NETWORK PERFORMANCE TESTER
MP1590B

CE

Supports Next Generation Network Measurement from OTN to 10 GbE

NEW

The MP1590B Network Performance Tester is a measuring instrument capable of measuring IP networks using the Ethernet plug-in modules of the Anritsu IP tester MD1230A, as well as traditional functions including testing of PDH, DSn, SDH/SONET, and OTN equipment and jitter measurement, with only one box. A new EoS unit supports EoS measurement, virtual concatenation, and LCAS measurement to enable testing of next-generation SDH/SONET equipment. The traditional MP1590A plug-in units can also be used without changes.
The MP1590B can perform some simultaneous applications - such as SDH/SONET, OTN, EoS, jitter and Ethernet measurement - using combination of plug-in units.

• Encapsulation test
The EoS unit MU150101A supports the GFP-F, LEX, LAPS (X.86), PPP, CiscoHDLC, and MAPOS encapsulation methods. With more than 120 types of real-time counter functions and a 256 MB frame capture analysis function, it is possible to verify detailed information of EoS frames like GFP-F frames.
Since both this unit and Ethernet modules can work at the same time, the EoS Layer and Ethernet Layer can be measured simultaneously to evaluate the EoS encapsulation function with one box.

• Virtual concatenation
In addition to traditional concatenation mapping, the MP1590B supports virtual concatenation and arbitrary concatenation.

Virtual concatenation member size

SONET	STS3cSPE-Xv (X = 1 to 16) STS1SPE-Xv (X = 1 to 48): High order VT2SPE-Xv (X = 1 to 63) VT1.5-Xv (X = 1 to 64)
SDH	VC-4-Xv (X = 1 to 16) VC-3-Xv (X = 1 to 48): High order VC-12-Xv (X = 1 to 63) VC-11-Xv (X = 1 to 64)

∗: Don't support the member setting over AU/STS3.

• LCAS measurement
The EoS unit also supports LCAS measurement.
The LCAS monitoring function can monitor all members and all MSTs (Member Statuses) in a VCAT group simultaneously.
The LCAS capture function can capture up to 64 LCAS sequences for easy analysis of the LCAS protocol. The LCAS generation function can generate up to 64 LCAS sequences to test the LCAS function using several sequence patterns.

• Ethernet/IP measurement
Since the 10M/100M, Gigabit, and 10 Gigabit Ethernet modules for the Anritsu IP tester MD1230A can be used without changes, the MP1590B can be used as a full-scale IP tester with these Ethernet modules.
Also, because the MP1590B unit and Ethernet modules can be used simultaneously, comprehensive measurements for several layers including SDH/SONET, OTN, Ethernet, IP, and TCP/UDP can be performed.

• Supports PDH/DSn/SDH/SONET/OTN (1.5 Mbit/s to 10.7 Gbit/s) interfaces with only one unit
The MP1590B supports the following electrical interfaces and optical interfaces.

Electrical interfaces:
PDH (2.048, 8.448, 34.368, 139.264 Mbit/s), DSn (1.544, 44.736 Mbit/s), STM-0/1/64, STS-1/3/192
Optical interfaces:
STM-0/1/4/16/64, STS-1/3/12/48/192 OTU-1, OTU-2

Because a plug-in system is employed, units can be used in various combinations as needed.

• ITU-T G.709 OTN measurement
The MP1590B supports setting/monitoring of all overheads for OTU-1 (2.66 Gbit/s) and OTU-2 (10.71 Gbit/s) conforming to ITU-T G.709. It also supports multi-frame OH. Functions of OTN equipment can be tested by using error/alarm generation/ detection functions. In particular, the random error insertion function on the MP1590B enables evaluation of the FEC function on OTN equipment. The built-in optical output power adjustable function allows one MP1590B to test the error correction ratio of OTN equipment based on its input power specification.

• SDH/SONET functions
Switchover between SDH and SONET can be controlled on the screen. Transmission/reception with a Tandem Connection pattern (ITU-T Rec. G.707) is possible, and functions for setting and monitoring the section overhead (SOH/TOH) and path overhead (POH) have been implemented. Moreover, various error/alarm generation functions enable stress testing of SDH/SONET equipment.

• Jitter generation/measurement
Installing a jitter unit enables SDH/SONET (52 to 9953 Mbit/s), OTU-1 (2.66 Gbit/s), OTU-2 (10.71 Gbit/s) generation/measurement. Jitter tolerance and jitter transfer characteristic measurements conforming to ITU-T Rec. G.783, G.825, G.8251 and Telcordia GR-253 can be performed. The measured results are displayed in numeric values and graphs, allowing user evaluation and simplifying pass/fail judgment. It also supports 10.3 GHz clock jitter generation/measurement.

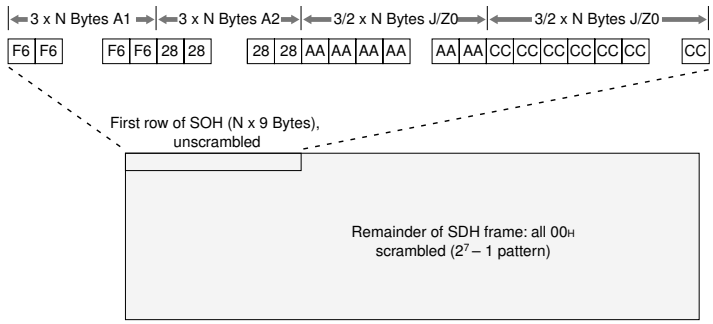
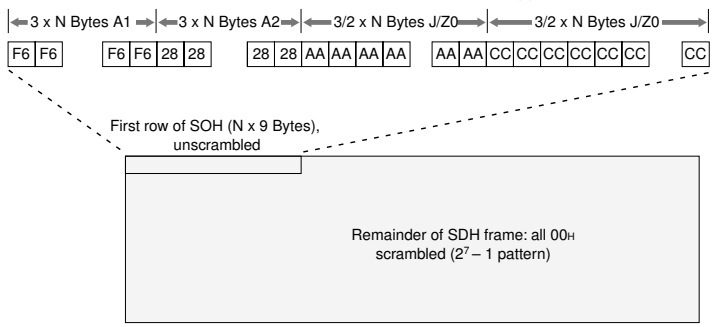
Specifications

• MP1590B (main frame)

Mode	SDH/SONET/OTN/PDH/DSn mode	EoS/Ethernet mode
Reference Clock input	Frequency Clock: 1.544 MHz*1, 2.048 MHz, 64 kHz + 8 kHz, 5 MHz*1, 10 MHz*1 Data: 1.544 Mbit/s (BITS), 2.048 Mbit/s Input range: ±50 ppm Level/Code 1.544 Mbit/s: ANSI T1.403 (B8ZS) 2.048 Mbit/s: ITU-T G.703 Table10 (HDB3) 1.544 MHz*1, 2.048 MHz, 5 MHz*1, 10 MHz*1: TTL (Rectangle, Sine Wave) 64 kHz + 8 kHz: 0.63 to 1.1 Vo-p (AMI, 8 kHz violation) Connector 1.544 MHz*1, 2.048 MHz, 2.048 Mbit/s, 5 MHz*1, 10 MHz*1: BNC 75 Ω 2.048 MHz, 2.048 Mbit/s, 64 kHz + 8 kHz: SIEMENS 120 Ω 1.544 Mbit/s: BANTAM 100 Ω Effective SDH/SONET/OTN bit rate.	
Reference Clock output	Frequency Clock: 1.544 MHz, 2.048 MHz, 5 MHz, 10 MHz Data: 1.544 Mbit/s (BITS), 2.048 Mbit/s Level/Code 1.544 Mbit/s: ANSI T1.403 (B8ZS) 2.048 Mbit/s: ITU-T G.703 Table10 (HDB3) 1.544 MHz, 2.048 MHz, 5 MHz, 10 MHz: TTL (Rectangle) Connector 1.544 MHz, 2.048 MHz, 2.048 Mbit/s, 5 MHz, 10 MHz: BNC 75 Ω 1.544 Mbit/s: BANTAM 100 Ω Effective SDH/SONET/OTN bit rate.	—
Trigger	Trigger input: For capture/APS measurement Trigger output: Transmit Error/Alarm, Receive Error/Alarm, Capture trigger Level: TTL (active High) Connector: BNC 75 Ω	Trigger input: For capture Trigger output: Capture trigger Level: TTL (active High) Connector: BNC 75 Ω
DCC/GCC	Data input/output: D1-D3 (192 kbit/s), D4-D12 (576 kbit/s), GCC0-2 (13124 kbit/s, 326.7 kbit/s) Clock output: 192 kHz , 576 kHz, 13124 kHz, 326.7 kHz Level: V.11 Connector: D-sub 9 pin	—
Remote interface	RS-232C (installed MP1590B-01), GPIB (installed MP1590B-02), LAN (10BASE-T/100BASE-TX, installed MP1590B-03)	
Peripheral connection	VGA output (SVGA), USB (2 port, Rev. 1.1), keyboard (PS/2)	
External memory	Compact flash (2 to 512 MB, recommended by CFA)	
Pointing device	By standard pointing device for a main frame, cursor movement in a screen is possible.	
Display size	8.4 inch, color TFT (800 x 600)	
LED	OTN: Frame, OTU, ODU, OPU SDH/SONET: Frame, MS/Line, AU/Path, TU/VT Standby, HDD, Clock Loss, Power Fail, History, Signal Loss, Errors, Test Pattern, Jitter, PDH/DSn, Event, All Errors, All Alarms	
EMC	EN61326: 1997/A2: 2001 (Class A), EN61000-3-2: 2000 (Class A), EN61326: 1997/A2: 2001 (Annex A)	
LVD	EN61010-1: 2001 (Pollution degree 2)	
Power	85 to 132/170 to 250 Vac (100/200 V system automatic change), 47.5 to 63 Hz	
Power consumption	≤500 VA	
Operational temperature	+5˚ to +40˚C	
Dimensions and mass	320 (W) x 177 (H) x 350 (D) mm, ≤13 kg (excluding plug-in units)	

*1: Only support on SDH/SONET/OTN/PDH/DSn mode.

• MP1590B Option 30 (High Precision Jitter Analysis)

Bit rate	2488.32 Mbit/s, 9953.28 Mbit/s
The Jitter generation measurement accuracy	±20 mUIp-p (toward the amount of transmitter Jitter (≤100 mUIp-p) made a standard by the Phase Analysis Calibration Method) Measurement condition Measurement period: 60 sec/1 time Measurement method: The Phase Analysis Calibration Method (O.172 May. 2004 Appendix VIII) Average value: Five measurements Filters: 10G, 20 kHz to 80 MHz, 50 kHz to 80 MHz 2.5G, 5 kHz to 20 MHz, 12 kHz to 20 MHz Optical unit for Tx: MU150121A or Transmitter specified by Anritsu Frame format: Based on ITU-T O.172 draft recommendation appendix VIII / A.1  Optical input power: –10 to –12 dBm
Repeatability of Jitter generation measurement	±5 mUIp-p (Average value at five measurements under constant measurement condition) Measurement condition Measurement period: 60 sec/1 time Measurement method: Loop Back Filters: 10G, 20 kHz to 80 MHz, 50 kHz to 80 MHz, 4 to 80 MHz 2.5G, 5 kHz to 20 MHz, 12 kHz to 20 MHz Optical unit for Tx: 10G, MU150121A, MU150134A 2.5G, MU150100A Mapping: STS192c/VC4-64c-Bulk, STS48c/VC4-16c-Bulk Payload pattern: $2^{23} – 1$ (Inv.) Optical input power: –10 to –12 dBm
Intrinsic Jitter (at Loop back mode)	<50 mUIp-p Measurement condition Measurement period: 60 sec/1 time Measurement method: Loop Back Filters: 10G, 20 kHz to 80 MHz, 50 kHz to 80 MHz Optical unit for Tx: 10G, MU150134A Mapping: STS192c/VC4-64c-Bulk Payload pattern: $2^{23} – 1$ (Inv.) Optical input power: –10 to –12 dBm
Output Jitter of Transmitter	MU150121A, <60 mUIp-p MU150134A, <50 mUIp-p Measurement condition Measurement method: The Phase Analysis Calibration Method (O.172 May.2004 Appendix VIII) Filters: 10G, 20 kHz to 80 MHz, 50 kHz to 80 MHz 2.5G, 5 kHz to 20 MHz, 12 kHz to 20 MHz Frame format: Based on ITU-T O.172 draft recommendation appendix VIII / A.1  Sampling oscilloscope: >20 GHz bandwidth
General specification	Operating temperature: +20˚ to +30˚C Recommending calibration period: One year after the shipping or after the calibration

Notes for MP1590B Option 30:

This option is only appropriate for instruments configured as follows:

MP1590B:	Network Performance Tester
MU150100A:	10/10.7G Unit
MU150121A/134A:	10/10.7G Optical Unit (Tx)
MU150123A:	10/10.7G Optical Unit (Rx Wide)
MU150125A:	10/10.7G Jitter Unit

This option doesn't support the MU150101A.
This option cannot be installed in other combinations.

