLAN / single / stacked VLAN
 Data size: 0 to 9,554 bytes
 Replies: Issued on port IP address match

ERROR INJECTIONS

PCS sublayer: LOS / Remote Fault / Local Fault / error control character / user-defined 64B / 66B block (single, rates) / sync header error (single, HI BER, loss of sync) / 64B / 66B block type error (single, rates)

SINGLE STREAM

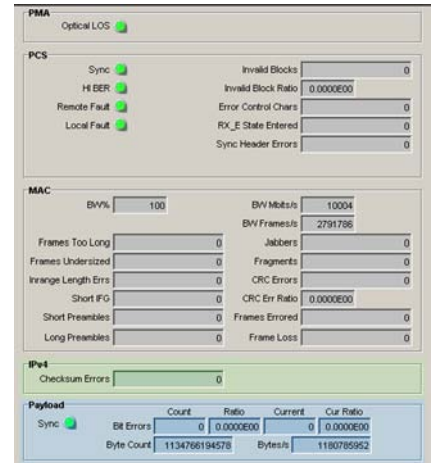
MAC: CRC single, error rate

MULTIPLE STREAMS

Applies to physical ports and logical ports (ExStreams) modes Applied to a specific stream
 MAC: CRC count / sequence number error (lost, out of order, duplicate) count

ERROR MONITORING

PCS sublayer: LOS / PCS synchronization / HI BER / Remote Fault / Local Fault / invalid 64B / 66B blocks / sync header errors / error control characters / Rx_E state



MAC sublayer: Frames too long (>jumbo) / Jabbers / undersized / fragments / CRC errors / in-range length errors (802.3 frames) / short IFGs (adjustable threshold)
 IPv4: Checksum errors

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 length bins) / short preamble count / long preamble count
 MPLS: Frame count
 IPv4: Packet count / ICMP packets
 IPv6: Packet count / ICMP packets
 Per stream statistics: Valid frames / valid bytes / frame rate (fps) / BW in % / BW in Mbps / MAC CRC error count / frames lost (count, ratio) / frames duplicated / frames out of order

Slot	Id	Valid Frames	Valid Bytes	FPS	BW %	Mbps
9.1	2	6950376	1640289500	32074	0.6556	66.866
9.1	3	1390076	123947752	6414	0.4680	46.800
9.1	4	4170231	179199350	19243	0.6928	69.276
9.1	5	1390076	1089821152	6414	0.4126	41.258
9.1	6	4170240	1701467920	19244	0.6590	65.894
9.1	7	1390081	1062291917	6414	0.3699	36.972
9.1	8	2780104	1916227264	12828	0.6918	69.172
9.1	9	1390083	1052660639	6414	0.6943	69.430
9.1	10	2780170	1901636280	12829	0.7226	72.256
9.1	11	2780172	1923620448	12828	0.6199	61.969
9.1	12	2780174	1720927706	12828	0.6556	65.561
9.1	13	1390080	1751510880	6414	0.7493	74.923

In logical ports multiple streams (ExStreams), a linked error summary is provided

4

LATENCY AND SEQUENCING

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

One-way latency measurements available across module in a chassis; requires group controller

FILTERS

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

CAPTURES

Two modes: 64B / 66B PCS, and MAC level

PCS

Triggers: Manual / PCS sync loss / invalid 64B / 66B block / sync header error / Remote Fault / Local Fault / control code match / block type field match / data pattern match (up to 8 bytes)

	Block Format	Sync	Block Payload							
4001	00 01 02 03 04 05 06 07	01	00	00	aa	aa	03	00	00	00
4002	00 01 02 03 04 05 06 07	01	00	00	aa	aa	00	00	e4	01 15
4003	00 01 02 03 04 05 06 07	01	00	00	1e	11	16	6a	0a	0e
4004	00 01 02 03 04 05 06 07	01	04	7d	0a	0c	04	85	db	a7
4005	00 01 02 03 04 05 06 07	01	31	07	02	c2	81	2f	36	52
4006	00 01 02 03 04 05 06 07	01	ef	52	16	74	04	75	74	5b
4007	00 01 02 03 04 05 06 07	01	10	42	52	16	db	5e	75	83

Trigger point: Start / middle / end
 Display: Trigger point / 64B / 66B blocks as in Figure 49-7 IEEE 802.3ae-2005
 Size: 3,355,400 64B / 66B blocks
 File type: Binary / ASCII

