MU183040A
28G/32G bit/s ED
MU183041A
28G/32G bit/s 4ch ED
MU183040B
28G/32G bit/s High Sensitivity ED
MU183041B
28G/32G bit/s 4ch High Sensitivity ED
Operation Manual

17th Edition

- **For safety and warning information, please read this manual before attempting to use the equipment.**
- **Additional safety and warning information is provided in the MP1800A Signal Quality Analyzer Installation Guide, the MT1810A 4 Slot Chassis Installation Guide. Please also refer to one of these documents before using the equipment.**
- **Keep this manual with the equipment.**

ANRITSU CORPORATION

Document No.: M-W3595AE-17.0

Safety Symbols

To prevent the risk of personal injury or loss related to equipment malfunction, Anritsu Corporation uses the following safety symbols to indicate safety-related information. Ensure that you clearly understand the meanings of the symbols BEFORE using the equipment. Some or all of the following symbols may be used on all Anritsu equipment. In addition, there may be other labels attached to products that are not shown in the diagrams in this manual.

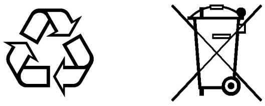
Symbols used in manual

⚠ DANGER	This indicates a very dangerous procedure that could result in serious injury or death if not performed properly.
⚠ WARNING	This indicates a hazardous procedure that could result in serious injury or death if not performed properly.
⚠ CAUTION	This indicates a hazardous procedure or danger that could result in light-to-severe injury, or loss related to equipment malfunction, if proper precautions are not taken.

Safety Symbols Used on Equipment and in Manual

The following safety symbols are used inside or on the equipment near operation locations to provide information about safety items and operation precautions. Ensure that you clearly understand the meanings of the symbols and take the necessary precautions BEFORE using the equipment.

⃠	This indicates a prohibited operation. The prohibited operation is indicated symbolically in or near the barred circle.
○	This indicates an obligatory safety precaution. The obligatory operation is indicated symbolically in or near the circle.
△	This indicates a warning or caution. The contents are indicated symbolically in or near the triangle.
□	This indicates a note. The contents are described in the box.



These indicate that the marked part should be recycled.

MU183040A 28G/32G bit/s ED MU183041A 28G/32G bit/s 4ch ED
MU183040B 28G/32G bit/s High Sensitivity ED MU183041B 28G/32G bit/s 4ch High Sensitivity ED
Operation Manual

20	July	2012 (First Edition)
6	April	2018 (17th Edition)

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Equipment Certificate

Anritsu Corporation certifies that this equipment was tested before shipment using calibrated measuring instruments with direct traceability to public testing organizations recognized by national research laboratories, including the National Institute of Advanced Industrial Science and Technology, and the National Institute of Information and Communications Technology, and was found to meet the published specifications.

Anritsu Warranty

Anritsu Corporation will repair this equipment free-of-charge if a malfunction occurs within one year after shipment due to a manufacturing fault. However, software fixes will be made in accordance with the separate Software End-User License Agreement. Moreover, Anritsu Corporation will deem this warranty void when:

- The fault is outside the scope of the warranty conditions separately described in the operation manual.
- The fault is due to mishandling, misuse, or unauthorized modification or repair of the equipment by the customer.
- The fault is due to severe usage clearly exceeding normal usage.
- The fault is due to improper or insufficient maintenance by the customer.
- The fault is due to natural disaster, including fire, wind, flooding, earthquake, lightning strike, or volcanic ash, etc.
- The fault is due to damage caused by acts of destruction, including civil disturbance, riot, or war, etc.
- The fault is due to explosion, accident, or breakdown of any other machinery, facility, or plant, etc.
- The fault is due to use of non-specified peripheral or applied equipment or parts, or consumables, etc.
- The fault is due to use of a non-specified power supply or in a non-specified installation location.
- The fault is due to use in unusual environments(Note).
- The fault is due to activities or ingress of living organisms, such as insects, spiders, fungus, pollen, or seeds.

In addition, this warranty is valid only for the original equipment purchaser. It is not transferable if the equipment is resold.

Anritsu Corporation shall assume no liability for injury or financial loss of the customer due to the use of or a failure to be able to use this equipment.

Note:
For the purpose of this Warranty, "unusual environment" means use:

- In places of direct sunlight
- In dusty places
- Outdoors
- In liquids, such as water, oil, or organic solvents, and medical fluids, or places where these liquids may adhere
- In salty air or in place chemically active gases (sulfur dioxide, hydrogen sulfide, chlorine, ammonia, nitrogen dioxide, or hydrogen chloride etc.) are present
- In places where high-intensity static electric charges or electromagnetic fields are present
- In places where abnormal power voltages (high or low) or instantaneous power failures occur
- In places where condensation occurs
- In the presence of lubricating oil mists
- In places at an altitude of more than 2,000 m
- In the presence of frequent vibration or mechanical shock, such as in cars, ships, or airplanes

Anritsu Corporation Contact

In the event of this equipment malfunctions, contact an Anritsu Service and Sales office. Contact information can be found on the last page of the printed version of this manual, and is available in a separate file on the PDF version.

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   - iv) If this Software or the Equipment has been modified, repaired, or otherwise altered without Anritsu's prior approval.
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Anritsu affixes the CE Conformity marking on the following product(s) in accordance with the Decision 768/2008/EC to indicate that they conform to the EMC, LVD and RoHS directive of the European Union (EU).

CE marking

1. Product Model

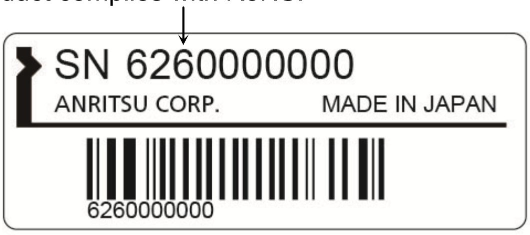
Plug-in Units: MU183040A 28G/32G bit/s ED
MU183041A 28G/32G bit/s 4ch ED
MU183040B 28G/32G bit/s High Sensitivity ED
MU183041B 28G/32G bit/s 4ch High Sensitivity ED

2. Applied Directive and Standards

When the MU183040A 28G/32G bit/s ED, MU183041A 28G/32G bit/s 4ch ED, MU183040B 28G/32G bit/s High Sensitivity ED or MU183041B 28G/32G bit/s 4ch High Sensitivity ED is installed in the MP1800A or MT1810A, the applied directive and standards of this unit conform to those of the MP1800A or MT1810A main frame.

PS: About main frame

Please contact Anritsu for the latest information on the main frame types that MU183040A/MU183041A/MU183040B/MU183041B can be used with.



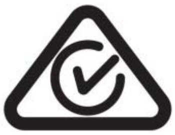
If the third digit of the serial number is “6”, the product complies with RoHS.

Serial number example

RCM Conformity Marking

Anritsu affixes the RCM mark on the following product(s) in accordance with the regulation to indicate that they conform to the EMC framework of Australia/New Zealand.

RCM marking



1. Product Model

Plug-in Units: MU183040A 28G/32G bit/s ED
MU183041A 28G/32G bit/s 4ch ED
MU183040B 28G/32G bit/s High Sensitivity ED
MU183041B 28G/32G bit/s 4ch High Sensitivity ED

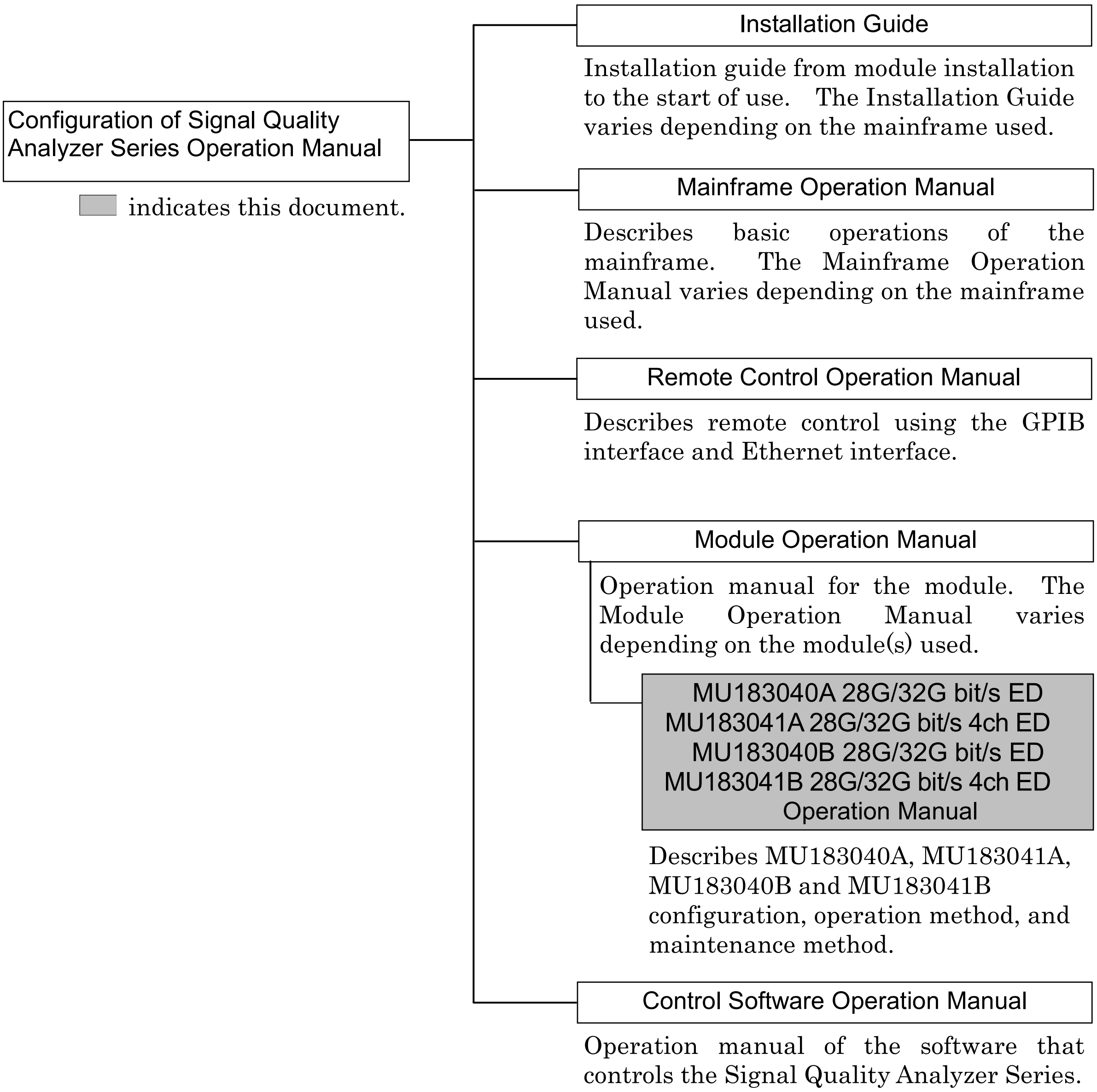
2. Applied Directive and Standards

When the MU183040A 28G/32G bit/s ED, MU183041A 28G/32G bit/s 4ch ED, MU183040B 28G/32G bit/s High Sensitivity ED or MU183041B 28G/32G bit/s 4ch High Sensitivity ED is installed in the MP1800A or MT1810A, the applied directive and standards of this unit conform to those of the MP1800A or MT1810A main frame.

PS: About main frame
Please contact Anritsu for the latest information on the main frame types that MU183040A/MU183041A/MU183040B/MU183041B can be used with.

About This Manual

A testing system combining an MP1800A Signal Quality Analyzer or MT1810A 4-Slot Chassis mainframe, module(s), and control software is called a Signal Quality Analyzer Series. The operation manuals of the Signal Quality Analyzer Series consist of separate documents for the installation guide, the mainframe, remote control operation, module(s), and control software, as shown below.



Configuration of Signal Quality Analyzer Series Operation Manual

▨ indicates this document.

Installation Guide

Installation guide from module installation to the start of use. The Installation Guide varies depending on the mainframe used.

Mainframe Operation Manual

Describes basic operations of the mainframe. The Mainframe Operation Manual varies depending on the mainframe used.

Remote Control Operation Manual

Describes remote control using the GPIB interface and Ethernet interface.

Module Operation Manual

Operation manual for the module. The Module Operation Manual varies depending on the module(s) used.

MU183040A 28G/32G bit/s ED
MU183041A 28G/32G bit/s 4ch ED
MU183040B 28G/32G bit/s ED
MU183041B 28G/32G bit/s 4ch ED
Operation Manual

Describes MU183040A, MU183041A, MU183040B and MU183041B configuration, operation method, and maintenance method.

Control Software Operation Manual

Operation manual of the software that controls the Signal Quality Analyzer Series.

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Chapter 1 Overview

This chapter provides an overview of the MU183040A 28G/32 G bit/s ED, the MU183041A 28G/32G bit/s 4ch ED, the MU183040B 28G/32G bit/s High Sensitivity ED and the MU183041B 28G/32G bit/s 4ch High Sensitivity ED (hereinafter, referred to as “MU183040A/41A/40B/41B”).

This document only explains the MU183040A, unless there is a special item.

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1.1 Product Overview

The MU183040A/41A/40B/41B is a plug-in module that can be built into a Signal Quality Analyzer Series mainframe. It can measure a variety of patterns within the operating frequency range, including PRBS, Data, Zero-Substitution, Mixed, and Sequence patterns.

Various option configurations are available for the MU183040A/41A/40B/41B. This module is therefore useful for research, development, and production of various types of digital communication equipment, modules, and devices.

The features of the MU183040A/41A/40B/41B are as follows:

- Capable of measuring PRBS, Data, Zero-Substitution, Mixed, and Sequence patterns.
- Provides a large amount of user-programmable patterns (256 Mbits)
- Providing a variety of applications including research, development, and production of various devices by selecting configuration options.
- MU183040A/MU183040B is equipped with up to 2 channels of 32 Gbit/s data input and can evaluate 64 Gbit/s serial communication.
- MU183041A/MU183041B is equipped with up to 4 channels of 32 Gbit/s data input and can evaluate 128 Gbit/s serial communication.
- With input sensitivity of Typ. 15 mVp-p, the MU183040B/MU183041B is the best for signal evaluation.
- The following clocks can be recovered by adding the MU183040B/MU183041B-x22/x23:
  - 2.4 to 28.1 Gbit/s (MU183040B/MU183041B-x22)
  - 25.5 to 32.1 Gbit/s (MU183040B/MU183041B-x23)

1.2 Product Configuration

1.2.1 Standard Configuration

Table 1.2.1-1 to Table 1.2.1-4 show the standard configurations of MU183040A/41A/40B/41B.

Table 1.2.1-1 Standard Configuration of MU183040A

Item	Model name	Product name	Q'ty	Remarks
Mainframe	MU183040A	28G/32G bit/s ED	1	
Accessories	J1137	Terminator	2	Aux Output × 2
	J1341A	Open	1	Ext Clock Input
	Z0897A	MP1800A Manual CD	1	CD-ROM
	Z0918A	MX180000A Software CD	1	CD-ROM

Table 1.2.1-2 Standard Configuration of MU183041A

Item	Model name	Product name	Q'ty	Remarks
Mainframe	MU183041A	28G/32G bit/s 4ch ED	1	
Accessories	J1137	Terminator	2	Aux Output × 2
	J1341A	Open	9	Ext Clock Input, Data Input × 8
	J1359A	Coaxial adapter (compatible among K-P, K-J, and SMA)	8	Data Input × 8
	Z0897A	MP1800A Manual CD	1	CD-ROM
	Z0918A	MX180000A Software CD	1	CD-ROM

Table 1.2.1-3 Standard Configuration of MU183040B

Item	Model name	Product name	Q'ty	Remarks
Mainframe	MU183040B	28G/32G bit/s High Sensitivity ED	1	
Accessories	J1137	Terminator	2	Aux Output × 2
	J1341A	Open	1	Ext Clock Input
	Z0897A	MP1800A Manual CD	1	CD-ROM
	Z0918A	MX180000A Software CD	1	CD-ROM

Table 1.2.1-4 Standard Configuration of MU183041B

Item	Model name	Product name	Q'ty	Remarks
Mainframe	MU183041B	28G/32G bit/s 4ch High Sensitivity ED	1	
Accessories	J1137	Terminator	2	Aux Output × 2
	J1341A	Open	9	Ext Clock Input, Data Input × 8
	J1359A	Coaxial adapter (compatible among K-P, K-J, and SMA)	8	Data Input × 8
	41KC-6	Precision Fixed Attenuator 6 dB	8	Data Input × 8
	Z0897A	MP1800A Manual CD	1	CD-ROM
	Z0918A	MX180000A Software CD	1	CD-ROM

1.2.2 Options

Table 1.2.2-1 to Table 1.2.2-4 show the options for the MU183040A/ MU183041A/MU183040B/MU183041B. Table 1.2.2-5 to Table 1.2.2-8 show the Accessories for options for the MU183040A/MU183040B-x10/x20. Each of the following options can be purchased separately.

Table 1.2.2-1 Options for MU183040A

Model name	Product name	Remarks
MU183040A-x01	32 Gbit/s Extension	
MU183040A-x10	1ch ED	This option cannot be installed together with MU183040A-x20.
MU183040A-x20	2ch ED	This option cannot be installed together with MU183040A-x10.

Table 1.2.2-2 Options for MU183041A

Model name	Product name	Remarks
MU183041A-x01	32 Gbit/s Extension	

Table 1.2.2-3 Options for MU183040B

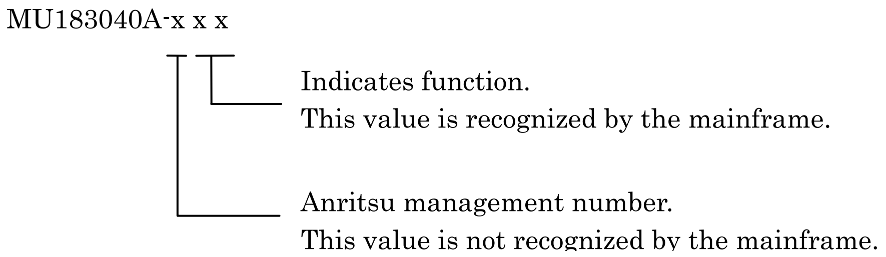
Model name	Product name	Remarks
MU183040B-x01	32 Gbit/s Extension	
MU183040B-x10	1ch ED	This option cannot be installed together with MU183040B-x20.
MU183040B-x20	2ch ED	This option cannot be installed together with MU183040B-x10.
MU183040B-x22	2.4G to 28.1G bit/s Clock Recovery	This option cannot be installed together with MU183040B-x23.
MU183040B-x23	25.5G to 32.1G bit/s Clock Recovery	This option can be installed only when MU183040B-x01 is installed, and cannot be installed together with MU183040B-x22.

Table 1.2.2-4 Options for MU183041B

Model name	Product name	Remarks
MU183041B-x01	32 Gbit/s Extension	
MU183041B-x22	2.4G to 28.1G bit/s Clock Recovery	This option cannot be installed together with MU183041B-x23.
MU183041B-x23	25.5G to 32.1G bit/s Clock Recovery	This option can be installed only when MU183041B-x01 is installed, and cannot be installed together with MU183041B-x22.

Note:

Option name format is as follows:



MU183040A-x x x

Indicates function.
This value is recognized by the mainframe.

Anritsu management number.
This value is not recognized by the mainframe.

Table 1.2.2-5 Standard Accessories for MU183040A-x10 Options

Model name	Product name	Q'ty	Remarks
J1341A	Open	2	Data Input × 2
J1359A	Coaxial adapter (compatible among K-P, K-J, SMA)	2	Data Input × 2

Table 1.2.2-6 Standard Accessories for MU183040A-x20 Options

Model name	Product name	Q'ty	Remarks
J1341A	Open	4	Data Input × 4
J1359A	Coaxial adapter (compatible among K-P, K-J, SMA)	4	Data Input × 4

Table 1.2.2-7 Standard Accessories for MU183040B-x10 Options

Model name	Product name	Q'ty	Remarks
J1341A	Open	2	Data Input × 2
J1359A	Coaxial adapter (compatible among K-P, K-J, SMA)	2	Data Input × 2
41KC-6	Precision Fixed Attenuator 6 dB	2	Data Input × 2

Table 1.2.2-8 Standard Accessories for MU183040B-x20 Options

Model name	Product name	Q'ty	Remarks
J1341A	Open	4	Data Input × 4
J1359A	Coaxial adapter (compatible among K-P, K-J, SMA)	4	Data Input × 4
41KC-6	Precision Fixed Attenuator 6 dB	4	Data Input × 4

1.2.3 Application parts

Table 1.2.3-1 shows the application parts for the MU183040A/ MU183041A/MU183040B/MU183041B.

Each of the following application parts can be purchased separately.

Table 1.2.3-1 Application parts for MU183040A/MU183040B

Model name	Product name	Remarks
J1449A	Measurement kit	Coaxial cable 0.8 m × 2 Coaxial cable 1.0 m × 1
J1625A	Coaxial cable, 1 m	SMA connector
J1342A	Coaxial cable, 0.8 m	APC3.5 mm connector
Z0306A	Wrist strap	
J1137	Terminator	
J1359A	Coaxial adapter (compatible among K-P, K-J, and SMA)	
W3595AE	Operation manual	Printed version
41KC-3	Precision Fixed Attenuator 3 dB	
41KC-6	Precision Fixed Attenuator 6 dB	
41KC-10	Precision Fixed Attenuator 10 dB	
41KC-20	Precision Fixed Attenuator 20 dB	
J1349A	Coaxial Cable 0.3 m	APC 3.5 mm connector
J1550A	Coaxial skew match cable (0.8 m, APC3.5 connector)	APC 3.5 mm connector, Pair cable
J1551A	Coaxial skew match cable (0.8 m, K connector)	Pair cable
J1611A	Coaxial cable (1.3 m, K connector)	K connector
J1741A	Fixed Electrical Length Coaxial Cable (0.8 m, K Connector)	K connector
J1615A*	Coaxial Cable set (Jitter-PPG-Emphasis)	Cable set for jitter tolerance measurement
J1618A*	Coaxial Cable set (Jitter-2chPPG-Emphasis)	Cable set for jitter tolerance measurement
J1620A	Coaxial Cable (0.9 m K Connector)	K connector
J1621A	Passive Equalizer 3dB	
J1622A	Passive Equalizer 6dB	
J1678A	ESD Protection Adapter-K	K connector

*: For examples of how to connect instruments with coaxial cables, refer to Appendix E.

1.3 Specifications

1.3.1 Specifications for MU183040A

Table 1.3.1-1 Operating bit rate

Item	Specifications
Operating bit rate	2.4 to 28.1 Gbit/s*1 2.4 to 32.1 Gbit/s*2

*1: When option x01 is not installed.

*2: When option x01 is installed.

Table 1.3.1-2 System Clock

Item	Specifications
System Clock	External

Table 1.3.1-3 Data Input

Item	Specifications
Number of inputs	2 (Data, XData) (Differential)*1
	4 (Data1, XData1, Data2, XData2) (Differential)*2
Amplifier	Single-Ended 50Ohm, Differential 50Ohm, Differential 100Ohm can be set.
	Data and XData can be set.
	Tracking, Independent, Alternate can be set.
	When Alternate is selected: Data-XData and XData-Data can be set.*3
Input signal format	NRZ
Input amplitude	0.25 to 2.0 Vp-p
Threshold voltage	–3.5 to +3.3 V (1mV step) (Can be set separately.)
	(Absolute value of difference between Data and XData Threshold values shall be 3 V or less.)
Input sensitivity	50 mVp-p*4,*5,*6
Phase margin	20 ps*4,*6,*7,*9
	28 ps*6,*7,*8,*9
Termination	GND/50 Ω, Variable/50 Ω
Termination voltage	When Variable is selected for Termination: –2.5 to +3.5 V / 10 mV step
Connector	K (f.)

*1: Option x10

*2: Option x20

*3: Absolute value of difference between Data and XData Threshold values shall be 1.5 V or less.

*4: 28.1 Gbit/s

*5: PRBS31, Single-Ended, Mark ratio 1/2, 20 to 30°C

*6: Typical value

*7: 0.5 Vp-p Input

*8: 25 Gbit/s

*9: PRBS31, Single-Ended, Mark ratio 1/2

Table 1.3.1-4 Clock Input

Item	Specifications
Number of inputs	1 (Single-Ended)
Frequency range	1.2 to 16.05 GHz
Input level	0.3 to 1.0 Vp-p (–6.5 to +4.0 dBm)
Termination	AC/50 Ω
Connector	SMA (f.)

Table 1.3.1-5 Aux Input, Aux Output

Item	Specifications
Aux Input	
Number of inputs	1 (Single-Ended)
Input signal	External Mask, Burst, Capture External Trigger
Minimum pulse width	1/128 of Data rate
Input level	0/–1 V (H: –0.25 to 0.05 V / L: –1.1 to –0.8 V)
Termination	GND/50 Ω
Connector	SMA (f.)
Aux Output	
Number of outputs	2 (Differential)
Output Signal Selection	1/n Clock (n = 4, 6, 8, 10…510, 512), Pattern Sync, Error, Sync. gain
Pattern Sync	
PRBS, PRGM	Position: 1 to {(Least common multiple of Pattern Length’ and 128) –135} / 8 step Pattern Length’ shall be the value obtained by multiplying Pattern Length setting until it becomes 512 or more if it is 511 or less.
Mixed Data	Block No. setting: 1 to (the Block No. specified for Mixed Data), in single steps Row No. setting: 1 to (the Row No. specified for Mixed Data), in single steps
Output level	0/–0.6 V (H: –0.25 to 0.05V /L: –0.80 to –0.45 V)
Termination	GND/50 Ω
Connector	SMA (f.)

Table 1.3.1-6 Pattern Detection

Item	Specifications
PRBS	
Pattern length	2^n-1 (n = 7, 9, 10, 11, 15, 20, 23, 31)
Mark ratio	1/2 (1/2INV is supported by a logical inversion.)
Zero-Substitution	
Additional Bit	0 bit, 1 bit
Pattern length	2^n or 2^n-1 (n = 7, 9, 10, 11, 15, 20, 23)
Start position	Substitutes the bit coming after the maximum “0” successive bits.
Successive-zeros bit length	1 to (Pattern Length–1) bits If the bit coming after Zero-substitution is “0”, then it is replaced with “1”.
Data	
Pattern length	2 to 268 435 456 bits / 1 bit step
Mixed Pattern	
Pattern	Data
Mixed Block	To the smaller of the following values: 1 to 511 Block / 1 Block step $\mathrm{INT}\left(\frac{268435456}{\text{ROW count}}\times\text{Data length}\right)$ bits $\mathrm{INT}\left(\frac{2415919104}{\text{ROW length}}\times\text{ROW count}\right)$ bits
Mixed Row Length	1 536 to 2 415 919 104 / 256 bits step (Data + PRBS Length)
Pattern length	1 024 to 268 435 456 bits / 1 bit step
Number of rows	1 to 16 / 1 step
Number of blocks	1 to 511 / 1 step
PRBS steps/Mark ratio	Same as PRBS
PRBS Sequence	Restart, Consecutive
Descramble	Can be set per PRBS and Data for each Block (except the Data area for Block 1).

Table 1.3.1-7 Pattern Sequence

Item	Specifications
Sequence	Repeat/Burst
Repeat	Continuous Pattern
Burst	
Source	Internal, External-Trigger (Aux Input), External-Enable (Aux Input)
Delay	Internal: 0 to 2 147 483 640 bits / 8 bits step Ext Trigger/Enable: 0 to 2 147 483 520 bits / 8 bits step Adjust Method: Auto, Manual
Enable Period	Internal: 12 800 to 2 147 482 624 bits / 256 bits step Ext Trigger, Enable: 12 800 to 2 147 483 392 bits / 256 bits step
Burst Cycle	25 600 to 2 147 483 648 bits / 256 bits step

Table 1.3.1-8 Measurement

Item	Specifications
Measurement types	Error Rate: 0.0001E–18 to 1.0000E00
	Error Count: 0 to 9999999, 1.0000E07 to 9.9999E17
	Error Interval: 0 to 9999999, 1.0000E07 to 9.9999E17
	%Error Free Interval: 0.0000 to 100.0000
	Frequency: 2400.000 to 32100.000 MHz
	Frequency measurement accuracy: ±1 ppm ±1 kHz*
	Clock Count: 0 to 9999999, 1.0000E07 to 9.9999E17
	Sync Loss Interval: 0 to 9999999, 1.0000E07 to 9.9999E17
	Clock Loss Interval: 0 to 9999999, 1.0000E07 to 9.9999E17
Gating	Time, Clock Count, Error Count, Block Count
Unit, Cycle setting	Time: 1 second to 99 days 23 hours 59 minute 59 seconds
	Clock Count: >E+4 to >E+16
	Error Count: >E+4 to >E+16
	Block Count: >E+2 to >E+14
Gating Cycle	Single / Repeat / Untimed
Current	On, Off can be set.
	Calculation: Progressive, Immediate
	Interval: 100 ms, 200 ms, 500 ms
Auto Sync	On / Off can be set.
	Synchronization threshold: INT, E–2 to E–8
Sync Control	PRBS: Automatic Synchronization
	Data: Frame On, Quick
	Mixed-Data: Frame On
Frame length	4 to 64 bits / 4 bits step
Frame mask	Available
Frame Position	1 to (Pattern Length'– Frame Length +1) bits / 1 bit step
Error/Alarm conditions	
Error detection mode	Total, Insertion/Omission, or Transition/Non Transition
EI/EFI interval	1 ms, 10 ms, 100 ms, 1 s

*: When Gating is selected and the main frame reference clock 10 MHz is calibrated.

Table 1.3.1-9 Error Analysis

Item	Specifications	
Block Window	Excludes the specified data pattern bit from the measurement target according to the settings. (Mask measurement function) Invalid when "Mixed" is selected for Test Pattern.	
Setting resolution	Pattern length (bits)	Step [bits]
	2 to 2 097 152	1
	2 097 153 to 4 194 304	2
	4 194 305 to 8 388 608	4
	8 388 609 to 16 777 216	8
	16 777 217 to 33 554 432	16
	33 554 433 to 67 108 864	32
	67 108 865 to 134 217 728	64
	134 217 729 to 268 435 456	128
Bit window	Excludes any channels among internal 32 channels from the measurement target.	
External mask	H: Measurement, L: Mask	
Capture function	Number of blocks:	1, 2, 4, 8, 16, 32, 64, 128
	Block length:	8 Mbits / n (n is Number of blocks.)
Automatic measurement function	Eye margin, Eye diagram, Bathtub, Q measurement, Eye Contour Auto Adjust, Auto Search*1,*2,*3	

*1: The input pattern must be an NRZ PRBS pattern with a mark ratio of 1/2.

*2: Under the following conditions:
There is at least 1 transition bit among 128 bits.
The ratio of both rising and falling edges to Pattern length is 1/5 or more.
Mark ratio is between 1/8 and 7/8.

*3: The Auto Adjust function obtains a point in the vicinity of the following as an optimum point:
- (Voh + Vol) / 2 in voltage direction
- (P1 + P2) / 2 in phase direction

The Auto Adjust functions properly when the input signal makes the waveform of 250 mVp-p or bigger on the oscilloscope.

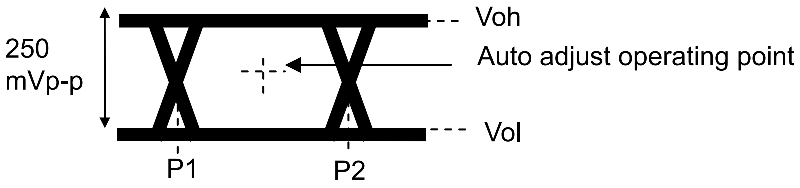


Table 1.3.1-10 Variable Clock Delay

Item	Specifications
Phase variable range	–1 000 to +1 000 mUI / 2 mUI step
Phase setting error	±50 mUIp-p*1,*2,*3 ±75 mUIp-p*1,*2,*4
mUI – ps switching	Available
Calibration	Available
Calibration indicator	This indicator is on when Calibration is required due to: • Change in 1/1Clock frequency by ±250 kHz. • Change in the ambient temperature by ±5°C.

*1: Using oscilloscope with residual jitter of less than 200 fs (RMS).

*2: Typical value

*3: Bit rate ≤ 28.1 Gbit/s

*4: Bit rate > 28.1 Gbit/s

Table 1.3.1-11 Jitter Tolerance

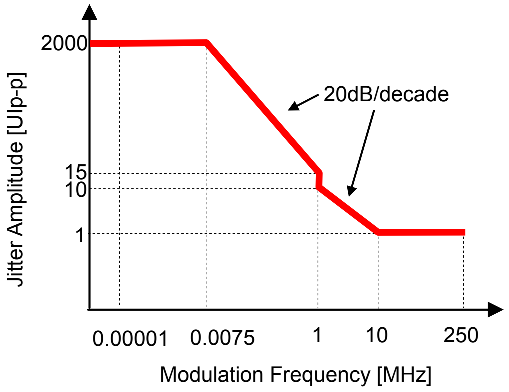
Item	Specifications
Jitter tolerance When using external clock	Bit Rate 16Gbit/s, 28.1Gbit/s, 32.1Gbit/s (When option x01 is installed.) Test pattern: PRBS2^{31}-1 SSC with a 5300 ppm amplitude and RJ of 0.3 UI can be simultaneously applied by using MU181500B. These specifications are defined assuming the following conditions: • Loopback connection with MU183020A/21A • At any temperature between 20 and 30°C 

Table 1.3.1-12 Multichannel operation

<table>
<tr><th>Item</th><th colspan="2">Specifications</th></tr>
<tr><td>Combination*1</td><td colspan="2"></td></tr>
<tr><td>Number of channels</td><td colspan="2">2</td></tr>
<tr><td>Pattern</td><td colspan="2"></td></tr>
<tr><td>Data</td><td colspan="2"></td></tr>
<tr><td>Pattern Length</td><td colspan="2">4 to 536 870 912 bits / 2 bits step*2</td></tr>
<tr><td>Mixed</td><td colspan="2"></td></tr>
<tr><td>Row Length</td><td colspan="2">3 072 to 4 831 838 208 bits / 512 bits step*2</td></tr>
<tr><td>Pattern Length</td><td colspan="2">2 048 to 536 870 912 bits / 2 bits step*2</td></tr>
<tr><td>Block Window</td><td colspan="2">Excludes the specified data pattern bit from the measurement target according to the settings. (Mask measurement function)
Invalid when “Mixed” is selected for Test Pattern.
Invalid when Zero-substitution is set to 2n–1.
n = 2 (2ch Combination) is considered in the following:</td></tr>
<tr><td>Setting resolution</td><td>Pattern length (bits)</td><td>Step [bits]</td></tr>
<tr><td></td><td>2 to 2 097 152 × n</td><td>1 × n</td></tr>
<tr><td></td><td>2 097 153 to 4 194 304 × n</td><td>2 × n</td></tr>
<tr><td></td><td>4 194 305 to 8 388 608 × n</td><td>4 × n</td></tr>
<tr><td></td><td>8 388 609 to 16 777 216 × n</td><td>8 × n</td></tr>
<tr><td></td><td>16 777 217 to 33 554 432 × n</td><td>16 × n</td></tr>
<tr><td></td><td>33 554 433 to 67 108 864 × n</td><td>32 × n</td></tr>
<tr><td></td><td>67 108 865 to 134 217 728 × n</td><td>64 × n</td></tr>
<tr><td></td><td>134 217 729 to 268 435 456 × n</td><td>128 × n</td></tr>
<tr><td>Burst</td><td colspan="2"></td></tr>
<tr><td>Burst Cycle</td><td colspan="2">51 200 to 4 294 967 296 bits / 512 bits step*2</td></tr>
<tr><td>Enable Period</td><td>Internal:</td><td>25 600 to 4 294 965 248 bits / 512 bits step*2</td></tr>
<tr><td></td><td>Ext Trigger:</td><td>25 600 to 4 294 966 784 bits / 512 bits step*2</td></tr>
<tr><td>Delay</td><td>Internal:</td><td>0 to 4 294 967 280 bits / 16 bits step*2</td></tr>
<tr><td></td><td>Ext Trigger, Enable:</td><td>0 to 4 294 967 040 bits / 16 bits step*2</td></tr>
<tr><td>Measurement</td><td colspan="2"></td></tr>
<tr><td>Sync Control</td><td colspan="2"></td></tr>
<tr><td>Frame length</td><td colspan="2">8 to 128 bits / 8 bits step*2</td></tr>
<tr><td>Frame Position</td><td colspan="2">1 to (Pattern Length' – Frame Length +n) bits / n bits step</td></tr>
<tr><td>Error detection mode</td><td colspan="2">Total, Insertion and Omission</td></tr>
<tr><td>Eye diagram</td><td colspan="2"></td></tr>
<tr><td>Measurement target</td><td colspan="2">ch1 to ch 2*3</td></tr>
<tr><td>Eye margin</td><td colspan="2"></td></tr>
<tr><td>Measurement target</td><td colspan="2">ch1 to ch 2*3</td></tr>
<tr><td>Bathtub</td><td colspan="2"></td></tr>
<tr><td>Measurement target</td><td colspan="2">ch1 to ch 2*3</td></tr>
<tr><td>Capture function</td><td colspan="2">2 Ch Combination is available*2</td></tr>
</table>

*1: Combination extending over multiple slots cannot be set.

*2: Common to every channel specified by Combination Setting.

*3: Separately specified for each channel.

Table 1.3.1-13 General

Item	Specifications
Dimensions	21 mm (H), 234 mm (W), 175 mm (D), Excluding protrusions
Mass	2.5 kg max.
Operating temperature	15 to 35°C
Storage temperature	–20 to 60°C

1.3.2 Specifications for MU183041A

Table 1.3.2-1 Operating bit rate

Item	Specifications
Operating bit rate	2.4 to 28.1 Gbit/s[*1] 2.4 to 32.1 Gbit/s[*2]

*1: When option x01 is not installed.

*2: When option x01 is installed.

Table 1.3.2-2 System Clock

Item	Specifications
System Clock	External

Table 1.3.2-3 Data Input

Item	Specifications
Number of inputs	8 (Data1 to Data4, XData1 to XData4) (Differential)
Amplifier	Single-Ended 50Ohm, Differential 50Ohm, Differential 100Ohm can be set. Data and XData can be set. Tracking, Independent, Alternate can be set. When Alternate is selected: Data-XData and XData-Data can be set.[*1]
Input signal format	NRZ
Input amplitude	0.25 to 2.0 Vp-p
Threshold voltage	–3.5 to +3.3 V (1 mV step) (Can be set separately.) (Absolute value of difference between Data and XData Threshold values shall be 3 V or less.)
Input sensitivity	50 mVp-p[*2,*3,*4]
Phase margin	20 ps[*2,*4,*5,*7] 28 ps[*4,*5,*6,*7]
Termination	GND/50 Ω, Variable/50 Ω
Termination voltage	When Variable is selected for Termination: –2.5 to +3.5 V / 10 mV step
Connector	K (f.)

*1: Absolute value of difference between Data and XData Threshold values shall be 1.5 V or less.

*2: 28.1 Gbit/s

*3: PRBS31, Single-Ended, Mark ratio 1/2, 20 to 30°C

*4: Typical value

*5: 0.5 Vp-p Input

*6: 25 Gbit/s

*7: PRBS31, Single-Ended, Mark ratio 1/2

Table 1.3.2-4 Clock Input

Item	Specifications
Number of inputs	1 (Single-Ended)
Frequency range	1.2 to 16.05 GHz
Input level	0.3 to 1.0 Vp-p (–6.5 to +4.0 dBm)
Termination	AC/50 Ω
Connector	SMA (f.)

Table 1.3.2-5 Aux Input, Aux Output

Item	Specifications
Aux Input	
Number of inputs	1 (Single-Ended)
Input signal	External Mask, Burst, Capture External Trigger
Minimum pulse width	1/128 of Data rate
Input level	0/–1 V (H: –0.25 to 0.05 V / L: –1.1 to –0.8 V)
Termination	GND/50 Ω
Connector	SMA (f.)
Aux Output	
Number of outputs	2 (Differential)
Output Signal Selection	1/n Clock (n = 4, 6, 8, 10…510, 512), Pattern Sync, Error, Sync. gain
Pattern Sync	
PRBS, PRGM	Position: 1 to {(Least common multiple of Pattern Length' and 128) –135} / 8 step Pattern Length' shall be the value obtained by multiplying Pattern Length setting until it becomes 512 or more if it is 511 or less.
Mixed Data	Block No. setting: 1 to the Block No. specified for Mixed Data, in single steps Row No. setting: 1 to the Row No. specified for Mixed Data, in single steps
Output level	0/–0.6 V (H: –0.25 to 0.05V / L: –0.80 to –0.45 V)
Termination	GND/50 Ω
Connector	SMA (f.)

Table 1.3.2-6 Pattern Detection

Item	Specifications
PRBS	
Pattern length	2^n-1 (n = 7, 9, 10, 11, 15, 20, 23, 31)
Mark ratio	1/2 (1/2INV is supported by a logical inversion.)
Zero-Substitution	
Additional Bit	0 bit, 1 bit
Pattern length	2^n or 2^n-1 (n = 7, 9, 10, 11, 15, 20, 23)
Start position	Substitutes the bit coming after the maximum “0” successive bits.
Successive-zeros bit length	1 to (Pattern Length–1) bits If the bit coming after Zero-substitution is “0”, then it is replaced with “1”.
Data	
Pattern length	2 to 268 435 456 bits / 1 bit step
Mixed Pattern	
Pattern switching	Data
Mixed Block	To the smaller of the following values: 1 to 511 Block / 1 Block step $\mathrm{INT}\left(\frac{268435456}{\mathrm{ROW\ count}}\times \mathrm{Data\ length}\right)$ bits $\mathrm{INT}\left(\frac{2415919104}{\mathrm{ROW\ length}}\times \mathrm{ROW\ count}\right)$ bits
Mixed Row Length	1 536 to 2 415 919 104 bits / 256 bits step (Data + PRBS Length)
Pattern length	1 024 to 268 435 456 bits / 1 bit step
Number of rows	1 to 16 / 1 step
Number of blocks	1 to 511 / 1 step
PRBS steps/Mark ratio	Same as PRBS.
PRBS Sequence	Restart, Consecutive
Descramble	Can be set per PRBS and Data for each Block (except the Data area for Block 1).

Table 1.3.2-7 Pattern Sequence

Item	Specifications	
Sequence	Repeat/Burst	
Repeat	Continuous Pattern	
Burst		
Source	Internal, External-Trigger (Aux Input), External-Enable (Aux Input)	
Delay	Internal:	0 to 2 147 483 640 bits / 8 bits step
	Ext Trigger, Enable:	0 to 2 147 483 520 bits / 8 bits step
	Adjust Method:	Auto, Manual
Enable Period	Internal:	12 800 to 2 147 482 624 bits / 256 bits step
	Ext Trigger, Enable:	12 800 to 2 147 483 392 bits / 256 bits step
Burst Cycle	25 600 to 2 147 483 648 bits / 256 bits step	

Table 1.3.2-8 Measurement

Item	Specifications	
Measurement types	Error Rate:	0.0001E–18 to 1.0000E00
	Error Count:	0 to 9999999, 1.0000E07 to 9.9999E17
	Error Interval:	0 to 9999999, 1.0000E07 to 9.9999E17
	%Error Free Interval:	0.0000 to 100.0000
	Frequency:	2400.000 to 32100.000 MHz
	Frequency measurement accuracy:	±1 ppm ±1 kHz*
	Clock Count:	0 to 9999999, 1.0000E07 to 9.9999E17
	Sync Loss Interval:	0 to 9999999, 1.0000E07 to 9.9999E17
	Clock Loss Interval:	0 to 9999999, 1.0000E07 to 9.9999E17
Gating	Time, Clock Count, Error Count, Block Count	
Unit, Cycle setting	Time:	1 second to 99 days 23 hours 59 minute 59 seconds
	Clock Count:	>E+4 to >E+16
	Error Count:	>E+4 to >E+16
	Block Count:	>E+2 to >E+14
Gating Cycle	Single / Repeat / Untimed	
Current	On, Off	
	Calculation:	Progressive, Immediate
	Interval:	100 ms, 200 ms, 500 ms
Auto Sync	On / Off	
	Synchronization threshold:	INT, E–2 to E–8
Sync Control	PRBS:	Automatic Synchronization
	Data:	Frame On, Quick
	Mixed-Data:	Frame On
Frame length	4 to 64 bits / 4 bits step	
Frame mask	Available	
Frame Position	1 to (Pattern Length'– Frame Length +1) bits / 1 bit step	
Error/Alarm conditions		
Error detection mode	Total, Insertion/Omission, or Transition/Non Transition	
EI/EFI interval	1 ms, 10 ms, 100 ms, 1 s	

*: When Gating is selected and the main frame reference clock 10 MHz is calibrated.

Table 1.3.2-9 Error Analysis

Item	Specifications	
Block Window	Excludes the specified data pattern bit from the measurement target according to the settings. (Mask measurement function) Invalid when “Mixed” is selected for Test Pattern.	
Setting resolution	Pattern length (bits)	Step [bits]
	2 to 2 097 152	1
	2 097 153 to 4 194 304	2
	4 194 305 to 8 388 608	4
	8 388 609 to 16 777 216	8
	16 777 217 to 33 554,432	16
	33 554 433 to 67 108 864	32
	67 108 865 to 134 217 728	64
	134 217 729 to 268 435 456	128
Bit window	Excludes any channels among internal 32 channels from the measurement target.	
External mask	H: Measurement, L: Mask	
Capture function	Number of blocks: 1, 2, 4, 8, 16, 32, 64, 128 Block length: 8 Mbits / n (n is Number of blocks.)	
Automatic measurement function	Eye margin, Eye diagram, Bathtub, Q measurement, Eye Contour Auto Adjust, Auto Search*1,*2,*3	

*1: The input pattern must be an NRZ PRBS pattern with a mark ratio of 1/2.

*2: Under the following conditions:
There is at least 1 transition bit among 128 bits.
The ratio of both rising and falling edges to Pattern length is 1/5 or more.
Mark ratio is between 1/8 and 7/8.

*3: The Auto Adjust function obtains a point in the vicinity of the following as an optimum point:
- (Voh + Vol) / 2 in voltage direction
- (P1 + P2) / 2 in phase direction

The Auto Adjust functions properly when the input signal makes the waveform of 250 mVp-p or bigger on the oscilloscope.

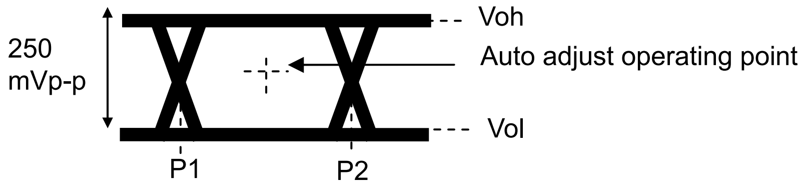


Table 1.3.2-10 Variable Clock Delay

Item	Specifications
Phase variable range	–1 000 to +1 000 mUI / 2 mUI step
Phase setting error	±50 mUIp-p[*1,*2,*3] ±75 mUIp-p[*1,*2,*4]
mUI – ps switching	Available
Calibration	Available
Calibration indicator	This indicator is on when Calibration is required due to: • Change in 1/1 Clock frequency by ±250 kHz. • Change in the ambient temperature by ±5°C.

*1: Using oscilloscope with residual jitter of less than 200 fs (RMS).

*2: Typical value

*3: Bit rate ≤ 28.1 Gbit/s

*4: Bit rate > 28.1 Gbit/s

Table 1.3.2-11 Jitter Tolerance

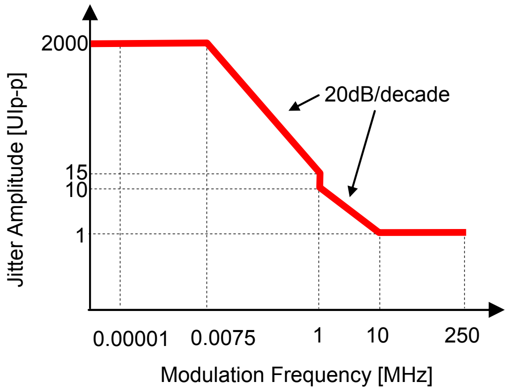
Item	Specifications
Jitter tolerance When using external clock	Bit Rate 16Gbit/s, 28.1Gbit/s, 32.1Gbit/s (When option x01 is installed.) Test pattern: PRBS2^{31}-1 SSC with a 5300 ppm amplitude and RJ of 0.3 UI can be simultaneously applied by using MU181500B. These specifications are defined assuming the following conditions: • Loopback connection with MU183020A/21A • At any temperature between 20 and 30°C 

Table 1.3.2-12 Multichannel operation

Item	Specifications	
Combination*1		
Number of channels	2, 4	
Pattern		
Data		
Pattern Length	Two channels: 4 to 536 870 912 bits / 2 bits step*2 Four channels: 8 to 1 073 741 824 bits / 4 bits step*2	
Mixed		
Row Length	Two channels: 3 072 to 4 831 838 208 / 512 bits step*2 Four channels: 6 144 to 9 663 676 416 / 1024 bits step*2	
Pattern Length	Two channels: 2 048 to 536 870 912 bits / 2 bits step*2 Four channels: 4 096 to 1 073 741 824 bits / 4 bits step*2	
Block Window	Excludes the specified data pattern bit from the measurement target according to the settings. (Mask measurement function) Invalid when “Mixed” is selected for Test Pattern. Invalid when Zero-substitution is set to 2n–1.	
Setting resolution	n: Number of channels for Channel Combination (2 or 4)	
	Pattern length (bits)	Step [bits]
	2 to 2 097 152 × n	1 × n
	2 097 153 to 4 194 304 × n	2 × n
	4 194 305 to 8 388 608 × n	4 × n
	8 388 609 to 16 777 216 × n	8 × n
	16 777 217 to 33 554 432 × n	16 × n
	33 554 433 to 67 108 864 × n	32 × n
	67 108 865 to 134 217 728 × n	64 × n
	134 217 729 to 268 435 456 × n	128 × n

*1: Combination extending over multiple slots cannot be set.

*2: Common to every channel specified by Combination Setting.

Table 1.3.2-12 Multichannel operation (Cont'd)

Item	Specifications
Burst	
Burst Cycle	Two channels: 51 200 to 4 294 967 296 bits / 512 bits step*2
	Four channels: 102 400 to 8 589 934 592 bits / 1024 bits step*2
Enable Period	Internal: Two channels: 25 600 to 4 294 965 248 bits / 512 bits step*2
	Four channels: 51 200 to 8 589 930 496 bits / 1024 bits step*2
	Ext Trigger: Two channels: 25 600 to 4 294 966 784 bits / 512 bits step*2
	Four channels: 51 200 to 8 589 933 568 bits / 1024 bits step*2
Delay	Internal: Two channels: 0 to 4 294 967 280 bits / 16 bits step*2
	Four channels: 0 to 8 589 934 560 bits / 32 bits step*2
	Ext Trigger, Enable: Two channels: 0 to 4 294 967 040 bits / 16 bits step*2
	Four channels: 0 to 8 589 934 080 bits / 32 bits step*2
Measurement	
Sync Control	
Frame length	Two channels: 8 to 128 bits /8 bits step*2
	Four channels: 16 to 256 bits /16 bits step*2
Frame Position	Two channels: 1 to (Pattern length' – Frame length +2) bits / 2 bits step
	Four channels: 1 to (Pattern length' – Frame length +4) bits / 4 bits step
Error detection mode	Total, Insertion and Omission
Eye diagram	
Measurement target	ch1 to ch 4*3
Eye margin	
Measurement target	ch1 to ch 4*3
Bathtub	
Measurement target	ch1 to ch 4*3
Capture Function	2 Ch Combination is available.*2

*3: Separately specified for each channel.

Table 1.3.2-13 General

Item	Specifications
Dimensions	41 mm (H), 234 mm (W), 175 mm (D), Excluding protrusions
Mass	5 kg max.
Operating temperature	15 to 35°C
Storage temperature	–20 to 60°C

1.3.3 Specifications for MU183040B

Table 1.3.3-1 Operating bit rate

Item	Specifications
Operating bit rate	2.4 to 28.1 Gbit/s*1 2.4 to 32.1 Gbit/s*2

*1: When option x01 is not installed.

*2: When option x01 is installed.

Table 1.3.3-2 System Clock

Item	Specifications
System Clock	External, Recovered* can be set

*: The system clock can be selected only when option x22 or x23 is installed. This is fixed to External Clock when option x22 or x23 is not installed. Clock is recovered from the data input to the Data1 Input connector when Recovered is selected.

Table 1.3.3-3 Data Input

Item	Specifications
Number of inputs	2 (Data, XData) (Differential)*1 4 (Data1, XData1, Data2, XData2) (Differential)*2
Amplifier	Single-Ended 50Ohm, Differential 50Ohm, Differential 100Ohm can be set. Data and XData can be set. Tracking, Independent, Alternate can be set. When Alternate is selected: Data-XData and XData-Data can be set.*3
Input signal format	NRZ, PAM4
Input amplitude*10	0.05 to 1.0 Vp-p (NRZ) 0.3 to 0.6 Vp-p (PAM4, ≤28.1Gbaud) 0.4 to 0.7 Vp-p (PAM4, > 28.1Gbaud) ***Note:*** Be careful about the maximum input amplitude. 2 Vp-p Max for A-type, and 1 Vp-p Max for B type.
Threshold voltage	–3.5 to +3.3 V (1mV step) (Can be set separately.) (Absolute value of difference between Data and XData Threshold values shall be 3 V or less.)
Input sensitivity*10	15 mVp-p*4,*5,*6, ≤25 mVp-p*4 10 mVp-p*4,*5,*6,*11
Phase margin	20 ps*4,*6,*7,*9 28 ps*6,*7,*8,*9
Termination	GND/50 Ω, Variable/50 Ω
Termination voltage	When Variable is selected for Termination: –2.5 to +3.5 V / 10 mV step
Connector	K (f.)

*1: Option x10

*2: Option x20

*3: Absolute value of difference between Data and XData Threshold values shall be 1.5 V or less.

*4: 28.1 Gbit/s

*5: PRBS31, Single-Ended, Mark ratio 1/2, 20 to 30°C

*6: Typical value

*7: 0.5 Vp-p Input

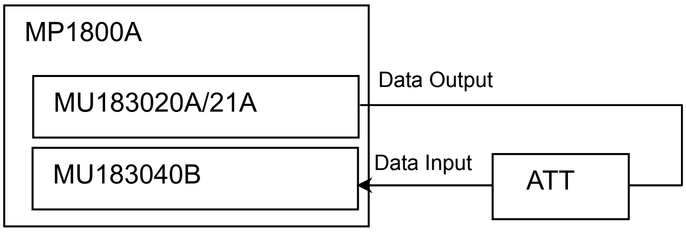
*8: 25 Gbit/s

*9: PRBS31, Single-Ended, Mark ratio 1/2

*10: The amplitude for NRZ input is the range in which AutoAdjust works. The amplitude for PAM4 input is the range in which PAM4 AutoSearch works. Input sensitivity is the minimum input amplitude which becomes error-free.

*11: Sensitivity of eye height.
When the output amplitude of the MU183020A/21A + ATT is set to 15 mV with the measurement system as the figure below, the error

rate range is 1E–9 or less. (A sampling oscilloscope with the bandwidth of 70 GHz or more is used.)


MP1800A
MU183020A/21A
MU183040B
Data Output
Data Input
ATT

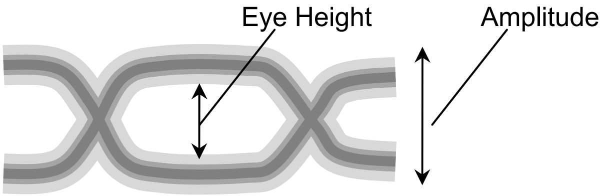

Eye Height
Amplitude

Table 1.3.3-4 Clock Input

Item	Specifications
Number of inputs	1 (Single-Ended)
Frequency range	1.2 to 16.05 GHz
Input level	0.3 to 1.0 Vp-p (–6.5 to +4.0 dBm)
Termination	AC/50 Ω
Connector	SMA (f.)

Table 1.3.3-5 Aux Input, Aux Output

Item	Specifications
Aux Input	
Number of inputs	1 (Single-Ended)
Input signal	External Mask, Burst, Capture External Trigger
Minimum pulse width	1/128 of Data rate
Input level	0/–1 V (H: –0.25 to 0.05 V / L: –1.1 to –0.8 V)
Termination	GND/50 Ω
Connector	SMA (f.)
Aux Output	
Number of outputs	2 (Differential)
Output Signal Selection	1/n Clock (n = 4, 6, 8, 10…510, 512), Pattern Sync, Error, Sync. gain
Pattern Sync	
PRBS, PRGM	Position: 1 to {(Least common multiple of Pattern Length' and 128) –135} / 8 step Pattern Length' shall be the value obtained by multiplying Pattern Length setting until it becomes 512 or more if it is 511 or less.
Mixed Data	Block No. setting: 1 to the Block No. specified for Mixed Data, in single steps Row No. setting: 1 to the Row No. specified for Mixed Data, in single steps
Output level	0/–0.6 V (H: –0.25 to 0.05V / L: –0.80 to –0.45 V)
Termination	GND/50 Ω
Connector	SMA (f.)

Table 1.3.3-6 Pattern Detection

Item	Specifications
PRBS	
Pattern length	2^n–1 (n = 7, 9, 10, 11, 15, 20, 23, 31)
Mark ratio	1/2 (1/2INV is supported by a logical inversion.)
Zero-Substitution	
Additional Bit	0 bit, 1 bit
Pattern length	2^n or 2^n–1 (n = 7, 9, 10, 11, 15, 20, 23)
Start position	Substitutes the bit coming after the maximum “0” successive bits.
Successive-zeros bit length	1 to (Pattern Length–1) bits If the bit coming after Zero-substitution is “0,” then it is replaced with “1.”
Data	
Pattern length	2 to 268 435 456 bits / 1 bit step
Mixed Pattern	
Pattern	Data
Mixed Block	To the smaller of the following values: 1 to 511 Block / 1 Block step $\mathrm{INT}\left(\dfrac{268435456}{\text{ROW count}} \times \text{Data length}\right)$ bits $\mathrm{INT}\left(\dfrac{2415919104}{\text{ROW length}} \times \text{ROW count}\right)$ bits
Mixed Row Length	1 536 to 2 415 919 104 / 256 bits step (Data + PRBS Length)
Pattern length	1 024 to 268 435 456 bits / 1 bit step
Number of rows	1 to 16 / 1 step
Number of blocks	1 to 511 / 1 step
PRBS steps/Mark ratio	Same as PRBS.
PRBS Sequence	Restart, Consecutive
Descramble	Can be set per PRBS and Data for each Block (except the Data area for Block 1).

Table 1.3.3-7 Pattern Sequence

Item	Specifications
Sequence	Repeat/Burst
Repeat	Continuous Pattern
Burst	
Source	Internal, External-Trigger (Aux Input), External-Enable (Aux Input)
Delay	Internal: 0 to 2 147 483 640 bits / 8 bits step Ext Trigger/Enable: 0 to 2 147 483 520 bits / 8 bits step Adjust Method: Auto, Manual
Enable Period	Internal: 12 800 to 2 147 482 624 bits / 256 bits step Ext Trigger, Enable: 12 800 to 2 147 483 392 bits / 256 bits step
Burst Cycle	25 600 to 2 147 483 648 bits / 256 bits step

Table 1.3.3-8 Measurement

Item	Specifications	
Measurement types	Error Rate:	0.0001E–18 to 1.0000E00
	Error Count:	0 to 9999999, 1.0000E07 to 9.9999E17
	Error Interval:	0 to 9999999, 1.0000E07 to 9.9999E17
	%Error Free Interval:	0.0000 to 100.0000
	Frequency:	2400.000 to 32100.000 MHz
	Frequency measurement accuracy:	±1 ppm ±1 kHz*
	Clock Count:	0 to 9999999, 1.0000E07 to 9.9999E17
	Sync Loss Interval:	0 to 9999999, 1.0000E07 to 9.9999E17
	Clock Loss Interval:	0 to 9999999, 1.0000E07 to 9.9999E17
Gating	Time, Clock Count, Error Count, Block Count	
Unit, Cycle setting	Time:	1 second to 99 days 23 hours 59 minute 59 seconds
	Clock Count:	>E+4 to >E+16
	Error Count:	>E+4 to >E+16
	Block Count:	>E+2 to >E+14
Gating Cycle	Single / Repeat / Untimed	
Current	On, Off can be set.	
	Calculation:	Progressive, Immediate
	Interval:	100 ms, 200 ms, 500 ms
Auto Sync	On / Off can be set.	
	Synchronization threshold:	INT, E–2 to E–8
Sync Control	PRBS:	Automatic Synchronization
	Data:	Frame On, Quick
	Mixed-Data:	Frame On
Frame length	4 to 64 bits / 4 bits step	
Frame mask	Available	
Frame Position	1 to (Pattern Length'– Frame Length +1) bits / 1 bit step	
Error/Alarm conditions		
Error detection mode	Total, Insertion/Omission, or Transition/Non Transition	
EI/EFI interval	1 ms, 10 ms, 100 ms, 1 s	

*: When Gating is selected and the main frame reference clock 10 MHz is calibrated.

Table 1.3.3-9 Error Analysis

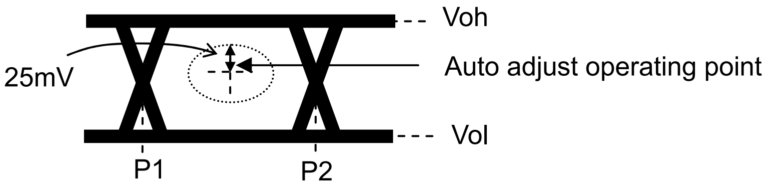
Item	Specifications	
Block Window	Excludes the specified data pattern bit from the measurement target according to the settings. (Mask measurement function) Invalid when "Mixed" is selected for Test Pattern.	
Setting resolution	Pattern length (bits)	Step [bits]
	2 to 2 097 152	1
	2 097 153 to 4 194 304	2
	4 194 305 to 8 388 608	4
	8 388 609 to 16 777 216	8
	16 777 217 to 33 554 432	16
	33 554 433 to 67 108 864	32
	67 108 865 to 134 217 728	64
	134 217 729 to 268 435 456	128
Bit window	Excludes any channels among internal 32 channels from the measurement target.	
External mask	H: Measurement L: Mask	
Capture function	Number of blocks:	1, 2, 4, 8, 16, 32, 64, 128
	Length of block:	8 Mbits / n (n is Number of blocks.)
Automatic measurement function	Eye margin, Eye diagram, Bathtub, Q measurement, Eye Contour, PAM4 BER measurement Auto Adjust[*1,*2,*3], Auto Search[*1], Auto Search PAM mode[*4]	

*1: The input pattern must be an NRZ PRBS pattern with a mark ratio of 1/2.

*2: The Auto Adjust function obtains a point in the vicinity of the following as an optimum point:

- (Voh + Vol) / 2 in voltage direction
- (P1 + P2) / 2 in phase direction

The Auto Adjust function works properly when there are no mask-hits which are observed by the oscilloscope vertically within ±25 mV area from the Auto Adjust operating point.



*3: If eye diagram of input signal is not symmetry, the Auto Adjust may not adjust input signals to the optimum value. The Auto Search Fine is recommended to measure asymmetric input signals.

*4: Each of PAM4 waveform levels is equal.

Table 1.3.3-10 Variable Clock Delay

Item	Specifications
Phase variable range	–1 000 to +1 000 mUI / 2 mUI step
Phase setting error	±50 mUIp-p[*1,*2,*3]
	±75 mUIp-p[*1,*2,*4]
mUI – ps switching	Available
Calibration	Available
Calibration indicator	This indicator is on when Calibration is required due to: • Change in 1/1Clock frequency by ±250 kHz. • Change in the ambient temperature by ±5°C.

*1: Using oscilloscope with residual jitter of less than 200 fs (RMS).

*2: Typical value

*3: Bit rate ≤ 28.1 Gbit/s

*4: Bit rate > 28.1 Gbit/s

Table 1.3.3-11 Clock Recovery

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Clock source options</td><td>External Clock/Recovered Clock*1</td></tr>
<tr><td>Operating bit rate</td><td>2.4 Gbit/s to 28.1 Gbit/s*2
25.5 Gbit/s to 32.1 Gbit/s*3</td></tr>
<tr><td>Setting range</td><td>2.400 000 to 28.100 000 Gbit/s / 0.000 001 Gbit/s step*2
25.500 000 to 32.100 000 Gbit/s / 0.000 001 Gbit/s step*3</td></tr>
<tr><td>Supported standard and bit rate</td><td>When the option x22 is installed
<table>
<tr><th>Standard</th><th>Bit Rate [Gbit/s]</th></tr>
<tr><td>32GFC</td><td>28.050 000</td></tr>
<tr><td>100G OTU4</td><td>27.952 496</td></tr>
<tr><td>100GbE(25.78x4)</td><td>25.781 250</td></tr>
<tr><td>InfiniBand EDR</td><td>25.781 250</td></tr>
<tr><td>SAS</td><td>24.000 000</td></tr>
<tr><td>PCI Express Gen4</td><td>16.000 000</td></tr>
<tr><td>InfiniBand FDR</td><td>14.062 500</td></tr>
<tr><td>16G FC</td><td>14.025 000</td></tr>
<tr><td>10G FC Over FEC</td><td>11.316 800</td></tr>
<tr><td>10GbE Over FEC</td><td>11.095 700</td></tr>
<tr><td>OTU2</td><td>10.709 225</td></tr>
<tr><td>G975 FEC</td><td>10.664 228</td></tr>
<tr><td>10G FC</td><td>10.518 750</td></tr>
<tr><td>10GbE</td><td>10.312 500</td></tr>
<tr><td>InfiniBand QDR</td><td>10.000 000</td></tr>
<tr><td>OC-192/STM-64</td><td>9.953 280</td></tr>
<tr><td>8G FC</td><td>8.500 000</td></tr>
<tr><td>PCI Express Gen3</td><td>8.000 000</td></tr>
<tr><td>HSBI</td><td>6.250 000</td></tr>
<tr><td>SATA 6Gb/s</td><td>6.000 000</td></tr>
<tr><td>PCI Express Gen2</td><td>5.000 000</td></tr>
<tr><td>USB3.0</td><td>5.000 000</td></tr>
<tr><td>InfiniBand DDR</td><td>5.000 000</td></tr>
<tr><td>4G FC</td><td>4.250 000</td></tr>
<tr><td>XAUI</td><td>3.125 000</td></tr>
<tr><td>SATA 3Gb/s</td><td>3.000 000</td></tr>
<tr><td>OTU1</td><td>2.666 060</td></tr>
<tr><td>InfiniBand SDR</td><td>2.500 000</td></tr>
<tr><td>PCI Express Gen1</td><td>2.500 000</td></tr>
<tr><td>OC-48/STM-16</td><td>2.488 320</td></tr>
</table>
When the option x23 is installed
<table>
<tr><th>Standard</th><th>Bit Rate [Gbit/s]</th></tr>
<tr><td>100G ULH</td><td>32.100 000</td></tr>
<tr><td>32GFC</td><td>28.050 000</td></tr>
<tr><td>100G OTU4</td><td>27.952 496</td></tr>
<tr><td>100GbE(25.78x4)</td><td>25.781 250</td></tr>
<tr><td>InfiniBand EDR</td><td>25.781 250</td></tr>
</table>
</td></tr>
</table>

*1: The system clock can be selected only when option x22 or x23 is installed. This is fixed to External Clock when option x22 or x23 is not installed. Clock is recovered from the data input to the Data1 Input connector. The input pattern must be an NRZ PRBS pattern with a mark ratio of 1/2.

*2: When option x22 is installed.

*3: When option x23 is installed.

Table 1.3.3-11 Clock Recovery (Cont'd)

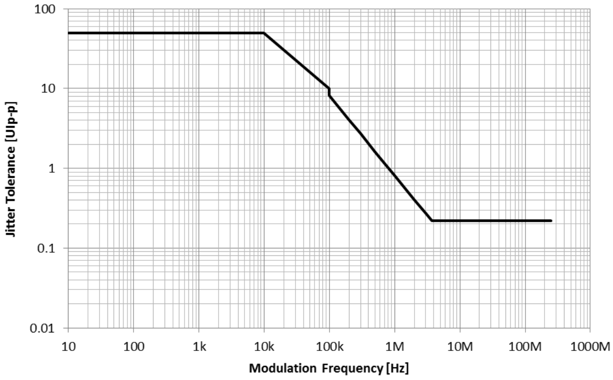
<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Operating bit rate tracking</td><td>Supported.
Tracking target: The operating bit rate of the PPG mounted to the same mainframe</td></tr>
<tr><td>Maximum number of consecutive zeros*4</td><td>72bit (Zero Substitution 2^15)</td></tr>
<tr><td>Lock range for clock data recovery*4</td><td>±200 ppm*2
±100 ppm*3</td></tr>
<tr><td>Target loop band</td><td>When the option x22 is installed
Available options are (Bit rate / 1667) MHz, (Bit rate / 2578) MHz, Jitter Tolerance*5 and Variable.
If the Variable option is selected, the following settings are available:
<table>
<tr><th>Bit rate [Gbit/s]</th><th>Setting Range [MHz] / Step[MHz]</th></tr>
<tr><td>2.400 000 to 5.500 000</td><td>3 / -</td></tr>
<tr><td>5.500 001 to7.500 000</td><td>3 to 4 / 1</td></tr>
<tr><td>7.500 001 to 9.500 000</td><td>3 to 5 / 1</td></tr>
<tr><td>9.500 001 to 10.500 000</td><td>3 to 6 / 1</td></tr>
<tr><td>10.500 001 to 12.500 000</td><td>3 to 7 / 1</td></tr>
<tr><td>12.500 001 to 14.500 000</td><td>3 to 8 / 1</td></tr>
<tr><td>14.500 001 to 15.500 000</td><td>3 to 9 / 1</td></tr>
<tr><td>15.500 001 to 17.500 000</td><td>3 to 10 / 1</td></tr>
<tr><td>17.500 001 to 19.500 000</td><td>3 to 11 / 1</td></tr>
<tr><td>19.500 001 to 20.500 000</td><td>3 to 12 / 1</td></tr>
<tr><td>20.500 001 to 22.500 000</td><td>3 to 13 / 1</td></tr>
<tr><td>22.500 001 to 24.500 000</td><td>3 to 14 / 1</td></tr>
<tr><td>24.500 001 to 25.500 000</td><td>3 to 15 / 1</td></tr>
<tr><td>25.500 001 to 27.500 000</td><td>3 to 16 / 1</td></tr>
<tr><td>27.500 001 to 28.100 000</td><td>3 to 17 / 1</td></tr>
</table>
When the option x23 is installed
Available options are (Bit rate / 1667) MHz, (Bit rate / 2578) MHz, and Jitter Tolerance*5.</td></tr>
</table>

*4: When the option x22 is installed:
The target loop band is specified by the maximum setting value of each bit rate.
When the option x23 is installed:
The target loop band is specified by (Bit rate / 1667) and (Bit rate / 2578).

*5: The Jitter Tolerance option makes the loop band wider than the other options and enables the Jitter Tolerance measurement.