This option does not guarantee the amount of Jitter contained in transmitting data.
A certificate about the amount of Jitter normally contained in transmitting data is attached.

This option guarantees the performance for instruments configured when option 30 is installed.
When units from other instruments are exchanged after installing option 30 (including the situation where a module is exchanged for another of the same type with a different serial number), the performance of option 30 is not guaranteed.
Other MP1590B functions can still be operated normally, however.

The guarantee period of MP1590B-30 performance is one year after the shipping or after the calibration.
Therefore MP1590B-90 (Extended three years warranty service) is not applied to the specifications or calibration cycle of the MP1590B-30.

• MU150100A 10G/10.7G Unit, MU150101A 2.5/2.6G EoS Unit

Model	MU150100A	MU150101A*1
Electrical interface (1.544 to 155.52 Mbit/s)	Bit rate PDH/DSn: 1.544 Mbit/s, 2.048 Mbit/s, 8.448 Mbit/s, 34.368 Mbit/s, 44.736 Mbit/s, 139.264 Mbit/s SDH/SONET: 51.84 Mbit/s, 155.52 Mbit/s Code 1.544 Mbit/s: AMI/B8ZS 2.048 Mbit/s, 8.448 Mbit/s, 34.368 Mbit/s: HDB3 44.736 Mbit/s, 51.84 Mbit/s: B3ZS 139.264 Mbit/s, 155.52 Mbit/s: CMI Connector 1.5M: BANTAM 100 Ω Balanced 2M: 3 pin Siemens 120 Ω Balanced 2/8/34/139/45/52/156M: BNC 75 Ω Level ANSI T1.102 (1.5/45M) ITU-T G.703 (2/8/34/139/156M) DSX output (1.5M): 0/655 feet DSX output (45M, 52M): 0/450/900 feet Monitor gain 20 dB, 26 dB: 1.5M/2M/8M/34M/45M/52M 20 dB: 139M/156M	
Electrical interface (9953.28 M, 10709.225 Mbit/s)	Bit rate SDH/SONET: 9953.28 Mbit/s OTN: 10709.225 Mbit/s (Installed Option 05) Code: NRZ Connector: SMA 50 Ω Level Clock Output: 1.3 to 0.6 Vp-p Data Output: 0 to –0.2 V (High), –0.85 to –1.5 V (Low) Data Input: 1.5 to 0.3 Vp-p	—
Optical interface	Bit rate SDH/SONET: 51.84 Mbit/s, 155.52 Mbit/s, 622.08 Mbit/s, 2488.32 Mbit/s OTN: 2666.057 Mbit/s (Installed Option 05) Code: NRZ Connector: FC-PC (SMF), replaceable	
Optical output	Level: –1 to +3 dBm (ATT = 0 dB, Option 04) Extinction ratio: ≥10 dB SMSR: ≥30 dB Peak wavelength: 1550 nm ±20 nm (Option 02,03), 1310 nm ±20 nm (Option 01,03) –20 dB width: ≤1 nm Safety classification: IEC 60825-1: CLASS 1M, 21CFR 1040.10: CLASS III b	
Optical input	Optical input level: –8 to –33 dBm (52/156M), –8 to –29 dBm (622M/2.5G/2.6G) Wavelength: 1260 to 1610 nm Overload: +3 dBm (Average)	
Clock	Internal, External (Reference input, 1/1 input), Receive Internal Accuracy: ±0.1 ppm [After power on, calibrate after 24 hours, warm-up 23 ±5°C, aging rate (Max.): ±0.05 ppm/day, ±0.5 ppm/year] Offset range: ±100 ppm/0.1 ppm step	

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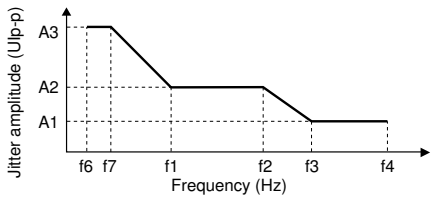
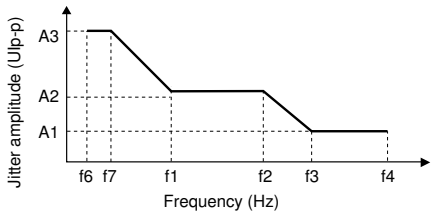
Model	MU150100A	MU150101A*1
Frame	1.544 Mbit/s: D4/ESF/Japan ESF 2.048 Mbit/s: 30, 31ch with or without CRC4 8.448 Mbit/s: G.742 34.368 Mbit/s: G.751 44.736 Mbit/s: M13/C-bit 139.264 Mbit/s: G.751 51.84 Mbit/s: SDH/SONET 155.52 Mbit/s: SDH/SONET 622.08 Mbit/s: SDH/SONET 2488.32 Mbit/s: SDH/SONET 9953.28 Mbit/s: SDH/SONET*2	
No frame	1.544, 2.048, 8.448, 34.368, 44.736, 139.264 Mbit/s 51.84, 155.52, 622.08, 2488.32, 9953.28*2 Mbit/s	
Test pattern	PRBS, Word, all0, all1, 3 in 24 (only 1.5M) PRBS (SDH/SONET) No Frame: $2^{15}-1$ (only 52/156M), $2^{23}-1$, $2^{31}-1$ Concatenation mapping: $2^{15}-1$ (1c/4c), $2^{23}-1$, $2^{31}-1$ Another mapping: $2^{11}-1$, $2^{15}-1$, $2^{20}-1$, $2^{20}-1z$ (only 1.5M/45M), $2^{23}-1$ Invert ON/OFF PRBS (PDH/DSn) $2^{11}-1$, $2^{15}-1$, $2^{20}-1$, $2^{20}-1z$ (only 1.5M/45M), $2^{23}-1$ Invert ON/OFF Word: 16-bit programmable (mark ratio 1/2 at no frame) Transmit/Receive: An independent setup is possible	
OH preset	SOH/TOH/POH: All bytes (except parity byte, K1/K2 byte, H1, H2 and H3) Dummy channel POH: All bytes (except parity byte)	
Error addition/ measurement	PDH/DSn: Bit all (only addition), Code, Bit info, Bit 1.5M, Bit 2M, Bit 8M, Bit 34M, Bit 45M, Bit 139M, FAS 1.5M, FAS 2M, FAS 8M, FAS 34M, FAS 45M, FAS 139M, EXZ, CRC6, Ebit, Parity, Cbit, REI SDH: FAS, Frame (only measurement), B1, B2, HP-B3, LP-B3, BIP-2, MS-REI (M0/M1), HP-REI, LP-REI, Bit all (only addition), Bit info, OH bit, HP-IEC, LP-IEC, N2 BIP-2, HP-TC-REI, LP-TC-REI, HP-OEI, LP-OEI SONET: FAS, Frame (only measurement), B1, B2, HP-B3, LP-B3, BIP-2, REI-L (M0/M1), REI-P, REI-V, Bit all (only addition), Bit info, OH bit, HP-IEC, LP-IEC, N2 BIP-2, HP-TC-REI, LP-TC-REI, HP-OEI, LP-OEI	
Error addition timing	Rate, Alternative, Single, Burst, All, Frame Rate Fix rate: $1*10^{-n}$ (n: 3 to 9), User program: $A*10^{-B}$ (A: 1.0 to 9.9 step 0.1, B: 2 to 10) Alternative Error frame: 0 to 64000, Normal frame: 1 to 64000 Frame (only PDH/DSn) : n in 16 frame (n: 1 to 4) B1, B2, B3, BIP-2 can be set Error bit.	
Alarm addition/ measurement	PDH/DSn: LOS, LOF, AIS, RDI, RDI (MF) SDH: LOS, LOF, OOF (only measurement), RS-TIM, MS-AIS, MS-RDI, AU-AIS, AU-LOP, HP-RDI, HP-ERDIP, HP-ERDIS, HP-ERDIC, HP-TIM, HP-UNEQ, HP-SLM, TU-AIS, TU-LOP, TU-LOM, LP-RDI, LP-ERDIP, LP-ERDIS, LP-ERDIC, ISF, LP-RFI, LP-TIM, LP-UNEQ, LP-SLM, Sync. loss, OH Sync., HP-VC-AIS, LP-VC-AIS, HP-FAS, LP-FAS, HP-Incoming AIS, LP-Incoming AIS, HP-TC-RDI, LP-TC-RDI, HP-ODI, LP-ODI, HP-TC-TIM, LP-TC-TIM, HP-LTC, LP-LTC SONET: LOS, LOF, OOF (only measurement), RS-TIM, AIS-L, RDI-L, AIS-P, LOP-P, RDI-P, ERDIP-P, ERDIS-P, ERDIC-P, TIM-P, UNEQ-P, PLM-P, AIS-V, LOP-V, LOM-V, RDI-V, ERDIP-V, ERDIS-V, ERDIC-V, ISF, RFI-V, TIM-V, UNEQ-V, PLM-V, Sync. loss, OH Sync., HP-VC-AIS, LP-VC-AIS, HP-FAS, LP-FAS, HP-Incoming AIS, LP-Incoming AIS, HP-TC-RDI, LP-TC-RDI, HP-ODI, LP-ODI, HP-TC-TIM, LP-TC-TIM, HP-LTC, LP-LTC	
Alarm addition timing	Single, Burst, Alternative, All Alternative Error frame = 0 to 64000, Normal frame = 1 to 64000	
Monitor	PDH/DSn: FAS 1.5M, FW 2M, NFW 2M, MFW 2M, FAS 8M, FAS 34M, FAS 45M, FAS 139M, Info byte (only 2M) SDH/SONET: SOH/TOH/POH, Path Trace, Tandem byte, K1/K2 byte, AU/STS, TU/VT pointer	
Through	Transparent, Overhead overwrite (only SDH/SONET/OTN)	
MUX/DEMUX	MUX/DEMUX is possible to 64 k units in PDH and DSn	
Add/Drop	PDH/DSn signal can be added to or dropped from the SDH/SONET mapping. Bit rate: 1.5 Mbit/s, 2 Mbit/s, 34 Mbit/s, 45 Mbit/s, 139 Mbit/s STM-0/1/4/16 or OC-1/3/12/48 signal can be added to or dropped from STM-64 or OC-192 signal (required MU150100A-09)*2	
Delay measurement	Measurement period: 0.5, 1, 2, 5, 10 s Measurement range: 0.1 to 999 µs, 1.0 to 999.9 ms, 1.0 to 10.0 s, >Time out	
Dummy channel	Mode: Copy/Dummy Dummy pattern: all 0, all 1, $2^{11}-1$, $2^{15}-1$ (Invert)	
Path Trace	J0, J1, J2 byte can be set arbitrarily. 16 byte (CRC On), 32 byte (CRC Off)	
Tandem connection	N1/Z5, N2 byte can be set arbitrarily. It can set ON/OFF	
Pointer generation	AU/STS, TU/VT pointer Action: NDF, ±PJ (Pointer Justification) PJC Timing: Manual, Burst (2 to 64)	
Pointer measurement	AU/STS, TU/VT pointer, C bit Measurement item: NDF, + PJC, –PJC, Cons, C, C1/C2	
Payload offset	Offset range: ±100 ppm/0.1 ppm step can set at the Async. mapping.	