MAC

Triggers: Manual / CRC error / undersized frame / frame too long / in-range length error

	TS (µs)	Len	Dest Addr	Src Addr	S-VLAN	C-VLAN
1	1.0	1521	10 FF FF FF FF FF	22 22 22 22 22 22	88 A8 01 E4	B1 00 02 31
2	1.0	1360	10 FF FF FF FF FF	22 22 22 22 22 22	88 A8 01 F4	B1 00 02 01
3	2.1	440	1A FF FF FF FF FF	22 22 22 22 22 22	88 A8 02 04	B1 00 02 11
4	2.4	372	1B FF FF FF FF FF	22 22 22 22 22 22	88 A8 02 14	B1 00 02 11
5	1407067.1	1347	1C FF FF FF FF FF	22 22 22 22 22 22	88 A8 02 24	B1 00 02 21
6	1407068.2	1122	1D FF FF FF FF FF	22 22 22 22 22 22	88 A8 02 34	B1 00 02 31
7	1407069.1	1520	1E FF FF FF FF FF	22 22 22 22 22 22	88 A8 02 44	B1 00 02 31

Trigger point: Start / middle / end
 Filters: MAC filters / pattern filter
 Display: Trigger point / timestamp / MAC layer decode
 Size: 400,000 frames / 32.4 Mbytes / full frame or slicing (first 64 bytes)
 File type: Binary (snoop compatible with Wireshark)

RFC 2544

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 10 GigE settings, errors, and statistics

OPTICAL TEST PATTERNS

Square wave: Programmable between 4 and 11 bits
 Pseudo-random (AnAiBnBi- LF, AnAiBnBi-zero, AnAiAnAi-zero, BnBiBnBi-LF) Transmit and receive with PCS sync header and block error counts
 PRBS31: Transmit and receive with bit error injection and bit error count

SONET / SDH

CHANNELIZATION

OC-192: STS-192c / STS-48c / STS-12c / STS-3c / STS-1
 STM-64: VC-4-64c / VC-4-16c / VC-4-4c / VC-4 / VC-3 (AU-3)

ALARMS

LOS / LOF / OOF / [AIS-L / MS-AIS] / [RDI-L / MS-RDI] / [LOP-P / AU-LOP] / [AIS-P / AU-AIS] / [ERDI-P / HP-ERDI] / [UNEQ-P / HP-UNEQ]

ERRORS

Single / rates for LOF / [AIS-L / MS-AIS] / [RDI-L / MS-RDI] / [REI-L / MS-REI] / [REI-P / HP-REI] / B1 / B2 / B3
 Duration (in ms) for LOF / [AIS-L / MS-AIS] / [RDI-L / MS-RDI]

OVERHEADS

Pointer adjustments: Increment / decrement (single, rates) / NDF count / pointer values / SS bits
 Trace messages: J0 / J1; 1, 16 or 64 bytes
 Decoded bytes: K1 / K2 / S1 / C2
 Byte diagram: User editable overhead fields (includes B1,B2, B3 xor masks) in two alternating overhead banks. Interleaving and injection counts in frames / continuous injection support

5

PERFORMANCE MONITORING

(G.828 / G.829)

Available except for 10 GigE WAN

For section / Regenerator section (near-end) and line / multiplex section (near-end; far-end): ES, ESR, SES, SESR, BBE, BBER, UAS
 For path (near-end; far-end): ES, ESR, SES, SESR, BBE, BBER, SEP, SEPI, UAS, Verdict Threshold configuration

The image shows three screenshots of performance monitoring configuration screens for Section G.829, Line G.829, and Path G.828. Each screen displays various error rate parameters and their thresholds for Near End and Far End.

