

Anritsu envision : ensure

Network Performance Tester

MP1590B8



All-In-One Next-Generation Network Testing OTN, SDH/SONET, PDH/DSn, Jitter, Ethernet Analyzer

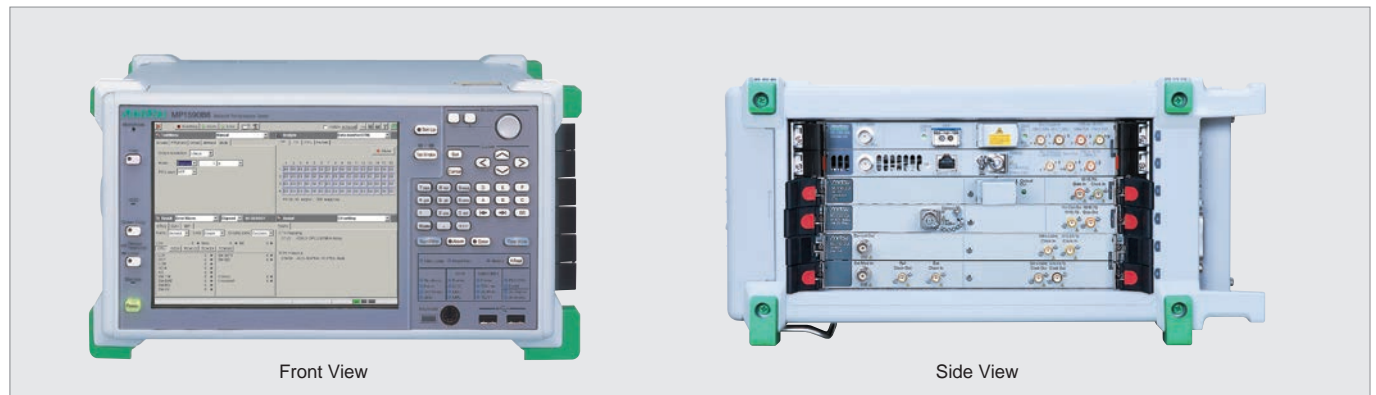
The dawn of the NGN era and the spread of high value-added and seamless networks are driving the need for high-level testing and evaluation of these networks and their network devices.

Using modular plug-in units, Anritsu's MP1590B8 supports performance and jitter measurements of networks, equipment and devices with SDH/SONET/OTN/PDH/DSn/Ethernet interfaces.

This tester family is the perfect tool for performing the wide range of measurements covering the physical to application layers needed for constructing next-generation networks.

- Simultaneous Multichannel Measurement
- All-in-one Support for Performance Measurements of OTN, SDH/SONET, PDH/DSn, Jitter
- Supports 10 Gigabit Ethernet BER measurements

MP1590B8 Main Frame*



*: Only a module with an option-088 can be inserted in MP1590B8.

6-slot Integrated screen model
 Dimensions: 320 (W) x 177 (H) x 350 (D) mm
 Mass: 13 kg max. (excl. options and units)

OTN, SDH/SONET, PDH/DSn, Jitter Unit Frame Generation/Detection

MU150110A Multirate Unit



- PDH/DSn Measurement
- SDH/SONET (STM-0/OC-1 to STM-64/OC-192) Measurement
- OTN (OTU1, OTU2) Measurement (Option 005)
- OTN (OTU1e, OTU2e) Measurement (Option 006)
- 10G Ethernet Measurement (Option 008)
- Multichannel Measurement (Option 010)

MU150125A 10/10.7G Jitter Unit



- Bit Rate: 52 Mbit/s to 10.7 Gbit/s
- Jitter Generation Measurement
- Jitter Tolerance Measurement
- Jitter Transfer Measurement

10/10.3/10.7G Optical Interfaces

MU150121A 10/10.7G Optical Unit (Tx)



Interface: Optical Output
 Bit rate: 9.95328 Gbit/s, 10.709225 Gbit/s

MU150123A 10/10.7G Optical Unit (Rx Wide)



Interface: Optical Input
 Bit rate: 9.95328 Gbit/s, 10.709225 Gbit/s



Main Applications

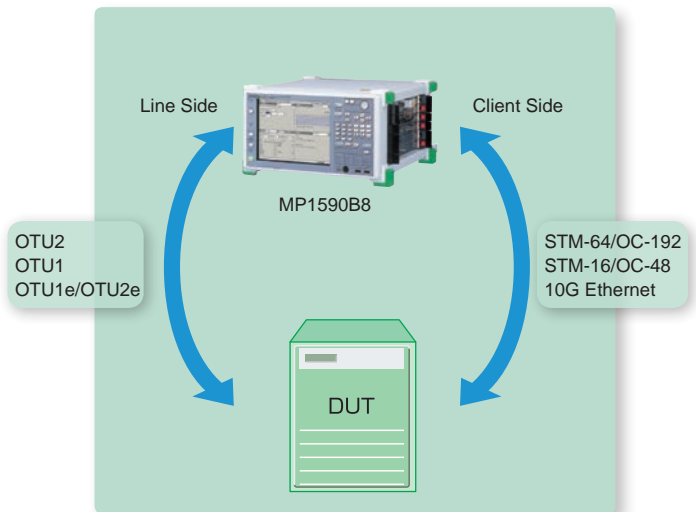
OTN, SDH/SONET, PDH/DSn, 10 GigE Performance Measurements

The MP1590B8 supports ITU-T, Telcordia and IEEE compliance tests of 1.5M to 11.1G OTN, SDH/SONET, PDH/DSn, 10 GigE equipment. The following functions can be used to evaluate the performance of networks, equipment, and devices supporting these standards:

- Multichannel Measurement
- Error/Alarm Measurements
- Alarm Detection and Removal Conditions Setting Function
- Delay Time Measurement
- APS (Automatic Protection Switching) Measurement
- Through Mode Function
- Overhead Editing Function
- Monitor Functions
- Unframe BER Measurement
- Variable Frequency Offset Function
- FEC Performance Measurement
- 10G Ethernet BER Measurement

Sending remote control commands via the Ethernet/RS-232C/GPIB interfaces makes it easy to configure a customized measurement environment for maintenance, installation, R&D, and manufacturing.

Different bit rates can be specified for MP1590B8 Tx and Rx signals. This means that line- and client-side equipment and networks can be tested simultaneously, supporting configuration of an efficient measurement environment.



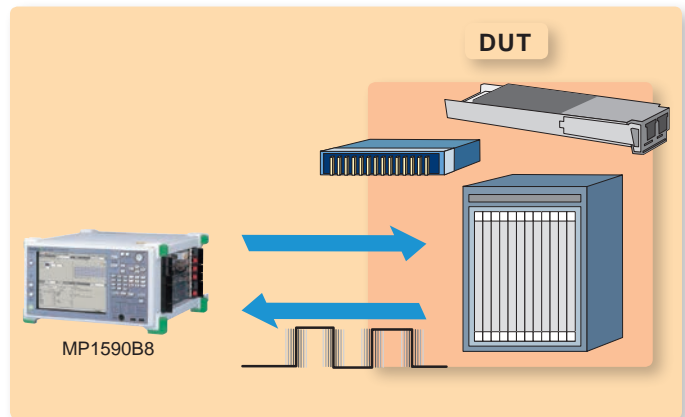
See page 4 for function details, page 8 for the list of functions and supported mappings, and page 16 for the specifications of the main frame and plug-in modules.

OTN, SDH/SONET Jitter Measurements

Jitter is a key index expressing the performance and quality of OTN and SDH/SONET transmission equipment and devices. Jitter evaluation is also an important part of assuring interoperability and network stability. The MP1590B8 supports the following ITU-T and Telcordia-compliant OTN, SDH/SONET measurements from 52 Mbit/s to 10.7 Gbit/s:

- Jitter Generation Measurement
- Jitter Tolerance Measurement
- Jitter Transfer Measurement

The user can set any mask standard values for these measurements. Because the MP1590B8 supports optical, electrical and electrical differential (10G band only) interfaces, network equipment jitter as well as device and optical module jitter can be measured. In the 10G band, jitter measurement of 10.3 Gbit/s transfers used by 10G Ethernet can be measured.



When required, a high-accuracy jitter measurement option can be installed in the MP1590B8 to perform high-accuracy and high-repeatability measurements with calibration based on Appendix VIII of the April 2005 ITU-T O.172 standard. But even without this option, jitter measurement is still in full compliance with the April 2005 ITU-T O.172 standards.

See page 6 for details of individual functions, page 8 for the list of functions and supported mappings, and page 11 for the specifications of the main frame and plug-in modules.

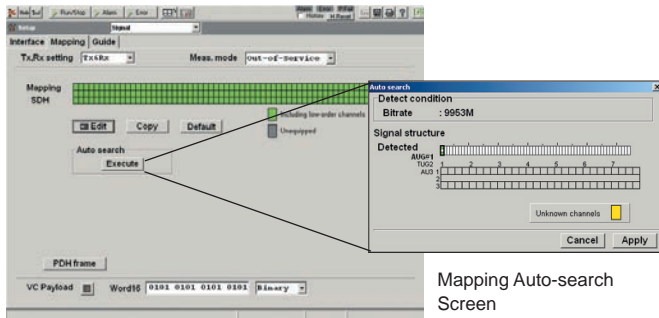
Anritsu is a proactive member of the ITU-T standardization working groups and has extensive knowledge and practical experience of jitter measurement that is incorporated in the MP1590B8.

Individual Applications

OTN, SDH/SONET, PDH/DSn, 10 GigE Performance Measurements

Multichannel Measurement

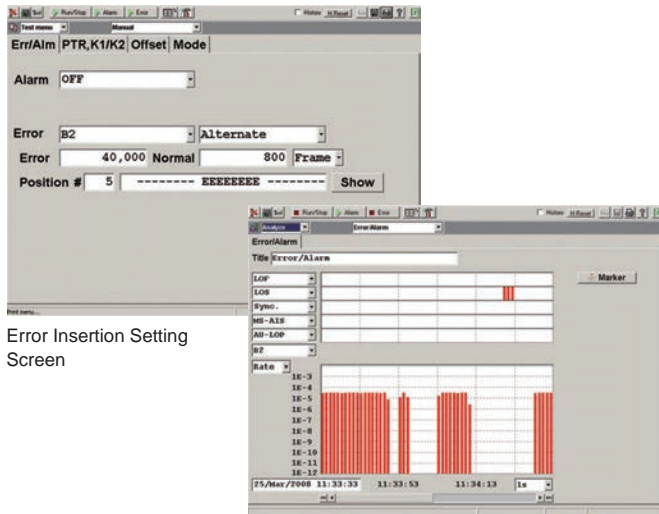
SDH/SONET signal channel configurations ranging from STM-0/OC-1 to STM-64/OC-192 are detected automatically and the performance (errors, alarms, BER, APS, delay time) of all channels including both high and low order (max. 5,376 channels at VC11/VT1.5) can be measured simultaneously, supporting correlation confirmation between channels as well as greatly reduced measurement times.



Mapping Auto-search Screen

Error/Alarm Measurements

Errors (such as FAS, BIP-8, and B1/B2/B3) and alarms (such as LOF, LOM, and AIS) can be generated at any timing and counted or monitored by the MP1590B8 for stress testing SDH/SONET and OTN equipment.

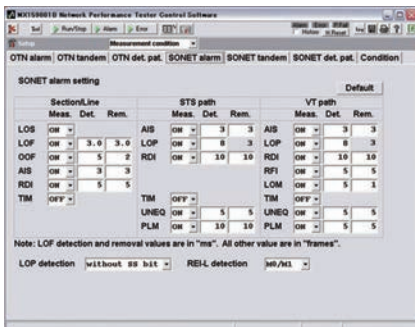


Error Insertion Setting Screen

Error Monitor Screen

Alarm Detection and Removal Condition Setting Function

This function changes the conditions for detecting and removing alarms, making it easy to stress test ITU-T and Telcordia-compliant equipment and networks. This greatly simplifies fault testing.



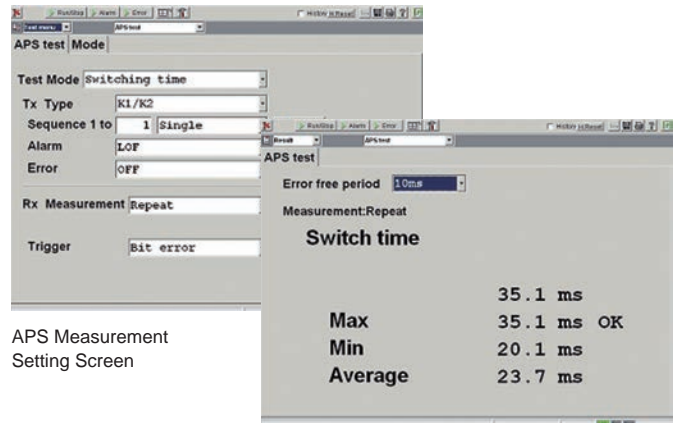
Delay Time Measurement

Network delay is known to be a key factor that directly impacts network quality. This measurement supports measurement of payload data transmission quality to the order of 0.1 μ s.



APS Measurements

The Auto Protection Switch (APS) test function checks of equipment switching time with 0.1 ms resolution. The switching time until the fault condition triggered by an error or alarm is released can be measured to check standards-compliant rerouting caused by faults.