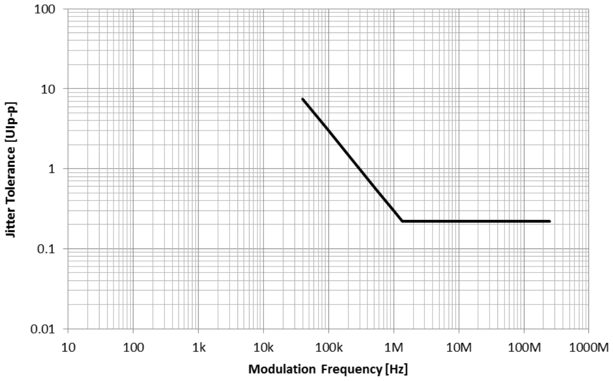
Table 1.3.3-11 Clock Recovery (Cont'd)

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Jitter Tolerance
When option x22 is installed*6,*7</td><td>
At the bit rate of 28.05 Gbit/s, conforming to Jitter Tolerance Mask defined by the "32G FC standard"



<table>
<tr><th>Modulation Frequency (Hz)</th><th>Jitter Tolerance Mask (UIp-p)</th></tr>
<tr><td>10</td><td>50</td></tr>
<tr><td>10,000</td><td>50</td></tr>
<tr><td>100,000</td><td>10</td></tr>
<tr><td>108,805</td><td>7.5</td></tr>
<tr><td>3,709,271</td><td>0.22</td></tr>
<tr><td>250,000,000</td><td>0.22</td></tr>
</table>

At the bit rate of 25.78125 Gbit/s, conforming to Jitter Tolerance Mask defined by the "100GbE(25.78x4) standard"



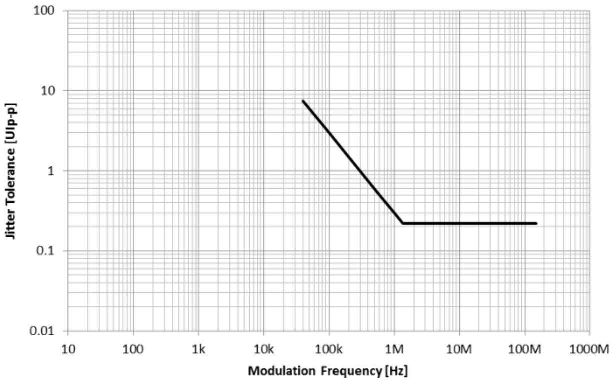
<table>
<tr><th>Modulation Frequency (Hz)</th><th>Jitter Tolerance Mask (UIp-p)</th></tr>
<tr><td>40,000</td><td>7.5</td></tr>
<tr><td>1,363,636</td><td>0.22</td></tr>
<tr><td>250,000,000</td><td>0.22</td></tr>
</table>
</td></tr>
</table>

*6: Defined assuming the following conditions:
- Loop-back connection to MU183020A
- Test Pattern (Length): PRBS (2^23-1)
- Data input amplitude: 0.05 Vp-p

*7: Typical value, specified at 20 to 30°C

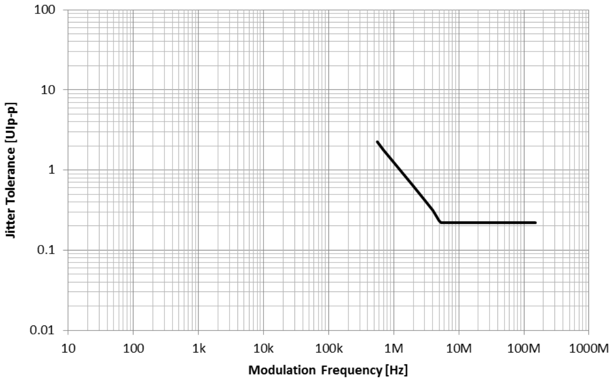
Table 1.3.3-11 Clock Recovery (Cont'd)

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr>
<td>Jitter Tolerance
When option x22 is installed
(Cont'd)</td>
<td>
At the bit rate of 14.0625 Gbit/s, conforming to Jitter Tolerance Mask defined by the "Infiniband FDR standard"



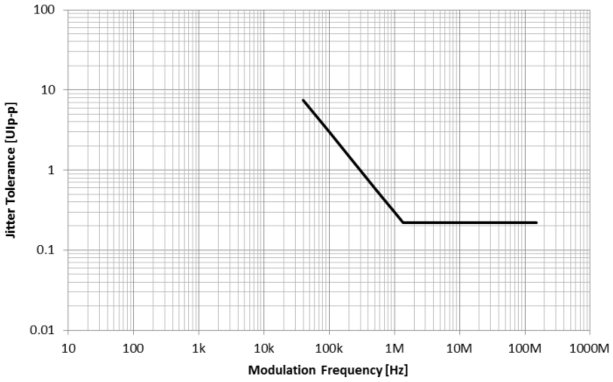
<table>
<tr><th>Modulation Frequency (Hz)</th><th>Jitter Tolerance Mask (UIp-p)</th></tr>
<tr><td>40,000</td><td>7.5</td></tr>
<tr><td>1,363,636</td><td>0.22</td></tr>
<tr><td>150,000,000</td><td>0.22</td></tr>
</table>

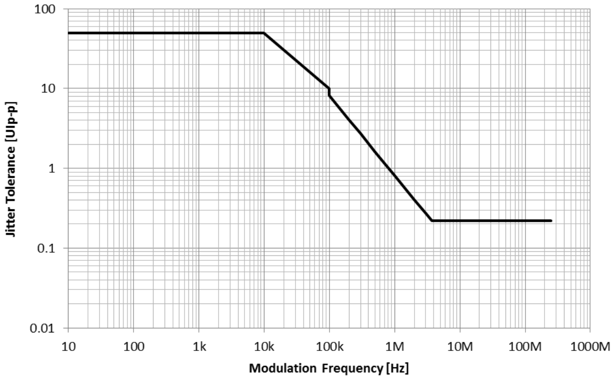
At the bit rate of 14.025 Gbit/s, conforming to Jitter Tolerance Mask defined by the "16G FC standard"



<table>
<tr><th>Modulation Frequency (Hz)</th><th>Jitter Tolerance Mask (UIp-p)</th></tr>
<tr><td>561,000</td><td>2.25</td></tr>
<tr><td>5,535,929</td><td>0.22</td></tr>
<tr><td>150,000,000</td><td>0.22</td></tr>
</table>
</td>
</tr>
</table>

Table 1.3.3-11 Clock Recovery (Cont'd)

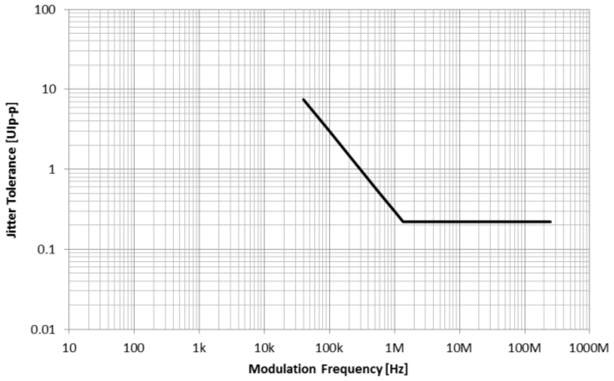
<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Jitter Tolerance
When option x22 is installed
(Cont'd)</td><td>At the bit rate of 10.3125 Gbit/s, conforming to Jitter Tolerance Mask defined by the "10GbE standard"


<table>
<tr><th>Modulation Frequency (Hz)</th><th>Jitter Tolerance Mask (UIp-p)</th></tr>
<tr><td>40,000</td><td>7.5</td></tr>
<tr><td>1,363,636</td><td>0.22</td></tr>
<tr><td>150,000,000</td><td>0.22</td></tr>
</table></td></tr>
<tr><td>Jitter Tolerance
When option x23 is installed[*6,*7]</td><td>At the bit rate of 28.05 Gbit/s, conforming to Jitter Tolerance Mask defined by the "32G FC standard"


<table>
<tr><th>Modulation Frequency (Hz)</th><th>Jitter Tolerance Mask (UIp-p)</th></tr>
<tr><td>10</td><td>50</td></tr>
<tr><td>10,000</td><td>50</td></tr>
<tr><td>100,000</td><td>10</td></tr>
<tr><td>108,805</td><td>7.5</td></tr>
<tr><td>3,709,271</td><td>0.22</td></tr>
<tr><td>250,000,000</td><td>0.22</td></tr>
</table></td></tr>
</table>

Table 1.3.3-11 Clock Recovery (Cont'd)

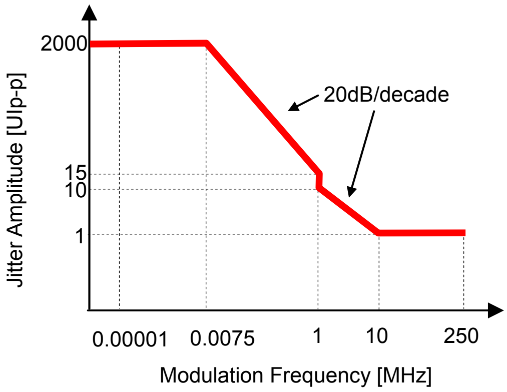
<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Jitter Tolerance
When option x23 is installed
(Cont'd)</td><td>At the bit rate of 25.78125 Gbit/s, conforming to Jitter Tolerance Mask defined by the “100GbE(25.78x4) standard”



<table>
<tr><th>Modulation Frequency (Hz)</th><th>Jitter Tolerance Mask (UIp-p)</th></tr>
<tr><td>40,000</td><td>7.5</td></tr>
<tr><td>1,363,636</td><td>0.22</td></tr>
<tr><td>250,000,000</td><td>0.22</td></tr>
</table>
</td></tr>
</table>

Table 1.3.3-12 Jitter Tolerance

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Jitter tolerance
When using external clock</td><td>Bit Rate 16Gbit/s, 28.1Gbit/s, 32.1Gbit/s (When option x01 is installed.)
Test pattern: PRBS2^{31}-1
SSC with a 5300 ppm amplitude and RJ of 0.3 UI can be simultaneously applied by using MU181500B.
These specifications are defined assuming the following conditions:
• Loopback connection with MU183020A/21A
• At any temperature between 20 and 30°C



</td></tr>
</table>

Table 1.3.3-13 Multichannel operation

Item	Specifications	
Combination*1		
Number of channels	2	
Pattern		
Data		
Pattern Length	4 to 536 870 912 bits / 2 bits step*2	
Mixed		
Row Length	3 072 to 4 831 838 208 bits / 512 bits step*2	
Pattern Length	2 048 to 536 870 912 bits / 2 bits step*2	
Block Window	Excludes the specified data pattern bit from the measurement target according to the settings. (Mask measurement function) Invalid when “Mixed” is selected for Test Pattern. Invalid when Zero-substitution is set to “2n–1”. n = 2 (2ch Combination) is considered in the following:	
Setting resolution	Pattern length (bits)	Step [bits]
	2 to 2 097 152 × n	1 × n
	2 097 153 to 4 194 304 × n	2 × n
	4 194 305 to 8 388 608 × n	4 × n
	8 388 609 to 16 777 216 × n	8 × n
	16 777 217 to 33 554 432 × n	16 × n
	33 554 433 to 67 108 864 × n	32 × n
	67 108 865 to 134 217 728 × n	64 × n
	134 217 729 to 268 435 456 × n	128 × n
Burst		
Burst Cycle	51 200 to 4 294 967 296 bits / 512 bits step*2	
Enable Period	Internal:	25 600 to 4 294 965 248 bits / 512 bits step*2
	Ext Trigger:	25 600 to 4 294 966 784 bits / 512 bits step*2
Delay	Internal:	0 to 4 294 967 280 bits / 16 bits step*2
	Ext Trigger, Enable:	0 to 4 294 967 040 bits / 16 bits step*2
Measurement		
Sync Control		
Frame length	8 to 128 bits /8 bits step*2	
Frame Position	1 to (Pattern Length' – Frame Length + n) bits / n bits step	
Error detection mode	Total, Insertion and Omission	
Eye diagram		
Measurement target	ch1 to ch2*3	
Eye margin		
Measurement target	ch1 to ch2*3	
Bathtub		
Measurement target	ch1 to ch2*3	
Capture function	2 Ch Combination is available*2	

*1: Combination extending over multiple slots cannot be set.

*2: Common to every channel specified by Combination Setting.

*3: Separately specified for each channel.

Table 1.3.3-14 General

Item	Specifications
Dimensions	21 mm (H), 234 mm (W), 175 mm (D), Excluding protrusions
Mass	2.5 kg max.
Operating temperature	15 to 35°C
Storage temperature	–20 to 60°C

1.3.4 Specifications for MU183041B

Table 1.3.4-1 Operating bit rate

Item	Specifications
Operating bit rate	2.4 to 28.1 Gbit/s*1 2.4 to 32.1 Gbit/s*2

*1: When option x01 is not installed.

*2: When option x01 is installed.

Table 1.3.4-2 System Clock

Item	Specifications
Clock source	External, Recovered* can be set

*: The system clock can be selected only when option x22 or x23 is installed. This is fixed to External Clock when option x22 or x23 is not installed. Clock is recovered from the data input to the Data1 Input connector. For the option x22, the clock is recovered from the data input to the Data1 Input connector. For the option x23, the clock is recovered from the data input to the Data1 Input and Data3 Input connectors.

Table 1.3.4-3 Data Input

Item	Specifications
Number of inputs	8 (Data1 to Data4, XData1 to XData4) (Differential)
Amplifier	Single-Ended 50Ohm, Differential 50Ohm, Differential 100Ohm can be set. Data and XData can be set. Tracking, Independent, Alternate can be set. When Alternate is selected: Data-XData and XData-Data can be set.*1
Input signal format	NRZ, PAM4
Input amplitude*8	0.05 to 1.0 Vp-p (NRZ) 0.3 to 0.6 Vp-p (PAM4, ≤28.1Gbaud) 0.4 to 0.7 Vp-p (PAM4, > 28.1Gbaud) ***Note:*** Be careful about the maximum input amplitude. 2 Vp-p Max for A-type, and 1 Vp-p Max for B type.
Threshold voltage	–3.5 to +3.3 V (1 mV step) (Can be set separately.) (Absolute value of difference between Data and XData Threshold values shall be 3 V or less.)
Input sensitivity*8	15 mVp-p*2,*3,*4, ≤ 25 mVp-p*2 10 mVp-p*2,*3,*4,*9
Phase margin	20 ps*2,*4,*5,*7 28 ps*4,*5,*6,*7
Termination	GND/50 Ω, Variable/50 Ω
Termination voltage	When Variable is selected for Termination: –2.5 to +3.5 V / 10 mV step
Connector	K (f.)

*1: Absolute value of difference between Data and XData Threshold values shall be 1.5 V or less.

*2: 28.1 Gbit/s

*3: PRBS31, Single-Ended, Mark ratio 1/2, 20 to 30°C

*4: Typical value

*5: 0.5 Vp-p Input

*6: 25 Gbit/s

*7: PRBS31, Single-Ended, Mark ratio 1/2

*8: The amplitude for NRZ input is the range in which AutoAdjust works. The amplitude for PAM4 input is the range in which PAM4 AutoSearch works.
Input sensitivity is the minimum input amplitude which becomes error-free.

*9: Sensitivity of eye height.
When the output amplitude of the MU183020A/21A+ATT is set to 15 mV with the measurement system as the figure below, the error rate range is 1E–9 or less. (A sampling oscilloscope with the bandwidth of 70 GHz or more is used.)

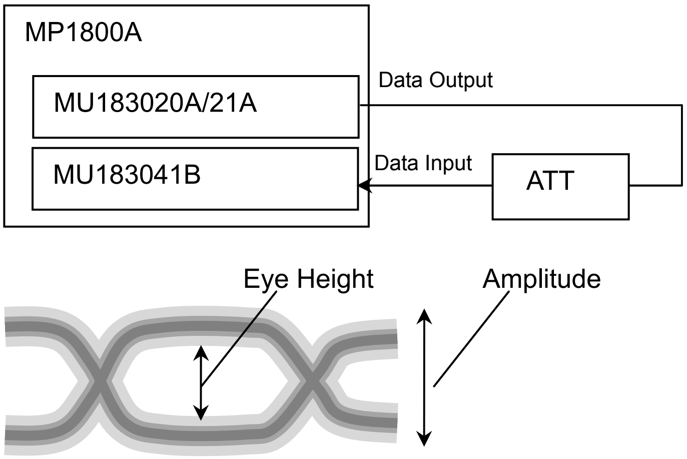

MP1800A
MU183020A/21A
MU183041B
Data Output
Data Input
ATT
Eye Height
Amplitude

Table 1.3.4-4 Clock Input

Item	Specifications
Number of inputs	1 (Single-Ended)
Frequency range	1.2 to 16.05 GHz
Input level	0.3 to 1.0 Vp-p (–6.5 to +4.0 dBm)
Termination	AC/50 Ω
Connector	SMA (f.)

Table 1.3.4-5 Aux Input, Aux Output

Item	Specifications
Aux Input	
Number of inputs	1 (Single-Ended)
Input signal	External Mask, Burst, Capture External Trigger
Minimum pulse width	1/128 of Data rate
Input level	0/–1 V (H: –0.25 to 0.05 V / L: –1.1 to –0.8 V)
Termination	GND/50 Ω
Connector	SMA (f.)
Aux Output	
Number of outputs	2 (Differential)
Output Signal Selection	1/n Clock (n = 4, 6, 8, 10…510, 512), Pattern Sync, Error, Sync. gain
Pattern Sync	
PRBS, PRGM	Position: 1 to {(Least common multiple of Pattern Length' and 128) –135} / 8 step Pattern Length' shall be the value obtained by multiplying Pattern Length setting until it becomes 512 or more if it is 511 or less.
Mixed Data	Block No. setting: 1 to the Block No. specified for Mixed Data, in single steps Row No. setting: 1 to the Row No. specified for Mixed Data, in single steps
Output level	0/–0.6 V (H: –0.25 to 0.05V /L: –0.80 to –0.45 V)
Termination	GND/50 Ω
Connector	SMA (f.)

Table 1.3.4-6 Pattern Detection

Item	Specifications
PRBS	
Pattern length	2^n-1 (n = 7, 9, 10, 11, 15, 20, 23, 31)
Mark ratio	1/2 (1/2INV is supported by a logical inversion.)
Zero-Substitution	
Additional Bit	0 bit, 1 bit
Pattern length	2^n or 2^n-1 (n = 7, 9, 10, 11, 15, 20, 23)
Start position	Substitutes the bit coming after the maximum “0” successive bits.
Successive-zeros bit length	1 to (Pattern Length–1) bits If the bit coming after Zero-substitution is “0,” then it is replaced with “1.”
Data	
Pattern length	2 to 268 435 456 bits / 1 bit step
Mixed Pattern	
Pattern switching	Data
Mixed Block	To the smaller of the following values: 1 to 511 Block / 1 Block step $\mathrm{INT}\left(\frac{268435456}{\text{ROW count}} \times \text{Data length}\right)$ bits $\mathrm{INT}\left(\frac{2415919104}{\text{ROW length}} \times \text{ROW count}\right)$ bits
Mixed Row Length	1 536 to 2 415 919 104 bits / 256 bits step (Data + PRBS Length)
Pattern length	1 024 to 268 435 456 bits / 1 bit step
Number of rows	1 to 16 / 1 step
Number of blocks	1 to 511 / 1 step
PRBS steps/Mark ratio	Same as PRBS.
PRBS Sequence	Restart, Consecutive
Descramble	Can be set per PRBS and Data for each Block (except the Data area for Block 1).

Table 1.3.4-7 Pattern Sequence

Item	Specifications
Sequence	Repeat/Burst
Repeat	Continuous Pattern
Burst	
Source	Internal, External-Trigger (Aux Input), External-Enable (Aux Input)
Delay	Internal: 0 to 2 147 483 640 bits / 8 bits step Ext Trigger, Enable: 0 to 2 147 483 520 bits / 8 bits step Adjust Method: Auto, Manual
Enable Period	Internal: 12 800 to 2 147 482 624 bits / 256 bits step Ext Trigger, Enable: 12 800 to 2 147 483 392 bits / 256 bits step
Burst Cycle	25 600 to 2 147 483 648 bits / 256 bits step

Table 1.3.4-8 Measurement

Item	Specifications	
Measurement types	Error Rate:	0.0001E–18 to 1.0000E00
	Error Count:	0 to 9999999, 1.0000E07 to 9.9999E17
	Error Interval:	0 to 9999999, 1.0000E07 to 9.9999E17
	%Error Free Interval:	0.0000 to 100.0000
	Frequency:	2400.000 to 32100.000 MHz
	Frequency measurement accuracy:	±1 ppm ±1 kHz*
	Clock Count:	0 to 9999999, 1.0000E07 to 9.9999E17
	Sync Loss Interval:	0 to 9999999, 1.0000E07 to 9.9999E17
	Clock Loss Interval:	0 to 9999999, 1.0000E07 to 9.9999E17
Gating	Time, Clock Count, Error Count, Block Count	
Unit, Cycle setting	Time:	1 second to 99 days 23 hours 59 minute 59 seconds
	Clock Count:	>E+4 to >E+16
	Error Count:	>E+4 to >E+16
	Block Count:	>E+2 to >E+14
Gating Cycle	Single / Repeat / Untimed	
Current	On, Off	
	Calculation:	Progressive, Immediate
	Interval:	100 ms, 200 ms, 500 ms
Auto Sync	On / Off	
	Synchronization threshold:	INT, E–2 to E–8
Sync Control	PRBS:	Automatic Synchronization
	Data:	Frame On, Quick
	Mixed-Data:	Frame On
Frame length	4 to 64 bits / 4 bits step	
Frame mask	Available	
Frame Position	1 to (Pattern Length'– Frame Length +1) bits / 1 bit step	
Error/Alarm conditions		
Error detection mode	Total, Insertion/Omission, or Transition/Non Transition	
EI/EFI interval	1 ms, 10 ms, 100 ms, 1 s	

*: When Gating is selected and the main frame reference clock 10 MHz is calibrated.

Table 1.3.4-9 Error Analysis

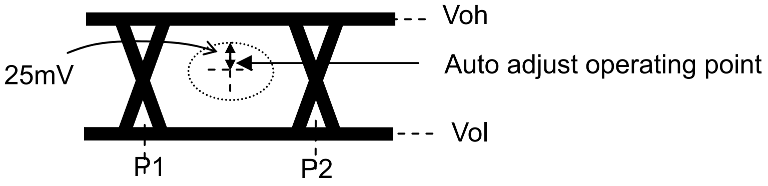
Item	Specifications	
Block Window	Excludes the specified data pattern bit from the measurement target according to the settings. (Mask measurement function) Invalid when “Mixed” is selected for Test Pattern.	
Setting resolution	Pattern length (bits)	Step [bits]
	2 to 2 097 152	1
	2 097 153 to 4 194 304	2
	4 194 305 to 8 388 608	4
	8 388 609 to 16 777 216	8
	16 777 217 to 33 554 432	16
	33 554 433 to 67 108 864	32
	67 108 865 to 134 217 728	64
	134 217 729 to 268 435 456	128
Bit window	Excludes any channels among internal 32 channels from the measurement target.	
External mask	H: Measurement L: Mask	
Capture function	Number of blocks: 1, 2, 4, 8, 16, 32, 64, 128 Block length: 8 Mbits / n (n is Number of blocks.)	
Automatic measurement function	Eye margin, Eye diagram, Bathtub, Q measurement, Eye Contour, PAM4 BER measurement Auto Adjust*1,*2,*3, Auto Search*1, Auto Search PAM4 mode*4	

*1: Equivalent to NRZ PRBS pattern, Mark ratio 1/2.

*2: The Auto Adjust function obtains a point in the vicinity of the following as an optimum point:

- (Voh + Vol) / 2 in voltage direction
- (P1 + P2) / 2 in phase direction

The Auto Adjust function works with no error when there are no mask-hits which are observed by the oscilloscope vertically within ±25 mV area from the Auto adjust operating point.



*3: If eye diagram of input signal is not symmetry, the Auto Adjust may not adjust to the optimum value. The Auto Search Fine is recommended to measure asymmetric input signals.

*4: Each of PAM4 waveform levels is equal.

Table 1.3.4-10 Variable Clock Delay

Item	Specifications
Phase variable range	–1 000 to +1 000 mUI / 2 mUI step
Phase setting error	±50 mUIp-p[*1,*2,*3] ±75 mUIp-p[*1,*2,*4]
mUI – ps switching	Available
Calibration	Available
Calibration indicator	This indicator is on when Calibration is required due to: • Change in 1/1 Clock frequency by ±250 kHz. • Change in the ambient temperature by ±5°C.

*1: Using oscilloscope with residual jitter of less than 200 fs (RMS).

*2: Typical value

*3: Bit rate ≤ 28.1 Gbit/s

*4: Bit rate > 28.1 Gbit/s

Table 1.3.4-11 Clock Recovery

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Clock source options</td><td>External Clock/ Recovered Clock*1</td></tr>
<tr><td>Operating bit rate</td><td>2.4 Gbit/s to 28.1 Gbit/s*2
25.5 Gbit/s to 32.1 Gbit/s*3</td></tr>
<tr><td>Setting Range</td><td>2.400 000 to 28.100 000 Gbit/s / 0.000 001 Gbit/s step*2
25.500 000 to 32.100 000 Gbit/s / 0.000 001 Gbit/s step*3</td></tr>
<tr><td>Supported standard and bit rate</td><td>When the option x22 is installed
<table>
<tr><th>Standard</th><th>Bit Rate [Gbit/s]</th></tr>
<tr><td>32GFC</td><td>28.050 000</td></tr>
<tr><td>100G OTU4</td><td>27.952 496</td></tr>
<tr><td>100GbE(25.78x4)</td><td>25.781 250</td></tr>
<tr><td>InfiniBand EDR</td><td>25.781 250</td></tr>
<tr><td>SAS</td><td>24.000 000</td></tr>
<tr><td>PCI Express Gen4</td><td>16.000 000</td></tr>
<tr><td>InfiniBand FDR</td><td>14.062 500</td></tr>
<tr><td>16G FC</td><td>14.025 000</td></tr>
<tr><td>10G FC Over FEC</td><td>11.316 800</td></tr>
<tr><td>10GbE Over FEC</td><td>11.095 700</td></tr>
<tr><td>OTU2</td><td>10.709 225</td></tr>
<tr><td>G975 FEC</td><td>10.664 228</td></tr>
<tr><td>10G FC</td><td>10.518 750</td></tr>
<tr><td>10GbE</td><td>10.312 500</td></tr>
<tr><td>InfiniBand QDR</td><td>10.000 000</td></tr>
<tr><td>OC-192/STM-64</td><td>9.953 280</td></tr>
<tr><td>8G FC</td><td>8.500 000</td></tr>
<tr><td>PCI Express Gen3</td><td>8.000 000</td></tr>
<tr><td>HSBI</td><td>6.250 000</td></tr>
<tr><td>SATA 6Gb/s</td><td>6.000 000</td></tr>
<tr><td>PCI Express Gen2</td><td>5.000 000</td></tr>
<tr><td>USB3.0</td><td>5.000 000</td></tr>
<tr><td>InfiniBand DDR</td><td>5.000 000</td></tr>
<tr><td>4G FC</td><td>4.250 000</td></tr>
<tr><td>XAUI</td><td>3.125 000</td></tr>
<tr><td>SATA 3Gb/s</td><td>3.000 000</td></tr>
<tr><td>OTU1</td><td>2.666 060</td></tr>
<tr><td>InfiniBand SDR</td><td>2.500 000</td></tr>
<tr><td>PCI Express Gen1</td><td>2.500 000</td></tr>
<tr><td>OC-48/STM-16</td><td>2.488 320</td></tr>
</table>
When the option x23 is installed
<table>
<tr><th>Standard</th><th>Bit Rate [Gbit/s]</th></tr>
<tr><td>100G ULH</td><td>32.100 000</td></tr>
<tr><td>32GFC</td><td>28.050 000</td></tr>
<tr><td>100G OTU4</td><td>27.952 496</td></tr>
<tr><td>100GbE(25.78x4)</td><td>25.781 250</td></tr>
<tr><td>InfiniBand EDR</td><td>25.781 250</td></tr>
</table>
</td></tr>
</table>

*1: The system clock can be selected only when option x22 or x23 is installed. This is fixed to External Clock when option x22 or x23 is not installed. For the option x22, the clock is recovered from the data input to the Data1 Input connector. For the option x23, the clock is recovered from the data input to the Data1 Input and Data3 Input connectors.
The input pattern must be an NRZ PRBS pattern with a mark ratio of 1/2.

*2: When option x22 is installed.

*3: When option x23 is installed.

Table 1.3.4-11 Clock Recovery (Cont'd)

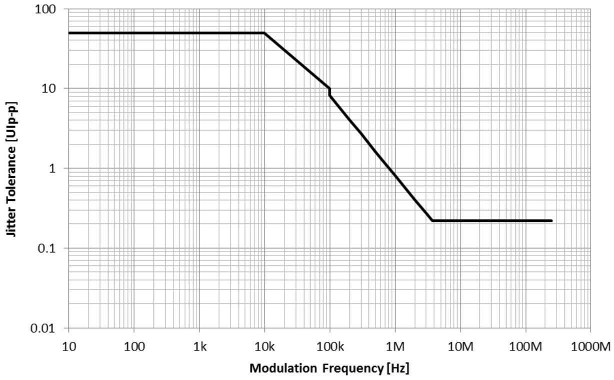
<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Operating bit rate tracking</td><td>Supported.
Tracking target: The operating bit rate of the PPG mounted to the same mainframe</td></tr>
<tr><td>Maximum number of consecutive zeros*4</td><td>72bit (Zero Substitution 2^15)</td></tr>
<tr><td>Lock range for clock data recovery*4</td><td>±200 ppm*2
±100 ppm*3</td></tr>
<tr><td>Loop band</td><td>When the option x22 is installed
Available options are (Bit rate / 1667) MHz, (Bit rate / 2578) MHz, Jitter Tolerance*5 and Variable.
If the Variable option is selected, the following settings are available:
<table>
<tr><th>Bit Rate [Gbit/s]</th><th>Setting Range [MHz] / Step[MHz]</th></tr>
<tr><td>2.400 000 to 5.500 000</td><td>3 / -</td></tr>
<tr><td>5.500 001 to7.500 000</td><td>3 to 4 / 1</td></tr>
<tr><td>7.500 001 to 9.500 000</td><td>3 to 5 / 1</td></tr>
<tr><td>9.500 001 to 10.500 000</td><td>3 to 6 / 1</td></tr>
<tr><td>10.500 001 to 12.500 000</td><td>3 to 7 / 1</td></tr>
<tr><td>12.500 001 to 14.500 000</td><td>3 to 8 / 1</td></tr>
<tr><td>14.500 001 to 15.500 000</td><td>3 to 9 / 1</td></tr>
<tr><td>15.500 001 to 17.500 000</td><td>3 to 10 / 1</td></tr>
<tr><td>17.500 001 to 19.500 000</td><td>3 to 11 / 1</td></tr>
<tr><td>19.500 001 to 20.500 000</td><td>3 to 12 / 1</td></tr>
<tr><td>20.500 001 to 22.500 000</td><td>3 to 13 / 1</td></tr>
<tr><td>22.500 001 to 24.500 000</td><td>3 to 14 / 1</td></tr>
<tr><td>24.500 001 to 25.500 000</td><td>3 to 15 / 1</td></tr>
<tr><td>25.500 001 to 27.500 000</td><td>3 to 16 / 1</td></tr>
<tr><td>27.500 001 to 28.100 000</td><td>3 to 17 / 1</td></tr>
</table>
When the option x23 is installed
Available options are (Bit rate / 1667) MHz, (Bit rate / 2578) MHz, and Jitter Tolerance*5.</td></tr>
</table>

*4: When the option x22 is installed:
The target loop band is specified by the maximum setting value of each bit rate.
When the option x23 is installed:
The target loop band is specified by (Bit rate / 1667) and (Bit rate / 2578).

*5: The Jitter Tolerance option makes the loop band wider than the other options and enables the Jitter Tolerance measurement.

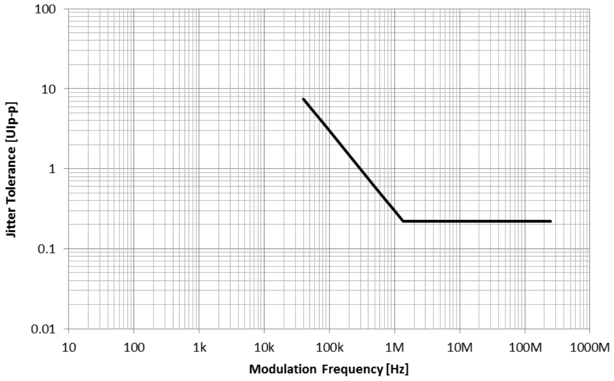
Table 1.3.4-11 Clock Recovery (Cont'd)

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Jitter Tolerance
When option x22 is installed*6,*7</td><td>
At the bit rate of 28.05 Gbit/s, conforming to Jitter Tolerance Mask defined by the "32G FC standard"



<table>
<tr><th>Modulation Frequency (Hz)</th><th>Jitter Tolerance Mask (UIp-p)</th></tr>
<tr><td>10</td><td>50</td></tr>
<tr><td>10,000</td><td>50</td></tr>
<tr><td>100,000</td><td>10</td></tr>
<tr><td>108,805</td><td>7.5</td></tr>
<tr><td>3,709,271</td><td>0.22</td></tr>
<tr><td>250,000,000</td><td>0.22</td></tr>
</table>

At the bit rate of 25.78125 Gbit/s, conforming to Jitter Tolerance Mask defined by the "100GbE(25.78x4) standard"



<table>
<tr><th>Modulation Frequency (Hz)</th><th>Jitter Tolerance Mask (UIp-p)</th></tr>
<tr><td>40,000</td><td>7.5</td></tr>
<tr><td>1,363,636</td><td>0.22</td></tr>
<tr><td>250,000,000</td><td>0.22</td></tr>
</table>
</td></tr>
</table>

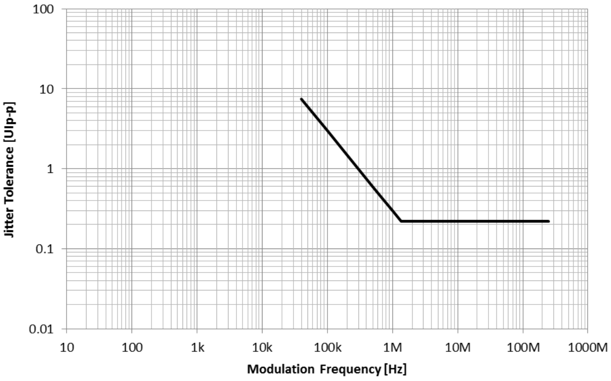
*6: Defined assuming the following conditions:
- Loop-back connection to MU183020A
- Test Pattern (Length): PRBS (2^23-1)
- Data input amplitude: 0.05 Vp-p

*7: Typical value, specified at 20 to 30°C

Table 1.3.4-11 Clock Recovery (Cont'd)

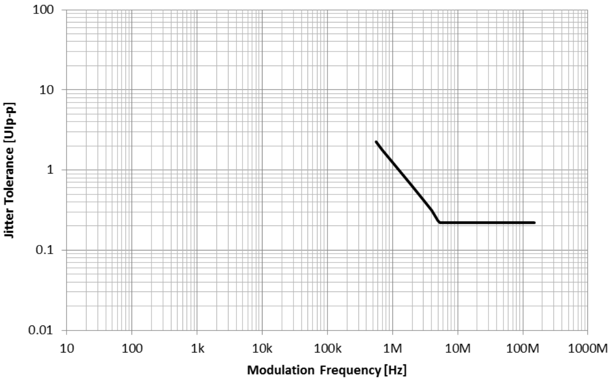
<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Jitter Tolerance
When option x22 is installed (Cont'd)</td><td>

At the bit rate of 14.0625 Gbit/s, conforming to Jitter Tolerance Mask defined by the “Infiniband FDR standard”



<table>
<tr><th>Modulation Frequency (Hz)</th><th>Jitter Tolerance Mask (UIp-p)</th></tr>
<tr><td>40,000</td><td>7.5</td></tr>
<tr><td>1,363,636</td><td>0.22</td></tr>
<tr><td>150,000,000</td><td>0.22</td></tr>
</table>

At the bit rate of 14.025 Gbit/s, conforming to Jitter Tolerance Mask defined by the “16G FC standard”

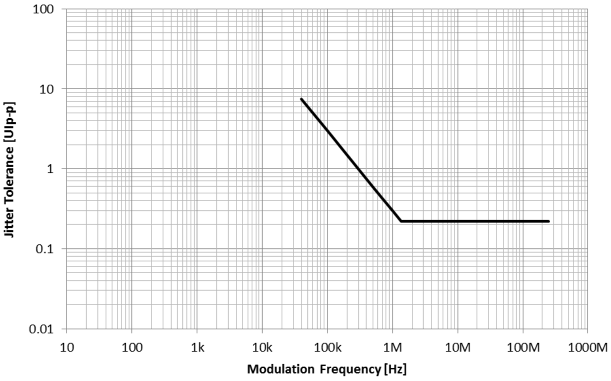


<table>
<tr><th>Modulation Frequency (Hz)</th><th>Jitter Tolerance Mask (UIp-p)</th></tr>
<tr><td>40,000</td><td>2.25</td></tr>
<tr><td>5,535,929</td><td>0.22</td></tr>
<tr><td>150,000,000</td><td>0.22</td></tr>
</table>

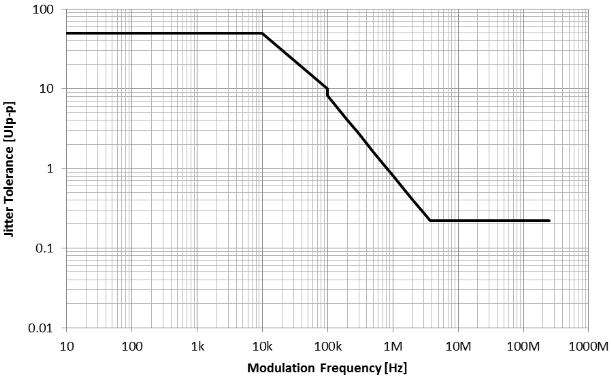
</td></tr>
</table>

Table 1.3.4-11 Clock Recovery (Cont'd)

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Jitter Tolerance
When option x22 is installed (Cont'd)</td><td>At the bit rate of 10.3125 Gbit/s, conforming to Jitter Tolerance Mask defined by the "10GbE standard"



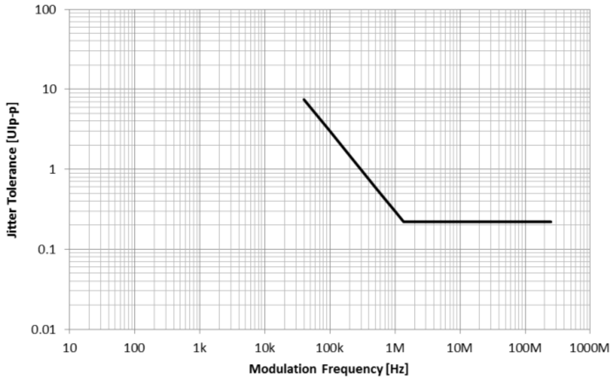
<table>
<tr><th>Modulation Frequency (Hz)</th><th>Jitter Tolerance Mask (UIp-p)</th></tr>
<tr><td>40,000</td><td>7.5</td></tr>
<tr><td>1,363,636</td><td>0.22</td></tr>
<tr><td>150,000,000</td><td>0.22</td></tr>
</table>
</td></tr>
<tr><td>Jitter Tolerance
When option x23 is installed*6,*7</td><td>At the bit rate of 28.05 Gbit/s, conforming to Jitter Tolerance Mask defined by the "32G FC standard"



<table>
<tr><th>Modulation Frequency (Hz)</th><th>Jitter Tolerance Mask (UIp-p)</th></tr>
<tr><td>10</td><td>50</td></tr>
<tr><td>10,000</td><td>50</td></tr>
<tr><td>100,000</td><td>10</td></tr>
<tr><td>108,805</td><td>7.5</td></tr>
<tr><td>3,709,271</td><td>0.22</td></tr>
<tr><td>250,000,000</td><td>0.22</td></tr>
</table>
</td></tr>
</table>

Table 1.3.4-11 Clock Recovery (Cont'd)

<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Jitter Tolerance
When option x23 is installed (Cont'd)</td><td>At the bit rate of 25.78125 Gbit/s, conforming to Jitter Tolerance Mask defined by the "100GbE(25.78x4) standard"



<table>
<tr><th>Modulation Frequency (Hz)</th><th>Jitter Tolerance Mask (UIp-p)</th></tr>
<tr><td>40,000</td><td>7.5</td></tr>
<tr><td>1,363,636</td><td>0.22</td></tr>
<tr><td>250,000,000</td><td>0.22</td></tr>
</table>
</td></tr>
</table>

Table 1.3.4-12 Jitter Tolerance

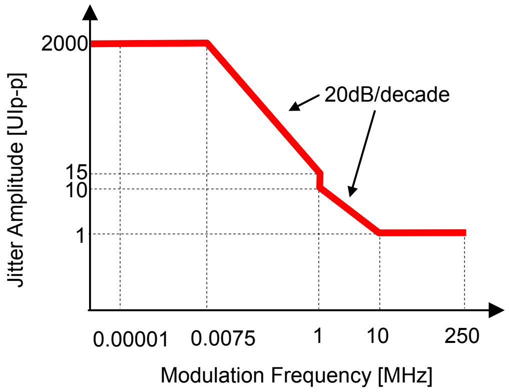
<table>
<tr><th>Item</th><th>Specifications</th></tr>
<tr><td>Jitter tolerance
When using external clock</td><td>Bit Rate 16Gbit/s, 28.1Gbit/s, 32.1Gbit/s (When option x01 is installed.)

Test pattern: PRBS2^{31}-1

SSC with a 5300 ppm amplitude and RJ of 0.3 UI can be simultaneously applied by using MU181500B.

These specifications are defined assuming the following conditions:

- Loopback connection with MU183020A/21A
- At any temperature between 20 and 30°C



</td></tr>
</table>

Table 1.3.4-13 Multichannel operation

Item	Specifications	
Combination*1		
Number of channels	2, 4	
Pattern		
Data		
Pattern Length	Two channels: 4 to 536 870 912 bits / 2 bits step*2 Four channels: 8 to 1 073 741 824 bits / 4 bits step*2	
Mixed		
Row Length	Two channels: 3 072 to 4 831 838 208 / 512 bits step*2 Four channels: 6 144 to 9 663 676 416 / 1024 bits step*2	
Pattern Length	Two channels: 2 048 to 536 870 912 bits / 2 bits step*2 Four channels: 4 096 to 1 073 741 824 bits / 4 bits step*2	
Block Window	Excludes the specified data pattern bit from the measurement target according to the settings. (Mask measurement function) Invalid when “Mixed” is selected for Test Pattern. Zero-substitution is invalid when “2n–1” is selected.	
Setting resolution	n: Number of channels for Channel Combination (2 or 4)	
	Pattern length (bits)	Step [bits]
	2 to 2 097 152 × n	1 × n
	2 097 153 to 4 194 304 × n	2 × n
	4 194 305 to 8 388 608 × n	4 × n
	8 388 609 to 16 777 216 × n	8 × n
	16 777 217 to 33 554 432 × n	16 × n
	33 554 433 to 67 108 864 × n	32 × n
	67 108 865 to 134 217 728 × n	64 × n
	134 217 729 to 268 435 456 × n	128 × n

*1: Combination extending over multiple slots cannot be set.

*2: Common to every channel specified by Combination Setting.

Table 1.3.4-13 Multichannel operation (Cont'd)

Item	Specifications
Burst	
Burst Cycle	Two channels: 51 200 to 4 294 967 296 bits / 512 bits step*2 Four channels: 102 400 to 8 589 934 592 bits / 1024 bits step*2
Enable Period	Internal: Two channels: 25 600 to 4 294 965 248 bits / 512 bits step*2 Four channels: 51 200 to 8 589 930 496 bits / 1024 bits step*2
	Ext Trigger: Two channels: 25 600 to 4 294 966 784 bits / 512 bits step*2 Four channels: 51 200 to 8 589 933 568 bits / 1024 bits step*2
Delay	Internal: Two channels: 0 to 4 294 967 280 bits / 16 bits step*2 Four channels: 0 to 8 589 934 560 bits / 32 bits step*2
	Ext Trigger, Enable: Two channels: 0 to 4 294 967 040 bits / 16 bits step*2 Four channels: 0 to 8 589 934 080 bits / 32 bits step*2
Measurement	
Sync Control	
Frame length	Two channels: 8 to 128 bits /8 bits step*2 Four channels: 16 to 256 bits /16 bits step*2
Frame Position	Two channels: 1 to (Pattern length' – Frame length +2) bits / 2 bits step Four channels: 1 to (Pattern length' – Frame length +4) bits / 4 bits step
Error detection mode	Total, Insertion and Omission
Eye diagram	
Measurement target	ch1 to ch 4*3
Eye margin	
Measurement target	ch1 to ch 4*3
Bathtub	
Measurement target	ch1 to ch 4*3
Capture Function	2 Ch Combination is available.*2

*3: Separately specified for each channel.

Table 1.3.4-14 General

Item	Specifications
Dimensions	41 mm (H), 234 mm (W), 175 mm (D), Excluding protrusions
Mass	5 kg max.
Operating temperature	15 to 35°C
Storage temperature	–20 to 60°C

Chapter 2 Before Use

This chapter describes preparations required before using the MU183040A/41A/40B/41B.

2.1 Installation to Signal Quality Analyzer 2-2
2.2 How to Operate Application 2-2
2.3 Preventing Damage 2-3

2.1 Installation to Signal Quality Analyzer

For information on how to install the MU183040A/41A/40B/41B to the Signal Quality Analyzer and how to turn on the power, refer to Chapter 2 “Preparation before Use” in the Signal Quality Analyzer Series Installation Guide.

2.2 How to Operate Application

The modules connected to the Signal Quality Analyzer are controlled by operating the MX180000A Signal Quality Analyzer Control Software (hereinafter, referred to as “MX180000A”).

For information on how to start up, shut down, and operate MX180000A, refer to the MX180000A Signal Quality Analyzer Control Software Operation Manual.

2.3 Preventing Damage

Be sure to observe the rating ranges when connecting input and output of the MU183040A/41A/40B/41B. Otherwise, the MU183040A/41A/40B/41B may be damaged.

⚠ CAUTION

- **When signals are input to the MU183040A/41A/40B/41B, avoid excessive voltage beyond the rating. Otherwise, the circuit may be damaged.**

- **When output is used at the 50 Ω/GND terminator, never feed any current or input signals to the output.**

- **As a countermeasure against static electricity, ground other devices to be connected (including experimental circuits) with ground wires before connecting the I/O connector.**

- **The outer conductor and core of the coaxial cable may become charged as a capacitor. Use any metal to discharge the outer conductor and core before use.**

- **Never open the MU183040A/41A/40B/41B. If you open it and the MU183040A/41A/40B/41B has failed or sufficient performance cannot be obtained, we may decline to repair the MU183040A/41A/40B/41B.**

- **The MU183040A/41A/40B/41B incorporates important parts and circuits, such as a hybrid IC, which are vulnerable to static electricity. Do not open the MU183040A/41A/40B/41B to touch such components.**

- **The hybrid IC incorporated in the MU183040A/41A/40B/41B is hermetically shielded. Do not open the hybrid IC. If you open it and sufficient performance cannot be obtained, we may decline to repair the MU183040A/41A/40B/41B.**

⚠ CAUTION

- **To protect the MU183040A/41A/40B/41B from electrostatic discharge failure, a conductive sheet should be placed onto the workbench, and the operator should wear an electrostatic discharge wrist strap. Connect the ground connection end of the wrist strap to the conductive sheet or to the ground terminal of the mainframe.**

Chapter 3 Panel Layout and Connectors

This chapter describes the panel and connectors of the MU183040A/41A/40B/41B.

3.1 Panel Layout 3-2
3.2 Inter-Module Connection 3-5
    3.2.1 Connecting with MU183020A........................... 3-7
    3.2.2 Connecting with MU183021A........................... 3-9

3.1 Panel Layout

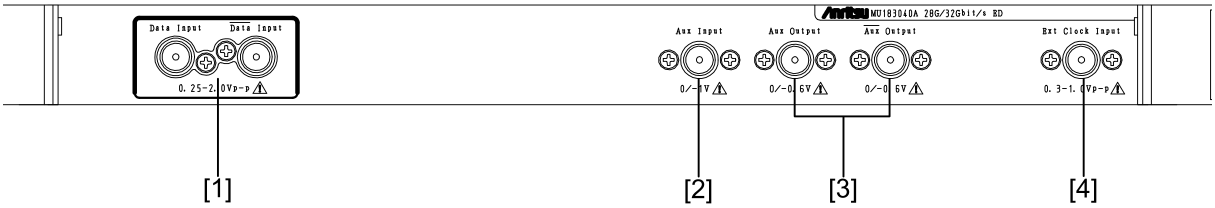

MU183040A 28G/32Gbit/s ED
Data Input
Data Input
0.25-2.0Vp-p
Aux Input
0/-1V
Aux Output
0/-0.6V
Aux Output
0/-0.6V
Ext Clock Input
0.3-1.0Vp-p
[1]
[2]
[3]
[4]

Figure 3.1-1 Panel layout (MU183040A-x10)

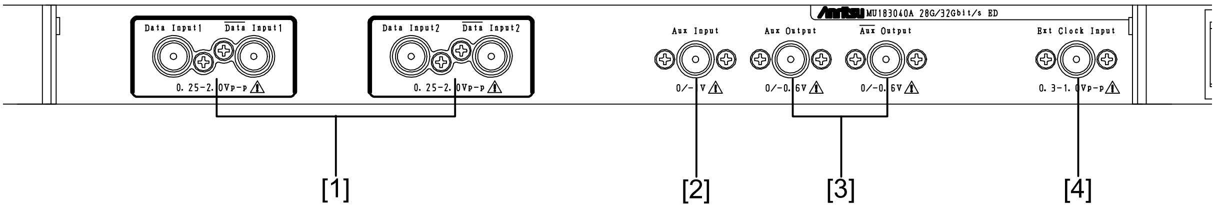

MU183040A 28G/32Gbit/s ED
Data Input1
Data Input1
0.25-2.0Vp-p
Data Input2
Data Input2
0.25-2.0Vp-p
Aux Input
0/-1V
Aux Output
0/-0.6V
Aux Output
0/-0.6V
Ext Clock Input
0.3-1.0Vp-p
[1]
[2]
[3]
[4]

Figure 3.1-2 Panel layout (MU183040A-x20)

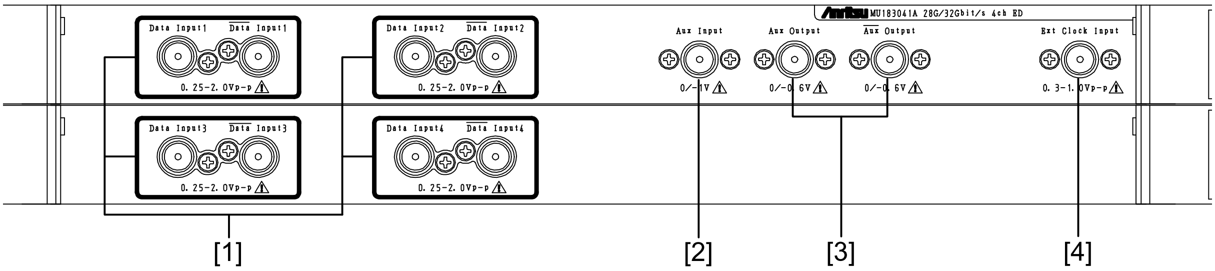

MU183041A 28G/32Gbit/s 4ch ED
Data Input1
Data Input1
0.25-2.0Vp-p
Data Input2
Data Input2
0.25-2.0Vp-p
Data Input3
Data Input3
0.25-2.0Vp-p
Data Input4
Data Input4
0.25-2.0Vp-p
Aux Input
0/-1V
Aux Output
0/-0.6V
Aux Output
0/-0.6V
Ext Clock Input
0.3-1.0Vp-p
[1]
[2]
[3]
[4]

Figure 3.1-3 Panel layout (MU183041A)

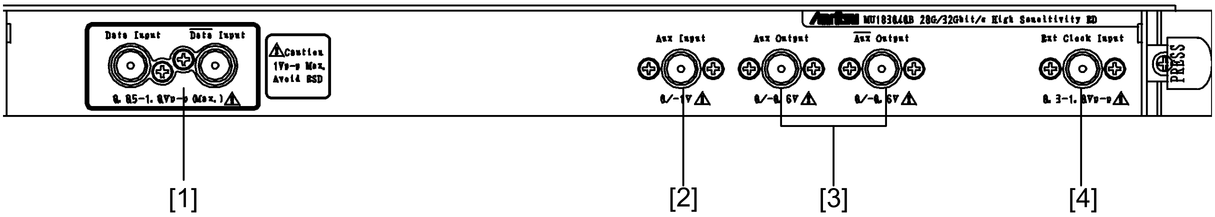

Data Input
Data Input
0.05-1.0Vp-p (Max.)
Caution
1Vp-p Max.
Avoid ESD
MU183040B 28G/32Gbit/s High Sensitivity ED
Aux Input
0/-1V
Aux Output
0/-0.6V
Aux Output
0/-0.6V
Ext Clock Input
0.3-1.0Vp-p
PRESS
[1]
[2]
[3]
[4]

Figure 3.1-4 Panel layout (MU183040B-x10)

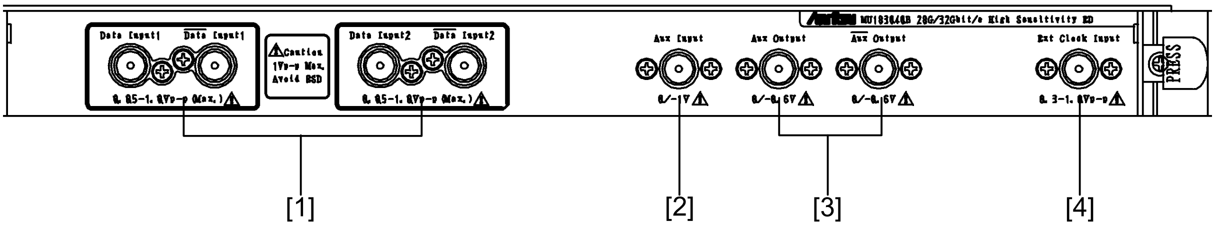

Data Input1
Data Input1
0.05-1.0Vp-p (Max.)
Caution
1Vp-p Max.
Avoid ESD
Data Input2
Data Input2
0.05-1.0Vp-p (Max.)
MU183040B 28G/32Gbit/s High Sensitivity ED
Aux Input
0/-1V
Aux Output
0/-0.6V
Aux Output
0/-0.6V
Ext Clock Input
0.3-1.0Vp-p
PRESS
[1]
[2]
[3]
[4]

Figure 3.1-5 Panel layout (MU183040B-x20)

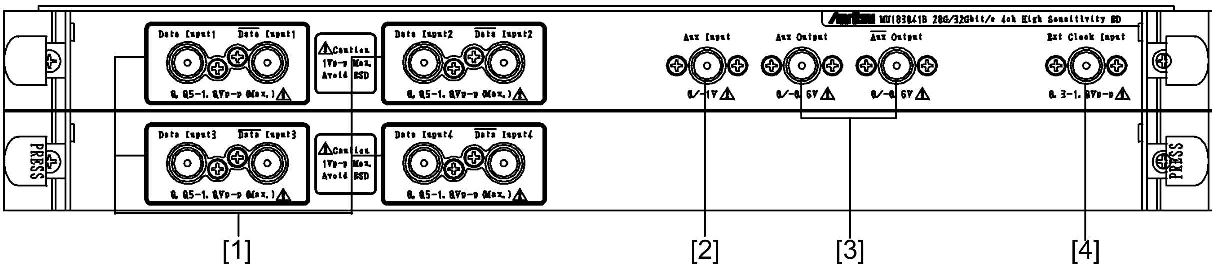

Data Input1
Data Input1
Caution
1Vp-p Max.
Avoid ESD
Data Input2
Data Input2
Data Input3
Data Input3
Data Input4
Data Input4
0.05-1.0Vp-p (Max.)
MU183041B 28G/32Gbit/s 4ch High Sensitivity ED
Aux Input
0/-1V
Aux Output
0/-0.6V
Aux Output
0/-0.6V
Ext Clock Input
0.3-1.0Vp-p
PRESS
[1]
[2]
[3]
[4]

Figure 3.1-6 Panel layout (MU183041B)

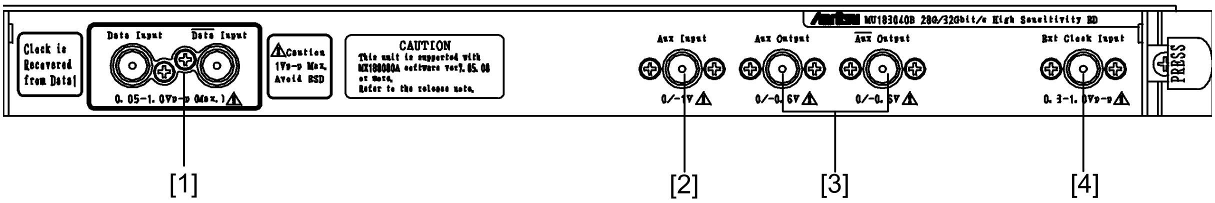

Clock is Recovered from Data1
Data Input
Data Input
0.05-1.0Vp-p (Max.)
Caution
1Vp-p Max.
Avoid ESD
CAUTION
This unit is supported with MX180000A software ver7.05.00 or more.
Refer to the release note.
MU183040B 28G/32Gbit/s High Sensitivity ED
Aux Input
0/-1V
Aux Output
0/-0.6V
Aux Output
0/-0.6V
Ext Clock Input
0.3-1.0Vp-p
PRESS
[1]
[2]
[3]
[4]

Figure 3.1-7 Panel layout (MU183040B-x10+x22/x23)

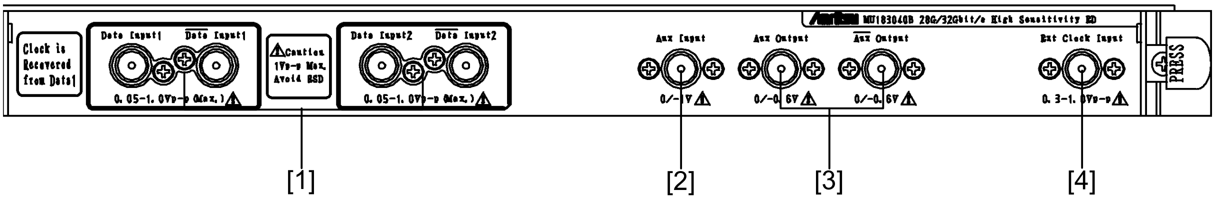

Clock is Recovered from Data1
Data Input1
Data Input1
0.05-1.0Vp-p (Max.)
Caution
1Vp-p Max.
Avoid ESD
Data Input2
Data Input2
0.05-1.0Vp-p (Max.)
MU183040B 28G/32Gbit/s High Sensitivity ED
Aux Input
0/-1V
Aux Output
0/-0.6V
Aux Output
0/-0.6V
Ext Clock Input
0.3-1.0Vp-p
PRESS
[1]
[2]
[3]
[4]

Figure 3.1-8 Panel layout (MU183040B-x20+x22/x23)

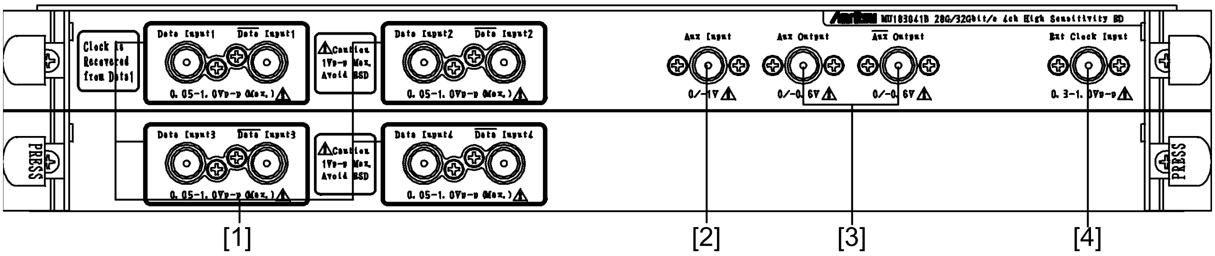

Data Input1
Data Input1
Data Input2
Data Input2
Data Input3
Data Input3
Data Input4
Data Input4
Aux Input
Aux Output
Aux Output
Ext Clock Input
PRESS
PRESS
[1]
[2]
[3]
[4]

Figure 3.1-9 Panel layout (MU183041B-x22)

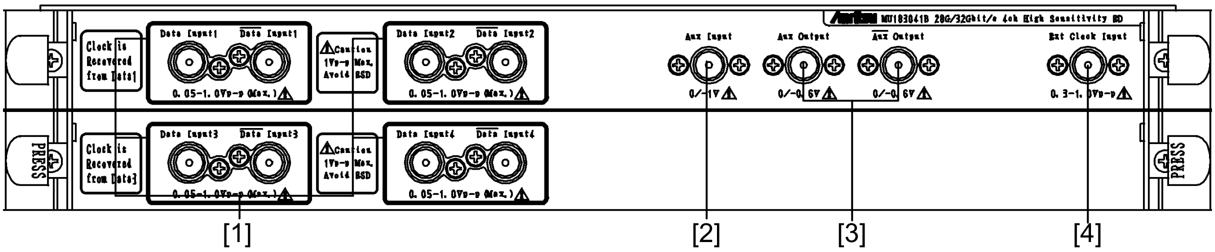

Data Input1
Data Input1
Data Input2
Data Input2
Data Input3
Data Input3
Data Input4
Data Input4
Aux Input
Aux Output
Aux Output
Ext Clock Input
PRESS
PRESS
[1]
[2]
[3]
[4]

Figure 3.1-10 Panel layout (MU183041B-x23)

Table 3.1-1 Connectors on panel

Symbol	Name	Description
[1]	Data and $\overline{\text{Data}}$ Input connectors	Input data signals. Support both differential and single-ended input signals. When the MU183040B-x22/x23 or MU183041B-x22 Clock Recovery option is installed, the clock is recovered from the signal input to the Data Input1 connector. When the MU183041B-x23 Clock Recovery option is installed, the clock for each Data1 and Data2 is recovered from the signal input to the Data Input1 connector, and the clock for each Data3 and Data4 is recovered from the signal input to the Data Input3 connector.
[2]	Aux Input connector	Inputs auxiliary signals. External Mask, Burst can be selected, Capture External Trigger.
[3]	Aux and $\overline{\text{Aux}}$ Output connectors	Outputs auxiliary signals. 1/N Clock, Pattern Sync, Error, and Sync Gain output signals can be selected. Because of differential output, be sure to connect the coaxial terminator (J1137) to unused side connector.
[4]	Ext Clock Input connector	Inputs clock signals.

3.2 Inter-Module Connection

Note:

Avoid static electricity when handling the devices.

⚠ CAUTION

- **When signals are input to this device, avoid excessive voltage beyond the rating. Otherwise, the circuit may be damaged.**

- **As a countermeasure against static electricity, ground other devices to be connected (including experimental circuits) with ground wires before connecting the I/O connector.**

- **The outer conductor and core of the coaxial cable may become charged as a capacitor. Use any metal to discharge the outer conductor and core before use.**

- **The power supply voltage rating for the mainframe is shown on the rear panel. Be sure to operate the mainframe within the rated voltage range. The mainframe may be damaged if a voltage out of the rating range is applied.**

- **To protect the device from electrostatic discharge failure, a conductive sheet should be placed onto the workbench, and the operator should wear an electrostatic discharge wrist strap. Connect the ground connection end of the wrist strap to the conductive sheet or to the ground terminal of the mainframe.**

- **When removing a cable from a connector on the front panel of the device, be careful not to add excessive stress to the connector. Addition of excessive stress to a connector may result in characteristic degradation or a failure.**
  Use a torque wrench (recommended torque: 0.9 N-M) when attaching or removing a cable.

⚠ CAUTION

Note that the maximum output level of the Data Output connector of MU183020A-x13/x23 and MU183021A-x13 is “3.50 Vp-p”, the maximum input level of the Data Input connector of MU183040A/MU183041A is “2.00 V”, and the maximum input level of the Data Input connector of MU183040B/MU183041B is “1.00 V”.

Make sure the Data Output setting of MU183020A/MU183021A is 2.00/1.00 V or less respectively before directly connecting the Data Output connector of MU183020A/MU183021A to the Data Input connector of MU183040A/MU183041A or MU183040B/MU183041B, for example, when checking the operation.

Avoid inputting the signal exceeding the maximum input level to the Data Input connector of MU183040A/ MU183041A/MU183040B/MU183041B. Failure to do so can cause damage.

3.2.1 Connecting with MU183020A

This section shows an example of connecting the MU183040A, MU183020A 28G/32G bit/s Pulse Pattern Generator (hereinafter, referred to as “MU183020A”), and MU181000A 12.5 GHz Synthesizer (hereinafter, referred to as “MU181000A”) that are inserted into a mainframe.

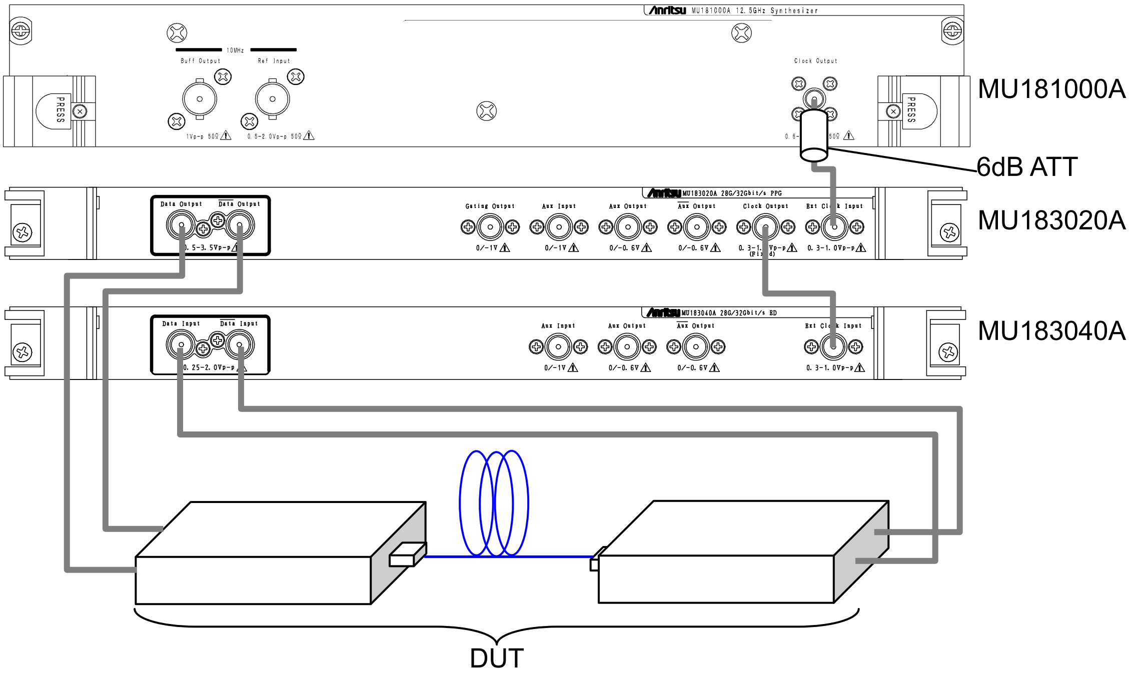


Figure 3.2.1-1 Connection example of MU183020A and MU183040A

1. For the case of the MU181000A, attach the 6 dB fixed attenuator (ATT) to the Clock Output connector.
   The following models and options do not require the 6 dB fixed attenuator.

   MU181000A-x01, MU181000B, MU181000B-x01
2. Connect the Clock Output connector of the MU181000A and the Ext. Clock Input connector of the MU183020A, using a coaxial cable.
3. Connect the Clock Output connector of the MU183020A and the Ext. Clock Input connector of the MU183040A, using a coaxial cable.
4. Connect the Data Output connector of the MU183020A and the Data Input connector of the device under test (DUT) using a coaxial cable. Also connect the $\overline{\text{Data}}$ Output connector of the MU183020A and the $\overline{\text{Data}}$ Input connector of the DUT, using a coaxial cable.

5. Connect the Data Output connector of the DUT and the Data Input connector of the MU183040A, using a coaxial cable. Also connect the $\overline{\text{Data}}$ Output connector of the DUT and the $\overline{\text{Data}}$ Input connector of the MU183040A, using a coaxial cable.
6. Select “Initialize” from the File menu on the menu bar to initialize the entire system. Note that all of the settings are returned to the initial settings at factory shipment after initialization. Save the settings before initialization, if necessary, by selecting “Save” from the File menu.

3.2.2 Connecting with MU183021A

This section describes a connection example of MU183021A, MU183041A, and External Clock. In this description, MG3692C is used for the external clock.

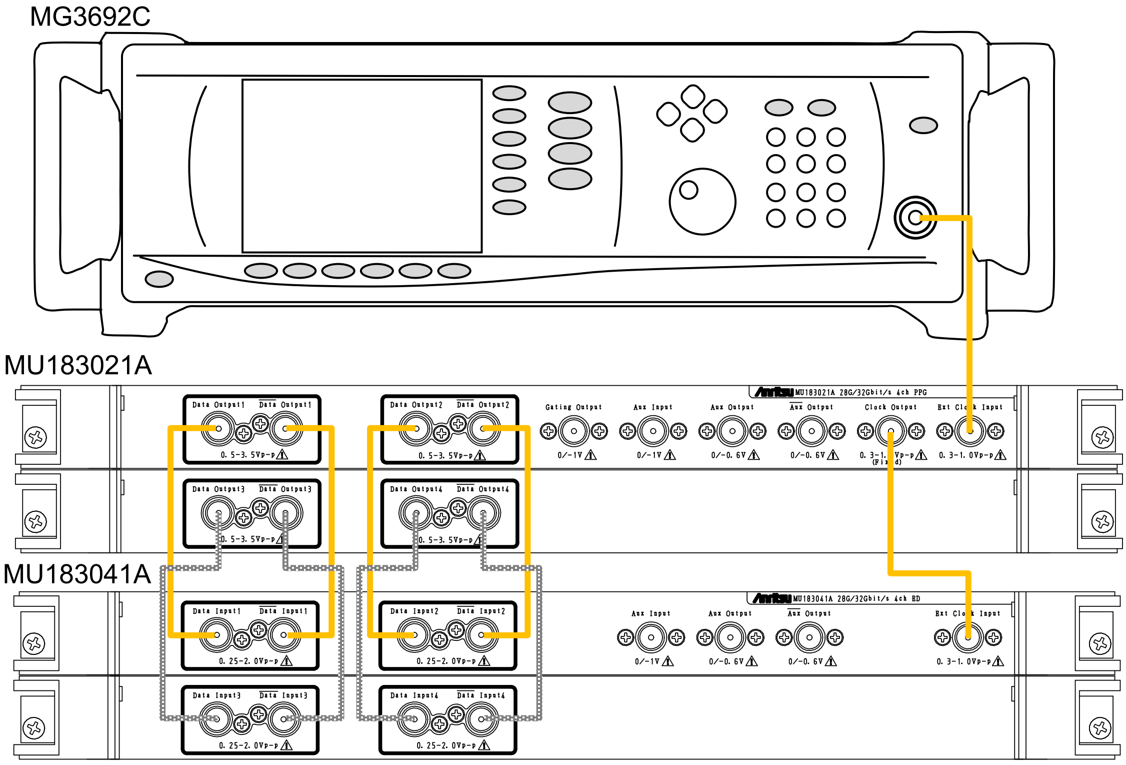


Figure 3.2.2-1 Connection example of MU183021A and MU183041A

1. Connect the RF Output connector of the MG3692C and the Ext. Clock Input connector of the MU183021A, using a coaxial cable.
2. Connect the Clock Output connector of the MU183021A and the Ext. Clock Input connector of the MU183041A, using a coaxial cable.
3. Use coaxial cables to connect Data Output and $\overline{\text{Data}}$ Output connectors of the MU183021A with Data Input and $\overline{\text{Data}}$ Input connectors of the MU183041A (4 connections).
4. Select "Initialize" from the File menu on the menu bar to initialize the entire system. Note that all of the settings are returned to the initial settings at factory shipment after initialization. Save the settings before initialization, if necessary, by selecting "Save" from the File menu.

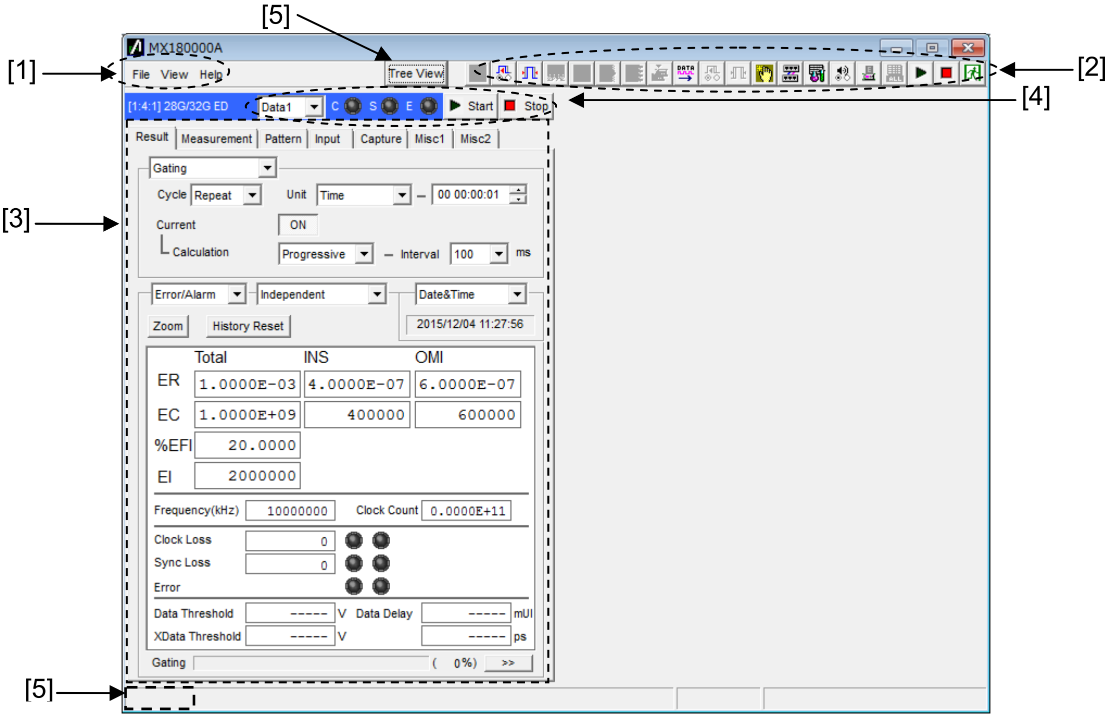
Chapter 4 Configuration of Setup Dialog Box

This chapter describes the configuration of the MU183040A/41A/40B/41B setup dialog box.