Section G.829

Parameter	Near End Value	Threshold
ES	0	0.0000E00
ESR	0	0.0000E00
SES	0	0.0000E00
SESR	0	0.0000E00
BBE	0	0.0000E00
BBER	0	0.0000E00
UAS	0	

Line G.829

Parameter	Near End Value	Threshold	Far End Value	Threshold
ES	2	2.9240E-03	0	0.0000E00
ESR	0	0.0000E00	0	0.0000E00
SES	0	0.0000E00	0	0.0000E00
SESR	0	0.0000E00	0	0.0000E00
BBE	2109700	6.2754E-05	0	0.0000E00
BBER	0		0	0.0000E00
UAS	0		0	

Path G.828

Parameter	Near End Value	Threshold	Far End Value	Threshold
ES	0	0.0000E00	6	6.7719E-03
ESR	0	0.0000E00	2	2.9240E-03
SES	0	0.0000E00	383	7.0198E-05
SESR	0	0.0000E00	0	0.0000E00
BBE	0	0.0000E00	0	0.0000E00
BBER	0	0.0000E00	0	0.0000E00
SEP	0	0.0000E00	0	0.0000E00
SEPI	0	0.0000E00	0	0.0000E00
UAS	0		0	
Verdict	PASS		FAIL	

TRAFFIC

10 GigE client (10 GigE WAN) / PRBS 15, 23 or 31 / 4-byte sequence / GFP-F / cHDL

DIGITAL WRAPPER AND FEC

For both GFEC and EFEC I.4

EFEC is as per ITU-T G.975.1 I.4
 Description covers ODU2, OTU2, 11.049G FEC, 11.095G FEC, 11.270G FEC and 11.317G FEC.
 GFEC and EFEC does not apply to ODU2

ALARMS

The image shows two screenshots related to alarms. The top one is a configuration screen for OTU alarms, and the bottom one is a status table for ODU alarms.

OTU Alarms Configuration

Alarm	Enabled	Value
LOS	On	BIP8: 0
AIS	On	BIP8 Ratio: 0.0000E00
LOF	On	BEI: 0
LOM	On	BEI Ratio: 0.0000E00
OOB	On	BEI Ratio: 0.0000E00
OOM	On	BEI Ratio: 0.0000E00
ECH	On	
IAE	On	
BIAE	On	

FEC Errors

Correctable Bytes	0
Correctable Bits	0
BER	0.0000E00
Uncorrectable Subrows	0

ODU Alarm Status

Alarm	AIS	LCK	OCI	BIAE	ECI	BIP8	BIP8 Ratio	BEI	BEI Ratio
TCM 1	On	On	On	On	On	0	0.0000E00	0	0.0000E00
TCM 2	On	On	On	On	On	0	0.0000E00	0	0.0000E00
TCM 3	On	On	On	On	On	0	0.0000E00	0	0.0000E00
TCM 4	On	On	On	On	On	0	0.0000E00	0	0.0000E00
TCM 5	On	On	On	On	On	0	0.0000E00	0	0.0000E00
TCM 6	On	On	On	On	On	0	0.0000E00	0	0.0000E00
PM	On	On	On	On	On	0	0.0000E00	0	0.0000E00

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

OVERHEADS

Multi-frame structure: OTU-TTI / ODU-TTI (PM / TCM1-6) / 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 GCC0-2 / 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

	OTU							
	FAS	MFAS	SM	GCC0	RES	RES	RES	TCM/ACT
-8	00 00 01	00 00	00 00 00	00 00	00 00 00	00		
-7	01 00 2E 01	00 00	00 00	00 00 00	00			
-6	02 00 8C 01	00 00	00 00	00 00 00	00			
-5	03 00 80 01	00 00	00 00	00 00 00	00			
-4	07 00 85 01	00 00	00 00	00 00 00	00			
-3	7A 00 F1 01	00 00	00 00	00 00 00	00			

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 / GCC0-2 / 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)

CLIENTS

OTU2: PRBS 9, 15, 23, or 31 / 4-byte sequence / pattern invert / 10 GigE WAN / (SONET / SDH BERT) / GFP-F / GFP-T

ODU2: PRBS 9, 15, 23, or 31 / 4-byte sequence / pattern invert / (SONET / SDH)

11.049 G / 11.095G: 10 GigE LAN

11.270 G / 11.317 G: 10GFC

GFEC (G.709) and EFEC I.4 (G.975.1)

Settings: GFEC / EFEC / all-zeroes FEC selectable. 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 ratio / number of uncorrectable sub-rows

6

8G FIBRE CHANNEL

8GFC point-to-point mode is described here

TRAFFIC SETTINGS

Frame Transmission
 Send Mode: Continuous Frame Count: 16

FC Parameters
 Class Of Service 3
 Buffer to Buffer Credits: 128 Current: 0
 R_RDY Enable:

FC-2

R_CTL: 0x00
 D_ID: 0x000044
 CS_CTL_P: 0x00
 S_ID: 0x000022
 Type: 0x00
 F_CTL: 0x390000
 SEQ_ID: 0x00
 DF_CTL: 0x00
 SEQ_CNT: 0x0000
 OX_ID: 0x0001
 RX_ID: 0x0000
 Parameter: 0x00000000

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 , frames/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 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 15, 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 failure count

ERROR INJECTIONS

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

ERROR MONITORING

PCS
 Sync:
 Invalid Block Ratio: 0.0000E00
 Running Disparity Errors: 0
 Running Disparity Errors Ratio: 0.0000E00
 Short IFG: 0
 Link Initialization: Active:
 LF1:
 LF2:
 Link Fail Count: 0
 Loss of Sync Count: 0
 Primitive Sequence Protocol Errors: 0

FC-1
 Frames Oversized: 0 BW%: 100.00
 Frames Undersized: 0 BW Mbits/s: 6800.071
 Frames Misaligned: 0 BW Frames/s: 391348

FC-2
 CRC Errors: 0
 CRC Err Ratio: 0.0000E00

Payload
 Sync:
 Bit Errors: 0 Count: 0 Ratio: 0.0000E00 Current: 0 Our Ratio: 0.0000E00
 Byte Count: 63835965600 Bytes/s: 826519648

PCS sublayer: LOS / synchronization / running disparity errors / invalid 8B / 10B Code groups / short IFGs (adjustable threshold)
 FC-1: Frames oversized (>2148 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
 Timestamping: Latency (min, max, avg over test period and 0.5 s window) / packet jitter.
 One-way latency measurements available across all modules in a chassis; requires group controller

CAPTURES

	Raw Data				Code Group Names			
2237	1010000101	0110101110	1010000100	1010100111	015.2	022.7	015.3	02.3
2241	0001011000	0110001101	1001100101	1010000100	022.3	06.0	025.2	015.1
2245	0101011011	1001100001	1001101010	1010000101	026.4	025.7	025.5	011.4
2249	0100011011	1000110100	0110100001	0111000011	029.4	017.0	019.7	030.3
2253	0101000011	1010100001	1010100100	1001110101	031.2	031.7	011.3	00.2
2257	0010101001	0110001101	1001010010	1001010101	04.1	06.0	09.4	09.2

Captures 8B / 10B codes
 Triggers : Manual / 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 code groups
 File type: Binary / ASCII

RFC 2544

Functionality as described under 10 GigE

TEST REPORT

Contains settings, errors, and statistics

OPTICAL TEST PATTERNS

Transmits JSPAT, JTSPAT with receive BER measurement

10G FIBRE CHANNEL

10GFC point-to-point mode is described here

TRAFFIC SETTINGS

Frame Transmission
 Send Mode: Continuous Frame Count: 16

FC Parameters
 Class Of Service 3
 Buffer to Buffer Credits: 128 Current: 0
 R_RDY Enable:

FC-2

R_CTL: 0x00
 D_ID: 0x000044
 CS_CTL_P: 0x00
 S_ID: 0x000022
 Type: 0x00
 F_CTL: 0x390000
 SEQ_ID: 0x00
 DF_CTL: 0x00
 SEQ_CNT: 0x0000
 OX_ID: 0x0001
 RX_ID: 0x0000
 Parameter: 0x00000000

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 , frames/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 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 15, 23 or 31 / 16-byte sequence / pattern invert

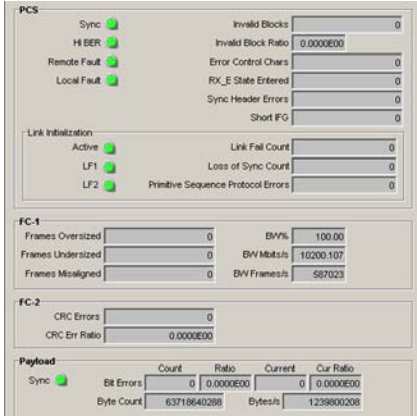
LINK INITIALIZATION

Settings: Enable / Disable. LF1 / LF2 state force
 Reporting: Active state indicator / LF1 / LF2 / primitive sequence protocol error count / loss of sync count / link failure count