Continued on next page

<table>
<tr><th>Model</th><th>MU150100A</th><th>MU150101A*1</th></tr>
<tr><td>APS test</td><td colspan="2">Switching time measurement
Measurement time: 0.1 to 2000.0 ms, Timeout (not include time for pointer/frame synchronization)
APS Sequence Generator
Generator timing: 2 to 64 word, Max. 8000 frame/word
It can be set for each K1/K2, K3, K4.</td></tr>
<tr><td>Overhead sequence capture</td><td colspan="2">Capture byte: K1/K2, K3, K4, AU/STS-Pointer, TU/VT-Pointer
Size: 64 sequence
Repeat: Max. 8000 frame/sequence</td></tr>
<tr><td>Overhead test</td><td colspan="2">SOH/TOH/POH 1byte, A1/A2, K1/K2, RSOH, MSOH, SOH, POH (except parity byte, K1/K2 byte, H1, H2 and H3)
Timing: Alternative (A: 1 to 8000 times, B: 1 to 8000 times), A and B can be set up to 256 frames.</td></tr>
<tr><td>OH BERT test</td><td colspan="2">Test byte: SOH/TOH/POH 1 byte, D1-D3, D4-D12 (except parity byte, K1/K2 byte, H1, H2 and H3)
Pattern: $2^{11}-1$, $2^{15}-1$ (Invert)
Error addition: Bit (only Single)
Measurement: Bit error, Sync loss</td></tr>
<tr><td>OH Add/Drop</td><td colspan="2">Test byte: D1-D3, D4-D12</td></tr>
<tr><td>Performance</td><td colspan="2">G.821, G.826, G.828, G.829, M.2100, M.2101, M.2110, M.2120, GR.820</td></tr>
<tr><td>Optical power meter</td><td colspan="2">Wavelength: 1310 nm/1550 nm, Measurement range: –7 to –40 dBm
Measurement accuracy: ±1 dB (–10 to –30 dBm), ±2 dB (–7 to –9.9 dBm, –30.1 to –40 dBm)</td></tr>
<tr><td>Frequency counter</td><td colspan="2">Measurement frequency (f0):
1.544, 2.048, 8.448, 34.368, 44.736, 139.264 MHz
51.84, 155.52, 622.08, 2488.320, 2666.057 MHz
9953.28*2, 10709.225*2 MHz
Measurement range: f0 ±100 ppm
Accuracy: ±0.1 ppm</td></tr>
<tr><td>Jitter tolerance
(52M to 2.5G/2.6G)</td><td colspan="2"> 

<table>
<tr><th>Bit rate (Mbit/s)</th><th>A1 (UIp-p)</th><th>A2 (UIp-p)</th><th>A3 (UIp-p)</th><th>f6 (Hz)</th><th>f7 (Hz)</th><th>f1 (Hz)</th><th>f2 (Hz)</th><th>f3 (Hz)</th><th>f4 (Hz)</th></tr>
<tr><td>51.84</td><td>20</td><td>2</td><td>0.2</td><td>10</td><td>30</td><td>300</td><td>2k</td><td>20k</td><td>400k</td></tr>
<tr><td>155.52</td><td>50</td><td>2</td><td>0.2</td><td>10</td><td>19.3</td><td>500</td><td>6.5k</td><td>65k</td><td>1.3M</td></tr>
<tr><td>622.08</td><td>200</td><td>2</td><td>0.2</td><td>10</td><td>10</td><td>1k</td><td>25k</td><td>250k</td><td>5M</td></tr>
<tr><td>2488.32</td><td>800</td><td>2</td><td>0.2</td><td>10</td><td>12.1</td><td>5k</td><td>100k</td><td>1M</td><td>20M</td></tr>
<tr><td>2666.05*3</td><td>800</td><td>2</td><td>0.2</td><td>10</td><td>12.1</td><td>5k</td><td>100k</td><td>1M</td><td>20M</td></tr>
</table>
Measurement condition: MU150100A/MU150101A loop-back measurement
Temperature condition: +10˚ to +40˚C
Optical input level: –10 to –12 dBm (2488M, 2666M), –10 to –20 dBm (52M, 156M, 622M)
Error threshold: 10^{-8} (52M), 10^{-9} (156M, 622M), 10^{-10} (2488M, 2666M)
Optical input wavelength: 1310 nm/1550 nm
Mapping
SDH: VC3-Bulk (52M), VC4-nc (n = 1, 4, 16) (156M/622M/2488M)
SONET: STSnc (n = 1, 3, 12, 48)
OTU-1: ODU1-OPU1-PRBS
Test pattern: $2^{23}-1$ (Inv.) (SDH/SONET), $2^{23}-1$ (OTU-1), Mark ratio 1/2, Scramble “On”
Clock: internal</td></tr>
</table>

Continued on next page

<table>
<tr><th>Model</th><th>MU150100A</th><th>MU150101A*1</th></tr>
<tr><td>Jitter tolerance*2
(9.9G/10.7G)</td><td>


<table>
<tr><th>Bit rate (Mbit/s)</th><th>A1 (UIp-p)</th><th>A2 (UIp-p)</th><th>A3 (UIp-p)</th></tr>
<tr><td>9953</td><td>0.2</td><td>2</td><td>3200</td></tr>
<tr><td>10709*3</td><td>0.2</td><td>2</td><td>3200</td></tr>
</table>
<table>
<tr><th>Bit rate (Mbit/s)</th><th>f6 (Hz)</th><th>f7 (Hz)</th><th>f1 (Hz)</th><th>f2 (Hz)</th><th>f3 (Hz)</th><th>f4 (Hz)</th></tr>
<tr><td>9953</td><td>10</td><td>12.1</td><td>20k</td><td>400k</td><td>4M</td><td>80M</td></tr>
<tr><td>10709*3</td><td>10</td><td>12.1</td><td>20k</td><td>400k</td><td>4M</td><td>80M</td></tr>
</table>
Measurement condition:
MU150100A, MU150121A, MU150123A loop-back measurement
Temperature condition: +10˚ to +40˚C
Optical input level: –10 to –12 dBm
Optical input wavelength: 1310 nm/1550 nm
Mapping
SDH: VC4-64c (9953M)
SONET: STS192c (9953M)
OTU-2: ODU2-OPU2-PRBS
Test pattern: $2^{23} – 1$ (Inv.) (SDH/SONET), $2^{31} – 1$ (OTU-2), Mark ratio 1/2, Scramble “On”
Clock: internal
</td><td>—</td></tr>
<tr><td>Auxiliary interface</td><td colspan="2">External clock input, Receive clock output, Cock/Frame sync. output</td></tr>
<tr><td>Optical output power adjustable (Option 04)</td><td colspan="2">Variable range: 0 to 30 dB, Accuracy: ≤±0.5 dB (0 to 10 dB), ≤±1.0 dB (10.1 to 30 dB), Setting resolution: 0.1 dB</td></tr>
<tr><td>Supported main frame option</td><td>MP1590B-30</td><td>MP1590B-11</td></tr>
</table>

*1: Please refer to the section of MU150101A-06/-07 about specification of EoS mode.
*2: Don't support in MU150101A.
*3: When it is installed MU150125A-05.

• MU150100A Option 05 (OTU-1/OTU-2), MU150101A Option 05 (OTU-1)

Option	MU150100A-05	MU150101A-05*1
Bite rate	10709.225 Mbit/s, 2666.057 Mbit/s	2666.057 Mbit/s
Frame	10709.225 Mbit/s: OTU-2, 2666.057 Mbit/s: OTU-1	2666.057 Mbit/s: OTU-1
No frame	10709.225 Mbit/s, 2666.057 Mbit/s	2666.057 Mbit/s
Test pattern	PRBS, Word, all 0, all 1 PRBS No frame: $2^{15} – 1$, $2^{23} – 1$, $2^{31} – 1$ PRBS mapping: $2^{15} – 1$, $2^{23} – 1$, $2^{31} – 1$ SDH/SONET mapping: According to SDH/SONET mapping Invert ON/OFF Word: 16-bit programmable (mark ratio 1/2 at no frame) Transmit/Receive: An independent setup is possible	
OH preset	OTU, ODU, OPU, FAS (except parity byte, MFAS and JC byte) TTI (SPAI [1] - [15], DAPI [1] - [15]) can be set character. PT is set automatically according to mapping (can be edit).	
FEC	G.709, RS (255, 239) It can set ON/OFF.	
Justification	Generation Action: ±Justification Timing: Single, Burst (2 to 64) Measurement item: + JC, –JC	
Payload offset	Offset range: ±65.9 ppm/0.1 ppm step can set at the Async. mapping.	
Error addition/ measurement	FAS, BIP-8 (SM, PM, TCM1-6), BEI (SM, PM, TCM1-6), Bit all (only addition for OTN frame), Bit, Corrected error bit (only measurement), Uncorrectable FEC block (only measurement)	

Continued on next page

Option	MU150100A-05	MU150101A-05*1
Error addition timing	Single, Rate, All, Alternate, Random (only Bit all) Rate Fix rate: $1*10^{-n}$ (n: 3 to 9), User program: $A*10^{-B}$ (A: 1.0 to 9.9, B: 2 to 10) Alternative Error frame: 0 to 64000, Normal frame: 1 to 64000 Random: Only Bit all When the Parity error is set, it can be select Error position	
Alarm addition/ measurement	LOF, OOF (only measurement), LOM, OOM (only measurement), BDI (SM, PM, TCM1-6), AIS (OTU, ODU), ODU-OCI, ODU-LCK, ODU-PLM (only measurement), IAE (SM,TCM1-6), TIM (SM, PM, TCM1-6), LTC (TCM1-6), BIAE (SM, TCM1-6)	
Alarm addition timing	Alternative, All, Burst, Single Alternative Error frame: 0 to 64000, Normal frame: 1 to 64000	
Monitor	All OH (OTU, ODU, OPU), TTI, FTFL, Payload Multi-frame indicate is possible at the TTI and FTFL.	
Overhead sequence capture	Capture byte: APS/PCC Size: 64 sequence Repeat: Max. 8000 frame/sequence	
Overhead test	OTU/ODU/OPU 1byte, FAS, APS/PCC, TCM1-6, SM, PM, GCC0-2, EXP (except parity byte, MFAS and JC byte) Timing: Alternative (A: 1 to 8000 times, B: 1 to 8000 times), A and B can be set up to 256 frames.	
OH BERT test	GCC0-2, OH 1byte (except Parity byte) Pattern: $2^{11} - 1$, $2^{15} - 1$ (Invert) Error addition: Bit (only Single) Measurement: Bit error, Sync.loss	
OH Add/Drop	Test byte: GCC0-2	

*1: MU150101A doesn't support OTN measurement on EoS mode.

• MU150100A Option 07 (10/10.7G Minus option)

Function	This Option removes the 10/10.7G electrical capability from the MU150100A. This Option must be installed in the factory.

*1: This option cannot be installed together with MU150100A-09.

• MU150101A Option 06 (GFP-F/LEX/LAPS), MU150101A Option 07 (POS)

Option	MU150101A-06	MU150101A-07
Bit rate	155.52 Mbit/s, 622.08 Mbit/s, 2488.32 Mbit/s	
Encapsulation	GFP-F, LEX, LAPS (X.86)	PPP, CiscoHDLC, MAPOS version1, MAPOS 16
Frame setting	FCS(LEX): 16 bit MAC address: fixed, increment, decrement, random (Changeable portions specified in 4 bits units) IP address: fixed, increment, decrement, random VLAN tag*1: fixed, increment, decrement, random Protocol editing: GFP, LEX, LAPS, Ethernet, ARP, IPv4, IGMP/IPv4, ICMP/IPv4, TCP/IPv4, UDP/IPv4, RIP/UDP/IPv4, DHCP/UDP/IPv4, IPv6, IPX, IS-IS, MAC Control Frame, LEX Control Packet	FCS: CRC32, CRC16 IP address: fixed, increment, decrement, random Protocol editing: PPP, CiscoHDLC, MAPOS v1, MAPOS16, ARP, IPv4, IGMP/IPv4, ICMP/IPv4, TCP/IPv4, UDP/IPv4, RIP/UDP/IPv4, DHCP/UDP/IPv4, IPv6, IS-IS
	MPLS label*1: Up to 10 MPLS labels can be appended. Fixed setting Data field Can set any 4 parts in data field: All 1, All 0, Alternate 1/0 (Each bit, Each 2 bits, Each 4 bits, Each byte, Each 2 bytes), Increment*2, Decrement*2, Random*2, Single PRBS9*2 Data field 1 only: Time stamp*2, Sequence number*2, User defined, Test frame	
Frame length	8 to 65536 byte (Settable as auto, Fixed, Increment*3, or Random*3)	
Stream Gap Setting	Stream transport mode: Continuous, continuous burst, stop after this stream, next stream, jump to stream, jump to stream for count (loop count: 1 to 16,000,000, frame count per burst: 1 to 16,000,000, burst count per stream: 1 to 16,000,000) Inter frame gap GFP: 0 ns to 120 s, Resolution of 13.4 ns, Settable as fixed, Random*4 Other: 3.3 ns to 120 s, Resolution of 3.2 ns, Settable as fixed, Random*4 Inter burst gap: 51.4 ns to 120 s, Resolution of 3.2 ns, Settable as fixed (IFG <51.4 ns or frame length <63 bytes) IFG + 51.4 ns to 120 s Inter stream gap: 427.4 ns to 120 s, Resolution of 3.2 ns, Settable as fixed (IFG <51.4 ns or frame length <63 bytes) IFG + 427.4 ns to 120 s	
Number of streams	256 streams	