APS Measurement Setting Screen

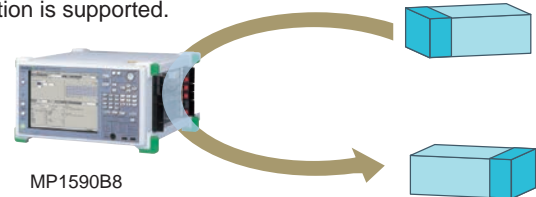
APS Measurement Results Screen

Through Mode Function

The MP1590B8 Through mode can be used for all supported bit rates. Connecting devices using this mode allows monitoring the actual signal quality as well as inserting various errors and alarms into the circuit path.

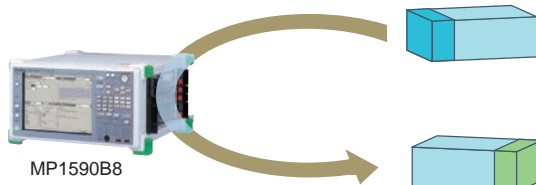
– Transparent Mode –

In this mode, the received signal is looped back as is which is useful for emulating the transmission path because bit error insertion is supported.



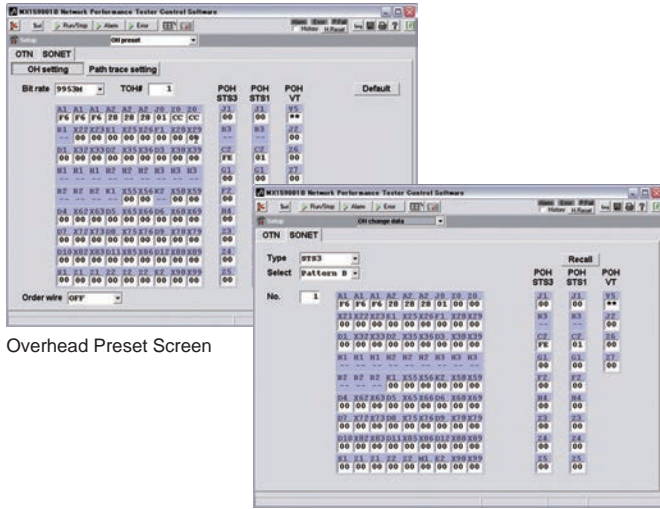
– Overhead Overwrite Mode –

In this loopback mode, the overhead part of the received SDH/SONET/OTN signal can be overwritten with a new overhead specified by the MP1590B8 in order to emulate various errors and alarms that can occur in actual circuits.



Overhead Editing Function

Tx frame overhead can be changed easily to simplify stress and fault testing of ITU-T and Telcordia-compliant equipment and networks.

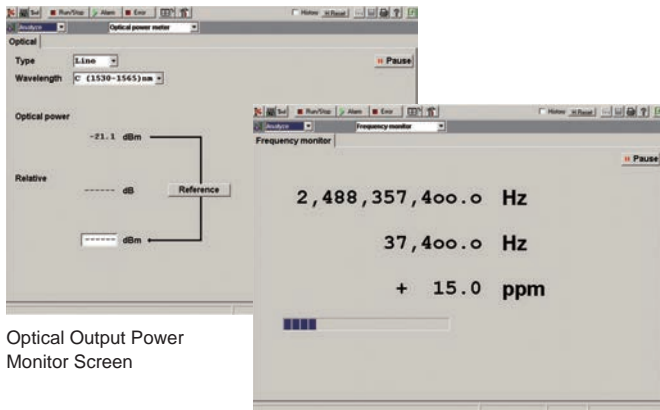


Overhead Preset Screen

Overhead Test Screen

Monitor Function

Networks are easily monitored using a full line-up of versatile functions for monitoring errors/alarms, frequency, pointers, overhead, optical output power, and more.

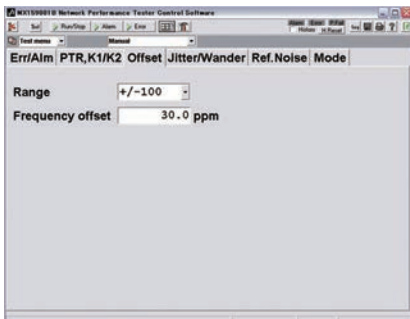


Optical Output Power Monitor Screen

Frequency Monitor Screen

Variable Frequency Offset Function

The MP1590B8 supports variation of the Tx clock in 0.1 ppm steps over a range of ±100 ppm. They can also send signals synchronized with an external clock source to perform device and network stress tests using degraded clocks exceeding the ITU-T and Telcordia specified ±20 ppm frequency range.

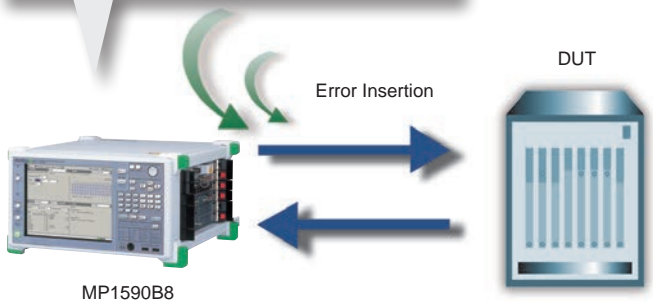


FEC Performance Measurement (OTN-specific)

This function for inserting Poisson-distributed random errors specified by ITU-T O.182 supports easy and high-reproducibility validation of the error-correction performance of FEC decoders, avoiding the use of external equipment such as noise generators. Burst error insertion provides an efficient method of validating FEC burst-error correction performance.

Random Error Insertion using O.182 Method.

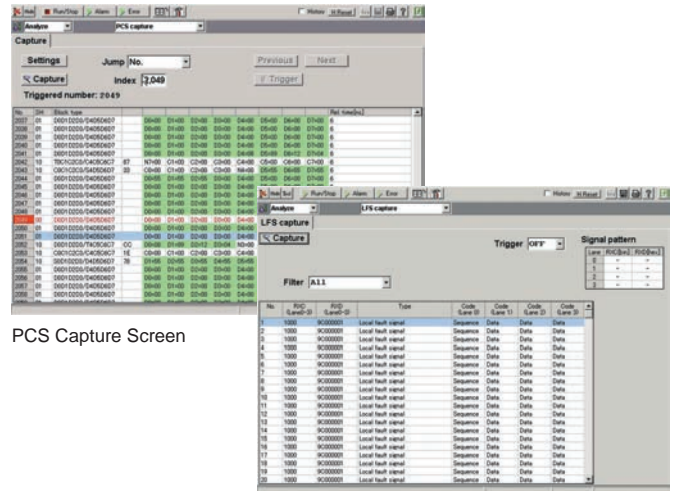
This function is required for FEC evaluation. Accurate measurement was impossible using previous error insertion method.



MP1590B8

10G Ethernet BER Measurement

The quality of 10G Ethernet equipment and networks can be evaluated by measuring throughput, BER, sequence errors, and latency. In addition, detailed analysis of the 10G Ethernet Physical layer is supported by functions including measurement of the 64B/66B encoding used by the PCS (Physical Coding Sublayer) layer, LFS (Link Fault Signaling) which performs warning notifications at faults, clock frequency variations, optical power, etc.



PCS Capture Screen

LFS Capture Screen

■ OTN, SDH/SONET Jitter Measurements

Using the MU150125A 10/10.7G Jitter Unit supports jitter generation and measurement for SDH/SONET/OTN 52 Mbit/s to 10.7 Gbit/s equipment. Jitter of optical modules such as XFP can be measured by adding options supporting 10.3G.

■ Jitter Measurements

There are three types of jitter measurement, depending on the purpose, as shown below. The MP1590B8 simplifies each of these measurements.

• Jitter Generation Measurement

The jitter generated at the output side of equipment and devices is measured to check that it is better than the standard value established by ITU-T and Telcordia.

• Jitter Tolerance Measurement

The jitter tolerance at the input side required for equipment and devices to operate normally is measured to check that it is better than the standard value established by ITU-T and Telcordia.

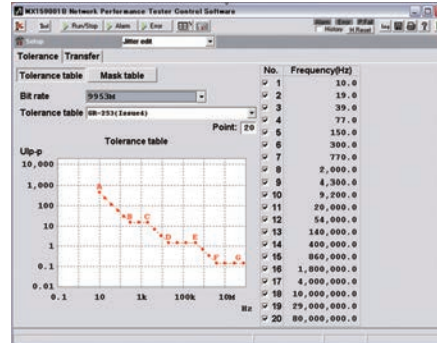
• Jitter Transfer Measurement

The jitter attenuation characteristics between the jitter input to equipment and devices and the output side is measured to check that it is better than the standard value established by ITU-T and Telcordia.

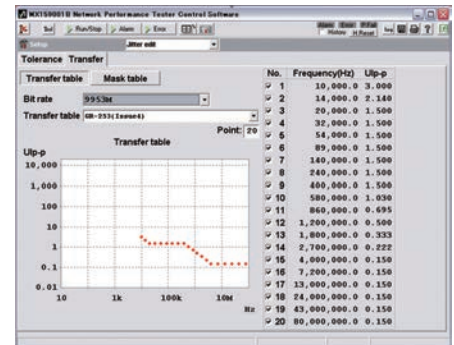
There is a correlation between jitter generation and jitter tolerance measurements: if both meet the standards, network connection compatibility is assured. Jitter transfer characteristics are a standard for curbing accumulated jitter caused by each unit of connected transmission equipment. Jitter transfer can be a major issue when there is a large number of elements in a long-distance network.

■ User Mask Settings

The MP1590B8 can set masks defined by the ITU-T and Telcordia standards as well as any user-defined masks, such as masks with standards-compliant margins.



Jitter Tolerance Mask Setting Screen



Jitter Transfer Mask Setting Screen



Useful Functions

Remote Control from PC

Installing the MX159001B Network Performance Tester Control Software Package in PCs allows remote control of these testers using the same GUI.

• Single User



MP1590B-01: RS-232C
MP1590B-02: GPIB
MP1590B-03: Ethernet



Remote Script

Remote Command Interface

Sending text-based command messages to these testers using the remote command interface provides automated control for creating automatic test applications. The remote command interface supports the RS-232C, GPIB, and Ethernet (Option 01, 02, 03) Interfaces.

• Single User



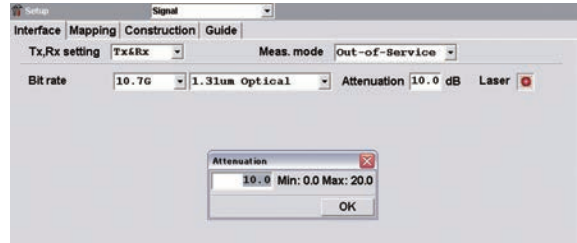
MP1590B-01: RS-232C
MP1590B-02: GPIB
MP1590B-03: Ethernet



Remote Script

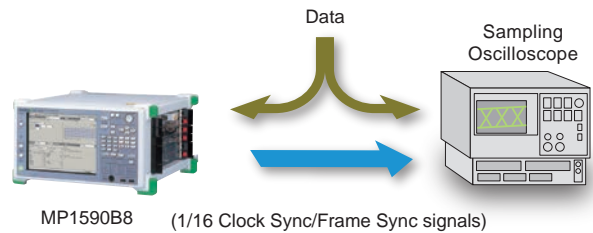
Optical Power Measurement, Optical Attenuation Function

This function measures the average power of the input optical signal when using an optical interface. The optional optical attenuator (Option 04) can attenuate optical output levels up to 30 dB (≤ 2.6 Gbit/s)/20 dB (≥ 9953 Mbit/s).



Trigger Output

A received signal can be used as a trigger output to external equipment. The trigger output can be synchronized to the clock output or divided clock output as well as to a frame. For example, linking the trigger output to an external sampling oscilloscope enables the MP1590B8 to evaluate errors and alarms at the same time the oscilloscope evaluates the waveform.





OTN, SDH/SONET, PDH/DSn, 10 GigE, Jitter Interface List

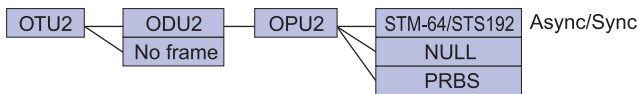
Typical Configuration			For OTN, SDH/SONET, PDH/DSn, 10 GigE Performance Measurement	For OTN, SDH/SONET, Jitter Measurement		
Model/Slot Position	MP1590B8	Slot 1	MU150110A + MU150110A-088	MU150110A + MU150110A-088		
		Slot 2				
		Slot 3	Blank	MU150121A + MU150121A-088		
		Slot 4	Blank	MU150123A + MU150123A-088		
		Slot 5	Blank	MU150125A + MU150125A-088		
		Slot 6	Blank			
Item	Bit Rate	Interface				
Performance Measurement	PDH/DSn	1.5 Mbit/s to 139 Mbit/s	Electrical	✓	✓	
		SDH/SONET	52 Mbit/s to 156 Mbit/s	Electrical • Optical	✓	✓
	622 Mbit/s to 2488 Mbit/s		Optical	✓	✓	
	9953 Mbit/s		Electrical • Optical	✓	✓	
	2666 Mbit/s		Optical	✓*	✓*	
	OTN	10.7 Gbit/s	Electrical • Optical	✓*	✓*	
		11.04 Gbit/s to 11.09 Gbit/s	Optical	✓*	✓*	
			10G Ethernet	10.3 Gbit/s	Electrical • Optical	✓*
	Jitter Measurement	PDH/DSn	1.5 Mbit/s to 139 Mbit/s	Electrical		
			SDH/SONET	52 Mbit/s to 156 Mbit/s	Electrical • Optical	
622 Mbit/s to 2488 Mbit/s		Optical			✓	
9953 Mbit/s		Electrical • Optical			✓	
2666 Mbit/s		Optical			✓*	
OTN		10.7 Gbit/s	Electrical • Optical		✓*	
		11.04 Gbit/s to 11.09 Gbit/s	Optical			

*: Requires addition of separate option.