ERROR INJECTIONS

PCS sublayer: LOS / Remote Fault / Local Fault / error control character / user-defined 64B / 66B block (single, rates) / sync header error (single, HI BER, loss of sync) / 64B / 66B block type error (single, rates)
 FC-1: Misaligned frames (non-multiple of 4 bytes size)
 FC-2: CRC (single, rates)

ERROR MONITORING



PCS sublayer: LOS / PCS synchronization / HI BER / Remote Fault / Local Fault / invalid 64B / 66B blocks / sync header errors / error control characters / RX_E state / short IFGs (adjustable threshold)
 FC-1 frames oversized (>2148 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
 Timestamping: Latency (min, max, avg over test period and 0.5 s window) / packet jitter. One-way latency measurements available across all modules in a chassis; requires group controller

CAPTURES

Captures 64B / 66B codes
 Triggers: Manual / PCS sync loss / invalid 64B / 66B block / sync header error / Remote Fault / Local Fault / control code pattern match / block type field match / block pattern match (up to 8 bytes)
 Trigger point: Start / middle / end
 Display: Trigger point / 64B / 66B blocks as in figure 49-7 IEEE 802.3-2005
 Size: 3,355,400 64B / 66B blocks
 File type: Binary / ASCII

RFC 2544

Functionality as described under 10 GigE

TEST REPORT

Contains FC settings, errors, and statistics

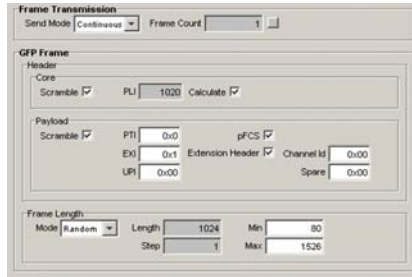
OPTICAL TEST PATTERNS

Square wave: Programmable between 4 and 11 bits
 Pseudo-random: AnAiBnBi- LF, AnAiBnBi-Zero, AnAiAnAi-zero, BnBiBnBi-LF : Transmit and receive with PCS Sync header and block error counts
 PRBS31: Transmit and receive with bit error injection and bit error count

GFP-F

There are three possible mappings for GFP-F: as direct OTU2 client ; in OC-192 / STM-64 (STS-192c / VC-4 64c); or in OC-192 / STM-64 wrapped in OTU2

TRAFFIC SETTINGS

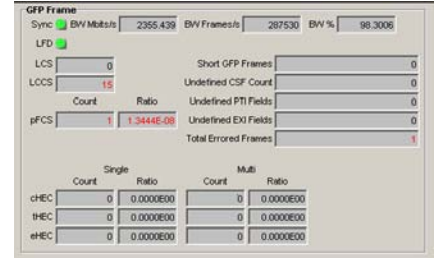


Send mode: Continuous / burst of frames
 Header settings: PLI (auto-calculate on / off) / PTI / EXI / UPI / pFCS (on / off) / linear extension header (on / off) / channel ID / spare
 cHEC error correction on / off on receive
 Protocol support: MAC / single / stacked VLAN. User can set header values
 Scrambler: Core header scrambler (enable / disable); payload header scramble(enable / disable)
 Frame size: Range of 33 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 15, 23, or 31 / 4-byte sequence / pattern invert

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, rates)

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) / Jabbers / 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 frames / frame length Bins (including jumbo) / CRC counts (total and lengths bins)

FILTERS

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

CAPTURES

	TS	Len	GFP Core Header		GFP Payload Header				Des	
			PLI	cHEC	P p E	UPI	tHEC	Ext		eHEC
12	22.5	763	02 ED	4A E1	11	01	20 83	00 00	00 00	FE FF FF
13	20.1	879	03 6B	89 0E	11	01	20 83	00 00	00 00	FE FF FF
14	17.1	868	03 60	39 F5	11	01	20 83	00 00	00 00	FE FF FF
15	13.7	798	03 0E	B4 9D	11	01	20 83	00 00	00 00	FE FF FF

Triggers: Manual / 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: Exclude Idle frame (on / off)
 Display: Trigger point / Timestamp / GFP and MAC layer decode
 Size: 700,000 frames / 32.4 Mbytes / full frame or slicing (first 64 bytes)
 File type: Binary (Snoop) / ASCII

GFP-F with Preambles (G.Sup43 7.3)

