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FREECALL 1800 680 680

TestPoint Multi-Rate

Key Features

- **Support of OC-3/12/48 STM-1/4/16, OTN, and Ethernet/Fibre Channel in one module**
- **OTN rates: OTU1 (2.666G) and ODU1 (2.498G)**
- **GFP-F and ATM into SONET/SDH**
- **Unique support of Ethernet over PDH (ITU-T G.7043)**
- **Availability of multiple Ethernet interfaces: 1000BASE-X, 10/100/1000BASE-T, 100BASE-FX**
- **RPR intrusive monitor mode on OC-48/STM-16**
- **1G and 2G Fibre Channel**

2007 FROST & SULLIVAN
Global Communications Test & Measurement Company of the Year Award

Applications

- SONET/SDH on OC-3/12/48 STM-1/4/16 with GFP-F and ATM support
- OTN testing at OTU1 (2.666G), and ODU1 (2.498G)
- Optical Gigabit Ethernet, 10/100/1000BASE-T, and 100BASE-FX
- Fibre Channel 1G/2G

Compliance

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

The TestPoint Multi-Rate is a single slot, customizable module with three physical ports, which are:

- OC-48/STM-16 (option OTU1)

- OC-3/12 STM-1/4

- Ethernet/Fibre Channel

One physical port can be active at a time for testing and at least 1 SONET/SDH port must be licensed. Traffic generation of up to 128 streams is available on Gigabit Ethernet.

A hardware option provides Digital Wrapper and Forward Error Correction (FEC) G.709 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 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 (2.499G).

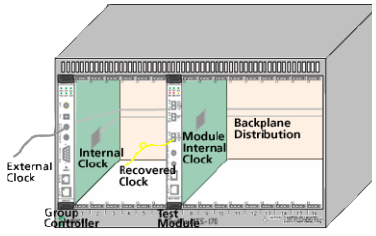
NOTE: The Multi-Rate is available in either modules (TS-30/TS-170) or in configurations (TS-10). The term module is used in this document.

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	RJ-45; supports full-duplex 10-BASE-T, 100-BASE-TX, 1000-BASE-T		
Clock Out	LVPECL signal, AC coupled on SMA connector		
LAN (Ethernet) Port	RJ-45 (10/100BASE-T)		
Operator Port	RJ-12 into RS-232 serial cable		

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 (1G FC)
1.25 Gbps (GigE)
2.125 Gbps (2G FC)
2.488 Gbps (OC-48/STM-16)
2.498 Gbps (ODU1)
2.666 Gbps (OTU1)

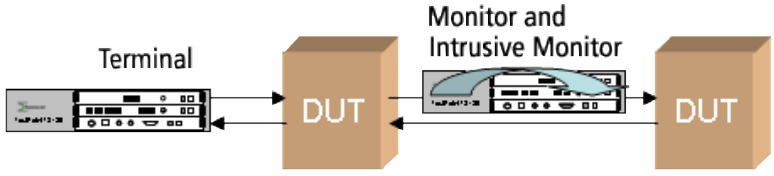


CLOCKING

Internal (+/- 4.6 ppm accuracy)
Recovered
External via Group Controller (TS-170)
Clock rate variations
+/-30 ppm: SONET/SDH, OTU1
+/-110 ppm: Ethernet, Fibre Channel
Clock out (LVPECL, AC coupled on SMA)

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

Descriptions of the following applications follow:

SONET/SDH:
OC-3/12/48 and STM-1/4/16

Digital Wrapper and FEC:
OTU1: ITU-T G.709; OC-48/STM-16 client
ODU1: OTU1 frame structure without FEC

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

Fibre Channel
1G and 2G FC 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 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

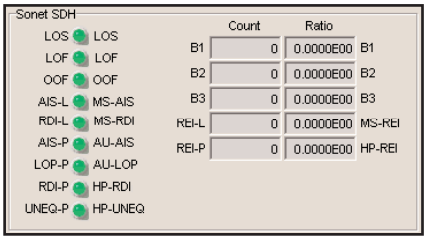
SONET/SDH

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.