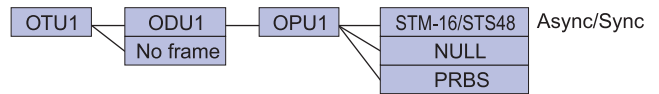
Supported Mappings

OTN Mappings

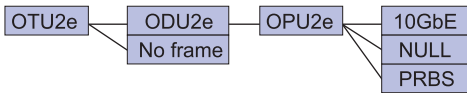
OTU2 (10.71 Gbit/s) Mapping structure



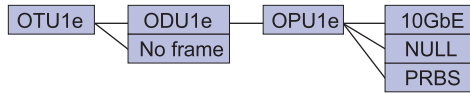
OTU1 (2.66 Gbit/s) Mapping structure



OTU2e (11.09 Gbit/s) Mapping structure

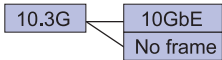


OTU1e (11.04 Gbit/s) Mapping structure



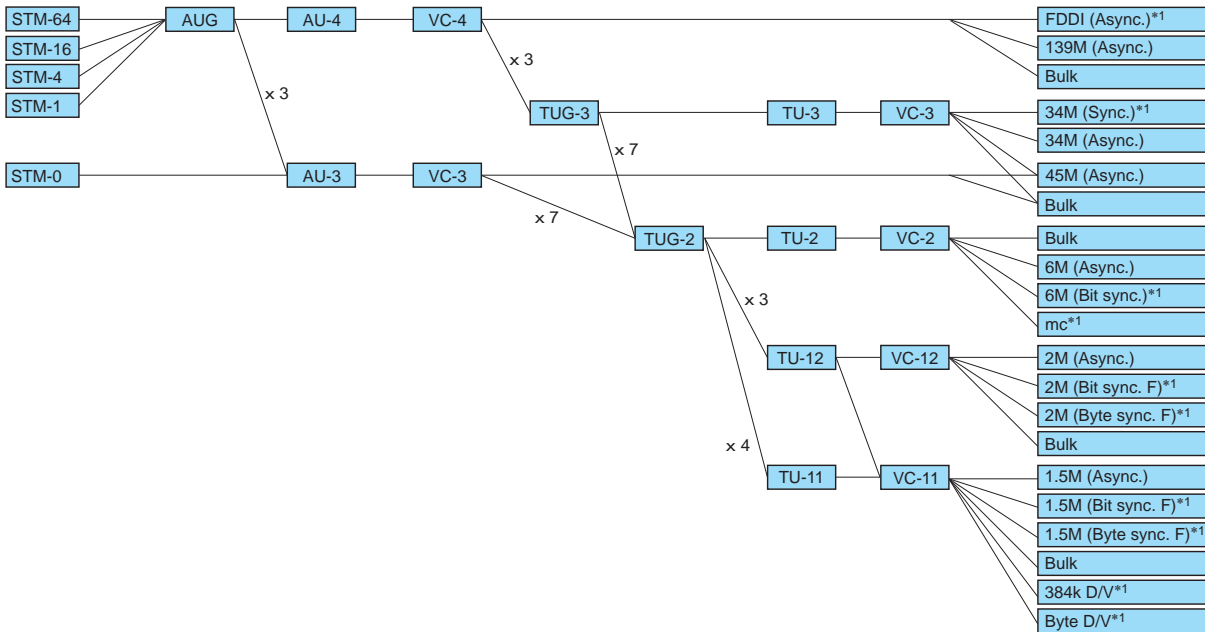
10G Ethernet Mapping

10.3G Mapping structure

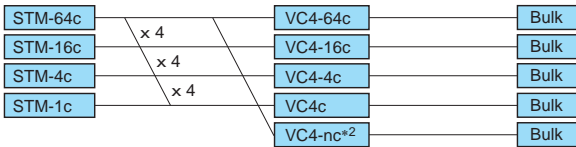


SDH Mappings

SDH Mapping structure

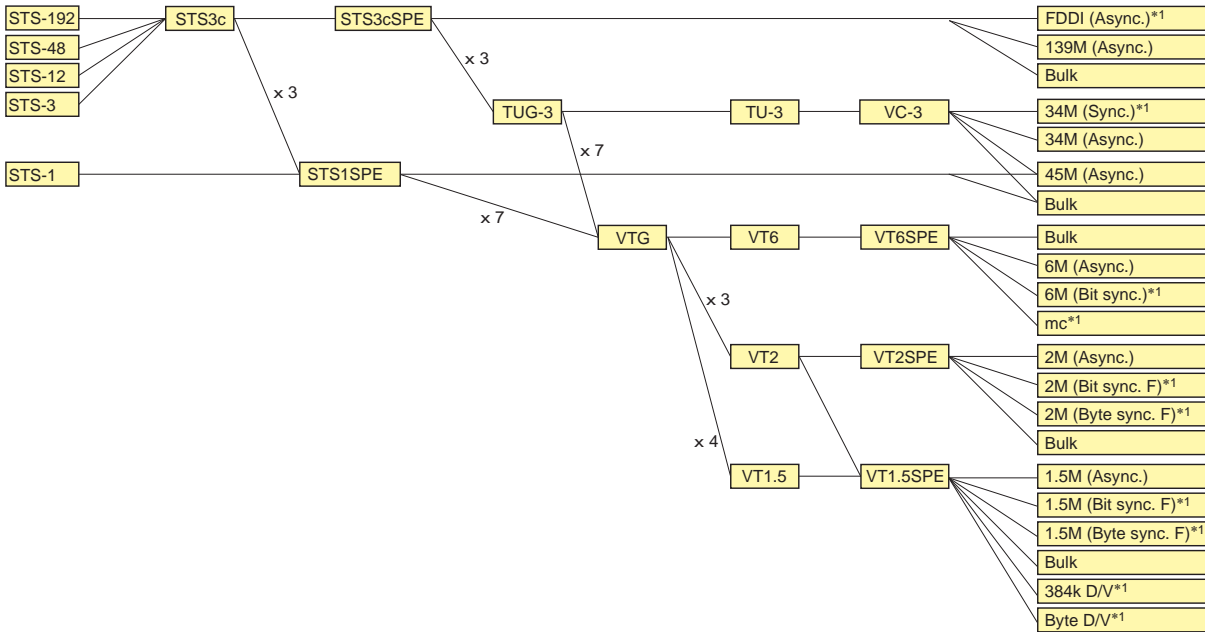


SDH Concatenation mapping structure

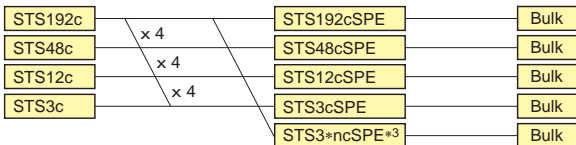


SONET Mappings

SONET Mapping structure



SONET Concatenation mapping structure



*1: Not supported in multichannel mode

*2: The maximum value of n is 16. However, this value is 8 in the multichannel mode. Links cannot be made across the following groups.
 AUG#1 to AUG#8, AUG#9 to AUG#16, AUG#17 to AUG#24,
 AUG#25 to AUG#32, AUG#33 to AUG#40, AUG#41 to AUG#48,
 AUG#49 to AUG#56, AUG#57 to AUG#64

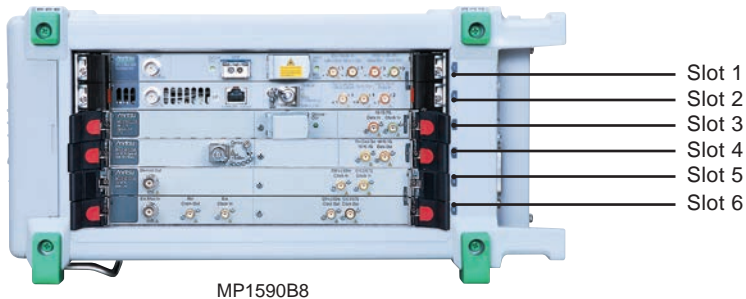
*3: The maximum value of n is 16. However, this value is 8 in the multichannel mode. Links cannot be made across the following groups.

STS3c#1 to STS3c#8, STS3c#9 to STS3c#16, STS3c#17 to STS3c#24,
 STS3c#25 to STS3c#32, STS3c#33 to STS3c#40, STS3c#41 to STS3c#48,
 STS3c#49 to STS3c#56, STS3c#57 to STS3c#64



Selection Guide

Unit Insertion Positions



Plug-in Unit Insertion Table

Model/Order No.	Module Name	No. of Slots Required	No. of Ports	Max. No. Modules	Supported Slots
MU150110A + MU150110A-088	Multirate Unit	2	—	1	1 to 2
MU150121A + MU150121A-088	10/10.7G Optical Unit (Tx)	1		1	3
MU150123A + MU150123A-088	10/10.7G Optical Unit (Rx Wide)	1		1	4
MU150125A + MU150125A-088	10/10.7G Jitter Unit	2		1	5 to 6

MP1590B8 Main Frame Options

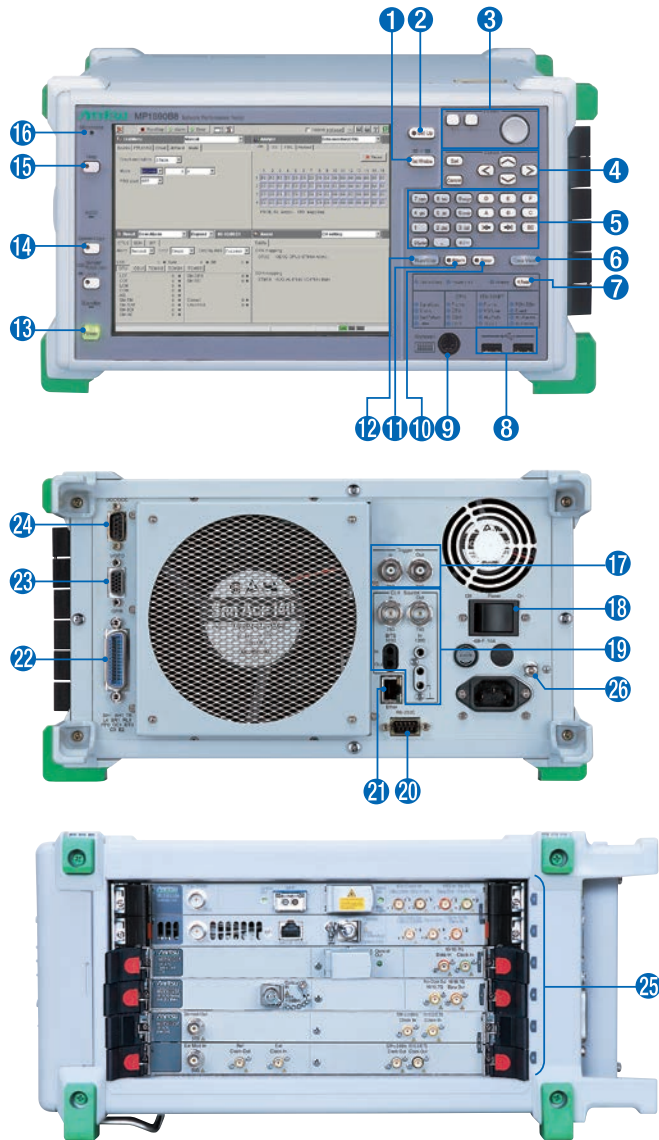
Name	Model/Order No.
RS-232C	MP1590B-01
GPIB	MP1590B-02
Ethernet	MP1590B-03

Plug-in Unit Options

	Model/Order No.	Name	MU150110A + MU150110A-088	MU150121A + MU150121A-088	MU150123A + MU150123A-088	MU150125A + MU150125A-088
OTN, SDH/SONET, PDH/DSn, Jitter, Unit	MU150110A-004, MU150121A-04	Optical Output Power Adjustable	✓	✓		
	MU150110A-005, MU150125A-05	OTU1/OTU2	✓			✓
	MU150123A-05	OTU2			✓	
	MU150110A-006	11.1G	✓			
	MU150125A-01	Wander Measurement				✓
	MU150110A-008, MU150125A-06	10.3G	✓			✓
	MU150110A-009	Insert/Extract	✓			
	MU150110A-010	Multichannel Measurement	✓			
MU150110A/21A/23A-40	SC Connector	✓	✓	✓		



MP1590B8 Network Performance Tester



1	Test Window	Switches between one screen and four split screens
2	Set Up	Switches between Setup window and Test Window
3	Pointer	Performs same operation as mouse
4	Cursor	Set: Sets data Cancel: Deletes set data <> < >: Move cursor around screen
5	Input Keys	Input numeric values and data
6	Tree View	Toggles Tree View area display on/off
7	H.Reset	Resets history data
8	USB (2 Ports)	Connects USB devices
9	Keyboard	Connects PS/2 keyboard
10	Error	Starts/Stops error addition
11	Alarm	Starts/Stops alarm addition
12	Run/Stop	Starts/Stops measurement
13	Power	When Power lamp lit, quits MP1590B8 application and returns to Standby status When in Standby status (Standby lamp lit), launches MP1590B8 application
14	Screen Copy	Copies screen contents
15	Help	Displays Help screen
16	Microphone	Microphone for order wire
17	Trigger	Input: Connector for inputting external trigger for running APS test and capture Output: Connector for outputting errors/alarms and capture trigger
18	Power (main)	Switches main power on and off
19	CLK Source	Input: Connector for inputting reference signal for syncing Tx signal to reference signal Output: Connector for outputting reference signal synchronized to Tx signal
20	RS-232C	RS-232C interface connector
21	Ethernet	10BASE-T/100BASE-TX Ethernet connector for remote control.
22	GPIB	GPIB interface connector
23	VIDEO	VGA connector for external display
24	DCC/GCC	I/O connector for DCC (SDH/SONET) and GCC (OTN) bytes, and for data and clock for add/drop
25	Plug-in slot	Slot for plug-in unit
26	Functional Ground Terminal	Terminal for grounding frame to earth