Maps 10GigE LAN with preambles into extended ODU2 payload as per ITU-T G.Sup43 7.3

TRAFFIC SETTINGS

Send mode: Continuous / burst of frames
Header settings: PTI / UPI
Protocol support: MAC / single / stacked VLAN. User can set header values
Scrambler: Core header scrambler (enable / disable); payload header scramble(enable / disable)
Frame size: Range of 35 to 10,240 bytes (GFP frame). Size can be: Fixed / incrementing / decrementing / random
Transmission rate: Specified as bandwidth (Mbps, fps)
Frame payload: PRBS 15, 23, or 31 / 16-byte sequence / pattern invert

ERROR INJECTIONS

GFP: Loss of client signal (LCS) / loss of client character synchronization (LCCS) / Core header (single; 16-bit XOR mask) / Type header (single; 16-bit XOR mask)
PCS: Ordered Set continuous (Remote Fault, Local Fault, User)
MAC: CRC (single, rates)
Payload: Bit Errors (single, rates)

The screenshot shows a configuration window for GFP. It is divided into several sections:

- GFP:** Contains checkboxes for LCS and LCCS. Below them are dropdown menus for Core Header (set to Single) and Type Header (set to Single), each with a corresponding cHEC or tHEC value (both set to 0x0001).
- PCS:** Contains a dropdown for Ordered Set (set to Remote Fault), a Value field (set to 0x000002), and a checked checkbox for Auto UPI.
- MAC Error Inject:** Contains a CRC checkbox (checked) and a dropdown menu (set to 1E-2).
- Payload:** Contains a BB Errors checkbox (checked) and a Byte Count field (set to 0).

ERROR MONITORING

GFP: Loss of frame delineation (LFD) / LCS count / LCCS count / undefined fields CSF count / pFCS errors / single-bit cHEC errors / multi-bit cHEC errors
PCS: Remote Fault, Local Fault
MAC: Frames too long (>jumbo) / Jabbers / Undersized / Fragments / CRC errors / In-range length errors (802.3 frames)

STATISTICS

PCS: Bandwidth (Mbps, %, frames/s)
GFP: Data frame count / GFP Idle frame count
MAC: Frame count / octet count / unicast frames / multicast frames / broadcast frames / single / stacked VLAN tagged frames / frame length bins (including jumbo) / CRC counts (total and lengths bins)
Payload: Byte count

FILTERS

MAC: 8 MAC / VLAN filters with accept / discard operation

CAPTURES

Two modes: 64B / 66B PCS, and MAC level PCS
Triggers: Manual / Remote Fault / Local Fault / control code match / block type field match / data pattern match (up to 8 bytes)
Trigger point: Start / middle / end
Display: Trigger point / 64B / 66B blocks as in Figure 49-7 IEEE 802.3ae-2005
Size: 3,355,400 64B / 66B blocks
File type: Binary / ASCII

MAC

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 / timestamp / MAC layer decode
Size: 400,000 frames / 32.4 Mbytes / full frame or slicing (first 64 bytes)
File type: Binary (snoop compatible with Wireshark)

GFP-T with 8GFC Client

Mapped into OPU2

Full OTU2 wrapper as described under Digital Wrapper and FEC
Full 8GFC client as described under 8GFC

TRAFFIC SETTINGS

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 scramble(enable / disable)
Superblocks per Frame: Range of 1 to 512
Transmission rate: Specified as bandwidth (Mbps) / number of GFP Fixed Idle frames; range 0 to 65,535 bytes
Client Rate Adaptation: adjust client rate in \pm ppm

ERROR INJECTIONS

GFP: Loss of client signal (LCS) / loss of client character synchronization (LCCS) / short GFP frame / pFCS / PLI (single, 15-bit x or mask) / 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; 16-bit x or mask)
Superblock: CRC (single, rates, burst; 16-bit x or mask) / Flag Bit Error (single, rates; 8-bit x or mask)

ERROR MONITORING

GFP: Loss of frame delineation (LFD) / LCS count / LCCS count / short GFP frames / undefined fields (client signal Fail, PTI, EXI) / pFCS errors / total errored frames / single-bit cHEC errors / multi-bit cHEC errors / single-bit tHEC errors / multi-Bit tHEC errors / single-bit eHEC errors / multi-Bit eHEC errors
Superblock: CRC correctable, uncorrectable / 10B_ERR