Continued on next page

Option	MU150101A-06	MU150101A-07
Error insertion	GFP: cHEC error, Correctable cHEC error, tHEC error, Correctable tHEC error, eHEC error, Correctable eHEC error, FC LAPS: FCS error, abort frame LEX: FCS error, fragment error, undersize, oversize, oversize & FCS error	—
	Frame error: FCS error, abort frame, flagment, undersize, oversize, oversize & FCS error Packet error: IPv4 header checksum error, TCP/UDP checksum error PRBS: PRBS bit error (required MP1590B-11)	
Counter	GFP/LEX/LAPS: Transmitted bytes (after stuffing), Transmitted bytes (after adaptation), cHEC error, Correctable cHEC error, tHEC error, Correctable tHEC error, eHEC error, GFP FCS error, Server signal fail interval, Client loss of sync frame, Client loss of sync interval, Client loss of signal frame, Client loss of signal interval, Fragment, Undersize, Oversize, Oversize & FCS error, Abort frame Ethernet: Transmitted Ethernet frame/rate, Received Ethernet frame/rate, Transmitted Ethernet byte, Received Ethernet byte, Ethernet FCS error, Flow control, Ethernet fragment error, Ethernet undersize error, Ethernet oversize error, Ethernet oversize & FCS error	—
	SDH/SONET/Bulk: B1 count/rate, B2 count/rate, B3 count/rate, HP-IEC count/rate, MS-REI count/rate, HP-REI count/rate, LOS count/second, LOF count/second, OOF count/second, MS-AIS count/second, MS-RDI count/second, AU-AIS count/second, AU-LOP count/second, HP-SLM count/second, HP-RDI count/second, HP-UNEQ count/second, Bit Info count/rate, Pattern Sync Loss second, MFI alignment Error count/second, sequence error count Justification: NDF count/rate, +PJC count/rate, –PJC count/rate, Consecutive count/rate, PPM Common: Transmitted frame count/rate, Received frame count/rate, Transmitted bit count/rate, Received bit count/rate, Transmitted byte/rate, Received byte/rate, Capture trigger, Capture filter, User defined 1 count/rate, User defined 2 count/rate, Transmitted test frame, Received test frame ARP: Transmitted ARP request, Received ARP request, Transmitted ARP reply, Received ARP reply PPP/IP/TCP/UDP: Transmitted bytes (after stuffing), Received bytes (before destufing), Transmitted IPv4 packet count/rate, Received IPv4 packet count/rate, Transmitted PING reply, Received PING reply, Transmitted PING request, Received PING request, QoS 0 to 7 frame/rate, Received TCP packet count/rate, Received UDP packet count/rate, IPv4 header checksum error, TCP checksum error, UDP checksum error Unframe: Bit Info count/rate, Pattern Sync Loss second Packet BER (MP1590B-11): Sequence error, Received PRBS frame error count/rate, Received PRBS bit error count/rate	
Frame Arrival Time Variation Measurement	Time resolution: 1 µs, 10 µs, 100 µs, 1 ms, 10 ms, 100 ms, 1 s	
QoS Counter Settings	Using QoS described below, 8-level priority frame count: IEEE802.1D VLAN tag user priority field, 3 LSB of RFC2474 DSCP field	
Unframed BER Test	Test pattern: $2^{23}-1$ (Inv), $2^{31}-1$ Error insertion: Bit unit Error insertion timing: Single error, Fix rate: 1×10^{-n} (n: 3 to 9), User program: $A \times 10^{-B}$ (A: 1.0 to 9.9 step 0.1, B: 2 to 10)	
Capture Buffer	256 Mbyte	
Capture Filter	At following conditions, capture filter condition settings: Destination MAC address*5, Source MAC address*5, Destination IP address, Source IP address, 32-bit pattern (settable bit length and offset) x 2, Error conditions	
Capture Trigger	At following conditions, capture trigger condition settings: Destination MAC address*5, Source MAC address*5, Destination IP address, Source IP address, 32-bit pattern (settable bit length and offset) x 2, Error conditions, Traffic over, Latency over, External trigger input	
Protocol Decode	ARP, Cisco HDLC, DHCP, DVMRP, Ethernet, GFP, ICMP, ICMPv6, IGAP, IGMP, IPCP, IPv4, IPv6, IPv6CP, IPX, IS-IS, LAPS (X.86), LCP, LDP, LEX, LLC, MAC Control Frame, MAPOS, MPLS, MPLSCP, OSPFv2, PPP, PPP-LEX, RIP, RSVP, SNAP, TCP, UDP, VLAN, Test Frame	
Protocol Emulation	ARP, PPP, ICMPv4 (PING), IGMP,	
Traffic Monitor	IP packet count for up to 64 flows, Frame count for up to 64 protocols	
Traffic Map	IP data flow for up to 256 flows	
Service Disruption Time	Measure a total time of receiving no frame as service disruption time. A resolution of this measurement depends on the transmitted frame size and IFG.	

∗1: VLAN tag and MPLS labels cannot be used simultaneously.
∗2: This function causes TCP/UDP checksum error when it uses TCP/UDP frame.
∗3: Increment and random of frame length can be used only when choosing None as a protocol.
∗4: Random setting is effective only when frame length is more than 64 bytes.
∗5: Available only on GFP/LAPS/LEX mapping.

• MU150101A Option 11 (HO Virtual Concatenation), MU150101A Option 12 (LO Virtual Concatenation)

Option	MU150101A-11	MU150101A-12
Mapping	VC-4-Xv (X = 1 to 16)/STS3cSPE-Xv (X = 1 to 16) VC-3-Xv (X = 1 to 48)/STS1SPE-Xv (X = 1 to 48)	VC-12-Xv (X = 1 to 63)/VT2SPE-Xv (X = 1 to 63) VC-11-Xv (X = 1 to 64)/VT1.5 SPE-Xv (X = 1 to 64)
Group	A setup is arbitrarily possible in a member's position and SQ.	
Dummy channel	Payload data: $2^{15}-1$ (Inv.), $2^{23}-1$ (Inv.), $2^{31}-1$, all 0, all 1, Idle	
Error addition	1st MFI (HOVCAT), 2nd MFI (LOVCAT), SQM, MFI (LOVCAT)	
Error addition timing	Single, all (About a VCAT group all channel)	
Alarm addition	VCAT-LOM	
Alarm addition timing	Single, Single burst, Alternative, all (About a VCAT group all channel)	
Error measurement	1st MFI count/rate, 2nd MFI count/rate, SQM count/rate	
Alarm measurement	VCAT-LOM count/rate, LOA count/rate, OOM1 count/rate, OOM2 count/rate	

• MU150101A Option 13 (LCAS)

LCAS ON/OFF	ON/OFF is settable
Command generation	ADD, REMOVE, TEMP REMOVE, User defined command
Sequence generation	It is possible to set LCAS sequences gap and transmitting time of each command. Generating up to 64 sequences.
Monitor	About a VCAT group all channel, a monitor is possible in SQ, CTRL, RS-Ack, MST of SQ0 and GID.
Capture	A capture is possible in a maximum of 64 LCAS sequences. Trigger condition: Change point of CTRL, SQ, MST and RS-Ack. And external trigger input. It is possible to set trigger channel. It is possible to set capture channel. Display items: SQ, CTRL, Rs-Ack, MST and number of multi-frames
Error addition	GID, CRC8 (HOVCAT), CRC3 (LOVCAT)
Error addition timing	Single, All (About a VCAT group all channel)

• MU150121A 10/10.7G Optical Unit (Tx)

Bit rate	9953.28 Mbit/s, 10709.225 Mbit/s Depends on frequency accuracy and external input frequency of the MU150100A.
Peak wavelength	1310 ±20 nm (Option 01, 03), 1550 ±20 nm (Option 02, 03)
–20 dB width	≤0.5 nm (@–20 dB)
SMSR	≥30 dB
Extinction ratio	≥10 dB
Optical output power	0 to +3 dBm
Signal code	NRZ
Connector	FC-PC (SMF), replaceable
Electrical input	9953.28 Mbit/s ±100 ppm, 10709.225 Mbit/s ±100 ppm Input level H: 0 to –0.2 V, L: –0.85 to –1.5 V Impedance: 50 Ω Connector: SMA
Safety classification	IEC 60825-1: CLASS 1M, 21CFR 1040.10: CLASS Ⅲb
Optical output power adjustable (MU150121A-04)	Variable range: 0 to 20 dB, Accuracy: ≤±0.5 dB (0 to 10 dB), ≤±1.0 dB (10.1 to 20 dB), Setting resolution: 0.1 dB
Supported main frame option	MP1590B-30

• MU150134A 10/10.7G Optical Unit (Tx external modulation)

Bit rate	9953.28 Mbit/s 10709.225 Mbit/s Depends on frequency accuracy of the MU150100A and external input frequency.
Optical output modulation	Output power: +3 dBm (C band) However, typical value when using built-in CW light source, and modulating by data signal of mark ratio 1/2. Extinction ratio: ≥10 dB Signal code: NRZ Connector: FC-PC (SMF) replaceable
External optical input	Light source: CW light source, polarization preservation fiber is used Peak wavelength: C band, L band Maximum input power: +15 dBm Minimum input power: +6 dBm Insertion loss: ≤7 dB (C band), ≤8 dB (L band) Connector: FC-PC (PMF), replaceable
Clock input	Frequency: 9953.28 MHz ±100 ppm, 10709.225 MHz ±100 ppm Input voltage: 1.3 to 0.6 Vp-p Connector: SMA (50 Ω GND)
Data input	Bit rate: 9953.28 Mbit/s ±100 ppm, 10709.225 Mbit/s ±100 ppm Input voltage Hi: 0.0074 to –0.2074 V, Lo: –0.8426 to –1.3074 V Connector: SMA (50 Ω GND)
Optical reference output	Optical source: CW light source Peak wavelength: 1550 ±20 nm (C band) –20 dB width: ≤1 nm Side mode suppression ratio: ≥30 dB Output power: +10 to +13 dBm Polarization Extinction ratio: ≥20 dB Connector: FC-PC (PMF), replaceable
Safety classification	IEC 60825-1: CLASS 1M, 21CFR 1040.10: CLASS Ⅲb
Optical output power adjustable (MU150134A-04)	Variable range: 0 to 20 dB, Accuracy: ≤±0.5 dB (0 to 10 dB), ≤±1.0 dB (10.1 to 20 dB), Setting resolution: 0.1 dB
Supported main frame option	MP1590B-30

• MU150122A 10/10.7G Optical Unit (Rx narrow), MU150123A 10/10.7G Optical Unit (Rx wide)

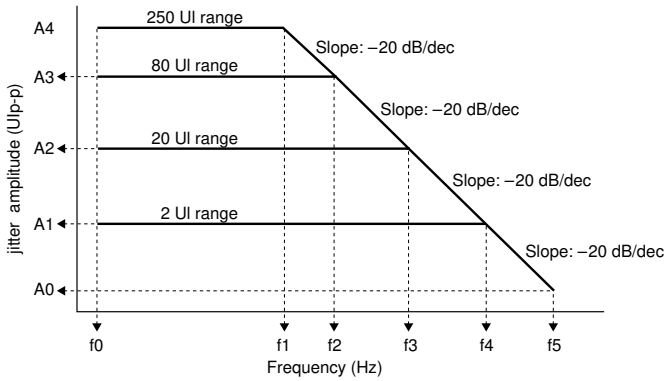
Model	MU150122A	MU150123A
Bit rate	9953.28 Mbit/s ±100 ppm, 10709.225 Mbit/s ±100 ppm	
Optical input wavelength	1260 to 1610 nm	
Optical input sensitivity	–14 to 0 dBm	
Absolute maximum optical input	+3 dBm (average)	
Optical input signal code	NRZ	
Optical input return loss	≥27 dB	
Optical connector	FC-PC (SMF), replaceable	
Electrical output signal	9953.28 Mbit/s, 10709.225 Mbit/s Output level: 0.2 to 1.0 Vp-p Signal code: NRZ Impedance: 50 Ω Connector: SMA	Data output: 9953.28 Mbit/s, 10709.225 Mbit/s*1 Output level: 1.0 ±0.25 Vp-p Signal code: NRZ Clock output 9953.28 MHz, 10709.225 MHz*1 Output level: 0.8 ±0.25 Vp-p Impedance: 50 Ω Connector: SMA
Optical input power measurement	Measurement range: –20 to +2 dBm Measurement accuracy: ≤±0.5 dB (+2 to –10 dBm), ≤±1.0 dB (–10.1 to –20 dBm)	
Supported main frame option	—	MP1590B-30

*1: MU150123A-05 is required.