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
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 REI-L/MS-REI / REI-P/HP-REI / B1 / B2 / B3
VC-3 (TUG-3): Single / Rates for LP-REI / LP-BIP

OVERHEADS

Pointer adjustments: Increment/Decrement (single, rates) / NDF count / Pointer Value / 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 /C ontinuous Injection support

TRAFFIC

PRBS 23 or 31 / 4-Byte Sequence

DISRUPTION TIME

Measurement: µsec Resolution

Triggers: LOS / LOF / PRBS Sync

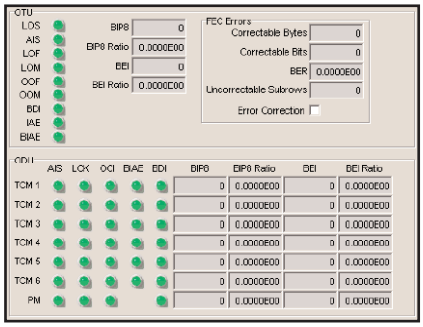
TRIGGER SIGNAL

OC-48/STM-16: Output pulse either on Received/Transmitted A2 byte

DIGITAL WRAPPER AND FEC

Covers OTU1, ODU1. Forward Error Correction does not apply to ODU1.

ALARMS

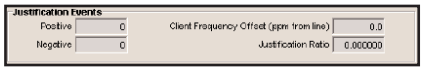


LOS / OOF / LOF / OOM / LOM / OTU-AIS (PN-11) / OTU-IAE / OTU-BDI / OTU-BIAE / ODU-AIS (PM/TCM1-6) / ODU-LCK (PM/TCM1-6) / ODU-OCI (PM/TCM1-6) / ODU-BDI (PM/TCM 1-6) / ODU-BIAE (TCM1-6)

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 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

FAS	MFAS	SM	GCC0	RES	RES	TCM/ACT	TCM6
F6 F6 F6 28 28 28	99	00 32 01	00 00	00 00	00 00 00	00	00 32 01
F6 F6 F6 28 28 28	9A	00 B5 01	00 00	00 00	00 00 00	00	00 B5 01
F6 F6 F6 28 28 28	9B	00 C5 01	FF FF	00 00	00 00 00	00	00 C5 01
F6 F6 F6 28 28 28	9C	00 43 01	00 00	00 00	00 00 00	00	00 43 01
F6 F6 F6 28 28 28	9D	00 4B 01	00 00	00 00	00 00 00	00	00 4B 01

Triggers: Manual / OOF / LOF / OOM / LOM / OTU-IAE / OTUBDI / 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)

CLIENT

OC-48/STM-16 signal

FEC

Settings: Standard FEC/All-Zeroes 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

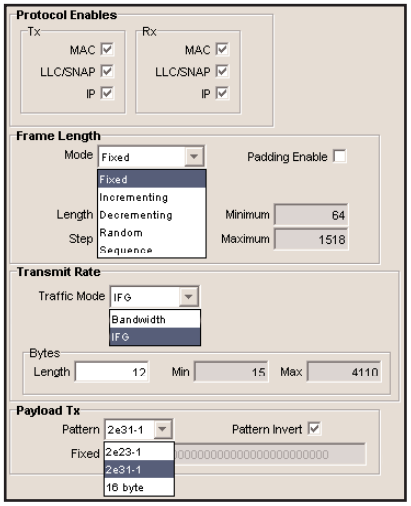
Covers optical GigE, 10/100/1000BASE-T, and 100BASE-FX depending on the SFP used.

TRAFFIC SETTINGS

2 modes: Single Stream, Multiple Streams

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

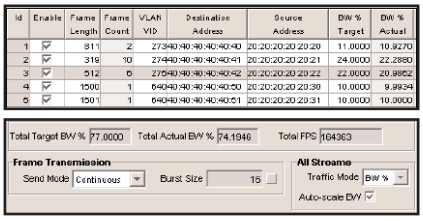
Frame Size: Range of 19 to 65535 bytes (19 to 9600 bytes for 10/100/1000BASE-T). Size can be: Fixed / Incrementing / Decrementing / Random / User Sequence (up to 8)

Transmission Rate: Specified as Bandwidth (%, Mbps) 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

Multiple Streams

Used for traffic simulation and multi-protocol support.



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 9600 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%.