STATISTICS

GFP: Bandwidth (Mbps, %, frames/s) / frame count / octet count / management frame count / GFP Idle frame count
Superblock: superblocks per frame / total superblocks / 65B_PAD / 65B_PAD/s
Pattern Filter: pattern matched frames

FILTERS

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

CAPTURES

Triggers: Manual / LFD / single-bit cHEC error / multi-bit cHEC error / tHEC error / eHEC error / pFCS error / management frame / large GFP frame (with threshold) / Superblock CRC correctable, uncorrectable / Ctrl Code Match / Data Pattern Match (8 bytes)

Trigger point: Start / middle / end

Filters: Exclude Idle frame (on / off)

Display: Trigger point / Timestamp / GFP and MAC layer decode

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

File type: Binary (Snoop) / ASCII

cHDLC

cHDLC is Cisco-HDLC. Two possible mappings: in OC-192 / STM-64 (STS-192c / VC-4-64c); or in OC-192 / STM-64 wrapped in OTU2

TRAFFIC SETTINGS

Two modes: Single stream / multiple streams

SINGLE STREAM

Used for BERT testing

Send mode: Continuous / burst of frames

Protocol support: IPv4 (can also support MAC / single / stacked VLAN directly in HDLC). User can set header values including address / control / protocol

Frame size: Range of 9 to 65,535 bytes. Size can be: fixed / incrementing

FCS Size: CRC-32

Transmission rate: Specified as number of flags (fixed) between 1 and 65,535

Frame payload: PRBS 15, 23 or 31 / 16-byte sequence / pattern invert

MULTIPLE STREAMS

Used for traffic simulation and multi-protocol support

Stream Signature <input checked="" type="checkbox"/>							
ID	Enable	Frame Length	Frame Count	MPLS Label	Source IP	Destination IP	Payload (Fill)
1	<input checked="" type="checkbox"/>	142	9		10.12.4.125	10.12.4.133	0x00
2	<input checked="" type="checkbox"/>	750	1		12.15.8.130	11.14.7.127	0x00
3	<input checked="" type="checkbox"/>	86	16		14.18.12.135	12.16.10.141	0x00
4	<input checked="" type="checkbox"/>	340	4		16.21.16.140	13.19.13.145	0x00

Maximum number of streams: 128

Send mode: Continuous / burst of frames

Protocol support: MPLS / IPv4 / TCP / UDP.

User can set header values per stream (HDLC address / control / protocol values are global)
Frame size: range of 37 to 9,600 bytes. Size is fixed within a stream

FCS Size: CRC-32

Transmission Rate: BW% / number of flags in bytes / frames/s

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

CONTROL PLANE

SLARP: Filters out SLARP packets from data stream

ERROR INJECTIONS

Abort (single) / FCS (single)

ERROR MONITORING

FCS errors / frames too short (threshold) / address mismatches / control mismatches / abort errors / invalid control sequences / IPv4 checksum errors (single stream)

STATISTICS

Bandwidth (% , Mbps , frames / s) / frame count / octet count / SLARP packet count / IPv4 packet count (single stream)

Service Disruption Time

Measurement: μ s resolution

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

Automatic re-triggering

Triggers:

10GE LAN and Fibre Channel: LOS / PRBS Sync / PCS Sync

SONET/SDH: LOS / LOF / PRBS Sync / AIS-L / MS-AIS / AIS-P/AU-AIS / OOF / RDI-L/MS-RDI / RID-P/AU-RDI / B1 / B2 / B3

Disruption Time Measurement

Configuration

Trigger

Debounce (ms)

Measurement

Current (ms)

Previous (ms)

Minimum (ms)

Maximum (ms)

Average (ms)

Disruption Count

ORDERING INFORMATION

TS-30/170
Module

N530-0163	10 Gbps module –XFP Version
N530-0163-PA1	Electrical Production Package 9.9G-10.5G
N530-0163-PA2	Electrical Production Package 8.5G-11.3G

Hardware option

OPT 0160-03	OTN DW & GFEC for 10Gbps module
OPT 0163-04	OTN DW & GFEC / EFEC I.4 for 10Gbps module