• **MU150125A 10/10.7G jitter Unit**

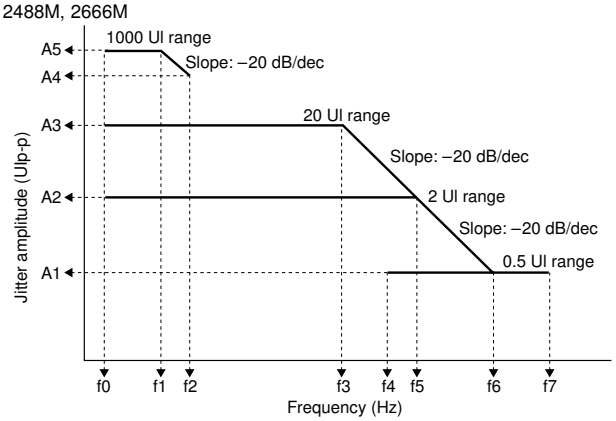
<table>
<tr><td>Jitter generation/
measurement
frequency</td><td>51.84 MHz, 155.52 MHz, 622.08 MHz, 2488.32 MHz, 9953.28 MHz
2666.06 MHz (MU150125A-05), 10709.225 MHz (MU150125A-05)
10312.5 MHz (MU150125A-06)</td></tr>
<tr><td>10/10.3/10.7G
Clock output
52M to 2.66 GHz
Clock output</td><td>Frequency:
51.84 MHz ±100 ppm, 155.52 MHz ±100 ppm, 622.08 MHz ±100 ppm, 2488.32 MHz ±100 ppm, 2666.057 MHz ±100 ppm,
9953.28 MHz ±100 ppm, 10312.5 MHz ±100 ppm, 10709.225 MHz ±100 ppm
Accuracy: ±0.1 ppm [After power on, calibrate after 24 hours, warm-up 23 ±5˚C, aging rate (Max.): ±0.05 ppm/day, ±0.5 ppm/year]
Level: 0.8 Vp-p ±0.25 V
Connector: SMA, 50 Ω (AC)</td></tr>
<tr><td>Jitter generation</td><td>Modulation frequency: 0.1 to 80 MHz
Amplitude: 0 to 4040 UIp-p

Modulation value:
52M, 156M, 622M</td></tr>
</table>



Bit rate (bit/s)	f0 (Hz)	f1 (kHz)	f2 (kHz)	f3 (kHz)	f4 (kHz)	f5 (MHz)	A0 (UIp-p)	A1 (UIp-p)	A2 (UIp-p)	A3 (UIp-p)	A4 (UIp-p)
52M	0.1	—	—	50	500	1.3	0.776	2.02	20.20	—	—
155M	0.1	—	38	150	1500	3.8	0.797	2.02	20.20	80.8	—
622M	0.1	4.8	15	60	600	5	0.242	2.02	20.20	80.8	253.0

2488M, 2666M



Bit rate (bit/s)	f0 (Hz)	f1 (Hz)	f2 (Hz)	f3 (kHz)	f4 (kHz)	f5 (MHz)	f6 (MHz)	f7 (MHz)	A1 (UIp-p)	A2 (UIp-p)	A3 (UIp-p)	A4 (UIp-p)	A5 (UIp-p)
2488M 2666M	0.1	15	600	100	500	1	4	20	0.505	2.02	20.2	25	1010

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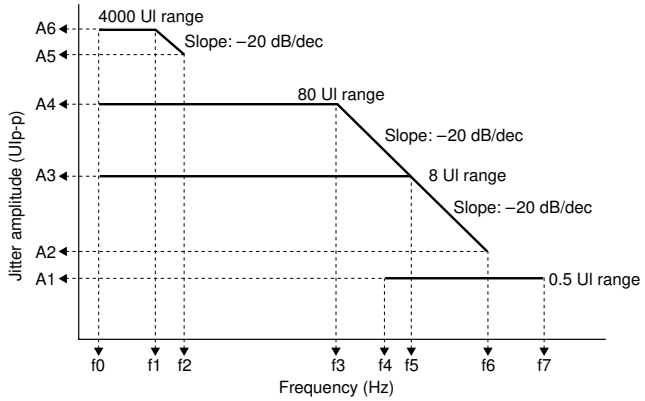
Jitter generation

9953M, 10.3G, 10.7G



Bit rate (bit/s)	f0 (Hz)	f1 (Hz)	f2 (Hz)	f3 (kHz)	f4 (kHz)	f5 (kHz)	f6 (MHz)	f7 (MHz)	A1 (UIp-p)	A2 (UIp-p)	A3 (UIp-p)	A4 (UIp-p)	A5 (UIp-p)	A6 (UIp-p)
9953M 10.3G 10.7G	0.1	15	600	100	500	1	4	80	0.505	2.02	8.08	80.8	110	4040

Accuracy:
0.5 UI range: ±Q % of setting ±0.02 UIp-p
2 UI range: ±Q % of setting ±0.02 UIp-p
8 UI range: ±Q % of setting ±0.8 UIp-p
20 UI range: ±Q % of setting ±0.2 UIp-p
20 UI range: ±Q % of setting ±1.2 UIp-p (2488M, 2666M)
80 UI range: ±Q % of setting ±1.2 UIp-p
80 UI range: ±Q % of setting ±4.8 UIp-p (9953M, 10.3G, 10.7G)
250 UI range: ±Q % of setting ±6 UIp-p
1000 UI range: ±Q % of setting ±6 UIp-p
4000 UI range: ±Q % of setting ±24 UIp-p

Frequency	Variable error Q	Frequency range
52 MHz	±8 %	0.1 to 500 kHz
	±12 %	500 kHz to 1.3 MHz
156 MHz	±8 %	0.1 to 500 kHz
	±12 %	500 kHz to 1.5 MHz
	±15 %	1.5 MHz to 3.8 MHz
622 MHz	±8 %	0.1 to 500 kHz
	±12 %	500 kHz to 2 MHz
	±15 %	2M to 5 MHz
2488 MHz 2666 MHz	±8 %	0.1 to 500 kHz
	±12 %	500 kHz to 2 MHz
	±15 %	2M to 20 MHz
9953MHz 10.3 GHz 10.7 GHz	±8 %	0.1 to 500 kHz
	±12 %	500 kHz to 2 MHz
	±15 %	2M to 80 MHz

10/10.3/10.7G Clock input
52M to 2.66 GHz Clock input

Frequency:
51.84 MHz ±100 ppm, 155.52 MHz ±100 ppm, 622.08 MHz ±100 ppm, 2488.32 MHz ±100 ppm, 2666.057 MHz ±100 ppm, 9953.28 MHz ±100 ppm, 10312.5 MHz ±100 ppm, 10709.225 MHz ±100 ppm
Level: 0.8 Vp-p ±0.3 V (52 MHz to 2.6 GHz), 0.8 Vp-p ±0.25 V (10/10.3/10.7 GHz)
Connector: SMA, 50 Ω (AC)

Jitter measurement

Manual jitter measurement: UIp-p, UI+p, UI-p/UIrms
UIp-p measurement:
2 UI range (–1.010 to 1.010 UIp-p/Step 0.001 UIp-p)
20 UI range (–10.10 to 10.10 UIp-p/Step 0.01 UIp-p)
80 UI range (–40.4 to 40.4 UIp-p/Step 0.25 UIp-p)
250 UI range (–123.0 to 123.0 UIp-p/Step 0.5 UIp-p)
1000 UI range (–510.0 to 510.0 UIp-p/Step 1 UIp-p)
4000 UI range (–2020 to 2020 UIp-p/Step 2 UIp-p)
UIrms measurement:
2 UI range (0.000 to 0.714 UIrms/Step 0.001 UIrms)
20 UI range (0.00 to 7.14 UIrms/Step 0.01 UIrms)

Continued on next page

Jitter measurement

Filter

Frequency (Hz)	HP0 (Hz)	HP1 (Hz)	HP1' (Hz)	HP2 (Hz)	HP' (Hz)	HP (Hz)	LP (Hz)	LP' (Hz)
52M	10	100	—	20k	—	12k	400k	—
156M	10	500	—	65k	—	12k	1.3M	500
622M	10	1k	—	250k	—	12k	5M	1k
2488M 2666M	10	5k	—	1M	—	12k	20M	5k
9953M 10.3G 10.7G	10	20k	10k	4M	50k	12k	80M	20k

Accuracy (Ulp-p, UI+p, UI-p):
2 UI range: ±R% ±W Ulp-p
20 UI range: ±R% ±W Ulp-p
80 UI range: ±R% ±W Ulp-p
250 UI range: ±R% ±W Ulp-p
1000 UI range: ±R% ±W Ulp-p
4000 UI range: ±R% ±W Ulp-p
Accuracy (UIrms)
2 UI range: ±R% ±Y UI rms
20 UI range: ±R% ±Y UI rms

Frequency (Hz)	W Clock signal						
	HP1+LP		HP2+LP		HP+LP*		HP0+LP'
	2 UI	20 UI	2 UI	20 UI	2 UI	20 UI	80/250/1000/4000 UI
52M	0.05	0.5	0.03	0.3	0.03	0.3	—
156M	0.05	0.5	0.02	0.2	0.03	0.3	2
622M	0.05	0.5	0.03	0.3	0.03	0.3	8
2488M 2.6G	0.05	0.5	0.03	0.3	0.03	0.3	20
9953M 10.3G 10.7G	0.05	0.5	0.03	0.3	0.03	0.3	80

Frequency (Hz)	Y Clock signal	
	HP+LP*	
	2 UI	20 UI
52M	0.008	0.04
156M	0.008	0.04
622M	0.008	0.04
2488M 2666M	0.008	0.04
9953M 10.3G 10.7G	0.008	0.05

*: Apply HP'+LP at 9953M, 10.3G, 10.7G

MU150100A loop back measurement

Bit rate (Mbit/s)	W data signal			Y data signal
	Ulp-p			UIrms
	HP1+LP	HP+LP	HP2+LP	HP+LP
	2 UI	2 UI	2 UI	2 UI
51.84 (Optical)	0.070	0.070	0.035	0.010
51.84 (Electrical)	0.070	0.070	0.035	0.010
155.52 (Optical)	0.070	0.070	0.035	0.010
155.52 (Electrical)	0.070	0.070	0.035	0.010
622.08 (Optical)	0.070	0.070	0.035	0.010
2488.32 (Optical)	0.080	0.080	0.060	0.010
2666.05* (Optical)	0.080	0.080	0.060	0.010

*: Built-in MU150125A-05

Measurement condition
Temperature condition: +10˚ to +40˚C
Optical input level: –10 to –12 dBm
Measurement time: 1 min
Optical input wavelength: 1310 nm/1550 nm
Mapping
SDH: VC3-Bulk (52M), VC4-nc (n = 1, 4, 16) (156M/622M/2488M)
SONET: STSnc (n = 1, 3, 12, 48)
OTU-1: ODU1-OPU1-PRBS
Test pattern: $2^{23} - 1$ (Inv.) (SDH/SONET), $2^{31} - 1$ (OTU-1), Mark ratio 1/2, Scramble "On"
Clock: internal

Continued on next page

Jitter measurement

MU150100A with MU150125A Receiver only

Bit rate (Mbit/s)	W data signal (Typical)			Y data signal
	UIp-p			UIrms
	HP1+LP	HP+LP	HP2+LP	HP+LP
	2 UI	2 UI	2 UI	2 UI
51.84 (Optical)	0.035	0.035	0.035	0.009
51.84 (Electrical)	0.035	0.035	0.035	0.009
155.52 (Optical)	0.035	0.035	0.035	0.009
155.52 (Electrical)	0.035	0.035	0.025	0.009
622.08	0.035	0.035	0.035	0.009
2488.32	0.035	0.035	0.035	0.009
2666.05*	0.035	0.035	0.035	0.009

*: Built-in MU150125A-05

Measurement condition
Temperature condition: +10˚ to +40˚C
Optical input level: –10 to –12 dBm
Measurement time: 1 min
Optical input wavelength: 1310 nm/1550 nm
Mapping
SDH: VC3-Bulk (52M), VC4-nc (n = 1, 4, 16) (156M/622M/2488M)
SONET: STSnc (n = 1, 3, 12, 48)
OTU-1: ODU1-OPU1-PRBS
Test pattern: $2^{23} - 1$ (Inv.) (SDH/SONET), $2^{31} - 1$ (OTU-1), Mark ratio 1/2, Scramble "On"