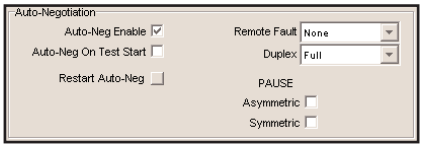
Frame Payload: Fill Byte / Random / Custom (user defined byte-by-byte)

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

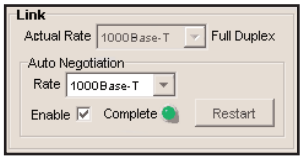


Settings: Enable / Disable. Remote Fault (offline, link failure, auto-neg error) / Pause Encoding / Operation Mode

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

CONTROL PLANE

Pause Frames: Single / Continuous with Interval. Pause Timer. Receiver throttles.

ARP: ARP request sent for each unique destination IP address; retry period and count support. ARP Reply sent on port MAC address match.

PING

Send Mode: Continuous / Packet Count

Transmission Period: 1000 to 4,294,967,295 msec

Protocol Support: IPv4 with no VLAN / Single/Stacked VLAN

Data size: 0 to 9572 bytes

Replies: Issued on port IP address match

ERROR INJECTIONS

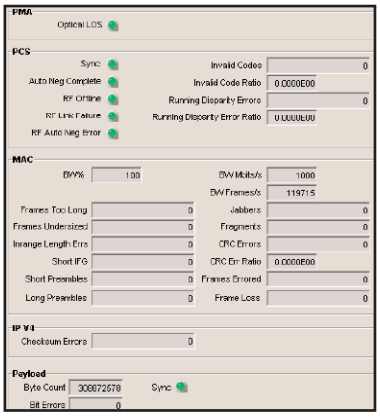
PCS/PMA Sublayer:

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 Codegroups

100BASE-FX: LOS / Sync / Far End Fault / Invalid Codes

MAC Sublayer: Frames Too Long (> jumbo) / Jabbers / Undersized / Fragments / CRC Errors / Inrange 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

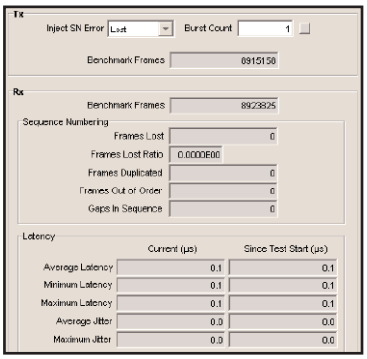
IPv4: Packet Count / ICMP Packets

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.

Timestamping: Latency (min, max, avg over test period and 0.5 sec 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

There are 2 modes: 8B/10B (optical GigE only), and MAC level

PCS

	Raw Data				Code Group Names			
21	1101101000	1010100101	1010100101	1010100101	K27.7	D21.2	D21.2	D21.2
25	1010100101	1010100101	1010100101	1010100110	D21.2	D21.2	D21.2	D21.6
29	1101010101	0010100101	1101010101	0010100101	D4.2	D4.2	D4.2	D4.2

21	1101101000	1010100101	1010100101	1010100101	FB	55	55	55
25	1010100101	1010100101	1010100101	1010100110	55	55	55	55
29	1101010101	0010100101	1101010101	0010100101	44	44	44	44

Triggers: Manual / PCS Sync Loss / Invalid 8B/10B Codegroup / Running Disparity Error / Codegroup Pattern Match (up to 6 bytes)

Trigger Point: Start / Middle / End

Display: Trigger Point / 8B/10B codegroup and decode (D/K codes and hex)

Size: 8,250,000 8B/10B Codegroups

File Type: Binary / ASCII

MAC

	TS (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	81 00 01 11	00 6A	AA A6
23	0.6	128	44 44 44 44 44 44	22 22 22 22 22 22	81 00 01 11	00 6A	AA A6
24	3.0	63	44 44 44 44 44 44	22 22 22 22 22 22	81 00 01 11	00 29	AA A6
25	1.2	128	44 44 44 44 44 44	22 22 22 22 22 22	81 00 01 11	00 6A	AA A6

Triggers: Manual / CRC error / Undersized Frame / Frame Too Long / In-range Length Error