Specifications

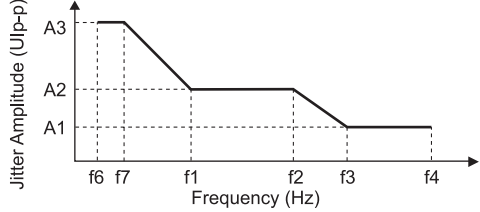
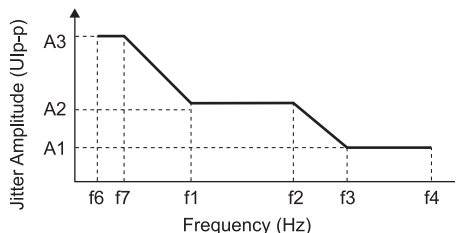
• MP1590B8 Network Performance Tester

Indicator	LCD	8.4", Color TFT, SVGA (800 × 600)	
	LED	OTN: Frame, OTU, ODU, OPU SDH/SONET: Frame, MS/Line, AU/Path, TU/VT Other: Standby, HDD, Clock Loss, Power Fail, History, Signal Loss, Errors, Test Pattern, Jitter, PDH/DSn, Event, All Errors, All Alarms	
OS		Windows 7, [Windows Embedded Standard 7 (32 bits)]	
Storage Unit		HDD	
RS-232C, GPIB, Ethernet (RJ-45), USB1.1 × 2 ports, Keyboard (PS/2), VGA (15-pin mini D-sub)			
Interface	Reference Clock Input	<p>Frequency</p> <p>Clock: 1.544 MHz, 2.048 MHz, 64 kHz + 8 kHz, 5 MHz, 10 MHz</p> <p>Data: 1.544 Mbit/s (BITS), 2.048 Mbit/s</p> <p>Input Range: ±50 ppm</p> <p>Level/Code</p> <p>1.544 Mbit/s: ANSI T1.403 (B8ZS)</p> <p>2.048 Mbit/s: ITU-T G.703 Table 10 (HDB3)</p> <p>1.544 MHz, 2.048 MHz, 5 MHz, 10 MHz: TTL (Rectangular, Sine Wave)</p> <p>64 kHz + 8 kHz: 0.63 to 1.1 Vo-p (AMI, 8 kHz violation)</p>	<p>Connector</p> <p>1.544 MHz, 2.048 MHz, 2.048 Mbit/s, 5 MHz, 10 MHz: BNC (75 Ω)</p> <p>2.048 MHz, 2.048 Mbit/s, 64 kHz + 8 kHz: Siemens (120 Ω)</p> <p>1.544 Mbit/s: BANTAM (100 Ω)</p> <p>Effective SDH/SONET/OTN Bit Rate.</p>
	Reference Clock Output	<p>Frequency</p> <p>Clock: 1.544 MHz, 2.048 MHz, 5 MHz, 10 MHz</p> <p>Data: 1.544 Mbit/s (BITS), 2.048 Mbit/s</p> <p>Level/Code</p> <p>1.544 Mbit/s: ANSI T1.403 (B8ZS)</p> <p>2.048 Mbit/s: ITU-T G.703 Table 10 (HDB3)</p> <p>1.544 MHz, 2.048 MHz, 5 MHz, 10 MHz: TTL (Rectangular)</p>	<p>Connector</p> <p>1.544 MHz, 2.048 MHz, 2.048 Mbit/s, 5 MHz, 10 MHz: BNC (75 Ω)</p> <p>1.544 Mbit/s: BANTAM (100 Ω)</p> <p>Effective SDH/SONET/OTN Bit Rate.</p>
	Trigger	<p>Trigger Input: For capture/APS Measurement</p> <p>Trigger Output: Transmit error/alarm, Receive error/alarm, Capture trigger</p>	<p>Level: TTL (Active High)</p> <p>Connector: BNC (75 Ω)</p>
	DCC/GCC	<p>Data Input/Output: D1-D3 (192 kbit/s), D4-D12 (576 kbit/s), GCC0-2 (1312.4 kbit/s, 326.7 kbit/s)</p> <p>Clock Output: 192 kHz, 576 kHz, 1312.4 kHz, 326.7 kHz</p> <p>Level: V.11</p> <p>Connector: 9-pin D-sub</p>	
Remote Control		Remote control using MX159001B via LAN (10BASE-T/100BASE-TX) In addition, remote command control supported using any of GPIB (Option 02), LAN (Option 03), RS-232C (Option 01)	
Input Device		Pointing device, front keys	
Power		100 V(ac) to 120 V(ac)/200 V(ac) to 240 V(ac) (autoswitching), 50 Hz to 60 Hz	
Power Consumption		≤500 VA	
Operational Temperature and Humidity		5° to 40°C, 20 to 80%	
Dimensions and Mass		320 (W) × 177 (H) × 350 (D) mm, ≤13 kg (excluding options and plug-in units)	
EMC		EN61326-1, EN61000-3-2	
LVD		EN61010-1	
Laser Safety		Depends on installed module. Refer to the safety standards for each module.	
Number of Slots		6	

• MU150110A Multirate Unit

Electrical Interface (1.544 Mbit/s to 155.52 Mbit/s)	<p>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</p> <p>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</p> <p>Connector 1.544 Mbit/s: RJ-45 100 Ω Balanced 2.048 Mbit/s: RJ-45 120 Ω Balanced 2.048 Mbit/s, 8.448 Mbit/s, 34.368 Mbit/s, 44.736 Mbit/s, 51.84 Mbit/s, 139.264 Mbit/s, 155.52 Mbit/s: BNC 75 Ω</p> <p>Level ANSI T1.102 (1.544 Mbit/s, 44.736 Mbit/s) ITU-T G.703 (2.048 Mbit/s, 8.448 Mbit/s, 34.368 Mbit/s, 139.264 Mbit/s) DSX Output (1.544 Mbit/s): 0/655 feet DSX Output (44.736 Mbit/s, 51.84 Mbit/s): 0/450/900 feet</p> <p>Monitor Gain 20 dB, 26 dB: 1.544 Mbit/s, 2.048 Mbit/s, 8.448 Mbit/s, 34.368 Mbit/s, 44.736 Mbit/s, 51.84 Mbit/s 20 dB: 139.264 Mbit/s, 155.52 Mbit/s</p>												
Electrical Interface (9953.28 M, 10312.5 M, 10709.225 Mbit/s)	<p>Bit Rate SDH/SONET: 9953.28 Mbit/s 10.3 G: 10312.5 Mbit/s (Option 008 installed) OTN: 10709.225 Mbit/s (Option 005 installed)</p> <p>Code: NRZ</p> <p>Connector: SMA 50Ω</p> <p>Level Clock Output: 0.6 to 1.3 Vp-p Data Output: -0.2 to 0 V (High), -1.5 to -0.85 V (Low) Data Input: 0.3 to 1.5 Vp-p</p>												
Optical Interface (51.84 Mbit/s to 2666.057 Mbit/s)	<p>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 (Option 005 installed)</p> <p>Code: NRZ</p> <p>Connector: FC-PC (SMF), Replaceable</p>												
Optical Output (51.84 Mbit/s to 2666.057 Mbit/s)*1	<p>Level: -1 to +3 dBm (ATT = 0 dB, Option 04/004)</p> <p>Extinction Ratio: ≥10 dB</p> <p>SMSR: ≥30 dB</p> <p>Peak Wavelength: 1550 nm ±20 nm, 1310 nm ±20 nm</p> <p>Spectrum Width: ≤1 nm (@ -20 dB)</p>												
Optical Input (51.84 Mbit/s to 2666.057 Mbit/s)	<p>Optical Input Level: -33 to -8 dBm (51.84 Mbit/s, 155.52 Mbit/s), -29 to -8 dBm (622.08 Mbit/s, 2488.32 Mbit/s, 2666.057 Mbit/s)</p> <p>Wavelength: 1260 nm to 1610 nm</p> <p>Overload: +3 dBm (average)</p>												
Optical Interface (9953.28 Mbit/s to 11095.727 Mbit/s)	<p>Bit Rate SDH/SONET: 9953.28 Mbit/s 10.3G: 10312.5 Mbit/s (Option 008 installed) OTN: 10709.225 Mbit/s (Option 005 installed) 11049.107 Mbit/s (Option 006 installed) 11095.727 Mbit/s (Option 006 installed)</p> <p>Code: NRZ</p> <p>Connector: LC-PC (XFP module)</p>												
Optical Output (9953.28 Mbit/s to 11095.727 Mbit/s)	<p>G0194A 1310 nm XFP Module Level: -6 to -1 dBm Extinction Ratio: ≥6 dB SMSR: ≥30 dB Peak Wavelength: 1290 nm to 1330 nm (1310 nm typ.) Spectrum Width: ≤1 nm (@ -20 dB)</p> <p>G0195A 1550 nm XFP Module Level: -1 to +2 dBm Extinction Ratio: ≥8.2 dB SMSR: ≥30 dB Peak Wavelength: 1530 nm to 1565 nm (1550 nm typ.) Spectrum Width: ≤1 nm (@ -20 dB)</p>												
Optical Input (9953.28 Mbit/s to 11095.727 Mbit/s)	<p>G0194A 1310 nm XFP Module Sensitivity: -11 dBm (9953.28 Mbit/s, 10709.225 Mbit/s), -10.3 dBm (10312.5 Mbit/s, 11049.107 Mbit/s, 11095.727 Mbit/s) Wavelength: 1260 nm to 1355 nm Absolute Maximum Optical Input: +0.5 dBm (average)</p> <p>G0195A 1550 nm XFP Module Sensitivity: -14 dBm (9953.28 Mbit/s, 10709.225 Mbit/s), -11.3 dBm (10312.5 Mbit/s, 11049.107 Mbit/s, 11095.727 Mbit/s) Wavelength: 1260 nm to 1580 nm Absolute Maximum Optical Input: -1 dBm (average)</p>												
Clock	<p>Internal, External (Reference Input, 1/1 Input), Receive</p> <p>Internal Accuracy: ±0.1 ppm (After power-on, calibrated after 24 hours, warm-up at 23° ±5°C, aging rate (max.): ±0.05 ppm/day, ±0.5 ppm/year) Offset Range: ±100 ppm/0.1 ppm step</p>												
Frame	<table border="0"> <tr> <td>1.544 Mbit/s: D4/ESF/Japan ESF</td> <td>51.84 Mbit/s: SDH/SONET</td> </tr> <tr> <td>2.048 Mbit/s: 30, 31ch with or without CRC4</td> <td>155.52 Mbit/s: SDH/SONET</td> </tr> <tr> <td>8.448 Mbit/s: G.742</td> <td>622.08 Mbit/s: SDH/SONET</td> </tr> <tr> <td>34.368 Mbit/s: G.751</td> <td>2488.32 Mbit/s: SDH/SONET</td> </tr> <tr> <td>44.736 Mbit/s: M13/C-bit</td> <td>9953.28 Mbit/s: SDH/SONET</td> </tr> <tr> <td>139.264 Mbit/s: G.751</td> <td></td> </tr> </table>	1.544 Mbit/s: D4/ESF/Japan ESF	51.84 Mbit/s: SDH/SONET	2.048 Mbit/s: 30, 31ch with or without CRC4	155.52 Mbit/s: SDH/SONET	8.448 Mbit/s: G.742	622.08 Mbit/s: SDH/SONET	34.368 Mbit/s: G.751	2488.32 Mbit/s: SDH/SONET	44.736 Mbit/s: M13/C-bit	9953.28 Mbit/s: SDH/SONET	139.264 Mbit/s: G.751	
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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, All 0, All 1, 3 in 24 (1.544 Mbit/s only) PRBS (SDH/SONET) No Frame: 2 ¹⁵ - 1 (51.84 Mbit/s, 155.52 Mbit/s only), 2 ²³ - 1, 2 ³¹ - 1 Concatenation Mapping: 2 ¹⁵ - 1 (1c/4c), 2 ²³ - 1, 2 ³¹ - 1 Other Mapping: 2 ¹¹ - 1, 2 ¹⁵ - 1, 2 ²⁰ - 1, 2 ²⁰ - 1z (1.5M/45M only), 2 ²³ - 1 Invert On/Off PRBS (PDH/DSn) 2 ¹¹ - 1, 2 ¹⁵ - 1, 2 ²⁰ - 1, 2 ²⁰ - 1z (1.544 Mbit/s, 44.736 Mbit/s only), 2 ²³ - 1 Invert On/Off Word: 16-bit Programmable (Mark Ratio 1/2 at No Frame) Transmit/Receive: Independent setup supported
Overhead Preset	SOH/TOH/POH: All Bytes (except Parity Byte, K1/K2 Byte and H1/H2/H3 Byte) 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 (Measurement only), 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 (Measurement only), 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 x 10 ⁻ⁿ (n: 3 to 9), User Program: A x 10 ^{-B} (A: 0.1 to 9.9, step 0.1, B: 2 to 10) Alternative Error Frame: 0 to 64000, Normal Frame: 1 to 64000 Frame (only at PDH/DSn): Insert n Error Frames (n: 1 to 4) in 16 frames Specify insertion bit position at B1, B2, B3, BIP-2 error insertion
Alarm Addition/Measurement	PDH/DSn: LOS, LOF, AIS, RDI, RDI (MF) SDH: LOS, Generic-AIS (Measurement only), LOF, OOF (Measurement only), 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., 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, Generic-AIS (Measurement only), LOF, OOF (Measurement only), 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., 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-TCTIM, 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 (2M only) SDH/SONET: SOH/TOH/POH, Path Trace, Tandem Byte, K1/K2 Byte, AU/STS, TU/VT Pointer, Payload
Through	Transparent, Overhead Overwrite (SDH/SONET/OTN only)
MUX/DEMUX	MUX/DEMUX supported to 64 k units in PDH and DSn
Add/Drop	PDH/DSn signal added to or dropped from 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 added to or dropped from STM-64 or OC-192 signal (Option 009 installed)
Delay Measurement	Measurement Period: 0.5, 1, 2, 5, 10 s Measurement Range: 0 to 999 μs (1 μs step), 1.0 ms to 999.9 ms (0.1 ms step), 1.0 s to 10.0 s (0.1 s step), >Time Out
Dummy Channel	Mode: Copy/Dummy Dummy Pattern: All 0, All 1, PRBS 2 ¹¹ - 1, PRBS 2 ¹⁵ - 1 (Invert)
Path Trace	J0, J1, J2 Byte set arbitrarily 16 bytes (CRC On), 64 bytes (CRC Off, J1 only)
Tandem Connection	N1/Z5, N2 Byte set arbitrarily Set On/Off
Pointer Generation	AU/STS, TU/VT Pointer Action: NDF, ±PJ (Pointer Justification), Inc./Dec. PJC Timing: Manual, Burst (2 to 64), Inc./Dec. Timing: 4 to 8000 Frames
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 set at Async Mapping
APS Test	Switching Time Measurement Measurement Time: 0.1 ms to 2000.0 ms, Timeout (exclude Time for Frame/Pointer Synchronization) APS Sequence Generator Generator Timing: 2 to 64 words, Max. 8000 frames/words Set for K1/K2, K3, K4 Byte
Overhead Sequence Capture	Capture Byte: K1/K2, K3, K4, AU/STS Pointer, TU/VT Pointer Size: 64 Sequence Repeat: Max. 8000 Frame/Sequence
Overhead Test	SOH/TOH/POH 1 Byte, A1/A2, K1/K2, RSOH, MSOH, SOH, POH (except Parity Byte, K1/K2 Byte and H1/H2/H3 Byte) Timing: Alternative (A: 1 to 8000 Times, B: 1 to 8000 Times), A and B can be set up to 256 frames.
Overhead BERT Test	Test Byte: SOH/TOH/POH 1 Byte, D1-D3, D4-D12 (except Parity Byte, K1/K2 Byte and H1/H2/H3 Byte) Pattern: PRBS 2 ¹¹ - 1, PRBS 2 ¹⁵ - 1 (Invert) Error Addition: Bit (Only Single) Measurement: Bit Error, Sync Loss
Overhead Add/Drop	Test Byte: D1-D3, D4-D12
Error Performance	G.821, G.826, G.828, G.829, M.2100, M.2101, M.2110, M.2120, GR.820