MU150100A, MU150121A, MU150123A loop back measurement

Bit rate (Mbit/s)	W data signal			Y data signal
	UIp-p			UIrms
	HP1+LP	HP'+LP	HP2+LP	HP'+LP
	2 UI	2 UI	2 UI	2 UI
9953.280	0.080	0.080	0.060	0.010
10709.225*	0.080	0.080	0.060	0.010

*: Built-in MU150125A-05

Measurement condition
Temperature condition: +10° to +40°C
Optical input level: –10 to –12 dBm
Measurement time: 1 min
Optical input wavelength: 1310 nm/1550 nm
Mapping
SDH: VC4-64c (9953M)
SONET: STS192c (9953M)
OTU-2: ODU2-OPU2-PRBS
Test pattern: $2^{23} - 1$ (Inv.) (SDH/SONET), $2^{31} - 1$ (OTU-2), Mark ratio 1/2, Scramble "On"
Clock: internal

MU150100A, MU150134A, MU150123A loop back measurement

Bit rate (Mbit/s)	W data signal			Y data signal
	UIp-p			UIrms
	HP1+LP	HP'+LP	HP2+LP	HP'+LP
	2 UI	2 UI	2 UI	2 UI
9953.280	0.065	0.065	0.060	0.010
10709.225*	0.065	0.065	0.060	0.010

*: Built-in MU150125A-05

Measurement condition
Temperature condition: +10° to +40°C
Optical input level: –10 to –12 dBm
Measurement time: 1 min
Optical input wavelength: 1550 nm
Mapping
SDH: VC4-64c (9953M)
SONET: STS192c (9953M)
OTU-2: ODU2-OPU2-PRBS
Test pattern: $2^{23} - 1$ (Inv.) (SDH/SONET), $2^{31} - 1$ (OTU-2), Mark ratio 1/2, Scramble "On"
Clock: internal

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Jitter measurement

MU150123A with MU150125A Receiver only

Bit rate (Mbit/s)	W data signal			Y data signal
	UIp-p			UIrms
	HP1+LP	HP'+LP	HP2+LP	HP'+LP
	2 UI	2 UI	2 UI	2 UI
9953.280	0.035	0.035	0.035	0.009
10709.225*	0.035	0.035	0.035	0.009

*: Built-in MU150125A-05

Measurement condition
- Temperature condition: +10° to +40°C
- Optical input level: –10 to –12 dBm
- Measurement time: 1 min
- Optical input wavelength: 1310 nm/1550 nm
- Mapping
  - SDH: VC4-64c (9953M)
  - SONET: STS192c (9953M)
  - OTU-2: ODU2-OPU2-PRBS
- Test pattern: $2^{23} - 1$ (Inv.) (SDH/SONET), $2^{31} - 1$ (OTU-2), Mark ratio 1/2, Scramble "On"

Additional error [R]

Additional error	Frequency range
±15 %	<100 Hz (52M) <500 Hz (156M) <1 kHz (622M) <5 kHz (2488M, 2666M) <20 kHz (9953M/10.3G/10.7G)
±7 %	100 Hz to 300 kHz (52M) 500 Hz to 300 kHz (156M) 1 kHz to 300 kHz (622M) 5 kHz to 300 kHz (2488M, 2666M) 20 kHz to 300 kHz (9953M/10.3G/10.7G)
±8 %	300 kHz to 400 kHz (52M) 300 kHz to 1 MHz (≥156M)
±10 %	1 MHz to 1.3 MHz (156M) 1 MHz to 3 MHz (≥622M)
±15 %	3 MHz to 5 MHz (622M) 3 MHz to 10 MHz (≥2448M)
±20 %	10 MHz to 20 MHz (2488M, 2666M) 10 MHz to 80 MHz (9953M/10.3G/10.7G)

Hit measurement

Count, Hit seconds, % free seconds

Jitter tolerance

Evaluate jitter tolerance by selected Mask
Mask selection:
- Telcordia GR-253, ANSI T1.105.03
- ITU-T G.783, G.825, G.813, G.8251
- ETSI EN 302 084
- User

Jitter transfer

Evaluate jitter transfer by selected Mask
Accuracy:±0.05 dB ±0.12*g
Applicable frequency range
- 0.01*fc to 100*fc, or maximum frequency setting value
- The maximum frequency setting value is applied in the case of 100*fc

g: Transfer gain (dB) for every frequency point
fc: Cut-off frequency of transfer mask
Measurement condition
- Average level: Fine
- Waiting time: 20 s
- Input jitter value: ≥0.15 UIp-p
- Jitter modulation frequency: ≥300 Hz
- Dynamic range: ≤–40 dB (at the above measurement condition)

Mask selection [Maximum value of a mask is 100 times as much modulation frequency as a break point (fc)]:
- Telcordia GR-253
- ANSI T1.105.03
- ITU-T G.783, G.8251
- ETSI 300 417-1-1
- User

Reference clock output

Frequency:	52M:	51.84 MHz ±100 ppm
	156M:	155.52 MHz ±100 ppm
	622M:	622.08 MHz ±100 ppm
	2448M/9953M:	155.52 MHz ±100 ppm or 622.08 MHz ±100 ppm
	2666M:	166.629 MHz ±100 ppm or 666.514 MHz ±100 ppm
	10.3G:	161.133 MHz ±100 ppm or 644.531 MHz ±100 ppm
	10.7G:	167.332 MHz ±100 ppm or 669.327 MHz ±100 ppm

Output Voltage: 0.8 Vp-p ±0.25 V
Connector: SMA (50 Ω AC)

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External jitter modulation signal input

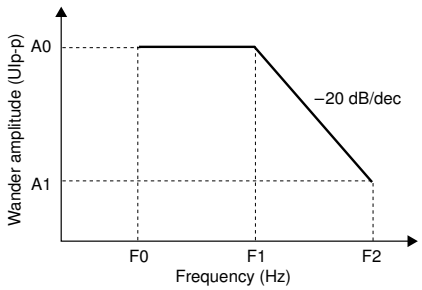
Frequency: 0.1 to 80 MHz
Accuracy:
0.5 UI range : 2488M/2666M 0.5 UIp-p / 1Vp-p, 9953M/10.3G/10.7G 0.5 UIp-p / 0.25Vp-p
2 UI range : 2 UIp-p / 1 Vp-p
20 UI range : 20 UIp-p / 1 Vp-p
80 UI range : 80 UIp-p / 1 Vp-p
250 UI range : 250 UIp-p / 1 Vp-p
1000 UI range : 1000 UIp-p / 1 Vp-p
4000 UI range : 4000 UIp-p / 1 Vp-p
Connector: BNC (50 Ω GND)

Jitter recovery signal output

Frequency: 0.1 to 80 MHz
2 UI range : 2 UIp-p / 1 Vp-p
20 UI range : 20 UIp-p / 1 Vp-p
80 UI range : 80 UIp-p / 1 Vp-p
250 UI range : 250 UIp-p / 1 Vp-p
1000 UI range : 1000 UIp-p / 1 Vp-p
4000 UI range : 4000 UIp-p / 1 Vp-p
Connector: BNC (50 Ω GND)

Wander generation

Modulation frequency: 10 µHz to 10 Hz
Amplitude: 0 to 400,000 UI/Step 1 UIp-p



Bit rate (bit/s)	F0 (Hz)	F1 (Hz)	F2 (Hz)	A0 (UIp-p)	A1 (UIp-p)	Step (UIp-p)
52M 156M 622M 2488M 9953M	10 µ	400m	10	400,000	16,000	1

Accuracy
±Q% of setting ±100 UIp-p

Error Q	Frequency range
±8 %	10 µHz to 0.125 Hz
±12 %	0.125 to 1 Hz
±15 %	1 to 10 Hz

Wander measurement (MU150125A-01)

Bit rate (bit/s): 52M, 156M, 622M, 2488M, 9953M
Evaluation mode: TIE (P-P, +P, –P)
Range
p-p: 0.0 to 2E10 ns
+p, –p: 0.0 to 1E10 ns
Resolution: 0.1 ns
Accuracy: TIE
±0.5% ±Z0 (τ)
Filter selection: DC to 10 Hz, DC to 0.01 Hz, 0.01 to 10 Hz

Z0 (τ)(ns)	Observation time τ (s)
2.5 + 0.0275 τ	0.05 ≤ τ ≤1000
29 + 0.001 τ	τ >1000

Supported main frame option

MP1590B-30

• MU120101A 10M/100M Ethernet Module, MU120102A Gigabit Ethernet Module, MU120118A 10 Gigabit Ethernet Module

Model		MU120101A	MU120102A	MU120118A
Ports		10BASE-T/100BASE-TX Number of ports: 8 Connector: RJ-45 Link speed: 10 Mbit/s, 100 Mbit/s Duplex mode: Full, Half Auto negotiation: On/Off Flow control: On/Off	1000BASE-SX/LX/LH/ZX*1 Number of ports: 2 Connector: GBIC interface (SC connector) Link speed: 1 Gbit/s Duplex mode: Full Auto negotiation: On/Off Flow control: On/Off	10GBASE-SR/LR/ER*2 Number of ports: 2 Connector: XENPAK interface (SC connector) Link speed: 10 Gbit/s Duplex mode: Full Flow control: On/Off
LEDs		Link, Tx/Collision, Rx/Error	Link, Tx, Rx, Error	
Frame Settings		MAC address: Fixed, Increment, Decrement, Random (changeable portions specified in 4 bits units) VLAN tag*3: Fixed, Increment, Decrement, Random MPLS label*3: Up to 10 MPLS labels can be appended. Fixed setting Protocol editing: IPv4, IPv6, TCP/IPv4, UDP/IPv4, IGMP/IPv4, ICMP/IPv4, RIP/UDP/IPv4, DHCP/UDP/IPv4, IPX, ARP, MAC control, IS-IS Data field Can set any 4 portions of data field: All 1, All 0, Alternate1/0 (Each bit, Each 2 bits, Each 4 bits, Each byte, Each 2 bytes), Increment*4, Decrement*4, Random*4, Single PRBS9*4 Data field 1 only: Time stamp*4, Sequence number*4, User defined, Test frame		
Frame Length		12 to 10000 byte (Settable as auto, Fixed, Increment*5, or Random*5)	48 to 65280 byte (Settable as auto, Fixed, Increment*5, or Random*5)	
Stream Transport Mode		Continuous, Continuous burst, Stop after this stream, Next stream, Jump to stream, Jump to stream for count Loop count: 1 to 16,000,000, Frame count per burst: 1 to 16,777,215, Burst count per stream: 1 to 16,777,215		Continuous, Continuous burst, Stop after this stream, Next stream, Jump to stream, Jump to stream for count Loop count: 1 to 16,000,000, Frame count per burst: 1 to 1,099,511,627,775, Burst count per stream: 1 to 1,099,511,627,775
Stream Gap Setting	Inter Frame Gap	10BASE-T: Resolution of 800 ns 8 µs to 1700 s, Settable as fixed, Random 100BASE-TX: Resolution of 80 ns 800 ns to 170 s, Settable as fixed, Random	Resolution of 8 ns 64 ns to 120 s, Settable as fixed, Random	Resolution of 0.8 ns 7.2 ns to 120 s, Settable as fixed, Random
	Inter Burst Gap	10BASE-T: Resolution of 800 ns 8 µs to 1700 s, Settable as fixed 100BASE-TX: Resolution of 80 ns 800 ns to 170 s, Settable as fixed	Resolution of 8 ns 64 ns to 120 s, Settable as fixed	Resolution of 0.8 ns 7.2 ns to 120 s, Settable as fixed
	Inter Stream Gap	10BASE-T: Resolution of 800 ns 8 µs to 1700 s, Settable as fixed 100BASE-TX: Resolution 80 ns 800 ns to 170 s, Settable as fixed	Resolution of 8 ns 64 ns to 120 s, Settable as fixed	Resolution of 0.8 ns 64 ns to 120 s, Settable as fixed
Number of Streams		256 Streams/Port		
Error Insertion	Frame Error	FCS error, Undersize error, Oversize error, Fragments error, Oversize & FCS error, Alignment error, Dribble bit error, Collision	FCS error, Undersize error, Oversize error, Fragments error, Oversize & FCS error	
	Packet Error	IPv4 header checksum error, TCP/UDP checksum error		
	Packet BER Test (MP1590B-11)*6	—	PRBS bit error	
Counter	Common	Transmitted frame count/rate, Received frame count/rate, Transmitted bit count/rate, Received bit count/rate, Transmitted byte/rate, Received byte/rate, Capture trigger, Capture filter, User defined 1 count/rate, User defined 2 count/rate		
	Ethernet	Transmitted ARP reply, Received ARP reply, Transmitted ARP request, Received ARP request, Flow control, Dribble bit error, Line error, Fragment, Undersize, Oversize, Oversize & FCS error, FCS error, Alignment error, Collision	Transmitted ARP reply, Received ARP reply, Transmitted ARP request, Received ARP request, Flow control, Line error,Fragment, Undersize, Oversize, Oversize & FCS error, FCS error, Byte alignment error	Transmitted ARP reply, Received ARP reply, Transmitted ARP request, Received ARP request, Flow control, Fragment, Undersize, Oversize, Oversize & FCS error, FCS error
	IP/TCP/UDP	Transmitted IPv4 packet count/rate, Received IPv4 packet count/rate, IPv4 header checksum error, Transmitted PING reply, Received PING reply, Transmitted PING request, Received PING request, Fragments, Received TCP packet count/rate, TCP checksum error, Received UDP packet count/rate, UDP checksum error, QoS 0 to 7 frame count/rate		
	Unframed	—	Bit error count/rate, Pattern Sync Loss count/second	MP1590B-13*7
	Packet BER Test (MP1590B-11)*6	—	Transmitted test frame, Received test frame, Sequence error, Received PRBS bit error count/rate, Received PRBS error frame count/rate	
	XENPAK Test (MP1590B-13)*7	—		Bit error count/rate, Pattern sync loss count/rate, Bit error count lane 0 to 3, Bit error rate lane 0 to 3, Pattern sync loss lane 0 to 3, Pattern sync loss second lane 0 to 3
	Link Fault Signaling (MP1590B-16)*6	—		Transmitted LFS, Received LFS