Trigger Point: Start / Middle / End

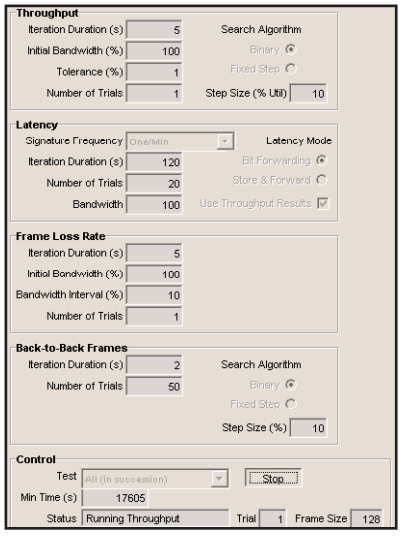
Filters: MAC Filters / Pattern Filter

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 Ethereal)

RFC 2544



Standard product feature in GUI/CLI. 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.

DISRUPTION TIME

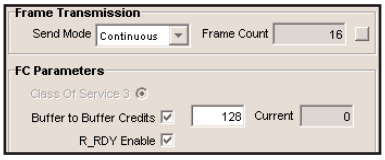
Measurement: µsec Resolution

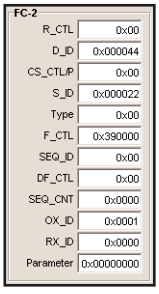
Triggers: LOS (optical GigE only) / PRBS Sync

FIBRE CHANNEL

This covers 1G 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 4104 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) / Number of Inter Frame Gap (IFG) bytes (fixed / random / sequence up to 8; range 8 to 65535 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 4095. Sending of R_RDY may be Enabled / Disabled.

Frame Payload: PRBS 23 or 31 / 16-byte Sequence

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

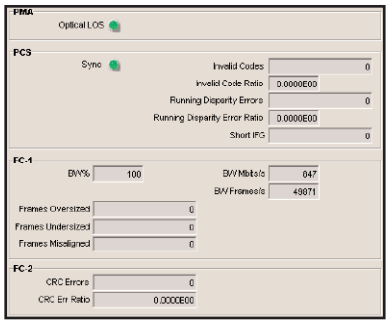
PCS Sublayer: LOS / Running Disparity Error (single, rates) / 8B/10B Coding Error (single, rates) / Random Bit Corruption

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 Codegroups / 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 sec window) / Packet Jitter

CAPTURES

At the PCS level

Triggers: Manual / PCS Sync Loss / Invalid 8B/10B Codegroup / Running Disparity Error / Codegroup Pattern Match (up to 6 bytes)

Trigger Point: Start / Middle / End

Display: Trigger Point / 8B/10B codegroup and decode (D/K codes and hex)

Size: 8,250,000 8B/10B Codegroups

File Type: Binary / ASCII

TEST REPORT

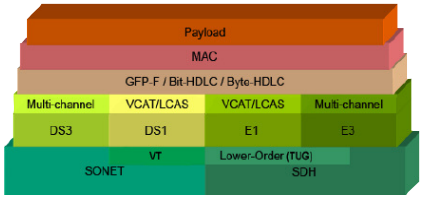
Contains FC settings, errors, and statistics.

TEST PATTERNS

CJTPAT / CRPAT / CSPAT

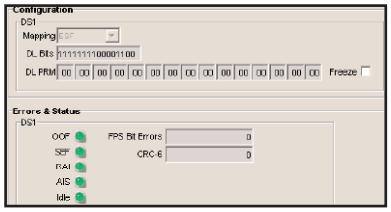
ETHERNET OVER PDH

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

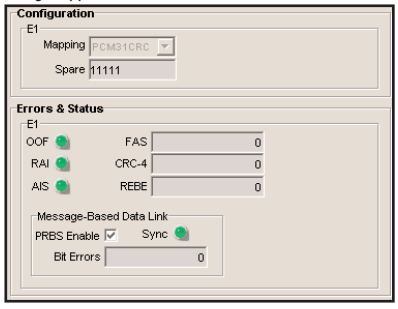
ESF Errors: OOF / SEF / AIS / RAI / Idle / FPS bits (burst with mask, 10^{-3} rate, error reporting) / CRC-6 (single, 10-3 rate, error reporting)