4.1 Configuration of Entire Setup Dialog Box 4-2
4.2 Operation Tab Windows 4-4
4.3 User Customize Dialog 4-5

4.1 Configuration of Entire Setup Dialog Box

The configuration of the setup dialog box when the MU183040A/41A/40B/41B is inserted into a mainframe is shown below.


[1]
[2]
[3]
[4]
[5]
[5]
MX180000A
File
View
Help
Tree View
Start
Stop
Result
Measurement
Pattern
Input
Capture
Misc1
Misc2
Zoom
History Reset
>>

[1:4:1] 28G/32G ED

Data1 C S E

Gating

Cycle Repeat Unit Time – 00 00:00:01

Current ON

Calculation Progressive – Interval 100 ms

Error/Alarm Independent Date&Time

2015/12/04 11:27:56

	Total	INS	OMI
ER	1.0000E-03	4.0000E-07	6.0000E-07
EC	1.0000E+09	400000	600000
%EFI	20.0000		
EI	2000000		

Frequency(kHz) 10000000 Clock Count 0.0000E+11

Clock Loss 0

Sync Loss 0

Error

Data Threshold ----- V Data Delay ----- mUI

XData Threshold ----- V ----- ps

Gating (0%)

Figure 4.1-1 Configuration of entire setup dialog box for MU183040A/41A/40B/41B

The setup dialog box mainly consists of four blocks ([1] to [4] in the figure above). The following table describes each of the blocks.

Table 4.1-1 Functions of blocks

No.	Block	Function
[1]	Menu bar	Selects the setting functions related to the entire device.
[2]	Module function buttons	Shortcut buttons for the function items common to the connected modules. Users can customize up to 17 pre-defined function buttons according to their own applications. For the user customize screen of ✋ buttons, refer to 4.3 "User Customize Dialog".
[3]	Operation tab window	Configures settings specific to each module. See Chapter 5 “Operation Method” for details.
[4]	Module common function area	Contains the following controls for functions specific to the module. Start/Stop button C: Clock Loss LED S: Sync Loss LED E: Error LED Channel selection list box*
[5]	Tree View Display Button Display Area	Clicking the button can display the Tree View screen. Also, moving the cursor over the bottom left area can display the Tree View screen.

*: MU183040A/B-x20 and MU183041A/B only

Tab colors

For MU183040A/B-x20 and MU183041A/B, data channels can be selected as control targets. Tab colors vary by channels.

Data 1: Blue
Data 2: Pink
Data 3: Purple
Data 4: Orange

4.2 Operation Tab Windows

The MU183040A/41A/40B/41B operation tab windows are listed below. See Chapter 5 "Operation Method" for details on each operation tab window.

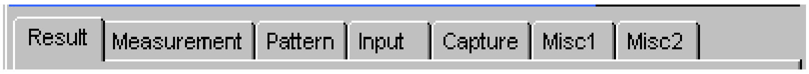


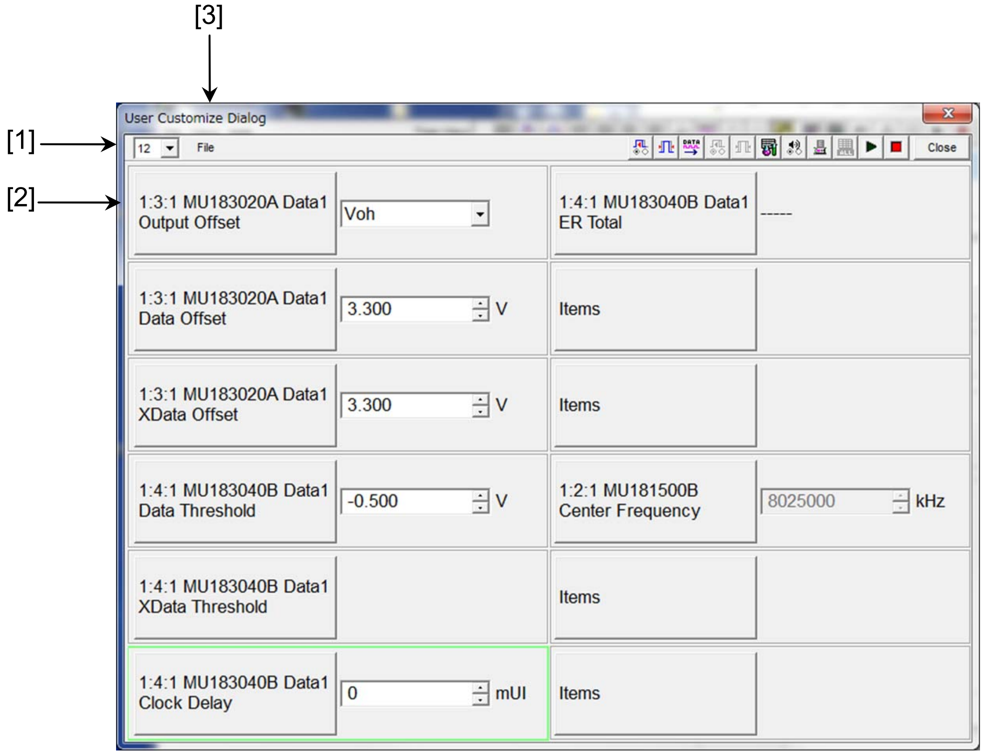
Figure 4.2-1 Function setting selection tabs

Table 4.2-1 List of function setting selection tabs

Tab window	Function
Result	Measurement results are displayed.
Measurement	Various measurement conditions can be set.
Pattern	Test pattern types can be set. A test pattern can be selected and edited in this tab window.
Input	Test signal input interface can be set.
Capture	Test patterns can be captured into the internal memory.
Misc1	Other settings can be configured. Pattern generation method setting, auxiliary input/output selection, and other settings can be configured in this tab window.
Misc2	Combination operation between clocks and channels can be set.

4.3 User Customize Dialog

On the User Customize Dialog, main parameters of multiple modules can be displayed and set. The figure below shows a dialog displaying some parameters of the MU183020A, MU183040B, and MU181500B as an example. Additionally, parameters of a module that is not installed in the MP1800A cannot be set.



12

1:3:1 MU183020A Data1 Output Offset: Voh

1:4:1 MU183040B Data1 ER Total: -----

1:3:1 MU183020A Data1 Data Offset: 3.300 V

Items

1:3:1 MU183020A Data1 XData Offset: 3.300 V

Items

1:4:1 MU183040B Data1 Data Threshold: -0.500 V

1:2:1 MU181500B Center Frequency: 8025000 kHz

1:4:1 MU183040B Data1 XData Threshold

Items

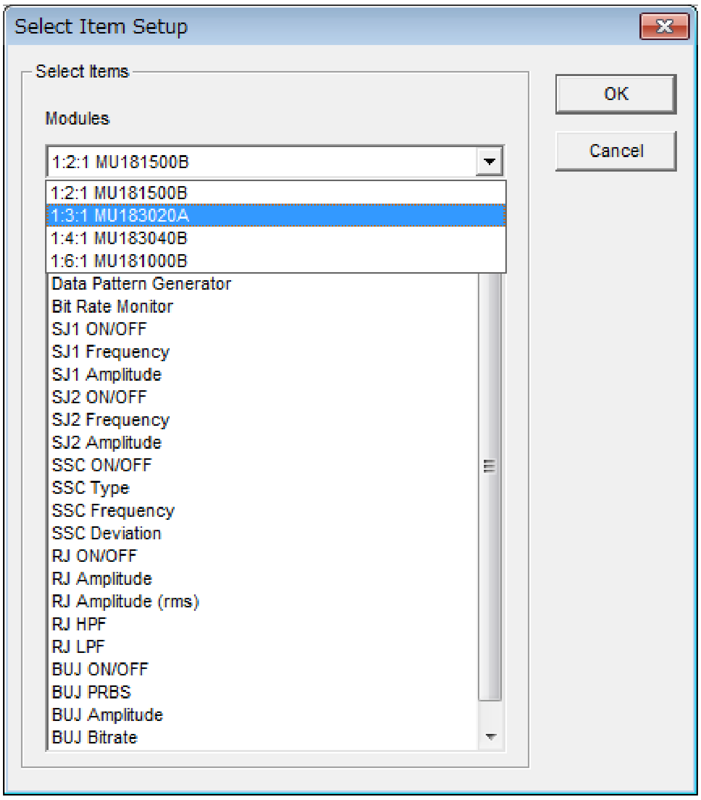
1:4:1 MU183040B Data1 Clock Delay: 0 mUI

Items

Figure 4.3-1 User Customize Dialog

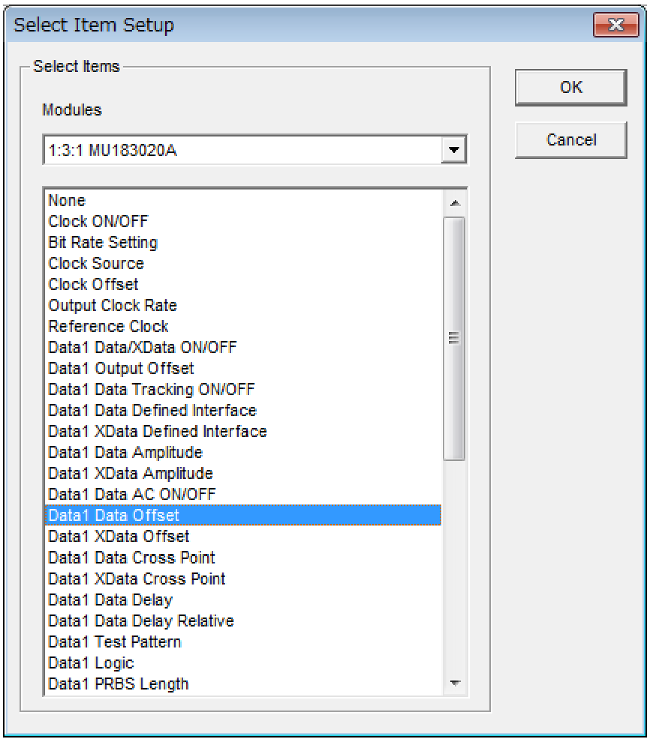
[1] Number of parameters displayed
Select 6 or 12 or 18.

[2] Selection of custom items
Select a desired module and parameter. For example, to select Data1 Data Offset of MU183020A 32Gbit/s PPG of Unit1, Slot3, and Port1, first select the desired module 1:3:1 MU183020A and then the parameter Data1 Data Offset.


Select Item Setup
Select Items
Modules
1:2:1 MU181500B
1:2:1 MU181500B
1:3:1 MU183020A
1:4:1 MU183040B
1:6:1 MU181000B
Data Pattern Generator
Bit Rate Monitor
SJ1 ON/OFF
SJ1 Frequency
SJ1 Amplitude
SJ2 ON/OFF
SJ2 Frequency
SJ2 Amplitude
SSC ON/OFF
SSC Type
SSC Frequency
SSC Deviation
RJ ON/OFF
RJ Amplitude
RJ Amplitude (rms)
RJ HPF
RJ LPF
BUJ ON/OFF
BUJ PRBS
BUJ Amplitude
BUJ Bitrate
OK
Cancel

Modules: 1:3:1 MU183020A

Figure 4.3-2 Selecting Module


Select Item Setup
Select Items
Modules
1:3:1 MU183020A
None
Clock ON/OFF
Bit Rate Setting
Clock Source
Clock Offset
Output Clock Rate
Reference Clock
Data1 Data/XData ON/OFF
Data1 Output Offset
Data1 Data Tracking ON/OFF
Data1 Data Defined Interface
Data1 XData Defined Interface
Data1 Data Amplitude
Data1 XData Amplitude
Data1 Data AC ON/OFF
Data1 Data Offset
Data1 XData Offset
Data1 Data Cross Point
Data1 XData Cross Point
Data1 Data Delay
Data1 Data Delay Relative
Data1 Test Pattern
Data1 Logic
Data1 PRBS Length
OK
Cancel

Modules: 1:3:1 MU183020A

Data1 Data Offset

Figure 4.3-3 Selecting Parameter

[3] File Menu

Saves and reads the customize dialog setup. The customize dialog setup file can be saved and read by the extension (.UCD). Additionally, the 32G systems (MU183020A, MU183040B, MU181500B, and MU181000B) can load a preset file (.UCP) of frequently used functions.

Chapter 5 Operation Method

This chapter describes the functions available on the tabs of the module operation window of the MU183040A, MU183041A, MU183040B and MU183041B.

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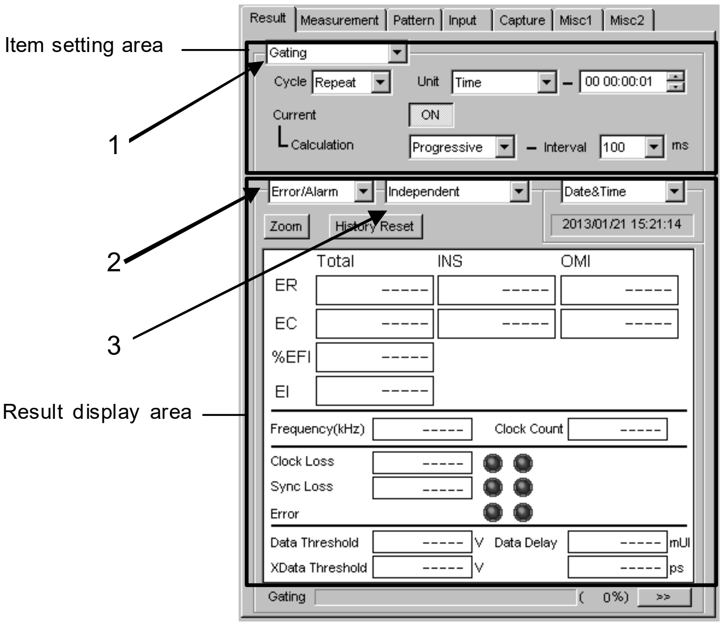
5.1 Displaying Measurement Results

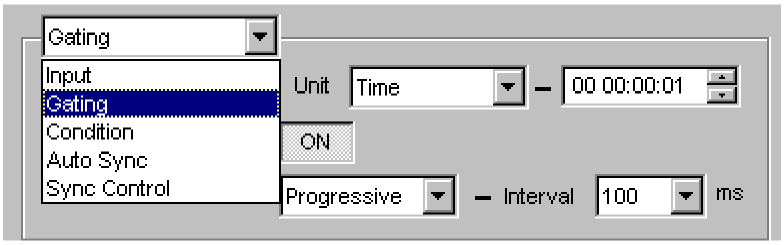
On the **Result** tab of the module operation window, you can view measurement results. The **Result** tab consists of the item setting area (upper) and the result display area (lower). Measurement results can be viewed while changing the setting items of the MU183040A/41A/40B/41B.


Item setting area
1
2
3
Result display area
Result
Measurement
Pattern
Input
Capture
Misc1
Misc2
Zoom
History Reset
Total
INS
OMI
ER
EC
%EFI
EI
Clock Loss
Sync Loss
Error
>>

Gating
Cycle Repeat
Unit Time – 00 00:00:01
Current ON
Calculation Progressive – Interval 100 ms
Error/Alarm
Independent
Date&Time
2013/01/21 15:21:14
Frequency(kHz) ----- Clock Count -----
Data Threshold ----- V Data Delay ----- mUI
XData Threshold ----- V ----- ps
Gating (0%)

Figure 5.1-1 Result tab

The setting items change according to the item selected in the list box ("1" in the figure above) in the item setting area.


Gating
Input
Gating
Condition
Auto Sync
Sync Control

Unit Time – 00 00:00:01
ON
Progressive – Interval 100 ms

Figure 5.1-2 Item setting area

Table 5.1-1 Setting items of list box in item setting area

Item	Description
Input	Select to configure the settings related to the input signal interface.
Gating	Select to configure the settings related to the measurement period.
Condition	Select to configure the settings related to the measurement conditions.
Auto Sync	Select to configure the settings related to the automatic synchronization establishment function.
Sync Control	Select to configure the settings related to the synchronization establishment method.

The display items change according to the item selected in the list box ("2" in the Figure 5.1-1) in the result display area.
Note that the current version provides only Error and Alarm results.

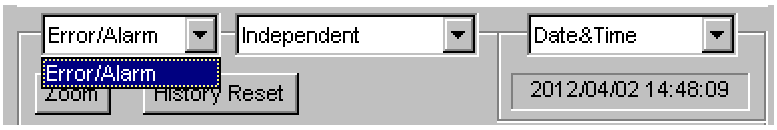


Figure 5.1-3 Result display area

Table 5.1-2 Setting items of list box in result display area

Item	Description
Error/Alarm	Select to display the Error/Alarm measurement results.

Display of channel combination can be switched by selecting from the list box (“3” in the Figure 5.1-1) result display area.

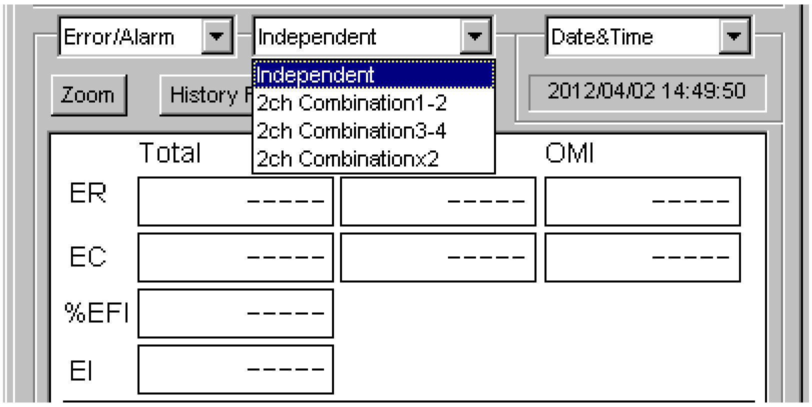

Error/Alarm
Independent
Date&Time
Zoom
History
Independent
2ch Combination1-2
2ch Combination3-4
2ch Combinationx2
2012/04/02 14:49:50
Total
OMI
ER
EC
%EFI
EI

Figure 5.1-4 Result display area

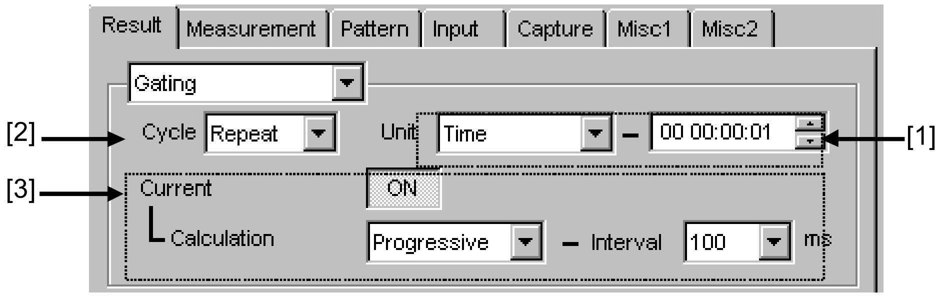
Table 5.1-3 Setting items in list box in result display area

Item	Description
Independent	Single channel measurement result.
4ch Combination *1	4ch combination measurement result.
2ch Combination 1-2 *1,*2	2ch combination measurement result of Data 1/2.
2ch Combination 3-4 *1	2ch combination measurement result of Data3/4.
2ch Combination x 2 *1	Simultaneous display of 2ch combination measurement result of Data 1/2 and Data3/4.

*1: MU183041A/B has this item.

*2: MU183040A/B-x20 has this item.

5.1.1 Setting items when Gating is selected



Gating

Cycle Repeat

Unit Time – 00 00:00:01

Current ON

Calculation Progressive – Interval 100 ms

Figure 5.1.1-1 Gating setting items

[1] Select the unit of the measurement period from the Unit list box, and set the measurement period in the upper-right text box.

Table 5.1.1-1 Measurement period setting

Unit	Description
Time	Time can be set from 1 second to 99 days 23 hours 59 minutes 59 seconds in second units. When **Untimed** is selected from the **Cycle** list box, the value set by this parameter becomes invalid.
Clock Count	The setting range is from E+4 to E+16, in E+1 units. The minimum measurement time resolution is 1 second, so the measurement will end at the end of the 1-second period in which the clock count reaches the number specified by this parameter (refer to Figure 5.1.1-2). When **Untimed** is selected from the **Cycle** list box, the value set by this parameter becomes invalid.
Error Count	The setting range is from E+4 to E+16, in E+1 units. The minimum measurement time resolution is 1 second, so the measurement will end at the end of the 1-second period in which the error count reaches the number specified by this parameter (refer to Figure 5.1.1-2). When **Untimed** is selected from the **Cycled** list box, the value set by this parameter becomes invalid
Block Count	The number of blocks to be executed is set to Gating when the test pattern is Mixed Pattern or Sequence. The setting range is from E+2 to E+14, in E+1 units. The minimum measurement time resolution is 1 second, so the measurement will end at the end of the 1-second period in which the block count reaches the number specified by this parameter (refer to Figure 5.1.1-2). When **Untimed** is selected from the **Cycle** list box, the value set by this parameter becomes invalid.

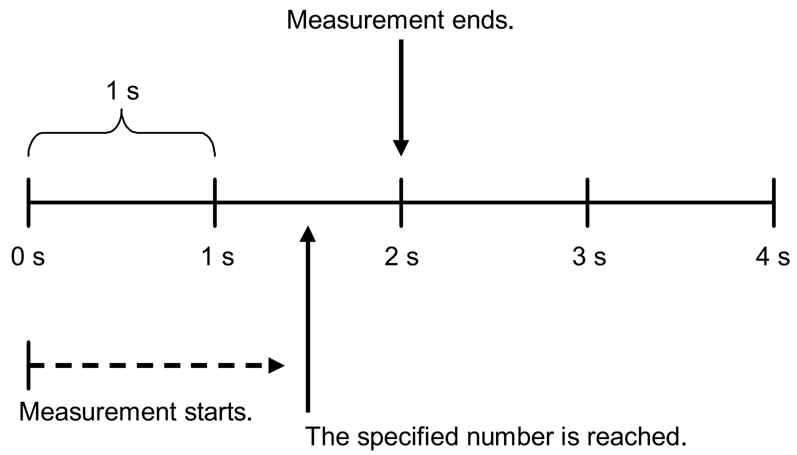

Measurement ends.
1 s
0 s
1 s
2 s
3 s
4 s
Measurement starts.
The specified number is reached.

Figure 5.1.1-2 Measurement end timing

[2] Select the measurement operation from the **Cycle** list box.

Table 5.1.1-2 Select the measurement operation from the Cycle list box.

Cycle	Description
Repeat	Specified-period measurement is performed repeatedly.
Single	Measurement ends when it is performed once for the specified period.
Untimed	Measurement is performed continuously from the measurement start instruction to the measurement end instruction.

[3] Set the measurement progress display method.

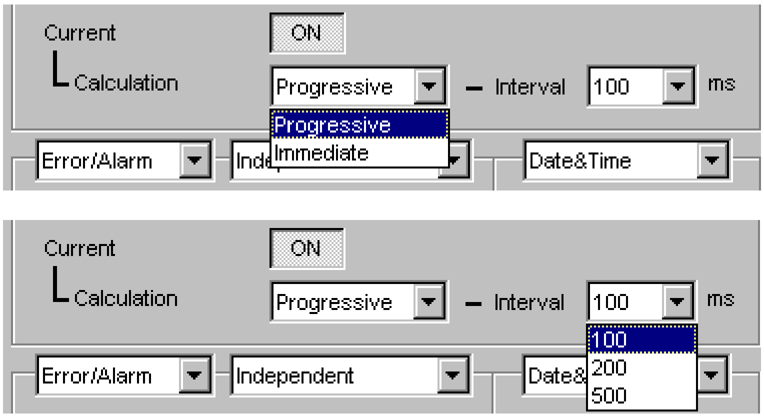

Current
ON
Calculation
Progressive
Interval
100
ms
Progressive
Immediate
Error/Alarm
Inde
Date&Time
Current
ON
Calculation
Progressive
Interval
100
ms
100
200
500
Error/Alarm
Independent
Date&

Figure 5.1.1-3 Measurement progress display setting items

Table 5.1.1-3 Measurement progress display setting

Current	Description
ON	The accumulated measurement result, up to the current time, is displayed in the specified interval (cycle time). Select 100 (ms), 200 (ms) or 500 (ms)* from the **Interval** list box for the cycle time. Select **Progressive** or **Immediate** from the Calculation list box for the method to display measurement results in the middle of the measurement. In the Progressive mode, the measurement result accumulated from the measurement start is displayed. In the Immediate mode, the immediate-value result for each cycle time is displayed.
OFF	The measurement result in the last measurement period is displayed. The display remains until the measurement ends for the next measurement period.

*: 500 (ms) is available only during 2ch or 4ch Combination.

The following figure shows a correspondence between the selection in the Calculation list box (Progressive/Immediate) and the measurement result when the measurement period is 1 second and Interval is set to 200 ms.

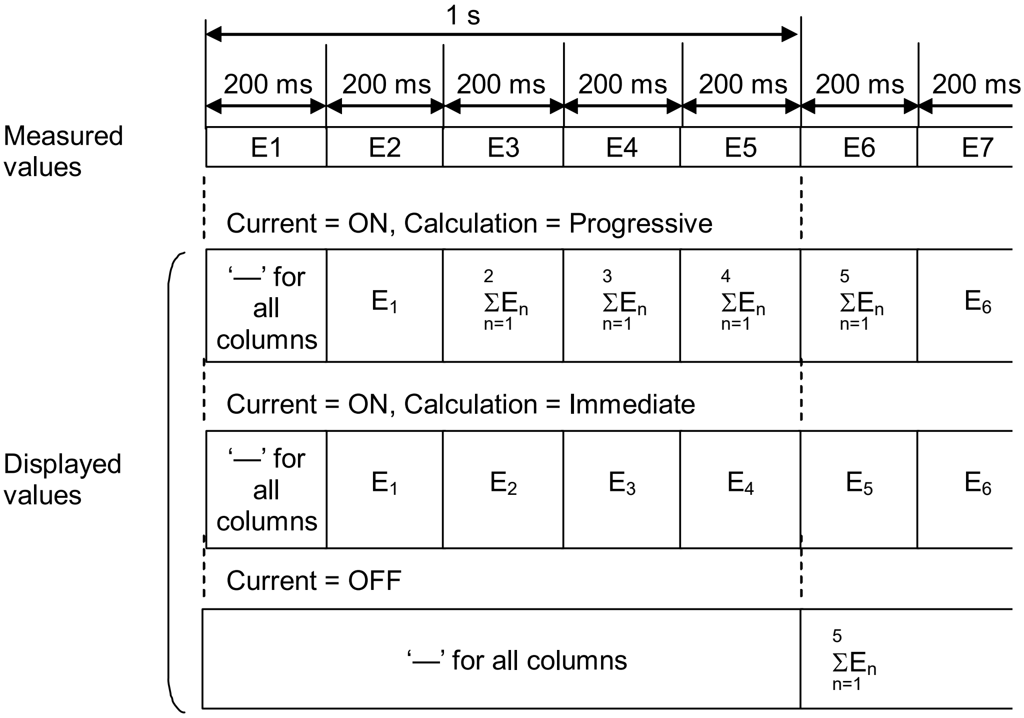

1 s
200 ms
200 ms
200 ms
200 ms
200 ms
200 ms
200 ms
Measured values
E1
E2
E3
E4
E5
E6
E7
Current = ON, Calculation = Progressive
'—' for all columns
E_1
$\sum_{n=1}^{2} E_n$
$\sum_{n=1}^{3} E_n$
$\sum_{n=1}^{4} E_n$
$\sum_{n=1}^{5} E_n$
E_6
Current = ON, Calculation = Immediate
'—' for all columns
E_1
E_2
E_3
E_4
E_5
E_6
Current = OFF
'—' for all columns
$\sum_{n=1}^{5} E_n$
Displayed values

Figure 5.1.1-4 Relationship between measured values and displayed values

5.1.2 Setting items when Auto Sync is selected

This section describes the setting items when Auto Sync is selected from the list box in the item setting area (“1” in Figure 5.1-1).

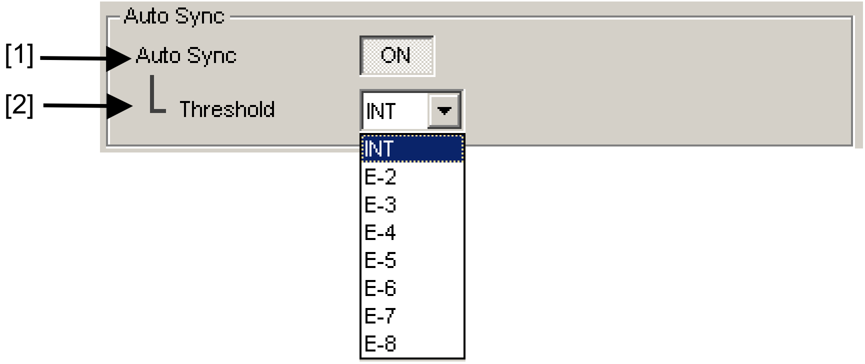


Figure 5.1.2-1 Items when Auto Sync is selected

[1] Specify whether to start resynchronization automatically when the synchronization threshold is exceeded from Sync Gain to Sync Loss.

Table 5.1.2-1 Auto sync setting

Auto Sync	Description
ON	Automatically starts resynchronization.
OFF	Does not start resynchronization automatically.

[2] Select the error rate threshold to execute resynchronization when Auto Sync is set to **ON**. From the **Threshold** list box, 10^{-N} (N = 2 to 8) or **INT** can be set.
When **INT** is set, whether the synchronization is established (Sync Gain) or lost (Sync Loss) is judged according to the synchronization threshold. If the error rate exceeds the synchronization threshold in the Sync Gain state, it is judged as a Sync Loss. On the other hand, if the error rate falls to the synchronization threshold or below in the Sync Loss state, it is judged as a Sync Gain.
For details on the synchronization threshold, refer to Table 5.1.2-2 for **INT** and Table 5.1.2-3 for 10^{-N} (N = 2 to 8).

Table 5.1.2-2 Synchronization thresholds when INT is set

Sync Control	Test Pattern	Data Length	Threshold error rate = $\left[\frac{\text{Error Count}}{\text{Clock Count}}\right]$	
			Sync Gain → Sync Loss	Sync Loss → Sync Gain
–	PRBS, Mixed Pattern, PRBS part of Mixed Pattern	2^n-1 (n=7, 9, 10, 11, 15, 20, 23, 31)	$\frac{(128)\times 2\ 000}{(2{,}048)\times 5\ 000}$ $=\frac{1}{40}$ $= 2.5\ \text{E} - 2$	$\frac{(128)}{(2{,}048)\times 4}$ $=\frac{1}{64}$ $= 1.56\ \text{E} - 2$
Frame ON, Quick	Mixed Data Part, Zero-Substitution Data	128 to 5,120	$\frac{(128)\times 200}{(2{,}048)\times 64{,}000}$ $=\frac{1}{5{,}120}$ $= 1.95\ \text{E} - 4$	$\frac{(128)\times 1}{(2{,}048)\times \frac{\text{DataLength}}{128\times 8}}$
		5,121 to 10,240	$\frac{(128)\times 200}{(2{,}048)\times 128{,}000}$ $=\frac{1}{10{,}240}$ $= 9.77\ \text{E} - 5$	$\frac{(128)\times 1}{(2{,}048)\times \frac{\text{DataLength}}{128\times 8}}$
		10,241 to 51,200	$\frac{(128)\times 200}{(2{,}048)\times 640{,}000}$ $=\frac{1}{51{,}200}$ $= 1.95\ \text{E} - 5$	$\frac{(128)\times 1}{(2{,}048)\times \frac{\text{DataLength}}{128\times 8}}$
		51,201 to 102,400	$\frac{(128)\times 200}{(2{,}048)\times 1{,}280{,}000}$ $\frac{1}{102{,}400}$ $= 9.77\ \text{E} - 6$	$\frac{(128)\times 1}{(2{,}048)\times \frac{\text{DataLength}}{128\times 8}}$
		102,401 to 204,800	$\frac{(128)\times 200}{(2{,}048)\times 2{,}560{,}000}$ $=\frac{1}{204{,}800}$ $= 4.88\ \text{E} - 6$	$\frac{(128)\times 1}{(2{,}048)\times \frac{\text{DataLength}}{128\times 8}}$
		204,801 to 307,200	$\frac{(128)\times 200}{(2{,}048)\times 3{,}840{,}000}$ $=\frac{(256)\times 200}{(4{,}096)\times 3{,}840{,}000}$ $=\frac{1}{307{,}200}$ $= 3.26\ \text{E} - 6$	$\frac{(128)\times 1}{(2{,}048)\times \frac{\text{DataLength}}{128\times 8}}$ $=\frac{(512)\times 1}{(8{,}192)\times \frac{\text{DataLength}}{128\times 8}}$

Table 5.1.2-2 Synchronization thresholds when INT is set (Cont'd)

Sync Control	Test Pattern	Data Length	Threshold error rate = $\left[\frac{\text{Error Count}}{\text{Clock Count}}\right]$	
			Sync Gain → Sync Loss	Sync Loss → Sync Gain
Frame ON, Quick (cont'd)	Mixed Data Part, Zero-Substitution Data (cont'd)	307,201 to 409,600	$\frac{(128)\times 200}{(2{,}048)\times 5{,}120{,}000}$ $=\frac{(256)\times 200}{(4{,}096)\times 5{,}120{,}000}$ $=\frac{1}{409{,}600}$ $= 2.44\text{ E}-6$	$\frac{(128)\times 1}{(2{,}048)\times\frac{\text{DataLength}}{128\times 8}}$ $=\frac{(512)\times 1}{(8{,}192)\times\frac{\text{DataLength}}{128\times 8}}$
		409,601 to 524,288	$\frac{(128)\times 200}{(2{,}048)\times 6{,}553{,}600}$ $=\frac{(256)\times 200}{(4{,}096)\times 6{,}553{,}600}$ $=\frac{1}{524{,}288}$ $= 1.91\text{ E}-6$	$\frac{(128)\times 1}{(2{,}048)\times\frac{\text{DataLength}}{128\times 8}}$ $=\frac{(512)\times 1}{(8{,}192)\times\frac{\text{DataLength}}{128\times 8}}$
		524,289 to 1,048,576	$\frac{(128)\times 200}{(2{,}048)\times 13{,}107{,}200}$ $=\frac{(256)\times 200}{(4{,}096)\times 13{,}107{,}200}$ $=\frac{1}{1{,}048{,}576}$ $= 9.54\text{ E}-7$	$\frac{(128)\times 1}{(2{,}048)\times\frac{\text{DataLength}}{128\times 8}}$ $=\frac{(512)\times 1}{(8{,}192)\times\frac{\text{DataLength}}{128\times 8}}$
		1,048,577 to 2,097,152	$\frac{(128)\times 200}{(2{,}048)\times 26{,}214{,}400}$ $=\frac{(256)\times 200}{(4{,}096)\times 26{,}214{,}400}$ $=\frac{1}{2{,}097{,}152}$ $= 4.77\text{ E}-7$	$\frac{(128)\times 1}{(2{,}048)\times\frac{\text{DataLength}}{128\times 8}}$ $=\frac{(512)\times 1}{(8{,}192)\times\frac{\text{DataLength}}{128\times 8}}$
		2,097,153 to 4,194,304	$\frac{(128)\times 200}{(2{,}048)\times 52{,}428{,}800}$ $=\frac{(256)\times 200}{(4{,}096)\times 52{,}428{,}800}$ $=\frac{1}{4{,}194{,}304}$ $= 2.38\text{ E}-7$	$\frac{(128)\times 1}{(2{,}048)\times\frac{\text{DataLength}}{128\times 8}}$ $=\frac{(512)\times 1}{(8{,}192)\times\frac{\text{DataLength}}{128\times 8}}$

Table 5.1.2-2 Synchronization thresholds when INT is set (Cont'd)

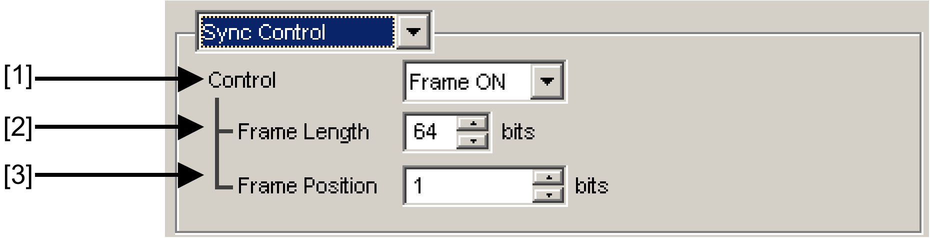
Sync Control	Test Pattern	Data Length	Threshold error rate = $\left[\frac{\text{Error Count}}{\text{Clock Count}}\right]$	
			Sync Gain → Sync Loss	Sync Loss → Sync Gain
Frame ON, Quick (cont'd)	Mixed Data Part, Zero-Substitution Data (cont'd)	4,194,305 to 8,388,608	$\frac{(128)\times 200}{(2{,}048)\times 104{,}857{,}600}$ $=\frac{1}{8{,}388{,}608}$ $= 1.19\text{ E}-7$	$\frac{(128)\times 1}{(2{,}048)\times\frac{\text{DataLength}}{128\times 8}}$
		8,388,609 to 16,777,216	$\frac{(128)\times 200}{(2{,}048)\times 209{,}715{,}200}$ $=\frac{1}{16{,}777{,}216}$ $= 5.96\text{ E}-8$	$\frac{(128)\times 1}{(2{,}048)\times\frac{\text{DataLength}}{128\times 8}}$
		16,777,217 to 33,554,432	$\frac{(128)\times 200}{(2{,}048)\times 419{,}430{,}400}$ $=\frac{1}{33{,}554{,}432}$ $= 2.98\text{ E}-8$	$\frac{(128)\times 1}{(2{,}048)\times\frac{\text{DataLength}}{128\times 8}}$
		33,554,433 to 67,108,864	$\frac{(128)\times 200}{(2{,}048)\times 838{,}860{,}800}$ $=\frac{1}{67{,}108{,}864}$ $= 1.49\text{ E}-8$	$\frac{(128)\times 1}{(2{,}048)\times\frac{\text{DataLength}}{128\times 8}}$
		67,108,865 to 134,217,728	$\frac{(128)\times 200}{(2{,}048)\times 1{,}677{,}721{,}600}$ $=\frac{1}{134{,}217{,}728}$ $= 7.45\text{ E}-9$	$\frac{(128)\times 1}{(2{,}048)\times\frac{\text{DataLength}}{128\times 8}}$
		134,217,729 to 268,435,456	$\frac{(128)\times 200}{(2{,}048)\times 3{,}355{,}443{,}200}$ $=\frac{1}{268{,}435{,}456}$ $= 3.73\text{ E}-9$	$\frac{(128)\times 1}{(2{,}048)\times\frac{\text{DataLength}}{128\times 8}}$

Table 5.1.2-3 Synchronization thresholds when one of E-2 to E-8 is set

Sync Control	**Threshold error rate =** $\left[\frac{\text{Error Count}}{\text{Clock Count}}\right]$	
	Sync Gain → Sync Loss	**Sync Loss → Sync Gain**
E–2	$\frac{(128)\times 2{,}000}{(2{,}048)\times 5{,}000}$ $=\frac{1}{40}$ = 2.5 E – 2	$\frac{(128)}{(2{,}048)\times 4}$ $=\frac{1}{64}$ = 1.56 E – 2
E–3	$\frac{(128)\times 2{,}000}{(2{,}048)\times 50{,}000}$ $=\frac{1}{400}$ = 2.5 E – 3	$\frac{(128)}{(2{,}048)\times 40}$ $=\frac{1}{640}$ = 1.56 E – 3
E–4	$\frac{(128)\times 2{,}000}{(2{,}048)\times 500{,}000}$ $=\frac{1}{4{,}000}$ = 2.5 E – 4	$\frac{(128)}{(2{,}048)\times 400}$ $=\frac{1}{6{,}400}$ = 1.56 E – 4
E–5	$\frac{(128)\times 2{,}000}{(2{,}048)\times 5{,}000{,}000}$ $=\frac{1}{40{,}000}$ = 2.5 E – 5	$\frac{(128)}{(2{,}048)\times 4{,}000}$ $=\frac{1}{64{,}000}$ = 1.56 E – 5
E–6	$\frac{(128)\times 2{,}000}{(2{,}048)\times 50{,}000{,}000}$ $=\frac{1}{400{,}000}$ = 2.5 E – 6	$\frac{(128)}{(2{,}048)\times 40{,}000}$ $=\frac{1}{640{,}000}$ = 1.56 E – 6
E–7	$\frac{(128)\times 2{,}000}{(2{,}048)\times 500{,}000{,}000}$ $=\frac{1}{4{,}000{,}000}$ = 2.5 E – 7	$\frac{(128)}{(2{,}048)\times 400{,}000}$ $=\frac{1}{6{,}400{,}000}$ = 1.56 E – 7
E–8	$\frac{(128)\times 2{,}000}{(2{,}048)\times 5{,}000{,}000{,}000}$ $=\frac{1}{40{,}000{,}000}$ = 2.5 E – 8	$\frac{(128)}{(2{,}048)\times 4{,}000{,}000}$ $=\frac{1}{64{,}000{,}000}$ = 1.56 E – 8

5.1.3 Setting items when Sync Control is selected

This section describes the setting items when Sync Control is selected from the list box in the item setting area (“1” in Figure 5.1-1).



Control: Frame ON

Frame Length: 64 bits

Frame Position: 1 bits

Figure 5.1.3-1 Items when Sync Control is selected

[1] Select the test pattern synchronization method.

Table 5.1.3-1 Sync control setting

Control	Description
Frame ON	Selects the frame synchronization method. This can be selected when the test pattern is Zero-Substitution, Data, or Mixed. Synchronization is established upon frame pattern detection. Synchronization is processed quickly if the length of the pattern is long.
Quick	Selects the quick synchronization method. This can be selected when the test pattern is Zero-Substitution or Data. Error measurement is performed using the pattern that has been saved into the internal memory as the reference pattern.

The test pattern synchronization methods selectable from the Control list box vary depending on the test pattern selected on the **Pattern** tab. Refer to the Table 5.1.3-2.

Table 5.1.3-2 Synchronization method setting

Test Pattern	Description	
	Frame ON	Quick
PRBS	Not available	Not available
Zero-Substitution	Available	Available
Data	Available	Available
Mixed	Available	Not available

[2] Set the frame pattern length when Frame ON is selected from the Control list box. In the Frame Length text box, 4 to 64 can be set in 4-bit steps.

The number of frame bits increases by N times (N ch Combi) when a Channel Combination is set.

Note:

If synchronization is hardly achieved during the combination, set the frame pattern length to 64 bits.

[3] Set the start position of the pattern for frame detection when Frame ON is selected from the **Control** list box. The setting range of Frame Position is shown below:

- In case of Independent:
  1 to {(Length of pattern for frame detection) – (Frame Length + 1)} in 1-bit steps.
- In case of 2ch Combination:
  1 to 1+2n, in 2-bit steps
  Maximum value of n = INT((Length of pattern for frame detection – Frame Length) / 2)
- In case of 4ch Combination:
  1 to 1+4n, in 4-bit steps
  Maximum value of n = INT((Length of pattern for frame detection – Frame Length) / 4)

The length of the pattern for frame detection varies depending on the test pattern selected on the **Pattern** tab. Refer to the table below.

Table 5.1.3-3 Setting of pattern length for frame detection

Test Pattern	Length of pattern for frame detection
Zero-Substitution	Pattern length
Data	Pattern length
Mixed	Pattern length of Row1 of Block1

Note:

When Frame ON is set, synchronization may take a long time if there is another pattern that is the same as the set frame pattern. The frame pattern is therefore recommended to be specific. Pattern Length in this case shall be the value obtained by multiplying Pattern Length setting until it becomes 512 or more if it is 511 or less.

5.1.4 Setting items when Condition is selected

This section describes the setting items when **Condition** is selected from the list box in the item setting area ("1" in Figure 5.1-1).

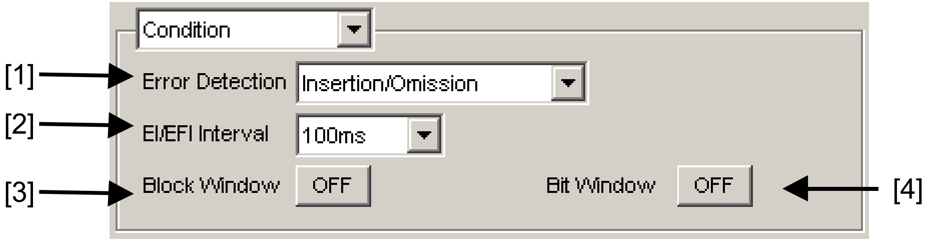

[1]
[2]
[3]
[4]
Condition
Error Detection
Insertion/Omission
EI/EFI Interval
100ms
Block Window
OFF
Bit Window
OFF

Figure 5.1.4-1 Items when Condition is selected

[1] Select the error detection method from the **Error Detection** list box.

Table 5.1.4-1 Error detection method setting

Error Detection	Description
Insertion/Omission	Counts errors where the bit pattern changes between 0 and 1. Insertion error: An error where the bit pattern changes from 0 to 1 Omission error: An error where the bit pattern changes from 1 to 0
Transition/ Non Transition	Counts errors that occur in a transition or non-transition bit. Cannot be selected for Combination.

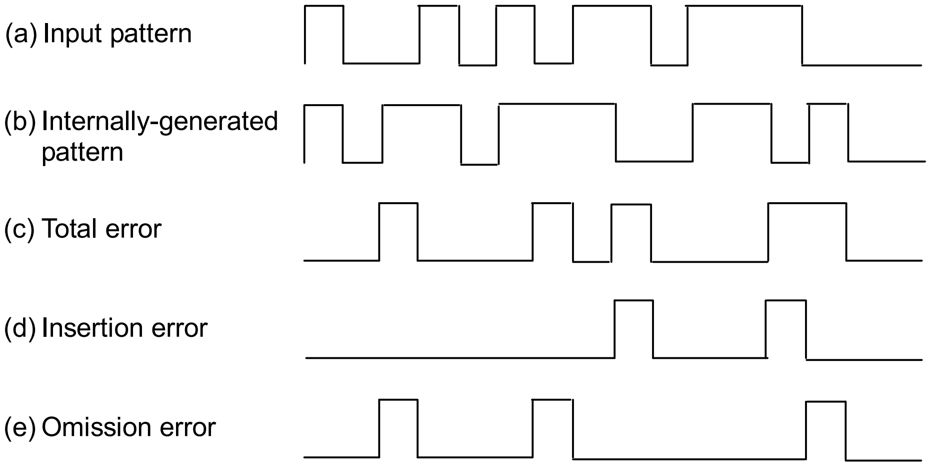

(a) Input pattern
(b) Internally-generated pattern
(c) Total error
(d) Insertion error
(e) Omission error

Figure 5.1.4-2 Error detection (Total, Insertion, and Omission errors)

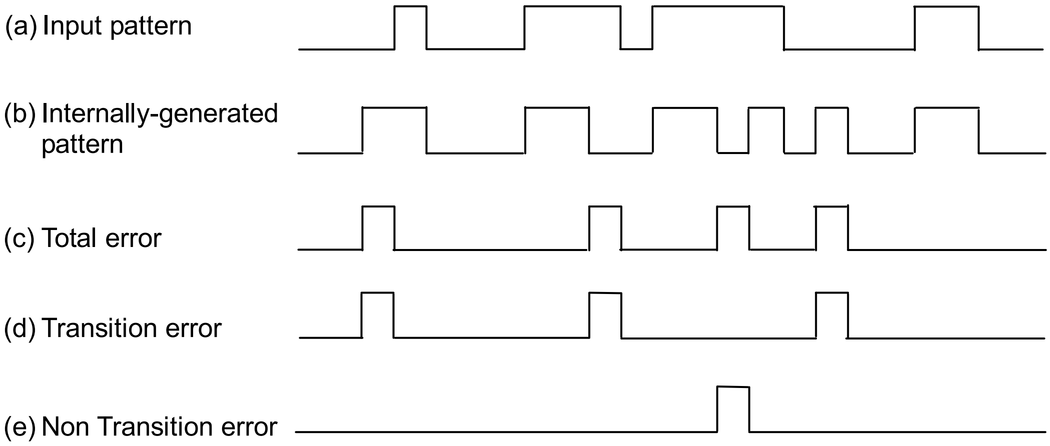

(a) Input pattern
(b) Internally-generated pattern
(c) Total error
(d) Transition error
(e) Non Transition error

Figure 5.1.4-3 Error detection (Total, Insertion, and Omission errors)

[2] Select the interval for error interval and error free interval measurements from the **EI/EFI Interval** list box.

Table 5.1.4-2 Interval time setting

EI-EFI Interval	Description
1 ms	Sets the interval to 1 ms. The interval counter value indicates the number of intervals.
10 ms	Sets the interval to 10 ms. The interval counter value indicates the number of intervals.
100 ms	Sets the interval to 100 ms. The interval counter value indicates the number of intervals.
1 s	“1” is applied if the result of 1-second accumulation of interval counter values is not 0.

[3] Specify whether to enable the Block Window function.
The Block Window function masks errors in the set area by setting a mask area for the patterns occurring internally. Refer to Sections 5.3.6 “Mask selection” and 5.3.7 “Editing test pattern in Pattern Editor dialog box” for details.

Table 5.1.4-3 Block window function setting

Block Window	Description
ON	Enables the Block Window function. Error measurement is masked for bits for which the Block Window setting is set to “1”.
OFF	Disables the Block Window function.

Note that Block Window cannot be set in the following cases:

- When PRBS test pattern or Mixed test pattern is selected
- When capturing has started

[4] Specify whether to enable the Bit Window function. The Bit Window function enables/disables measurement for every 32 bits of the test pattern. Refer to Sections 5.3.6 “Mask selection” and 5.3.7 “Editing test pattern in Pattern Editor dialog box” for details.

Table 5.1.4-4 Bit window function setting

Bit Window	Description
ON	Enables the Bit Window function.
OFF	Disables the Bit Window function.

5.1.5 Setting items when Input is selected

This section describes the setting items when **Input** is selected from the list box in the item setting area (“1” in Figure 5.1-1).

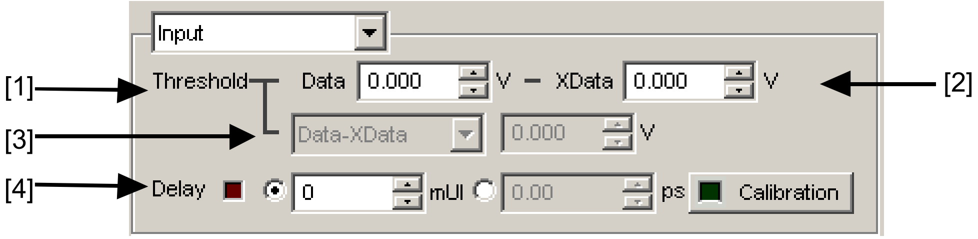

Input
Threshold
Data
0.000
V
XData
0.000
V
Data-XData
0.000
V
Delay
0
mUI
0.00
ps
Calibration
[1]
[2]
[3]
[4]

Figure 5.1.5-1 Items when Input is selected

[1], [2] Set the threshold voltage for Data input and XData input.

The Data signal is input from the Data Input connector of the MU183040A/41A/40B/41B, and the XData signal is input from the $\overline{\text{Data}}$ Input connector. Hereinafter, the settings for the XData Input connector are described as the settings for $\overline{\text{Data}}$.

The threshold voltage can be set within the range from –3.500 to +3.300 V, in 0.001 V steps.

Note, however, that the absolute difference between the threshold values set for Data and XData inputs is limited to 3.000 V or less if **Input Condition** is set to **Differential 50Ohm** or **Differential 100Ohm** on the **Input** tab.

[3] Set the difference between the threshold voltages for Data and XData inputs.
This item is enabled when **Input Condition** is set to **Differential 50Ohm** or **Differential 100Ohm,** and **Alternate** is selected on the **Input** tab.

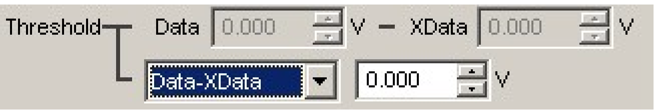

Threshold
Data
0.000
V
XData
0.000
V
Data-XData
0.000
V

Figure 5.1.5-2 Input voltage threshold difference setting items

Select “Data – XData” or “XData - Data”. Set a value within the range from –3.000 to +3.000 V, in 0.001 V steps.

[4] When option-x30 is installed, set the clock phase unit and phase variable.

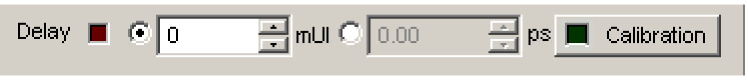


Figure 5.1.5-3 Clock phase setting item

Select the unit from mUI or ps by clicking the radio button

<When mUI is selected>

The setting range is from –1000 to +1000 mUI, in 2 mUI steps

<When ps is selected>

Delay time can be set by ps step that is equivalent to 2 mUI.

The setting range is equivalent to the range when the unit is mUI (–1000 to +1000 mUI), converted into ps units.

Table 5.1.5-1 Clock phase setting (in ps units)

Frequency	Setting range
32.1 GHz	–31.14 to 31.14
25 GHz	–40 to 40
2.4 GHz	–416 to 416

Notes:

- When the frequency or the temperature condition is changed, the LED on the “Calibration” lights, prompting performance of calibration. If calibration is not performed at this time, the error in the phase setting may be greater than at a normal phase setting.

- Values displayed in ps units vary as the frequency changes, because the MU183040A/41A/40B/41B sets phases in mUI units as an internal standard.

5.1.6 Setting items when Error/Alarm is selected

This section describes the items displayed when **Error/Alarm** is selected from the list box in the result display area (“2” in Figure 5.1-1).

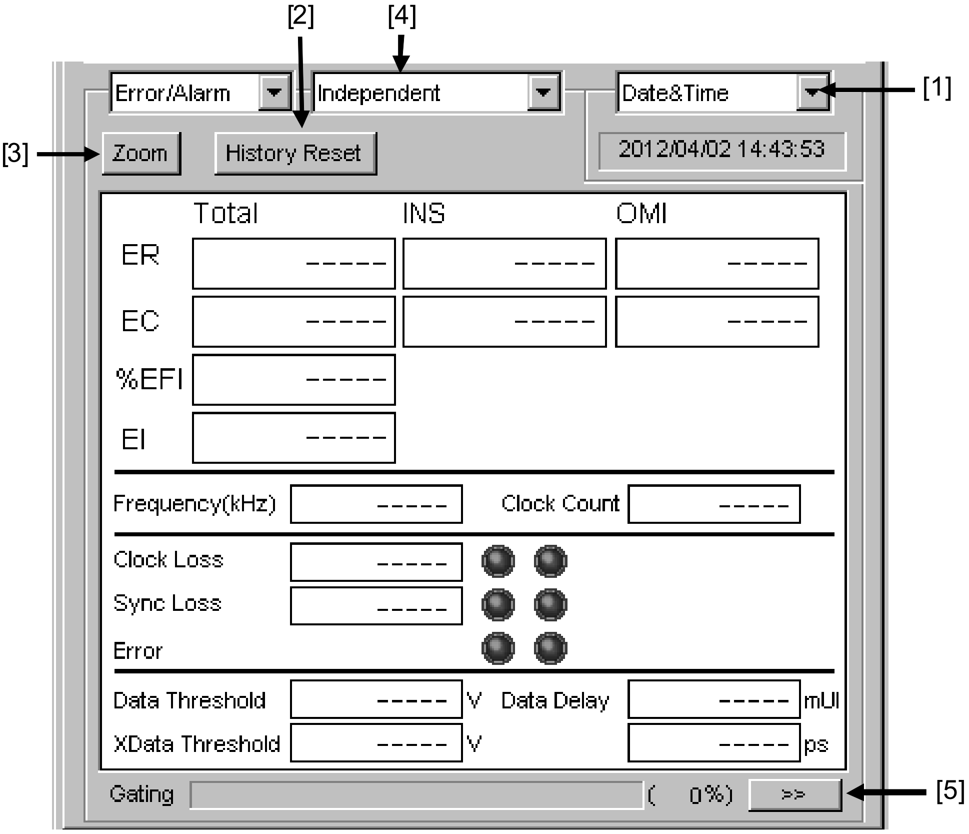

[2]
[4]
[1]
[3]
[5]
Error/Alarm
Independent
Date&Time
Zoom
History Reset
2012/04/02 14:43:53
Total
INS
OMI
ER
EC
%EFI
EI
Frequency(kHz)
Clock Count
Clock Loss
Sync Loss
Error
Data Threshold
V
Data Delay
mUI
XData Threshold
V
ps
Gating
(0%)
>>

Figure 5.1.6-1 Items when Error/Alarm is selected

[1] Select the measurement time display type.

Date&Time: Select to display the current time.

Start Time: Select to display the current measurement start time.

Elapsed Time: Select to display the elapsed time in the measurement period.

Remaining Time: Select to display the remaining time in the measurement period.

[2] Reset Error/Alarm history data.

History Reset: Click to reset the history data of the error/alarm display.

[3] Enable or disable enlarged display of Error/Alarm measurement result.

Zoom:	Click to enlarge the display of the error count, error rate, error interval count, Clock Loss interval count, Sync Loss interval count, Clock Loss occurrence state, Sync Loss occurrence state, and error occurrence state.

When the enlarged display is disabled (Zoom is not selected), the items shown in Table 5.1.6-1 are displayed in the result display area with Error/Alarm selected.

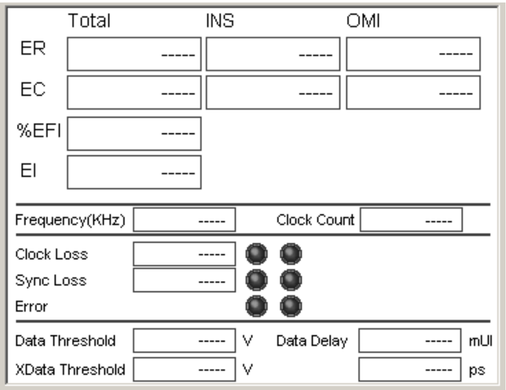
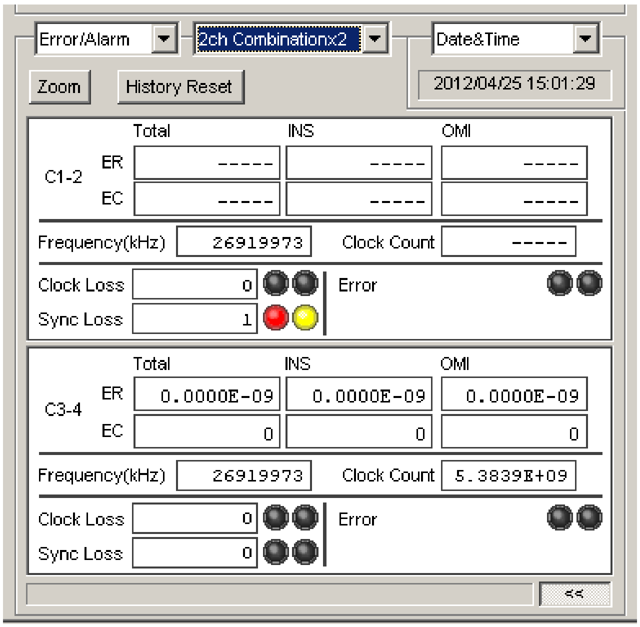

Total
INS
OMI
ER
EC
%EFI
EI
Frequency(KHz)
Clock Count
Clock Loss
Sync Loss
Error
Data Threshold
V
Data Delay
mUI
XData Threshold
V
ps

Figure 5.1.6-2 Items when Zoom is not selected

Total/INS/OMI or Transition/Non Transition is displayed according to the error detection method set in the setting item area when Condition is selected (refer to Section 5.1.4).

Table 5.1.6-1 Items (controls) when Zoom is not selected

Item		Function
ER	Total	Displays the total error rate.
	INS	Displays the insertion error rate.
	OMI	Displays the omission error rate.
	Transition	Displays the transition bit error rate.
	Non Transition	Displays the non-transition bit error rate.
EC	Total	Displays the total error count.
	INS	Displays the insertion error count.
	OMI	Displays the omission error count.
	Transition	Displays the transition bit error count.
	Non Transition	Displays the non-transition bit error count.
%EFI		Displays the error free interval rate.
EI		Displays the number of intervals where an error occurs.
Frequency(kHz)		Displays the frequency.
Clock Count		Displays the clock count.
Clock Loss		Displays the Clock Loss interval count and monitored occurrence state. Lights in red: Current data Lights in yellow: History data
Sync Loss		Displays the Sync Loss interval count and monitored occurrence state. Lights in red: Current data Lights in yellow: History data
Error		Displays the monitored error occurrence state. Lights in red: Current data Lights in yellow: History data
Data Threshold		Displays the Data Threshold voltage when Auto Adjustment is executed.
XData Threshold		Displays the XData Threshold voltage when Auto Adjustment is executed.
Data Delay		Displays the Delay value when Auto Adjustment is executed.



2012/04/25 15:01:29

C1-2

	Total	INS	OMI
ER	-----	-----	-----
EC	-----	-----	-----

Frequency(kHz) 26919973
Clock Count -----
Clock Loss 0
Sync Loss 1
Error

C3-4

	Total	INS	OMI
ER	0.0000E-09	0.0000E-09	0.0000E-09
EC	0	0	0

Frequency(kHz) 26919973
Clock Count 5.3839E+09
Clock Loss 0
Sync Loss 0
Error

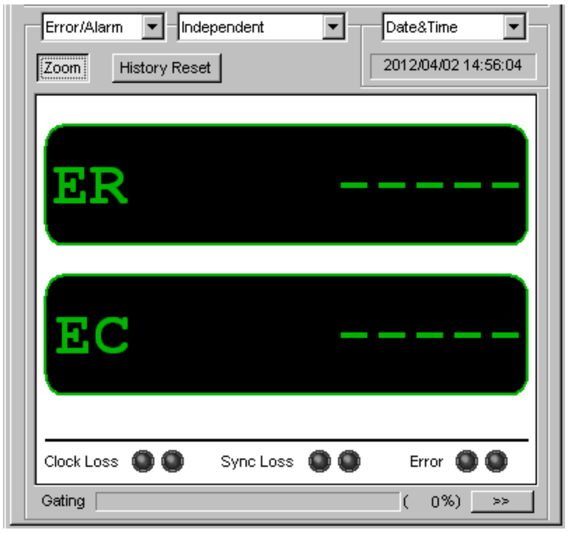
Figure 5.1.6-3 Screen of MU183041A/B at 2ch Combination

Table 5.1.6-2 Control configuration of MU183041A/B at 2ch Combination

Item		Function
C1-2 / C3-4* ER	Total	Displays the total error rate.
	INS	Displays the insertion error rate.
	OMI	Displays the omission error rate.
	Transition	Displays the transition bit error rate.
	Non Transition	Displays the non-transition bit error rate.
C1-2 / C3-4* EC	Total	Displays the total error count.
	INS	Displays the insertion error count.
	OMI	Displays the omission error count.
	Transition	Displays the transition bit error count.
	Non Transition	Displays the non-transition bit error count.
C1-2 / C3-4* Frequency(kHz)		Displays the frequency.
C1-2 / C3-4* Clock Count		Displays the clock count.
C1-2 / C3-4* Clock Loss		Displays the Clock Loss interval count and monitored occurrence state. Lights in red: Current data Lights in yellow: History data
C1-2 / C3-4* Sync Loss		Displays the Sync Loss interval count and monitored occurrence state. Lights in red: Current data Lights in yellow: History data
C1-2 / C3-4* Error		Displays the monitored error occurrence state. Lights in red: Current data Lights in yellow: History data

*: C1-2 means Combination of Data1 and Data2.
Similarly, C3-4 means Combination of Data3 and Data4.

When the enlarged display is enabled (Zoom is selected), the items shown in Table 5.1.6-3 are displayed in the result display area with Error/Alarm selected.


Error/Alarm
Independent
Date&Time
Zoom
History Reset
2012/04/02 14:56:04
ER

EC

Clock Loss
Sync Loss
Error
Gating
(0%)
>>

Figure 5.1.6-4　Items when Zoom is selected

Table 5.1.6-3　Items (controls) when Zoom is selected

Item	Function
ER	Displays the error rate.
EC	Displays the error count.
Clock Loss	Displays the Clock Loss interval count and monitored occurrence state. Lights in red: Current data Lights in yellow: History data
Sync Loss	Displays the Sync Loss interval count and monitored occurrence state. Lights in red: Current data Lights in yellow: History data
Error	Displays the monitored error occurrence state. Lights in red: Current data Lights in yellow: History data

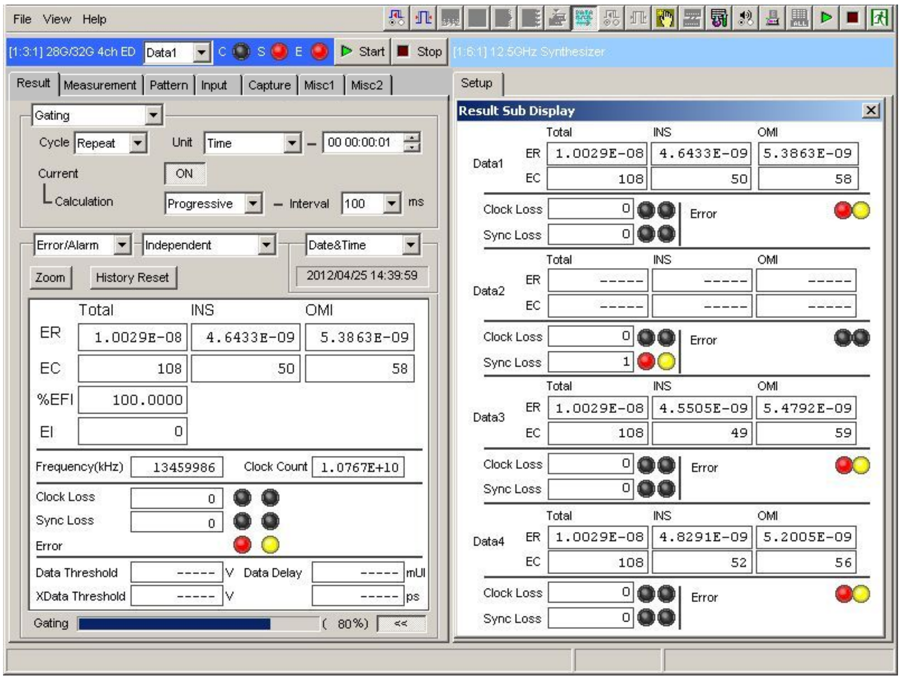
[4]　Combination display

Select Combination condition of result display.

[5] Showing/hiding Error/Alarm measurement result sub-window
Click to show/hide the measurement result sub-window (Result Sub Display window). The Result Sub Display window contains the items shown in Table 5.1.6-4.

Table 5.1.6-4 Items in Result Sub Display window

Item		Function
ER	Total	Displays the total error rate.
	INS	Displays the insertion error rate.
	OMI	Displays the omission error rate.
	Transition	Displays the transition bit error rate.
	Non Transition	Displays the non-transition bit error rate.
EC	Total	Displays the total error count.
	INS	Displays the insertion error count.
	OMI	Displays the omission error count.
	Transition	Displays the transition bit error count.
	Non Transition	Displays the non-transition bit error count.
Clock Loss		Displays the Clock Loss interval count and monitored occurrence state. Lights in red: Current data Lights in yellow: History data
Sync Loss		Displays the Sync Loss interval count and monitored occurrence state. Lights in red: Current data Lights in yellow: History data
Error		Displays the monitored error occurrence state. Lights in red: Current data Lights in yellow: History data



Gating
Cycle Repeat Unit Time 00 00:00:01
Current ON
Calculation Progressive Interval 100 ms
Error/Alarm Independent Date&Time
2012/04/25 14:39:59

	Total	INS	OMI
ER	1.0029E-08	4.6433E-09	5.3863E-09
EC	108	50	58
%EFI	100.0000		
EI	0		

Frequency(kHz) 13459986 Clock Count 1.0767E+10
Clock Loss 0
Sync Loss 0
Error
Data Threshold ----- V Data Delay ----- mUI
XData Threshold ----- V ----- ps
Gating (80%) <<

		Total	INS	OMI
Data1	ER	1.0029E-08	4.6433E-09	5.3863E-09
	EC	108	50	58
	Clock Loss	0		
	Sync Loss	0		
Data2	ER	-----	-----	-----
	EC	-----	-----	-----
	Clock Loss	0		
	Sync Loss	1		
Data3	ER	1.0029E-08	4.5505E-09	5.4792E-09
	EC	108	49	59
	Clock Loss	0		
	Sync Loss	0		
Data4	ER	1.0029E-08	4.8291E-09	5.2005E-09
	EC	108	52	56
	Clock Loss	0		
	Sync Loss	0		

Figure 5.1.6-5 Result Sub Display window (4ch Combination)

5.1.7 When inputting jitter-modulated signals

- When executing jitter tolerance test, etc. by inputting jitter-modulated clock, set **Jitter Input** of Delay to **ON** to avoid malfunction of Delay caused by excess jitter modulation. (Refer to Figure 5.1.7-1.) When using the MU181000A/B (with Option 001 Jitter Modulation) or MU181500B, set **Jitter Input** of Delay to **ON**, and then set **Jitter Modulation** of the MU181000A/B or MU181500B to **ON**.
- When executing Calibration of Delay, set jitter modulation of input signal to non-modulation.

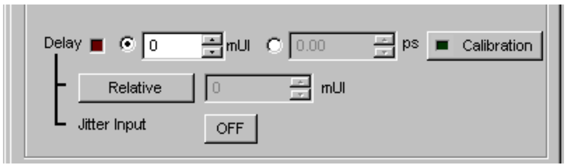


Figure 5.1.7-1 Clock delay setting items

Notes:

- When jitter-modulated clock is input while **Jitter Input** of Delay is set to **OFF**, the phase may become unstable.

- The Delay lamp may light up when a jitter-modulated clock signal is input. In addition, phase setting error may increase.

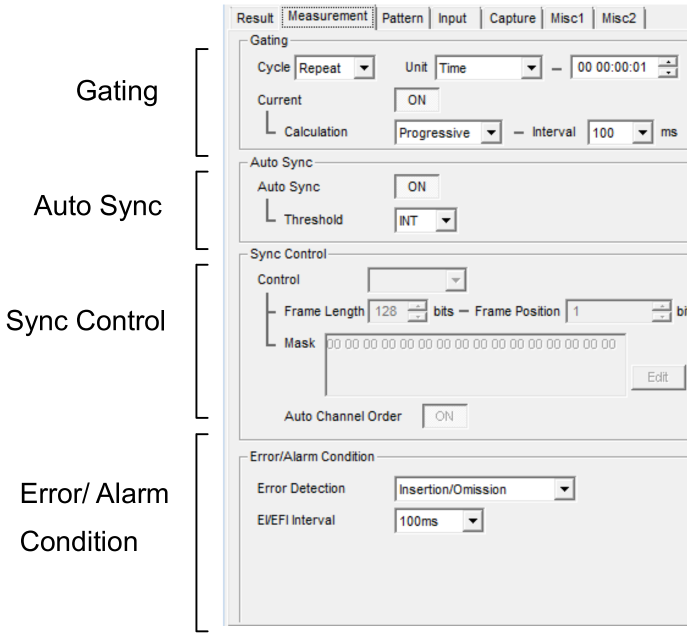
- The Delay function has feedback process to improve its setting accuracy at default setting (**Jitter Input** is set to **OFF**.). However, if **Jitter Input** is set to **ON**, the setting accuracy is lowered because the feedback process is stopped.

Jitter Input	Use
ON	Jitter Tolerance Measurement BER measurement when jitter amount applied to clock signal is big. (Delay is unstable when **Jitter Input** is **OFF**.)
OFF	Phase margin measurement Eye Margin measurement, Eye Diagram measurement, Bathtub measurement

5.2 Setting Measurement Conditions

On the **Measurement** tab of the module operation window, you can set the measurement conditions.

The **Measurement** tab consists of four setting and displaying areas. Figure 5.2-1 and Table 5.2-1 show the configuration of the **Measurement** tab.