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Model	MU120101A	MU120102A	MU120118A
Latency	Maximum, Minimum, Average		
Frame Arrival Time Variation Measurement	Time resolution: 1 µs, 10 µs, 100 µs, 1 ms, 10 ms, 100 ms, 1 s		
QoS Counter Setting	Using Qos described below, 8-level priority frame count: IEEE802.1D VLAN tag user priority field, 3 LSB of RFC2474 DSCP field		
Unframed BER Test*7	—	Test pattern: All 0, All 1, User-defined 16-bit pattern, $2^{23}-1$ (Inv.), $2^{31}-1$, CJ PAT, CRPAT Error insertion: Bit error Error insertion timing: Single error, Fix rate: $1*10^{-n}$ (n: 3 to 9), User program: A $*10^{-B}$ (A: 1.0 to 9.9 step 0.1, B: 2 to 10)	
Capture Buffer	8 Mbyte/port	32 Mbyte/port	256 Mbyte/port
Capture Filter	At following conditions for each port, capture filter condition settings: Destination MAC address, Source MAC address, 32-bit pattern (settable bit length and offset) x 2, Error conditions		
Capture Trigger	At following conditions for each port, capture trigger condition settings: Destination MAC address, Source MAC address, 32-bit pattern (settable bit length and offset) x 2, Error conditions, Traffic over, Latency over, External trigger input		
Protocol Decode	ARP, BGP-4, DHCP, DVMRP, Ethernet, ICMP, ICMPv6, IGAP, IGMP, IPCP, IPv4, IPv6, IPv6CP, IPX, IS-IS, LCP, LDP, MAC Control Frame, MPLS, MPLSCP, OSPFv2, RIP, RSVP, SNAP, TCP, UDP, VLAN, Test Frame		
Protocol Emulation	ARP, PING, IGMP, BGP-4		
Traffic Monitor	Ethernet frame count for up to 64 flows, IP packet count for up to 64 flows, Frame count for up to 64 protocols		
Traffic Map	Ethernet data flow for up to 256 flows, IP data flow for up to 256 flows		
Service Disruption Time	Measure a total time of receiving no frame as service disruption time. A resolution of this measurement depends on the transmitted frame size and IFG.		
RFC2544 Automatic Test	Throughput, Latency, Frame Loss Rate, Back to Back Frame, System Recovery, Reset		
RFC2889 Automatic Test (MP1590B-10)*6	—	[1] Fully Meshed Throughput, Frame Loss and Forwarding Rates, [2] Partially Meshed one-to-Many/Many-to-One, [3] Partially Meshed Multiple Devices, [4] Partially Meshed Unidirectional Traffic, [5] Congestion Control, [6] Forward Pressure and Maximum Forwarding Rate, [7] Address Caching Capacity, [8] Address Learning Rate, [9] Error Frames Filtering, [10] Broadcast Frame Forwarding and Latency	—
Link Fault Signaling (MP1590B-16)*6	—		LFS pattern transmit function, LFS transmitted counter function, Received counter function, LFS data capture, LFS emulation function
Supported main frame option	—	MP1590B-10, MP1590B-11	MP1590B-11, MP1590B-13, MP1590B-16

∗1: 1000BASE-SX/LX/LH/ZX can be selected by changing the GBIC module.
∗2: 10GBASE-LR/SR/ER can be selected by changing the XENPAK module.
∗3: VLAN tag and MPLS labels cannot both be used simultaneously.
∗4: This function causes TCP/UDP checksum error when it uses TCP/UDP frame.
∗5: Increment and random of frame length can be used only when choosing “None” as a protocol.
∗6: Main frame option is required.
∗7: Unframed BER Test (MU120118A) requires main frame option (MP1590B-13)

• **MU120111A 10/100M Ethernet Module, MU120112A Gigabit Ethernet Module**

Model		MU120111A	MU120112A
Ports		10BASE-T/100BASE-TX Number of ports: 8 Connector: RJ-45 Link speed: 10 Mbit/s, 100 Mbit/s Duplex mode: Full, Half Auto negotiation: On/Off Flow control: On/Off	1000BASE-SX/LX/LH/ZX*1, Electrical: 1000BASE-T*1 Number of ports: 2 Connector: GBIC interface (GBIC: SC, RJ-45) Link speed: 1 Gbit/s Duplex mode: Full Auto negotiation: On/Off Flow control: On/Off
LEDs		Link (10/100M), Tx/Collision, Rx/Error	Link, Tx, Rx, Error
Frame settings		MAC address: Fixed, Increment, Decrement, Random (changeable portions specified in 4 bits units) VLAN tag*2: Fixed, Increment, Decrement, Random MPLS label*2: Up to 10 MPLS labels can be appended (fixed setting) Protocol editing: Ethernet, IPv4, IPv6, TCP/IPv4, UDP/IPv4, IGMP/IPv4, ICMP/IPv4, RIP/UDP/IPv4, DHCP/UDP/IPv4, IPX, ARP, MAC control, IS-IS MP1590B-12*3: TCP/IPv6, UDP/IPv6, ICMPv6/IPv6, IPv6 over IPv4, ICMPv6/IPv6 over IPv4, TCP/IPv6 over IPv4, UDP/IPv6 over IPv4 Data field Can set any 4 portions of data field: All 1, All 0, Alternate1/0 (Each bit, Each 2 bits, Each 4 bits, Each byte, Each 2 bytes), Increment*4, Decrement*4, Random*4, Single PRBS9*4 Data Field 1 only: Time stamp*4, Sequence number*4, User defined, Test frame	
Frame length		12 to 10000 byte (Settable as auto, Fixed, Increment*5, or Random*5)	48 to 65280 byte (Settable as auto, Fixed, Increment*5, or Random*5)
Stream Transport Mode		Continuous, Continuous burst, Stop after this stream, Next stream, Jump to stream, Jump to stream for count (Loop count: 1 to 16,000,000, Frame count per burst: 1 to 16,777,215, Burst count per stream: 1 to 16,777,215)	
Stream Gap Setting	Inter Frame Gap	10BASE-T: Resolution of 800 ns 8 µs to 1700 s, Settable as fixed, Random 100BASE-TX: Resolution of 80 ns 800 ns to 170 s, Settable as fixed, Random	Resolution of 8 ns 64 ns to 120 s, Settable as fixed, Random
	Inter Burst Gap	10BASE-T: Resolution of 800 ns 8 µs to 1700 s, Settable as fixed 100BASE-T: Resolution of 80 ns 800 ns to 170 s, Settable as fixed	Resolution of 8 ns 64 ns to 120 s, Settable as fixed
	Inter Stream Gap	10BASE-T: Resolution of 800 ns 8 µs to 1700 s, Settable as fixed 100BASE-TX: Resolution 80 ns 800 ns to 170 s, Settable as fixed	Resolution of 8 ns 64 ns to 120 s, Settable as fixed
Number of Streams		256 Streams/Port	
Error Insertion	Frame Error	FCS error, Undersize error, Oversize error, Fragments error, Oversize & FCS error, Alignment error, Dribble bit error, Collision	FCS error, Undersize error, Oversize error, Fragments error, Oversize & FCS error
	Packet Error	IPv4 header checksum error, TCP/UDP checksum error	
	Packet BER Test (MP1590B-11)*3	PRBS error	
Counter	Common	Transmitted frame count/rate, Received frame count/rate, Transmitted bit count/rate, Received bit count/rate, Transmitted byte/rate, Received byte/rate, Capture trigger, Capture filter, User defined 1 count/rate, User defined 2 count/rate	
	Ethernet	Transmitted ARP reply, Received ARP reply, Transmitted ARP request, Received ARP request, Flow control, Dribble bit error, Line error, Fragments, Undersize, Oversize, Oversize & FCS error, FCS error, Alignment error, Collision	Transmitted ARP reply, Received ARP reply, Transmitted ARP request, Received ARP request, Flow control, Line error, Fragments, Undersize, Oversize, Oversize & FCS error, FCS error, Byte alignment error
	IP/TCP/UDP	Transmitted IPv4 packet count/rate, Received IPv4 packet count/rate, Transmitted PING reply, Received PING reply, Transmitted PING request, Received PING request, QoS 0 to 7 frame count/rate, Received TCP packet count/rate, Received UDP packet count/rate, IPv4 header checksum error, TCP checksum error, UDP checksum error	
	Unframed*6	Bit error count/rate, Pattern sync loss count/second	
	Packet BER Test (MP1590B-11)*3	Transmitted test frame, Received test frame, Sequence error, PRBS bit error count/rate, PRBS frame error count/rate	
	IPv6 Expansion (MP1590B-12)*3	Transmitted IPv6 packet count/rate, Received IPv6 packet count/rate, Transmitted ICMPv6 echo request, Received ICMPv6 echo request, Transmitted ICMPv6 echo reply, Received ICMPv6 echo reply, Transmitted ICMPv6 (NA), Received ICMPv6 (NA), Transmitted ICMPv6 (NS), Received ICMPv6 (NS)	
Latency		Maximum, Minimum, Average	
Frame Arrival Time Variation Measurement		Time resolution: 1 µs, 10 µs, 100 µs, 1 ms, 10 ms, 100 ms, 1 s	
QoS Counter Setting		Using QoS described below, 8-level priority frame count: IEEE802.1D VLAN tag user priority field, 3 LSB of RFC2474 DSCP field	
Unframe BER Test*6		Test pattern: All 0, All 1, User-defined 16-bit pattern, $2^{23}-1$ (Inv.), $2^{31}-1$ Error insertion: Bit unit Error insertion timing: Single error, Fix rate: $1 * 10^{-n}$ (n: 3 to 9), User program: A $*10^{-B}$ (A: 1.0 to 9.9 step 0.1, B: 2 to 10)	Test pattern: All 0, All 1, User-defined 16-bit pattern, $2^{23}-1$ (Inv.), $2^{31}-1$, CJPAT, CRPAT Error insertion: Bit unit Error insertion timing: Single error, Fix rate: $1 * 10^{-n}$ (n: 3 to 9), User program: A $*10^{-B}$ (A: 1.0 to 9.9 step 0.1, B: 2 to 10)
Capture Buffer		8 Mbyte/port	32 Mbyte/port