Interfaces

OPT 0164-11	1310 nm XFP optics for 10Gbps module
OPT 0164-12	1550 nm XFP optics for 10Gbps module
OPT 0164-13	850 nm XFP optics for 10Gbps module
OPT 0164-45	Differential electrical XFP for 10Gbps module

Software options

OPT 0160-05	10G GFP for 10Gbps module
OPT 0160-06	11.27G FEC extended rate for 10Gbps module
OPT 0160-07	cHDLC for 10Gbps module
OPT 0160-08	11.317G FEC extended rate for 10Gbps module
OPT 0160-09	10G WAN for 10Gbps module
OPT 0160-10	ExStreams Ethernet Multi-Streaming for 10Gbps module (4096 streams)
OPT 0160-15	10G FC for 10bps module
OPT 0160-30	ODU2 10.037G digital wrapper for 10Gbps module
OPT 0160-34	OC-192 / STM-64 channelization for 10Gbps module (Includes full concatenation)
OPT 0163-41	8GFC for 10Gbps module
OPT 0160-44	GFP-F with preambles in extended OPU2 for TS-10 10Gbps
OPT 0163-43	GFP-T for 8GFC client for 10Gbps module

Packages

OPT 0160-14	10G LAN / WAN and OC-192c / STM-64c for 10Gbps module
OPT 0160-16	10G LAN and OC-192c / STM-64 for 10 Gbps module
OPT 0160-17	10G LAN / WAN and OC-192c / STM-64c & 10GFC for 10Gbps module
OPT 160-31	11.2709G/11.317G FEC extended rate for 10 bps module
OPT 0163-42	8G / 10GFC for 10Gbps module

Accessories

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

TS-10 10Gbps configuration

N550-0228	TS-10 10 Gbps XFP Version
N550-0228-PB1	Electrical Production Package 9.9G-10.5G
N530-0228-PB2	Electrical Production Package 8.5G-11.3G

Hardware option

OPT 0221-03	OTN DW & GFEC for TS-10 10Gbps
OPT 0228-04	OTN DW & GFEC / EFEC I.4 for TS-10 10Gbps

Interfaces

OPT 0225-11	1310 nm XFP optics for TS-10 10Gbps
OPT 0225-12	1550 nm XFP optics for TS-10 10Gbps
OPT 0225-13	850 nm XFP optics for TS-10 10Gbps
OPT 0225-45	Differential electrical XFP for TS-10 10Gbps

Software options

OPT 0221-05	10G GFP for TS-10 10Gbps
OPT 0221-06	11.27G FEC extended rate for TS-10 10Gbps
OPT 0221-07	cHDLC for TS-10 10Gbps
OPT 0221-08	11.317G FEC extended rate for TS-10 10Gbps
OPT 0221-09	10G WAN for TS-10 10Gbps
OPT 0221-10	ExStreams Ethernet Multi-Streaming for TS-10 10Gbps (4096 streams)
OPT 0221-15	10G FC for TS-10 10Gbps
OPT 0221-30	ODU2 10.037G digital wrapper for TS-10 10Gbps
OPT 0221-34	OC-192 / STM-64 channelization for TS-10 10Gbps (Includes full concatenation)
OPT 0228-41	8GFC for TS-10 10Gbps
OPT 0221-44	GFP-F with preambles in extended OPU2 for TS-10 10bps
OPT 0228-43	GFP-T for 8GFC client for TS-10 10Gbps

Packages

OPT 0221-14	10G LAN / WAN & OC-192c / STM-64c for TS-10 10Gbps
OPT 0221-16	10G LAN and OC-192c / STM-64 for TS-10 10Gbps
OPT 0221-17	10G LAN / WAN & OC-192c / STM-64c & 10GFC for TS-10 10Gbps
OPT 0221-31	11.270G/11.317G FEC extended rate for TS-10 10Gbps
OPT 0228-42	8G / 10GFC for TS-10 10Gbps

Test & Measurement Regional Sales

NORTH AMERICA TEL: 1 866 228 3762 FAX: +1 301 353 9216	LATIN AMERICA TEL: +1 954 688-5660 FAX: +1 954 3454668	ASIA PACIFIC TEL: +852 2892 0990 FAX: +852 2892 0770	EMEA TEL: +49 7121 86 2222 FAX: +49 7121 86 1222	WEBSITE: www.jdsu.com/test
---	---	---	---	--