Gating
Cycle Repeat
Unit Time
00 00:00:01
Current ON
Calculation Progressive
Interval 100 ms

Auto Sync
Auto Sync ON
Threshold INT

Sync Control
Control
Frame Length 128 bits
Frame Position 1
Mask 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Auto Channel Order ON

Error/Alarm Condition
Error Detection Insertion/Omission
EI/EFI Interval 100ms

Figure 5.2-1 Measurement tab

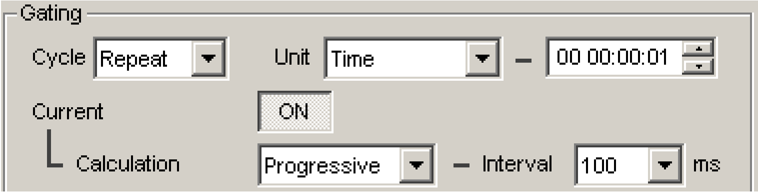
Table 5.2-1 Setting/displaying areas of Measurement tab

Area	Description
Gating	Contains items for configuring the settings related to the measurement period.
Auto Sync	Contains items for configuring the settings related to the automatic synchronization establishment function.
Sync Control	Contains items for configuring the settings related to the synchronization establishment method.
Error/Alarm Condition	Contains items for configuring the settings related to the measurement method.

Although similar settings can be configured on the **Result** tab, more detailed settings are possible from the Sync Control and Error/Alarm areas on the **Measurement** tab.

5.2.1　Gating area

The setting operations in the Gating area are the same as those in the setting item area of the **Result** tab when **Gating** is selected. Refer to Section 5.1.1 “Setting items when Gating is selected” for details.

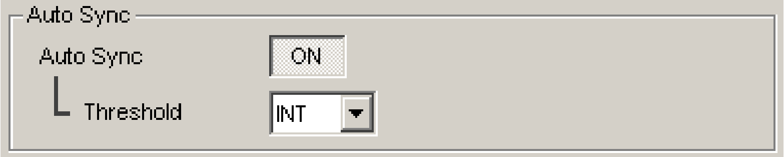


Gating
Cycle: Repeat
Unit: Time – 00 00:00:01
Current: ON
Calculation: Progressive – Interval: 100 ms

Figure 5.2.1-1　Measurement period setting items in Gating area

5.2.2　Auto Sync area

The setting operations in the Auto Sync area are the same as those in the setting item area of the **Result** tab when **Auto Sync** is selected. Refer to Section 5.1.2 “Setting items when Auto Sync is selected” for details.

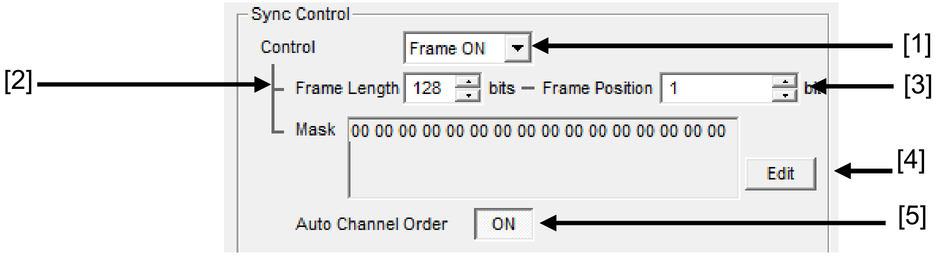


Auto Sync
Auto Sync: ON
Threshold: INT

Figure 5.2.2-1　Measurement period setting items in Gating area

5.2.3　Sync Control area

In the Sync Control area, the setting operations for the test pattern synchronization method, frame length, and start position of the pattern for frame detection are the same as those in the setting item area of the **Result** tab when **Sync Control** is selected.



Sync Control
Control: Frame ON
Frame Length: 128 bits – Frame Position: 1 bit
Mask: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
Auto Channel Order: ON

Figure 5.2.3-1　Synchronization establishment method setting items in Sync Control area

[1]　Select the test pattern synchronization method.

[2]　Set the frame pattern length. (Available when **Frame ON** is selected from the **Control** list box.)

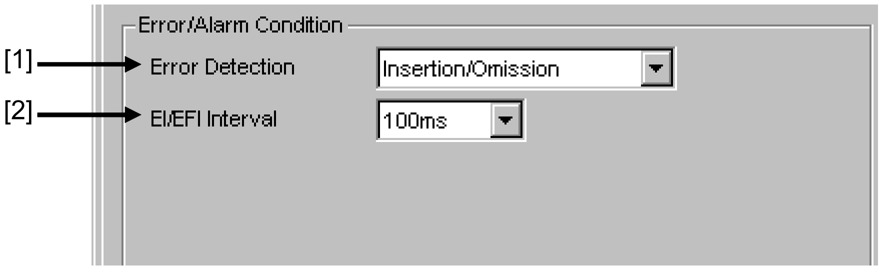
[3] Set the start position of the pattern for frame detection. (Available when **Frame ON** is selected from the **Control** list box.) Refer to Section 5.1.3 "Setting items when Sync Control is selected" for details.

[4] Edit the mask pattern.
(Available when **Frame ON** is selected from the **Control** list box.)

[5] Turn On or Off automatic change of channel order.
Turn it Off when using PAM4 Decoder.

5.2.4 Error/Alarm Condition area

In the Error/Alarm Condition area, the setting operations for the error detection method, error interval, and error free interval are the same as those in the setting item area of the **Result** tab when **Condition** is selected.



Error Detection: Insertion/Omission

EI/EFI Interval: 100ms

Figure 5.2.4-1 Measurement condition setting items in Error/Alarm area

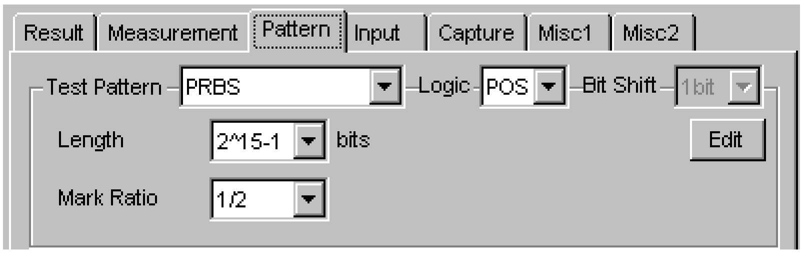
[1] Select the error detection method. Refer to Section 5.1.4"Setting items when Condition is selected" for details.

[2] Select the error interval and error free interval. Refer to Section 5.1.4 "Setting items when Condition is selected" for details.

5.3 Setting Test Patterns

On the **Pattern** tab of the module operation window, you can select and set a test pattern.

The **Pattern** tab consists of two item setting and displaying areas.


Result
Measurement
Pattern
Input
Capture
Misc1
Misc2
Edit

Test Pattern: PRBS
Logic: POS
Bit Shift: 1bit
Length: 2^15-1 bits
Mark Ratio: 1/2

Figure 5.3-1 Pattern tab

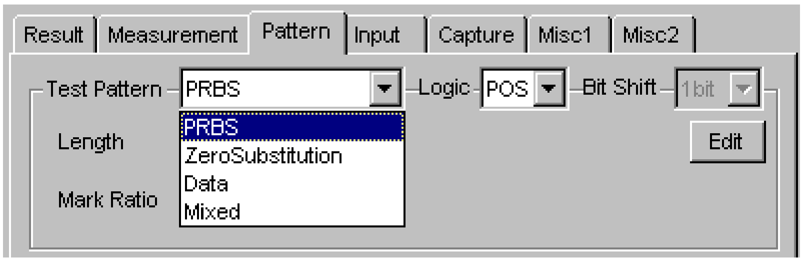
Table 5.3-1 Setting/displaying areas in Pattern tab

Area	Description
Test Pattern	Select a test pattern. The setting items vary depending on the selected test pattern.
Mask	Contains items for setting Block Window, Bit Window, and External Mask.

5.3.1 Test Pattern type

The following four test patterns can be selected.

- PRBS
- Zero-Substitution
- Data
- Mixed


Result
Measurement
Pattern
Input
Capture
Misc1
Misc2
Length
Mark Ratio
PRBS
ZeroSubstitution
Data
Mixed
Edit

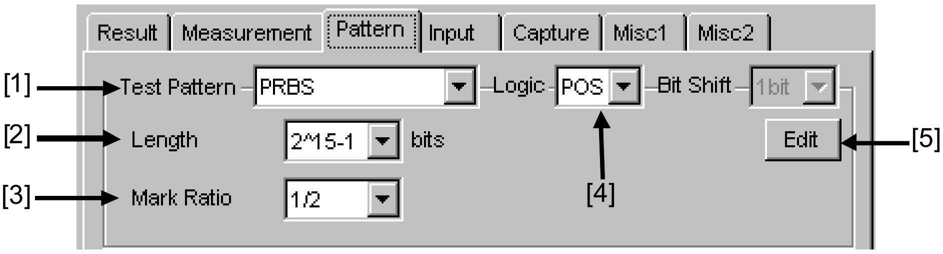
Test Pattern: PRBS
Logic: POS
Bit Shift: 1bit

Figure 5.3.1-1 Selecting test pattern

How to set each test pattern is described in the subsequent sections.

5.3.2 Setting PRBS pattern

This section describes how to set the parameters for a PRBS pattern.



Test Pattern PRBS
Logic POS
Bit Shift 1bit
Length 2^15-1 bits
Mark Ratio 1/2

Figure 5.3.2-1 Test Pattern (PRBS) setting items

[1] Select **PRBS** from the Test Pattern list box.

[2] Set the number of the PRBS pattern stages.

Set the PRBS pattern length in the format of $2^n - 1$ (n = 7, 9, 10, 11, 15, 20, 23, 31).

For the PRBS pattern generation principle, refer to Appendix A "Pseudo-Random Pattern".

[3] Set the mark ratio.

The selectable mark ratios vary depending on the logic setting (PRBS Logic).
When Logic is set to POS, 1/2 is selected.
When Logic is set to NEG, 1/2inv is selected.

[4] Set the logic of the test pattern.

Table 5.3.2-1 Test pattern logic setting

Logic	Description
POS (positive logic)	The high level of a signal is defined as "0" for the PRBS pattern.
NEG (negative logic)	The high level of a signal is defined as "1" for the PRBS pattern.

[5] Set Bit Window Data.

Clicking **Edit** opens the **Bit Window Setup** dialog box, in which the Bit Window Data can be edited. The Bit Windows is a function used to mask measurement for arbitrary route(s) of 32 routes.

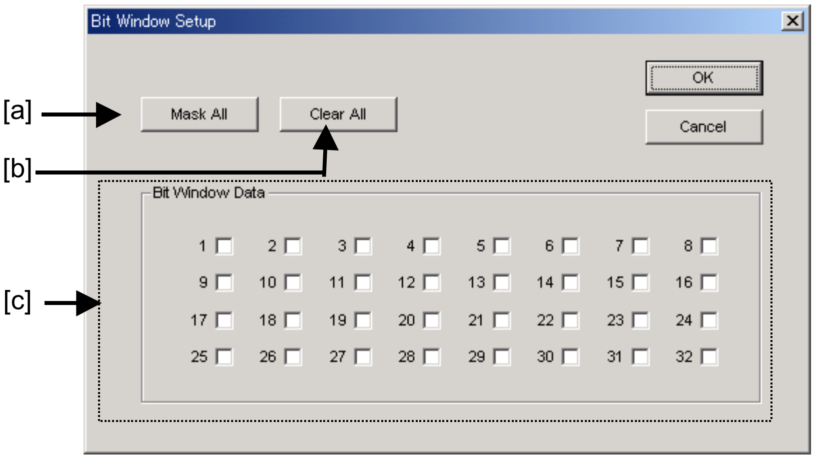

[a]
[b]
[c]
Bit Window Setup
Mask All
Clear All
OK
Cancel
Bit Window Data
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐
9 ☐ 10 ☐ 11 ☐ 12 ☐ 13 ☐ 14 ☐ 15 ☐ 16 ☐
17 ☐ 18 ☐ 19 ☐ 20 ☐ 21 ☐ 22 ☐ 23 ☐ 24 ☐
25 ☐ 26 ☐ 27 ☐ 28 ☐ 29 ☐ 30 ☐ 31 ☐ 32 ☐

Figure 5.3.2-2 Bit Window Setup dialog box

The functions of the controls in the **Bit Window Setup** dialog box are as follows.

[a] **Mask All**: Masks all 32 routes of the Bit Window Data.

[b] **Clear All**: Unmasks all 32 routes of the Bit Window Data.

[c] The MU183040A/41A/40B/41B has 32 internal error counters. Select the check box(es) of the route(s) you want to mask.

Note:

Refer to Section 5.3.6 "Mask selection" for details on selection in the **Bit Window Setup** dialog box.

5.3.3 Setting Zero-Substitution

This section describes how to set the parameters for a Zero-Substitution pattern.

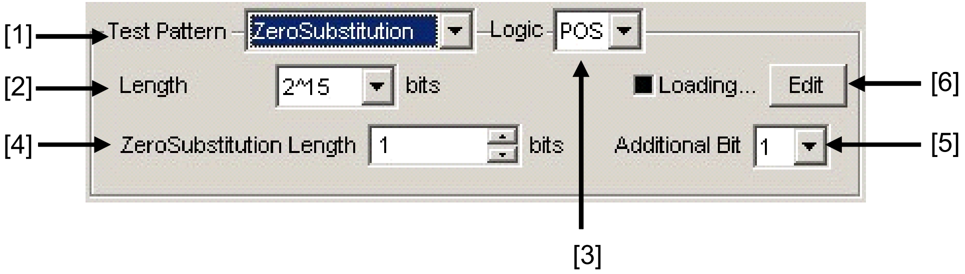


Figure 5.3.3-1 Setting items for Zero-Substitution pattern

[1] Select **ZeroSubstitution** from the **Test Pattern** list box. Test pattern loading starts and the "Loading..." LED lights.

[2] Set the configuration (number of stages) of the zero-insertion pattern signal.

Select either of the following test pattern signals.
2^n (n = 7, 9, 10, 11, 15, 20, or 23)
[Compatible with the existing models]
$2^n - 1$ (n = 7, 9, 10, 11, 15, 20, or 23) [Pure PRBS signal]

[3] Set the logic of the test pattern.

Table 5.3.3-1 Test pattern logic setting

Logic	Description
POS (positive logic)	The high level of a signal is defined as "1" for the Zero-substitution pattern.
NEG (negative logic)	The high level of a signal is defined as "0" for the Zero-substitution pattern.

[4] Set the number of 0-insertion (substitution) bits in the zero-insertion (substitution) pattern.

The number of available 0-insertion bits varies depending on the pattern test signal selected from the **Length** list box ([2] in Figure 5.3.3-1) as follows.

(a) When $2^n - 1$ is set for Length: 1 to $2^n - 2$, in 1-bit steps

(b) When 2^n is set for Length: 1 to $2^n - 1$, in 1-bit steps

[5] Set the final bit of the zero-insertion pattern.
Note that this setting is invalid when Length is set to $2^n - 1$.

Table 5.3.3-2 Setting of last bit of zero-insertion pattern

Setting	Description
1	The 2^nth bit is set to “1” (compatible with the existing models).
0	The 2^nth bit is set to “0”.

[6] Edit the Block Window and Bit Window.
Refer to Section 5.3.7 “Editing test pattern in Pattern Editor dialog box” for details on how to set a pattern in the Pattern Editor dialog box.

Note:

It may take a long time to load a test pattern when the data length is long. Refer to Section 5.3.6 “Mask selection” for selection of Block Window and Bit Window.

5.3.4 Setting Data pattern

This section describes how to set the parameters for a Data pattern.

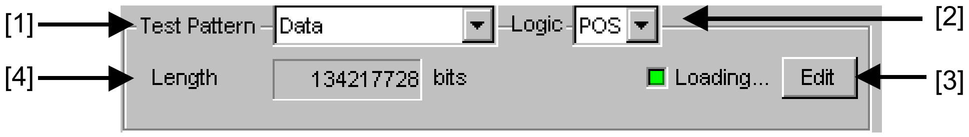


Figure 5.3.4-1 Setting items for Test pattern (Data)

[1] Select **Data** from the **Test Pattern** list box. Test pattern loading starts and the "Loading…" LED lights.

[2] Set the logic of the test pattern.

Table 5.3.4-1 Test pattern logic setting

Setting	Description
POS (positive logic)	The high level of a signal is defined as "1".
NEG (negative logic)	The high level of a signal is defined as "0".

[3] Edit the test pattern.
Click **Edit** to open the **Pattern Editor** dialog box in which test patterns can be edited.
When editing of a test pattern is finished, click **OK** to close the **Pattern Editor** dialog box. The edited test pattern is then loaded to the hardware. The "Loading…" LED lights during Data pattern loading. Refer to Section 5.3.7 "Editing test pattern in Pattern Editor dialog box" for details on how to edit test patterns in the **Pattern Editor** dialog box.

[4] The length of the test pattern data currently set is displayed.

Note:

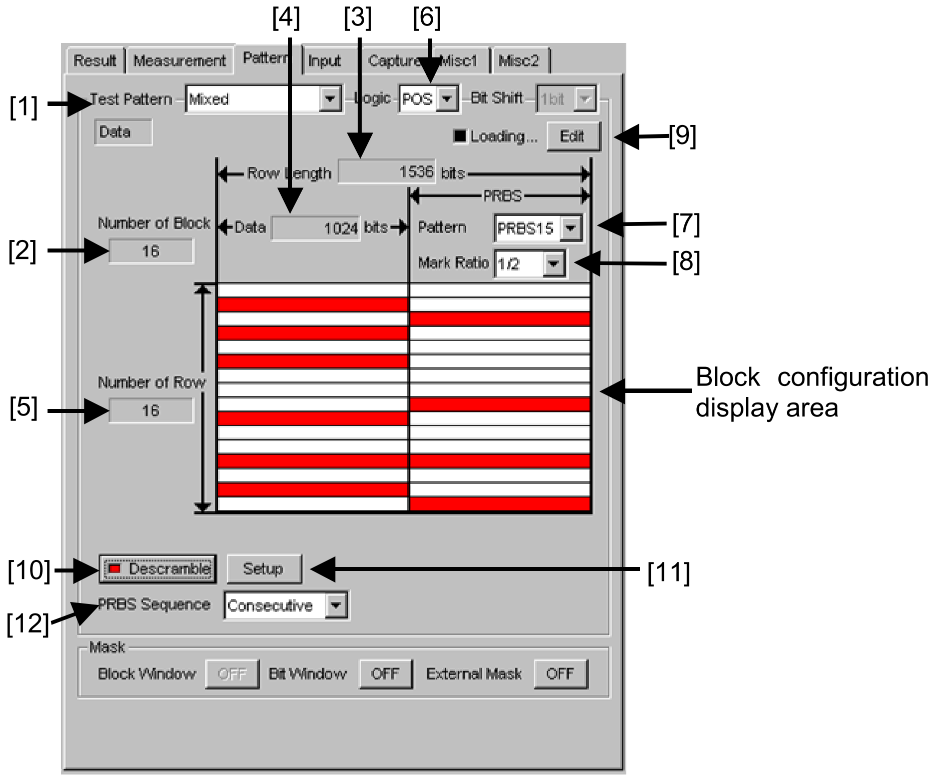
It may take a long time to load a test pattern when the data length is long. Refer to Section 5.3.6 "Mark selection" for selection of Block Window and Bit Window.

Refer to the following reference loading time values, for the cases where the data length is set to maximum. These values are only references and do not guarantee the Loading time.

Maximum loading time for 1ch: About 3 min.
Maximum loading time for 2ch: About 6 min.
Maximum loading time for 4ch: About 12 min.

5.3.5 Setting Mixed pattern

When "Mixed" is selected, a block consisting of programmable test patterns and PRBS patterns can be set.


[4]
[3]
[6]
Result
Measurement
Pattern
Input
Capture
Misc1
Misc2
[1]
[9]
[7]
[8]
[2]
Block configuration display area
[5]
[10]
[11]
[12]
Edit
Setup
PRBS

Test Pattern: Mixed
Logic: POS
Bit Shift: 1bit
Data
■ Loading...
Row Length: 1536 bits
Data: 1024 bits
Pattern: PRBS15
Mark Ratio: 1/2
Number of Block: 16
Number of Row: 16
Descramble
PRBS Sequence: Consecutive
Mask
Block Window: OFF
Bit Window: OFF
External Mask: OFF

Figure 5.3.5-1　Setting items for Mixed pattern

[1]　Select **Mixed** from the **Test Pattern** list box.

[2]　Displays the number of all blocks.
The number of blocks in the pattern data edited in the **Pattern Editor** dialog box is displayed.

[3]　Displays Row Length.
The length of 1 row of the pattern data edited in the **Pattern Editor** dialog box is displayed.

[4]　Displays Data Length.
The length of the Data pattern edited in the **Pattern Editor** dialog box is displayed.

[5]　Displays Number of Row.
The number of rows per block of the pattern data edited in the **Pattern Editor** dialog box is displayed.

[6] Set the logic of the test pattern.

Table 5.3.5-1 Test pattern logic setting

Setting	Description
POS (positive logic)	The high level of a signal is defined as “1”.
NEG (negative logic)	The high level of a signal is defined as “0”.

[7] Set the number of the PRBS pattern stages.

Set the PRBS pattern length in the format of $2^n - 1$ (n = 7, 9, 10, 11, 15, 20, 23, 31).

[8] Select the mark ratio.

The selectable mark ratios vary depending on the logic setting (PRBS Logic).
When **Logic** is set to **POS**, 1/2 is selected.
When **Logic** is set to **NEG**, 1/2inv is selected.

[9] Edit the test pattern.
Click **Edit** to open the **Pattern Editor** dialog box in which test patterns can be edited.
When editing of a test pattern is finished, click **OK** to close the **Pattern Editor** dialog box. The edited test pattern is then loaded to the hardware. The “Loading…” LED lights during test pattern loading. Refer to Section 5.3.7 “Editing test pattern in Pattern Editor dialog box” for details on how to edit test patterns in the **Pattern Editor** dialog box.

Note:

It may take a long time to load a test pattern when the data length is long. Refer to Section 5.3.6 “Mask selection” for selection of Block Window and Bit Window.

Refer to the following reference loading time values, for the cases where the data length is set to maximum. These values are only references and do not guarantee the Loading time.

Maximum loading time for 1ch: About 3 min.
Maximum loading time for 2ch: About 6 min.
Maximum loading time for 4ch: About 12 min.

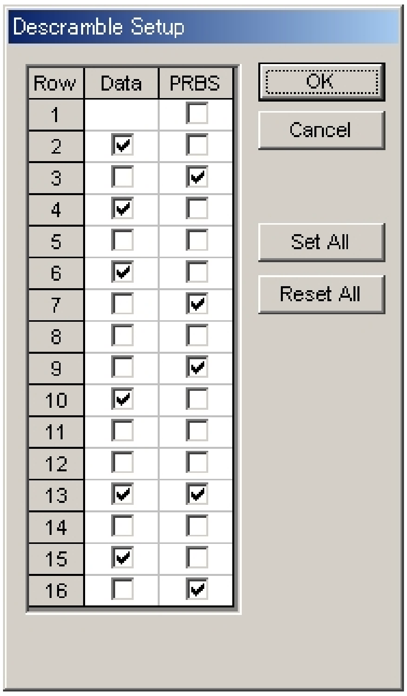
[10] Set Descramble ON/OFF.

When Descramble is set to ON, descramble is executed for the part that is set to be PRBS7-scrambled, according to the settings in the **Descramble Setup** dialog box (refer to [12] below). When **Descramble** is clicked while the LED on the button is off, the LED lights and the scramble setting for the specified reception signals is cancelled (descramble). The descramble area is displayed red in the block configuration display area.

When **Descramble** is clicked while the LED on the button is on, the LED goes off and descramble for the reception signals is stopped.

[11] Configure the descramble settings.

Clicking **Setup** opens the **Descramble Setup** dialog box. Select the check box for the target area for descramble. After selecting the target area(s), click **OK**.



Row	Data	PRBS
1		☐
2	☑	☐
3	☐	☑
4	☑	☐
5	☐	☐
6	☑	☐
7	☐	☑
8	☐	☐
9	☐	☑
10	☑	☐
11	☐	☐
12	☐	☐
13	☑	☑
14	☐	☐
15	☑	☐
16	☐	☑

Figure 5.3.5-2 Descramble Setup dialog box

Note:

Descramble cannot be set for the data area of the first row in each block.

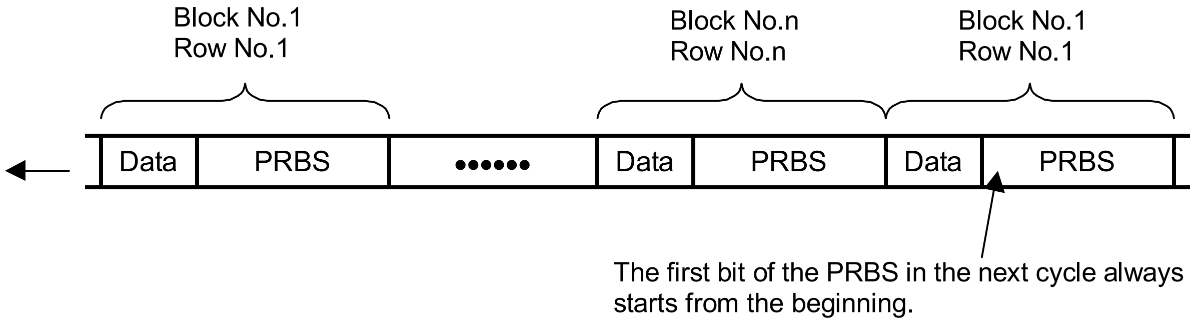
[12] Set the PRBS signal generation method.

Set the continuity of the PRBS pattern strings in a Mixed pattern.

Table 5.3.5-2 PRBS signal generation method setting

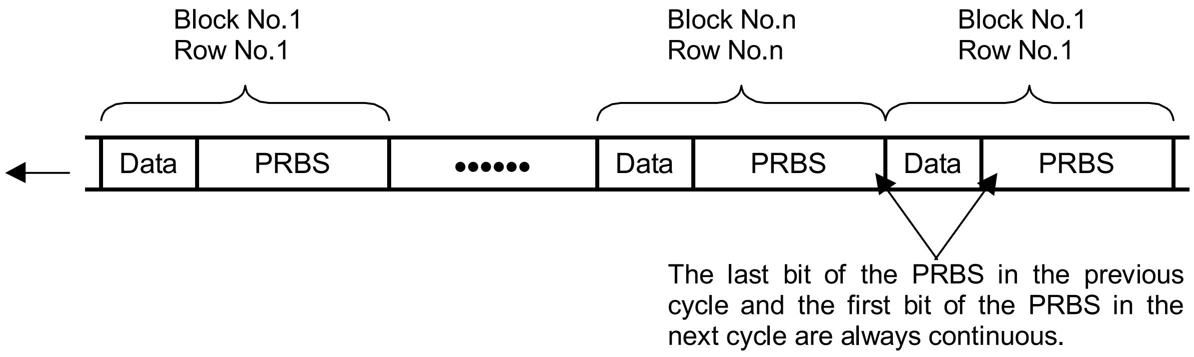
Setting	Description
Restart	The end of the PRBS of the specified last block and the start of the PRBS of the next subsequent block are not continuous.
Consecutive	The end of the PRBS of the specified last block and the start of the PRBS of the next subsequent block are continuous.

(a) When Restart is selected


Block No.1
Row No.1
Block No.n
Row No.n
Block No.1
Row No.1
Data
PRBS
••••••
Data
PRBS
Data
PRBS

The first bit of the PRBS in the next cycle always starts from the beginning.

(b) When Consecutive is selected


Block No.1
Row No.1
Block No.n
Row No.n
Block No.1
Row No.1
Data
PRBS
••••••
Data
PRBS
Data
PRBS

The last bit of the PRBS in the previous cycle and the first bit of the PRBS in the next cycle are always continuous.

Figure 5.3.5-3 Continuity of PRBS pattern strings

5.3.6 Mask selection

This section describes the controls in the mask area, which are used to mask a route and bit for the test pattern. The mask positions can be set in the **Pattern Editor** dialog box.

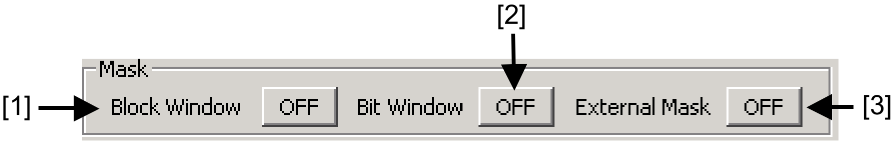


Figure 5.3.6-1 Controls in Mask area

[1] Enables (ON) or disables (OFF) the Block Window function.
The Block Window function specifies whether to enable or disable measurement (measurement mask) for each bit of the test pattern to be received. The mask positions can be set in the **Pattern Editor** dialog box.

Table 5.3.6-1 Block Window ON/OFF setting

Block Window	Description
ON	Enables the Block Window function.
OFF	Disables the Block Window function.

Note that the following restrictions apply:

- The Block Window cannot be executed when the test pattern is PRBS or Mixed.

In Block Window function, the bit which 1 bit of Block Window takes charge of with pattern length changes as follows.

N is number of Combination. At the time of Combination, Pattern Length and Step increase N times.

Pattern Length setting			Block Window step
2*N	to	2,097,152*N bits	1*N bits
2,097,153*N	to	4,194,304*N bits	2*N bits
4,194,305*N	to	8,388,608*N bits	4*N bits
8,388,609*N	to	16,777,216*N bits	8*N bits
16,777,217*N	to	33,554,432*N bits	16*N bits
33,554,433*N	to	67,108,864*N bits	32*N bits
67,108,864*N	to	134,217,728*N bits	64*N bits
134,217,729*N	to	268,435,456*N bits	128*N bits

Example:

When Control is 2ch Combination and Pattern length is 4,194,300 bits, the Block Window Step is set to 2 bits

[2] Enables (ON) or disables (OFF) the Bit Window function.
While test pattern measurement is usually performed using 32 error counters, the Bit Window function can mask measurement of the specified counter (route).
The following figure shows an example where the test pattern is a 32-bit length Data pattern and the error counters 2 and 4 are masked.

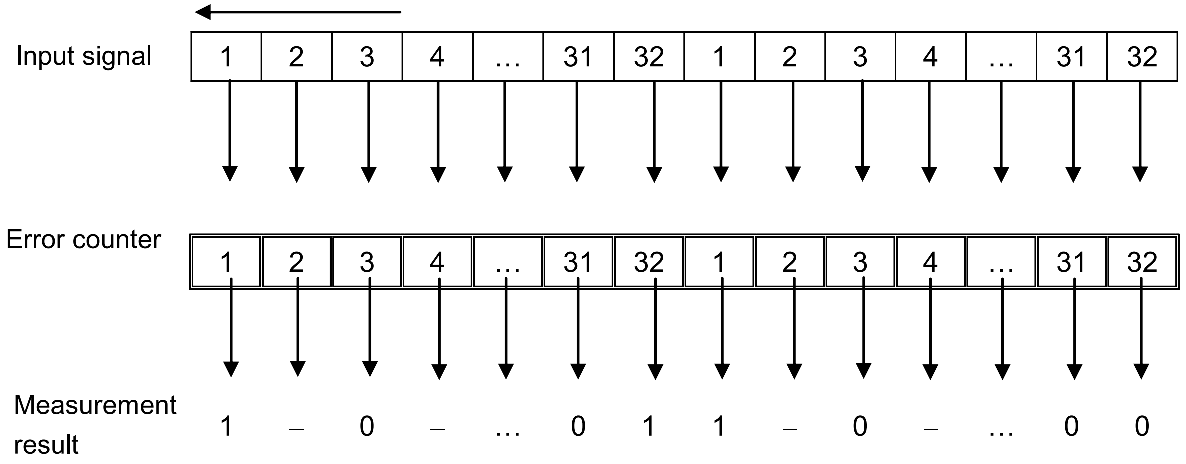


Figure 5.3.6-2 Bit Window Function

In this example, even if an error is detected by the masked counter 2 or 4, it is not included in the measurement result.

The mask position can be set in the **Pattern Editor** dialog box.

Table 5.3.6-2 Bit Window ON/OFF setting

Bit Window	Description
ON	Enables the Bit Window function.
OFF	Disables the Bit Window function.

[3] Enables (ON) or disables (OFF) the External Mask signal.

This control is available only when **External Mask** is selected from the **AUX Input** list box on the **Misc1** tab.

Table 5.3.6-3 External Mask ON/OFF setting

External Mask	Description
ON	Enables the External Mask signal.
OFF	Disables the External Mask signal.

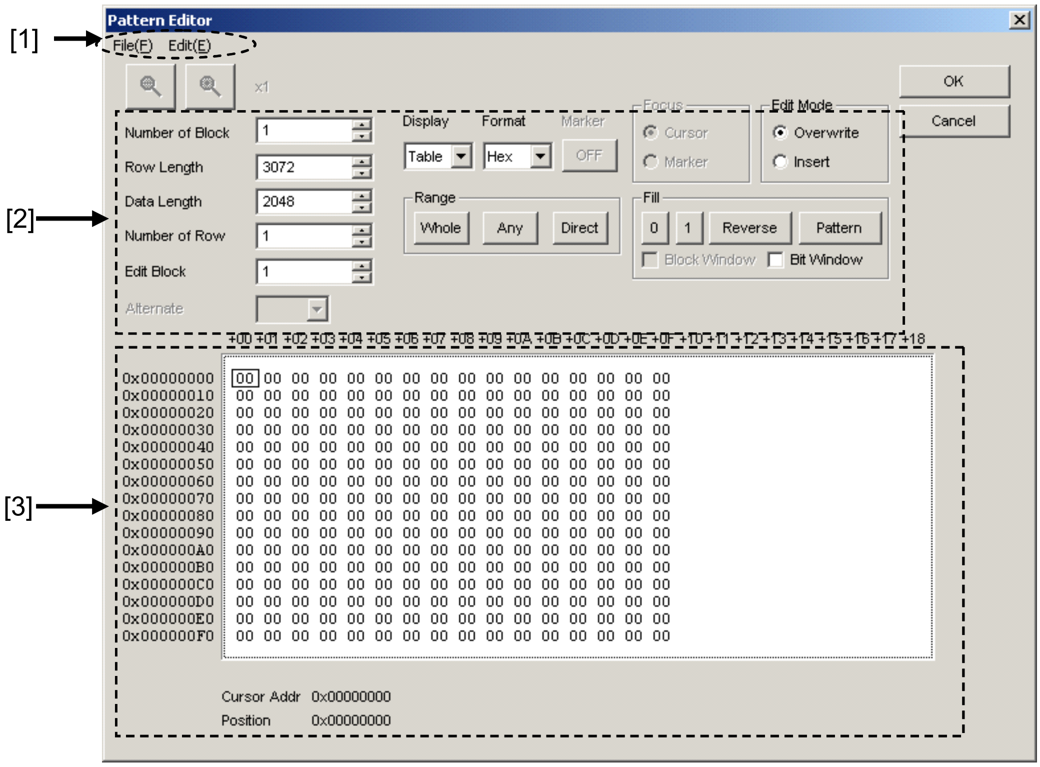
5.3.7 Editing test pattern in Pattern Editor dialog box

Editing of test patterns with the following patterns selected on the **Pattern** tab is described below.

- Zero-Substitution
- Data
- Mixed

5.3.7.1 Common setting items

The **Pattern Editor** dialog box is displayed when **Edit** is clicked.



Number of Block 1
Row Length 3072
Data Length 2048
Number of Row 1
Edit Block 1
Alternate
Display Table
Format Hex
Marker OFF
○ Cursor
○ Marker
● Overwrite
○ Insert
☐ Block Window
☐ Bit Window

```
           +00 +01 +02 +03 +04 +05 +06 +07 +08 +09 +0A +0B +0C +0D +0E +0F +10 +11 +12 +13 +14 +15 +16 +17 +18
0x00000000  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0x00000010  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0x00000020  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0x00000030  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0x00000040  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0x00000050  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0x00000060  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0x00000070  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0x00000080  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0x00000090  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0x000000A0  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0x000000B0  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0x000000C0  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0x000000D0  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0x000000E0  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0x000000F0  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
```

Cursor Addr 0x00000000
Position 0x00000000

Figure 5.3.7.1-1 Pattern Editor dialog box

[1] Menu items on menu bar

Table 5.3.7.1-1 Menu bar configuration

Menu	Menu item	Description
File	Open	Opens a setting file saved in the binary pattern (Binary Pattern), binary text pattern (BIN Text Pattern), or hexadecimal text pattern (HEX Text Pattern) format. Refer to 5.3.7.10 "Compatibility with test pattern files of existing models".
	Save	Saves a setting file in the binary pattern (Binary Pattern), binary text pattern (BIN Text Pattern), or hexadecimal text pattern (HEX Text Pattern) format. *
	ScreenCopy	Prints a screen image. When configuring the print settings, select **Screen Copy** → **Setup** from the **File** menu on the MX180000A menu bar.
Edit	Undo	Cancels the previous operation and restores the previous state.
	Cut	Overwrite: Cuts the pattern selected in the Pattern View area and transfers it onto the clipboard. The area that has been cut out becomes 0. Insert: Cuts the selected pattern with its address domain. After cutting, zero pattern with the same amount of the cut domain is added instead at the end of pattern length.
	Copy	Copies the pattern selected in the Pattern View area into the internal memory.
	Paste	Pastes the pattern copied in the internal memory to the cursor position.
	Jump	Moves the cursor to a specified address or pattern.
	Head	Moves the cursor to the start of the editing pattern.
	Tail	Moves the cursor to the end of the editing pattern.
	Marker	Moves the cursor to a position specified by the marker when set to ON.
	Address	Opens the **Input Address** dialog box. The cursor can be moved to the specified address position.
	Pattern	Opens the **Input Pattern** dialog box. Specifies a pattern string to search by binary digits, and a pattern to be masked by an "x". If a pattern matching the search condition is found in the editing pattern, the cursor moves to that position. Both forward search and backward search are supported. The search pattern can be specified in the Input Pattern window. Click **Set All** to set all the bits to "1", and click **Reset ALL** to set all the bits to "0". Click **ALL X** to set all the bits to "Don't care". Select the search direction by clicking **Forward** or **Backward**, and then click **OK**.
	Forward Next	Searches for a pattern that matches the search pattern set in the **Input Pattern** dialog box in the forward direction. If a matching pattern is found, the cursor moves to that position.

*: The settings will not be read from the saved file if the file name is changed.

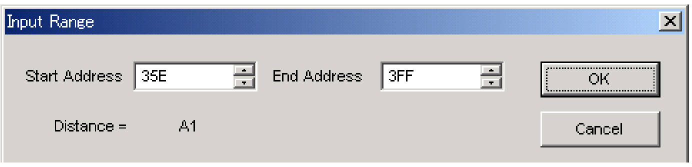
[2] Pattern setting items

Table 5.3.7.1-2 Pattern setting items

Setting item	Description
Zoom 🔍 🔍	The waveform displayed in the Pattern View area can be enlarged or reduced by changing Zoom. The selectable scale is 1/8, 1/4, 1/2, 1, 2, 4, and 8. This is enabled only when **Display** is set to **Time** and **Format** is set to **Wave** .
Display	Select the display format in the Patter View area from “Time” or “Table”. Time: The Pattern View area is displayed based on the time axis. Table: The Pattern View area is displayed in a tabular format.
Format	Specify the pattern display format in the Pattern View area. When **Display** is set to **Time**, **Wave** or **Bit** can be selected. Wave: The pattern is displayed by a waveform. Bit: The pattern is displayed by a bit string. Refer to Section 5.3.7.6 “Editing in Time display mode” for details. When **Display** is set to **Table**, **Bin** or **Hex** can be selected. Bin: Binary Hex: Hexadecimal Refer to Section 5.3.7.7 “Editing in Table display mode” for details.
Marker	Places a marker in the Pattern View area. This button is available when **Display** is set to **Time**.
Focus	This is available when **Marker** is set to **ON**. Select whether to activate a marker or cursor in the Pattern View area.
Edit Mode	Specify the pattern editing method from “Overwrite” or “Insert”. This must be specified in advance when executing **Paste** from the **Edit** menu or when performing direct editing in the Pattern View area (except for the Fill setting area). Overwrite: The selected pattern is overwritten. Insert: The editing pattern is inserted into the position of the selected pattern. Note that Data Length is not changed when Insert is selected. The inserted pattern therefore exceeds the Data Length value, and becomes invalid.
Range	Specify the pattern editing range from **Whole**, **Any** or **Direct**. **Whole**: Selects the whole editing patterns. **Any**: Displays the **Input Range** dialog box (refer to Figure 5.3.7.1-2), where you can specify the editing range by an address. **Direct**: Selects an arbitrary area by specifying addresses. Use the cursor to specify addresses. Refer to Section 5.3.7.8 “Editing area” for details.

Table 5.3.7.1-2 Pattern setting items (Cont’d)

Setting item	Description
Fill	Edits the pattern part selected by the cursor. 0: The highlighted part in the Pattern View area is set to “0”. 1: The highlighted part in the Pattern View area is set to “1”. Reverse: The highlighted part in the Pattern View area is logically inverted. Pattern: The **Input Pattern** dialog box (refer to Figure 5.3.7.1-3) is displayed. The highlighted part in the Pattern View area can be edited in this dialog box. Length: Specify the number of edit bits from the start address of the highlighted part. Repeat: The edited pattern for which the highlighted address is set to the first is repeated for the number of times specified here. Set All: Sets all the bits selected by Length to “1”. Reset All: Sets all the bits selected by Length to “0”. Block Window: This check box is available when **Display** is set to **Table**. Select this check box, select a desired position in the **Pattern View** area, and then click **1** to mask the selected position or click **0** to unmask it. Bit Window: This check box is available when **Display** is set to **Table**. Select this check box, select a desired position in the **Pattern View** area, and then click **1** to mask the selected position or click **0** to unmask it. ***Note:*** When the synchronization method (**Control**) is set to **Frame ON**, masking a pattern frame position results in a synchronization loss.



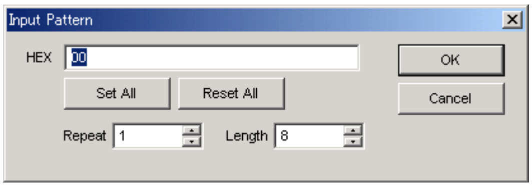
Input Range

Start Address 35E

End Address 3FF

Distance = A1

Figure 5.3.7.1-2 Input Range dialog box



Input Pattern

HEX 00

Repeat 1

Length 8

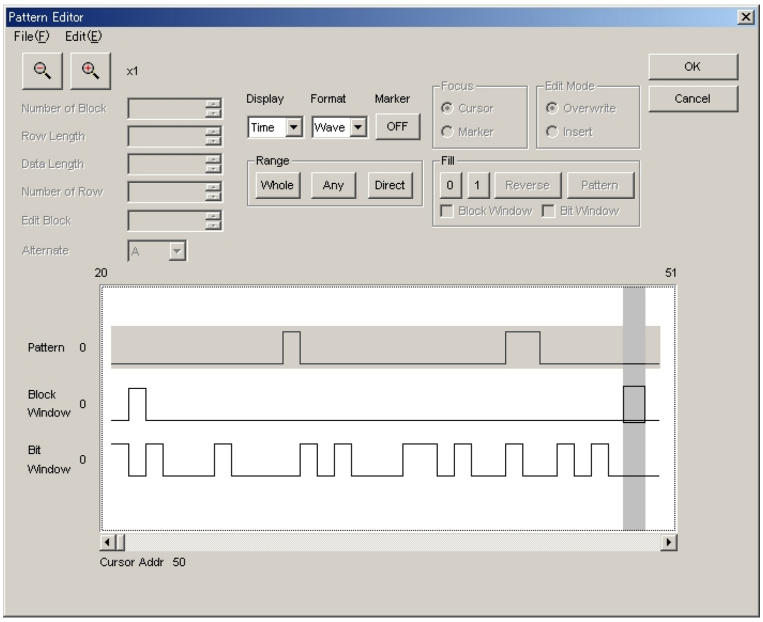
Figure 5.3.7.1-3 Input Pattern dialog box

[3] Pattern View area

The edited pattern is displayed in this area. Double-click a bit value on the pattern to edit it. Note, however, that the pattern cannot be edited by a mouse operation when **Display** is set to **Table** and **Format** is set to **Hex**.

5.3.7.2 Editing Zero-Substitution pattern

When **Edit** is clicked while **ZeroSubstitution** is selected for the test pattern, the **Pattern Editor** dialog box shown in Figure 5.3.7.2-1 is displayed. Note, however, that only **Block Window** and **Bit Window** can be edited, and Data Length and other settings cannot be configured.



Pattern Editor

x1

Display: Time

Format: Wave

Marker: OFF

Focus: ● Cursor ○ Marker

Edit Mode: ● Overwrite ○ Insert

☐ Block Window ☐ Bit Window

Alternate: A

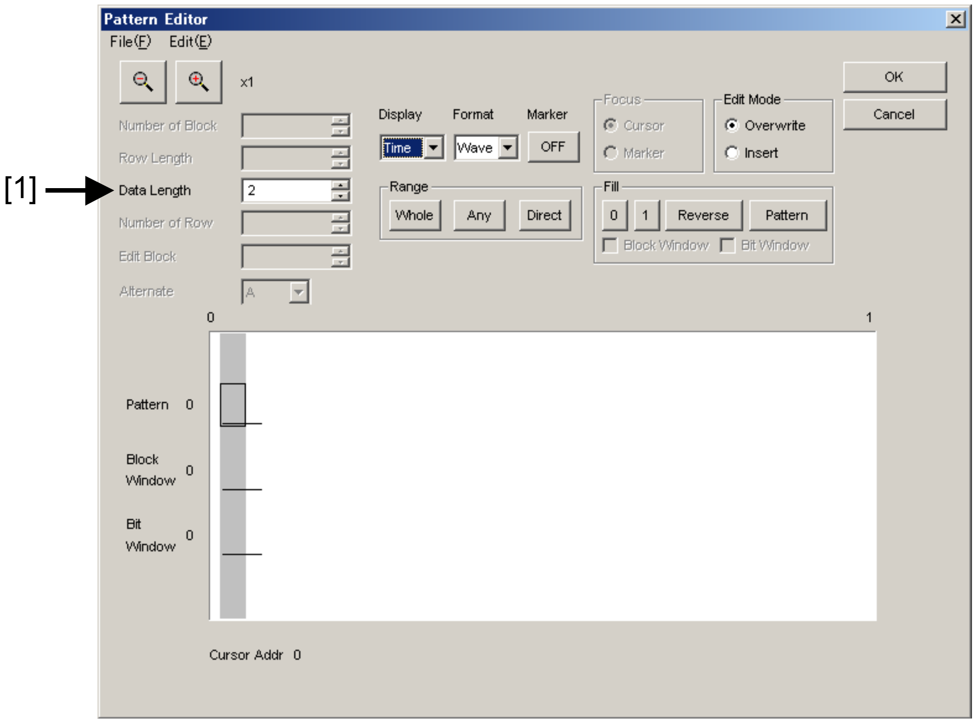
Cursor Addr 50

File(F)
Edit(E)
OK
Cancel
Number of Block
Row Length
Data Length
Number of Row
Edit Block
Range
Whole
Any
Direct
Fill
0
1
Reverse
Pattern
20
51
Pattern 0
Block Window 0
Bit Window 0

Figure 5.3.7.2-1 Pattern Editor dialog box for Zero-Substitution pattern

5.3.7.3 Editing Data pattern

When **Edit** is clicked while **Data** is selected for the test pattern, the **Pattern Editor** dialog box shown in Figure 5.3.7.3-1 is displayed.


[1]
Pattern Editor
File(F)
Edit(E)
x1
OK
Cancel
Number of Block
Row Length
Number of Row
Edit Block
Alternate
A
Display
Format
Marker
Focus
○ Cursor
○ Marker
Range
Whole
Any
Direct
Fill
0
1
Reverse
Pattern
☐ Block Window
☐ Bit Window
Edit Mode
○ Insert
0
1
Pattern 0
Block Window 0
Bit Window 0

Data Length 2

Display Time

Format Wave

Marker OFF

Edit Mode ● Overwrite

Cursor Addr 0

Figure 5.3.7.3-1 Pattern Editor dialog box for Data pattern

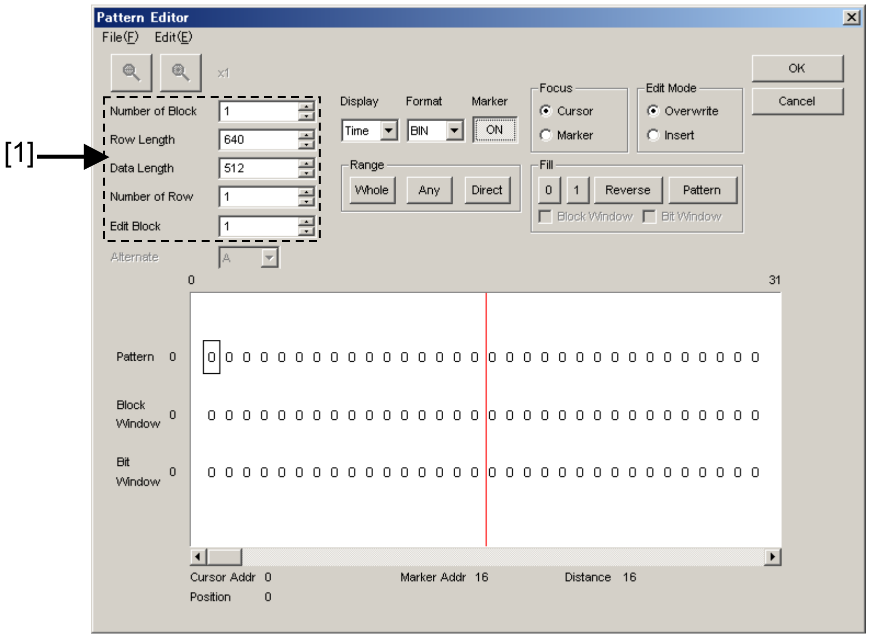
[1] Pattern setting item

Table 5.3.7.3-1 Pattern setting items (when Data is selected)

Setting item	Description
Data Length	Set the length of the Data pattern. The setting unit is one bit. 2 to 268 435 456 bits can be set, in 1-bit steps. In the case of 2ch Combination, 4 to 536 870 912 bits can be set, in 2-bit steps. In the case of 4ch Combination, 8 to 1 073 741 824 bits can be set, in 4-bit steps.

5.3.7.4 Editing Mixed pattern

When **Edit** is clicked while **Mixed** is selected for the test pattern, the **Pattern Editor** dialog box shown in Figure 5.3.7.4-1 is displayed.


[1]
Pattern Editor
File(F)
Edit(E)
x1
OK
Cancel
Alternate
A
Range
Whole
Any
Direct
Fill
0
1
Reverse
Pattern
☐ Block Window
☐ Bit Window
0
31
Pattern 0
Block Window 0
Bit Window 0

Number of Block 1
Row Length 640
Data Length 512
Number of Row 1
Edit Block 1
Display Time
Format BIN
Marker ON
Focus ● Cursor ○ Marker
Edit Mode ● Overwrite ○ Insert
Cursor Addr 0
Position 0
Marker Addr 16
Distance 16

Figure 5.3.7.4-1 Pattern Editor dialog box for mixed pattern

[1] Pattern setting items

Table 5.3.7.4-1 Pattern setting items (when Mixed is selected)

Setting item	Description
Number of Block	Set the number of blocks, from 1 to 511 in 1-block steps.
Row Length	Set the row length, from 1 536 to 2 415 919 104 bits in 256-bit steps. In the case of 2ch Combination, set from 3 072 to 4 831 838 208 bits in 512-bit steps. In the case of 4ch Combination, set from 6 144 to 9 663 676 416 bits in 1024-bit steps.
Data Length	Set the length of the Mixed pattern. 1 024 to 268 453 456 bits can be set in 1-bit steps. In the case of 2ch Combination, set from 2 048 to 536 870 912 bits in 2-bit steps. In the case of 4ch Combination, set from 4 096 to 1 073 741 824 bits in 4-bit steps.
Number of Row	Set the number of rows, from 1 to 16 in 1-row steps.
Edit Block	Specify the number of block to be edited.

Note:

The number of blocks and the number of rows are restricted as follows.

- Number of blocks
  1 to the smallest number among a to d, below, in 1-block steps

  a) 511

  b) INT (128 Mbits × x/(Number of rows × Data Length’))
  where Data Length’ is:
  - When Data Length is indivisible by (128 × x)
    =(INT(Data Length/(128 × x)) +1) × 128 × x
  - When Data Length is divisible by (128 × x)
    = Data Length

  The maximum number of blocks fulfilling the following formula applies:
  Data Length’ × Number of rows × Number of blocks ≤ 128 Mbits

  c) INT((128 Mbits +2^{31}) × x/(Row Length × Number of rows))
  where x is:
  1 for Independent
  2 for 2ch Combination
  4 for 4ch Combination

  d) (Row Length – Data Length) × Number of blocks ≥2^31(2147483648)

- Number of Rows
  1 to the smallest number among a to c, below, in 1-row steps

  a) 16

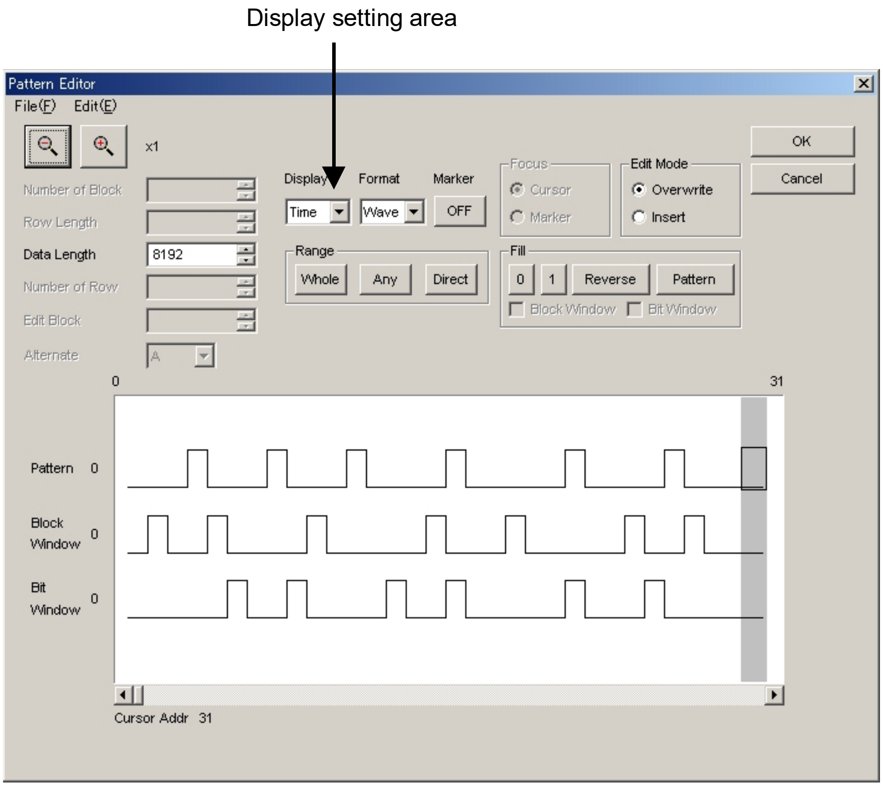
  b) INT(128 Mbit × x/Data Length’)
  where Data Length’ is:
  - When Data Length is indivisible by (128 × x)
    =(INT(Data Length/(128 × x))+1)× 128 × x
  - When Data Length is divisible by (128 × x)
    = Data Length

  The maximum number of rows fulfilling the following formula applies:
  Data Length’ × Number of rows × Number of blocks ≤ 128 Mbits

  c) INT((128 Mbits +2^{31})× x/Row Length)
  where x is;
  1 for Independent
  2 for 2ch Combination
  4 for 4ch Combination

5.3.7.5 Creating and editing test pattern

How to create and edit a test pattern in the **Pattern Editor** dialog box is described below.


Display setting area
Pattern Editor
File(F)
Edit(E)
x1
OK
Cancel
Display
Format
Marker
Focus
Edit Mode
Range
Whole
Any
Direct
Fill
0
1
Reverse
Pattern
0
31
Pattern 0
Block Window 0
Bit Window 0

Number of Block
Row Length
Data Length 8192
Number of Row
Edit Block
Alternate A
Display: Time
Format: Wave
Marker: OFF
Focus: ● Cursor ○ Marker
Edit Mode: ● Overwrite ○ Insert
☐ Block Window ☐ Bit Window
Cursor Addr 31

Figure 5.3.7.5-1 Pattern Editor dialog box

1. Select the Pattern View area display format from the **Display** list box.

Table 5.3.7.5-1 Selection in Display setting area

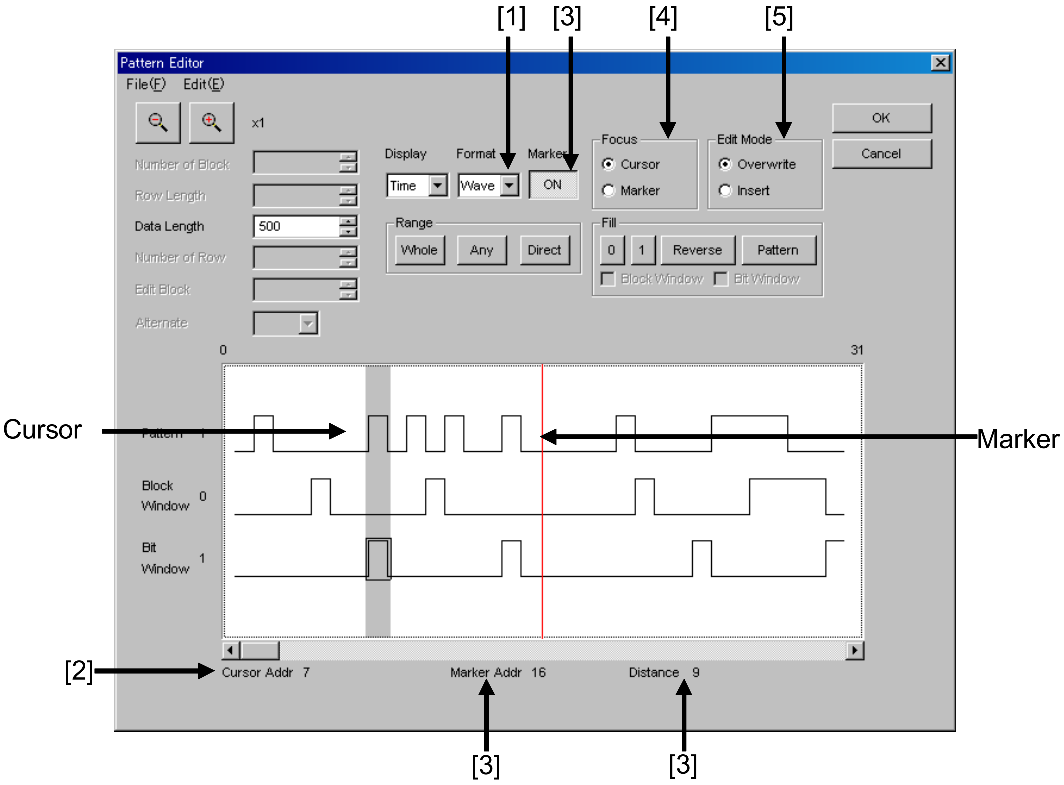
Setting item	Description
Time	The test pattern is displayed in a line with the horizontal time axis. The test pattern is displayed and can be edited with a waveform image or in binary.
Table	The test pattern is displayed with a memory dump image. The test pattern is displayed and can be edited in binary or hexadecimal format.

2. For how to edit a test pattern in the **Pattern Editor** dialog box, refer to the corresponding section according to the display mode, as follows:

When Time is selected:	Refer to Section 5.3.7.6 “Editing in Time display mode”.
When Table is selected:	Refer to Section 5.3.7.7 “Editing in Table display mode”.

5.3.7.6 Editing in Time display mode

How to create and edit a test pattern in the Time display mode is described below.



Data Length 500

Display Time

Format Wave

Marker ON

Focus: ● Cursor ○ Marker

Edit Mode: ● Overwrite ○ Insert

Cursor Addr 7

Marker Addr 16

Distance 9

[1]
[3]
[4]
[5]
Pattern Editor
File(F)
Edit(E)
x1
Number of Block
Row Length
Number of Row
Edit Block
Alternate
Range
Whole
Any
Direct
Fill
0
1
Reverse
Pattern
☐ Block Window
☐ Bit Window
OK
Cancel
0
31
Cursor
Pattern 1
Block Window 0
Bit Window 1
Marker
[2]
[3]
[3]

Figure 5.3.7.6-1 Editing in Time display mode

[1] Select the display format from the Format list box in the **Pattern Editor** dialog box.

Table 5.3.7.6-1 Display format settings

Setting item	Description
Wave	A test pattern is displayed and edited with a waveform image. The waveform image can be enlarged and reduced using the **Zoom In** and **Zoom Out** buttons.
Bin	A test pattern is displayed and edited in binary.

[2] The address of the cursor is displayed in.

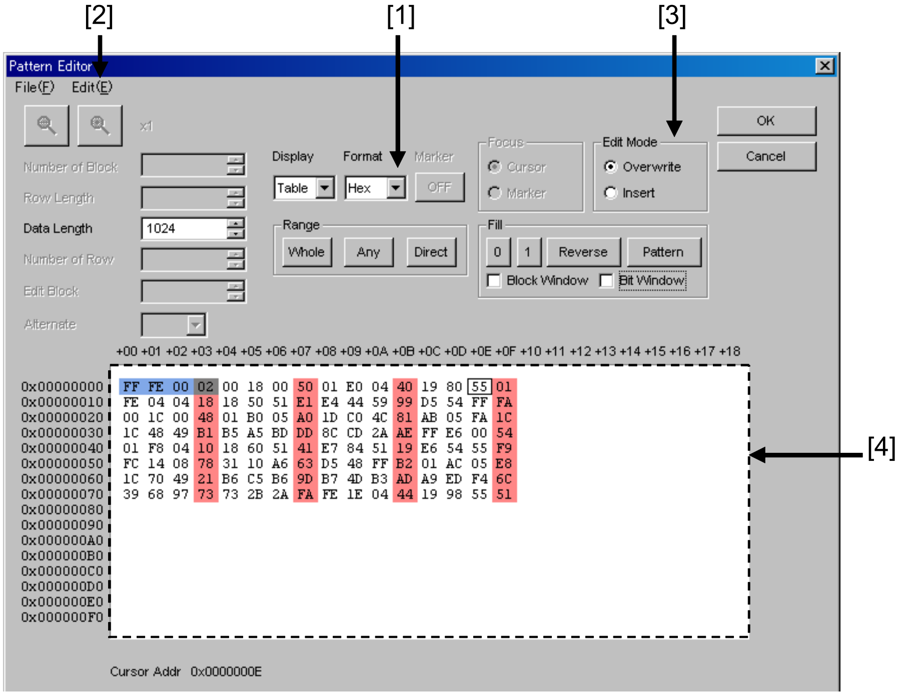
[3] Set marker display ON/OFF. The marker is displayed when the **Marker** is clicked and displayed as “ON”. The marker is not displayed when the button is clicked and displayed as “OFF”.
The address of the marker and the distance between the cursor and marker are displayed in “Marker Addr” and “Distance”, respectively.

[4] Select the operation target. The cursor is operated when **Cursor** is clicked, and the marker is operated when **Marker** is clicked.

[5] Set the editing mode. Editing is performed in the insertion mode when **Insert** is clicked, and is performed in the overwriting mode when **Overwrite** is clicked.

5.3.7.7 Editing in Table display mode

How to create and edit a test pattern in the Table display mode is described below.



Number of Block

Row Length

Data Length 1024

Number of Row

Edit Block

Alternate

Display Table

Format Hex

Marker OFF

Focus ● Cursor ○ Marker

Edit Mode ● Overwrite ○ Insert

```
           +00 +01 +02 +03 +04 +05 +06 +07 +08 +09 +0A +0B +0C +0D +0E +0F +10 +11 +12 +13 +14 +15 +16 +17 +18
0x00000000  FF  FE  00  02  00  18  00  50  01  E0  04  40  19  80  55  01
0x00000010  FE  04  04  18  18  50  51  E1  E4  44  59  99  D5  54  FF  FA
0x00000020  00  1C  00  48  01  B0  05  A0  1D  C0  4C  81  AB  05  FA  1C
0x00000030  1C  48  49  B1  B5  A5  BD  DD  8C  CD  2A  AE  FF  E6  00  54
0x00000040  01  F8  04  10  18  60  51  41  E7  84  51  19  E6  54  55  F9
0x00000050  FC  14  08  78  31  10  A6  63  D5  48  FF  B2  01  AC  05  E8
0x00000060  1C  70  49  21  B6  C5  B6  9D  B7  4D  B3  AD  A9  ED  F4  6C
0x00000070  39  68  97  73  73  2B  2A  FA  FE  1E  04  44  19  98  55  51
0x00000080
0x00000090
0x000000A0
0x000000B0
0x000000C0
0x000000D0
0x000000E0
0x000000F0
```

Cursor Addr 0x0000000E

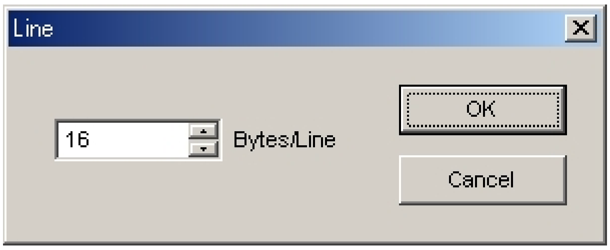
Figure 5.3.7.7-1 Editing in Table display mode

[1] Select the display format from the Format list box in the **Pattern Editor** dialog box.

Table 5.3.7.7-1 Display format settings

Setting item	Description
Bin	A test pattern is displayed and edited in binary.
Hex	A test pattern is displayed and edited in hexadecimal format.

[2] The amount of data to be displayed in one line can be changed. Select **Line** from the **Edit** menu to open the **Line** dialog box. Enter the number of bytes per line in the text box, and then click **OK**.



16 Bytes/Line

Figure 5.3.7.7-2 Line dialog box

[3] Set the editing mode. Editing is performed in the insertion mode when **Insert** is clicked, and is performed in the overwriting mode when **Overwrite** is clicked.

[4] Use the 0 and 1 keys for pattern input when the display format is binary. Use 0 to 9 and A to F keys when the display format is hexadecimal.

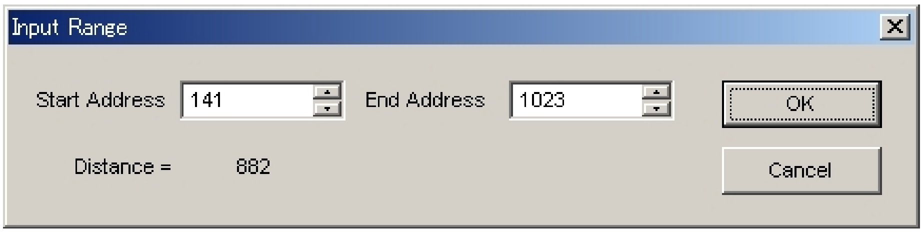
5.3.7.8 Editing area

In the **Pattern Editor** dialog box, batch editing is possible for an area by selecting it consisting of multiple bits. In this area, perform replace input using the Fill group box, or use Cut, Copy, and Paste editing commands.
The selection area setting procedure by using buttons in the Range group box is described below.
The function of each button is as follows:

Table 5.3.7.8-1 Area specification buttons

Button	Function
Whole	Selects the whole pattern.
Any	Sets an arbitrary area as the selection area by specifying addresses. The address is specified by entering values in the **Input Range** dialog box.
Direct	Sets an arbitrary area as the selection area by specifying addresses. The address is specified by using a cursor.

■ How to specify the selection area using the **Any** is as follows.



Start Address 141
End Address 1023
Distance = 882

Figure 5.3.7.8-1 Input Range dialog box

1. Enter the Start Address of the selection area in the **Start Address** spin-box.
2. Enter the End Address of the selection area in the **End Address** spin-box.
3. Click **OK** to set the specified area as the selection area. The selection area is highlighted in the **Pattern Editor** dialog box.

- How to specify the selection area using the **Direct** is as follows.
    1. Click **Direct**. The **Direct** is depressed and the Direct mode is entered. Note that pattern input and editing cannot be performed in the Direct mode.
    2. Specify the start position of the selection area by double-clicking the desired position or by moving the cursor to that position and pressing the **Enter** key.
    3. Specify the end position of the selection area. Display the desired position for the selection area by selecting **Jump** from the **Edit** menu. Next, double-click the position or move the cursor to that position and press the **Enter** key to determine the selection area.
- The selection area can also be specified by the following step.
    1. Drag the mouse to select an area.

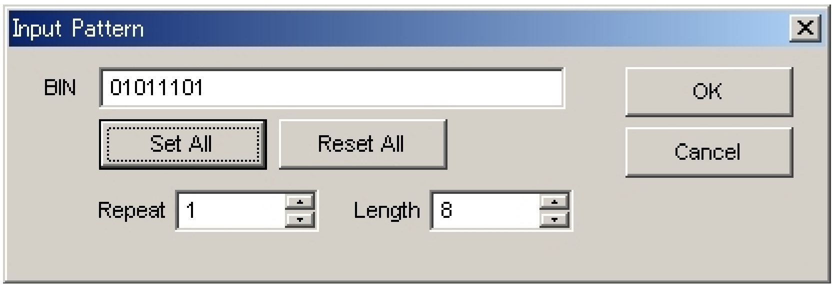
5.3.7.9 Inputting pattern

How to input a pattern by using the buttons in the Fill group box is described below. The function of each button is as follows:

Table 5.3.7.9-1 Fill button functions

Button	Function
0	Replaces the bit of the cursor position or the bits in the selection area to “0”.
1	Replaces the bit of the cursor position or the bits in the selection area to “1”.
Reverse	Inverts the bit of the cursor position or the bits in the selection area.
Pattern	Inputs an arbitrary pattern repeatedly.

- How to input a pattern using the **Pattern** is as follows.



BIN 01011101

Repeat 1

Length 8

Figure 5.3.7.9-1 Input Pattern dialog box

1. Enter into the **Length** spin-box the number of bits to be input.
2. Enter into the **Repeat** spin-box the number of specified pattern repetition times.
3. Click **Set ALL** to set all the bits to “1”.
4. Click **Reset ALL** to set all the bits to “0”.
5. Input a pattern into the **BIN** or **HEX** text box.
6. Click **OK** to input the pattern to the cursor position.

Note:

When the **Input Pattern** dialog box is displayed while the selection area is specified, a repetition of the specified pattern is applied to the selection area, regardless of the number of repetition times specified in the **Repeat** spin-box.

5.3.7.10 Compatibility with test pattern files of existing models

Pattern files (.PTN) created for the following existing models can be loaded into the **Pattern Editor** dialog box of the MU183040A/41A/40B/41B.

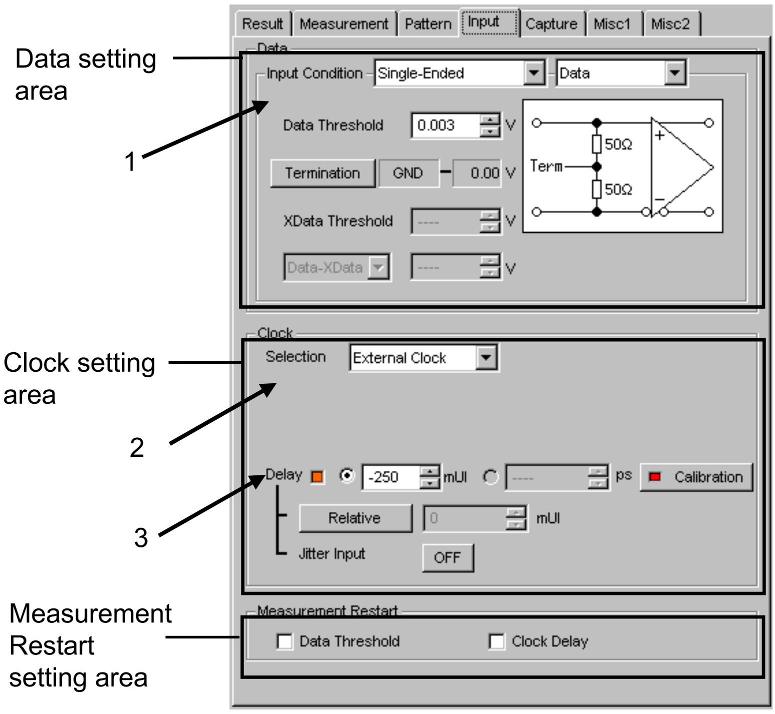
- MP1632C Digital Data Analyzer
- MP1761A/B/C Pulse Pattern Generator
- MP1762A/C/D Error Detector
- MP1775A Pulse Pattern Generator
- MP1776A Error Detector
- MU181020A/B Pulse Pattern Generator
- MU181040A/B Error Detector

5.4 Setting Input Interface

On the **Input** tab of the module operation window, you can configure the input interface.

5.4.1 Input setting items

The **Input** tab consists of three areas: Data setting area, Clock setting area and Measurement Restart setting area.