Optical Power Meter	51.84 Mbit/s to 2666.057 Mbit/s Wavelength: 1310 nm/1550 nm Measurement Range: -40 to -7 dBm Measurement Accuracy: ±1 dB (-30 to -10 dBm), ±2 dB (-9.9 to -7 dBm, -40 to -30.1 dBm)																																																												
	9953.28 Mbit/s to 11095.727 Mbit/s Wavelength: 1310 nm/1550 nm Measurement Range: -20 to +3 dBm Measurement Accuracy: ±2 dB																																																												
Frequency Counter	Measurement Frequency (f0): 1.544, 2.048, 8.448, 34.368, 44.736, 51.84, 139.264, 155.52, 622.08, 2488.320, 2666.057 (Option 05/005 installed), 9953.28, 10312.5 (Option 008 installed), 10709.225 (Option 005 installed), 11049.107 (Option 006 installed), 11095.727 (Option 006 installed) MHz Measurement Range: f0 ±100 ppm Accuracy: ±0.2 ppm																																																												
Auxiliary Interface	External Clock Input, Receive Clock Output, Clock/Frame Sync. Output																																																												
Optical Output Power Adjustable (Option 04/004)	Bit Rate: 51.84 Mbit/s to 2666.057 Mbit/s 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																																																												
Jitter Tolerance (52M to 2.5G/2.6G)	 <table border="1" data-bbox="858 577 1476 745"> <thead> <tr> <th>Bit Rate (Mbit/s)</th> <th>A1 (Ulp-p)</th> <th>A2 (Ulp-p)</th> <th>A3 (Ulp-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> </thead> <tbody> <tr> <td>51.84</td> <td>0.2</td> <td>2</td> <td>20</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>0.2</td> <td>2</td> <td>50</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>0.2</td> <td>2</td> <td>200</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>0.2</td> <td>2</td> <td>800</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*</td> <td>0.2</td> <td>2</td> <td>800</td> <td>10</td> <td>12.1</td> <td>5k</td> <td>100k</td> <td>1M</td> <td>20M</td> </tr> </tbody> </table> <p style="text-align: right;">*: When MU150125A-05 installed.</p> <p>Measurement Condition: MU150110A Loop-back Measurement Temperature Condition: 10° to 40° C Optical Input Level: -12 to -10 dBm (2488 M, 2666 M), -20 to -10 dBm (52 M, 156 M, 622 M) Error Threshold: 10⁻⁸ (52 M), 10⁻⁹ (156 M, 622 M), 10⁻¹⁰ (2488 M, 2666 M) Optical Input Wavelength: 1310 nm/1550 nm Mapping SDH: VC3-Bulk (52 M), VC4-nc (n = 1, 4, 16) (156 M/622 M/2488 M) SONET: STSnc (n = 1, 3, 12, 48) OTU1: ODU1-OPU1-PRBS Test Pattern: PRBS 2²³ - 1 (Inv.) (SDH/SONET), PRBS 2²³ - 1 (OTU1), Mark Ratio 1/2, Scramble On Clock: Internal</p>	Bit Rate (Mbit/s)	A1 (Ulp-p)	A2 (Ulp-p)	A3 (Ulp-p)	f6 (Hz)	f7 (Hz)	f1 (Hz)	f2 (Hz)	f3 (Hz)	f4 (Hz)	51.84	0.2	2	20	10	30	300	2k	20k	400k	155.52	0.2	2	50	10	19.3	500	6.5k	65k	1.3M	622.08	0.2	2	200	10	10	1k	25k	250k	5M	2488.32	0.2	2	800	10	12.1	5k	100k	1M	20M	2666.05*	0.2	2	800	10	12.1	5k	100k	1M	20M
Bit Rate (Mbit/s)	A1 (Ulp-p)	A2 (Ulp-p)	A3 (Ulp-p)	f6 (Hz)	f7 (Hz)	f1 (Hz)	f2 (Hz)	f3 (Hz)	f4 (Hz)																																																				
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9953	0.2	2	3200																																																										
10709*	0.2	2	3200																																																										
Bit Rate (Mbit/s)	f6 (Hz)	f7 (Hz)	f1 (Hz)	f2 (Hz)	f3 (Hz)	f4 (Hz)																																																							
9953	10	12.1	20k	400k	4M	80M																																																							
10709*	10	12.1	20k	400k	4M	80M																																																							
Laser Safety	IEC 60825-1: 2007: CLASS 1 21CFR1040.10*2																																																												

*1: To use the optical output (51.84 Mbit/s to 2666.057 Mbit/s) attach a 50-Ω terminator (J0994) to the SMA connector used for the data output of the electrical interface (9953.28M, 10312.5M, 10709.225 Mbit/s).

*2: Excludes deviations caused by conformance to Laser Notice No. 50 dated June 24, 2007

Safety measures for laser products

This product complies with optical safety standards in 21CFR1040.10 and IEC 60825-1; the following descriptive labels are affixed to the product.



- MU150110A-005 OTU1/OTU2
- MU150110A-006 11.1G (OTN specification only)

Option	MU150110A-005	MU150110A-006
Bite Rate	10709.225 Mbit/s, 2666.057 Mbit/s	11049.107 Mbit/s, 11095.727 Mbit/s
Frame	10709.225 Mbit/s: OTU2 2666.057 Mbit/s: OTU1	11049.107 Mbit/s: OTU1e 11095.727 Mbit/s: OTU2e
No Frame	10709.225 Mbit/s, 2666.057 Mbit/s	11049.107 Mbit/s, 11095.727 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	
Overhead 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) On/Off	
Justification	Generation Action: \pm Justification Timing: Single, Burst (2 to 64)	Measurement Item: + JC, -JC
Payload Offset	Offset Range: ± 65.9 ppm/0.1 ppm step set at Async. Mapping.	
Error Addition/ Measurement	FAS, BIP-8 (SM, PM, TCM1-6), BEI (SM, PM, TCM1-6), Bit All (Addition for OTN Frame only), Bit, Corrected Error Bit (Measurement only), Uncorrectable FEC Block (Measurement only)	
Error Addition Timing	Single, Rate, All, Alternate, Random (Only Bit All) Rate Fix Rate: 1×10^{-n} (n: 3 to 9), User Program: $A \times 10^{-B}$ (A: 1.0 to 9.9, B: 2 to 10) Alternative Error Frame: 0 to 64000, Normal Frame: 1 to 64000 Random: Poisson distributed error insertion (only at Bit all) Specify insertion bit position at parity error insertion	
Alarm Addition/ Measurement	LOF, OOF (Measurement only), LOM, OOM (Measurement only), BDI (SM, PM, TCM1-6), AIS (OTU, ODU, Client), ODU-OCI, ODU-LCK, ODU-PLM (Measurement only), 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 supported of TTI and FTFL.	
Overhead Sequence Capture	Capture Byte: APS/PCC Size: 64 Sequence Repeat: Max. 8000 Frames/Sequence	
Overhead Test	OTU/ODU/OPU 1 Byte, 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 set up to 256 frames	
Overhead BERT Test	GCC0-2, OH 1 Byte (except Parity Byte) Pattern: PRBS $2^{11} - 1$, PRBS $2^{15} - 1$ (Invert)	Error Addition: Bit (Only Single) Measurement: Bit Error, Sync Loss
Overhead Add/Drop	Test Byte: GCC0-2	

- MU150110A-006 11.1G (10G Ethernet specification only)
- MU150110A-008 10.3G

Option	MU150110A-006	MU150110A-008
Bit Rate	11049.107 Mbit/s, 11095.727 Mbit/s	10312.5 Mbit/s
Frame	11049.107 Mbit/s: OTU1e 11095.727 Mbit/s: OTU2e	10312.5 Mbit/s: 10G Ethernet
No Frame	11049.107 Mbit/s, 11095.727 Mbit/s	10312.5 Mbit/s
Ethernet Settings (General)	Maximum Frame Size: 64 bytes to 16,384 bytes IPG Violation Threshold: 5 to 12 bytes Link Fault Signaling Reply: On/Off Flow Control Receive: On/Off	
Ethernet Settings (Frame)	Frame Length: 48 bytes to 16,384 bytes Auto, Fixed, Increment, Random selectable *Only Auto or Fixed when test frame selected in data field VLAN: On/Off TPID, User Priority, CFI editable VLAN ID settable (Fixed, Increment, Decrement, Random) Background Data: All 0, All 1 Preamble Size: 4 bytes to 255 bytes (can edit all bytes except 1-byte header) MAC Address: Separate source and destination address settings Type: Fixed, Increment, Decrement, Random Mask: Set in 4-bit units (when Increment, Decrement, Random selected) Ethernet Type: Editable Data Field: All 0, All 1, Word 16, Increment, Decrement, Programmable, Test Frame Offset: 0 to 16,365 bytes Error Insertion: FCS Error, Fragments, Undersize, Oversize, Oversize & FCS Error	