SF Errors: FT OOF / FT & FS OOF / SEF / AIS / RAI / Idle / FT & FS bits (burst with mask, 10^{-3} 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^{-3} rate, error reporting) / Non-FAS Bit 2 (burst, continuous) / CRC-4 (burst, rates, error reporting) / REBE (single with mask, 10^{-3} rate, error reporting)

PCM31 Errors: OOF / AIS / RAI / FAS bits (burst with mask, 10^{-3} 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^{-3} rate, error reporting) / M-bits (single with value, 10^{-3} rate, error reporting) / C-bit Parity Errors (single with mask, 10^{-3} rate, error reporting) / P-bit Parity Errors (single, 10^{-3} rate, error reporting) / FEBE (single, 10^{-3} 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 (VLI 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

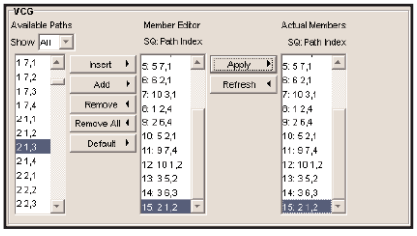
G.832 Errors: OOF / RDI / AIS / FAS (single with value, 10^{-3} rate, error reporting) / REI (single, 10^{-3} rate, error reporting) / BIP-8 (single, 10^{-3} rate, error reporting)

G.751 Errors: OOF / AIS / RAI / FAS (single with value, 10^{-3} rate, error reporting)

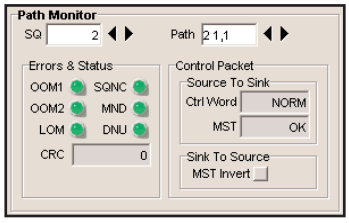
Payload: PRBS 15 or 23 / 4-byte Sequence into GFP-F, or bit-HDLC (RFC 1662) with MAC encapsulation.

PDH VCAT/LCAS

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



Error Injections: OOM1 / OOM2 / LOM (MFI1, MFI2) / 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 Deskewable) / DNU (LCAS) / CRC error count (LCAS)

Error Suppression: To optionally suppress non-member or non-candidate errors/alarms

LCAS Status: Control Word value / MST value

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.

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.

Scrambler: Core Header Scrambler (enable/disable); Payload Header Scrambler (enable/disable)

Frame Size: Range of 9 to 65535 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 xor mask) / Core Header (single, rates on DS1/E1 only; 16-bit xor mask) / Type Header (single, rates on DS1/E1 only; 16-bit xor mask) / Extension Header (DS1/E1 only; single, rates)

ERROR MONITORING

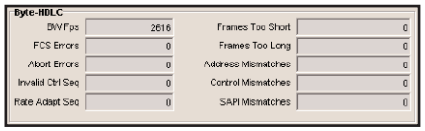
Loss of Frame Delineation (LFD) / LCS Count / LCCS Count / Short GFP Frames / Undefined fields (DS1/E1 only: Client Signal Fail, PTI, EXI) / pFCS Errors / Single-Bit cHEC Errors / Multi-Bit cHEC Errors / Single-Bit tHEC Errors / Multi-Bit tHEC Errors / Single-Bit eHEC Errors (DS1/E1 only) / Multi-Bit eHEC Errors (DS1/E1 only)

STATISTICS

Bandwidth (Mbps, %, frames/s) / Frame Count / Octet Count / Management Frame Count

HDLC

Bit-HDLC comes in two flavors, which are 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.



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 65535 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, twelve independent traffic engines are available on twelve 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 / jabbers / undersized / fragments / inrange 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 MFI1 / MFI2) / SQM / Multi-Frame (16-frame) control packet editor

Error Monitoring: LOM (per-member) / SQM (per-member) / LOA (adjustable threshold)

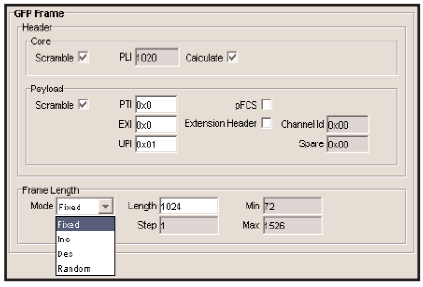
Error Suppression: To optionally suppress non-member errors/alarms

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-3/14/48 STM-1/4/16) and VCAT (OC-48/STM-16).