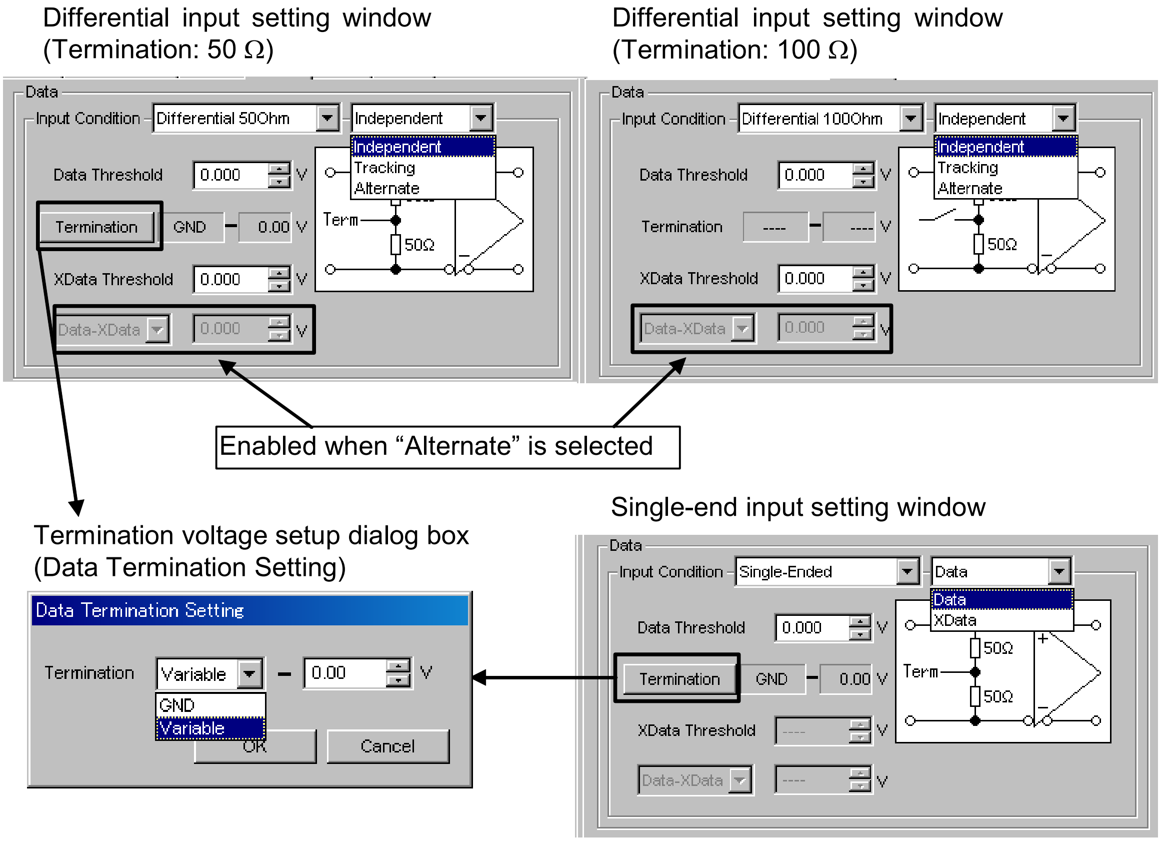

Result
Measurement
Pattern
Input
Capture
Misc1
Misc2
Data setting area
1
Data
Input Condition
Single-Ended
Data
Data Threshold
0.003
V
Termination
GND
0.00
V
XData Threshold

V
Data-XData

V
Term
50Ω
50Ω
+
−
Clock setting area
2
Clock
Selection
External Clock
3
Delay
-250
mUI
----
ps
Calibration
Relative
0
mUI
Jitter Input
OFF
Measurement Restart setting area
Measurement Restart
☐ Data Threshold
☐ Clock Delay

Figure 5.4.1-1 Input tab

1. Set the data input conditions.



Differential input setting window (Termination: 50 Ω)

Differential input setting window (Termination: 100 Ω)

Enabled when "Alternate" is selected

Termination voltage setup dialog box (Data Termination Setting)

Single-end input setting window

Data
Input Condition
Differential 50Ohm
Independent
Independent
Tracking
Alternate
Data Threshold
0.000
V
Termination
GND
0.00
Term
50Ω
XData Threshold
Data-XData
Differential 100Ohm

Data Termination Setting
Termination
Variable
GND
Variable
OK
Cancel
Single-Ended
Data
XData
+
–

Figure 5.4.1-2 Setting Data input conditions

Table 5.4.1-1 Data input condition setting items

Data input condition setting items			Description
Differential 100Ohm, Differential 50Ohm	Independent		Uses Data and XData as the differential input. Thresholds for Data and XData can be changed independently.
	Tracking		Uses Data and XData as the differential input. Thresholds for Data and XData can be changed while tracking each other.
	Alternate	Data-XData	Uses Data and XData as the differential input. The Data threshold and XData threshold can be changed interrelatedly, in conjunction with a difference between Data and XData (Data – XData).
		XData-Data	Uses Data and XData as the differential input. The Data threshold and XData threshold can be changed interrelatedly, in conjunction with a difference between XData and Data (XData – Data).
Single-Ended	Data		Used the Data side as single-ended input.
	XData		Used the XData side as single-ended input.

⚠ CAUTION

When data input condition is set to single-ended input, be sure to connect a standard accessory Open (J1341A) of Accessory to unused side of data input connector.

Operating while signal is inputting to unused side connector causes malfunction.

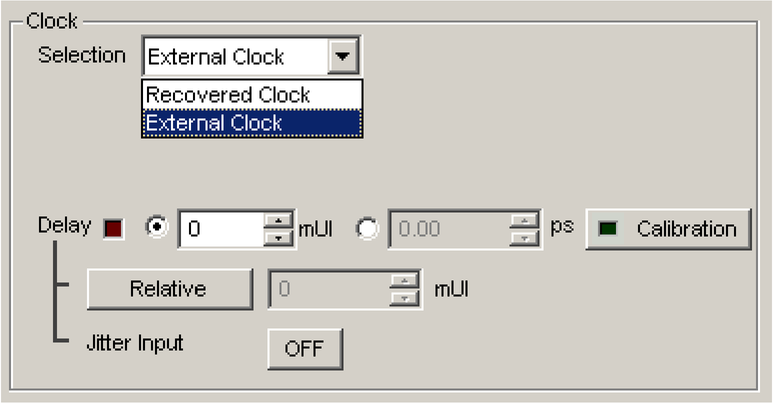
Table 5.4.1-2 Setting items in Data Termination Setting dialog box

Setting item		Description
Differential 100Ohm	None	For protection of equipment, the 50 Ω terminations at the Data and XData sides are fixed to the ground potential via a high resistor when input connectors are open.
Differential 50Ohm Single-Ended	GND	Terminates to 50 Ω/GND.
	Variable	Terminates to 50 Ω and an arbitrary set voltage within the range from –2.5 to +3.5 V. The voltage can be set in 10 mV steps.

⚠ CAUTION

- **Do not allow an excessively large current to flow to the terminator in the MU183040A, MU183041A, MU183040B, and MU183041B. Otherwise, performance may become degraded or failure may occur.**
- **If a differential signal is input via the Data or XData connector when Single-Ended is selected, the threshold margin becomes double.**

2. When your ED is MU183040B or MU183041B, the installation of MU183040B/MU183041B-x22/x23 allows you to select the clock source from the following: External Clock and Recovered Clock. If the option is not installed, this is fixed to **External Clock**.



Clock

Selection: External Clock

Recovered Clock

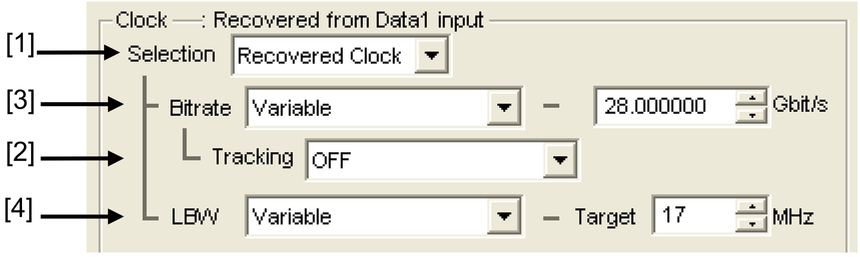
External Clock

Delay ● 0 mUI ○ 0.00 ps

Relative 0 mUI

Jitter Input: OFF

Figure 5.4.1-3 Clock Area (When External Clock Is Selected)



Clock : Recovered from Data1 input

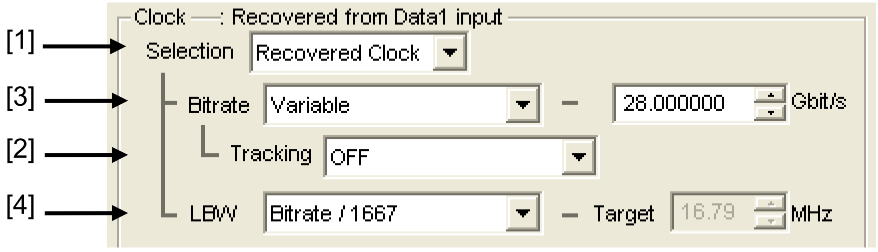
Selection: Recovered Clock

Bitrate: Variable – 28.000000 Gbit/s

Tracking: OFF

LBW: Variable – Target 17 MHz

Figure 5.4.1-4 Clock Area (When Recovered Clock Is Selected With MU183040B/MU183041B-x22 Installed)



Clock : Recovered from Data1 input

Selection: Recovered Clock

Bitrate: Variable – 28.000000 Gbit/s

Tracking: OFF

LBW: Bitrate / 1667 – Target 16.79 MHz

Figure 5.4.1-5 Clock Area (When Recovered Clock Is Selected With MU183040B/MU183041B-x23 Installed)

[1] Click **External Clock** or **Recovered Clock**.
Recovered Clock is available only when MU183040B/MU183041B-x22/x23 is installed on MU183040B/MU183041B. When **Recovered Clock** is clicked, the setting items in the **Clock** area differ according to your option.

Note:

When your option is MU183040B/MU183041B-x22, check that the data signal is being input to the Data Input 1 connector because the clock is recovered from the data signal.

Similarly, when your option is MU183040B-x23, check that the data signal is being input to the Data Input1 connector, and when your option is MU183041B-x23, check that the data signals are input to Data Input1 connector (for Data Input1 and Data Input2) and Data Input3 connector (for Data Input3 Data Input4).

[2] When selecting the MU183020A/MU183021A PPG mounted on the same mainframe, the recovered clock tracks PPG's operation bit rate setting.

Note:

When the bit rate setting of the PPG is out of the operating range of the Clock Recovery option, the bit rate of the recovery clock will be set to the upper or lower limit of the operating range.

[3] In the **Bitrate** box, click one of the preset standards listed in the following tables or click **Variable**. When clicking **Variable**, enter the bit rate in the **Gbit/s** box according to the input signal.

Table 5.4.1-3 When the Option x22 Is Installed

Preset Standard	Bit rate [Gbit/s]
32G FC	28.050 000
100G OTU4	27.952 496
100GbE(25.78x4)	25.781 250
InfiniBand EDR	25.781 250
SAS	24.000 000
PCI Express Gen4	16.000 000
InfiniBand FDR	14.062 500
16G FC	14.025 000
10GFC over FEC	11.316 800
10GbE over FEC	11.095 700
OTU2	10.709 225
G975 FEC	10.664 228
10G FC	10.518 750
10GbE	10.312 500
InfiniBand QDR	10.000 000
OC-192/STM-64	9.953 280
8G FC	8.500 000
PCI Express Gen3	8.000 000
HSBI	6.250 000
SATA 6Gb/s	6.000 000
PCI Express Gen2	5.000 000
InfiniBand DDR	5.000 000
USB3.0	5.000 000
4G FC	4.250 000
XAUI	3.125 000
SATA 3Gb/s	3.000 000
OTU1	2.666 060
InfiniBand SDR	2.500 000
PCI Express Gen1	2.500 000
OC-48/STM-16	2.488 320
Variable	2.400 000 to 28.100 000 Gbit/s Step: 0.000 001Gbit/s

Table 5.4.1-4 When the Option x23 Is Installed

Preset Standard	Bit rate [Gbit/s]
100G ULH	32.100 000
32G FC	28.050 000
100G OTU4	27.952 496
100GbE(25.78x4)	25.781 250
InfiniBand EDR	25.781 250
Variable	25.500 000 to 32.100 000 Gbit/s Step: 0.000 001Gbit/s

[4] You can select a loop band.
When the Option x22 is installed and **Variable** is clicked in the **LBW** box, you can set a loop band in the range that corresponds to the bit rate.

Operation Bitrate [Gbit/s]	Range [MHz] (Step: 1 MHz)
2.400 000 to 5.500 000	Fixed to 3 MHz
5.500 001 to 7.500 000	3 to 4 MHz
7.500 001 to 9.500 000	3 to 5 MHz
9.500 001 to 10.500 000	3 to 6 MHz
10.500 001 to 12.500 000	3 to 7 MHz
12.500 001 to 14.500 000	3 to 8 MHz
14.500 001 to 15.500 000	3 to 9 MHz
15.500 001 to 17.500 000	3 to 10 MHz
17.500 001 to 19.500 000	3 to 11 MHz
19.500 001 to 20.500 000	3 to 12 MHz
20.500 001 to 22.500 000	3 to 13 MHz
22.500 001 to 24.500 000	3 to 14 MHz
24.500 001 to 25.500 000	3 to 15 MHz
25.500 001 to 27.500 000	3 to 16 MHz
27.500 001 to 28.100 000	3 to 17 MHz

When the Option x22 or x23 is installed and **Bitrate/1667** or **Bitrate/2578** is clicked in the **LBW** box, the value obtained by the following formula will be set: (Bitrate/1667 or 2578) MHz.
When **Jitter Tolerance** is clicked, the loop band is set to the maximum value for the Jitter Tolerance measurement.

3. MU183040A/41A/40B/41B can vary delay time of clock output.

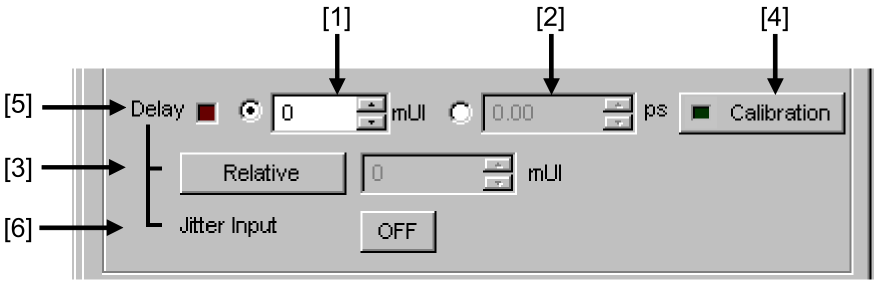


Figure 5.4.1-6 Clock delay setting items

[1] Click this radio button to set the clock delay in 2 mUI units. The MU183040A/41A/40B/41B operates based on the UI units. Setting a greater value increases the clock delay.

[2] Delay time can be set by ps unit. The frequency counter value is converted into ps units, based on the 2 mUI units. If the value read from the frequency counter is out of the range, "----ps" is displayed.

[3] When **Relative** is clicked and depressed, the text box on the right becomes enabled. The clock delay can be set in this text box by a relative value in 2 mUI units, based on the current delay as 0 mUI. When **Relative** is clicked again to be raised, the clock delay is calculated from the set relative value and set.

[4] Clicking **Calculation** starts a short-time self-calibration. When the LED on the Calculation button glows red, it indicates that calibration should be performed. When it glows green, it indicates that the operation is normal and calibration is not required. Note that the delay fluctuates greatly during calibration.

[5] This LED glows red while the "Delay" is being changed.

[6] Set the jitter input. When executing jitter tolerance test by inputting jitter-modulated clock, set **Jitter Input** of Delay to **ON**. Refer to 5.1.7 "When inputting jitter-modulated signals".

Notes:

- When the frequency or the temperature condition is changed, the LED on the "Calibration" lights, prompting performance of calibration. If calibration is not performed at this time, the error in the phase setting may be greater than at a normal phase setting.

- Values displayed in ps units vary as the frequency changes, because the MU183040A/41A/40B/41B sets phases in mUI units as an internal standard.

- When **Pattern Sequence** is set to **Burst** on the **Misc1** tab, the phase setting accuracy is degraded and becomes less than when Repeat is selected.

- During Auto Adjust execution, the delay amount of **Delay** is always changed in order to drive the clock phase to the optimum point. Therefore, the LEDs of **Delay** and **Calibration** light up in red continuously. This is not abnormal.

Refer to Section 5.1.7 “When inputting jitter-modulated signals” for operation and precautions in case of Combination or inputting jitter-modulated signals.

5.4.2 Measurement Restart area

The items to restart the measurement when its setting is changed can be selected.

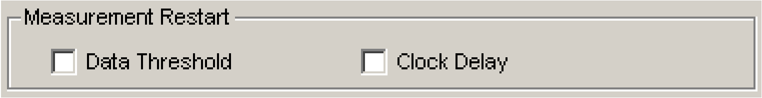


Figure 5.4.2-1 Selecting measurement restart item

Table 5.4.2-1 Items in Measurement Restart area

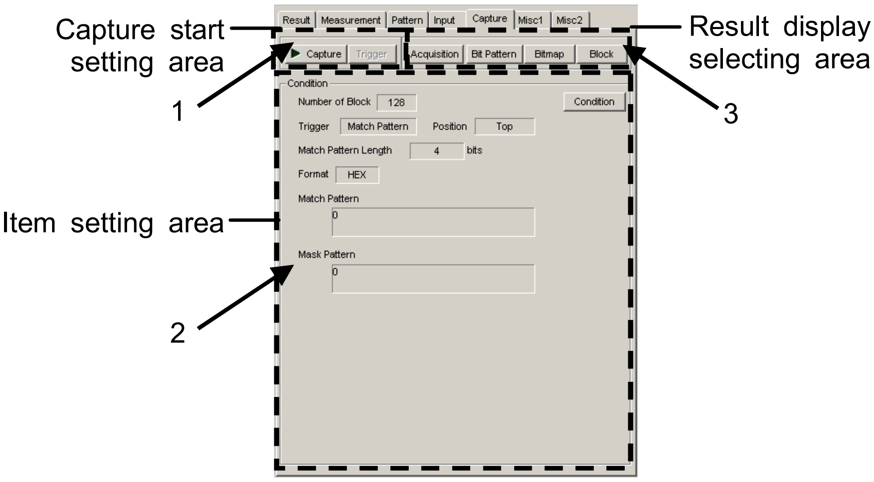
Setting item	Description
Data Threshold	Measurement is restarted when the Data/XData Threshold on the **Input** tab is changed.
Clock Delay	Measurement is restarted when Delay on the **Input** tab is changed.

5.5 Capturing Test Patterns

On the **Capture** tab of the module operation window, you can capture the input test pattern data.

5.5.1 Setting items on the Capture tab

This section describes how to capture and analyze a test pattern on the Capture tab.


Capture start setting area
1
Item setting area
2
Result display selecting area
3
Result
Measurement
Pattern
Input
Capture
Misc1
Misc2
Capture
Trigger
Acquisition
Bit Pattern
Bitmap
Block
Condition
Condition

Number of Block 128
Trigger Match Pattern
Position Top
Match Pattern Length 4 bits
Format HEX
Match Pattern
0
Mask Pattern
0

Figure 5.5.1-1 Capture tab

1. Start capturing of a test pattern. Manual trigger can be executed when **Manual** is selected from the **Trigger** list box in the **Condition Setting** dialog box.

Note:

Capture cannot be executed in the following settings.

- **Pattern Sequence** is set to **Burst**, or Combination Function is set to 4ch Combination, or **Sync Control** is set to **Quick**.
- Sync Loss is generated in BER measurement.
- The measurement is executed with plural data interfaces simultaneously.

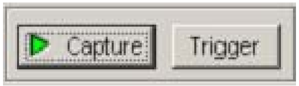
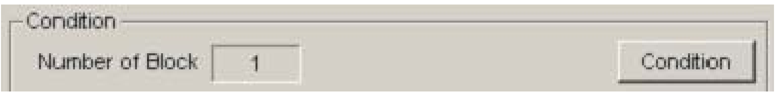

Capture
Trigger

Figure 5.5.1-2 Buttons in capture start setting area

Table 5.5.1-1 Capture/Trigger buttons

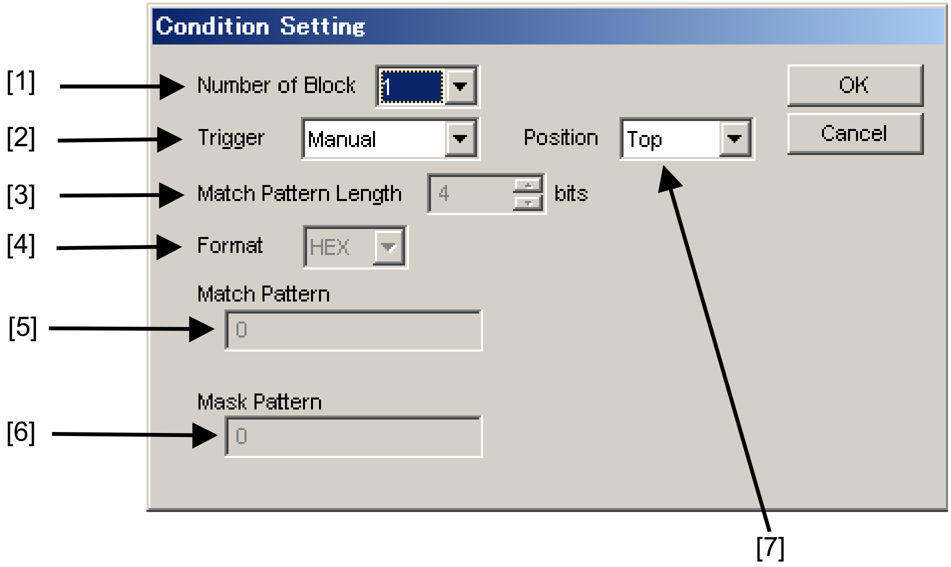
Buttons	Description
Capture	Starts capturing a test pattern. Its LED turns green during test pattern capturing. The MU183040A/41A/40B/41B enters and stays in the standby state until the trigger conditions match. When the trigger conditions match and the test pattern has been captured into the internal memory, the capturing operation is stopped and the LED on **Capture** turns off.
Trigger	When **Manual** is selected from the **Trigger** list box in the **Condition Setting** dialog box, test pattern capturing can be started manually by clicking this button (manual trigger).

2. When **Condition** in the item setting area is clicked, the **Condition Setting** dialog box is displayed. Be sure to set the trigger conditions before starting test pattern capturing. When the trigger conditions are set, click **OK** to apply the set conditions. When **Cancel** is clicked instead, the set conditions are canceled and the **Condition Setting** dialog box is closed.



Number of Block: 1

Figure 5.5.1-3 Condition button in item setting area



Number of Block: 1

Trigger: Manual

Position: Top

Match Pattern Length: 4 bits

Format: HEX

Match Pattern: 0

Mask Pattern: 0

Figure 5.5.1-4 Condition Setting dialog box

[1] Select the number of blocks of the test pattern to be captured into the MU183040A/41A/40B/41B, from 1, 2, 4, 8, 16, 32, 64, or 128. The size of each block to be captured can be calculated from the following expression:

Block size = 8 Mbits / Number of Block

[2] Select the type of the trigger to capture the test pattern.

Table 5.5.1-2 Trigger setting

Item	Description
Error Detect	Capturing starts when an error is detected.
Match Pattern	Capturing starts when a pattern that matches the set specific pattern is detected.
Manual	Capturing of one block starts when **Trigger** in the capture start setting area (refer to Figure 5.5.1-2) is clicked. To perform capturing for all the blocks, click **Trigger** for the number of times equal to the number of blocks set from the Number of Block list box in the **Condition Setting** dialog box.
External	Capturing starts at the falling edge of the signal input to the AUX Input connector.

[3] Set the length of the pattern used for match detection from 4 to 64 bits, in 4-bit units. This is enabled when **Match Pattern** is selected from the **Trigger** list box.

[4] Select the display format of the pattern used for match detection. This is enabled when **Match Pattern** is selected from the **Trigger** list box.

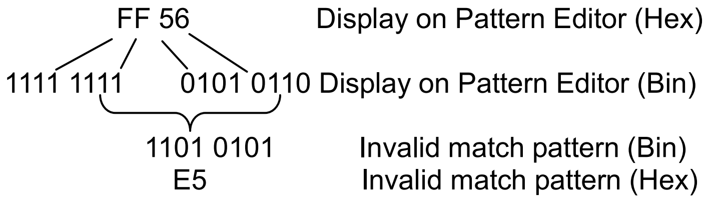
Table 5.5.1-3 Format setting

Item	Description
BIN	The match pattern is displayed in binary format.
HEX	The match pattern is displayed in hexadecimal format.

[5] Set the pattern used for match detection. This is enabled when **Match Pattern** is selected from the **Trigger** list box.

Note:

When setting a match pattern while the 2Ch Combination is configured, set it in 4-bit units, as displayed in the **Pattern Editor** dialog box of the MU183040A/41A/40B/41B in hexadecimal. If the match pattern that is displayed in hexadecimal format crosses bit boundaries, it becomes invalid and cannot be captured.


FF 56
Display on Pattern Editor (Hex)
1111 1111
0101 0110
Display on Pattern Editor (Bin)
1101 0101
E5
Invalid match pattern (Bin)
Invalid match pattern (Hex)

[6] Set the bits to be masked in the pattern used for match detection. To mask a bit for match detection, set “1” for that bit. This is enabled when **Match Pattern** is selected from the **Trigger** list box.

[7] Set the capturing start position based on the trigger position.

Table 5.5.1-4 Capture start position setting

Item	Description
Top	Captures a test pattern after the trigger position.
Middle	Captures a test pattern around the trigger position.
Bottom	Captures a test pattern before the trigger position.

3. The capture result display format can be specified using the buttons in the result display selecting area.

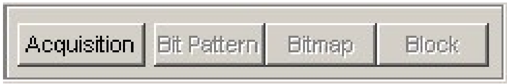

Acquisition
Bit Pattern
Bitmap
Block

Figure 5.5.1-5 Buttons in result display selecting area for selecting capture result display format

Table 5.5.1-5 Buttons for selecting capture result display format

Button	Description
Acquisition	Click to open the **Capture Acquisition** dialog box to acquire the results of capturing a test pattern into the MU181040A. The captured results can be viewed in three display formats: Bit Pattern, Bitmap, and Block. When **Acquisition** is clicked and the test pattern capture results are acquired, **Bit Pattern**, **Bitmap**, and **Block** on the right become available and the display format can be switched.
Bit Pattern	The captured test pattern is displayed in a bit pattern string, so that Insertion Error and Omission Error can be distinguished.
Bitmap	The captured test pattern is displayed in bitmap format, so that the correlation between bits in which errors occur can be assumed easily.
Block	The captured test pattern is displayed for each block, so that the correlation between bit patterns of each captured block can be understood.

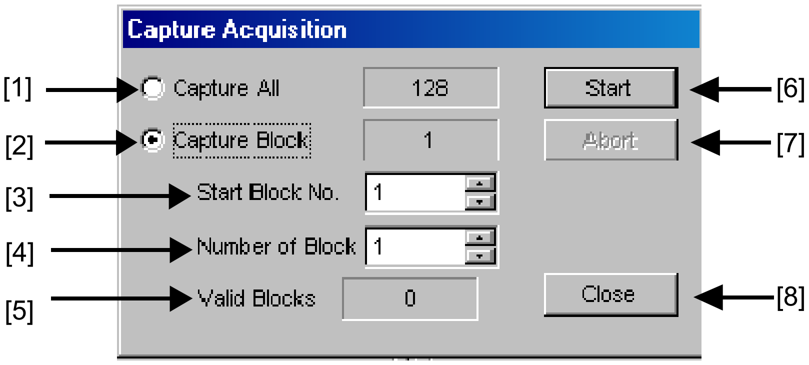


Figure 5.5.1-6 Capture Acquisition dialog box

[1] Select to display all the captured blocks.

[2] Select to display the specified captured blocks only.

[3] Specify the block number to be displayed first (**Start Block No.**).

[4] Specify the number of blocks to be displayed following the **Start Block No.** specified in [3].

[5] Displays the number of blocks that have been captured.

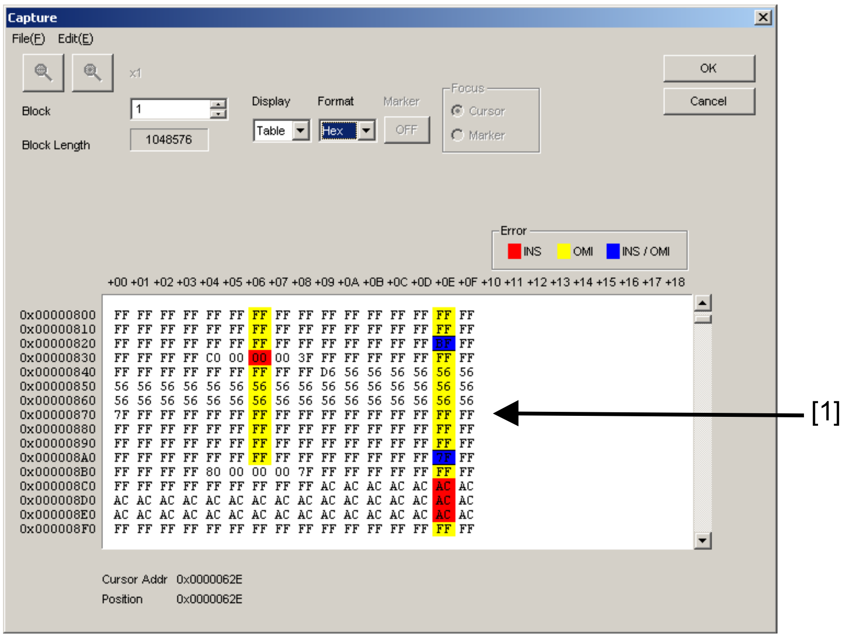
[6] Press **Start** to start loading the captured data of the blocks specified in Step [1] to [4]. The loading time depends on the number of blocks.

[7] Press **Abort** to abort loading the captured data. When aborted, the block results that are already loaded can be displayed.

[8] Press **Close** to close the screen.

5.5.2 Displaying captured test pattern (Bit Pattern)

After the captured data is acquired by clicking **Acquisition**, clicking **Bit Pattern** (refer to Figure 5.5.1-5) displays the Bit Pattern window. In this window, the captured test patterns are displayed in a bit pattern string so that Insertion Error and Omission Error can be distinguished.



Block 1
Block Length 1048576
Display Table
Format Hex
Marker OFF
Focus
○ Cursor
○ Marker

```
           +00 +01 +02 +03 +04 +05 +06 +07 +08 +09 +0A +0B +0C +0D +0E +0F +10 +11 +12 +13 +14 +15 +16 +17 +18
0x00000800 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0x00000810 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0x00000820 FF FF FF FF FF FF FF FF FF FF FF FF FF FF BF FF
0x00000830 FF FF FF FF C0 00 00 00 3F FF FF FF FF FF FF FF
0x00000840 FF FF FF FF FF FF FF FF FF D6 56 56 56 56 56 56
0x00000850 56 56 56 56 56 56 56 56 56 56 56 56 56 56 56 56
0x00000860 56 56 56 56 56 56 56 56 56 56 56 56 56 56 56 56
0x00000870 7F FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0x00000880 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0x00000890 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
0x000008A0 FF FF FF FF FF FF FF FF FF FF FF FF FF FF 7F FF
0x000008B0 FF FF FF FF 80 00 00 00 7F FF FF FF FF FF FF FF
0x000008C0 FF FF FF FF FF FF FF FF FF AC AC AC AC AC AC AC
0x000008D0 AC AC AC AC AC AC AC AC AC AC AC AC AC AC AC AC
0x000008E0 AC AC AC AC AC AC AC AC AC AC AC AC AC AC AC AC
0x000008F0 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
```

Cursor Addr 0x0000062E
Position 0x0000062E

Figure 5.5.2-1 Bit Pattern window

[1] The captured results are displayed in bit pattern.
The reference pattern of this device is displayed in binary or hexadecimal and marked by color according to error type. Insertion error (0 → 1) bits are displayed with red background, omission error (1 → 0) bits are yellow, and bits with no error are displayed without background color.

Notes:

- When **Display** is set to **Table** and **Format** is set to **Hex**, if an insertion error and an omission error occur in the same address, the bit is displayed with a blue background.
- The bit pattern display is based on the positive logic, with H = “1” and L = “0”.

- If select **File** → **Save** on the menu bar, the captured data can be saved in the file. The saving file types are as below.

  Binary Pattern, BIN Text Pattern, HEX Text Pattern:

    Used to redisplay the results on the Bit Pattern window.

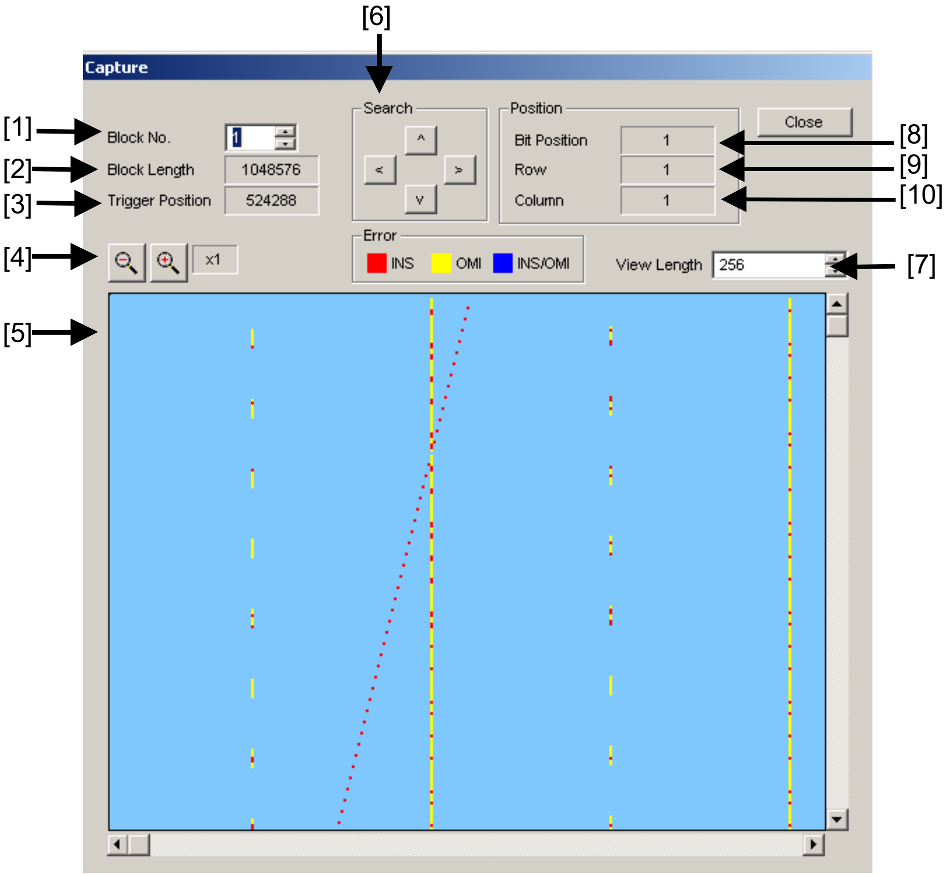
  Binary Pattern (Export), BIN Text Pattern (Export), HEX Text Pattern (Export):

    Pattern data including error information, and can be loaded by Pattern Editor.

  Additionally, if select **File** → **Open** on the menu bar, the saved captured data (Binary Pattern, BIN Text Pattern, HEX Text Pattern) is loaded and redisplayed. At that time, the file name will be displayed as a screen title.

5.5.3 Displaying captured test pattern (Bitmap)

After the captured data is acquired by clicking **Acquisition**, clicking **Bit Map** (refer to Figure 5.5.1-5) displays the Bitmap window. In this window, the captured test pattern is displayed in bitmap format, so that the correlation between bits in which errors occur can be easily assumed.



Block No. 1
Block Length 1048576
Trigger Position 524288
x1
Bit Position 1
Row 1
Column 1
View Length 256

Figure 5.5.3-1 Bitmap window

[1] Select the number of the captured blocks to be displayed.

[2] Displays the lengths of the captured blocks to be displayed.

[3] Displays the trigger detected position from the head of the captured pattern.

[4] Select the display scale for the captured data on the bitmap, from ×1, ×2, ×4, ×8, 1/2, 1/4, or 1/8.
When ×1 is selected, one dot on the display corresponds to 1 bit.
When ×2 is selected, one dot on the display corresponds to 2 bits.

[5] The captured results are displayed in several colors according to the error type. Insertion errors (0 → 1) are displayed in red, omission errors (1 → 0) are in yellow, and bits with no error are in light blue.

When the display scale is set to other than ×1, dots including an insertion error are displayed in red, dots including an omission error are displayed in yellow, and dots including both insertion and omission errors are displayed in light blue. In addition, when it overlaps with the cursor, the background color are displayed in lighten.

[6] Click a button to search for an error occurrence position in four directions.

[7] Specify the turning point for the data on the displayed bitmap. The setting range is from 256 bits to the block length, in 8-bit units. The correlation between bits in which errors occur can be assumed easier by adjusting the turning point.

[8] Displays the cursor position from the head of the block.

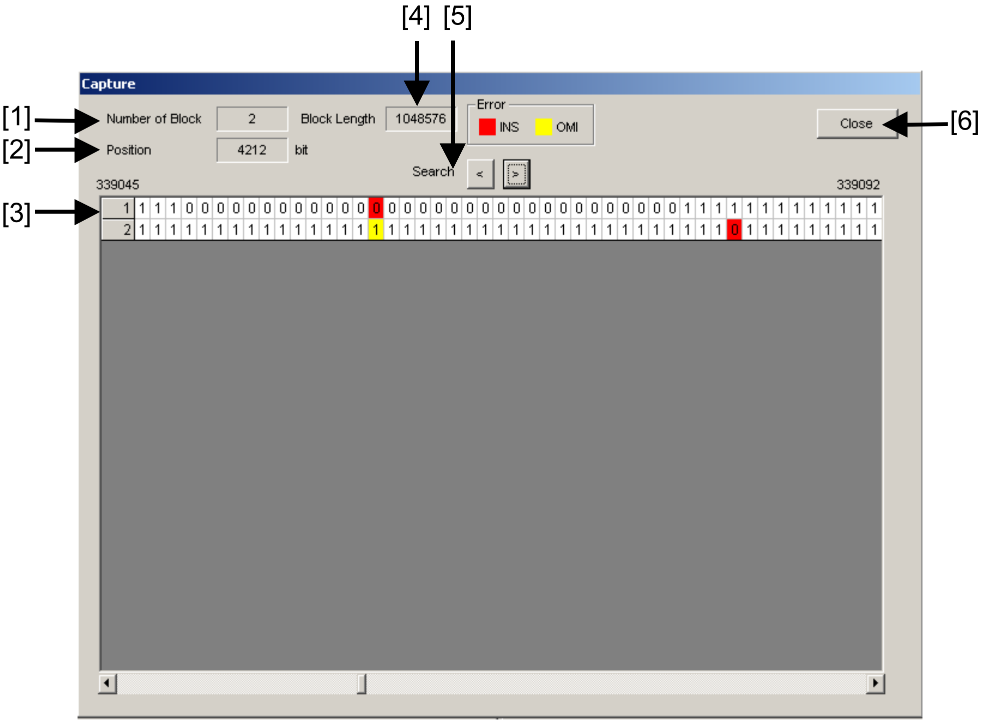
[9] Displays in dot units the current vertical position of the cursor in the Bitmap display area. The uppermost row on the Bitmap display area is “1”.

[10] Displays in dot units the current horizontal position of the cursor in the Bitmap display area. The leftmost column on the Bitmap display area is “1”.

[11] Clicking **Close** closes the Bitmap window.

5.5.4 Displaying captured test pattern (Block)

After the captured data is acquired by clicking **Acquisition**, clicking **Block** (refer to Figure 5.5.1-5) displays the Block window. In this window, the captured test pattern is displayed for each block, so that the correlation between bit patterns of each captured block can be understood.



Number of Block 2
Block Length 1048576
Position 4212 bit

339045 339092

1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1

Figure 5.5.4-1 Block window

[1] Displays the number of the captured blocks.

[2] Displays the cursor position.

[3] The captured results are displayed sequentially for each block. Bit strings of MU183040A/41A/40B/41B reference patterns are displayed in binary format (0 and 1), with different background colors according to the error type. Insertion errors (0 → 1) are displayed with a red background, omission errors (1 → 0) are yellow, and bits with no error are displayed without a background color.

[4] Displays the length of the block to be displayed.

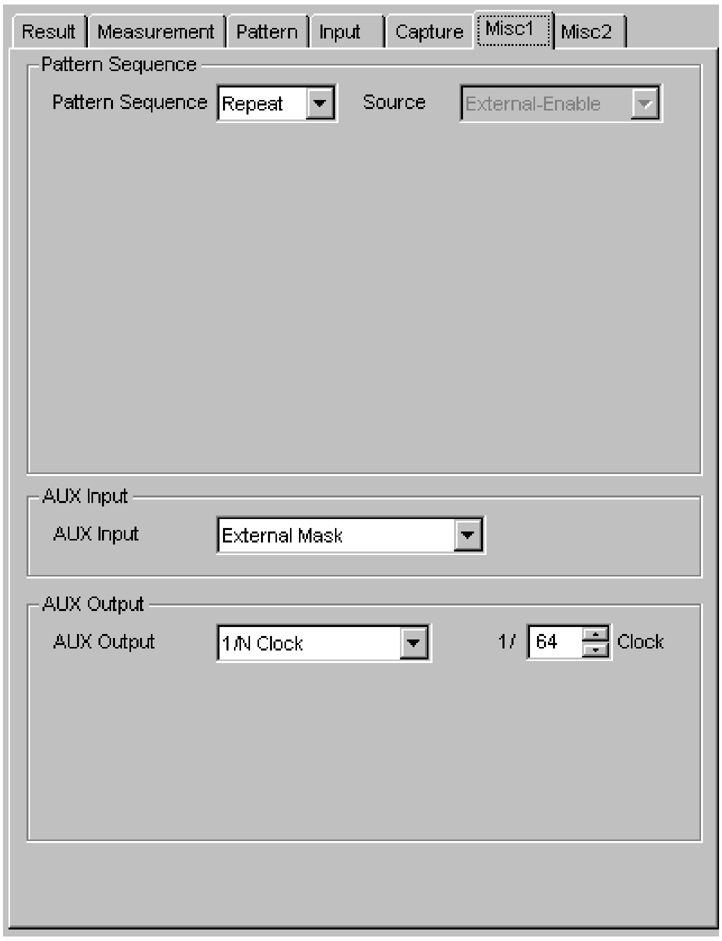
[5] Searches for errors on the right or left.

[6] Clicking **Close** closes the Block window.

5.6 Misc1 Function

Pattern sequence and auxiliary input and output can be set by the Misc1 function.

On the **Misc1** tab of the module operation window, you can set the Misc1 function.


Result
Measurement
Pattern
Input
Capture
Misc1
Misc2
Pattern Sequence
AUX Input
AUX Output

Pattern Sequence: Repeat

Source: External-Enable

AUX Input: External Mask

AUX Output: 1/N Clock

1/ 64 Clock

Figure 5.6-1 Misc1 tab

Table 5.6-1 Misc1 setting items

Item	Description
Pattern Sequence	Test pattern receiving method can be set.
AUX Input	The settings for the auxiliary input function can be configured.
AUX Output	The settings for the auxiliary output function can be configured.

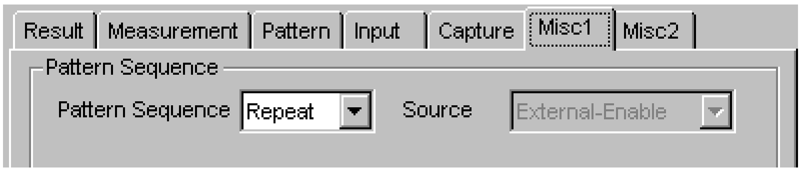
Note:

AUX Input settings are common to Data1 and Data2 at MU183040A-x20.

AUX Input settings are common from Data1 to Data4 at MU183041A/B.

5.6.1 Setting Pattern Sequence

Select the method for generating test patterns to be measured.


Result
Measurement
Pattern
Input
Capture
Misc1
Misc2

Pattern Sequence
Pattern Sequence Repeat
Source External-Enable

Figure 5.6.1-1 Selecting pattern sequence

Table 5.6.1-1 Pattern sequence setting

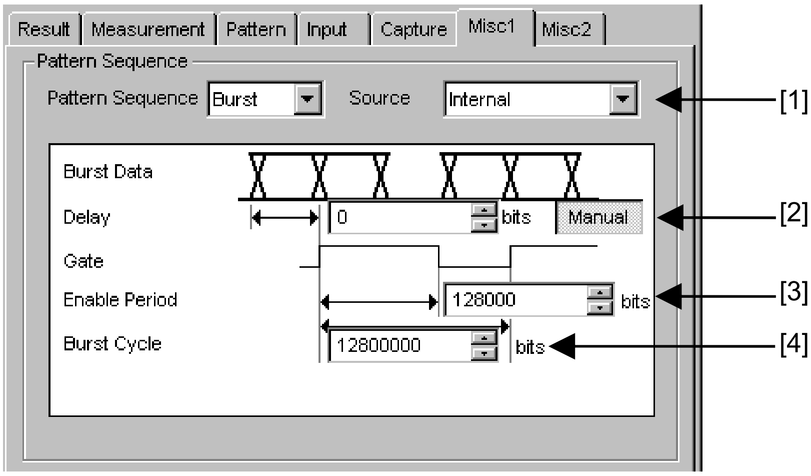
Selection item	Description
Repeat	Select when receiving Repeat data of the test pattern. Mainly used for electric device evaluation.
Burst	Select when receiving Burst data of the test pattern. Mainly used for long-distance optical transmission tests such as an optical circulating loop test, and packet communications evaluation. The target test patterns are PRBS, Zero-Substitution, Data, and Mixed.

5.6.1.1 Setting Repeat pattern

Select **Repeat** from the **Pattern Sequence** list box to receive Repeat data of the test pattern. No setting items are required.

5.6.1.2 Setting Burst pattern

Select **Burst** from the **Pattern Sequence** list box to receive Burst data of the test pattern.


Result
Measurement
Pattern
Input
Capture
Misc1
Misc2
Burst Data
Gate
Manual
[1]
[2]
[3]
[4]

Pattern Sequence
Pattern Sequence Burst
Source Internal
Delay 0 bits
Enable Period 128000 bits
Burst Cycle 12800000 bits

Figure 5.6.1.2-1 Pattern Sequence area when Burst is selected

[1] Select the definition method for the switching timing between the input test pattern valid period and invalid period.

Table 5.6.1.2-1 Burst setting items

Setting item	Description
Internal*	Select this item when setting the gate signal that determines the measuring period of the intermittently-input test pattern within the MU183040A/41A/40B/41B, instead of inputting it from external equipment. Select this item when the input signal valid period and the repetition cycle are known.
External-Trigger*	Select this item when defining the start timing of the input test pattern valid period. The length of the valid period can be set by the Enable Period text box (refer to [3] below).
External-Enable	Select this item when defining the start timing and the length of the input test pattern valid period.

*: When the test patterns of Burst Cycle and Enable Period are not constant, select **External-Enable**.

[2] Set the **Delay** for the input test pattern and source signal (selected by [1]). When **Auto** is selected, the delay is automatically adjusted within the MU183040A/41A/40B/41B.

When having chosen **Auto** and Enable Period of [3] is changed, operate **Manual** -> **Auto** once.

When **Manual** is selected, set the number of relative delay bits used in the MU183040A/41A/40B/41B. At this time, the signal input from the AUX Input connector indicates the period during which the test pattern is valid.

The setting range is as follows.

In the case of Independent:
0 to 2 147 483 640 bits, 8 bit step
In the case of 2ch Combination:
0 to 4 294 967 280 bits, 16 bit step
In the case of 4ch Combination:
0 to 8 589 934 560 bits, 32 bit step

[3] When **External-Trigger** or **Internal** is selected from the **Source** list box, specify the period during which Burst cycle signals of the test pattern to be input to the Aux Input connector are continuously generated by the number of bits.

The setting ranges for Burst Cycle are shown in Table 5.6.1.2-2.

[4] When **Internal** is selected from the **Source** list box, set the Burst cycle (one cycle of the Burst signal of the input test pattern).
The setting ranges for Burst Cycle are shown in Table 5.6.1.2-2.

Table 5.6.1.2-2 Setting ranges for Enable Period and Burst Cycle

No. of Channel Combinations	Enable Period (bits)	Burst Cycle (bits)	Setting Steps (bits)
1	When **Internal** is set: 12 800 to 2 147 482 624	25 600 to 2 147 483 648	256
	When **External-Trigger** is set: 12 800 to 2 147 483 392		
2	When **Internal** is set: 25 600 to 4 294 965 248	51 200 to 4 294 967 296	512
	When **External-Trigger** is set: 25 600 to 4 294 966 784		
4	When **Internal** is set: 51 200 to 8 589 930 496	102 400 to 8 589 934 592	1024
	When **External-Trigger** is set: 51 200 to 8 589 933 568		

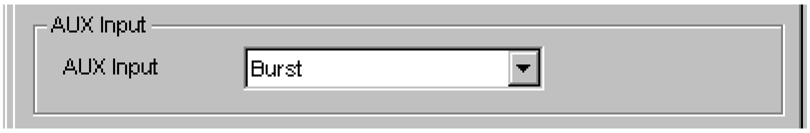
Notes:

- A Disable period of at least 512 bits is required between Burst Cycle and Enable Period.
  The Disable period is doubled at 2ch Combination.
  The Disable period is quadrupled at 4ch Combination

- When **Auto** is selected for the delay setting, set **Sync Control** to **Frame ON**.
  If any of the following items is changed when **Auto** is selected for the delay setting, change the delay setting to **Manual** and set to **Auto** again.
  - **Burst Cycle** or **Enable Period** of the test pattern
  - **Burst Cycle** when **External - Trigger** is selected
  - **Burst Cycle** or **Enable Period** when **External - Enable** is selected

5.6.2 Setting AUX Input

Use the Aux Input connector when receiving a Burst signal or capturing a reception signal based on the externally-generated timing signal. This section describes the function that uses the Aux Input connector.



AUX Input: Burst

Figure 5.6.2-1 Selecting auxiliary input

Table 5.6.2-1 AUX Input setting items

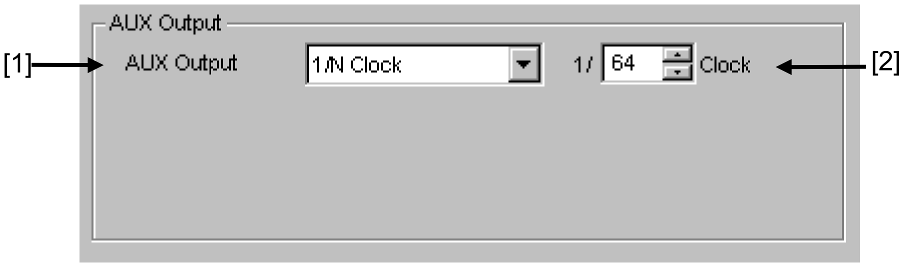
Setting item	Description
Burst	Select when **Burst** is selected from the **Pattern Sequence** list box, and **External-Trigger** or **External Enable** is selected from the **Source** list box. External-Trigger: Data is valid for the set Enable period after a rising edge is detected. External-Enable: Data is valid when the level of the signal is high.
External Mask	Measurement is masked when a low-level signal is input.

5.6.3 Setting AUX Output

The output settings of auxiliary signals, such as the synchronization signal, can be configured.

5.6.3.1 Setting 1/N Clock

A divided clock can be generated in synchronization with a generation pattern.


AUX Output

AUX Output: 1/N Clock

1/ 64 Clock

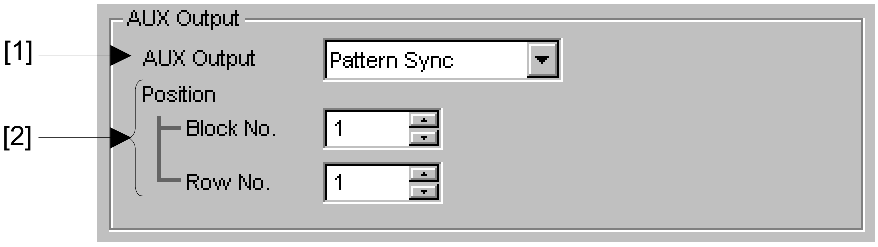
Figure 5.6.3.1-1 Setting items for AUX Output Clock

[1] When **1/N Clock** is selected from the **AUX Output** list box, a clock can be output from the AUX Output connector in synchronization with the test pattern.

[2] The division ratio for the synchronization clock can be set.
The setting division ratio (N) can be set from 4 to 512, in even numbers.

5.6.3.2 Setting Pattern Sync

A timing signal from Aux Output connector can be generated in synchronization with the test pattern period.


AUX Output

AUX Output: Pattern Sync

Position

Block No.: 1

Row No.: 1

Figure 5.6.3.2-1 Setting items for AUX Output Pattern Sync

[1] When **Pattern Sync** is selected from the **AUX Output** list box.

[2] The synchronization signal pulse generation position can be set.
The setting method varies depending on the test pattern.

Table 5.6.3.2-1 Synchronization signal pulse generation position setting

Test pattern	Description
PRBS, Data, Zero-Substitution	A signal pulse is generated in a pattern period. The pulse position can be specified within the range below, starting from the beginning of the pattern. 1 to {(Least common multiple of Pattern Length* and 128)–135}, in 8-bit steps. The maximum settable number is 34 359 738 105. In the case of 2ch Combination: 1 to {(Least common multiple of Pattern Length* and 128)–271}, in 16-bit steps. The maximum settable number is 68 719 476 209. In the case of 4ch Combination: 1 to {(Least common multiple of Pattern Length* and 256)–543}, in 32-bit steps. The maximum settable number is 137 438 952 417.
Mixed	A signal pulse is generated during the entire block generation pattern period. The pulse position can be specified in the positions of Block and Row.

*: Pattern Length defined here shall be the value obtained by multiplying Pattern Length setting until it becomes 512 or more if it is 511 or less.

In the case of 2ch Combination, Pattern Length shall be the value obtained by multiplying Pattern Length setting until it becomes 1024 or more if it is 1023 or less. And in the case of 4ch Combination, Pattern Length shall be obtained by multiplying Pattern Length setting until it becomes 2048 or more if it is 2047 or less.

5.6.3.3 Setting Sync Gain

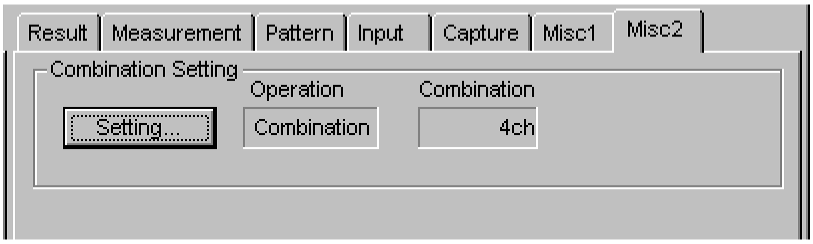
A signal indicating synchronization establishment can be output. When this signal is high, it indicates that synchronization is established.

5.6.3.4 Setting Error Output

A signal indicating error detection can be output. When this signal is high, it indicates that an error is detected within the MU1803040A/41A/40B/41B. No setting items are required.

5.7 Misc2 Function

Multiple Channel functions can be set by the Misc2 function.
On the **Misc2** tab of the module operation window, you can set the Misc2 function.


Result
Measurement
Pattern
Input
Capture
Misc1
Misc2
Combination Setting
Setting...

Operation: Combination
Combination: 4ch

Figure 5.7-1 Misc2 tab

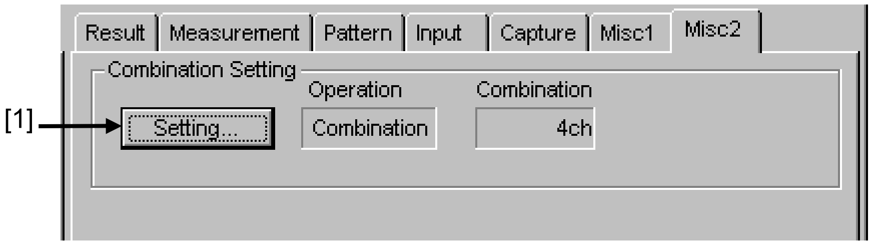
5.7.1 Combination Setting

The Multi Channel function synthesizes patterns among channels of MU183040A/41A/40B/41B, and enables reception synchronization. This enables the evaluation of the 100 Gbit/s application and 40 Gbit/s application.

Combination Function Types

(1)	4ch Combination:	MU183041A/B
(2)	2ch Combination × 2:	MU183041A/B
(3)	2ch Combination:	MU183041A/B or MU183040A/B-x20

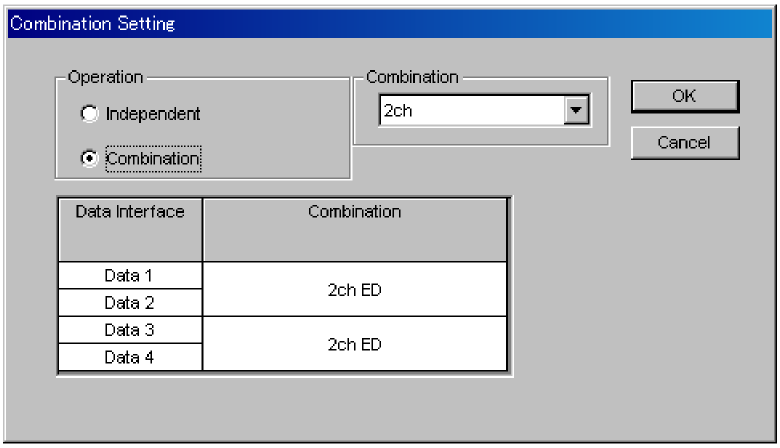
Combination function measures bit error by synthesizing bit sequences that multiple channels receive.


[1]
Result
Measurement
Pattern
Input
Capture
Misc1
Misc2
Combination Setting
Setting...

Operation: Combination
Combination: 4ch

Figure 5.7.1-1 Combination Setting window

[1] Click **Setting** to open the **Combination Setting** dialog box.
Contents of the dialog box vary depending on the model and option.

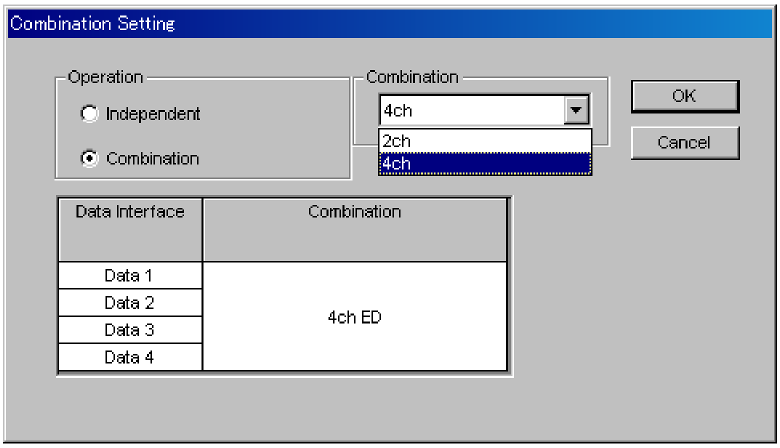


Operation: ○ Independent ● Combination

Combination: 2ch

Data Interface	Combination
Data 1	2ch ED
Data 2	
Data 3	2ch ED
Data 4	

Figure 5.7.1-2 Combination Setting dialog box



Operation: ○ Independent ● Combination

Combination: 4ch

Data Interface	Combination
Data 1	4ch ED
Data 2	
Data 3	
Data 4	

Figure 5.7.1-3 Combination Setting dialog box

Table 5.7.1-1 Screen Layout of Combination Setting

Operation Settings		Contents
Independent		Operate each channel of MU183040A/B or MU183041A/B independently
Combination	2ch	Synchronize two channels of MU183040A/B-x20 or MU183041A/B.
	4ch	Synchronize four channels of MU183041A/B

Confirm the selected operation by clicking **OK**.

By clicking **Combination**, buttons to select channels are displayed in the ED window.

5.7.2 Setting the Grouping function

The Grouping function allows you to group and share the settings on the **Pattern** and **Input** tabs among MU183040A, MU183041A, MU183040B and MU183041B channels. This function is useful when configuring multiple channels with the same settings.

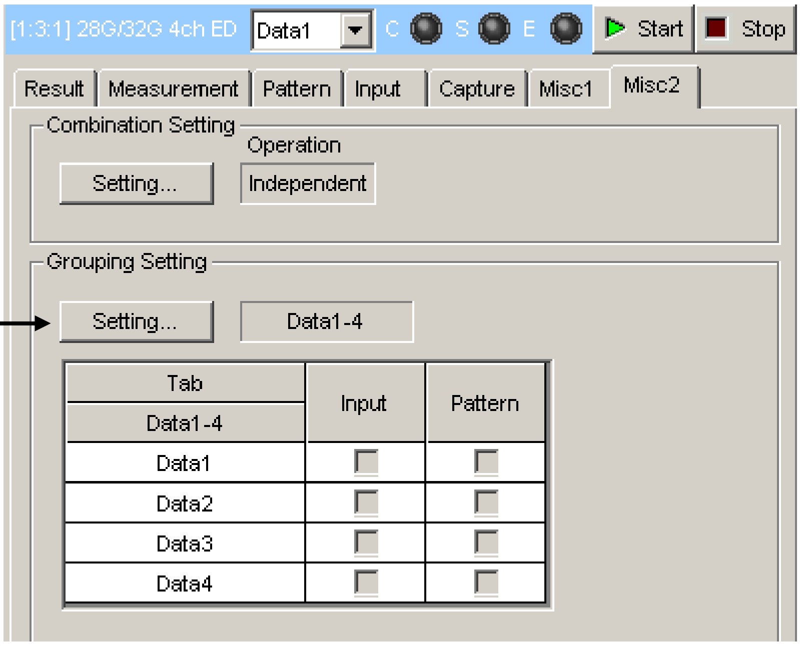
Also, you can perform batch setting of the items on the **Pattern** and **Input** tabs of multiple MU183040A, MU183041A, MU183040B and MU183041B channels.

Note:

Though the Grouping function allows you to configure the settings of the **Input** and **Pattern** tabs at a time, the period of time required until they are configured is the same as that required when separately configuring each of channels.

Procedure for setting the Channel Grouping function

[1] In the **Grouping Setting** area of the **Misc2** tab, click **Setting** to open the **Group Setting** dialog box.
Appearance may vary depending on the model and option.


[1:3:1] 28G/32G 4ch ED
Data1
C
S
E
Start
Stop
Result
Measurement
Pattern
Input
Capture
Misc1
Misc2
Combination Setting
Setting...
Grouping Setting
Setting...

Operation: Independent

Grouping Setting: Data1-4

Tab	Input	Pattern
Data1-4		
Data1	☐	☐
Data2	☐	☐
Data3	☐	☐
Data4	☐	☐

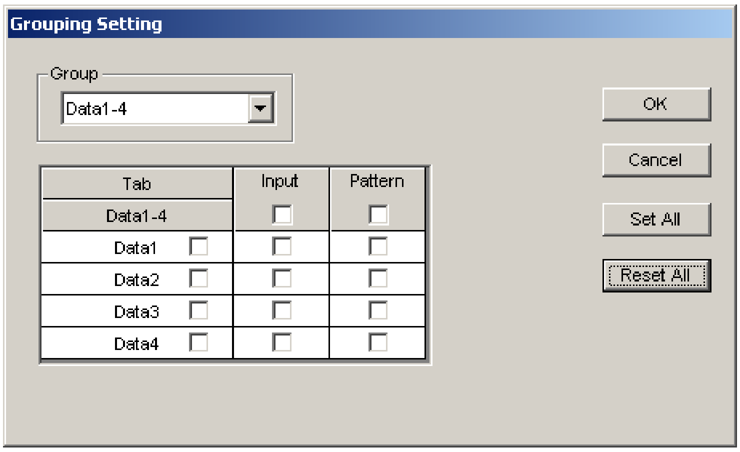
[1]

Figure 5.7.2-1 Location of the Button That Opens the Grouping Setting Dialog Box

[2] In the **Grouping Setting** dialog box, select the check boxes of Tabs (Input and Pattern) and Data Interfaces that you want to group together.
Clicking **Set All** selects all the check boxes, and clicking **Reset All** clears all the check boxes. For MU183041A/B, you can select one of the following settings:

- Setting that groups Data1 to Data4 together
- Setting that groups Data1 and Data2, and Data3 and Data4 together, respectively

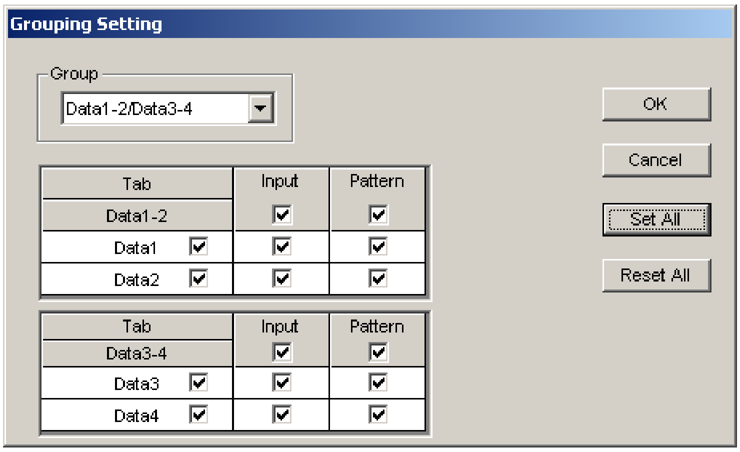
For details on tabs and setting items to be grouped together, refer to Table 5.7.2-1.



Group: Data1-4

Tab		Input	Pattern
Data1-4		☐	☐
Data1	☐	☐	☐
Data2	☐	☐	☐
Data3	☐	☐	☐
Data4	☐	☐	☐

Figure 5.7.2-2 Grouping Setting Dialog Box (When Data1-4 is Selected)



Group: Data1-2/Data3-4

Tab		Input	Pattern
Data1-2		☑	☑
Data1	☑	☑	☑
Data2	☑	☑	☑

Tab		Input	Pattern
Data3-4		☑	☑
Data3	☑	☑	☑
Data4	☑	☑	☑

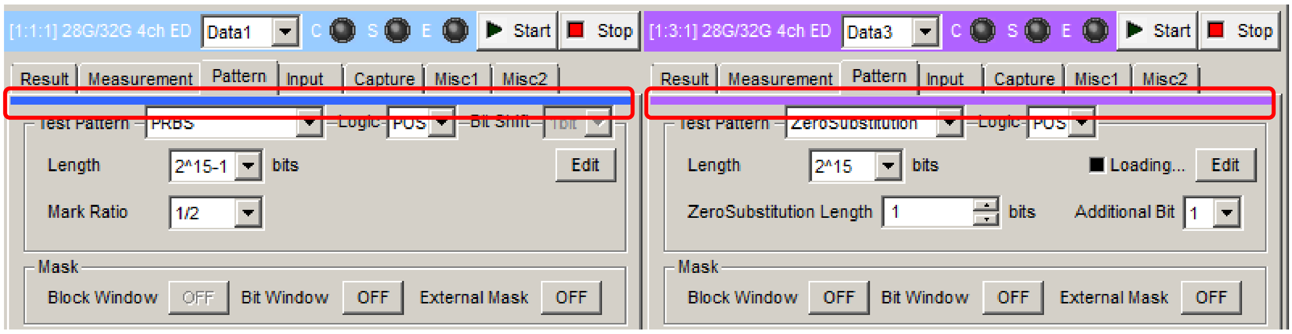
Figure 5.7.2-3 Grouping Setting Dialog Box (When Data1-2/Data3-4 is Selected)

Notes:

- You cannot select the **Input** tabs when the Auto Adjust function is working.
- When the **Input** tabs are grouped together with the others, the following functions and measurements cannot be executed:
  - Auto Adjust function
  - Auto Search function
  - Eye Margin measurement
  - Eye Diagram measurement
  - Bathtub measurement
- The Module Grouping function is available when at least two check boxes of each tab are selected.

[3]　When the **Grouping Setting** dialog box is closed by clicking **OK**, the settings of the Master DataInterface (Data1 or Data3) are shared among the Data Interfaces that are grouped together. When the **Grouping Setting** dialog box is closed by clicking **OK**, the settings of the Master DataInterface (Data1 or Data3) are shared among the Data Interfaces that are grouped together. Then, the grouped tabs operate using the same settings.
When the grouping function is enabled, a color bar appears at the upper part of the tab.

Data1-2 (or Data1-4): Blue (Master Data1)
Data3-4: Purple (Master Data3)


[1:1:1] 28G/32G 4ch ED
Data1
C
S
E
Start
Stop
Result
Measurement
Pattern
Input
Capture
Misc1
Misc2
Edit
Mask
[1:3:1] 28G/32G 4ch ED
Data3
C
S
E
Start
Stop
Result
Measurement
Pattern
Input
Capture
Misc1
Misc2
Loading...
Edit
Mask

Test Pattern PRBS
Logic POS
Bit Shift 1bit
Length 2^15-1 bits
Mark Ratio 1/2
Block Window OFF
Bit Window OFF
External Mask OFF

Test Pattern ZeroSubstitution
Logic POS
Length 2^15 bits
ZeroSubstitution Length 1 bits
Additional Bit 1
Block Window OFF
Bit Window OFF
External Mask OFF

Figure 5.7.2-4　Indication That Appears When the Grouping Function is Enabled

Table 5.7.2-1　Items Subject to the Grouping Function

Tab	Main Category	Sub-Category	Whether Supported or Not
Pattern	Test Pattern	Pattern Selection	Yes
	PRBS	Length	Yes
		Logic	Yes
		Mark Ratio	Yes
		Edit	Yes
	Zero-substitution	Logic	Yes
		Length	Yes
		Zero-Substitution Length	Yes
		Addition Bit	Yes
		Edit	Yes
	Data	Logic	Yes
		Length	No
		Edit	No

Table 5.7.2-1 Grouping Objects (Cont'd)

Tab	Main Category	Sub-Category		Whether Supported or Not
Pattern	Mixed Data	Logic		Yes
		Number of Blocks (Display)		No
		Row Length (Display)		No
		Data Length (Display)		No
		Number of Rows (Display)		No
		Edit		No
		PRBS	Pattern	No
			Mark Ratio	Yes
		Descramble		No
		Descramble Setup		No
		PRBS Sequence		No
	Mask	Block Window		No
		Bit Window		No
		External Mask		No
	Measurement Start*			Yes
	Measurement Stop*			Yes
Input	Data	Input Condition		Yes
		Differential Input Type		Yes
		Data/XData		Yes
		Data Threshold		Yes
		XData Threshold		Yes
		Differential Input Type for Data Threshold		Yes
		Differential Input Value for Data Threshold		Yes
		Data Termination Setting Dialog Box		Yes
		Data Termination Condition		Yes
		Data Termination Voltage		Yes
	Clock	All Selection settings		No
		All Delay settings		No

*: **Start** and **Stop** are located outside the **Pattern** tabs; however, their actions are grouped together with the **Pattern** tabs.

Procedure for setting the Module Grouping function

[1] Click the **File** menu, click [Module Grouping], and then click [Setup].

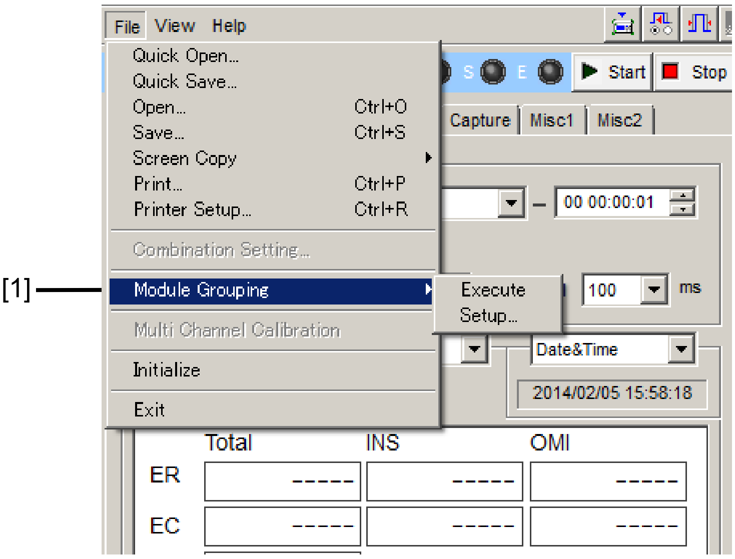
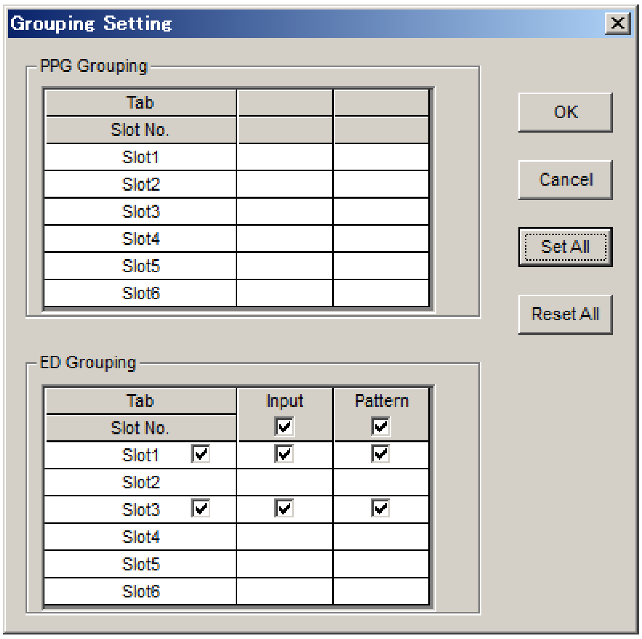

[1]
File
View
Help
Quick Open...
Quick Save...
Open... Ctrl+O
Save... Ctrl+S
Screen Copy
Print... Ctrl+P
Printer Setup... Ctrl+R
Combination Setting...
Module Grouping
Execute
Setup...
Multi Channel Calibration
Initialize
Exit
Start
Stop
Capture
Misc1
Misc2
00 00:00:01
100
ms
Date&Time
2014/02/05 15:58:18
Total
INS
OMI
ER
EC

Figure 5.7.2-5 Module Grouping Menu

[2] In the **Grouping Setting** dialog box, select the check boxes of Tabs (Input and Pattern) and Slot Nos. that you want to group together. The module with the lowest Slot No. is assumed to be the master module.