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Model	MU120111A	MU120112A
Capture Filter	At following conditions for each port, capture filter condition settings: Destination MAC address, Source MAC address, 128-bit pattern (settable bit length and offset) x 2, Error conditions	
Capture Trigger	At following conditions for each port, capture trigger condition settings: Destination MAC address, Source MAC address, 128-bit pattern (settable bit length and offset) x 2, Error conditions, Traffic over, Latency over, External trigger input	
Protocol Decode	ARP, BGP-4, DHCP, DVMRP, Ethernet, ICMP, ICMPv6, IGAP, IGMP, IPCP, IPv4, IPv6, IPv6CP, IPX, IS-IS, LCP, LDP, MAC Control Frame, MPLS, MPLSCP, OSPFv2, RIP, RSVP, SNAP, TCP, UDP, VLAN, MD1230A Test Frame	
Protocol Emulation	ARP, ICMP for IPv4, IGMP, BGP-4, OSPF (MP1590B-07), MPLS LDP/CR-LDP (MP1590B-08), MPLS RSVP (MP1590B-09), ICMP for IPv6 (MP1590B-12), IGAP (MP1590B-14)	
Traffic Monitor	Ethernet frame count for up to 64 flows, IP packet count for up to 64 flows, Frame count for up to 64 protocols	
Traffic Map	Ethernet data flow for up to 256 flows, IP data flow for up to 256 flows	
Service Disruption Time	Time of frame disruption	
RFC2544 Automatic Test	Throughput, Latency, Frame Loss Rate, Back-to-Back Frame, System Recovery, Reset	
RFC2889 Automatic Test (MP1590B-10)*3	[1] Fully Meshed Throughput and Frame Loss, Forwarding Rate, [2] Partially Meshed one-to-Many/Many-to-One, [3] Partially Meshed Multiple Devices, [4] Partially Meshed Unidirectional Traffic, [5] Congestion Control, [6] Forward Pressure and Maximum Forwarding Rate, [7] Address Caching Capacity, [8] Address Learning Rate, [9] Error Frames Filtering, [10] Broadcast Frame Forwarding and Latency	
Supported main frame option	MP1590B-07, MP1590B-08, MP1590B-09, MP1590B-10, MP1590B-11, MP1590B-12, MP1590B-14	

*1: 1000BASE-SX/LX/LH/ZX/T can be selected by changing the GBIC module.
*2: VLAN tag and MPLS labels cannot both be used simultaneously.
*3: Main frame option is required.
*4: This function causes TCP/UDP checksum error when it uses TCP/UDP frame.
*5: Increment and random of frame length can be used only when choosing “None” as a protocol.
*6: Unframe BER Test (MU120111A) works only on port 1 or port 5.

Ordering information

Please specify model/order number, name and quantity when ordering.

Model/Order No.	Name	
	Main frame	
MP1590B	Network Performance Tester	
	Standard accessories	
	Shield power cord, 2.6 m:	1 pc*1
	Power cord L type (C7), 2.5 m:	1 pc*1
F0105	Fuse, 10 A:	2 pcs
E0008A	Optical output control key:	1 pc
E0010	Side cover:	1 pc
J0907Q	Remote inter lock cord:	1 pc
J0908	Remote inter lock terminator:	1 pc
B0329G	Front cover (3/4MW4U):	1 pc
W2428AE	MP1590B operation manual CD-ROM:	1 copy
J0617B*2, *3	Replaceable optical connector (FC-PC):	1 pc/2 pcs
J0739G*4	Optical adapter FC PANDA:	2 pcs
J0635A*5	Optical fiber cable	
	(FC · PC-FC · PC-1M-SM), 1 m:	1 pc
J1200*6	Pmoptical fiber cord, 0.5 m:	1 pc
J0747B*7	Fixed optical attenuator (10 dB):	1 pc
J0747C*8	Fixed optical attenuator (15 dB):	1 pc
J1003N*9	Semi-rigid cable (136.6 mm):	2 pcs
J1003P*9	Semi-rigid cable (96 mm):	1 pc
J1003Q*10, *11	Semi-rigid cable (75.6 mm):	1 pc/2 pcs
J1003R*9	Semi-rigid cable (55.3 mm):	1 pc
J1003S*8	Semi-rigid cable (56.5 mm):	1 pc
	Units/Modules	
MU150100A*12	10/10.7G Unit	
MU150101A*12	2.5/2.6G EoS Unit	
MU150121A*12	10/10.7G Optical Unit (Tx)	
MU150122A	10/10.7G Optical Unit (Rx Narrow)	
MU150123A	10/10.7G Optical Unit (Rx Wide)	
MU150125A	10/10.7G Jitter Unit	
MU150134A	10/10.7G Optical Unit (Tx. Ex. mod)	
MU120101A	10M/100M Ethernet Module	
MU120102A*13	Gigabit Ethernet Module	
MU120111A	10/100M Ethernet Module	
MU120112A*13	Gigabit Ethernet Module	
MU120118A*14	10 Gigabit Ethernet Module	

Model/Order No.	Name
	Options
MP1590B-01	RS-232C
MP1590B-02	GPIB
MP1590B-03	LAN
MP1590B-07	OSPF Protocol
MP1590B-08	MPLS (LDP/CR-LDP) Protocol
MP1590B-09	MPLS (RSVP) Protocol
MP1590B-10	RFC2889 Benchmarking Test
MP1590B-11	Packet BER Test
MP1590B-12	IPv6 Expansion
MP1590B-13	XENPAK Test
MP1590B-14	IGAP Protocol
MP1590B-16	Link Fault Signaling
MP1590B-30*15	High precision Jitter analysis
MU150100A-01	Wavelength 1.31 µm
MU150100A-02	Wavelength 1.55 µm
MU150100A-03	Wavelength 1.31/1.55 µm
MU150100A-04	Optical output power adjustable
MU150100A-05	OTU1/OTU2
MU150100A-07*16	10/10.7G Minus Option
MU150100A-09*16	Insert/Extract
MU150100A-38*17	ST connector
MU150100A-39*17	DIN connector
MU150100A-40*17	SC connector
MU150100A-43*17	HMS-10/A connector
MU150101A-01	Wavelength 1.31 µm
MU150101A-02	Wavelength 1.55 µm
MU150101A-03	Wavelength 1.31/1.55 µm
MU150101A-04	Optical output power adjustable
MU150101A-05	OTU1
MU150101A-06	GFP-F/LEX/LAPS
MU150101A-07	POS
MU150101A-11	HO Virtual Concatenation
MU150101A-12	LO Virtual Concatenation
MU150101A-13*18	LCAS
MU150101A-38*17	ST connector
MU150101A-39*17	DIN connector
MU150101A-40*17	SC connector
MU150101A-43*17	HMS-10/A connector

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Model/Order No.	Name
MU150121A-01	Wavelength 1.31 µm
MU150121A-02	Wavelength 1.55 µm
MU150121A-03	Wavelength 1.31/1.55 µm
MU150121A-04	Optical output power adjustable
MU150121A-38*17	ST connector
MU150121A-39*17	DIN connector
MU150121A-40*17	SC connector
MU150121A-43*17	HMS-10/A connector
MU150122A-38*17	ST connector
MU150122A-39*17	DIN connector
MU150122A-40*17	SC connector
MU150122A-43*17	HMS-10/A connector
MU150123A-05	OTU2
MU150123A-38*17	ST connector
MU150123A-39*17	DIN connector
MU150123A-40*17	SC connector
MU150123A-43*17	HMS-10/A connector
MU150125A-01	Wander measurement
MU150125A-05	OTU1/OTU2
MU150125A-06	10.3G
MU150134A-04	Optical output power adjustable
MU150134A-38*17	ST connector
MU150134A-39*17	DIN connector
MU150134A-40*17	SC connector
MU150134A-43*17	HMS-10/A connector
	Maintenance service
MP1590B-90	Extended three year warranty service
MU150100A-90	Extended three year warranty service
MU150101A-90	Extended three year warranty service
MU150121A-90	Extended three year warranty service
MU150122A-90	Extended three year warranty service
MU150123A-90	Extended three year warranty service
MU150125A-90	Extended three year warranty service
MU150134A-90	Extended three year warranty service
MU120101A-90	Extended three year warranty service
MU120102A-90	Extended three year warranty service
MU120111A-90	Extended three year warranty service
MU120112A-90	Extended three year warranty service
MU120118A-90	Extended three year warranty service
	Optional accessories
J0796A	ST connector (replaceable, with protective caps, 1 set)
J0796B	DIN connector (replaceable, with protective caps, 1 set)
J0796C	SC connector (replaceable, with protective caps, 1 set)
J0796D	HMS-10/A connector (replaceable, with protective caps, 1 set)
J0796E	FC connector (replaceable, with protective caps, 1 set)
J0617B	Replaceable optical connector (FC-PC)
J1003N	Semi-rigid cable (136.6 mm)
J1003P	Semi-rigid cable (96 mm)
J1003Q	Semi-rigid cable (75.6 mm)
J1003R	Semi-rigid cable (55.3 mm)
J1003S	Semi-rigid cable (56.5 mm)
J1200	Pmoptical fiber cord (both-end SFC-SP connector), 0.5 m
J0747B	Fixed optical attenuator (10 dB)
J0747C	Fixed optical attenuator (15 dB)
J0747D	Fixed optical attenuator (20 dB)
J0775D	Coaxial cable (BNC-P620 · 3C-2WS · BNC-P620, 75 Ω), 2 m
J0776D	Coaxial cable (BNC-P-3W · 3D-2W · BNC-P-3W, 50 Ω), 2 m
J0322B	Coaxial cable (11SMA · SUCOFLEX104 · 11SMA), 1 m
J0162A	Balanced cable (Siemens 3P- Siemens 3P), 1 m
J0162B	Balanced cable (Siemens 3P- Siemens 3P), 2 m
J0845A	Balanced cable (BANTAM 3P/BANTAM 3P), 6 ft
J0635A	Optical fiber cable (SM, FC-SPC connector both ends), 1 m
J0635B	Optical fiber cable (SM, FC-SPC connector both ends), 2 m
J0635C	Optical fiber cable (SM, FC-SPC connector both ends), 3 m
J0008	GPIB cable, 2 m
Z0478	Polarization rotating module (for MU150134A)
G0105A*19	GBIC SX 850 nm
G0106A*19	GBIC LX 1310 nm
G0107A*19	GBIC LH 1310 nm
G0108A*19	GBIC ZX 1550 nm
G0124A*20	GBIC T (1000BASE-T)
G0126A*21	XENPAK (10GBASE-LR)
G0131*21	XENPAK (10GBASE-ER)
G0132*21	XENPAK (10GBASE-SR)

Model/Order No.	Name
MZ1221A	XAUI Extender
MZ1222A	XENPAK Interface
J1163A	XAUI cable, 0.5 m
J1164A	MDIO cable, 0.5 m
J1109B	LAN cable (Cross), 5 m
J1110B	LAN cable (Straight), 5 m
B0336C	Carrying case
B0448	Soft case
Z0321A	Keyboard (PS/2)
Z0541A	USB mouse
W2420AE	MP1590B operation manual
W2421AE	MX159001B operation SDH edition manual
W2422AE	MX159001B operation SONET edition manual
W2423AE	MP1590B remote control operation manual
W2424AE	MU150100A specifications operation manual
W2425AE	MU150101A specifications operation manual
W2426AE	MU150125A specifications operation manual
W2427AE	MU150121/2/3/34A specifications operation manual
W1931AE	MU120101A/11A 10M/100M Ethernet Module MU120102A/12A Gigabit Ethernet Module MU120118A 10 Gigabit Ethernet Module operation manual

*1: J0491 or J0670A is attached.
*2: Supplied with MU150100A, MU150121A, MU150122A, MU150123A, MU150134A.
*3: In MU150100A, 2 pcs are supplied.
*4: Supplied with MU150134A.
*5: Supplied with MU150100A, MU150122A, MU150123A. SM, FC-SPC connector both ends.
*6: Supplied with MU150134A, FC · PANDA cord.
*7: Supplied with MU150122A, MU150123A.
*8: Supplied with MU150100A.
*9: Supplied with MU150125A.
*10: Supplied with MU150121A, MU150122A, MU150123A, MU150134A.
*11: MU150122A/MU150123A: 1 pc, MU150121A/MU150134A: 2 pcs are supplied.
*12: Requires Option 01, 02 or 03.
*13: MU120102A/12A require GBIC modules (sold separately).
*14: MU120118A requires XENPAK modules (sold separately).
*15: Unit composition has restriction. For details, please refer to a specifications.
*16: This Option must be installed in the factory. MU150100A-07 and MU150101A-09 cannot be installed simultaneously.
*17: Replaceable.
*18: This option requires the MU150101A-11 and/or MU150101A-12.
*19: The GBIC module is sold per one piece on a per-unit basis. MU120102A/12A has two GBIC interface slots.
*20: The GBIC-T module is sold on a per-unit basis. MU120112A has two GBIC interface slots.
*21: The XENPAK module is sold on a per-unit basis. MU120118A has two XENPAK interface slots.