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 Scrambler (enable/disable)

Frame Size: Range of 9 to 65535 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 65535 bytes)

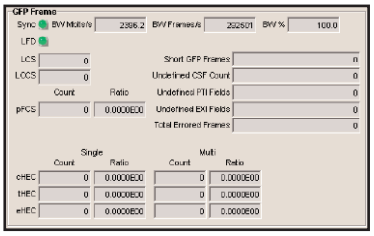
Frame Payload: PRBS 23 or 31 / 4-byte Sequence

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 xor mask) / Core Header (single, rates; 16-bit xor mask) / Type Header (single, rates; 16-bit xor mask) / Extension Header (single, rates; 16-bit xor 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) / Jabbers / Undersized / Fragments / CRC Errors / Inrange Length Errors (802.3 frames)

STATISTICS

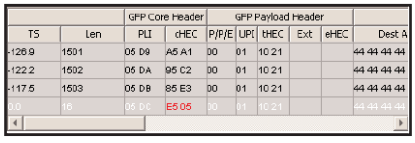
GFP: Bandwidth (Mbps, %, frames/s) / Frame Count / Octet Count / Management Frame Count / GFP Idle Frame Count

MAC: Frame Count / Octet Count / Unicast Frames / Multicast Frames / Broadcast Frames / Single/Stacked VLAN Tagged Frames

FILTERS

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

CAPTURES



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

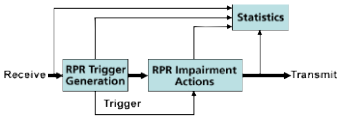
Display: Trigger point / Timestamp / GFP and MAC Layer Decode

Size: 700,000 frames / 32.4 Mbytes / Full Frame or Slicing (first 64 bytes)

File Type: Binary (Snoop) / ASCII

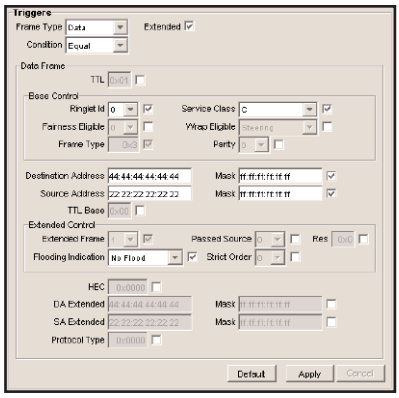
RPR

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.



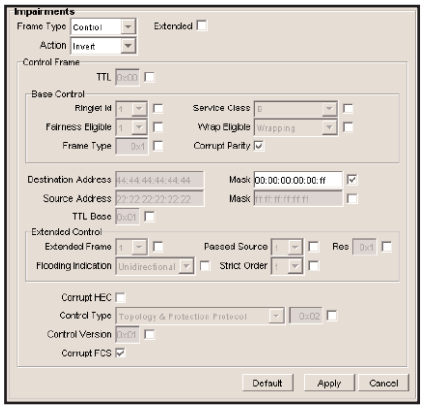
Frame Type: 1 choice from: Data (regular, extended) / Control / Fairness / Idle

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 Data Frames / Multicast & 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 / Timestamp / 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

2 configuration options based on engine line-ups, which are: 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 AAL5)

Saturation Engine: Provides AAL0 background traffic. Simulates multiple VCs. User programs a VPI/VCI Range / GFC / PT / CLP / Fill Byte Payload.

0.191: Single VC with CRC, timestamp, 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 / Quantums (back-to-back cells for file playback / saturation engine / PRBS) / %

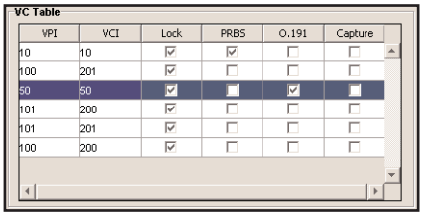
ERROR INJECTIONS

HEC: Continuous (single bit / multiple bits)

ERROR MONITORING

HEC: Single-Bit Correctable / Single-Bit Uncorrectable / Multiple-Bit; HEC Error. Error Correction Enable / Disable option.