Clicking **Set All** selects all the check boxes, and clicking **Reset All** clears all the check boxes. For details on tabs and setting items to be grouped together, refer to Table 5.7.2-1.


Grouping Setting
OK
Cancel
Set All
Reset All

PPG Grouping

Tab		
Slot No.		
Slot1		
Slot2		
Slot3		
Slot4		
Slot5		
Slot6		

ED Grouping

Tab		Input	Pattern
Slot No.		☑	☑
Slot1	☑	☑	☑
Slot2			
Slot3	☑	☑	☑
Slot4			
Slot5			
Slot6			

Figure 5.7.2-6 Grouping Setting Dialog Box

Notes:

- The Module Grouping function is available when the model name and option(s) of the modules match each other.

- The Module Grouping function is available when at least two check boxes of each tab are selected.

[3] Click **OK** to close the **Grouping Setting** dialog box.

[4] Click the **Module Grouping** function button, and the settings items of the master module will be shared by the modules you want to group together.

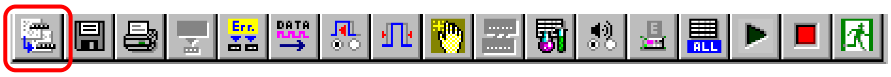


Figure 5.7.2-7 Module Grouping Function Button

5.8 Executing Auto Search

The Auto Search function is used to optimize the threshold voltage and phase for the input data. Click the **Auto Search** module function button to display the **Auto Search** dialog box.

The **Auto Search** module function button can be displayed and hidden by selecting **Button Menu** from the **View** menu on the menu bar.

When the pointer is closed to the **Auto Search**, "Auto Search(32G)" is displayed for help.

The Auto Search function optimizes the threshold voltage, and phase delay of the Data and XData input signals.

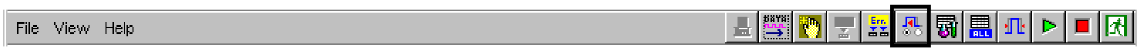


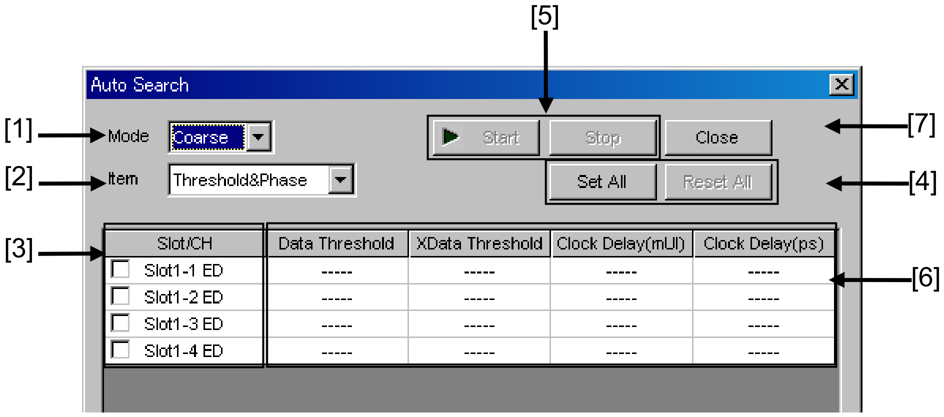
Figure 5.8-1 Auto Search Module Function Button

Note:

The **Auto Search** module function button is unavailable when the Input tab is grouped together with the other tab.

5.8.1 Input setting items in Auto Search dialog box

The **Auto Search** dialog box consists of the Auto Search operation setting area (upper of the dialog box, including [1], [2], [4], [5] and [7] in Figure 5.8.1-1 below), operation target slot and result display area (lower left of the dialog box, indicated by [3] and [6] in Figure 5.8.1-1).

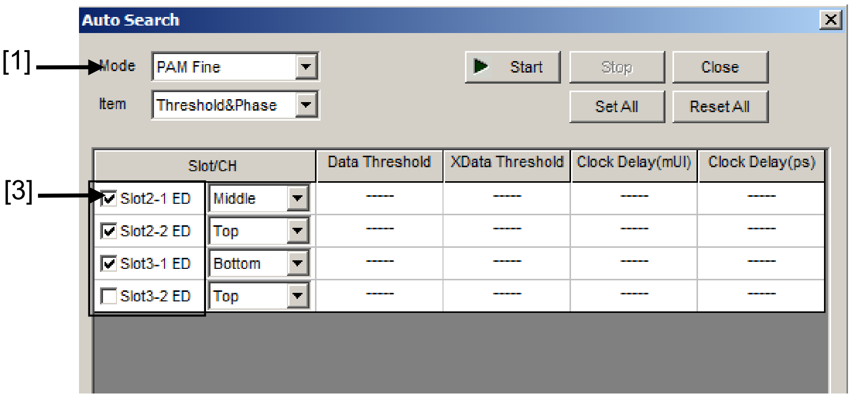


Mode: Coarse

Item: Threshold&Phase

Slot/CH	Data Threshold	XData Threshold	Clock Delay(mUI)	Clock Delay(ps)
☐ Slot1-1 ED	-----	-----	-----	-----
☐ Slot1-2 ED	-----	-----	-----	-----
☐ Slot1-3 ED	-----	-----	-----	-----
☐ Slot1-4 ED	-----	-----	-----	-----

Figure 5.8.1-1 Auto Search dialog box



Mode: PAM Fine

Item: Threshold&Phase

Slot/CH		Data Threshold	XData Threshold	Clock Delay(mUI)	Clock Delay(ps)
☑ Slot2-1 ED	Middle	-----	-----	-----	-----
☑ Slot2-2 ED	Top	-----	-----	-----	-----
☑ Slot3-1 ED	Bottom	-----	-----	-----	-----
☐ Slot3-2 ED	Top	-----	-----	-----	-----

Figure 5.8.1-2 Auto Search dialog box (PAM mode)

[1] Select the Auto Search execution method from the **Mode** list box.

Table 5.8.1-1 Execution method setting

Mode	Description
Coarse	Coarse adjustment is executed by the hardware. Adjustment will be finished faster than by **Fine** adjustment. The obtained result will be almost the same as that after the Auto Adjust function is executed and finished.
Fine	In addition to coarse adjustment by the hardware, fine adjustment is executed with a software algorithm. It takes longer to finish the adjustment compared to **Coarse** adjustment.
PAM Coarse*	Searches for an optimum threshold point of each level (Top, Middle, Bottom) of 4PAM (Pulse-Amplitude Modulation) waveforms by detecting High and Low levels of the waveforms input.
PAM Fine*	Performs fine adjustment by software algorithm in addition to auto search in PAM Coarse mode. It takes longer to finish the adjustment compared to PAM Coarse adjustment.

*: This mode is available only when your module is MU183040B or MU183041B.

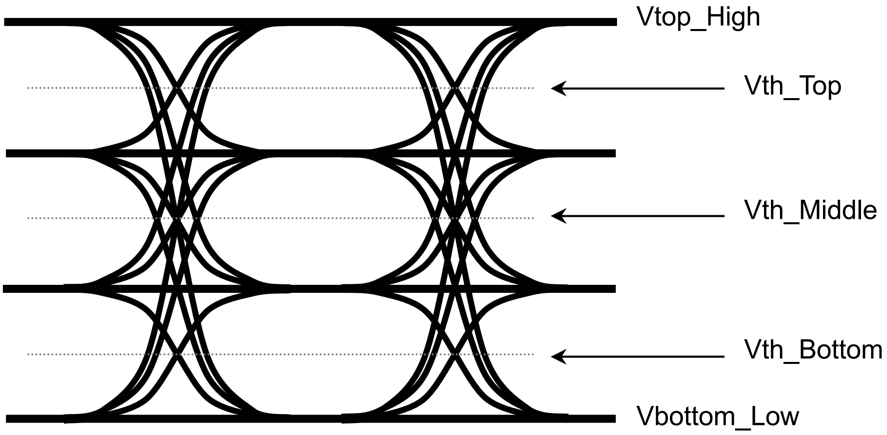


Figure 5.8.1-3 Vth image of 4PAM waveform

[2] Select the Auto Search target item from the **Item** list box.
The **Item** list box is not available when **PAM Coarse** or **PAM Fine** is selected in the **Mode** list box.

Table 5.8.1-2 Execution target setting

Mode	Description
Threshold&Phase	Auto Search is executed for both Threshold and Phase.
Threshold	Auto Search is executed for Threshold.
Phase	Auto Search is executed for Phase.

[3] Select the check boxes of the slot/channel numbers to be targeted for Auto Search. The selectable slot/channel numbers depend on the item set in the **Item** list box.
When **PAM Coarse** or **PAM Fine** is selected in the **Mode** list box, select a level (Top, Middle or Bottom) of the PAM waveform to search.

[4] Clicking **Set All** selects all the check boxes of the valid channels in the Slot area. Auto Search will be executed for all valid channels.
Clicking **Reset All** clears all the check boxes of the slots in the Slot area. Auto Search will not be executed for any slots.

[5] Clicking **Start** starts Auto Search for the specified channels.
Auto Search does not start if no valid channel is selected.
Clicking **Stop** stops Auto Search.

[6] Auto Search results are displayed.

Table 5.8.1-3 Result display items

Displayed result	Description
----	Indicates items for which Auto Search is not executed.
Failed	Indicates items for which Auto Search has failed.
XXXX mV	Indicates the result of Data/XData Threshold Auto Search in mV units.
XXXX mUI	Indicates the result of Phase Auto Search in mUI units.
XXXX ps	Indicates the result of Phase Auto Search in ps units. Data Delay in ps units is converted from that in mUI units, using the frequency counter value.

[7] Clicking **Close** closes the **Auto Search** dialog box. The **Close** becomes disabled during Auto Search.

5.9 Executing Auto Adjust

The Auto Adjust function automatically adjusts the threshold voltage and phase to the optimum values when the interface conditions for the signals to be input to the MU183040A/41A/40B/41B have changed.
Click the **Auto Adjust** module function button to display the **Auto Adjust** dialog box. The Auto Adjust setting items can be set in this dialog box.
The **Auto Adjust** module function button can be displayed and hidden by selecting **Button Menu** from the **View** menu on the menu bar.
When the pointer becomes close to the **Auto Adjust** button, "Auto Adjust(32G)" is displayed for help.
Click the **Auto Adjust** button to start and stop the Auto Adjust function.

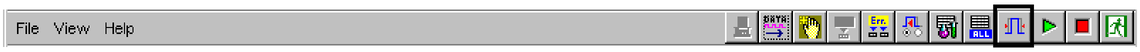


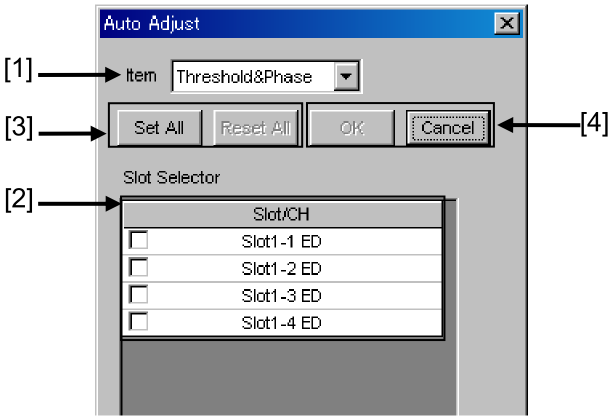
Figure 5.9-1 Auto Adjust button

Note:

The **Auto Search** module function button is unavailable when the Input tab is grouped together with the other tab.

5.9.1 Input setting items in Auto Adjust dialog box

The **Auto Adjust** dialog box consists of the Auto Adjust operation setting area (upper of the dialog box, including [1], [3], and [4] in Figure 5.9.1-1 below) and operation target slot setting area (lower of the dialog box, indicated by "[2]" in Figure 5.9.1-1).



Item: Threshold&Phase

☐	Slot/CH
☐	Slot1-1 ED
☐	Slot1-2 ED
☐	Slot1-3 ED
☐	Slot1-4 ED

Figure 5.9.1-1 Auto Adjust dialog box

[1] Select the Auto Adjust target item from the **Item** list box.

Table 5.9.1-1　Execution target setting

Mode	Description
Threshold & Phase	Auto Adjust is executed for both Threshold and Phase. Threshold and Delay cannot be changed during Auto Adjust.
Threshold	Auto Adjust is executed for Threshold. Threshold cannot be changed during Auto Adjust.
Phase	Auto Adjust is executed for Phase. Delay cannot be changed during Auto Adjust.

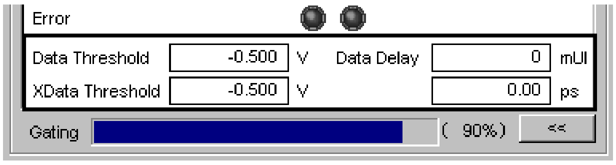
[2] Select the check box of the slot number to be targeted for Auto Adjust. In case of MU183040A/B-x20 or MU183041A/B, select the channel number check box(es).
The selectable channel numbers depend on the items set in the **Item** list box.

[3] Clicking **Set All** selects all the check boxes of the valid channels in the Slot/CH area.
Auto Adjust will be executed for all valid channels.
Clicking **Reset All** clears all the check boxes of the channels in the Slot/CH area. Auto Adjust will not be executed for any channels.

[4] Clicking **OK** starts Auto Adjust for the specified channels.

Auto Adjust does not start if no valid channel is selected.
Clicking **Cancel** stops Auto Adjust and closes the **Auto Adjust** dialog box.

The Auto Adjust executing status is displayed in the lower part of the **Result** tab. "----" is displayed when the Auto Adjust is stopped, and displayed for items that are not targeted for Auto Adjust. Threshold is displayed in XXXX V units, and Data Delay is displayed in XXXX mUI or XXXX ps units. Data Delay in ps units is converted from that in mUI units, using the frequency counter value.



Data Threshold -0.500 V　Data Delay 0 mUI
XData Threshold -0.500 V　0.00 ps
Gating (90%)

Figure 5.9.1-2　Auto Adjust executing status on the Result tab

Note:

Input the signal that makes the cross points at 50% when using the Auto Adjust. If inputting the signal that does not make the cross points at 50%, the Auto Adjust may not function properly.

5.10 Eye Margin Measurement

Eye Margin measurement measures a phase margin and threshold voltage margin in an eye pattern from the current position.

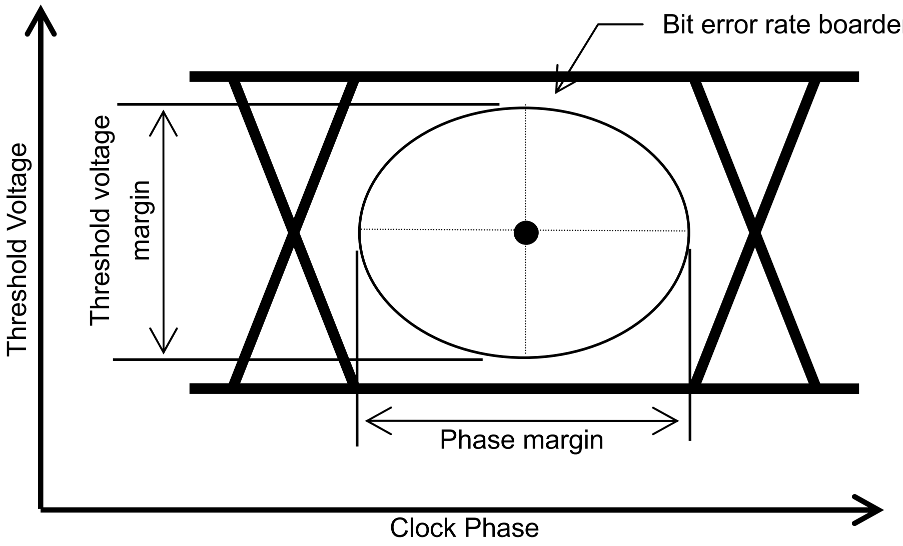


Figure 5.10-1 Schematic diagram of Eye Margin measurement

The margin in the clock phase direction (phase margin) and margin in the threshold voltage direction (threshold margin) are measured. The bit error rate to be a margin boarder can be selected from E–3 to E–12.
The bit error rate for the clock phase and threshold voltage at the start of Eye Margin measurement must be less than the specified rate, in order to obtain valid results.
Also, synchronization with the MU183040A/41A/40B/41B must be established (i.e., without Sync Loss) before the start of Eye Margin measurement.

Note:

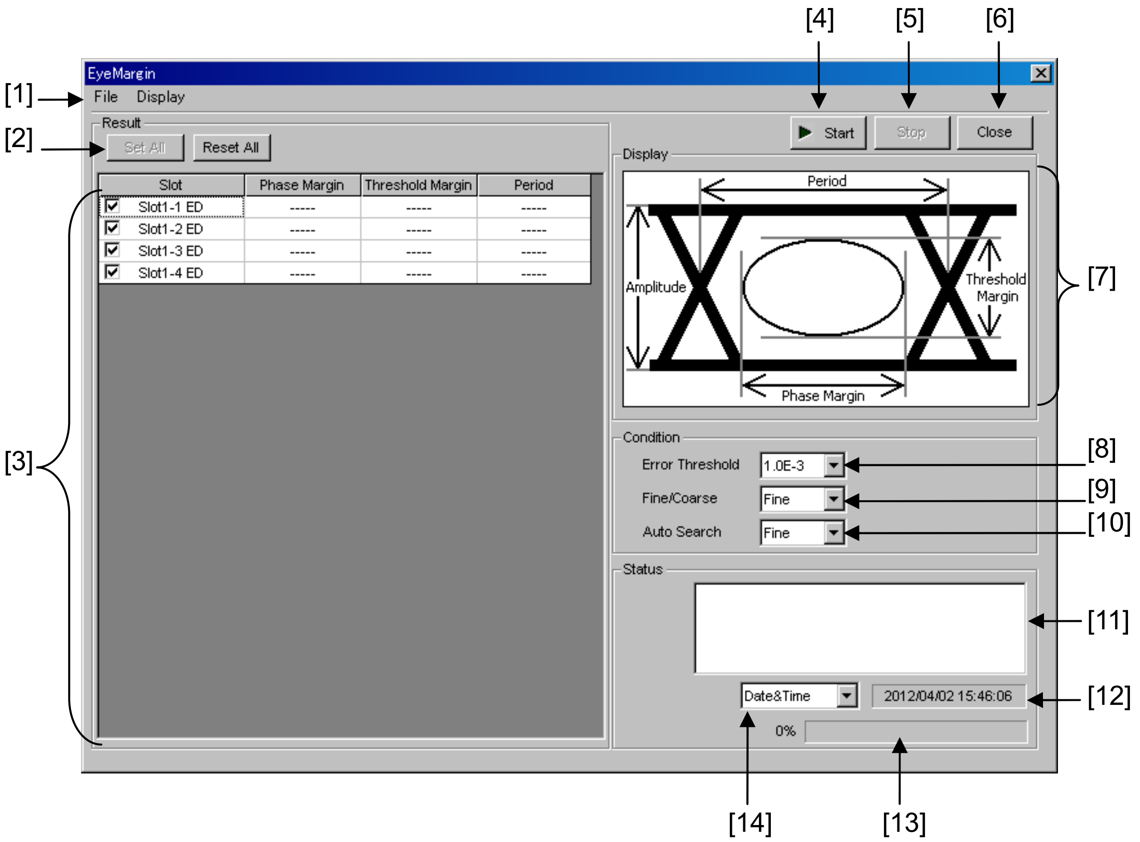
Eye Margin measurement cannot be performed for the following cases.

- When **Burst** is selected from the **Pattern Sequence** list box on the **Misc1** tab
- During Auto Adjust
- When **Auto Sync** is set to **OFF**
- When the **Input** tab is grouped together with the other tab

To use the Eye Margin measurement function, click the **Auto Measurement** ( ) module function button, and then select **Eye Margin**. Refer to the *MX180000A Signal Quality Analyzer Control Software Operation Manual* for details.

5.10.1 Eye Margin window

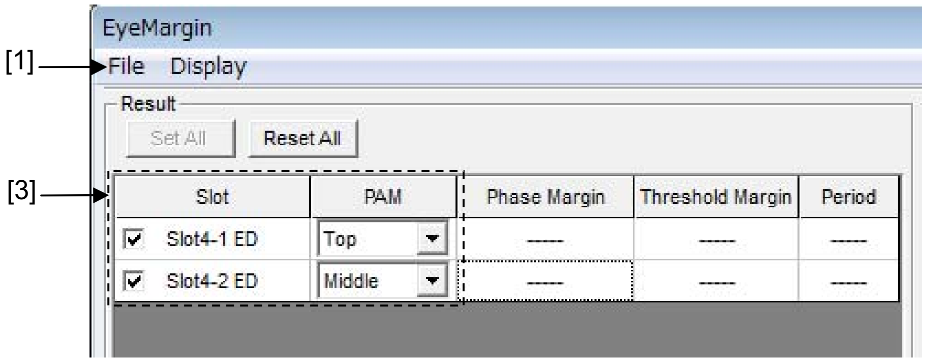
Figure 5.10.1-1 shows the Eye Margin window.


[4]
[5]
[6]
EyeMargin
[1]
File
Display
Result
[2]
Set All
Reset All
Start
Stop
Close
Display
Period
Amplitude
Threshold Margin
Phase Margin
[7]
[3]
Condition
[8]
[9]
[10]
Status
[11]
[12]
[14]
[13]

Slot	Phase Margin	Threshold Margin	Period
☑ Slot1-1 ED	-----	-----	-----
☑ Slot1-2 ED	-----	-----	-----
☑ Slot1-3 ED	-----	-----	-----
☑ Slot1-4 ED	-----	-----	-----

Error Threshold: 1.0E-3
Fine/Coarse: Fine
Auto Search: Fine
Date&Time: 2012/04/02 15:46:06
0%

Figure 5.10.1-1 Eye Margin window


EyeMargin
[1]
File
Display
Result
Set All
Reset All
[3]

Slot	PAM	Phase Margin	Threshold Margin	Period
☑ Slot4-1 ED	Top	------	------	------
☑ Slot4-2 ED	Middle	------	------	------

Figure 5.10.1-2 Eye Margin window (PAM mode)

[1] Menu bar
Refer to Section 5.10.2 “Menu items” for details.

[2] **Set All** and **Reset All**

Set All: Selects all the displayed channels.

Reset All: Deselects all the displayed channels.

[3] Displays the slots and channels to be selected for the Eye Margin measurement target, and the measurement results. The slot number where the MU183040A/41A/40B/41B is inserted and the number of channel are displayed. Select the check box for the channel to be measured. When the Eye Margin measurement is finished, the measurement results of phase margin, threshold margin, and period are displayed. If **PAM Coarse** or **PAM Fine** is selected in the **Auto Search** list box, **Top**, **Middle**, or **Bottom** needs to be specified for each of the selected channels.

[4] **Start**
Starts Eye Margin measurement. The Eye Margin measurement is performed for the channels whose check box is selected in [3], in the slot number order.

[5] **Stop**
Stops the Eye Margin measurement.

[6] **Close**
Closes the Eye Margin window.

[7] Display
The definition of the amplitude, period, threshold margin, and phase margin values are illustrated in an eye pattern.

[8] Error Threshold
Select the error threshold to be measured, from E–3 to E–12.

[9] Fine/Coarse
Select the measurement accuracy from the **Fine/Coarse** list box. In Eye Margin measurement, the error rate is calculated based on the ratio between the error count and the clock count. The amount of the error count and the clock count differs between the coarse measurement and the fine measurement. Table 5.10.1-1 lists the actual values of the error count and the clock count. The measuring quantity becomes greater when Fine is selected, so the Eye Margin measurement takes a longer time than when Coarse is selected.

Table 5.10.1-1 Error count and clock count for each error threshold

Error Threshold	Error Count/Clock Count	
	Coarse	Fine
E–3	1/1000	100/100000
E–4	1/10000	100/1000000
E–5	1/100000	100/10000000
E–6	1/1000000	100/100000000
E–7	1/10000000	100/1000000000
E–8	1/100000000	100/10000000000
E–9	1/1000000000	100/100000000000
E–10	1/10000000000	100/1000000000000
E–11	1/100000000000	100/10000000000000
E–12	1/1000000000000	100/100000000000000

The setting resolutions for Threshold and Phase also differ between coarse and fine measurement. Table 5.10.1-2 shows the differences in the setting resolutions for Threshold and Phase.

Table 5.10.1-2 Setting resolutions for Threshold and Phase

	Coarse	Fine
Threshold	5 mV	1 mV
Phase	10 mUI	1 mUI

[10] Auto Search ON/OFF

Select whether to execute Auto Search at the start of Eye Margin measurement.

OFF:	The threshold margin and phase margin are measured based on the current phase and threshold voltage.
Coarse:	The threshold margin and phase margin are measured based on the phase and threshold after performing Auto Search Coarse.
Fine:	The threshold margin and phase margin are measured based on the phase and threshold after performing Auto Search Fine.
PAM Coarse*:	Measures the threshold margin and phase margin, using each of the phase and threshold automatically searched in PAM Coarse mode as the origin. If this option is selected, the selected slots must be set to **Top**, **Middle**, or **Bottom**.
PAM Fine*:	The threshold margin and phase margin are measured based on the phase and threshold

after performing Auto Search PAM Fine. If this option is selected, the selected slots must be set to **Top**, **Middle**, or **Bottom**.

*: This mode is available only when your module is MU183040B or MU183041B.

[11] The measurement status and result (whether the measurement was finished normally) are displayed for each channel.

Measuring:	The Eye Margin measurement is being performed.
Measurement Completion:	The Eye Margin measurement has finished normally.
Failure:	The Eye Margin measurement has failed.

When Sync Loss, Clock Loss, Out of Range, or Illegal Error is detected, it is displayed in this area. All results can be viewed by using the scroll bar.

Table 5.10.1-3 Error display

Displayed Error	Cause
Sync Loss	A Sync Loss error has occurred in the MU183040A/41A/40B/41B.
Clock Loss	A Clock Loss error has occurred in the MU183040A/41A/40B/41B.
Out of Range	The measurement target is out of the measurement area when the delay value reaches the limit.
Illegal Error	The value set for the MU183040A/41A/40B/41B exceeds the Eye Margin error rate and measurement cannot be performed based on the set value.

Display example:

Slot1-1 ED: Measuring…

Slot1-1 ED: Measurement Completion

Slot1-2 ED: Measuring…

Slot1-2 ED: Sync Loss

[12] Displays the time related to the measurement (refer to [14] below).

[13] Indicates the measurement progress as a percentage and a gauge.

[14] Select the time to be displayed.

Date&Time:	Current time
Start Time:	Measurement start time
Elapsed Time:	Time elapsed from the measurement start time

Upon completion of measurement of all modules, the elapsed time display stops.

5.10.2 Menu items

Table 5.10.2-1 lists the menu items provided in the Eye Margin window. No menu items can be selected during measurement.

Table 5.10.2-1 Menu items in Eye Margin window

Menu	Menu Item				Function
File	Open				Opens a file. The file name is displayed as a window title.
	Save	Data Type	Eye Margin Result		Saves Eye Margin measurement results.
		File Type	Binary		Saves results in binary format.
			CSV		Saves results in CSV format.
			Text		Saves results in text format.
	Screen Copy	Execute			Executes the screen copy according to the setting in **Screen Copy** → **Setup**.
		Setup	Save Type	BMP	Copies data in the window in BMP format.
				PNG	Copies data in the window in PNG format.
				JPG	Copies data in the window in JPG format.
			Output	to File	Outputs data in the window to a file.
				to Printer	Outputs data in the window to a printer.
			Save to		Opens the dialog box showing the specified saving directory. The saving directory can be specified in this dialog box.
	Initialize				Initializes all the settings and measurement results.
	Exit				Closes the Eye Margin window.
Display	Phase Scale	mUI			Sets the phase unit to mUI.
		ps			Sets the phase unit to ps.

Notes:

- The screen-shot file (created by Screen Copy → Execute) is saved in the name format of “SC” + “date and time”.

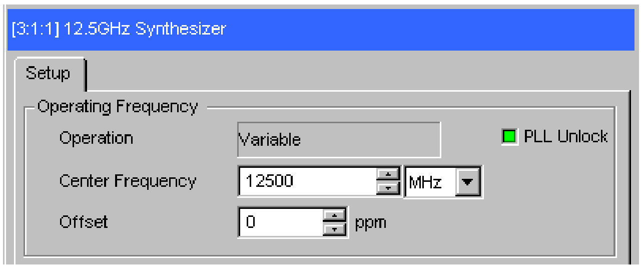
- The settings will not be read from the saved file if the file name is changed.

5.10.3 How to perform Eye Margin measurement

This section provides a basic procedure for performing Eye Margin measurement.

1. Checking connection
   Check that the MU183020A, DUT (Device Under Test), and MU183040A/41A/40B/41B are correctly connected.

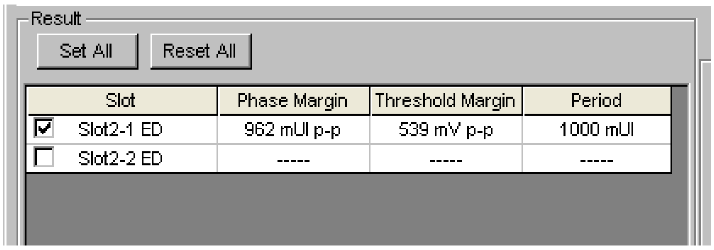
2. Setting frequency
   Set the frequency by the synthesizer window.



Operation: Variable
Center Frequency: 12500 MHz
Offset: 0 ppm

Figure 5.10.3-1 MU181000A 12.5GHz Synthesizer window

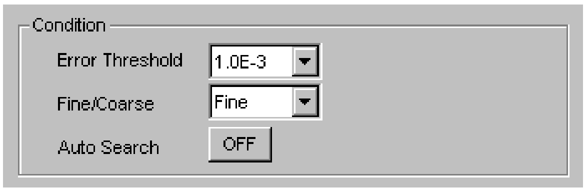
3. Selecting channel to be measured
   Open the Eye Margin window and select the slot to be measured.



Slot	Phase Margin	Threshold Margin	Period
☑ Slot2-1 ED	962 mUI p-p	539 mV p-p	1000 mUI
☐ Slot2-2 ED	-----	-----	-----

Figure 5.10.3-2 Selecting slot and channel

4. Setting measurement conditions
   Select the **Error Threshold** for measurement from E–3 to E–12.
   Select the measurement accuracy from **Fine** or **Coarse**.
   Select **OFF**, **Coarse** or **Fine** from **Auto search** before starting measurement.



Error Threshold: 1.0E-3
Fine/Coarse: Fine
Auto Search: OFF

Figure 5.10.3-3 Setting measurement conditions

The bit error rate for the clock phase and threshold voltage at the start of Eye Margin measurement must be less than the specified rate in order to obtain valid results.
Also, synchronization with the MU183040A/41A/40B/41B must be established (i.e., without Sync Loss) before the start of Eye Margin measurement.

5. Starting measurement

   Click **Start** to start Eye Margin measurement.

Start
Stop
Close

Figure 5.10.3-4 Measurement start button

6. Stopping measurement

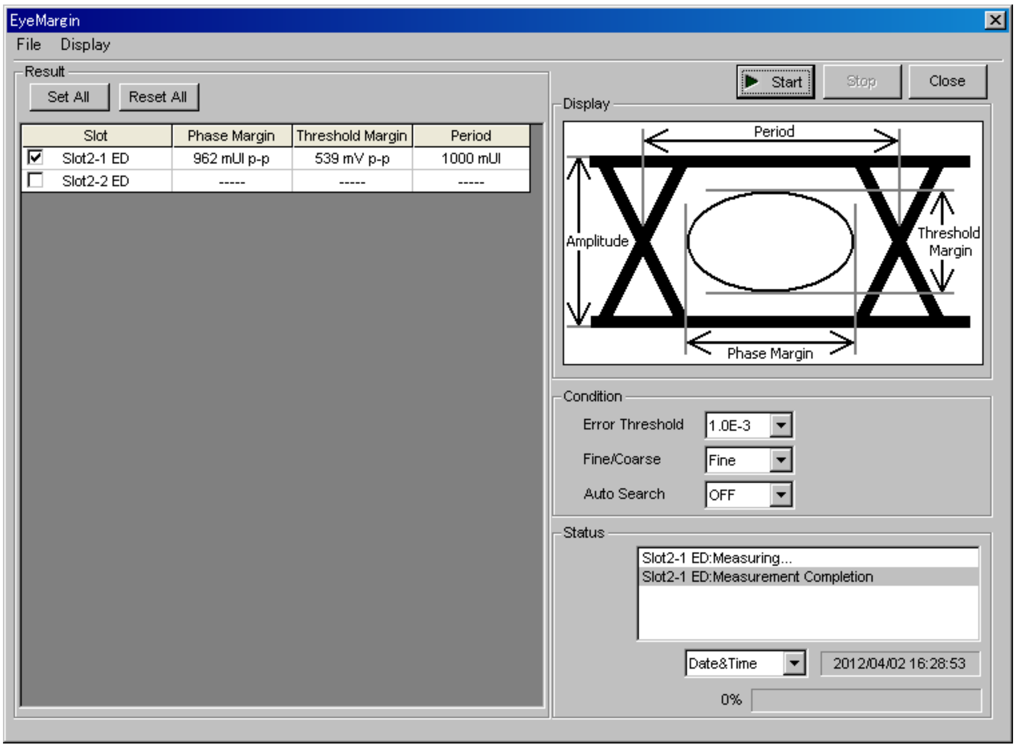
   Click **Stop** to stop the Eye Margin measurement.

Start
Stop
Close

Figure 5.10.3-5 Measurement stop button

7. Checking measurement results

   When the Eye Margin measurement is finished, "Measurement Completion" is displayed in the Status area, and the measurement results of phase margin, threshold margin, and period are displayed in the result display area (indicated by [3] in Figure 5.10.1-1).


EyeMargin
File
Display
Result
Set All
Reset All
Start
Stop
Close
Display
Period
Amplitude
Threshold Margin
Phase Margin
Condition
Status

Slot	Phase Margin	Threshold Margin	Period
☑ Slot2-1 ED	962 mUI p-p	539 mV p-p	1000 mUI
☐ Slot2-2 ED	-----	-----	-----

Error Threshold: 1.0E-3
Fine/Coarse: Fine
Auto Search: OFF

Slot2-1 ED:Measuring...
Slot2-1 ED:Measurement Completion

Date&Time 2012/04/02 16:28:53
0%

Figure 5.10.3-6 Eye Margin window with measurement results displayed

5.11 Eye Diagram Measurement

An eye diagram is a means for measuring digital signal quality. It visualizes an open-eye margin two-dimensionally.

For example, an eye diagram measurement can be used when it is required to measure the margin in the setting range for the threshold voltage and clock phase of a decision circuit, while quality with an error rate of E–12 or lower should be secured. In this event, a contour at an error rate of E–12 measured with eye diagram measurement can be obtained as a result. The required quality can be secured in the area inside the contour. Therefore, the wider this area, the higher the signal quality.

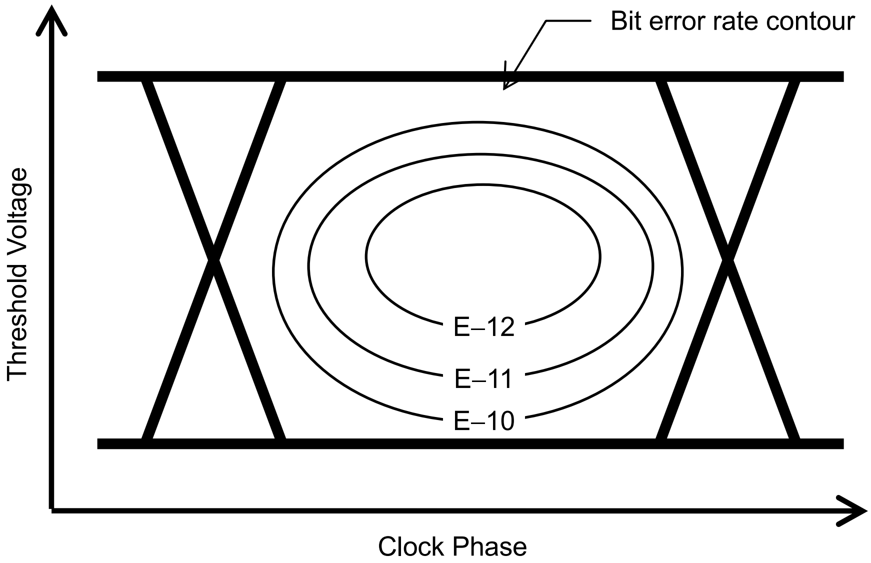


Figure 5.11-1 Schematic diagram of Eye Diagram measurement

To use the Eye Diagram measurement function, click the **Auto Measurement** ( ) module function button, and then select **Eye Diagram (32G)**. Refer to the *MX180000A Signal Quality Analyzer Control Software Operation Manual* for details.

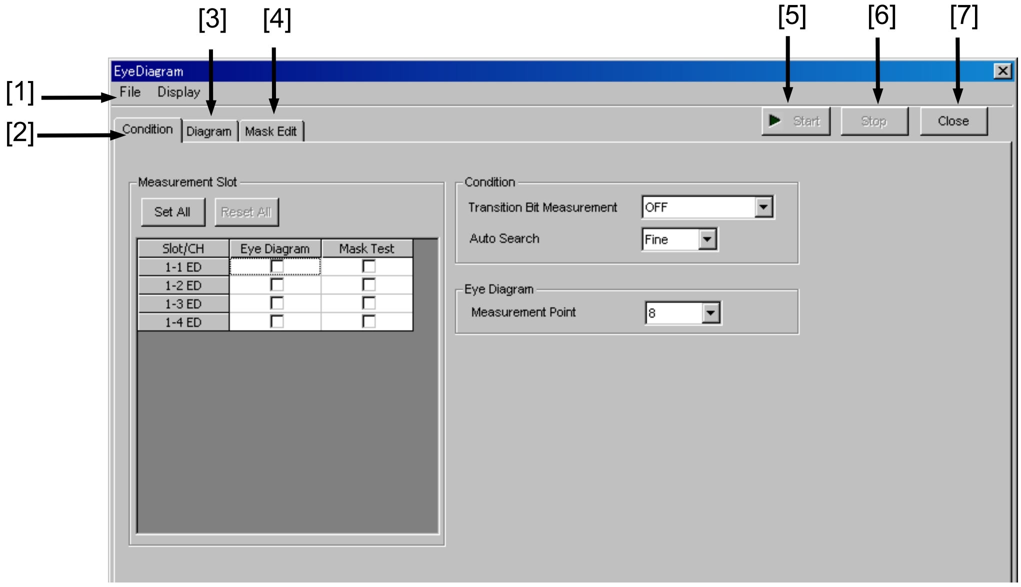
Note:

Eye Diagram measurement cannot be performed for the following cases.

- When **Burst** is selected from the **Pattern Sequence** list box on the **Misc1** tab
- During Auto Adjust
- When **Auto Sync** is set to **OFF**
- When the **Input** tab is grouped together with the other tab

5.11.1 Eye Diagram window

Figure 5.11.1-1 shows the Eye Diagram window.


[3]
[4]
[5]
[6]
[7]
[1]
[2]
EyeDiagram
File
Display
Condition
Diagram
Mask Edit
Start
Stop
Close
Measurement Slot
Set All
Reset All
Condition
Eye Diagram

Slot/CH	Eye Diagram	Mask Test
1-1 ED	☐	☐
1-2 ED	☐	☐
1-3 ED	☐	☐
1-4 ED	☐	☐

Transition Bit Measurement: OFF
Auto Search: Fine
Measurement Point: 8

Figure 5.11.1-1 Eye Diagram window

[1] Menu bar
Refer to Section 5.11.8 "Menu items" for details.

[2] **Condition** tab
Click to open the **Condition** tab.

[3] **Diagram** tab
Click to open the **Diagram** tab.

[4] **Mask Edit** tab
Click to open the **Mask Edit** tab.

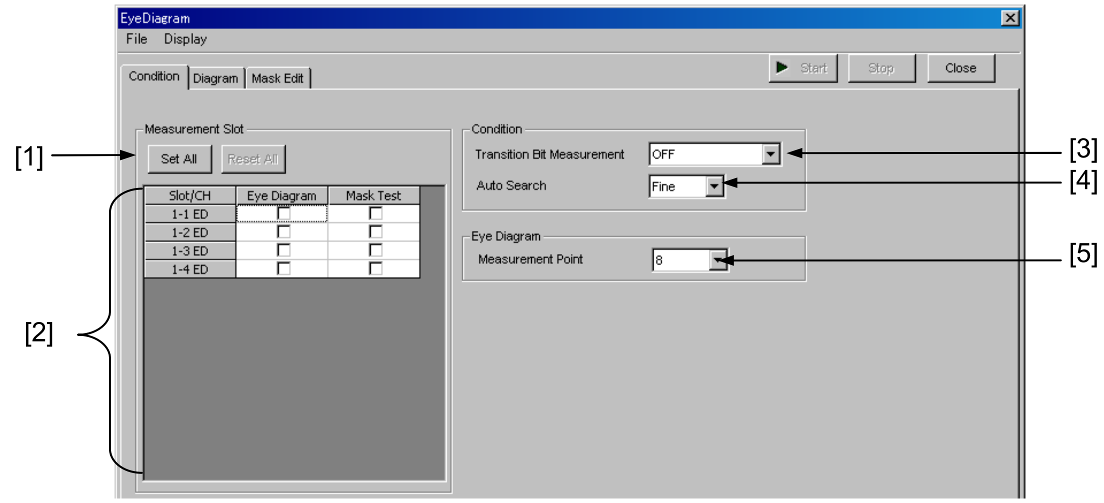
[5] **Start**
This button is available when at least one of the **Measurement Slot** check boxes is selected. Interfaces selected by check boxes in **Measurement Slot** are measured simultaneously.

[6] **Stop**
Stops the Eye Diagram measurement.

[7] **Close**
Closes the Eye Diagram window.

5.11.2 Condition tab

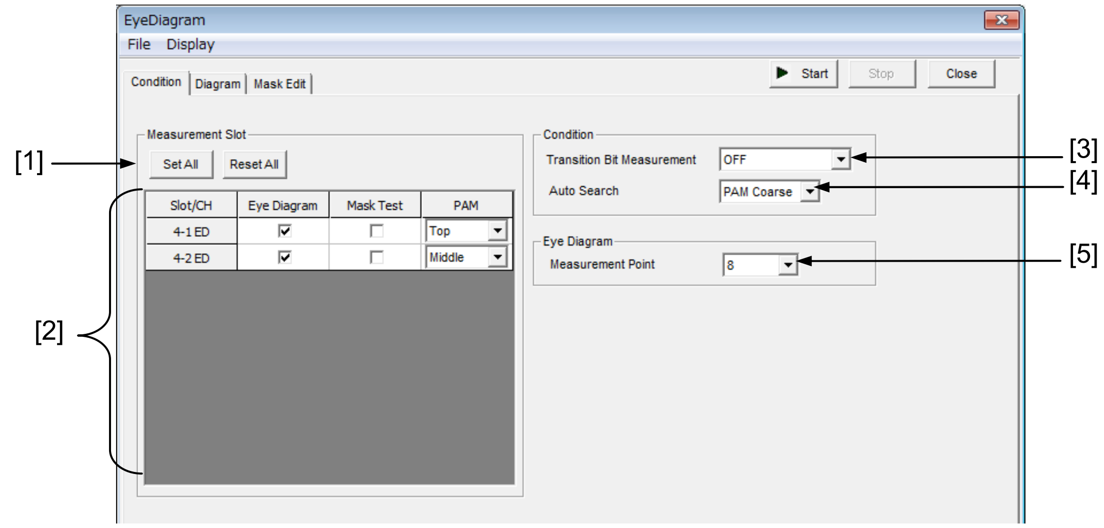
Figure 5.11.2-1 shows the **Condition** tab.


EyeDiagram
File
Display
Condition
Diagram
Mask Edit
Start
Stop
Close
Measurement Slot
Set All
Reset All
Condition
Eye Diagram
[1]
[2]
[3]
[4]
[5]

Slot/CH	Eye Diagram	Mask Test
1-1 ED	☐	☐
1-2 ED	☐	☐
1-3 ED	☐	☐
1-4 ED	☐	☐

Transition Bit Measurement: OFF
Auto Search: Fine
Measurement Point: 8

Figure 5.11.2-1 Condition tab


EyeDiagram
File
Display
Condition
Diagram
Mask Edit
Start
Stop
Close
Measurement Slot
Set All
Reset All
Condition
Eye Diagram
[1]
[2]
[3]
[4]
[5]

Slot/CH	Eye Diagram	Mask Test	PAM
4-1 ED	☑	☐	Top
4-2 ED	☑	☐	Middle

Transition Bit Measurement: OFF
Auto Search: PAM Coarse
Measurement Point: 8

Figure 5.11.2-2 Condition tab (PAM mode)

[1] Set All and Reset All

Set All: Selects all the displayed channels.

Reset All: Deselects all the displayed channels.

[2] Select the slot targeted for the Eye Diagram measurement. The slot number where the MU183040A/41A/40B/41B is inserted and the number of the channel are displayed. Select the check box for the slot to be measured. The Eye Diagram measurement is performed for the Eye Diagram and Mask Test of the selected slot. If **PAM Coarse** or **PAM Fine** is selected in the **Auto Search** list box, each of

the selected channels is followed by the **PAM** list box, where you can specify **Top**, **Middle**, or **Bottom**.

[3] Transition Bit Measurement

Set the transition bit measurement. Note, however, that transition bit measurement is impossible in the case of Combination. Only OFF is valid in this event.

OFF:	All bits are measured.
Transition bit:	Transition bits are measured but non-transition bits are not measured.
Non Transition bit:	Non-Transition bits are measured but Transition bits are not measured.

A transition bit is a bit whose level changes (0 → 1 or 1 → 0) from that of the previous bit. A non-transition bit is a bit whose level is the same as that of the previous bit.

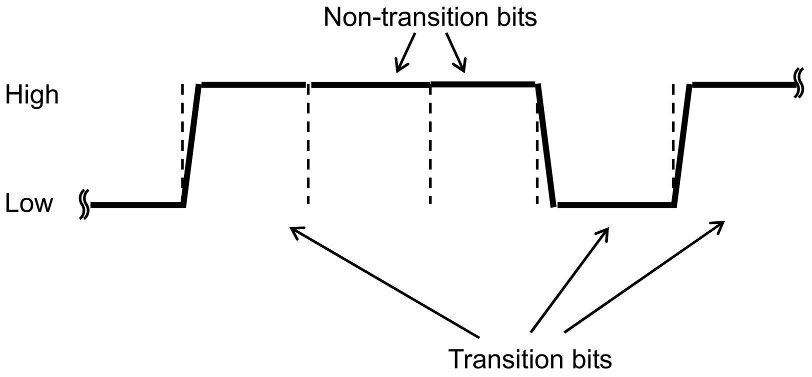


Figure 5.11.2-3 Transition bits and non-transition bits

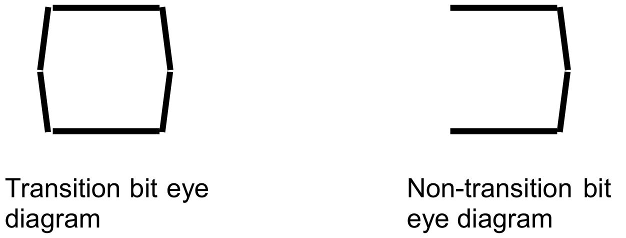


Figure 5.11.2-4 Eye diagrams of transition and non-transition bits

When **Transition bit** or **Non Transition bit** is selected, the number of bits to be measured decreases compared with when **OFF** is selected. Consequently, the number of measurement bits per unit time decreases, resulting in longer measurement time.

[4] Auto Search

Select the auto search On/Off when starting measurement.

OFF:	It is measured based on current phase and threshold.
Coarse:	It is measured based on the phase and threshold after performing Auto Search Coarse.
Fine:	It is measured based on the phase and threshold after performing Auto Search Fine.
PAM Coarse*:	Measurement is performed based on the phase and threshold after performing Auto Search PAM Coarse. If this option is selected, each of the channels needs to be set respectively to **Top**, **Middle**, or **Bottom**.
PAM Fine*:	Measurement is performed based on the phase and threshold after performing Auto Search PAM Fine. If this option is selected, each of the channels needs to be set respectively to **Top**, **Middle**, or **Bottom**.

*: This mode is available only when your module is MU183040B or MU183041B.

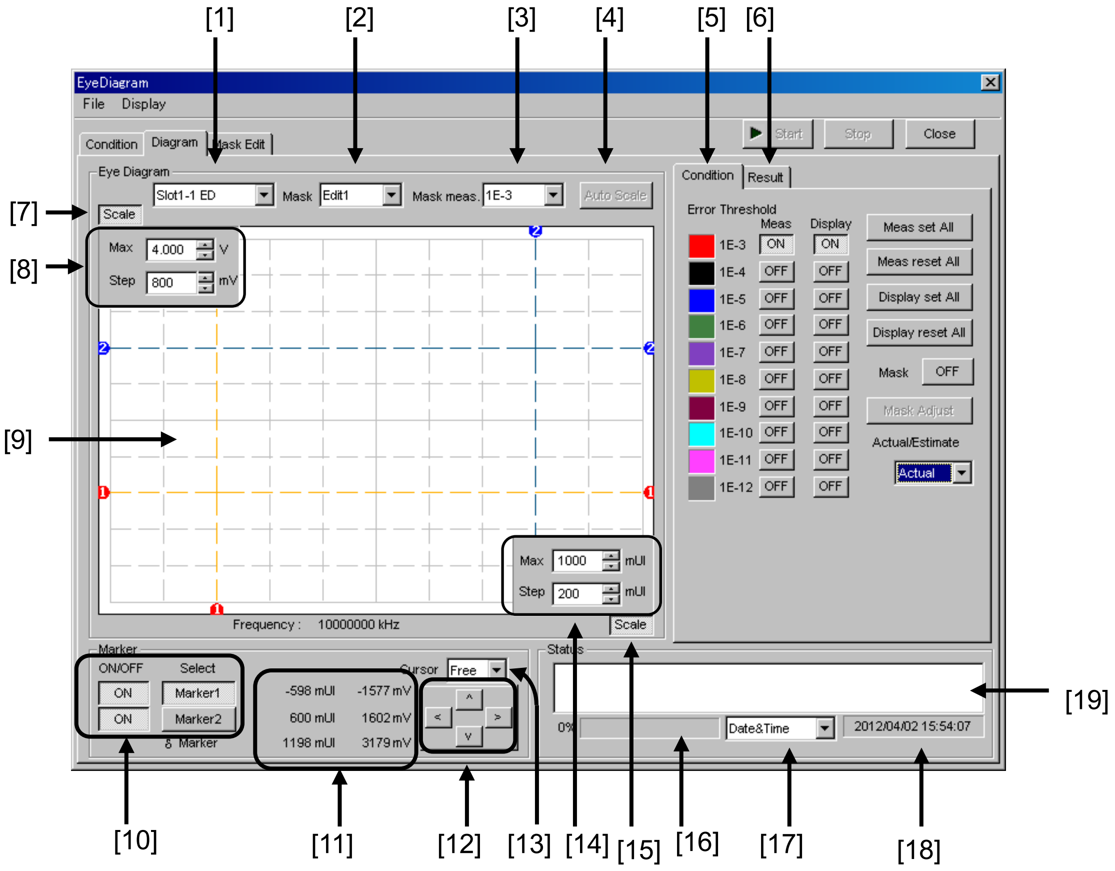
[5] Measurement Point

Set the number of Eye Diagram measurement points to 8, 16, 32, 64, or 128. More detailed measurement is performed when the number of measurement points increases, but at the same time, the measurement time also increases.

Note that Estimate measurement cannot be performed if the number of measurement points is 8. Set 16 or greater when performing Estimate measurement.

5.11.3 Diagram tab

Figure 5.11.3-1 shows the Diagram tab.


[1]
[2]
[3]
[4]
[5]
[6]
[7]
[8]
[9]
[10]
[11]
[12]
[13]
[14]
[15]
[16]
[17]
[18]
[19]
EyeDiagram
File
Display
Condition
Diagram
Mask Edit
Start
Stop
Close
Eye Diagram
Auto Scale
Scale
Condition
Result
Error Threshold
Meas
Display
Meas set All
Meas reset All
Display set All
Display reset All
Mask
Mask Adjust
Actual/Estimate
Marker
ON/OFF
Select
Marker1
Marker2
Marker
Status
0%

Slot1-1 ED
Mask Edit1
Mask meas. 1E-3
Max 4.000 V
Step 800 mV
Max 1000 mUI
Step 200 mUI
Frequency : 10000000 kHz
Cursor Free
-598 mUI -1577 mV
600 mUI 1602 mV
1198 mUI 3179 mV
Mask OFF
Actual/Estimate Actual
Date&Time 2012/04/02 15:54:07

	Meas	Display
🟥 1E-3	ON	ON
⬛ 1E-4	OFF	OFF
🟦 1E-5	OFF	OFF
🟩 1E-6	OFF	OFF
🟪 1E-7	OFF	OFF
🟨 1E-8	OFF	OFF
🟫 1E-9	OFF	OFF
1E-10	OFF	OFF
1E-11	OFF	OFF
1E-12	OFF	OFF

Figure 5.11.3-1 Diagram tab

[1] Select the slot number where the MU183040A/41A/40B/41B is inserted and the number of channel to be measured. Only slots where an MU183040A/41A/40B/41B is inserted can be selected.

[2] Mask
Select a mask to be displayed in the graph (“[9]” in Figure 5.11.3-1) from Edit1 through Edit4, which are created on the **Mask Edit** tab.

[3] Mask meas.
Select the error rate that corresponds to the mask selected in the **Mask** list box, from 1E–3 to 1E–12.

[4] **Auto Scale**
When this button is clicked, the vertical and horizontal axes on the graph ([9] in Figure 5.11.3-1) are automatically adjusted to be suitable for Diagram and Mask to be displayed.

[5] **Condition** tab
Click to display the **Condition** tab.

[6] **Result** tab

Click to open the **Result** tab.

[7] **Scale** (Vertical)

On: Displays the **Max** and **Step** boxes (indicated by “[8]” in Figure 5.11.3-1). The threshold scale on the vertical axis can be set by entering values in these boxes.

Off: Hides the **Max** and **Step** boxes and displays the Max and Step values of the vertical axis on the right of this button.

[8] **Max** and **Step** boxes (Vertical)

These boxes are displayed when **Scale** (Vertical) (indicated by “[7]” in Figure 5.11.3-1) is on.

Max: Set the upper limit of the vertical axis.
Setting range: –3.990 to +4.000 V
Resolution: 0.001 V

Step: Set the scale of the vertical axis.
Setting range: 1 to 800 mV
Resolution: 1 mV

[9] Graph

Eye Diagram and Mask are displayed.

[10] Marker

Specify whether to display or hide Marker1 and Marker2. The selected marker can be moved using the arrow keys (indicated by [12] in Figure 5.11.3-1). The marker can also be moved by moving the cursor onto the cross point of the target marker on the graph (the cursor changes to a cross icon at this time) and dragging it.

[11] Threshold voltage and phase value

The threshold voltage and phase value for Marker1 and Marker2 are displayed. The “δ” Marker shows a difference between Marker 1 and Marker2.

[12] Arrow keys

Click an arrow key to move the marker selected in [10] in the corresponding direction (up/down/left/right). The marker moves by 2 mUI or 1 mV each time a key is clicked once.

[13] Cursor

Select the Marker1/2 operation.

Free: The Marker operation is not restricted.

Point: The Marker can select the measured diagram points only.

[14] **Max** and **Step** boxes (Horizontal)

These boxes are displayed when **Scale** (Horizontal) (indicated by [15] in Figure 5.11.3-1) is on.

Max: Set the upper limit of the horizontal axis.
Setting range: –990 to +1000 mUI
Resolution: 1 mUI

Step: Set the scale of the horizontal axis.
Setting range: 1 to 200 mUI
Resolution: 1 mUI

[15] **Scale** (Horizontal)

On: Displays the **Max** and **Step** boxes (indicated by [14] in Figure 5.11.3-1). The phase value scale on the horizontal axis can be set by entering values in these boxes.

Off: Hides the **Max** and **Step** boxes and displays the Max and Step values of the horizontal axis on the left of this button.

[16] Indicates the measurement progress as a percentage and a gauge.

[17] Select the time to be displayed.

Date & Time	Current time
Start Time:	Measurement start time
Elapsed Time:	Time elapsed from the measurement start time

Upon completion of measurement of all modules, the elapsed time display stops.

[18] Displays the time related to the measurement. The displayed time can be selected from the list box on the left (refer to [17]).

[19] The measurement status and result (whether the measurement was finished normally) are displayed for each slot.

Measuring:	The Eye Diagram measurement is being performed.
Measurement Completion:	The Eye Diagram measurement has finished normally.
Failure:	The Eye Diagram measurement has failed.

When Sync Loss, Clock Loss, CR Unlock, or Out of Range is detected, it is displayed in this area. All results can be viewed by using the scroll bar.

Display example:
Slot4-1 ED: Measuring…
Slot4-1 ED: Measurement Completion
Slot5-1 ED: Measuring…
Slot5-1 ED: Sync Loss
Upon completion of measurement of all modules, the elapsed time display stops.

5.11.4 Setting items on the Condition tab

Figure 5.11.4-1 shows the setting items on the **Condition** tab.

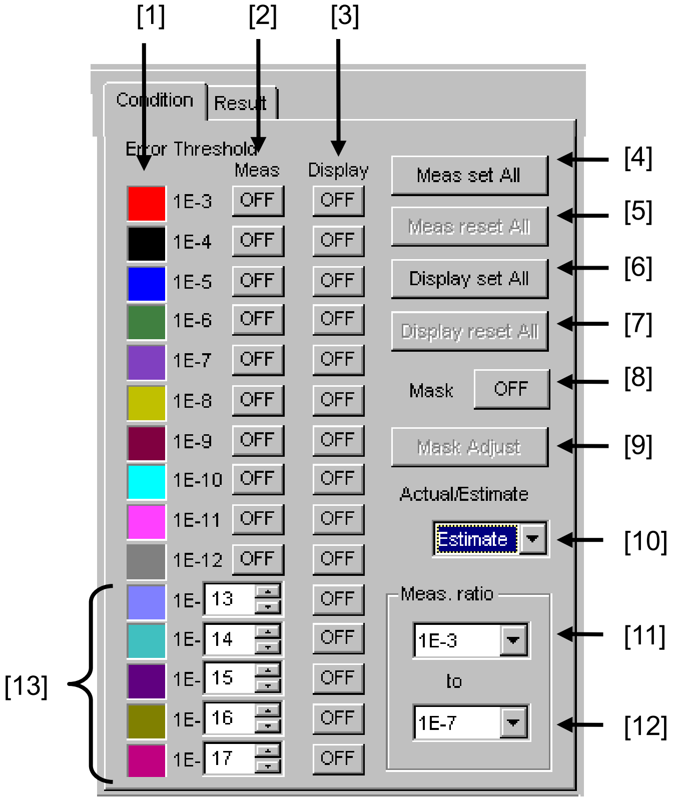

[1]
[2]
[3]
Condition
Result
Error Threshold
Meas
Display
1E-3 OFF OFF
1E-4 OFF OFF
1E-5 OFF OFF
1E-6 OFF OFF
1E-7 OFF OFF
1E-8 OFF OFF
1E-9 OFF OFF
1E-10 OFF OFF
1E-11 OFF OFF
1E-12 OFF OFF
1E- 13 OFF
1E- 14 OFF
1E- 15 OFF
1E- 16 OFF
1E- 17 OFF
[13]
Meas set All
Meas reset All
Display set All
Display reset All
Mask OFF
Mask Adjust
Actual/Estimate
Estimate
Meas. ratio
1E-3
to
1E-7
[4]
[5]
[6]
[7]
[8]
[9]
[10]
[11]
[12]

Figure 5.11.4-1 Condition tab

[1] Error rate
Shows the correspondence between the color of a diagram displayed in the graph and the error rate.

[2] Meas.
Specifies whether to perform measurement for each error rate.

ON: Measures.
OFF: Does not measure.

[3] Display
Specifies whether to display a measurement result diagram in the graph for each error rate.

ON: Displays.
OFF: Does not display.

[4] Meas set All
Performs Eye Diagram measurement for all error rates.

[5] Meas reset All
Does not perform Eye Diagram measurement for all error rates.

[6] **Display set All**
Displays a measurement result diagram in the graph for all error rates.

[7] **Display reset All**
Does not display a measurement result diagram in the graph for any error rates.

[8] Mask
Specify whether to display a mask created on the **Mask Edit** tab in the graph.

ON: Displays a mask in the graph.
OFF: Does not display a mask in the graph.

Only one of Edit1 to Edit4 can be displayed.

[9] **Mask Adjust**
Adjust the displayed mask to the measurement result diagram. At this time, the measurement result diagram does not change and the threshold voltage and phase value of the mask are offset.

[10] Actual/Estimate
Select **Actual** or **Estimate** from the list box.
When **Estimate** is selected, the controls indicated by [11], [12], and [13] in the Figure 5.11.4-1 become enabled. Refer to Sections 5.11.2 “Condition tab” and 5.11.5 “Actual measurement and Estimate measurement” for details.

[11] Meas. ratio (lower limit)
Set the lower limit of the error rate required for the Estimate measurement. This setting is independent of the setting for the Actual measurement.

[12] Meas. ratio (upper limit)
Set the upper limit of the error rate required for the Estimate measurement. This setting is independent of the setting for the Actual measurement.

[13] Estimate
Set the error rate for the Estimate measurement. The initial setting value is 1E–13 to 1E–17. An arbitrary error rate can be set within the range from 1E–13 to 1E–199.

5.11.5 Actual measurement and Estimate measurement

The Eye Diagram measurement is provided with two measurement modes: Actual measurement and Estimate measurement.

In Actual measurement, the contours of the displayed bit error rate are based on actual measurements. The measurement error rate range is from E–3 to E–12.

Estimate measurement is useful for displaying a diagram for an error rate at which the measurement cannot be finished in a practical period of time. For example, when E–20 is selected, a 1-bit error will occur within 10^{10} seconds (> 317 years) even with a 10 Gbit/s signal. The measurement cannot be practically performed at this error rate.

In Estimate measurement, a statistical method is used to estimate a diagram for an unmeasured error rate, based on an assumption that the factor that causes a bit error is a Gaussian distribution noise.

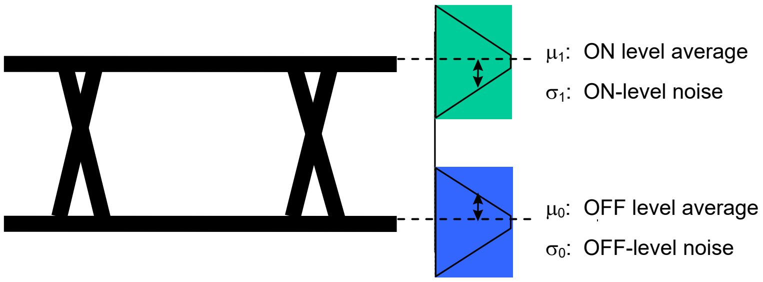
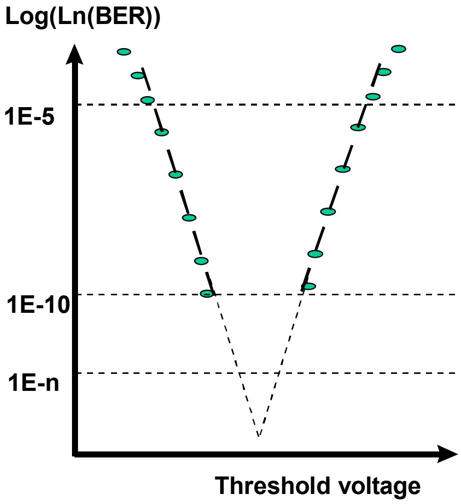

μ_1: ON level average
σ_1: ON-level noise
μ_0: OFF level average
σ_0: OFF-level noise

Figure 5.11.5-1 Eye pattern and Gaussian distribution noise

Noise distribution parameters, σ_0, σ_1, μ_0, and μ_1 can be obtained by measuring the correlation between the bit error rate and the threshold voltage in a certain range (refer to Figure 5.11.5-1). The bit error rate for an arbitrary threshold voltage can be calculated using the distribution and the expression shown in Figure 5.11.5-2.



$$\mathrm{BER}(D)=\frac{1}{2}\left\{\frac{e^{-\frac{\left(\frac{|\mu_1-D|}{\sigma_1}\right)^2}{2}}}{\left(\frac{|\mu_1-D|}{\sigma_1}\right)\sqrt{2\pi}}+\frac{e^{-\frac{\left(\frac{|\mu_0-D|}{\sigma_0}\right)^2}{2}}}{\left(\frac{|\mu_0-D|}{\sigma_0}\right)\sqrt{2\pi}}\right\}$$

Figure 5.11.5-2　Estimated noise distribution and BER estimating expression

Note:

During the Eye Diagram measurement, the Estimate function traces an Eye diagram for the error threshold, which was specified based on the measuring points in the Threshold and Phase directions, using both the point calculated from the Threshold direction and the point calculated from the Phase direction. Note that an Estimate Eye diagram for a lower error rate may therefore exceed an Estimate Eye diagram for a higher error in some points due to measurement results.

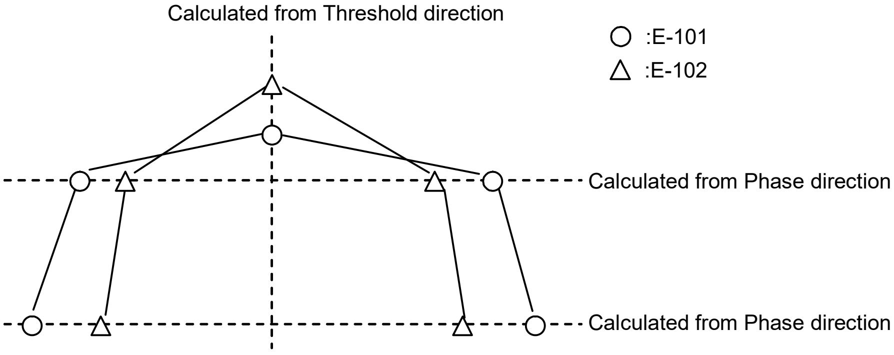
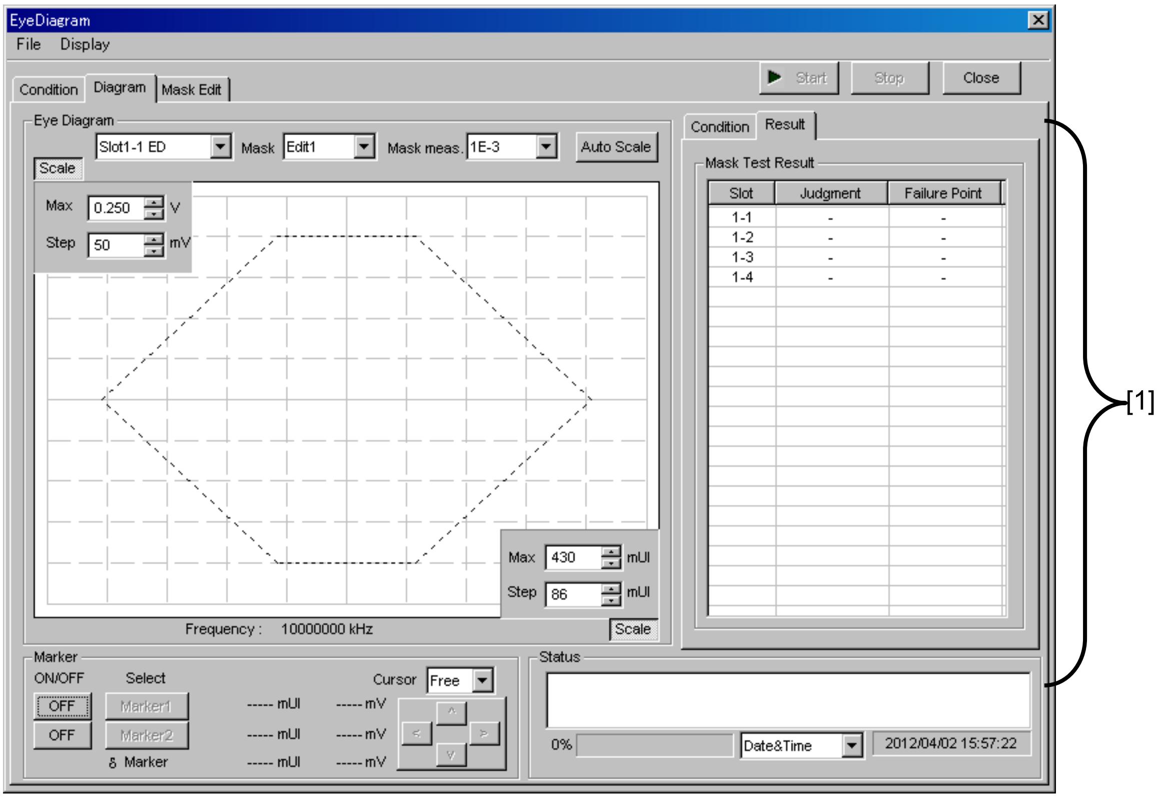

Calculated from Threshold direction
○ :E-101
△ :E-102
Calculated from Phase direction
Calculated from Phase direction

Figure 5.11.5-3　Example of tracing Estimate Eye diagram

5.11.6 Setting items on the Result tab

Figure 5.11.6-1 shows the setting items on the **Result** tab.