Option	MU150110A-006	MU150110A-008
User Defined Counter Settings	Separate User Defined Counter 1, 2 settings Pattern 1: Don't care, Match, Mismatch Pattern 1: Don't care, Match, Mismatch Error: Don't care, Match, Mismatch User Defined Counter 1, 2 common setting Pattern 1, 2: Pattern: 128 bits Mask: Byte units Base Position: Top of Frame Offset: 0 to 16,368 bytes Preset Pattern: MAC DA, MAC SA, Ethernet Type Error Type: Good frame, FCS error, Undersize, Fragments, Oversize, Oversize & FCS error, Sequence error	
Stream Control	Tx Mode: Repeat, Burst (Repeat only at Latency and BER measurements) Burst Length: 1 to 65,536 frames Gap Insertion Type: Fixed, Random Value: 7.2 ns to 120 s (0.8 ns resolution)	
Error Insertion (PCS)	Type: Sync header, Block type Timing: Single, Burst, Rate, Alternate, All Burst: 1 to 64,000 Rate: 1.0E-3 to 0.1E-11 Alternate: Error: 1 to 64,000, Normal: 0 to 64,000	
BER Test	Type: Framed, No frame Test Pattern: All 0, All 1, Word 16, PRBS23 (Invert On/Off), PRBS31 (Invert On/Off), CJPAT (fixed gap and frame length), CRPAT (fixed gap and frame length) Error Insertion Type: Bit Timing: Single, Rate Rate: 1.0E-4 to 1.0E-9 MAC Address (only Framed mode) Separate source and destination address settings Type: Fixed, Increment, Decrement, Random Mask: Set in 4-bit units (when Increment, Decrement, Random selected) Gap Insertion Type: Fixed, Random Value: 7.2 ns to 120 s (0.8 ns resolution) Frame Length: 48 bytes to 16,384 bytes Fixed, Increment, Random selectable	
PCS Test	Test Mode: Pattern, 66B programmable data Pattern Pattern: Pseudo-random, Square wave, PRBS31 Seed: Seed A, Seed B (editable) Data: LF, All 0 66B Programmable Data Size: 1 to 256 Block Error Insertion (only Pattern mode) Type: Bit Timing: Single, Rate Rate: 1.0E-3 to 1.0E-11 PCS Capture Block No.: 4,096 max. (decode) Filter/Trigger Settings On/Off Sync header: Don't care, Match, Mismatch Block type: Don't care, Match, Mismatch Error: Don't care, Match, Mismatch Alarm: Don't care, Match, Mismatch (trigger only) External: Don't care, Match, Mismatch (trigger only) Filter/Trigger Condition Sync header: Data (01), Control (10) Block type: IEEE802.3, Start, Terminate, Ordered_set, Programmable Error: No error, Sync header, Errored block, Block type, IPG violation Alarm: No alarm, Unlock Combination: And Trigger Position: Top, Middle, Bottom	
Latency	MAC Address Separate source and destination address settings Type: Fixed, Increment, Decrement, Random Mask: Set in 4-bit units (when Increment, Decrement, Random selected) Gap Insertion Type: Fixed, Random Value: 7.2 ns to 120 s (0.8 ns resolution) Frame Length: 48 bytes to 16,384 bytes Selectable at Fixed Measurement Result Display: Current, Maximum, Minimum, Average, Frame Count Current, Average, Frame Count: Test frame at 1 sec sampling Maximum, Minimum: All received test frames	
Link Fault Signaling	Send Data Signal Pattern: Remote fault signal, Local fault signal, Edit signal (only Lane 1, 2, 3 editable) LFS Capture Column No.: 512 max. (decode) Trigger Setting: On/Off (settable pattern) Display Filter: All, Sequence only	
Counters	Error/Alarm PCS: Link down, Unlock, Hi-BER, Pattern sync, Sync header, Errored block, Code, Block type, IPG violation, Pattern block, Pattern bit Ethernet: Oversize, Oversize & FCS error, Undersize, Fragments, FCS error, Sequence error BER: Sync., Bit Count: Transmitted/Received Frame, Transmitted/Received Byte, Transmitted/Received Test Frame, Transmitted/Received RF Signal, Transmitted/Received LF Signal, Received User Defined 1, Received User Defined 2, Received Pause, Received Capture Filter, Received Capture Trigger Rate: Transmitted/Received Frame (fps), Transmitted/Received Bit (%), Transmitted/Received Bit (bit/s), Transmitted/Received Rate (%), Received User Defined 1 (fps), Received User Defined 2 (fps)	

• MU150110A-010 Multichannel Measurement

Bit Rate	51.84 Mbit/s, 155.52 Mbit/s, 622.08 Mbit/s, 2488.32 Mbit/s, 9953.28 Mbit/s
Frame	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
Mapping	Auto-search: Auto-detect Rx mapping Unequipped: Selectable for each channel (On/Off) Measurement: Selectable for each channel (On/Off)
Test Pattern	PRBS, Word 16, All 0, All 1 PRBS: $2^{15} - 1$, $2^{23} - 1$, $2^{31} - 1$, Invert On/Off Independent setting for each channel but Word 16 pattern shared by all channels
Overhead Preset	SOH/TOH/POH: All bytes (except Parity, K1/K2, and H1/H2/H3) Independent setting for all channels
Error Addition	Simultaneous insertion into multichannels Selectable On/Off addition to each channel Shared Type and Timing for all channels PDH/DSn: Bit info SDH: FAS, B1, B2, HP-B3, LP-B3, BIP-2, MS-REI (M0/M1), HP-REI, LP-REI, Bit all, Bit info SONET: FAS, B1, B2, HP-B3, LP-B3, BIP-2, REI-L (M0/M1), REI-P, REI-V, Bit all, Bit info Timing: Rate, Alternative, Single, Burst Rate: Fix Rate: 1×10^{-9} (n: 3 to 9), User Program: $A \times 10^{-8}$ (A: 1.0 to 9.9, step 0.1, B: 2 to 10) Alternative: Error Frame: 0 to 64,000, Normal Frame: 1 to 64,000 Specify insertion bit position at B1, B2, B3, BIP-2 error insertion
Error Measurement	Simultaneous measurement of multiple channels PDH/DSn: Bit SDH: Frame, B1, B2, HP-B3, LP-B3, BIP-2, MS-REI (M0/M1), HP-REI, LP-REI, Bit SONET: Frame, B1, B2, HP-B3, LP-B3, BIP-2, REI-L (M0/M1), REI-P, REI-V, Bit
Alarm Addition	Simultaneous insertion into multiple channels Selectable On/Off addition to each channel Shared Type and Timing for all channels PDH/DSn: LOF, AIS SDH: LOS, LOF, 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-ERDIC, LP-ERDIC, LP-RFI, LP-TIM, LP-UNEQ, LP-SLM SONET: LOS, LOF, 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, ERDIC-V, ERDIC-V, RFI-V, TIM-V, UNEQ-V, PLM-V Timing: Single, Burst, Alternative, All (only All for PDH) Alternative: Error Frame: 0 to 64,000, Normal Frame: 1 to 64,000
Alarm Measurement	Simultaneous measurement of multiple channels PDH/DSn: LOF, AIS (only status display) Sync. SDH: LOS, Generic-AIS, LOF, OOF, 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-ERDIC, LP-ERDIC, LP-RFI, LP-TIM, LP-UNEQ, LP-SLM, Sync. loss SONET: LOS, Generic-AIS, LOF, OOF, 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, ERDIC-V, ERDIC-V, RFI-V, TIM-V, UNEQ-V, PLM-V, Sync. loss
Monitor	SOH/TOH/POH, Path Trace, K1/K2 Byte, AU/STS, TU/VT Pointer, Payload
Path Monitor	Displays errors and alarms at each channel
Through	Transparent, OH Overwrite
Delay Measurement	Simultaneous measurement of multiple channels Measurement Period: 0.5, 1, 2, 5, 10 s Measurement Range: 0 to 10,000,000.0 μ s (0.1 μ s step), >Timeout
Path Trace	Independent setting for all channels but CRC On/Off shared by all channels J0, J1, J2 byte set arbitrarily 16 bytes (CRC On), 64 bytes (CRC Off, J1 only) Auto-detection of path trace pattern
Pointer Generation	Independent setting for all channels AU/STS, TU/VT Pointer Action: NDF, \pm PJ (Pointer Justification) PJC Timing: Manual, Burst (2 to 64)
Pointer Measurement	Independent setting for all channels AU/STS, TU/VT Pointer, C Bit Measurement Item: NDF, +PJC, -PJC, Cons, C, C1/C2
APS Test	Switching Time Measurement Simultaneous measurement of multiple channels Measurement Time: 0.1 ms to 2000.0 ms, Timeout (exclude Time for Frame/Pointer Synchronization) Threshold: 1 ms to 100 ms (1-ms steps) Measurement Result: Current, Maximum, Minimum, Average (ms) OK (Pass), NG (Fail) (Count)
Log Function	Log Period: 1 s Target: Events (selectable items), APS Test

• MU150121A 10/10.7G Optical Unit (Tx)

Bit Rate	9953.28 Mbit/s, 10709.225 Mbit/s Accuracy: Depends on frequency accuracy of MU150110A and external input frequency	
Optical Output	Peak Wavelength: 1310 nm ±20 nm (Option 01, 03) 1550 nm ±20 nm (Option 02, 03) Spectrum Range: ≤0.5 nm (@-20 dB) Side Mode Suppression Ratio: ≥30 dB Extinction Ratio: ≥10 dB	Output Power: 0 to +3 dBm Code: NRZ Connector: FC-PC (SMF) Replaceable
Electrical Input (Data, Clock)	Input Level Data H: -0.2 to 0 V, L: -1.5 to -0.85 V Clock 0.6 to 1.3 Vp-p	Code: NRZ Impedance: 50 Ω Connector: SMA
Variable Optical Attenuator (Option 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	
Laser Safety	IEC 60825-1: 2007: CLASS 1, 21CFR1040.10*	

*: Excludes deviations caused by conformance to Laser Notice No. 50 dated June 24, 2007

Safety measures for laser products

This product complies with optical safety standards in 21CFR1040.10 and IEC 60825-1; the following descriptive labels are affixed to the product.



• MU150123A 10/10.7G Optical Unit (Rx Wide)

Bit Rate	9953.28 Mbit/s ±100 ppm, 10709.225 Mbit/s ±100 ppm*					
Optical Input	Wavelength: 1260 nm to 1610 nm Sensitivity: -14 to 0 dBm Absolute Maximum Optical Input: +3 dBm (average) Code: NRZ Return Loss: ≥27 dB Connector: FC-PC (SMF), Replaceable					
Electrical Output (for BER, Jitter Measurement)	Data Output: Output Level: 1.0 ±0.25 Vp-p Connector: SMA, 50 Ω Code: NRZ Clock Output: Output Level: 0.8 ±0.25 Vp-p Connector: SMA, 50 Ω (AC)					
Intrinsic Jitter	System Measurement (with MU150121A)					
	Bit Rate (Mbit/s)	Interface	Jitter Amplitude			Ulrms
			HP1+LP Framed	HP'+LP Framed	HP2+LP Framed	
9953.28	Optical Electrical*	0.08	0.08	0.06	0.006*/0.009	
10709.23*	Optical Electrical*	0.045	0.045	0.045	0.006	
Measurement Condition Temperature Range: 10° to 40°C Optical Input Level: -12 to -10 dBm Electrical Input Level: 200 to 500 mVp-p Measurement Time: 60 s Unit Configuration: Optical Interface (Loop-back Measurement)* MU150123A + MU150110A/MU150121A/MU150125A Optical Input Wavelength: 1310 nm/1550 nm Test Pattern: SDH VC4-64c, SONET STS192c, Test Pattern PRBS 2 ²³ - 1 OTU2-ODU2-OPU2-PRBS (PRBS 2 ³¹ - 1) Extinction Ratio: ≥8.2 dB						
Receiver Measurement			Measurement Condition			
Bit Rate (Mbit/s)	Interface	Jitter Amplitude			Ulrms	
		HP1+LP	HP'+LP	HP2+LP		
10709.225*	Electrical*	0.02			0.004	
Temperature Range: 20° to 30°C Electrical Input Amplitude: 200 to 500 mVp-p Measurement time: 60 s Transmitter: Anritsu Reference Transmitter Test Pattern: O.172 Appendix VIII						

Random Jitter	Measurement Condition Temperature Range: 10° to 40°C Optical Input Level: -12 to -10 dBm Measurement Time: 60 s Unit Configuration: Optical Interface (Loop-back Measurement)*, MU150123A + MU150110A/MU150121A/MU150125A Optical Input Wavelength: 1550 nm Test Pattern: Word16 ""1010101010101010"" (binary) Calculation Method (1) Set filter to HP1+LP and measure for 60 s by MU150125A Clock Loop-back. (2) Set filter to HP1+LP and measure for 60 s by MU150123A + MU150110A/MU150121A or MU150125A Optical Interface Loop-back. (3) Find difference of measurement results of (1) and (2). The value Obtained by (3) is Value of Random Jitter.	<table border="1"> <thead> <tr> <th rowspan="2">Bit Rate (Mbit/s)</th> <th rowspan="2">Interface</th> <th>Jitter Amplitude</th> </tr> <tr> <th>UIp-p HP1+LP</th> </tr> </thead> <tbody> <tr> <td>9953.28</td> <td rowspan="2">Optical</td> <td rowspan="2">≤0.010</td> </tr> <tr> <td>10709.225*</td> </tr> </tbody> </table>	Bit Rate (Mbit/s)	Interface	Jitter Amplitude	UIp-p HP1+LP	9953.28	Optical	≤0.010	10709.225*																					
	Bit Rate (Mbit/s)	Interface			Jitter Amplitude																										
UIp-p HP1+LP																															
9953.28	Optical	≤0.010																													
10709.225*																															
Jitter Tolerance	<table border="1"> <thead> <tr> <th rowspan="2">Bit Rate (Mbit/s)</th> <th>A1</th> <th>A2</th> <th>A3</th> <th>f6</th> <th>f7</th> <th>f1</th> <th>f2</th> <th>f3</th> <th>f4</th> </tr> <tr> <th colspan="3">UIp-p</th> <th colspan="6">Hz</th> </tr> </thead> <tbody> <tr> <td>9953.28</td> <td rowspan="2">0.2</td> <td rowspan="2">2</td> <td rowspan="2">3200</td> <td rowspan="2">10</td> <td rowspan="2">12.1</td> <td rowspan="2">20k</td> <td rowspan="2">400k</td> <td rowspan="2">4M</td> <td rowspan="2">80M</td> </tr> <tr> <td>10709.225*</td> </tr> </tbody> </table> <p>Measurement Condition Temperature Range: 10° to 40°C Optical Input Level: -12 to -10 dBm Electrical Input Level: 150 to 500 mVp-p Measurement Time: 60 s Unit Configuration: Optical Interface (Loop-back Measurement)* Electrical Interface (Differential Loop-back Measurement)* MU150123A + MU150110A/MU150121A/MU150125A Optical Input Wavelength: 1310 nm/1550 nm Test Pattern: SDH VC4-64c, SONET STS192c, Test Pattern PRBS 2²³ - 1 OTU2-ODU2-OPU2-PRBS (PRBS 2²³ - 1)</p>	Bit Rate (Mbit/s)	A1	A2	A3	f6	f7	f1	f2	f3	f4	UIp-p			Hz						9953.28	0.2	2	3200	10	12.1	20k	400k	4M	80M	10709.225*
Bit Rate (Mbit/s)	A1		A2	A3	f6	f7	f1	f2	f3	f4																					
	UIp-p			Hz																											
9953.28	0.2	2	3200	10	12.1	20k	400k	4M	80M																						
10709.225*																															
Optical Input Power Measurement	Measurement Range: -20 to +2 dBm Measurement Accuracy: ≤±0.5 dB (-10 to +2 dBm), ≤±1.0 dB (-20 to -10.1 dBm)																														

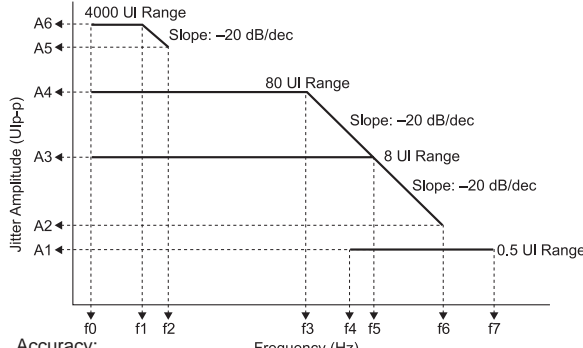
*: Requires MU150123A Option 05 for 10709M.