STATISTICS



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.

Timestamping: 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

ORDERING INFORMATION

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 & OC-48/STM-16
OPT 0130-14	OTU1 G.709 Digital Wrapper / FEC (upgrade option on N530-0130)
OPT 0130-18	FEC ODU1 Extended Rate (requires OTU1)
OPT 0130-08	ATM
OPT 0130-09	Ethernet Over SONET/SDH
OPT 0130-30	Ethernet Over PDH
OPT 0130-32	RPR

GigE/Ethernet & Fibre Channel Port

OPT 0130-10	GigE/Ethernet
OPT 0130-11	1G/2G Fibre Channel
OPT 0130-41	GigE/Ethernet & 1G/2G Fibre Channel
OPT 0130-42	OC-3/12/48 STM-1/4/16 & GigE/Ethernet
OPT 0130-43	OC-3/12/48 STM-1/4/16 & GigE/Ethernet & 1G/2G Fibre Channel
OPT 0130-44	OC-3/12/48 STM-1/4/16 &1G/2G Fibre Channel

SFP Optical Interfaces for SONET/SDH Ports

OPT 0130-16	OC-3/12 STM-1/4 1310nm SFP Optics
OPT 0130-17	OC-3/12 STM-1/41550nm SFP Optics
OPT 0130-91	No SFP Optics Requested for OC-3/12 STM-1/4 port
OPT 0130-26	OC-48/STM-16 1310nm SFP Optics
OPT 0130-27	OC-48/STM-16 1550nm SFP Optics
OPT 0130-93	No SFP Optics Requested for OC-48/STM-16 port

SFP Optical Interfaces for GigE/Ethernet/Fibre Channel Port

OPT 0130-05	GigE / FC 1310nm SFP Optics
OPT 0130-06	GigE / FC 1550nm SFP Optics
OPT 0130-07	GigE / FC 850nm SFP Optics
OPT 0130-12	10/100/1000BASE-T Electrical SFP
OPT 0130-13	100BASE-FX 1310nm SFP Optics
OPT 0130-92	No SFP Optics Requested for GE/Ethernet/Fibre Channel port

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 & OC-48/STM-16
OPT 0222-14	OTU1 G.709 Digital Wrapper / FEC (upgrade option on N550-0222)
OPT 0222-18	FEC ODU1 Extended Rate (requires OTU1)
OPT 0222-08	ATM
OPT 0222-09	Ethernet Over SONET/SDH
OPT 0222-30	Ethernet Over PDH
OPT 0222-32	RPR

GigE/Ethernet & Fibre Channel Port

OPT 0222-10	GigE/Ethernet
OPT 0222-11	1G/2G Fibre Channel
OPT 0222-41	GigE/Ethernet & 1G/2G Fibre Channel
OPT 0222-42	OC-3/12/48 STM-1/4/16 & GigE/Ethernet
OPT 0222-43	OC-3/12/48 STM-1/4/16 & GigE/Ethernet & 1G/2G Fibre Channel
OPT 0222-44	OC-3/12/48 STM-1/4/16 & 1G/2G Fibre Channel

SFP Optical Interfaces for SONET/SDH Ports

OPT 0222-16	OC-3/12 STM-1/4 1310nm SFP Optics
OPT 0222-17	OC-3/12 STM-1/4 1550nm SFP Optics
OPT 0222-91	No SFP Optics Requested for OC-3/12 STM-1/4 port
OPT 0222-26	OC-48/STM-16 1310nm SFP Optics
OPT 0222-27	OC-48/STM-16 1550nm SFP Optics
OPT 0222-93	No SFP Optics Requested for OC-48/STM-16 port

SFP Optical Interfaces for GigE/Ethernet/Fibre Channel Port

OPT 0222-05	GigE/FC 1310nm SFP Optics
OPT 0222-06	GE/FC 1550nm SFP Optics
OPT 0222-07	GE/FC 850nm SFP Optics
OPT 0222-12	10/100/100BASE-T Electrical SFP
OPT 0222-13	100BASE-FX 1310nm SFP Optics
OPT 0222-92	No SFP Optics Requested for GigE/Ethernet/Fibre Channel port

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