EyeDiagram
File
Display
Condition
Diagram
Mask Edit
Start
Stop
Close
Eye Diagram
Auto Scale
Scale
Condition
Result
Marker
ON/OFF
Select
OFF
OFF
Marker1
Marker2
δ Marker
Status
[1]

Slot1-1 ED

Mask: Edit1

Mask meas.: 1E-3

Max: 0.250 V

Step: 50 mV

Max: 430 mUI

Step: 86 mUI

Frequency : 10000000 kHz

----- mUI ----- mV

----- mUI ----- mV

----- mUI ----- mV

Cursor: Free

0%

Date&Time: 2012/04/02 15:57:22

Mask Test Result

Slot	Judgment	Failure Point
1-1	-	-
1-2	-	-
1-3	-	-
1-4	-	-

Figure 5.11.6-1 Result tab

[1] Mask Test Result

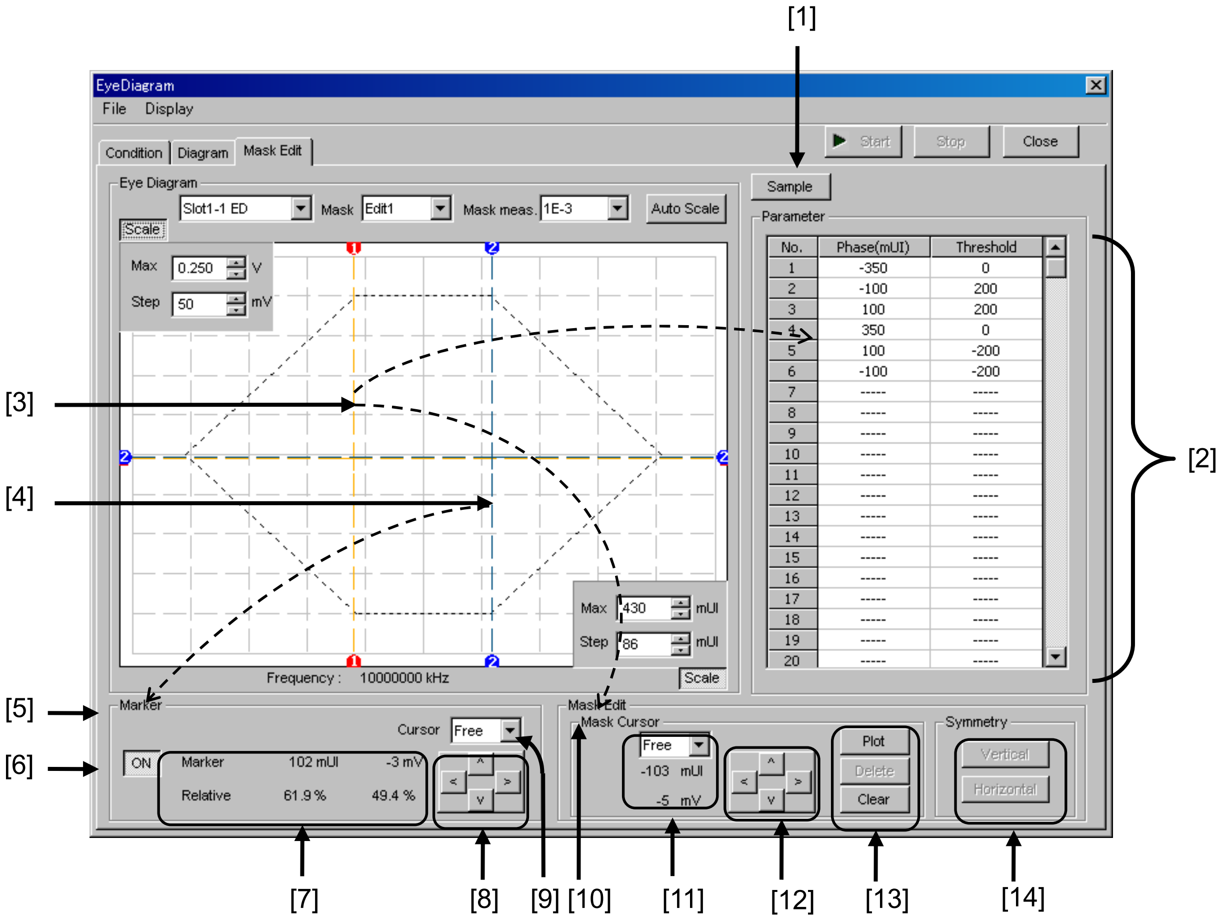
- Slot column:
  The mask test results for each channel are displayed.
- Judgment column

Pass:	Displayed when all the mask points satisfy the set error rate.
Failure:	Displayed when a mask point that does not satisfy the set error rate exists.

- Failure Point column
  The number of points that are evaluated as “Failure” is displayed.

5.11.7 Setting items on the Mask Edit tab

Figure 5.11.7-1 shows the setting items on the **Mask Edit** tab.


[1]
EyeDiagram
File Display
Condition
Diagram
Mask Edit
Start
Stop
Close
Eye Diagram
Sample
Parameter
Scale
Auto Scale
Frequency :
[2]
[3]
[4]
[5]
[6]
Marker
Mask Edit
Mask Cursor
Symmetry
ON
Plot
Delete
Clear
Vertical
Horizontal
[7]
[8]
[9] [10]
[11]
[12]
[13]
[14]

Slot1-1 ED · Mask Edit1 · Mask meas. 1E-3

Max 0.250 V · Step 50 mV

Max 430 mUI · Step 86 mUI

Frequency : 10000000 kHz

Cursor Free

Marker	102 mUI	-3 mV
Relative	61.9 %	49.4 %

Mask Cursor: Free · -103 mUI · -5 mV

No.	Phase(mUI)	Threshold
1	-350	0
2	-100	200
3	100	200
4	350	0
5	100	-200
6	-100	-200
7	-----	-----
8	-----	-----
9	-----	-----
10	-----	-----
11	-----	-----
12	-----	-----
13	-----	-----
14	-----	-----
15	-----	-----
16	-----	-----
17	-----	-----
18	-----	-----
19	-----	-----
20	-----	-----

Figure 5.11.7-1 Mask Edit tab

[1] Sample

Opens a mask pattern sample file conforming to typical standards. The sample files can only be loaded, and cannot be overwritten. When a sample file is changed on the **Mask Edit** tab, it can be saved as a user-defined file. When a sample file is loaded, it is displayed on the graph and the coordinates of each point are displayed in the Parameter field ([2] in Figure 5.11.7-1).

[2] Parameter

Displays the point coordinates (Phase mUI and Threshold mV) of the mask displayed in the graph.

[3] Mask Cursor (orange)
Indicates the point to be edited by the controls in the Mask Edit field ([10] in Figure 5.11.7-1). The point can be moved by clicking and dragging the cross point. The mask cursor can be moved using the arrow keys ([12] in Figure 5.11.7-1). The marker can be moved by moving the cursor onto the cross point of the target marker on the graph (the cursor changes to a cross icon at this time) and dragging it.

[4] Marker (blue)
Indicates the marker displayed in the Marker field ([5] in Figure 5.11.7-1).

[5] Marker field
Displays the information on the marker displayed in the graph when the button indicated by [6] in Figure 5.11.7-1 is selected to ON.

[6] Click to display/hide the marker.

ON: The marker is displayed.

OFF: The marker is hidden.

[7] Displays the coordinates of the marker when the button indicated by [6] in Figure 5.11.7-1 is selected to ON.

Marker: Phase value (in mUI units) and threshold voltage (in mV units)

Relative: Displays the percentage in the displayed graph.

[8] Arrow keys
Click an arrow key to move the marker in the corresponding direction (up/down/left/right). The marker moves by 2 mUI or 1 mV each time a key is clicked once.

[9] Cursor
Select the Marker operation.

Free: The Marker operation is not restricted.

Point: The Marker can select only the points on the set masks.

[10] Mask Edit field
Provides the controls to edit the coordinate in the graph (indicated by [3] in Figure 5.11.7-1) as the mask point.

[11] Displays the coordinates of the mask cursor.

[12] Arrow keys
Click an arrow key to move the selected mark cursor in the corresponding direction (up/down/left/right). The mask cursor moves by 2 mUI or 1 mV each time a key is clicked once.

[13] Mask cursor edit buttons

Plot: Plots the coordinates of the mask cursor. The plotted point is added into the Parameter field.

Delete: Deletes the mask point near the mask cursor. The deleted point is removed from the Parameter field.

Clear: Deletes all the mask points.

[14] Symmetry

Provides the buttons to add a point such that this point and the mask point displayed on the graph will be symmetrically located about the vertical or horizontal axis. Note that a horizontal or vertical symmetric point can only be added once for one mask point.

Vertical: Adds an upper or lower symmetric point based on the horizontal axis.

Horizontal: Adds a left or right symmetric point based on the vertical axis.

5.11.8 Menu items

Table 5.11.8-1 lists the menu items provided in the Eye Diagram window. No menu items can be selected during measurement.

Table 5.11.8-1 Menu items in Eye Diagram window

Menu	Menu Item				Function
File	Open				Opens a file. The file name is displayed as a screen title.
	Save	Data Type	Eye Diagram Result		Saves Eye Diagram measurement results.
			Eye Mask Point Result		Saves Eye Mask Point measurement results.
			Eye Mask Template		Saves Eye Mask Template measurement results. Only text format is supported.
		File Type	Binary		Saves results in binary format.
			CSV		Saves results in CSV format.
			Text		Saves results in text format.
	Screen Copy	Execute			Executes the screen copy according to the setting in **Screen Copy** → **Setup**.
		Setup	Save Type	BMP	Saves data in BMP format.
				PNG	Saves data in PNG format.
				JPG	Saves data in JPG format.
			Output	to File	Outputs data in the window to a file.
				to Printer	Outputs data in the window to a printer.
			Save to		Opens the dialog box showing the specified saving directory. The saving directory can be specified in this dialog box.
	Initialize				Initializes all the settings and measurement results.
	Exit				Closes the Eye Diagram window.
Display	mUI				Sets the phase unit to mUI.
	ps				Sets the phase unit to ps.

Notes:

- The screen-shot file (created by Screen Copy → Execute) is saved in the name format of “SC” + “date and time”.

- The settings will not be read from the saved file if the file name is changed.

5.11.9 How to perform Eye Diagram measurement

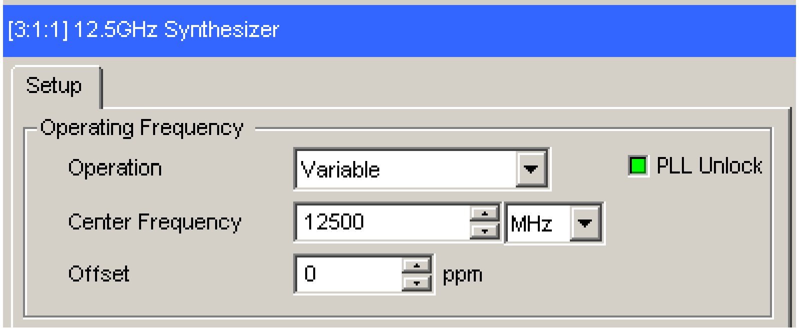
This section provides a basic procedure for performing Eye Diagram measurement.

1. Checking connection

   Check that the MU183020A/21A, DUT, and MU183040A/41A/40B/41B are correctly connected.

2. Setting frequency

   Set the frequency by the synthesizer.


[3:1:1] 12.5GHz Synthesizer
Setup
Operating Frequency
🟩 PLL Unlock

Operation: Variable

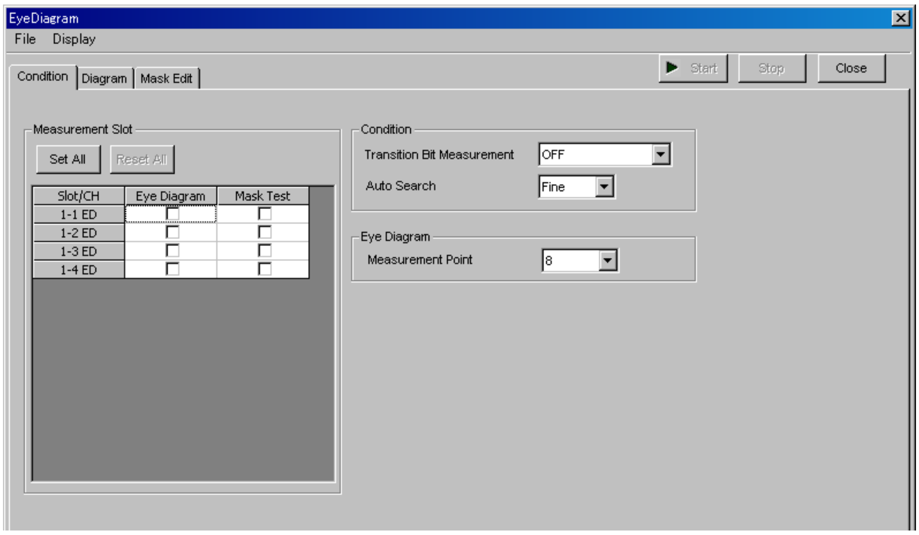
Center Frequency: 12500 MHz

Offset: 0 ppm

Figure 5.11.9-1 MU181000A 12.5GHz Synthesizer window

3. Selecting slot to be measured

   Start the Eye Diagram window in automatic measurement, then select the **Eye Diagram** check box of the Slot/CH to be measured, and then set **Transition Bit Measurement** and **Measurement Point**.


EyeDiagram
File
Display
Condition
Diagram
Mask Edit
Start
Stop
Close
Measurement Slot
Set All
Reset All
Condition
Eye Diagram

Slot/CH	Eye Diagram	Mask Test
1-1 ED	☐	☐
1-2 ED	☐	☐
1-3 ED	☐	☐
1-4 ED	☐	☐

Transition Bit Measurement: OFF

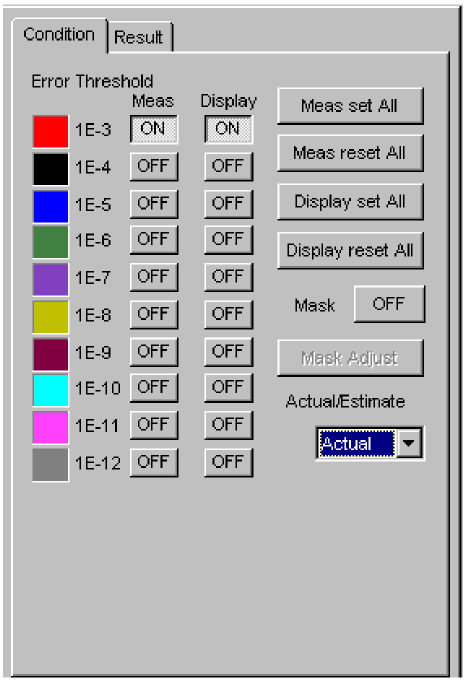
Auto Search: Fine

Measurement Point: 8

Figure 5.11.9-2 Eye Diagram window

4. Setting measurement conditions

   Set **Error Threshold** and **Actual/Estimate**.


Condition
Result
Meas set All
Meas reset All
Display set All
Display reset All
Mask Adjust

Error Threshold

	Meas	Display
1E-3	ON	ON
1E-4	OFF	OFF
1E-5	OFF	OFF
1E-6	OFF	OFF
1E-7	OFF	OFF
1E-8	OFF	OFF
1E-9	OFF	OFF
1E-10	OFF	OFF
1E-11	OFF	OFF
1E-12	OFF	OFF

Mask OFF

Actual/Estimate: Actual

Figure 5.11.9-3 Setting measurement conditions

5. Starting measurement

   Click **Start** to start Eye Diagram measurement.

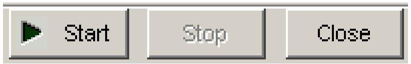

Start
Stop
Close

Figure 5.11.9-4 Measurement start button

6. Stopping measurement

   Click **Stop** to stop the Eye Diagram measurement.

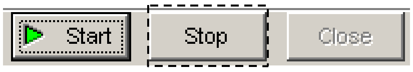
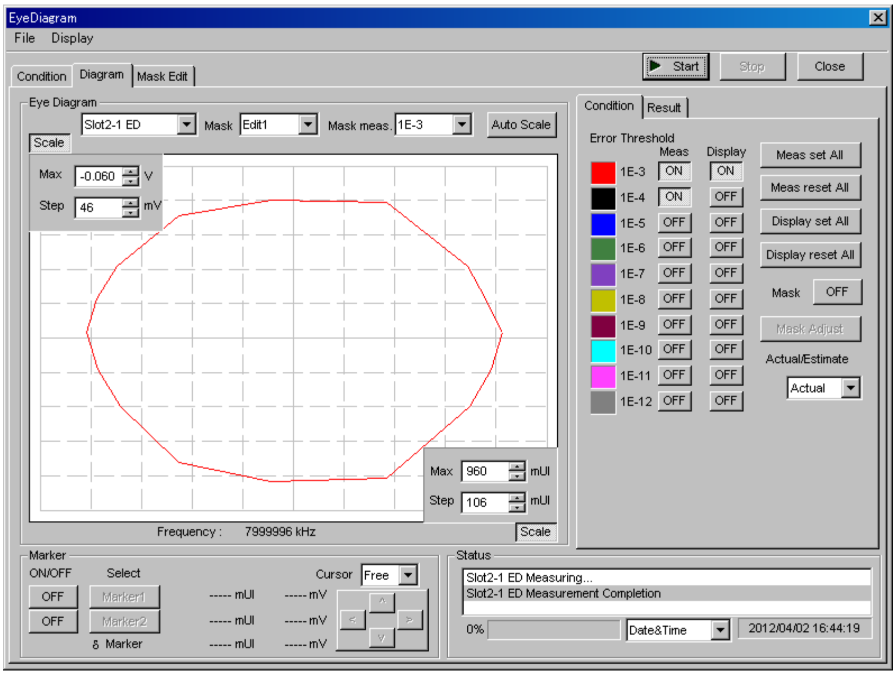

Start
Stop
Close

Figure 5.11.9-5 Measurement stop button

7. Checking measurement results

When the Eye Diagram measurement is finished, an Eye diagram of the measurement result is displayed in the graph. Eye diagrams for the error rates with **Display** set to **ON** are displayed. The color of a displayed Eye diagram accords to the color selected on the **Condition** tab.


EyeDiagram
File
Display
Condition
Diagram
Mask Edit
Start
Stop
Close
Eye Diagram
Auto Scale
Scale
Condition
Result
Error Threshold
Meas set All
Meas reset All
Display set All
Display reset All
Mask Adjust
Marker
ON/OFF
Select
OFF
OFF
Marker1
Marker2
δ Marker
Cursor
Status

Slot2-1 ED
Mask Edit1
Mask meas. 1E-3

Max -0.060 V
Step 46 mV

Max 960 mUI
Step 106 mUI

Frequency : 7999996 kHz

		Meas	Display
🟥	1E-3	ON	ON
■	1E-4	ON	OFF
🟦	1E-5	OFF	OFF
🟩	1E-6	OFF	OFF
🟪	1E-7	OFF	OFF
🟨	1E-8	OFF	OFF
■	1E-9	OFF	OFF
■	1E-10	OFF	OFF
■	1E-11	OFF	OFF
■	1E-12	OFF	OFF

Mask OFF
Actual/Estimate Actual

----- mUI ----- mV
----- mUI ----- mV
----- mUI ----- mV
Cursor Free

Slot2-1 ED Measuring...
Slot2-1 ED Measurement Completion

0% Date&Time 2012/04/02 16:44:19

Figure 5.11.9-6 Eye Diagram window with measurement results displayed

5.11.10 How to perform Mask Test measurement

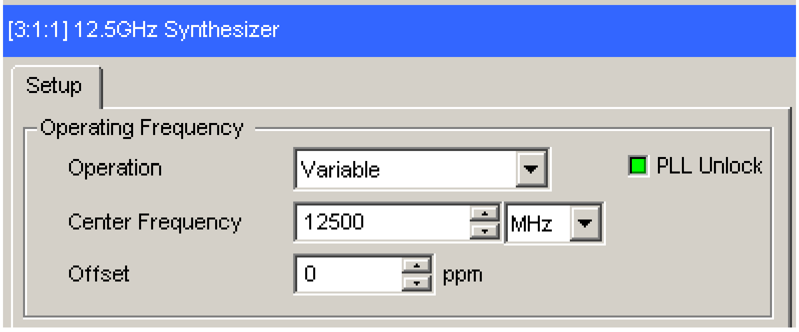
This section provides a basic procedure for performing Mask Test measurement.

1. Checking connection

   Check that the MU183020A/21A, DUT, and MU183040A/41A/40B/41B are correctly connected.

2. Setting frequency

   Set the frequency by the synthesizer.


[3:1:1] 12.5GHz Synthesizer
Setup
Operating Frequency
🟩 PLL Unlock

Operation: Variable

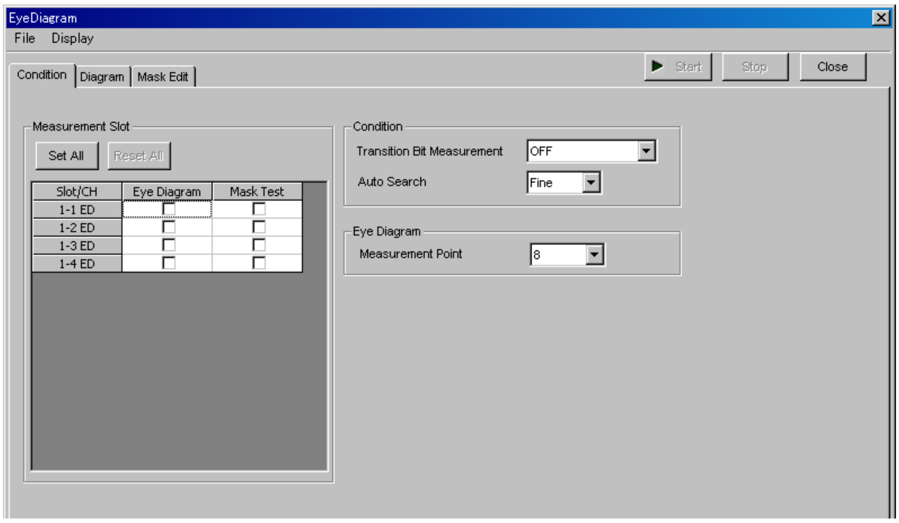
Center Frequency: 12500 MHz

Offset: 0 ppm

Figure 5.11.10-1 MU181000A 12.5GHz Setting frequency

3. Selecting slot/channel to be measured

   Select the **Mask Test** check box of the slot/channel to be measured on the **Condition** tab of the Eye Diagram measurement window in MU183040A/41A/40B/41B, and then set **Fine** or **Coarse**, **Transition Bit Measurement**, and **Measurement Point**.


EyeDiagram
File
Display
Condition
Diagram
Mask Edit
Start
Stop
Close
Measurement Slot
Set All
Reset All
Condition
Eye Diagram

Slot/CH	Eye Diagram	Mask Test
1-1 ED	☐	☐
1-2 ED	☐	☐
1-3 ED	☐	☐
1-4 ED	☐	☐

Transition Bit Measurement: OFF

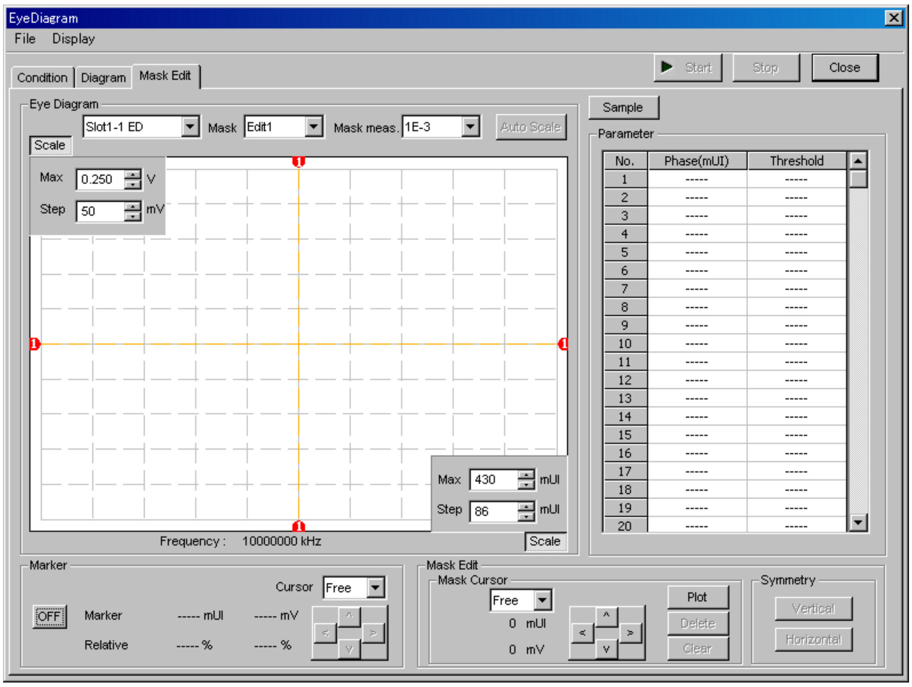
Auto Search: Fine

Measurement Point: 8

Figure 5.11.10-2 Selecting slot/channel

4. Setting a mask

   Configure the mask settings on the **Mask Edit** tab. One of Edit1 to Edit4 can be set as the mask.


EyeDiagram
File
Display
Start
Stop
Close
Condition
Diagram
Mask Edit
Auto Scale
Sample
Scale
Plot
Delete
Clear
Vertical
Horizontal
OFF

Eye Diagram: Slot1-1 ED, Mask: Edit1, Mask meas.: 1E-3

Scale: Max 0.250 V, Step 50 mV

Scale: Max 430 mUI, Step 86 mUI

Frequency : 10000000 kHz

Parameter

No.	Phase(mUI)	Threshold
1	-----	-----
2	-----	-----
3	-----	-----
4	-----	-----
5	-----	-----
6	-----	-----
7	-----	-----
8	-----	-----
9	-----	-----
10	-----	-----
11	-----	-----
12	-----	-----
13	-----	-----
14	-----	-----
15	-----	-----
16	-----	-----
17	-----	-----
18	-----	-----
19	-----	-----
20	-----	-----

Marker: Cursor Free

Marker ----- mUI ----- mV

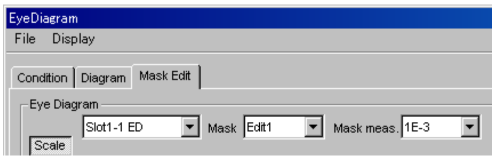
Relative ----- % ----- %

Mask Edit, Mask Cursor: Free, 0 mUI, 0 mV

Symmetry

Figure 5.11.10-3 Mask setting window

Set **Mask** and the error threshold for each slot or channel.


EyeDiagram
File
Display
Condition
Diagram
Mask Edit
Scale

Eye Diagram: Slot1-1 ED, Mask: Edit1, Mask meas.: 1E-3

Figure 5.11.10-4 Selecting mask

5. Starting measurement

   Click **Start** to start Eye Diagram measurement.

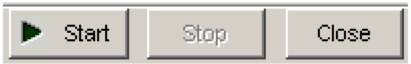

Start
Stop
Close

Figure 5.11.10-5 Measurement start button

6. Stopping measurement

   Click **Stop** to stop the Eye Diagram measurement.

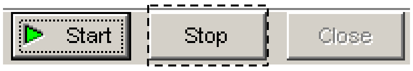
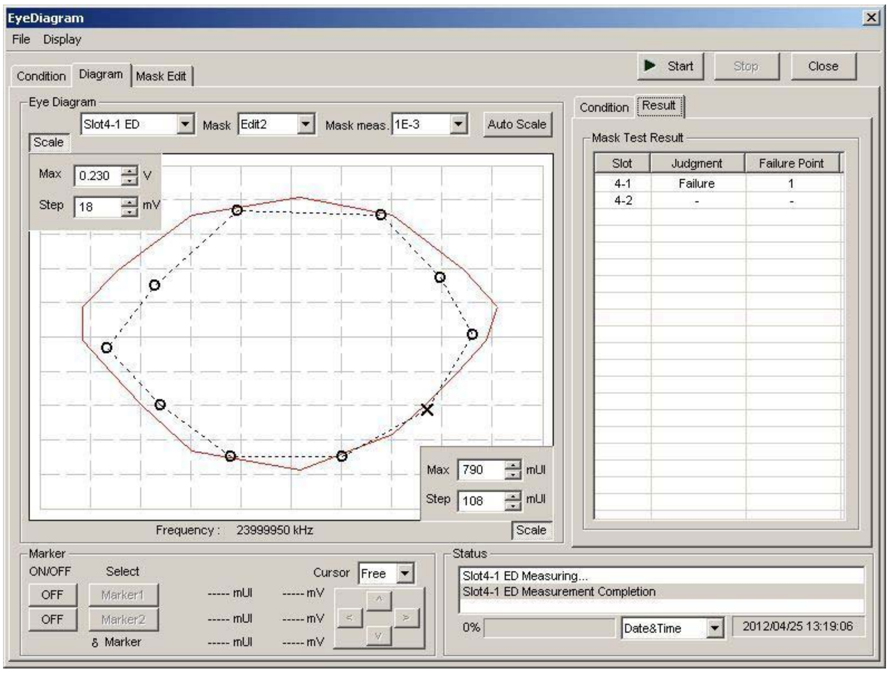

Start
Stop
Close

Figure 5.11.10-6 Measurement stop button

7. Checking measurement results

When the measurement is finished, the measurement results for each channel are displayed on the **Result** tab.


EyeDiagram
File
Display
Start
Stop
Close
Condition
Diagram
Mask Edit
Eye Diagram
Auto Scale
Scale
Condition
Result
Marker
ON/OFF
Select
OFF
OFF
Marker1
Marker2
δ Marker
Status

Slot4-1 ED

Mask Edit2

Mask meas. 1E-3

Max 0.230 V

Step 18 mV

Max 790 mUI

Step 108 mUI

Frequency : 23999950 kHz

Cursor Free

Mask Test Result

Slot	Judgment	Failure Point
4-1	Failure	1
4-2	-	-

----- mUI ----- mV

----- mUI ----- mV

----- mUI ----- mV

Slot4-1 ED Measuring...
Slot4-1 ED Measurement Completion

0%

Date&Time 2012/04/25 13:19:06

Figure 5.11.10-7 Eye Diagram window with measurement results displayed

5.12 Bathtub Function

The Bathtub function has the following features.

- Provides rich graph displaying modes.
- Calculates TJ, DJ, RJ, as well as optimum phase and optimum bit error rate.
- Calculates J2 and J9.

To use the Bathtub function, click the **Auto Measurement** () module function button, and then select “Bathtub”. Refer to the *MX180000A Signal Quality Analyzer Control Software Operation Manual* for details.

The followings are notes of caution for Bathtub measurement.

Notes:

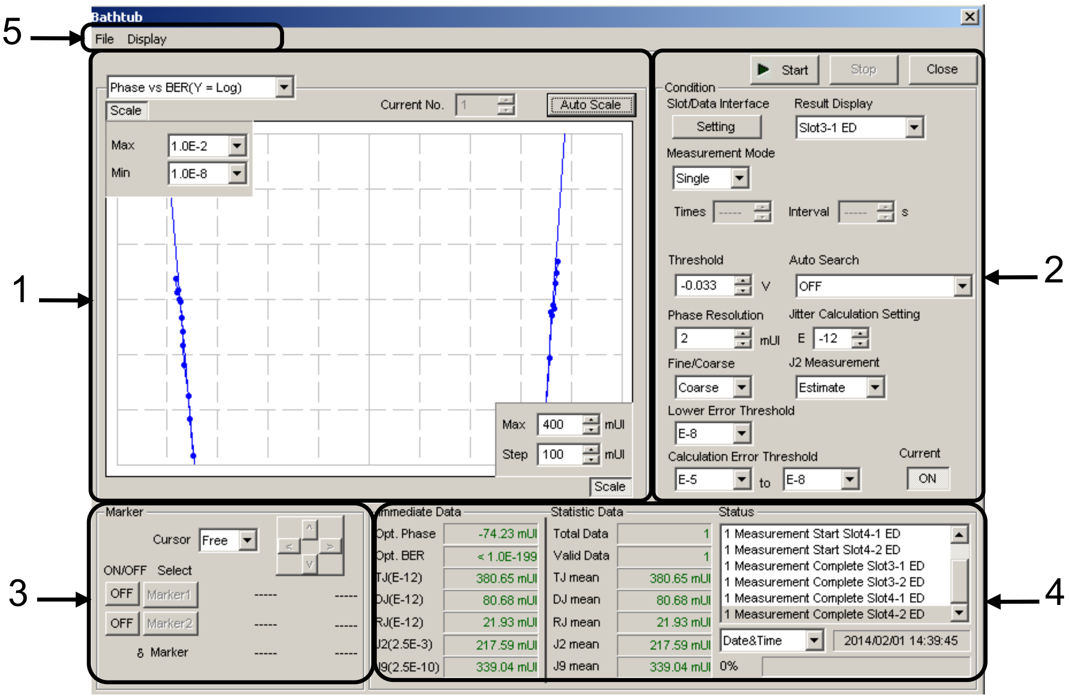
- Bathtub measurement cannot be performed for the following cases.

    - When **Burst** is selected from the **Pattern Sequence** list box on the **Misc1** tab.
    - During Auto Adjust
    - When **Auto Sync** is set to **OFF**.
    - When the **Input** tab is grouped together with the other tab

- For accuracy, start Bathtub measurement after the operations below.

    - Execute **Calibration** on the Clock Delay operation window.
    - **Jitter Input** is set to **OFF** on the Clock Delay operation window.

5.12.1 Displaying Bathtub measurement results in Bathtub window



Phase vs BER(Y = Log)

Current No. 1

Max 1.0E-2
Min 1.0E-8

Max 400 mUI
Step 100 mUI

Condition

Slot/Data Interface
Result Display: Slot3-1 ED
Measurement Mode: Single
Times ----- Interval ----- s
Threshold: -0.033 V
Auto Search: OFF
Phase Resolution: 2 mUI
Jitter Calculation Setting: E -12
Fine/Coarse: Coarse
J2 Measurement: Estimate
Lower Error Threshold: E-8
Calculation Error Threshold: E-5 to E-8
Current: ON

Marker

Cursor: Free
ON/OFF Select
OFF Marker1 ----- -----
OFF Marker2 ----- -----
δ Marker ----- -----

Immediate Data		Statistic Data	
Opt. Phase	-74.23 mUI	Total Data	1
Opt. BER	< 1.0E-199	Valid Data	1
TJ(E-12)	380.65 mUI	TJ mean	380.65 mUI
DJ(E-12)	80.68 mUI	DJ mean	80.68 mUI
RJ(E-12)	21.93 mUI	RJ mean	21.93 mUI
J2(2.5E-3)	217.59 mUI	J2 mean	217.59 mUI
J9(2.5E-10)	339.04 mUI	J9 mean	339.04 mUI

Status

```
1 Measurement Start Slot4-1 ED
1 Measurement Start Slot4-2 ED
1 Measurement Complete Slot3-1 ED
1 Measurement Complete Slot3-2 ED
1 Measurement Complete Slot4-1 ED
1 Measurement Complete Slot4-2 ED
```

Date&Time 2014/02/01 14:39:45

0%

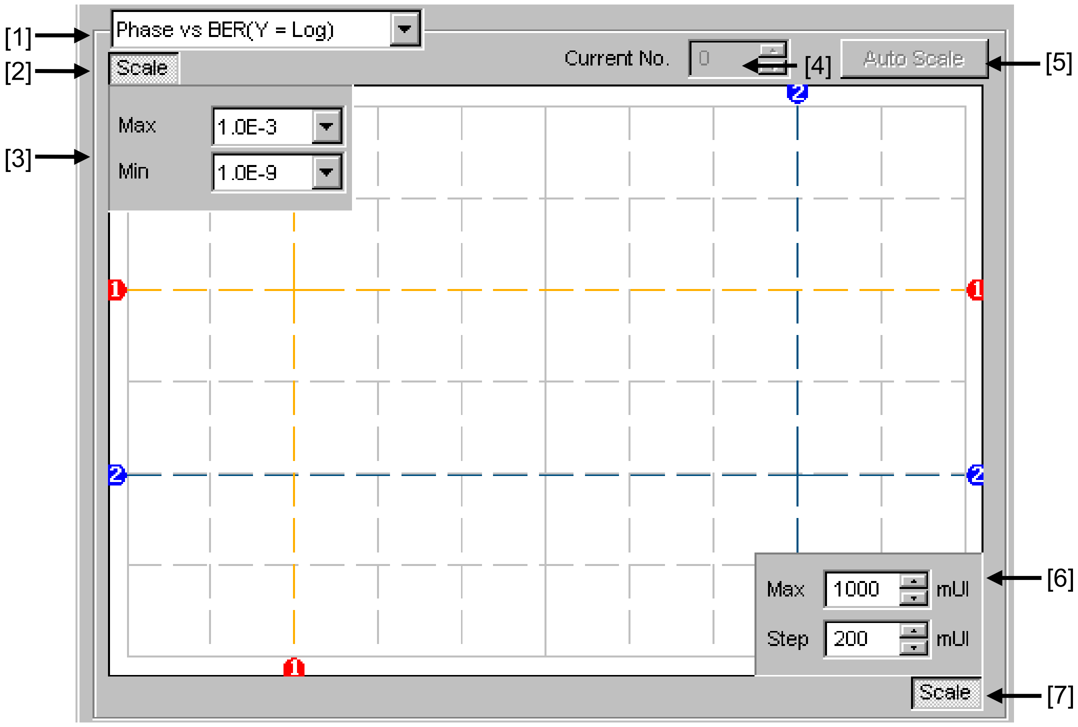
Figure 5.12.1-1 Bathtub window

The Bathtub window consists of five areas.

1. Measurement graph display area
2. Measurement control area
3. Display control area
4. Measurement result display area
5. Menu bar

The setting items in each area are described below.

5.12.1.1 Measurement graph display area



Phase vs BER(Y = Log)

Current No. 0

Max 1.0E-3

Min 1.0E-9

Max 1000 mUI

Step 200 mUI

Figure 5.12.1.1-1 Measurement graph display area

[1] Select the graph display method.

Table 5.12.1.1-1 Graph display items

Item	X-axis (Setting range)	Y-axis (Setting range)
Phase vs BER (Y = Log)	Phase (–900 to 1000 mUI)	Log(BER) (1.0E–2 to 10.E–14)
Phase vs BER (Y = Log(–Ln))		$\mathrm{Log}(\sqrt{-\mathrm{Ln}(\mathrm{BER})})$ (1.0E–2 to 10.E–14)
Histogram	16, 32, 64, 128, 256	Error distribution 1.0 E+6 to 1.0 E+14

[2] Specify whether to show the Max and Min value display indicated by [3] in Figure 5.12.1.1-1.

[3] Set the scales of the Y-axis on the graph.

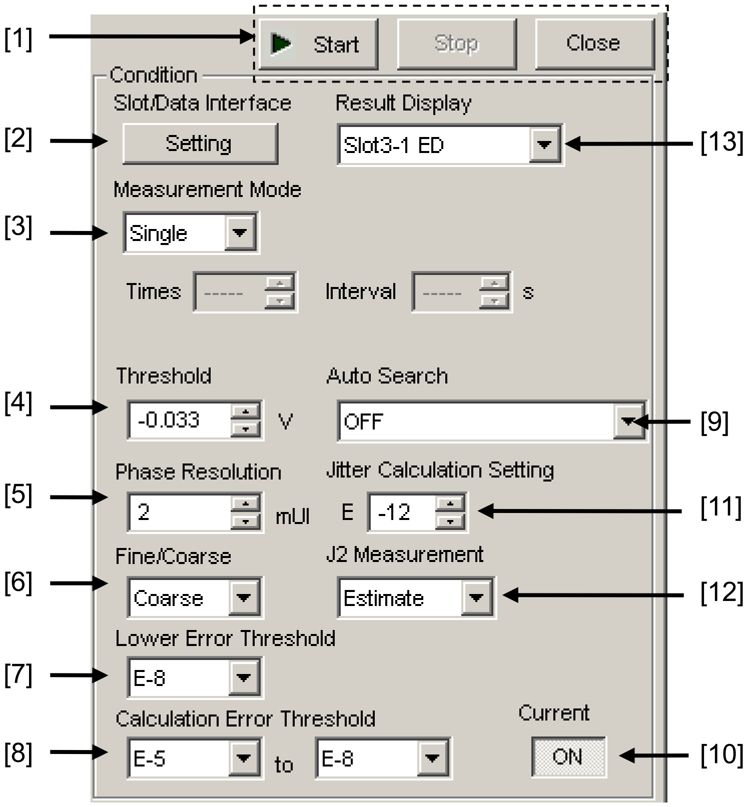
[4] Select the number of the measurement number displayed as a graph.

[5] Click this button to adjust the scale so as to optimize the measurement result position.

[6] Set the scales of the X-axis on the graph.

[7] Specify whether to show the Max and Step value display indicated by [6] in Figure 5.12.1.1-1.

5.12.1.2 Measurement control area


[1]
Start
Stop
Close
Condition
[2]
Setting
[13]
[3]
[4]
[9]
[5]
[11]
[6]
[12]
[7]
[8]
[10]

Slot/Data Interface

Result Display: Slot3-1 ED

Measurement Mode: Single

Times: -----

Interval: ----- s

Threshold: -0.033 V

Auto Search: OFF

Phase Resolution: 2 mUI

Jitter Calculation Setting: E -12

Fine/Coarse: Coarse

J2 Measurement: Estimate

Lower Error Threshold: E-8

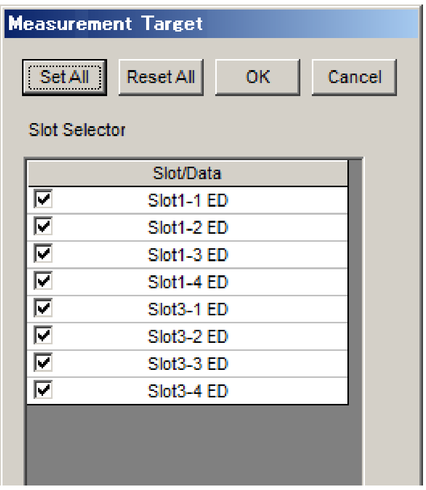
Calculation Error Threshold: E-5 to E-8

Current: ON

Figure 5.12.1.2-1 Measurement control area

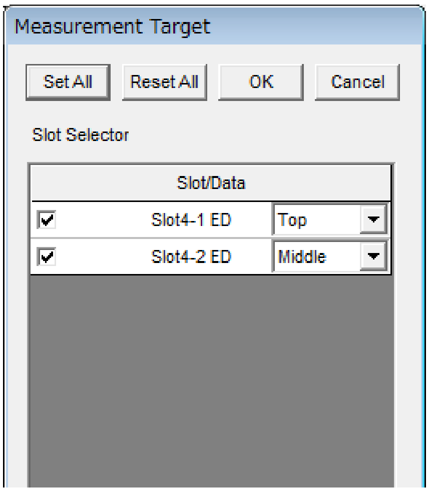
[1]	**Start:**	Starts measurement.
	Stop:	Stops measurement.
	Close:	Closes the Bathtub window.

[2] Displays the **Measurement Target** dialog box, where you can select the Slot/Data Interface combination(s) you want to measure.
In the PAM mode, the selected slots must be set respectively to **Top**, **Middle**, or **Bottom**.


Measurement Target
Set All
Reset All
OK
Cancel
Slot Selector

	Slot/Data
☑	Slot1-1 ED
☑	Slot1-2 ED
☑	Slot1-3 ED
☑	Slot1-4 ED
☑	Slot3-1 ED
☑	Slot3-2 ED
☑	Slot3-3 ED
☑	Slot3-4 ED

Figure 5.12.1.2-2 Measurement Target Dialog Box


Measurement Target
Set All
Reset All
OK
Cancel
Slot Selector

	Slot/Data	
☑	Slot4-1 ED	Top
☑	Slot4-2 ED	Middle

Figure 5.12.1.2-3 Measurement Target Dialog Box (PAM mode)

Note:

Because the measurement is performed in Combination units if a Channel Combination is set, select one of the Data Interfaces included in the Channel Combination. For example, if 2ch Combination of Data1 and Data 2 is specified, select either Data1 or Data2.

[3] Select the measurement mode in the **Measurement Mode** list box.

Single: Measurement is finished when it is performed once.
Repeat: Measurement is finished when it is performed for the specified number of times.
Untimed: Measurement is performed continuously from the measurement start instruction to the measurement end instruction.
Times: Set the measurement count when **Repeat** is selected (2 to 1000 times).
Interval: Set the measurement interval time when **Repeat** or **Untimed** is selected (0 to 9999 s).

[4] Set the data threshold position for measurement in the **Threshold** spin-box.

Setting range: –3.5 to +3.3 V, in 0.001 V steps (for Single-Ended)
–3.0 to 3.0 V, in 0.001 V steps (for Differential)

[5] Set the phase variation step for measurement in **Phase Resolution** spin-box.

Setting range: 2 to 100 mUI, in 2 mUI steps

[6] Select **Fine** or **Coarse** in the **Fine/Coarse** list box to set the error count.

Fine: Error count = 100
Coarse: Error count = 3

[7] Specify the error rate range for the measurement in **Lower Error Threshold** list box.

[8] Select the range (lower limit and upper limit values) used for calculating the error rate range for the measurement and calculating Best Fit Line, in the **Calculation Error Threshold** list box. Note that the lower limit is restricted by the setting of [7].

[9] Specify whether to execute Auto Search at the start of measurement in **Auto Search** list box.

OFF: Auto Search is not executed.
Phase: Auto Search is executed for phase.
Threshold&Phase: Auto Search is executed for both the threshold voltage and phase.
Phase(Fine): Auto Search for phase is executed in the Fine mode.
Threshold&Phase(Fine): Auto Search for both threshold and phase is executed in the Fine mode.

[10] Select the graph update timing at **Current**.

ON: The graph is updated every second.
OFF: The graph is updated at the end of measurement.

[11] Set the error rate used in the jitter calculation at **Jitter Calculation Setting** spin-box.

Setting range: E–7 to E–20

[12] Among setting items of **J2 Measurement**, select calculation method for J2.

Estimate:	Using **Best Fit Line** calculated in Step [8], calculate J2 value.
Actual:	Find the closest point to 2.5E–3 in BER measurement, and calculate J2 value. In this setting, the measurement time is longer than **Estimate** due to repetition of BER measurement. To measure J2 value more accurately, select **Actual**.

For calculation of J2 **Estimate/Actual**, refer to Figure 5.12.1.2-2.

[13] Select the Slot/Data Interface combination you want to display the measurement result in the Measurement result display area.

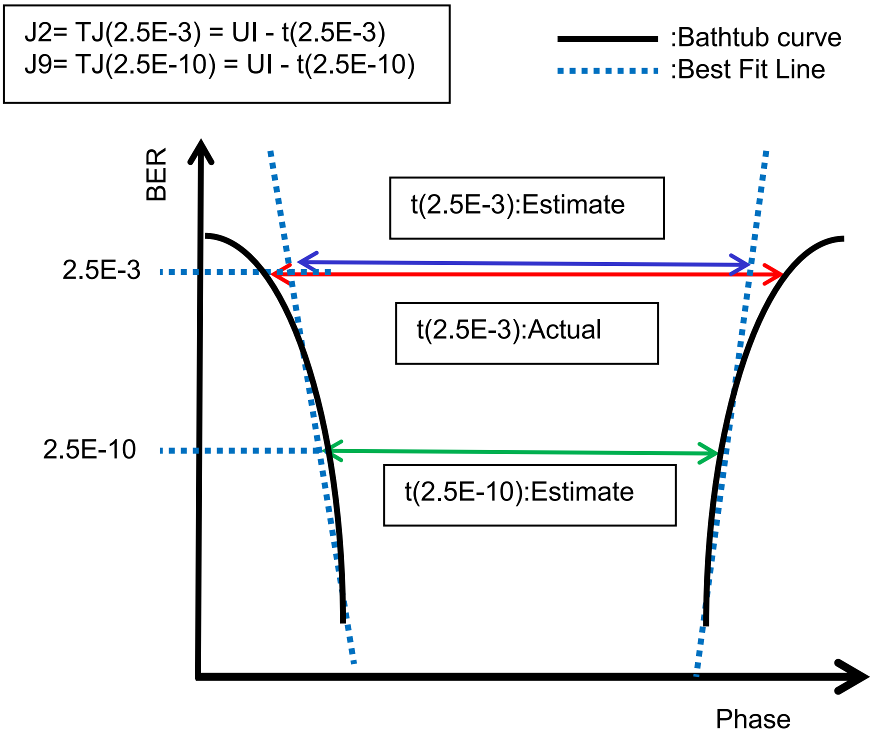
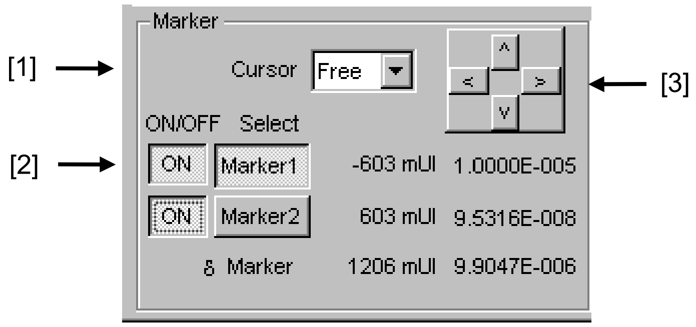

J2= TJ(2.5E-3) = UI - t(2.5E-3)
J9= TJ(2.5E-10) = UI - t(2.5E-10)
:Bathtub curve
:Best Fit Line
BER
t(2.5E-3):Estimate
2.5E-3
t(2.5E-3):Actual
2.5E-10
t(2.5E-10):Estimate
Phase

Figure 5.12.1.2-4 J2 Calculation

5.12.1.3 Display control area



Cursor Free

Marker1 -603 mUI 1.0000E-005

Marker2 603 mUI 9.5316E-008

δ Marker 1206 mUI 9.9047E-006

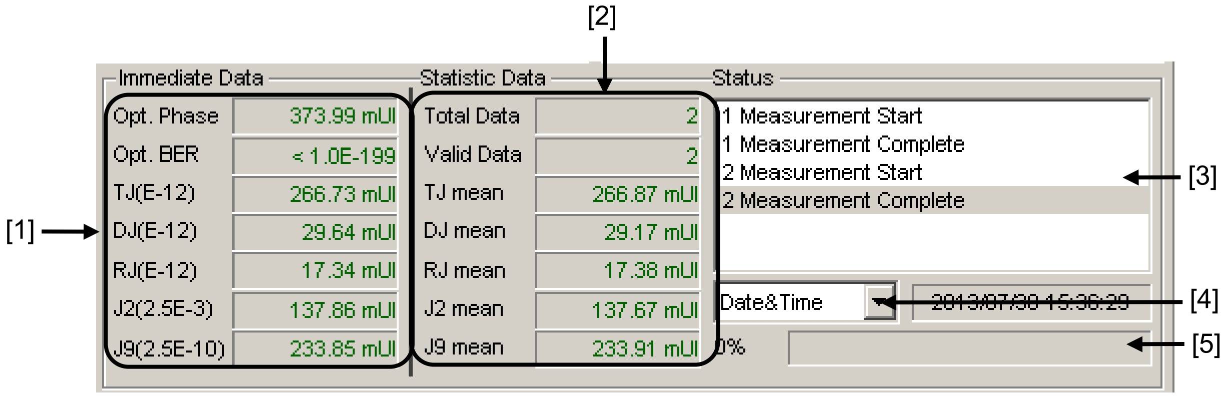
Figure 5.12.1.3-1 Display control area

[1] Select the cursor movement method from **Free** (minimum resolution) or **Point** (measurement point).

[2] Set the marker ON/OFF by clicking the ON/OFF button.
Select Marker1 or Marker2 for the cursor, by clicking the corresponding button. The selected marker can be moved using the four arrow keys described below [3]. The mouse cursor will turn to a “Cross Icon” when placed on the cross point of two markers and then you can move the icon by dragging.

[3] The cursor can be moved by clicking the arrow keys.

5.12.1.4 Measurement result display area



Opt. Phase 373.99 mUI
Opt. BER < 1.0E-199
TJ(E-12) 266.73 mUI
DJ(E-12) 29.64 mUI
RJ(E-12) 17.34 mUI
J2(2.5E-3) 137.86 mUI
J9(2.5E-10) 233.85 mUI

Total Data 2
Valid Data 2
TJ mean 266.87 mUI
DJ mean 29.17 mUI
RJ mean 17.38 mUI
J2 mean 137.67 mUI
J9 mean 233.91 mUI

1 Measurement Start
1 Measurement Complete
2 Measurement Start
2 Measurement Complete

Date&Time 2013/07/30 15:36:29
0%

Figure 5.12.1.4-1 Measurement result display area

[1] Immediate Data

Displays the results when Bathtub measurement is performed once.

Table 5.12.1.4-1 Result display items (Immediate Data)

Item	Description
Optimum Phase	Optimum phase value (Display format: XXX.XX (ps) or XXX (mUI))
Optimum BER	Optimum error rate (Display format: X.XXXXE – XXX)
TJ(E–xx) (Total Jitter)	Total jitter calculated from Bathtub curve (Display format: XXX.XX (ps) or XXX.XX (mUI))
DJ(E–xx) (Deterministic Jitter)	Deterministic jitter calculated from Bathtub curve (Display format: XXX.XX (ps) or XXX.XX (mUI))
RJ(E–xx) (Random Jitter)	Random jitter calculated from Bathtub curve (Display format: XXX.XX (ps) or XXX.XX (mUI))
J2 (2.5E–3)	J2 calculated from Bathtub curve (Estimate) Calculate J2 value from BER measurement point. (Actual) (Display format: XXX.XX (ps) or XXX.XX (mUI))
J9 (2.5E–9)	J9 calculated from Bathtub curve (Display format: XXX.XX (ps) or XXX.XX (mUI))

Notes:

- No values will be displayed for Optimum Phase and Optimum BER, TJ, DJ, RJ unless at least three measurement points are set for both the Phase + and – sides within the range set from the **Calculation Error Threshold** list box.

- "E–xx" Displays error rate (E–7 to E–12) used to calculate jitter set at **Jitter Calculation Setting**.

- J2 value may vary according to the calculation method selected in **J2 Measurement**. Select **Actual** to measure J2 value more accurately.

[2] Statistic Data field

Displays the statistical measurement results obtained when Bathtub measurement is performed several times.

Table 5.12.1.4-2 Result display items (Statistic Data)

Item	Description
Total Data	Total measurement count (Display format: XXXX)
Valid Data	Number of valid measurement results (Display format: XXXX)
TJ mean	Average of total jitter measurement (Display format: XXX.XX (ps) or XXX.XX (mUI))
DJ mean	Average of deterministic jitter measurement (Display format: XXX.XX (ps) or XXX.XX (mUI))
RJ mean	Average of random jitter measurement (Display format: XXX.XX (ps) or XXX.XX (mUI))
J2 mean	Average of J2 (Display format: XXX.XX (ps) or XXX.XX (mUI))
J9 mean	Average of J9 (Display format: XXX.XX (ps) or XXX.XX (mUI))

[3] Displays the measurement state as a comment.

[4] Select the measurement time display type.

Date&Time:	Displays the current time.
Start Time:	Displays the current measurement start time.
Elapsed Time:	Display the elapsed measurement time.

Upon completion of measurement of all modules, the elapsed time display stops.

[5] Displays the measurement progress as Gating.

5.12.1.5 Menu bar

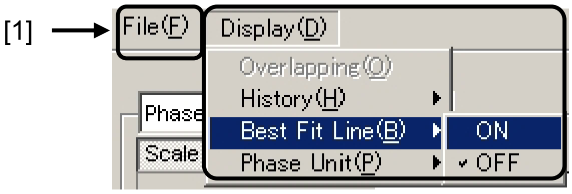


Figure 5.12.1.5-1 Menu bar

[1] Select File and Display menu item.

Table 5.12.1.5-1 Menu bar configuration

Menu	Item				Function
File	Open				Opens a file. The file name is displayed as a screen title.
	Save	Data Type	Phase vs Q BER Result		Saves the Phase vs Q BER Result measurement results.
		File Type	Binary		Saves results in binary format.
			CSV		Saves results in CSV format.
			Text		Saves results in text format.
	Screen Copy	Execute			Executes the screen copy according to the setting in **Screen Copy** → **Setup**.
		Setup	Save Type	BMP	Copies data in the window in BMP format.
				PNG	Copies data in the window in PNG format.
				JPG	Copies data in the window in JPG format.
			Output	to File	Outputs data in the window to a file.
				to Printer	Outputs data in the window to a printer.
			Save to		Opens the dialog box showing the specified saving directory. The saving directory can be specified in this dialog box.
	Initialize				Initializes all the settings and measurement results.
	Exit				Closes the Phase vs Q BER Result screen.
Display	Overlapping				Selects to configure the display settings for multiple displays. (Selectable when multiple measurements are performed.)
	History				Displays to display the results of the latest 15 measurements.
	Best Fit Line				Selects whether to display or hide approximated curves.
	Phase Unit				When Phase vs BER (xxx) graph display is selected for the Phase vs Q BER measurement, the horizontal axis unit for the marker displayed in the Marker group box can be switched between mUI and ps.

Notes:

- The screen-shot file (created by Screen Copy → Execute) is saved in the name format of “SC” + “date and time”.
- The settings will not be read from the saved file if the file name is changed.

5.13 Q Analysis Function

The Q analysis function has the following features.

- Conforms to OSFTP-9.
- Capable of calculating two Q values: Threshold vs. Q and Phase vs. Q.
- Provides rich graph displaying modes.
- Displays various measurement data, such as optimum bit error rate, threshold voltage, correlation coefficients of least-square method, and Gaussian parameters.
- Equipped with parameters for flexible Q-value measurement, including BER range and measurement accuracy for Q value calculation.

To use the Q analysis function, click the **Auto Measurement** ( ) module function button, and then select “Q Analysis (32G)”. Refer to the *MX180000A Signal Quality Analyzer Control Software Operation Manual* for details.

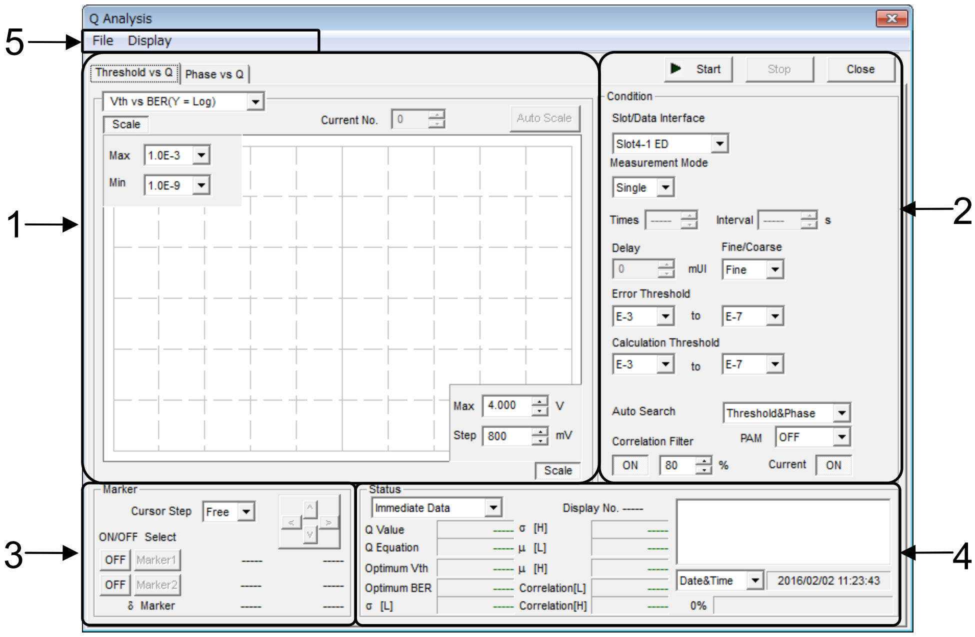
The following is a note for Q Analysis measurement:

Note:

Q Analysis measurement is not available when any of the following conditions is met:

- **Pattern Sequence** is set to **Burst**.
- Auto Adjust is on.
- **Auto Sync** is set to **OFF**.
- The **Input** tabs are grouped together with each other.
- On the **Input** tab, **Selection** is set to **Recovered Clock**.

5.13.1 Displaying results of Threshold vs. Q measurement in Threshold vs Q tab window


5
1
3
2
4
Q Analysis
File
Display
Threshold vs Q
Phase vs Q
Auto Scale
Scale
Start
Stop
Close
Condition
Marker
Status
Marker1
Marker2
δ Marker

Vth vs BER(Y = Log)
Current No. 0
Max 1.0E-3
Min 1.0E-9
Max 4.000 V
Step 800 mV
Slot/Data Interface: Slot4-1 ED
Measurement Mode: Single
Times -----
Interval ----- s
Delay 0 mUI
Fine/Coarse: Fine
Error Threshold: E-3 to E-7
Calculation Threshold: E-3 to E-7
Auto Search: Threshold&Phase
Correlation Filter: ON 80 %
PAM: OFF
Current: ON
Cursor Step: Free
ON/OFF Select
OFF Marker1 ----- -----
OFF Marker2 ----- -----
δ Marker ----- -----
Immediate Data
Display No. -----
Q Value ----- σ [H] -----
Q Equation ----- μ [L] -----
Optimum Vth ----- μ [H] -----
Optimum BER ----- Correlation[L] -----
σ [L] ----- Correlation[H] -----
Date&Time 2016/02/02 11:23:43
0%

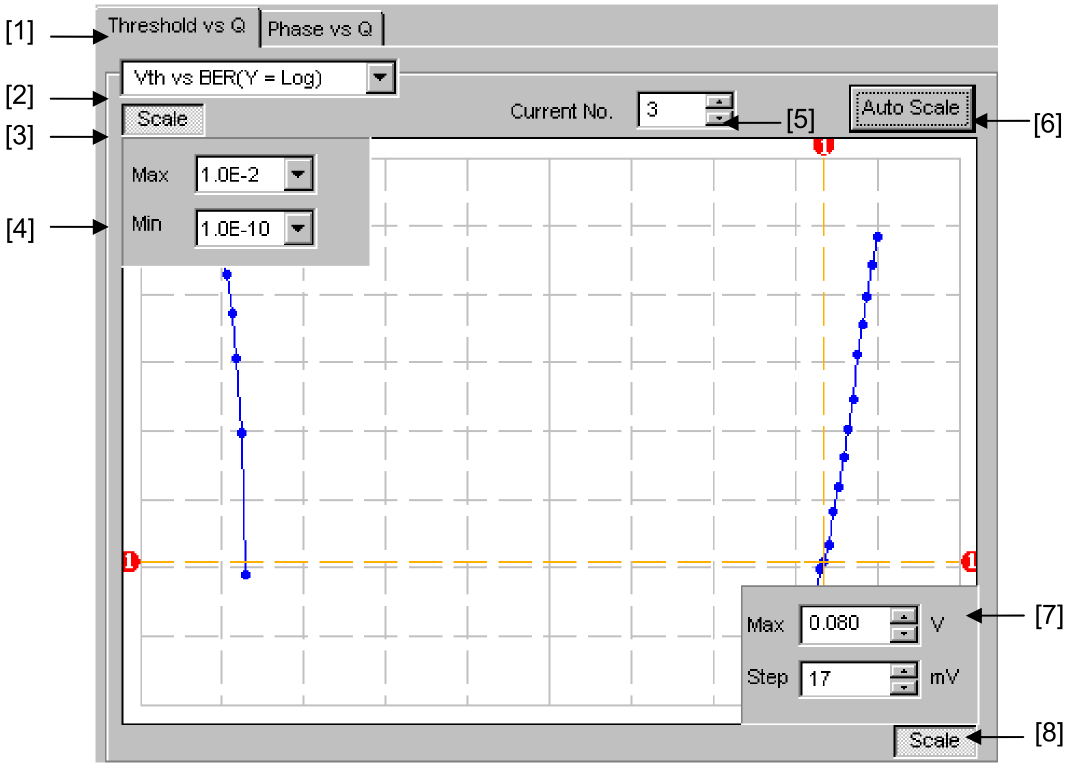
Figure 5.13.1-1 Threshold vs Q tab window

The Threshold vs Q tab window consists of five areas.

1. Measurement graph display area
2. Measurement control area
3. Display control area
4. Measurement result display area
5. Menu bar

The setting items in each area are described below.

1. Measurement graph display area



Vth vs BER(Y = Log)

Current No. 3

Max 1.0E-2

Min 1.0E-10

Max 0.080 V

Step 17 mV

Figure 5.13.1-2 Measurement graph display area

[1] Click to switch between the Threshold vs Q tab window and the Phase vs Q tab window, changing the measurement system.

[2] Select the graph display method.

Table 5.13.1-1 Graph display items

Item	X-axis (Setting range)	Y-axis (Setting range)
Vth vs BER (Y = Log)	Threshold voltage (–3.990 to 4.0 V)	Log (BER) (1.0 E–2 to 1.0 E–14)
Vth vs BER (Y = Log (–Ln))	Threshold voltage (–3.990 to 4.0 V)	$\text{Log}(\sqrt{-\text{Ln}(\text{BER})})$ (1.0 E–2 to 1.0 E–14)
Vth vs Q	Threshold voltage (–3.990 to 4.0 V)	Q value –40 to 60 (dB) 10 to 1000 (Linear)
Times vs Q	Measurement count (100 to 1000)	Q value –40 to 60 (dB) 10 to 1000 (Linear)
Histogram	Q value –34.00 to 60.00 (dB) 16.00 to 1000.00 (Linear)	Repetition (50 to 1000)

[3] Specify whether to show the Max and Min value display indicated by [4] in Figure 5.13.1-2.

[4] Set the scales of the Y-axis on the graph.

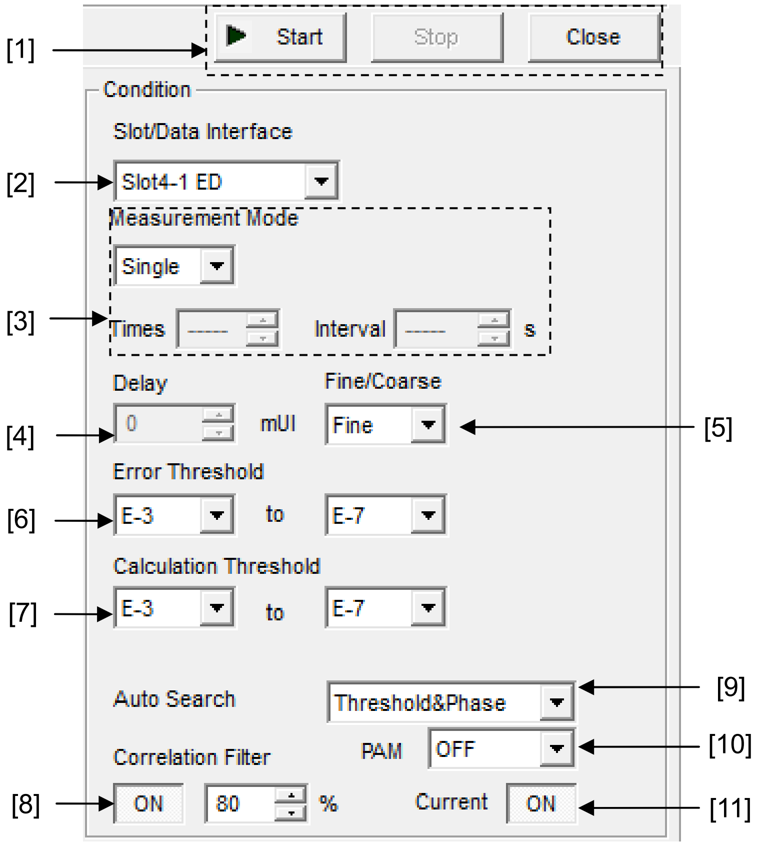
[5] Select the number of the measurement number displayed as a graph.

[6] Click this button to adjust the scale so as to optimize the measurement result position.

[7] Set the scales of the X-axis on the graph.

[8] Specify whether to show the Max and Step value display, indicated by [7] in Figure 5.13.1-2

2. Measurement control area



Condition
Slot/Data Interface: Slot4-1 ED
Measurement Mode: Single
Times ------ Interval ------ s
Delay: 0 mUI
Fine/Coarse: Fine
Error Threshold: E-3 to E-7
Calculation Threshold: E-3 to E-7
Auto Search: Threshold&Phase
Correlation Filter: ON 80 %
PAM: OFF
Current: ON

Figure 5.13.1-3 Measurement control area

[1] **Start:** Start measurement.
Stop: Stop measurement.
Close: Close the measurement window.

[2] Select the slot to be measured from the Slot list box.

[3] Select the measurement mode from the Measurement Mode list box.

Single: Measurement is finished when a Q value is measured once.

Repeat: Measurement is finished when a Q value is measured for the specified number of times.

Untimed: Measurement is performed continuously from the measurement start instruction to the measurement end instruction.

Times: Set the measurement count when Repeat is selected (2 to 1000 times).

Interval: Set the measurement interval time when Repeat or Untimed is selected (0 to 9999 seconds).

[4] Set the phase position for measurement in the Delay textbox.
Setting range: −1000 to 1000 mUI, in 2 mUI steps

[5] Select “Fine” or “Coarse” from the list box to set the error count and threshold variation step.

Fine: Error count: 100, Threshold variation step: 1 mV steps

Coarse: Error count: 1, Threshold variation step: 5 mV steps

[6] Specify the error rate range (upper limit and lower limit values) for the Q measurement from the Error Threshold list box.

[7] Specify the error rate range (upper limit and lower limit values) for calculating the Q value from the Error Threshold list box.

[8] Set the minimum correlation coefficients with which the measured Q value is valid, in the Correlation Filter textbox.
If either the correlation coefficient at the Top side or that at the Bottom side becomes less than the set value while the Correlation Filter function is enabled (ON), the measured Q value will become invalid.

[9] Specify whether to execute Auto Search at the start of Auto Search measurement.

OFF: Auto Search is not executed.

Threshold: Auto Search is executed for the threshold voltage.

Threshold & Phase: Auto Search is executed for both the threshold voltage and phase.

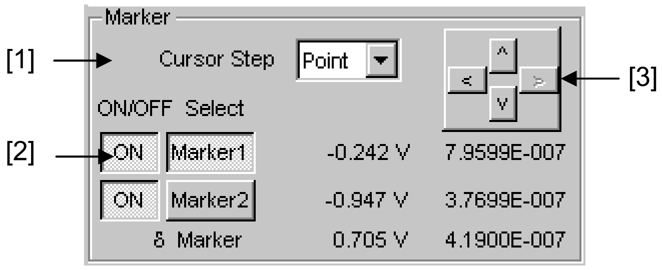
[10] Select one of the following options when performing Q measurement of 4PAM waveform.

OFF: Measures NRZ waveform.
Top: Measures the Top level of 4PAM waveform.
Middle: Measures the Middle level of 4PAM waveform.
Bottom: Measures the Bottom level of 4PAM waveform.

[11] Specify whether or not to update the graph every second.

ON: The graph is updated for each second.
OFF: The graph is updated at the end of measurement.

3. Display control area



Cursor Step: Point

ON/OFF	Select		
ON	Marker1	-0.242 V	7.9599E-007
ON	Marker2	-0.947 V	3.7699E-007
	δ Marker	0.705 V	4.1900E-007

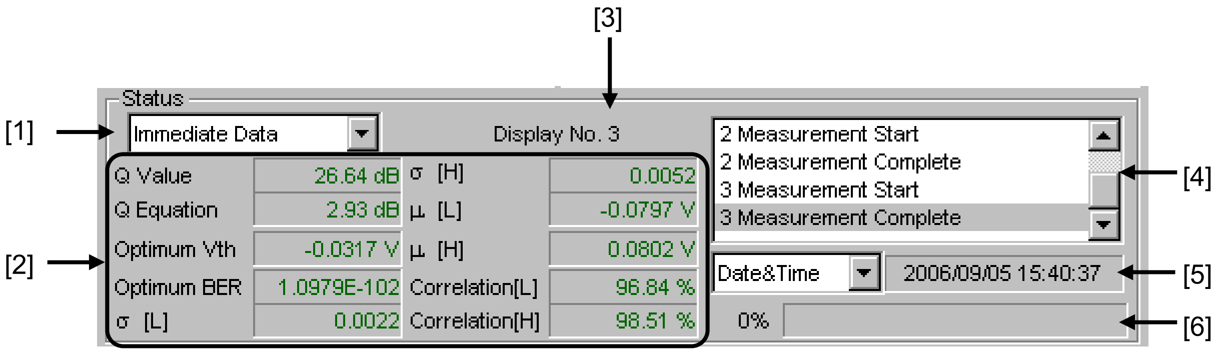
Figure 5.13.1-4　Display control area

[1] Select the cursor movement method from the Cursor Step list box, “Free” (minimum resolution) or “Point” (measurement point).

[2] Set the marker ON or OFF by clicking the ON/OFF button.
Select Marker1 or Marker2 for the cursor by clicking the corresponding button.
The selected marker can be moved using the arrow keys (indicated by [3] in Figure 5.13.1-4). The marker can also be moved by moving the cursor onto the crosspoint of the target marker on the graph (the cursor changes to a cross icon at this time) and dragging it.

[3] The cursor can be moved by clicking the arrow keys.

4. Measurement result display area



Immediate Data

Display No. 3

Q Value 26.64 dB

Q Equation 2.93 dB

Optimum Vth -0.0317 V

Optimum BER 1.0979E-102

σ [L] 0.0022

σ [H] 0.0052

μ [L] -0.0797 V

μ [H] 0.0802 V

Correlation[L] 96.84 %

Correlation[H] 98.51 %

2 Measurement Start
2 Measurement Complete
3 Measurement Start
3 Measurement Complete

Date&Time 2006/09/05 15:40:37

0%

Figure 5.13.1-5 Measurement result display area (Immediate Data)

[1] Select “Immediate Data” or “Statistic Data”.

[2] Displays the results when a Q value is measured once.

Table 5.13.1-2 Result display items (Immediate Data)

Item	Description
Q Value	Measured Q value (Unit: dB/–)
Q Equation	Maximum Q value error (Unit: dB/–)
Optimum Vth	Threshold voltage at the optimum state (Unit: V)
Optimum BER	Error rate at the optimum state
σ[L], σ[H] μ[L], μ[H]	σ_L, σ_R, μ_L, and μ_R when the Q value is calculated
Correlation[L] Correlation[H]	Correlation coefficients of the valid plot data at the high and low sides as a percentage (Unit: %)

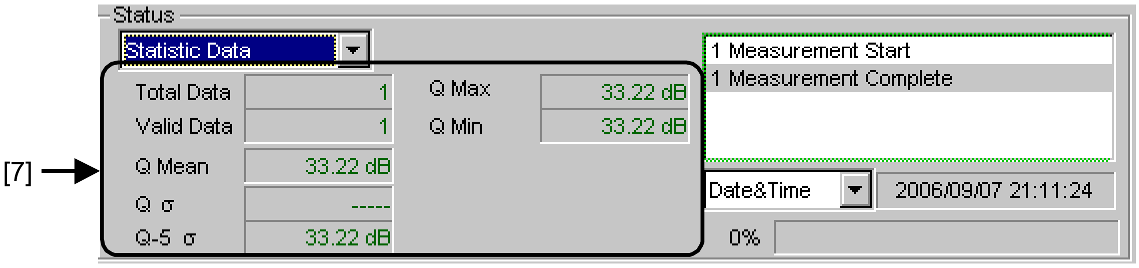
[3] Displays the measurement number of the displayed measurement result.