• MU150125A 10/10.7G Jitter Unit

Jitter Generation/ Measurement Frequency	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)																																																																			
10/10.3/10.7G Clock Output 52 MHz to 2.66 GHz Clock Output	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, calibrated after 24 hours at, warm-up of 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)																																																																			
Jitter Generation	<p>Modulation Frequency: 0.1 Hz to 80 MHz Amplitude: 0 to 4040 UIp-p Modulation Value: 52M, 156M, 622M</p> <table border="1"> <thead> <tr> <th>Frequency (Hz)</th> <th>f0 (Hz)</th> <th>f1 (kHz)</th> <th>f2 (kHz)</th> <th>f3 (kHz)</th> <th>f4 (kHz)</th> <th>f5 (MHz)</th> <th>A0 (UIp-p)</th> <th>A1 (UIp-p)</th> <th>A2 (UIp-p)</th> <th>A3 (UIp-p)</th> <th>A4 (UIp-p)</th> </tr> </thead> <tbody> <tr> <td>52M</td> <td rowspan="3">0.1</td> <td rowspan="3">4.8</td> <td rowspan="3">15</td> <td rowspan="3">60</td> <td rowspan="3">600</td> <td rowspan="3">5</td> <td rowspan="3">0.776</td> <td rowspan="3">2.02</td> <td rowspan="3">20.20</td> <td rowspan="3">80.8</td> <td rowspan="3">253.0</td> </tr> <tr> <td>156M</td> <td>—</td> <td>38</td> <td>150</td> <td>1500</td> <td>3.8</td> <td>0.797</td> </tr> <tr> <td>622M</td> <td>—</td> <td>—</td> <td>50</td> <td>500</td> <td>1.3</td> <td>0.776</td> </tr> </tbody> </table> <p>2488M, 2666M</p> <table border="1"> <thead> <tr> <th>Frequency (Hz)</th> <th>f0 (Hz)</th> <th>f1 (Hz)</th> <th>f2 (kHz)</th> <th>f3 (kHz)</th> <th>f4 (kHz)</th> <th>f5 (MHz)</th> <th>f6 (MHz)</th> <th>f7 (MHz)</th> <th>A1 (UIp-p)</th> <th>A2 (UIp-p)</th> <th>A3 (UIp-p)</th> <th>A4 (UIp-p)</th> <th>A5 (UIp-p)</th> </tr> </thead> <tbody> <tr> <td>2488M</td> <td rowspan="2">0.1</td> <td rowspan="2">15</td> <td rowspan="2">600</td> <td rowspan="2">100</td> <td rowspan="2">500</td> <td rowspan="2">1</td> <td rowspan="2">4</td> <td rowspan="2">20</td> <td rowspan="2">0.505</td> <td rowspan="2">2.02</td> <td rowspan="2">20.2</td> <td rowspan="2">25</td> <td rowspan="2">1010</td> </tr> <tr> <td>2666M</td> </tr> </tbody> </table>	Frequency (Hz)	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	4.8	15	60	600	5	0.776	2.02	20.20	80.8	253.0	156M	—	38	150	1500	3.8	0.797	622M	—	—	50	500	1.3	0.776	Frequency (Hz)	f0 (Hz)	f1 (Hz)	f2 (kHz)	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	0.1	15	600	100	500	1	4	20	0.505	2.02	20.2	25	1010	2666M
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9953M, 10.3G, 10.7G

Frequency (Hz)	f0 (Hz)	f1 (Hz)	f2 (kHz)	f3 (kHz)	f4 (kHz)	f5 (MHz)	f6 (MHz)	f7 (MHz)	A1 (Ulp-p)	A2 (Ulp-p)	A3 (Ulp-p)	A4 (Ulp-p)	A5 (Ulp-p)	A6 (Ulp-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: $\pm Q\%$ of Setting ± 0.02 Ulp-p
 2 UI Range: $\pm Q\%$ of Setting ± 0.02 Ulp-p
 8 UI Range: $\pm Q\%$ of Setting ± 0.08 Ulp-p
 20 UI Range: $\pm Q\%$ of Setting ± 0.2 Ulp-p
 80 UI Range: $\pm Q\%$ of Setting ± 0.8 Ulp-p
 250 UI Range: $\pm Q\%$ of Setting ± 2.5 Ulp-p
 1000 UI Range: $\pm Q\%$ of Setting ± 10 Ulp-p
 4000 UI Range: $\pm Q\%$ of Setting ± 40 Ulp-p

Frequency	Variable Error Q	Frequency Range
52 MHz	$\pm 8\%$	0.1 kHz to 500 kHz
	$\pm 12\%$	500 kHz to 1.3 MHz
156 MHz	$\pm 8\%$	0.1 kHz to 500 kHz
	$\pm 12\%$	500 kHz to 1.5 MHz
622 MHz	$\pm 8\%$	0.1 kHz to 500 kHz
	$\pm 15\%$	2 MHz to 5 MHz
2488 MHz	$\pm 8\%$	0.1 kHz to 500 kHz
	$\pm 12\%$	500 kHz to 2 MHz
2666 MHz	$\pm 15\%$	2 MHz to 20 MHz
	$\pm 8\%$	0.1 kHz to 500 kHz
9953 MHz	$\pm 8\%$	0.1 kHz to 500 kHz
	$\pm 12\%$	500 kHz to 2 MHz
10.3 GHz	$\pm 12\%$	500 kHz to 2 MHz
	$\pm 15\%$	2 MHz to 80 MHz

Jitter Generation

10/10.3/10.7G
 Clock Input
 52 MHz 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)

Manual Jitter Measurement: Ulp-p, UI+p, UI-p/Ulrms

Ulrms Measurement:
 2 UI Range (0.000 to 0.714 Ulrms/Step 0.001 Ulrms)
 20 UI Range (0.00 to 7.14 Ulrms/Step 0.01 Ulrms)

Ulp-p Measurement:
 2 UI Range (-1.010 to 1.010 Ulp-p/Step 0.001 Ulp-p)
 20 UI Range (-10.10 to 10.10 Ulp-p/Step 0.01 Ulp-p)
 80 UI Range (-40.4 to 40.4 Ulp-p/Step 0.25 Ulp-p)
 250 UI Range (-123.0 to 123.0 Ulp-p/Step 0.5 Ulp-p)
 1000 UI Range (-510.0 to 510.0 Ulp-p/Step 1 Ulp-p)
 4000 UI Range (-2020 to 2020 Ulp-p/Step 2 Ulp-p)

Measurement Filter

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

Jitter Measurement

Accuracy (Ulp-p, UI+p, UI-p)
 2 UI Range: $\pm R\% \pm W$ Ulp-p
 20 UI Range: $\pm R\% \pm W$ Ulp-p
 80 UI Range: $\pm R\% \pm W$ Ulp-p
 250 UI Range: $\pm R\% \pm W$ Ulp-p
 1000 UI Range: $\pm R\% \pm W$ Ulp-p
 4000 UI Range: $\pm R\% \pm W$ Ulp-p

Accuracy (Ulrms)
 2 UI range: $\pm R\% \pm Y$ UI rms
 20 UI range: $\pm R\% \pm Y$ UI rms

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

Frequency (Hz)	W Clock Signal						Y Clock Signal		
	Ulp-p						Ulrms		
	HP1+LP		HP2+LP		HP+LP*		HP+LP*		
52M	2 UI	20 UI	2 UI	20 UI	2 UI	20 UI	80UI 250 UI 1000 UI 4000 UI	2 UI	20 UI
156M	0.035	0.5	0.03	0.3			-	0.08	0.04
622M	0.035	0.5					2	0.08	0.04
2488M	0.035	0.5			0.03	0.3	8	0.08	0.04
2666M	0.035	0.5	0.03	0.3			20	0.08	0.04
9953M	0.035	0.5					80	0.01	0.05
10.3G									
10.7G									

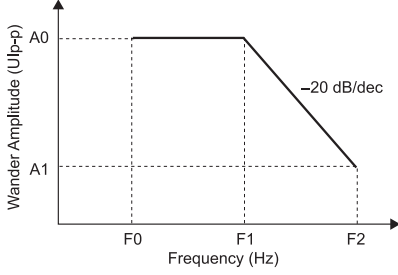
MU150110A Loop-back Measurement (*: MU150125A-05 installed)

Measurement Condition

Temperature Condition: 10° to 40°C
 Optical Input Level: -12 to -10 dBm
 Measurement Time: 60 s
 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)
 OTU1: ODU1-OPU1-PRBS
 Test Pattern: PRBS 2²³ - 1 (Inv.) (SDH/SONET), PRBS 2³¹ - 1 (OTU1), Mark Ratio 1/2, Scramble On
 Clock: Internal

Bit Rate (Mbit/s)	W Data Signal			Y Data Signal
	Ulp-p			Ulrms
	HP1+LP	HP+LP	HP2+LP	HP+LP
51.84 (Optical)	2 UI			
51.84 (Electrical)				
155.52 (Optical)		0.070	0.035	0.010
155.52 (Electrical)				
622.08 (Optical)				
2488.32 (Optical)				
2666.05 (Optical)*		0.080	0.060	

Jitter Measurement	<p>MU150110A with MU150125A Receiver Only (*: MU150125A-05 installed)</p> <p>Measurement Condition Temperature Condition: 10° to 40°C Optical Input Level: -12 to -10 dBm Measurement Time: 60 s Optical Input Wavelength: 1310 nm/1550 nm</p> <p>Mapping SDH: VC3-Bulk (52M), VC4-nc (n = 1, 4, 16) (156M/622M/2488M) SONET: STSnc (n = 1, 3, 12, 48) OTU1: ODU1-OPU1-PRBS Test Pattern: PRBS 2²³ - 1 (Inv.) (SDH/SONET), PRBS 2³¹ - 1 (OTU1), Mark Ratio 1/2, Scramble On</p>	<table border="1"> <thead> <tr> <th rowspan="3">Bit Rate (Mbit/s)</th> <th colspan="3">W Data Signal (Typical)</th> <th>Y Data Signal</th> </tr> <tr> <th colspan="3">Ulp-p</th> <th>Ulrms</th> </tr> <tr> <th>HP1+LP</th> <th>HP+LP</th> <th>HP2+LP</th> <th>HP+LP</th> </tr> </thead> <tbody> <tr> <td colspan="5" style="text-align: center;">2 UI</td> </tr> <tr> <td>51.84 (Optical)</td> <td colspan="3" rowspan="6" style="text-align: center;">0.035</td> <td rowspan="6" style="text-align: center;">0.009</td> </tr> <tr> <td>51.84 (Electrical)</td> </tr> <tr> <td>155.52 (Optical)</td> </tr> <tr> <td>155.52 (Electrical)</td> </tr> <tr> <td>622.08</td> </tr> <tr> <td>2488.32</td> </tr> <tr> <td>2666.05*</td> <td colspan="3"></td> <td></td> </tr> </tbody> </table>	Bit Rate (Mbit/s)	W Data Signal (Typical)			Y Data Signal	Ulp-p			Ulrms	HP1+LP	HP+LP	HP2+LP	HP+LP	2 UI					51.84 (Optical)	0.035			0.009	51.84 (Electrical)	155.52 (Optical)	155.52 (Electrical)	622.08	2488.32	2666.05*				
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<p>MU150123A with MU150125A Receiver Only (*: MU150125A-05 installed)</p> <p>Measurement Condition Temperature Condition: 10° to 40°C Optical Input Level: -12 to -10 dBm Measurement Time: 60 s Optical Input Wavelength: 1310 nm/1550 nm</p> <p>Mapping SDH: VC4-64c (9953M) SONET: STS192c (9953M) OTU2: ODU2-OPU2-PRBS</p>	<p>Test Pattern: PRBS 2²³ - 1 (Inv.) (SDH/SONET), PRBS 2³¹ - 1 (OTU2), Mark Ratio 1/2, Scramble On</p> <table border="1"> <thead> <tr> <th rowspan="3">Bit Rate (Mbit/s)</th> <th colspan="3">W Data Signal</th> <th>Y Data Signal</th> </tr> <tr> <th colspan="3">Ulp-p</th> <th>Ulrms</th> </tr> <tr> <th>HP1+LP</th> <th>HP+LP</th> <th>HP2+LP</th> <th>HP+LP</th> </tr> </thead> <tbody> <tr> <td colspan="5" style="text-align: center;">2 UI</td> </tr> <tr> <td>9953.280</td> <td colspan="3" style="text-align: center;">0.035</td> <td style="text-align: center;">0.009</td> </tr> <tr> <td>10709.225*</td> <td colspan="3"></td> <td></td> </tr> </tbody> </table>	Bit Rate (Mbit/s)	W Data Signal			Y Data Signal	Ulp-p			Ulrms	HP1+LP	HP+LP	HP2+LP	HP+LP	2 UI					9953.280	0.035			0.009	10709.225*										
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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 $\pm 0.12 \times g$ Applicable Frequency Range: 0.01 \times fc to 100 \times fc, or Maximum Frequency Setting Value Maximum Frequency Setting Value used for 100 \times 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 Ulp-p Jitter Modulation Frequency: ≥ 300 Hz Dynamic Range: ≤ -40 dB (at the above Measurement Condition)	Mask Selection [Modulation frequency of 100 times break point (fc) of mask upper limit]: 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 2488M/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)																											
External Clock Input	Frequency: 52M: 51.84 MHz ± 100 ppm 156M: 155.52 MHz ± 100 ppm 622M: 622.08 MHz ± 100 ppm 2488M/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	Level: 0.8 Vp-p ± 0.25 V Connector: SMA, 50 Ω (AC)																										
External Jitter Modulation Signal Input	Frequency: 0.1 Hz to 80 MHz Sensitivity: 0.5 UI range: 2488M/2666M 0.5 Ulp-p/1 Vp-p, 9953M/10.3G/10.7G 0.5 Ulp-p/0.25 Vp-p 2 UI range: 2 Ulp-p/1 Vp-p 20 UI range: 20 Ulp-p/1 Vp-p 80 UI range: 80 Ulp-p/1 Vp-p 250 UI range: 250 Ulp-p/1 Vp-p 1000 UI range: 1000 Ulp-p/1 Vp-p 4000 UI range: 4000 Ulp-p/1 Vp-p	Connector: BNC, 50 Ω (GND)																										
Jitter Recovery Signal Output	Frequency: 10 Hz to 80 MHz (Supports Jitter Demodulation Only) Sensitivity: 2 UI range: 2 Ulp-p/1 Vp-p 20 UI range: 20 Ulp-p/1 Vp-p 80 UI range: 80 Ulp-p/1 Vp-p 250 UI range: 250 Ulp-p/1 Vp-p 1000 UI range: 1000 Ulp-p/1 Vp-p 4000 UI range: 4000 Ulp-p/1 Vp-p	Connector: BNC, 50 Ω (GND)																										
Wander Generation	Modulation Frequency: 10 μ Hz to 10 Hz Amplitude: 0 to 400,000 UI/Step 1 Ulp-p <table border="1" data-bbox="327 1312 949 1459"> <thead> <tr> <th>Frequency (Hz)</th> <th>F0 (Hz)</th> <th>F1 (Hz)</th> <th>F2 (Hz)</th> <th>A0 (Ulp-p)</th> <th>A1 (Ulp-p)</th> <th>Step (Ulp-p)</th> </tr> </thead> <tbody> <tr> <td>52</td> <td rowspan="5">10 μ</td> <td rowspan="5">400 m</td> <td rowspan="5">10</td> <td rowspan="5">400000</td> <td rowspan="5">16000</td> <td rowspan="5">1</td> </tr> <tr><td>156</td></tr> <tr><td>622</td></tr> <tr><td>2488</td></tr> <tr><td>9953</td></tr> </tbody> </table> <p>Accuracy: $\pm Q\%$ of setting ± 100 Ulp-p</p> <table border="1" data-bbox="606 1480 949 1585"> <thead> <tr> <th>Variable Error Q</th> <th>Frequency Range</th> </tr> </thead> <tbody> <tr> <td>$\pm 8\%$</td> <td>10 μHz to 0.125 Hz</td> </tr> <tr> <td>$\pm 12\%$</td> <td>0.125 Hz to 1 Hz</td> </tr> <tr> <td>$\pm 15\%$</td> <td>1 Hz to 10 Hz</td> </tr> </tbody> </table>	Frequency (Hz)	F0 (Hz)	F1 (Hz)	F2 (Hz)	A0 (Ulp-p)	A1 (Ulp-p)	Step (Ulp-p)	52	10 μ	400 m	10	400000	16000	1	156	622	2488	9953	Variable Error Q	Frequency Range	$\pm 8\%$	10 μ Hz to 0.125 Hz	$\pm 12\%$	0.125 Hz to 1 Hz	$\pm 15\%$	1 Hz to 10 Hz	
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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 $\pm 0.5\% \pm Z0$ (t) Filter Selection: DC to 10 Hz, DC to 0.01 Hz, 0.01 Hz to 10 Hz <table border="1" data-bbox="973 1690 1364 1774"> <thead> <tr> <th>Z0 (t) (ns)</th> <th>Observation Time t (s)</th> </tr> </thead> <tbody> <tr> <td>$2.5 + 0.0275 t$</td> <td>$0.05 \leq t \leq 1000$</td> </tr> <tr> <td>$29 + 0.001 t$</td> <td>$t > 1000$</td> </tr> </tbody> </table>	Z0 (t) (ns)	Observation Time t (s)	$2.5 + 0.0275 t$	$0.05 \leq t \leq 1000$	$29 + 0.001 t$	$t > 1000$																				
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Ordering Information

Please specify the model/order number, name and quantity when ordering.
The names listed in the chart below are Order Names. The actual name of the item may differ from the Order Name.

Model/Order No.	Name
Main Frame	
MP1590B8	Network Performance Tester
Standard Accessories	
J0491	Shield Power Cord, 2.6 m*1 1 pc
F0105	Fuse, 10 A*1 2 pcs
E0010	Side Cover*1 1 pc
B0329G	Front Cover (for 3/4MW4U)*1 1 pc
Z0847A	MD1230/MP1590 Family Software CD*1, *2 1 pc
J0617B	Replaceable Optical Connector (FC-PC)*3, *4 1 pc/2 pcs
J0747B	Fixed Optical Attenuator (10 dB, FC connector)*5 1 pc
J1003N	Semi-rigid Cable (136.6 mm)*6 2 pcs
J1003P	Semi-rigid Cable (96 mm)*6 1 pc
J1003Q	Semi-rigid Cable (75.6 mm)*7, *8 1 pc/2 pcs
J1003R	Semi-rigid Cable (55.3 mm)*6 1 pc
J1003S	Semi-rigid Cable (56.5 mm)*9 1 pc
J1003T	Semi-rigid Cable (67 mm) 2 pcs
J0500A	Semi-rigid Cable 50 cm 1 pc
Plug-in Units	
MU150110A	Multirate Unit*10, *11
MU150110A-088*12	Mechanical key for MP1590B8
MU150121A	10/10.7G Optical Unit (Tx)*13
MU150121A-088*12	Mechanical key for MP1590B8
MU150123A	10/10.7G Optical Unit (Rx Wide)
MU150123A-088*12	Mechanical key for MP1590B8
MU150125A	10/10.7G Jitter Unit
MU150125A-088*12	Mechanical key for MP1590B8
Options	
MP1590B-01	RS-232C
MP1590B-02	GPIB
MP1590B-03	LAN
MU150110A-004	Optical Output Power Adjustable*14
MU150110A-005	OTU1/OTU2
MU150110A-006	11.1G
MU150110A-008	10.3G
MU150110A-009	Insert/Extract
MU150110A-010	Multichannel Measurement
MU150110A-040	SC Connector*15
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-40	SC Connector*15
MU150123A-05	OTU2
MU150123A-40	SC Connector*15
MU150125A-01	Wander Measurement
MU150125A-05	OTU1/OTU2
MU150125A-06	10.3G
Software	
MX159001B	Network Performance Tester Control Software*16, *17
Software Options	
MX159001B-03	Ethernet Control*17

Model/Order No.	Name
Optional Accessories	
G0194A	1310 nm XFP Module*18
G0195A	1550 nm XFP Module*18
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)
J0796E	FC Connector (replaceable, with protective caps, 1 set)
J0617B	Replaceable Optical Connector (FC-PC)
J0747B	Fixed Optical Attenuator (10 dB, FC Connector)
J0747C	Fixed Optical Attenuator (15 dB, FC Connector)
J0747D	Fixed Optical Attenuator (20 dB, FC Connector)
J1049A	Fixed Optical Attenuator (SC, 5 dB)
J1049B	Fixed Optical Attenuator (SC, 10 dB)
J1049C	Fixed Optical Attenuator (SC, 15 dB)
J1376A	Fixed Optical Attenuator (5 dB, LC connector)
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
J0660B	Optical Fiber Cord (SM, SC-SC connector), 2 m
J1344A	Optical Fiber Cord (Simplex, SM, LC-LC connector), 1 m
J1327B	Optical Fiber Cord (Simplex, SM, LC-LC connector), 2 m
J1271	Optical Fiber Cord (Duplex, SM, LC-LC connector), 2 m
J1272	Optical Fiber Cord (Duplex, SM, LC-SC connector), 2 m
J1273	Optical Fiber Cord (Duplex, GI, LC-LC connector), 2 m
J1274	Optical Fiber Cord (Duplex, GI, LC-SC connector), 2 m
J1139A	Optical Fiber Cord (Simplex, SM, LC-FC connector), 1 m
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)
J0776D	Coaxial Cable (BNC-P-3W · 3D-2W · BNC-P-3W, 50 Ω), 2 m
J0322B	Coaxial Cable (11SMA · SUCOFLEX104 · 11SMA), 1 m
J0696A	Coaxial Cable (AA-165-500), 0.5 m
J1268	Semiflexible Coaxial Cable
J1349A	Coaxial Cable, 0.3 m
J1173	6020180 Power Divider
J1059B	Balanced Cable (RJ-45/Siemens 3P), 2 m
J1060B	Balanced Cable (RJ-45/BANTAM 3P), 2 m
J0008	GPIB Cable, 2 m
J1109B	LAN Cable (CAT5, cross), 5 m
J1110B	LAN Cable (CAT5, straight), 5 m
J1275	LAN Cable (CAT5E, straight), 1 m
J1275B	LAN Cable (CAT5E, straight), 5 m
J1275C	LAN Cable (CAT5E, cross), 1 m
J1275D	LAN Cable (CAT5E, cross), 5 m
Z0321A	Keyboard (PS/2)
Z0541A	USB Mouse
Z0284	Adapter Cleaner
Z0838A	Stick Cleaner 1.25 mm (250 pcs/set)
B0336C	Carrying Case (3/4MW4U, 350D)
B0530	Carrying Case caster for B0336C
B0448	Soft Case
B0593A	Blank Panel
B0588A	Rack Mount Kit*19
Z0849A	MD1230/MP1590 Family Manual CD
W2420AE	MP1590B Operation Manual
W2421AE	MX159001B Operation SDH Edition Manual
W2422AE	MX159001B Operation SONET Edition Manual
W2423AE	MP1590B/MP1591A Remote Control Operation Manual
W2134AE	Application Traffic Monitor Operation Manual
W1931AE	Ethernet Module Operation Manual
W3218AE	MU150110A Specifications Operation Manual
W2426AE	MU150125A Specifications Operation Manual
W2427AE	MU150121/2/3/34A Specifications Operation Manual

- *1: Supplied with main frame.
- *2: CD includes installer, release notes and operation manual.
- *3: Supplied with MU150110A, MU150121A, and MU150123A.
- *4: Two pieces of MU150110A.
- *5: Supplied with MU150123A, and MU150124A.
- *6: Supplied with MU150125A.
- *7: Supplied with MU150121A and MU150123A.
- *8: One piece of MU150123A, and two pieces of MU150121A.
- *9: Supplied with MU150110A.
- *10: Requires XFP module (sold separately). In addition, operation with non-Anritsu modules not guaranteed.
- *11: An XFP module (G0194A/G0195A) and fixed optical attenuator (J0747C, J1376A) are required when performing the self-test.
- *12: Mandatory for MP1590B8
- *13: One of Option 01, 02, 03 required.
- *14: Only enabled for optical output signals up to 2.6G.
- *15: Exchangeable.
- *16: MP1590B-03 not required.
- *17: 32-bit versions of Windows 2000, XP, 7 are supported.
- *18: XFP modules sold as single units. One can be mounted in MU150110A.
- *19: Rack mount Kit for MP1590B8.

• Maintenance Service

Model/Order No.	Name
Maintenance Service	
***-ES210	2 Years Extended Warranty Service
***-ES310	3 Years Extended Warranty Service
***-ES510	5 Years Extended Warranty Service

*: Extends standard 1-year warranty service period on new main frame and plug-in units to 2, 3, or 5 years.
 Purchased separately at new purchase. (Cannot be purchased mid-contract, at contract renewal or in multi-year combinations.)

***-ES210: MP1590B-ES210, MU150110A-ES210, MU150121A-ES210, MU150123A-ES210, MU150125A-ES210

***-ES310: MP1590B-ES310, MU150110A-ES310, MU150121A-ES310, MU150123A-ES310, MU150125A-ES310

***-ES510: MP1590B-ES510, MU150110A-ES510, MU150121A-ES510, MU150123A-ES510, MU150125A-ES510



B0336C Carrying Case



B0448 Soft Case

Note:

Note:

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