[4] Displays the measurement state as a comment.

[5] Select the measurement time display type.

Date&Time:	Displays the current date and time.
Start Time:	Displays the current measurement start time.
Elapsed Time:	Display the elapsed measurement time.

[6] Displays the measurement progress as Gating.



Statistic Data

Total Data 1

Valid Data 1

Q Mean 33.22 dB

Q σ -----

Q-5 σ 33.22 dB

Q Max 33.22 dB

Q Min 33.22 dB

1 Measurement Start

1 Measurement Complete

Date&Time 2006/09/07 21:11:24

0%

Figure 5.13.1-6 Measurement result display area (Statistic Data)

[7] Displays the statistical measurement results obtained when a Q value is measured several times.

Table 5.13.1-3 Result display items (Statistic Data)

Item	Description
Total Data	Total measurement count
Valid Data	Number of valid Q values
Q Mean	Average of valid Q values (Unit: dB/–)
Q σ	Standard deviation of valid Q values (Unit: dB/–)
Q-5 σ	Average Q value – standard deviation × 5 (Unit: dB/–)
Q Max	Maximum value among valid Q values (Unit: dB/–)
Q Min	Minimum value among valid Q values (Unit: dB/–)

5. Menu bar

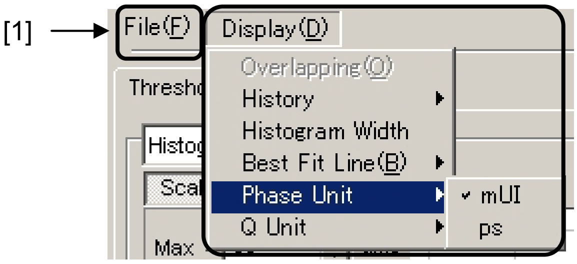


Figure 5.13.1-7 Menu bar

[1] Menu bar

Select a File and Display menu item.

Table 5.13.1-4 Menu bar configuration

Menu	Item				Function
File	Open				Opens a file. The file name is displayed as a screen title.
	Save	Data Type	Vth vs Q Result		Saves the Vth vs Q Result measurement results.
			Phase vs Q Result		Saves the Phase vs Q Result measurement results.
		File Type	Binary		Saves results in binary format.
			CSV		Saves results in CSV format.
			Text		Saves results in text format.
	Print	Type Of Print List	Vth vs Q Result		Prints Vth vs Q Result measurement results.*
			Phase vs Q Result		Prints Phase vs Q Result measurement results.*
	Screen Copy	Execute			Executes the screen copy according to the setting in Screen Copy → Setup.
		Setup	Save Type	BMP	Copies data in the window in BMP format.
				PNG	Copies data in the window in PNG format.
				JPG	Copies data in the window in JPG format.
			Output	to File	Outputs data in the window to a file.
				to Printer	Outputs data in the window to a printer.
			Save to		Opens the dialog box showing the specified saving directory. The saving directory can be specified in this dialog box.
	Initialize				Initializes all the settings and measurement results.
	Exit				Closes the Q Analysis window.

Table 5.13.1-4 Menu bar configuration (Cont'd)

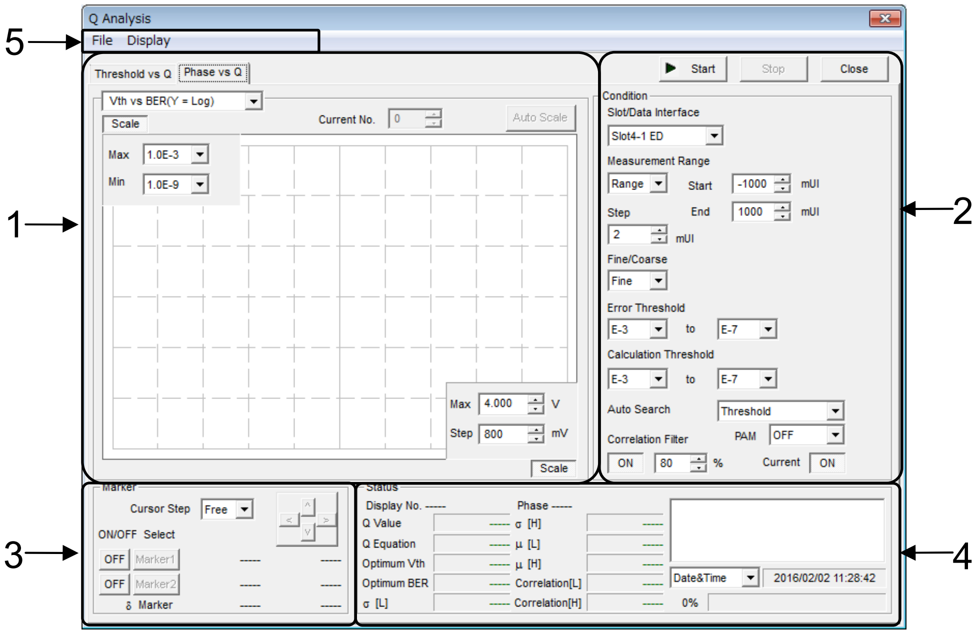
Menu	Item	Function
Display	Overlapping	Select to configure the display settings for multiple displays. (Selectable when multiple measurements are performed.)
	History	Select to display the results of the latest 15 measurements.
	Histogram Width	Select to set the display width (width of one bar) in the case of a histogram measurement. Setting range: log: 0.01 to 1.00 dB Linear: 0.01 to 1.00
	Best Fit Line	Select whether to display or hide approximated curves.
	Phase Unit	When Phase vs xxx graph display is selected for the Phase vs Q measurement, the horizontal axis unit for the marker displayed in the Marker group box can be switched between mUI and ps.
	Linear/Log	Select to switch the measurement result display between Liner and Log.

*: The printer setting must be configured in advance in the main frame main window.

Notes:

- The screen-shot file (created by Screen Copy → Execute) is saved in the name format of "SC" + "date and time".
- The settings will not be read from the saved file if the file name is changed.

5.13.2 Displaying results of Phase vs Q measurement in Phase vs Q tab window


5
1
3
2
4
Q Analysis
File
Display
Threshold vs Q
Phase vs Q
Auto Scale
Scale
Start
Stop
Close
Marker
Status
Marker1
Marker2

Vth vs BER(Y = Log)
Current No. 0
Max 1.0E-3
Min 1.0E-9
Max 4.000 V
Step 800 mV

Condition
Slot/Data Interface: Slot4-1 ED
Measurement Range: Range Start -1000 mUI End 1000 mUI
Step 2 mUI
Fine/Coarse: Fine
Error Threshold: E-3 to E-7
Calculation Threshold: E-3 to E-7
Auto Search: Threshold
Correlation Filter: ON 80 % PAM OFF Current ON

Cursor Step Free
ON/OFF Select
OFF Marker1 ----- -----
OFF Marker2 ----- -----
δ Marker ----- -----

Display No. -----
Phase -----
Q Value ----- σ [H] -----
Q Equation ----- μ [L] -----
Optimum Vth ----- μ [H] -----
Optimum BER ----- Correlation[L] -----
σ [L] ----- Correlation[H] -----
Date&Time 2016/02/02 11:28:42
0%

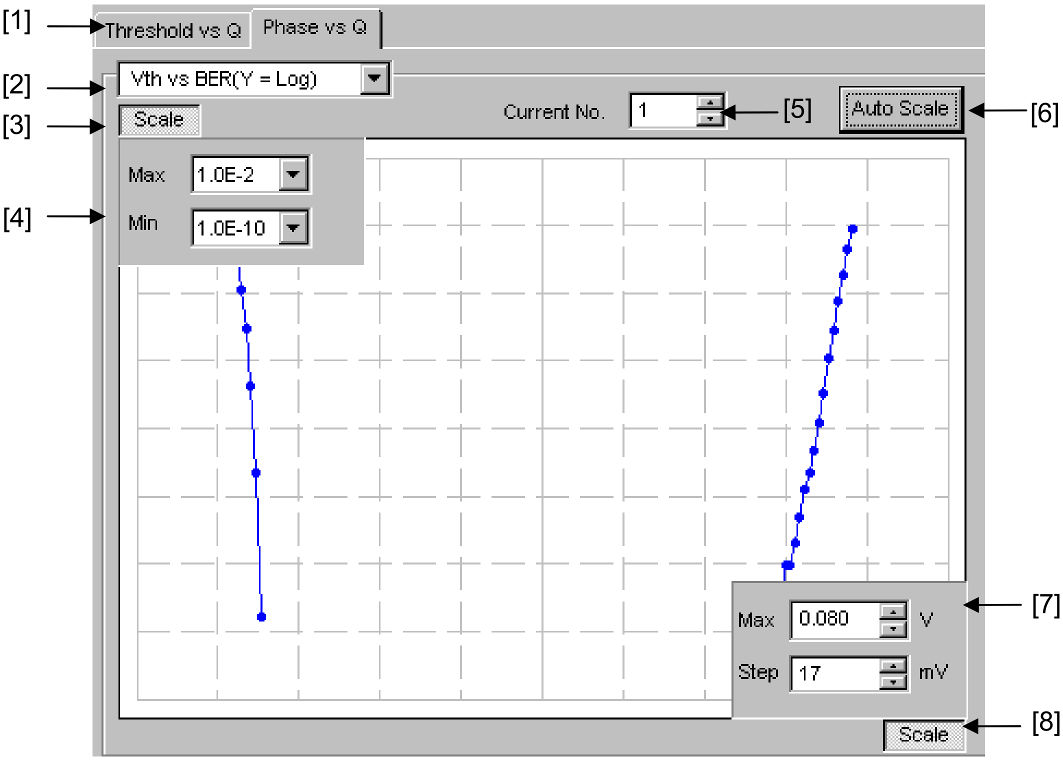
Figure 5.13.2-1 Phase vs Q tab window

The Phase vs Q tab window consists of five areas.

1. Measurement graph display area
2. Measurement control area
3. Display control area
4. Measurement result display area
5. Menu bar

The setting items in each area are described below.
The descriptions about the display control area and menu bar are omitted, however, because they are provided in Section 5.13.1 “Displaying results of Threshold vs. Q measurement in Threshold vs Q tab window”.

1. Measurement graph display area



Vth vs BER(Y = Log)

Current No. 1

Max 1.0E-2

Min 1.0E-10

Max 0.080 V

Step 17 mV

Figure 5.13.2-2 Measurement graph display area

[1] Click to switch between the Threshold vs Q tab window and the Phase vs Q tab window, changing the measurement system.

[2] Select the graph display method.

Table 5.13.2-1 Graph display items

Item	X-axis (Setting range)	Y-axis (Setting range)
Vth vs BER (Y = Log)	Threshold (–3.990 to 4.0 V)	Log (BER) (1.0 E–2 to 1.0 E–14)
Vth vs BER (Y = Log (–Ln))		$\text{Log}(\sqrt{-\text{Ln}(\text{BER})})$ (1.0 E–2 to 1.0 E–14)
Vth vs Q		Q value –40 to 60 (dB) 10 to 1000(Linear)
Phase vs Q	Phase (–900 to 1000 mUI)	Q value –40 to 60 (dB) 10 to 1000 (Linear)

Table 5.13.2-1 Graph display items (Cont'd)

Item	X-axis (Setting range)	Y-axis (Setting range)
Phase vs σ	Phase (–900 to 1000 mUI)	σ of Gaussian (0.0010 to 1.0000)
Phase vs μ		μ of Gaussian (–3.990 to 4.0 V)
Phase vs Opt BER		Log (optimum BER) (1.0 E–1 to 1.0 E–199)
Phase vs Opt Threshold		Optimum threshold voltage (–3.990 to 4.0 V)
Phase vs Correlation		Correlation coefficient (0 to 100)

[3] Specify whether to show the Max and Min value display indicated by [4] in Figure 5.13.2-2.

[4] Set the scales of the Y-axis on the graph.

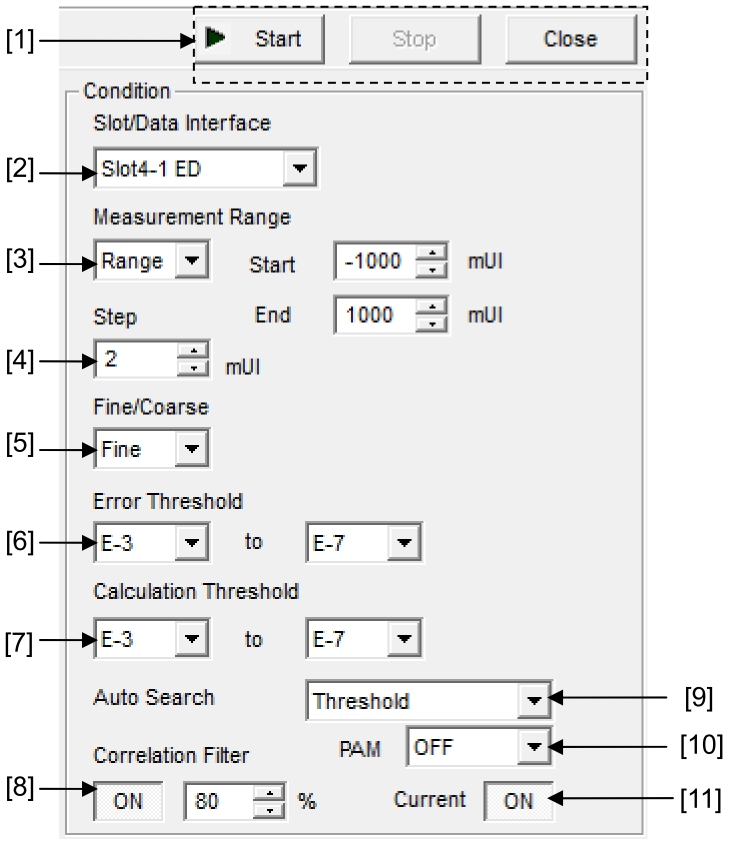
[5] Select the number of the measurement number displayed as a graph.

[6] Click this button to adjust the scale so as to optimize the measurement result position.

[7] Set the scales of the X-axis on the graph.

[8] Specify whether to show the Max and Step value display indicated by [7] in Figure 5.13.2-2.

2. Measurement control area



Condition

Slot/Data Interface: Slot4-1 ED

Measurement Range: Range

Start: -1000 mUI

End: 1000 mUI

Step: 2 mUI

Fine/Coarse: Fine

Error Threshold: E-3 to E-7

Calculation Threshold: E-3 to E-7

Auto Search: Threshold

Correlation Filter: ON 80 %

PAM: OFF

Current: ON

Figure 5.13.2-3 Measurement control area

[1] **Start:** Start measurement.

Stop: Stop measurement.

Close: lose the measurement window.

[2] Select the chassis or slot to be measured from the list box.

[3] Select the measurement range from the list box and textboxes in Measurement Range.

Range: The measurement range can be specified by entering the measurement start value, end value, and variation width (step).

Width: The measurement range can be specified by entering the center value, span, and variation width (step).

Start: Set the measurement start position when Range is selected (–1000 to 998 mUI, in 2 mUI steps).

End: Set the measurement end position when Range is selected (–998 to 1000 mUI, in 2 mUI steps).

Center: Set the center position when Width is selected (–998 to 998 mUI, in 2 mUI steps).

Span:	Set the span when Width is selected (4 to 2000 mUI, in 4 mUI steps).

[4] Set the measurement step in the Step textbox.

Setting range:2 to 200 mUI, in 2 mUI steps).

[5] Select “Fine” or “Coarse” from the list box to set the error count and threshold variation step.

Fine:	Error count: 100, Threshold variation step: 1 mV steps
Coarse:	Error count: 1, Threshold variation step: 5 mV steps

[6] Specify the error rate range (upper limit and lower limit values) for the Q measurement from the Error Threshold list box.

[7] Specify the error rate range (upper limit and lower limit values) for calculating the Q value from the Calculation Threshold list box.

[8] Set the minimum correlation coefficients with which the measured Q value is valid, in the Correlation Filter textbox.
If either the correlation coefficient at the Top or that at the Bottom becomes less than the set value while the Correlation Filter function is enabled (ON), the measured Q value will become. invalid.

[9] Specify whether to execute Auto Search at the start of Auto Search measurement.

OFF:	Auto Search is not executed.
Threshold:	Auto Search is executed for the threshold voltage.

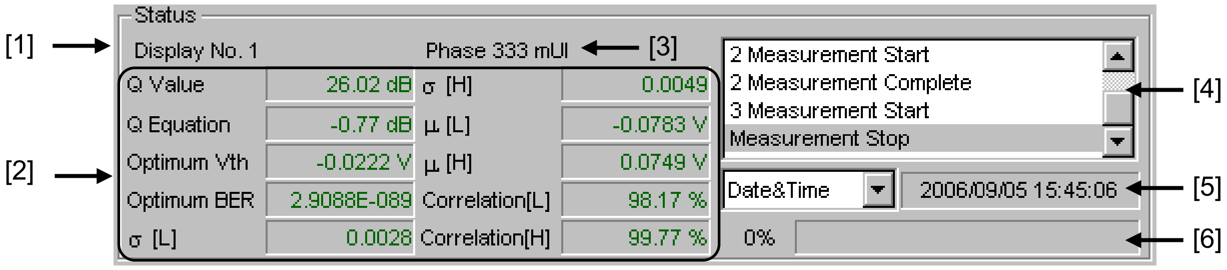
[10] Select one of the following options when performing Q measurement of 4PAM waveform.

OFF:	Measures NRZ waveform.
Top:	Measures the Top level of 4PAM waveform.
Middle:	Measures the Middle level of 4PAM waveform.
Bottom:	Measures the Bottom level of 4PAM waveform.

[11] Select the graph update timing.

ON:	The graph is updated for each second.
OFF:	The graph is updated at the end of measurement.

3. Measurement result display area



Status

Display No. 1

Phase 333 mUI

Q Value	26.02 dB	σ [H]	0.0049
Q Equation	-0.77 dB	μ [L]	-0.0783 V
Optimum Vth	-0.0222 V	μ [H]	0.0749 V
Optimum BER	2.9088E-089	Correlation[L]	98.17 %
σ [L]	0.0028	Correlation[H]	99.77 %

2 Measurement Start
2 Measurement Complete
3 Measurement Start
Measurement Stop

Date&Time 2006/09/05 15:45:06

0%

Figure 5.13.2-4 Measurement result display area

[1] Displays the measurement number of the displayed measurement result.

[2] Displays the results of each phase measurement.

Table 5.13.2-2 Result display items

Item	Description
Q Value	Measured Q value (Unit: dB/–)
Q Equation	Maximum Q value error (Unit: dB/–)
Optimum Vth	Threshold voltage at the optimum state (Unit: V)
Optimum BER	Error rate at the optimum state
σ [L], σ [H] μ [L], μ [H]	σ_L, σ_R, μ_L, and μ_R when the Q value is calculated
Correlation [L] Correlation [H]	Correlation coefficients of the valid plot data at the high and low sides as a percentage (Unit: %)

[3] Displays the measured phase of the displayed measurement result.

[4] Displays the measurement state as a comment.

[5] Select the measurement time display type.

Data&Time: Displays the current time.
Start Time: Displays the current measurement start time.
Elapsed Time: Display the elapsed measurement time.

[6] Displays the measurement progress as Gating.

5.14 PAM BER Measurement

PAM BER measurement enables the total BER to be measured by measuring the BER for each 4PAM signal level using 1ch or 3ch for ED. This function can be executed with MU183040B or MU183041B only.

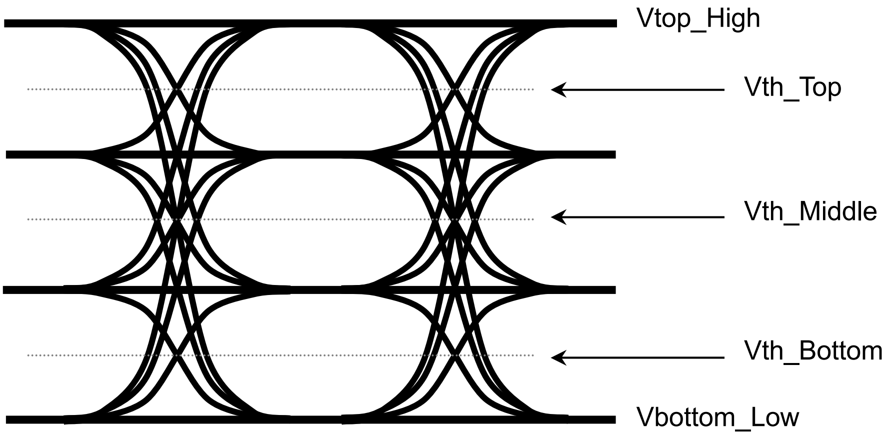


Figure 5.14-1 PAM BER Measurement

In the 3 Eye Serial mode, BER of Vth_Top/Vth_Middle/Vth_Bottom is measured respectively using 1 channel of ED. BER measurement is repeated 3 times while changing the threshold. From 3-time measurement results, the 4PAM total BER result is calculated and displayed.

In the 3 Eye Parallel mode, BER of Vth_Top/Vth_Middle/Vth_Bottom is measured simultaneously using 3 channels of ED. BER measurement is performed with different thresholds set to 3 channels of ED. From 3 measurement results, the 4PAM total BER result is calculated and displayed.

Notes:

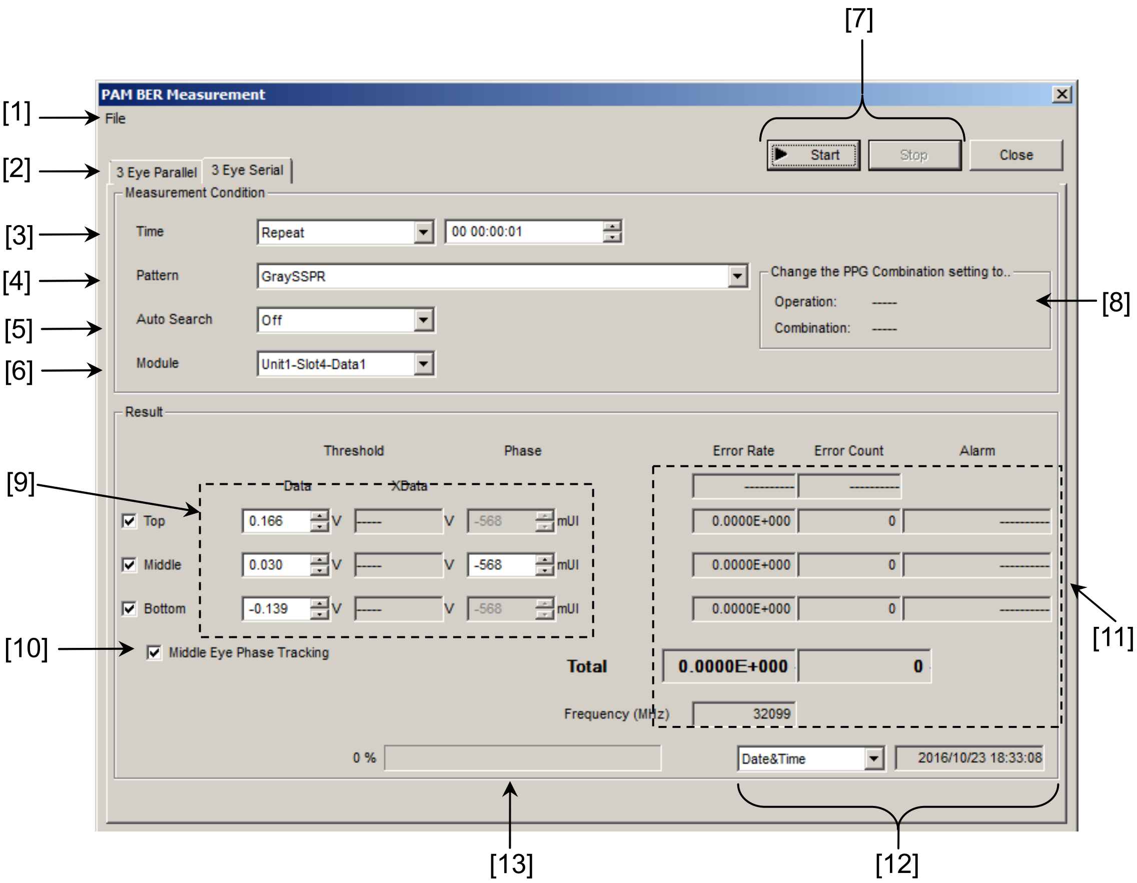
PAM BER measurement cannot be performed for the following cases.

- When **Auto Adjust** is set to **ON**
- When **Auto Sync** is set to **OFF**
- When the **Input** tab is grouped together with the other tab

To use the PAM BER measurement function, click the **Auto Measurement** ( ) module function button, and then select **PAM BER Meas**. Refer to the *MX180000A Signal Quality Analyzer Control Software Operation Manual* for details.

5.14.1 PAM BER Measurement window

Figure 5.14.1-1 shows the PAM BER Measurement window.



Measurement Condition

Time: Repeat 00 00:00:01

Pattern: GraySSPR

Auto Search: Off

Module: Unit1-Slot4-Data1

Change the PPG Combination setting to..

Operation: -----

Combination: -----

Result

	Threshold Data	Threshold XData	Phase	Error Rate	Error Count	Alarm
				----------	----------	
☑ Top	0.166 V	----- V	-568 mUI	0.0000E+000	0	----------
☑ Middle	0.030 V	----- V	-568 mUI	0.0000E+000	0	----------
☑ Bottom	-0.139 V	----- V	-568 mUI	0.0000E+000	0	----------

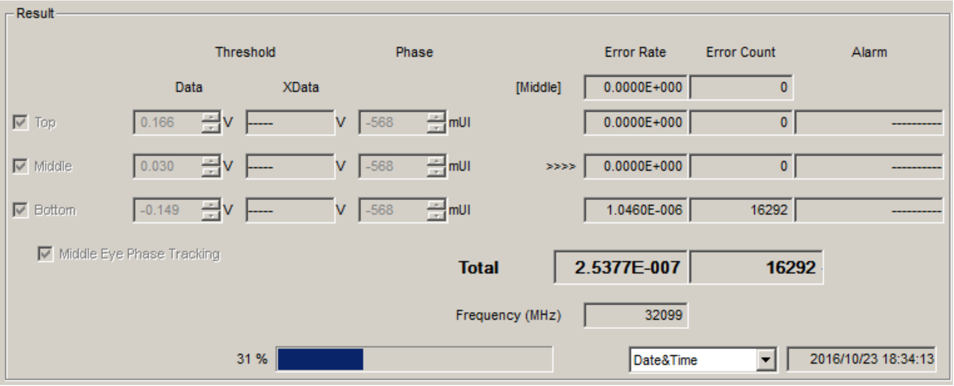
☑ Middle Eye Phase Tracking

Total 0.0000E+000 0

Frequency (MHz) 32099

0 %

Date&Time 2016/10/23 18:33:08



Result

	Threshold Data	Threshold XData	Phase		Error Rate	Error Count	Alarm
				[Middle]	0.0000E+000	0	
☑ Top	0.166 V	----- V	-568 mUI		0.0000E+000	0	----------
☑ Middle	0.030 V	----- V	-568 mUI	>>>>	0.0000E+000	0	----------
☑ Bottom	-0.149 V	----- V	-568 mUI		1.0460E-006	16292	----------

☑ Middle Eye Phase Tracking

Total 2.5377E-007 16292

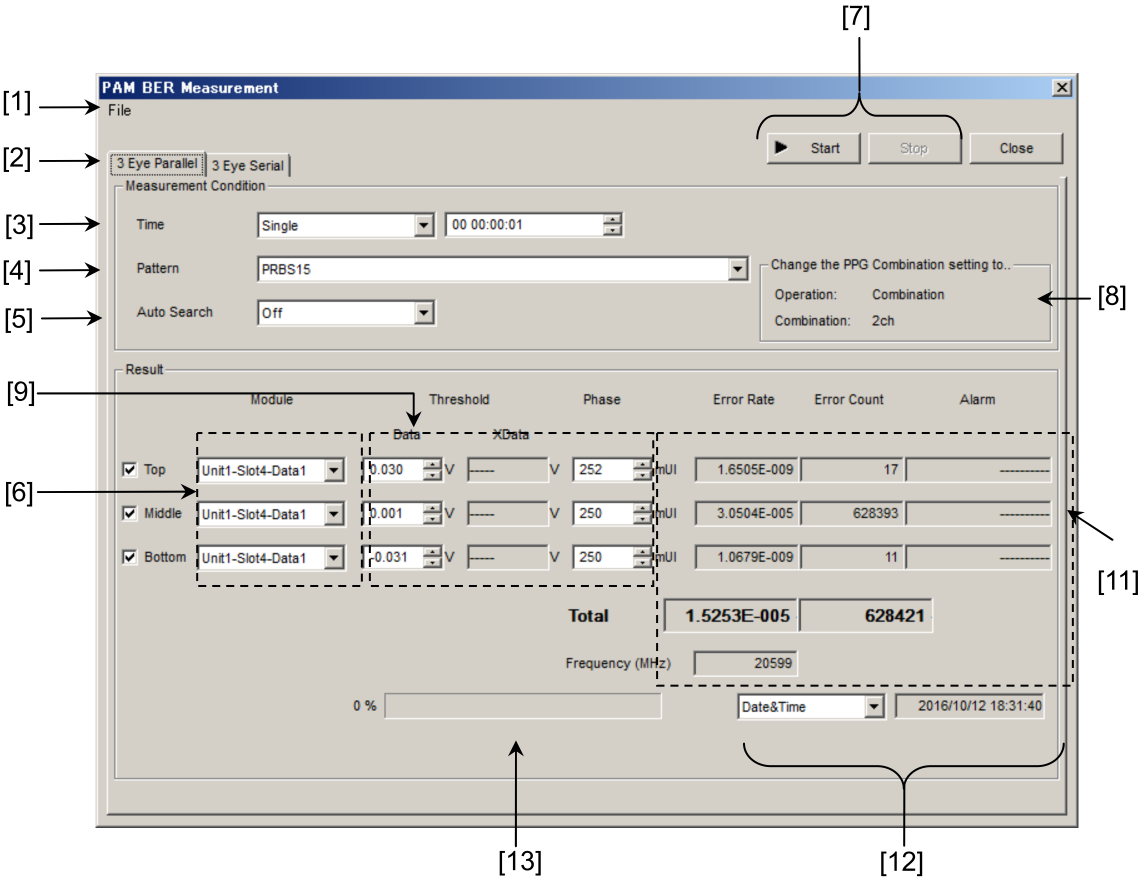
Frequency (MHz) 32099

31 %

Date&Time 2016/10/23 18:34:13

Display during measurement

Figure 5.14.1-1 PAM BER Measurement window (3 Eye Serial mode)



Measurement Condition

Time: Single, 00 00:00:01

Pattern: PRBS15

Auto Search: Off

Change the PPG Combination setting to..

Operation: Combination

Combination: 2ch

Result

	Module	Threshold Data	Threshold XData	Phase	Error Rate	Error Count	Alarm
☑ Top	Unit1-Slot4-Data1	0.030 V	----- V	252 mUI	1.6505E-009	17	----------
☑ Middle	Unit1-Slot4-Data1	0.001 V	----- V	250 mUI	3.0504E-005	628393	----------
☑ Bottom	Unit1-Slot4-Data1	-0.031 V	----- V	250 mUI	1.0679E-009	11	----------
				Total	1.5253E-005	628421	

Frequency (MHz): 20599

0 %

Date&Time: 2016/10/12 18:31:40

Figure 5.14.1-2 PAM BER Measurement window (3 Eye Parallel mode)

[1] Menu bar
Refer to Section 5.14.2 “Menu items” for details.

[2] Selecting 3 Eye Parallel mode or 3 Eye Serial mode

[3] Setting measurement cycle and measurement time
Set the BER measurement time for Single or Repeat mode.
This setting is the time for BER measurement, and is not the measurement time until the result is displayed.

[4] Setting pattern
Select the PAM waveform pattern to be measured.
For details of PAM patterns, refer to Appendix F “How to Use the PAM Function”.

[5] Auto Search setting
Select whether or not to use Auto Search before measuring.

PAM Coarse:	Measure after executing PAM Auto Search Coarse.
PAM Fine:	Measure after executing PAM Auto Search Fine.
Off:	Measure using the Threshold and Phase settings specified at [9].

[6] Selecting measurement target module
For 3 Eye Serial, select one ED slot and data interface to be used for PAM BER measurement.

When using 3 Eye Parallel, set the ED slot and data interface for measuring each Vth_Top/Middle/Bottom.

[7] **Start** and **Stop**Click **Start** to start PAM BER measurement. This operation is available when at least one ED module is selected in [5]. Measurement uses the Vth selected by the check box in [7]. Click **Stop** to stop PAM BER measurement.

[8] PPG Combination Setting

Displays the PPG Combination setting for the pattern set in [4]. Make sure the PPG is set as shown here. For how to set the PPG, refer to Appendix F “How to Use the PAM Function”.

[9] Threshold and Phase settings
Displays and sets Threshold and Phase for the BER measurement points at Top, Middle, and Bottom levels respectively. When PAM Coarse or PAM Fine is selected for [5], the results of PAM Auto Search are displayed. When Off is selected for [5], Threshold and Phase can be set.

When using 3 Eye Serial, the Threshold and Phase values of each channel ED will be set to the defaults of Middle in [9], if [5] is set to Off.
The default of Top is 0.100 V higher than that of Middle. The default of Bottom is 0.100 V lower than that of Middle.

When using 3 Eye Parallel, the Threshold and Phase values of each channel ED will be set to defaults of Top, Middle, and Bottom in [9], if [5] is set to Off.

[10] Middle Eye Phase Tracking
When this is selected, BER is searched in the phase direction using only the Middle Eye threshold.

[11] Displaying measurement results
The individual Vth_Top/Middle/Bottom, total error rate, error count, and alarm information are displayed.

For 3 Eye Serial, the individual Vth_Top/Middle/Bottom measurement completion results are displayed, and alarm information for the most recent alarm occurring is displayed during measurement. The total measurement results are calculated and displayed from the individual Vth measurement completion results.

And the real-time measurement for Eye pointed by [>>>>] is displayed at the row over the Top measurement result.

When using 3 Eye Parallel, the individual Vth_Top/Middle/Bottom measurement results and total measurement results are displayed at fixed intervals.

[12] Select the time to be displayed.

Date&Time:	Current time
Start Time:	Measurement start time
Elapsed Time:	Time elapsed from the measurement start time

[13] Displays the progress status.
The measurement progress percentage is displayed on a gauge and numerically.

5.14.2 Menu items

Table 5.14.2-1 lists the menu items provided in the PAM BER measurement window. No menu items can be selected during measurement.

Table 5.14.2-1 PAM BER Measurement Screen Menu Bar Layout

Menu	Menu Item				Function
File	Open				Opens a file. The file name is displayed as a screen title.
	Save	Data Type	PAM BER Result		Saves PAM BER measurement results.
		File Type	Binary		Saves results in binary format.
			CSV		Saves results in CSV format.
			Text		Saves results in text format.
	Screen Copy	Execute			Executes the screen copy according to the setting in **Screen Copy** → **Setup**.
		Setup	Save Type	BMP	Saves data in BMP format.
				PNG	Saves data in PNG format.
				JPG	Saves data in JPG format.
			Output	to File	Outputs data in the window to a file.
				to Printer	Outputs data in the window to a printer.
			Save to		Opens the dialog box showing the specified saving directory. The saving directory can be specified in this dialog box.
	Initialize				Initializes all the settings and measurement results.
	Exit				Closes the PAM BER window.

Notes:

- The screen-shot file (created by Screen Copy → Execute) is saved in the name format of "SC" + "date and time".
- The settings will not be read from the saved file if the file name is changed.

5.14.3 How to perform PAM BER Measurement

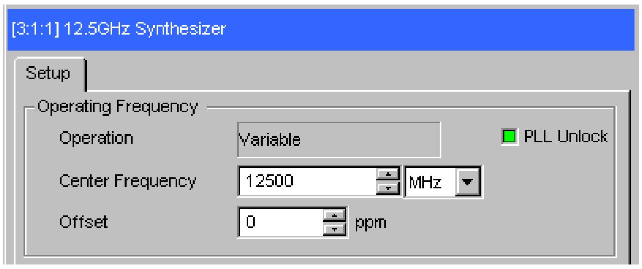
This section describes a basic procedure for measuring PAM BER.

1. Checking connection

   Check that the MU183020A, DUT (Device Under Test), and MU183040B/41B are correctly connected.

2. Setting frequency

   Set the frequency by the MU181000A/B Synthesizer window.

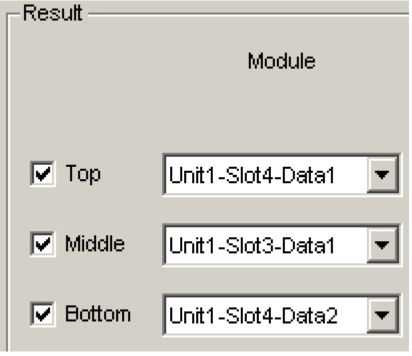


Operation: Variable
Center Frequency: 12500 MHz
Offset: 0 ppm

Figure 5.14.3-1 MU181000A 12.5GHz Synthesizer window

3. Selecting measurement ED and Interface

   Start the automatic measurement PAM BER and set the ED and Interface used for measurement. The example here uses 3 Eye Parallel.



☑ Top: Unit1-Slot4-Data1
☑ Middle: Unit1-Slot3-Data1
☑ Bottom: Unit1-Slot4-Data2

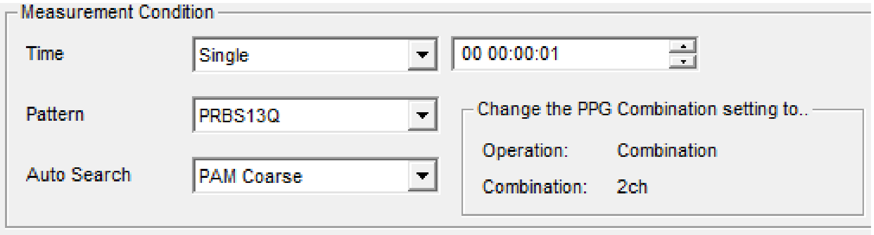
Figure 5.14.3-2 Measurement Data Interface Selection Screen

4. Setting conditions

   Set the measurement time using **Time**. In this example, it is set to Single 10 seconds.
   Select the **Pattern** to be used for measurement. In this example, **PRBS13Q** is selected.

   Select **PAM Fine**, **PAM Coarse**, or **OFF** for the **Auto Search** setting. In this example, **PAM Coarse** is selected.

Set the ED slot and data interface used for measurement and the Vth_Top/Middle/Bottom to be measured.



Measurement Condition

Time: Single 00 00:00:01

Pattern: PRBS13Q

Auto Search: PAM Coarse

Change the PPG Combination setting to..

Operation: Combination

Combination: 2ch

Figure 5.14.3-3 Condition Screen

5. Starting measurement

   Click **Start** to start PAM BER measurement.

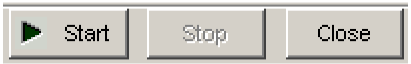


Figure 5.14.3-4 Measurement start button

6. Stopping measurement

   Click **Stop** to stop the PAM BER measurement.

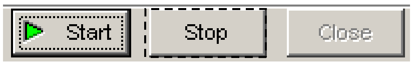
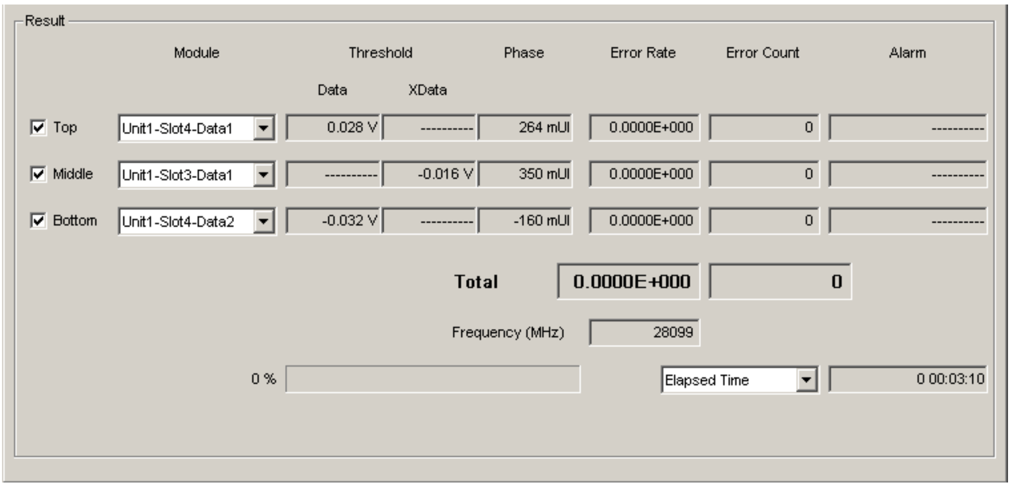


Figure 5.14.3-5 Measurement stop button

7. Measurement result

   Once measurement is complete, the individual Vth results and total result are displayed.



Result

	Module	Threshold Data	Threshold XData	Phase	Error Rate	Error Count	Alarm
☑ Top	Unit1-Slot4-Data1	0.028 V	----------	264 mUI	0.0000E+000	0	----------
☑ Middle	Unit1-Slot3-Data1	----------	-0.016 V	350 mUI	0.0000E+000	0	----------
☑ Bottom	Unit1-Slot4-Data2	-0.032 V	----------	-160 mUI	0.0000E+000	0	----------
Total					**0.0000E+000**	**0**	

Frequency (MHz) 28099

0 %

Elapsed Time 0 00:03:10

Figure 5.14.3-6 Measurement Result Display Screen

5.15 Eye Contour Measurement

The Eye Contour measurement is a function that plots bit-error-rate contours. Contours of bit error rates (1E–6 to 1E–20) are plotted by using measurement results for a number of bit error rates and estimating contours of the other bit error rates.

To use the Eye Contour measurement function, click the **Auto Measurement** ( ) module function button, and then select **Eye Contour.** Refer to the *MX180000A Signal Quality Analyzer Control Software Operation Manual* for details.

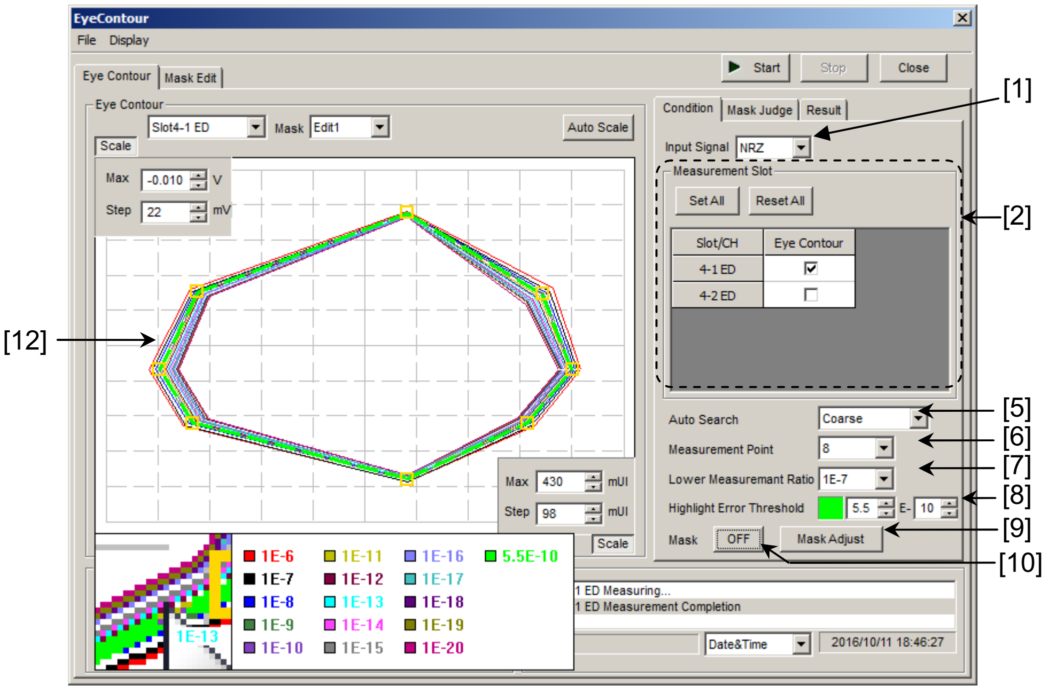
Note:

Eye Contour measurement cannot be performed for the following cases.

- When **Burst** is selected from the **Pattern Sequence** list box
- When **Auto Adjust** is set to **ON**
- When **Auto Sync** is set to **OFF**
- When the **Input** tab is grouped together with the other tab

5.15.1 Eye Contour window

Figure 5.15.1-1 shows the Eye Contour window.


EyeContour
File
Display
Eye Contour
Mask Edit
Start
Stop
Close
Auto Scale
Scale
Condition
Mask Judge
Result
Measurement Slot
Set All
Reset All
Mask Adjust
1E-6
1E-7
1E-8
1E-9
1E-10
1E-11
1E-12
1E-13
1E-14
1E-15
1E-16
1E-17
1E-18
1E-19
1E-20
5.5E-10
[1]
[2]
[5]
[6]
[7]
[8]
[9]
[10]
[12]

Eye Contour: Slot4-1 ED
Mask: Edit1
Max: -0.010 V
Step: 22 mV
Max: 430 mUI
Step: 98 mUI
Input Signal: NRZ

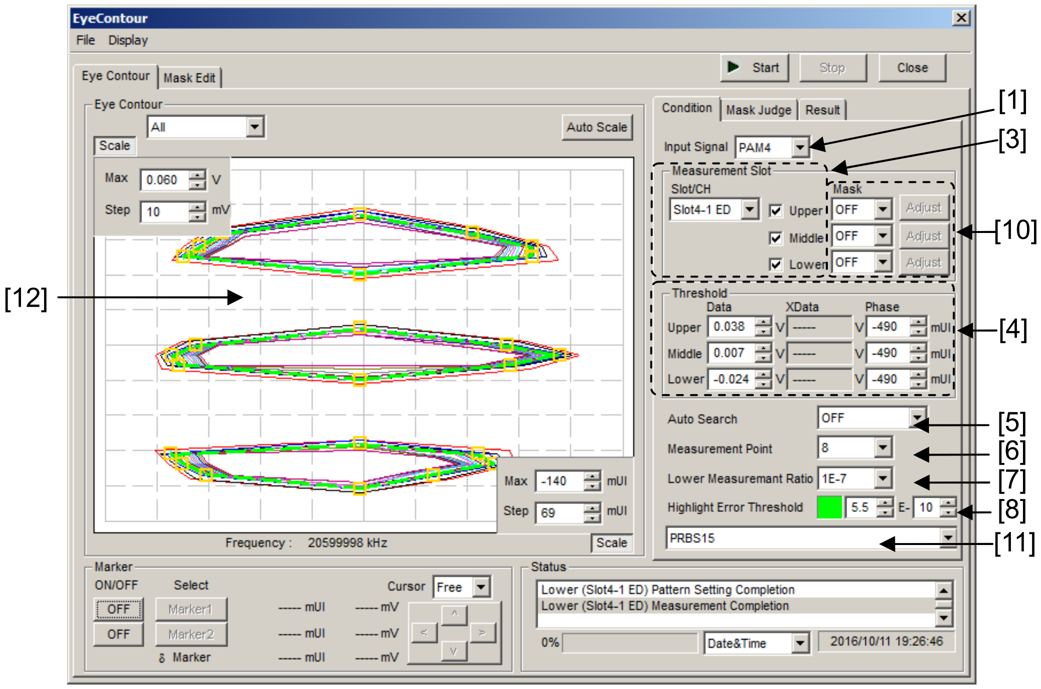
Slot/CH	Eye Contour
4-1 ED	☑
4-2 ED	☐

Auto Search: Coarse
Measurement Point: 8
Lower Measuremant Ratio: 1E-7
Highlight Error Threshold: 🟩 5.5 E- 10
Mask: OFF

1 ED Measuring...
1 ED Measurement Completion

Date&Time 2016/10/11 18:46:27

Figure 5.15.1-1 Eye Contour window



Eye Contour: All

Scale Max 0.060 V

Step 10 mV

Input Signal: PAM4

Measurement Slot

Slot/CH: Slot4-1 ED

☑ Upper Mask: OFF

☑ Middle Mask: OFF

☑ Lower Mask: OFF

Threshold

	Data		XData		Phase	
Upper	0.038	V	-----	V	-490	mUI
Middle	0.007	V	-----	V	-490	mUI
Lower	-0.024	V	-----	V	-490	mUI

Auto Search: OFF

Measurement Point: 8

Lower Measuremant Ratio: 1E-7

Highlight Error Threshold: 🟩 5.5 E- 10

PRBS15

Max -140 mUI

Step 69 mUI

Frequency : 20599998 kHz

Marker

ON/OFF	Select		
OFF	Marker1	----- mUI	----- mV
OFF	Marker2	----- mUI	----- mV
	δ Marker	----- mUI	----- mV

Cursor: Free

Status

Lower (Slot4-1 ED) Pattern Setting Completion
Lower (Slot4-1 ED) Measurement Completion

0%

Date&Time 2016/10/11 19:26:46

Figure 5.15.1-2 Eye Contour window (When measuring PAM4 signal)

[1] Input Signal

Select an input signal (**NRZ** or **PAM4**) to be measured.

[2] Measurement Slot (When **Input Signal** is **NRZ**)

Select the slots to be measured. The slots on which MU183040A/41A/40B/41B is mounted are displayed. Mask Test is executed by measuring the contour(s) using the interface(s) in the selected slot(s). Clicking **Set All** selects all of the interfaces displayed. Clicking **Reset All** unselects all of the interfaces displayed.

[3] Measurement Slot (When **Input Signal** is **PAM4**)

Select the eye(s) to be measured, and select the ED (Slot/CH) to be used for measurement. Mask Test is executed by measuring the contour(s) by the selected threshold(s) (Upper/Middle/Lower). Select an ED in the box listing the slots on which MU183040A/41A/40B/41B is mounted.

[4] Threshold (When **Input Signal** is **PAM4**)

If **OFF** is selected in the **Auto Search** box [5], set thresholds and phases for eyes. Without using Auto Search, manually set thresholds and phases at which eye measurement starts.

[5] Auto Search

Select the Auto Search type.

OFF:	The Eye Contour measurement is started, using the current phase and threshold voltage as the starting points.

Coarse: The Eye Contour measurement is started, using the phase and threshold obtained by performing Auto Search in the Course mode as the starting points. This is available when **Input Signal** is **NRZ**.

PAM Coarse: The Eye Contour measurement is started, using the phase and threshold obtained by performing Auto Search in the PAM Coarse mode as the starting points. Top/Middle/Bottom must be specified for each channel. This option is available only when your module is MU183040B or MU183041B. This is available when Input Signal is **PAM4**.

[6] Measurement Point
Sets the number of Contour Line measurement points to 4, 8, or 16. The greater the number of measurement points, the more detailed the measurement results. The detailed measurement takes long time.

[7] Lower Measurement
Sets the lower limit of the error rate for the Eye Contour measurement. If it is set to the value lower than 1E–7, the threshold voltage values and phase values are measured in the error rate range of 1E–7 to the specified error rate. For example, if it is set to 1E–10, measurement is performed in order of 1E–7, 1E–8, 1E–9, and then 1E–10 to calculate an approximate line of the error rate. (Refer to Figure 5.11.5-2 “Estimated noise distribution and BER estimating expression”.)

[8] Highlight Error Threshold
Sets the error rate of the contour to plot on the screen.

[9] Mask Adjust
Adjusts the displayed mask to the contour specified by **Highlight Error Threshold**. In this case, the Mask Threshold voltage and phase will be offset without varying the Contour Line for the measurement results.

[10] Mask ON/OFF

Setting to ON determines whether a Mask area is included in the error rate contour specified by Highlight Error Threshold. The mask area is filled with pink. (Refer to Figure 5.15.6-10.)

When **Input Signal** is **PAM4**, select **OFF** or one of **Edit1** to **Edit4** in the **Mask** box.

[11] **Pattern** (When **Input Signal** is **PAM4**)

Select the PAM4 signal pattern to be measured.

For details of PAM4 patterns, refer to Appendix F “How to Use the PAM Function”.

[12] BER contour display area

To check BER values of contours, put the cursor on the BER contours.

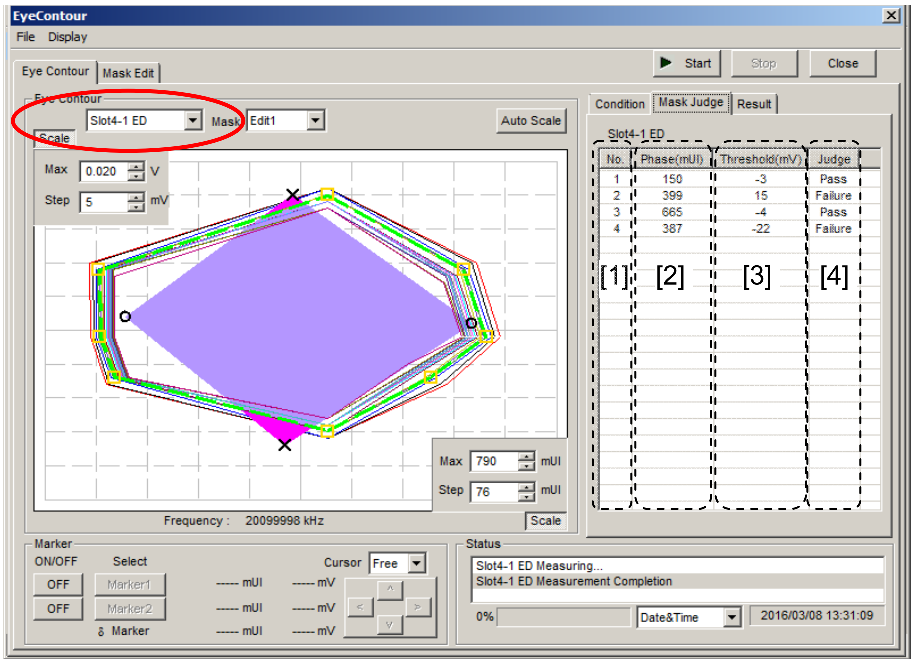
For details of other items here, refer to 5.11.3 “Diagram tab”.

For details of the Mask Edit screen, refer to 5.11.7 “Setting items on the Mask Edit tab”.

5.15.2 Mask Judge tab

The figure below shows the Mask Judge tab.

When **Slot Selection** is switched, the results on the Mask Judge tab are updated.


EyeContour
File Display
Eye Contour
Mask Edit
Start
Stop
Close
Auto Scale
Condition
Mask Judge
Result
Scale
Max
V
Step
mV
mUI
Marker
ON/OFF
Select
OFF
Marker1
Marker2
δ Marker
Cursor
Status

Eye Contour: Slot4-1 ED; Mask: Edit1

Max 0.020 V; Step 5 mV

Max 790 mUI; Step 76 mUI

Frequency : 20099998 kHz

Cursor: Free

Slot4-1 ED

No.	Phase(mUI)	Threshold(mV)	Judge
1	150	-3	Pass
2	399	15	Failure
3	665	-4	Pass
4	387	-22	Failure

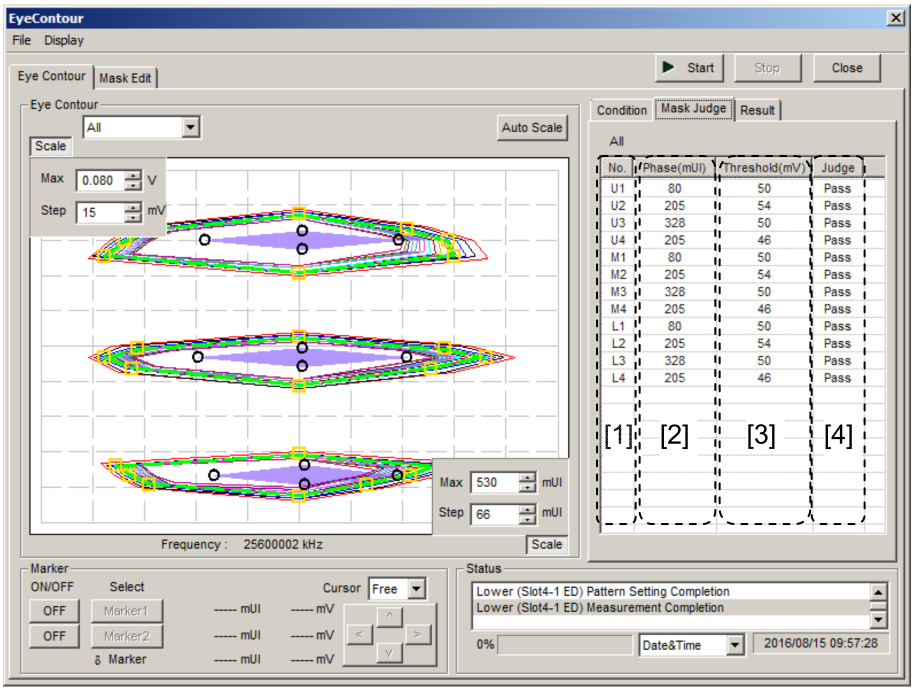
[1] [2] [3] [4]

Status:

Slot4-1 ED Measuring...
Slot4-1 ED Measurement Completion

0% Date&Time 2016/03/08 13:31:09

Figure 5.15.2-1 Mask Judge tab


EyeContour
File Display
Eye Contour
Mask Edit
Start
Stop
Close
Auto Scale
Condition
Mask Judge
Result
Scale
Max
V
Step
mV
mUI
Marker
ON/OFF
Select
OFF
Marker1
Marker2
δ Marker
Cursor
Status

Eye Contour: All

Max 0.080 V; Step 15 mV

Max 530 mUI; Step 66 mUI

Frequency : 25600002 kHz

Cursor: Free

All

No.	Phase(mUI)	Threshold(mV)	Judge
U1	80	50	Pass
U2	205	54	Pass
U3	328	50	Pass
U4	205	46	Pass
M1	80	50	Pass
M2	205	54	Pass
M3	328	50	Pass
M4	205	46	Pass
L1	80	50	Pass
L2	205	54	Pass
L3	328	50	Pass
L4	205	46	Pass

[1] [2] [3] [4]

Status:

Lower (Slot4-1 ED) Pattern Setting Completion
Lower (Slot4-1 ED) Measurement Completion

0% Date&Time 2016/08/15 09:57:28

Figure 5.15.2-2 Mask Judge tab (When measuring PAM4 signal)

[1] No.

Displays the Mask point number specified on the Mask Edit screen. The Mask points for PAM4 measurement are respectively numbered as follows:

- Upper Mask points: U1 to Ux
- Middle Mask points: M1 to Mx
- Lower Mask points: L1 to Lx

[2] Phase(mUI/ps)

Displays the phase value at the Mask point.

[3] Threshold(mV)

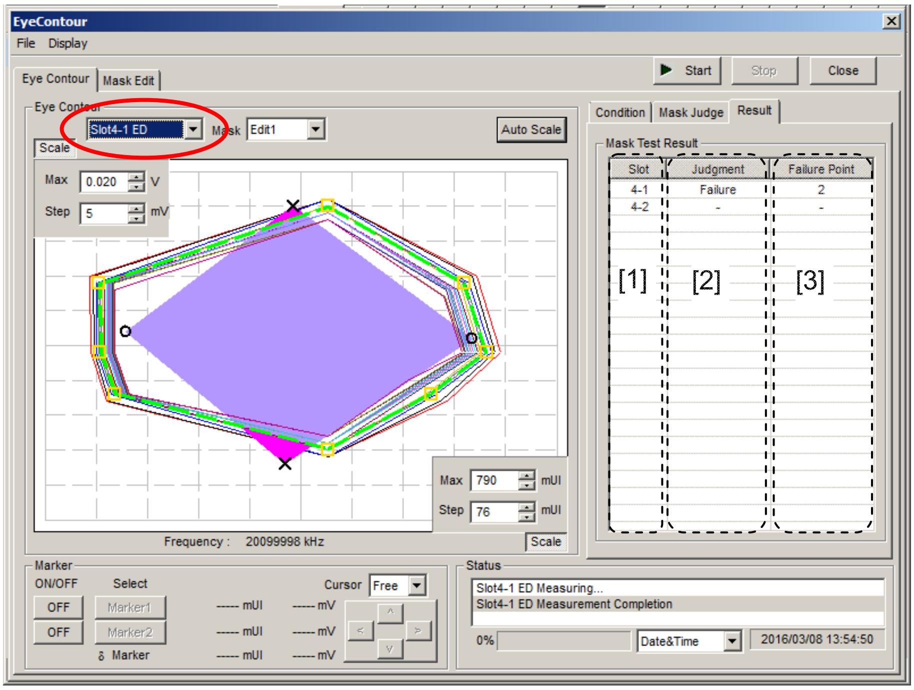
Displays the Threshold voltage value at the Mask point.

[4] Judge

Pass:	The Mask point is within the contour lines of error rate specified by Highlight Error Threshold.
Failure:	The Mask point is outside the contour lines of error rate specified by Highlight Error Threshold.

5.15.3 Result tab

The figure below shows the Result tab.
When switching **Slot Selection**, the results on the Result tab is updated.


EyeContour
File
Display
Eye Contour
Mask Edit
Start
Stop
Close
Auto Scale
Condition
Mask Judge
Result
Scale
Marker
ON/OFF
Select
OFF
Marker1
Marker2
δ Marker
Cursor
Status
[1]
[2]
[3]

Eye Contour: Slot4-1 ED　Mask: Edit1

Max 0.020 V　Step 5 mV

Max 790 mUI　Step 76 mUI

Frequency : 20099998 kHz

Cursor: Free

Mask Test Result

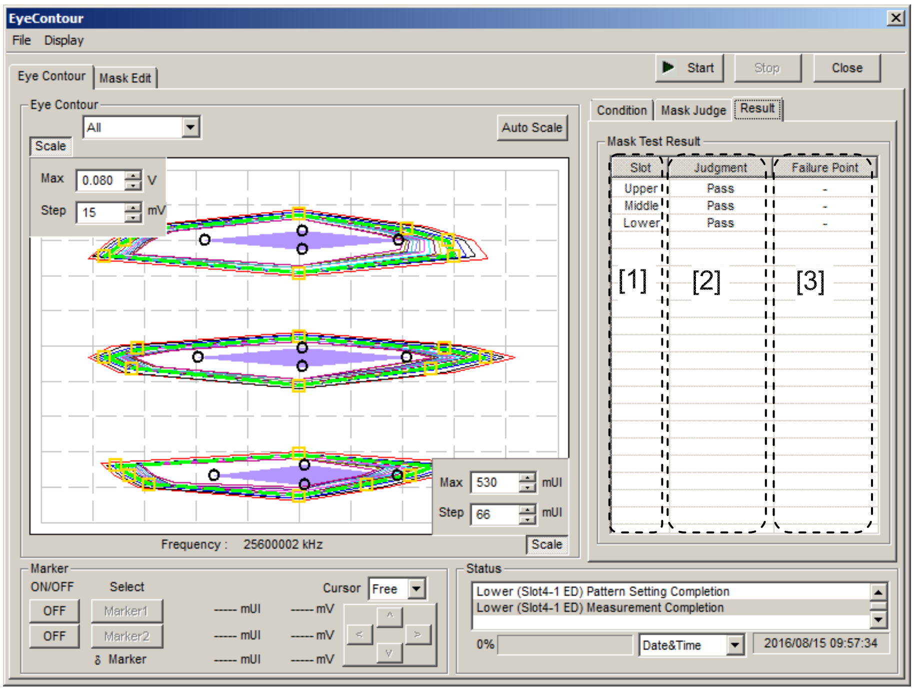
Slot	Judgment	Failure Point
4-1	Failure	2
4-2	-	-

Status

Slot4-1 ED Measuring...
Slot4-1 ED Measurement Completion

0%　Date&Time　2016/03/08 13:54:50

Figure 5.15.3-1　Result tab


EyeContour
File
Display
Eye Contour
Mask Edit
Start
Stop
Close
Auto Scale
Condition
Mask Judge
Result
Scale
Marker
ON/OFF
Select
OFF
Marker1
Marker2
δ Marker
Cursor
Status
[1]
[2]
[3]

Eye Contour: All

Max 0.080 V　Step 15 mV

Max 530 mUI　Step 66 mUI

Frequency : 25600002 kHz

Cursor: Free

Mask Test Result

Slot	Judgment	Failure Point
Upper	Pass	-
Middle	Pass	-
Lower	Pass	-

Status

Lower (Slot4-1 ED) Pattern Setting Completion
Lower (Slot4-1 ED) Measurement Completion

0%　Date&Time　2016/08/15 09:57:34

Figure 5.15.3-2　Result tab (When measuring PAM4 signal)

[1] Slot

Displays the Mask Test results of each slot and channel.
When measuring PAM4 signal, threshold (Upper, Middle, or Lower) is displayed.

[2] Judgment

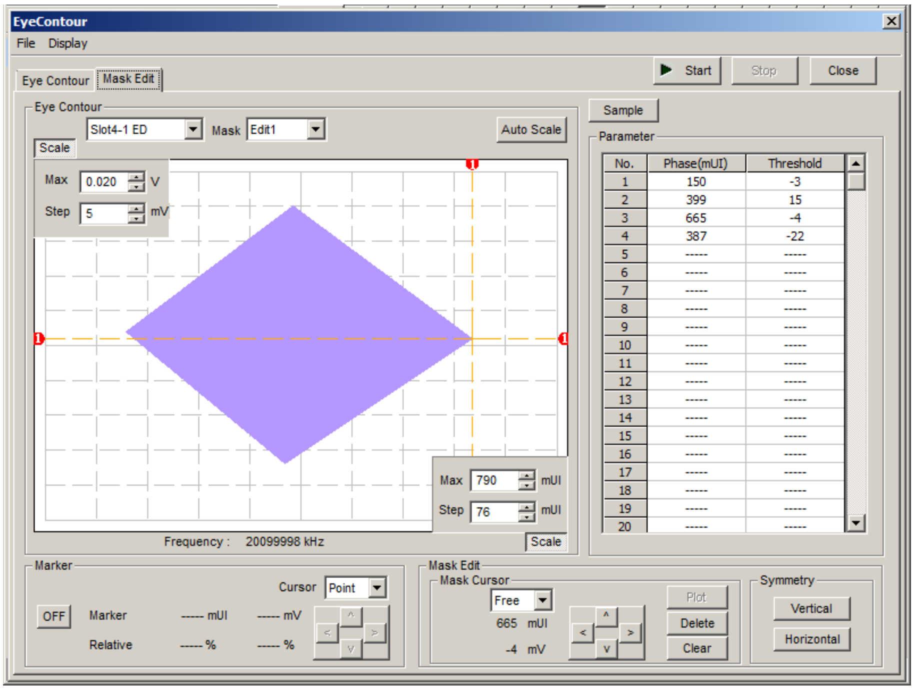
Pass:	All the Mask points are within the contour lines of error rate specified by Highlight Error Threshold.
Failure:	Some Mask points are outside the contour lines of error rate specified by Highlight Error Threshold.

[3] FailurePoint

Displays the number of points outside the contour lines of error rate specified by Highlight Error Threshold.

5.15.4 Setting items on the Mask Edit tab

The setting in this section is the same as that of the Mask Edit screen of the Eye Diagram measurement. For the setting details, refer to 5.11.7 “Setting items on the Mask Edit tab”.


EyeContour
File
Display
Eye Contour
Mask Edit
Start
Stop
Close
Eye Contour
Auto Scale
Scale
Sample
Parameter
Marker
OFF
Mask Edit
Plot
Delete
Clear
Symmetry
Vertical
Horizontal

Slot4-1 ED
Mask: Edit1
Max: 0.020 V
Step: 5 mV
Max: 790 mUI
Step: 76 mUI
Frequency : 20099998 kHz
Cursor: Point
Marker: ----- mUI ----- mV
Relative: ----- % ----- %
Mask Cursor: Free
665 mUI
-4 mV

No.	Phase(mUI)	Threshold
1	150	-3
2	399	15
3	665	-4
4	387	-22
5	-----	-----
6	-----	-----
7	-----	-----
8	-----	-----
9	-----	-----
10	-----	-----
11	-----	-----
12	-----	-----
13	-----	-----
14	-----	-----
15	-----	-----
16	-----	-----
17	-----	-----
18	-----	-----
19	-----	-----
20	-----	-----

Figure 5.15.4-1 Mask Edit tab

5.15.5 Menu items

Table 5.15.5-1 lists the menu items provided in the Eye Contour window. No menu items can be selected during measurement.

Table 5.15.5-1 Menu items in Eye Contour window

Menu	Menu Item				Function
File	Open				Opens a file. The file name is displayed as a screen title.
	Save	Data Type	Eye Contour Result		Saves Eye Contour measurement results.
			Eye Mask Point Result		Saves Eye Mask Point measurement results.
			Eye Mask Template		Saves Eye Mask Template measurement results. Only text format is supported.
		File Type	Binary		Saves results in binary format.
			CSV		Saves results in CSV format.
			Text		Saves results in text format.
	Screen Copy	Execute			Executes the screen copy according to the setting in **Screen Copy** → **Setup**.
		Setup	Save Type	BMP	Saves data in BMP format.
				PNG	Saves data in PNG format.
				JPG	Saves data in JPG format.
			Output	to File	Outputs data in the window to a file.
				to Printer	Outputs data in the window to a printer.
			Save to		Opens the dialog box showing the specified saving directory. The saving directory can be specified in this dialog box.
	Initialize				Initializes all the settings and measurement results.
	Exit				Closes the Eye Contour window.
Display	mUI				Sets the phase unit to mUI.
	ps				Sets the phase unit to ps.

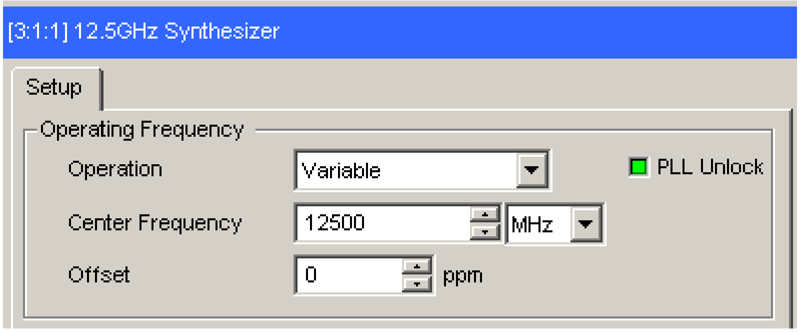
Note:

The settings will not be read from the saved file if the file name is changed.

5.15.6 How to perform Eye Contour Measurement

This section describes a basic procedure for performing the Eye Contour measurement.

1. Checking connection
   Check that the MU183020A (or MU183021A), DUT (Device Under Test), and MU183040A/41A/40B/41B are correctly connected.
2. Setting frequency
   Set the frequency by the MU181000A/B Synthesizer window.



[3:1:1] 12.5GHz Synthesizer

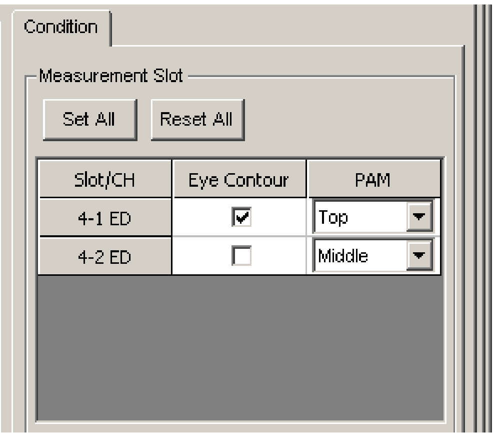
Operation: Variable

Center Frequency: 12500 MHz

Offset: 0 ppm

Figure 5.15.6-1 MU181000A 12.5GHz Synthesizer window

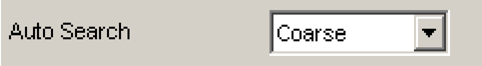
3. Setting interface
   Starts automatic measurement Eye Contour measurement.
   In the Measurement Slot area of the **Condition** tab, select the **Eye Contour** check box for the Slot/Channel to be measured.
   For PAM measurement, also set Top/Middle/Bottom.



Slot/CH	Eye Contour	PAM
4-1 ED	☑	Top
4-2 ED	☐	Middle

Figure 5.15.6-2 Condition tab (PAM mode)

4. Setting Auto Search
   Set Auto Search. OFF, Coarse, or PAM Coarse can be selected.



Auto Search: Coarse

Figure 5.15.6-3 Auto Search setting

5. Setting Measurement Point

   Set Measurement Point. Select 4, 8, or 16.

Measurement Point 8

Figure 5.15.6-4 Measurement Point setting

6. Setting Lower Measurement Ratio

   Set the Lower Measurement Ratio. Setting from 1E–7 to 1E–12 in 1E–1 steps are possible. Measurement is performed in the error rate range of 1E–7 to the specified error rate, in order to estimate a Contour Line.

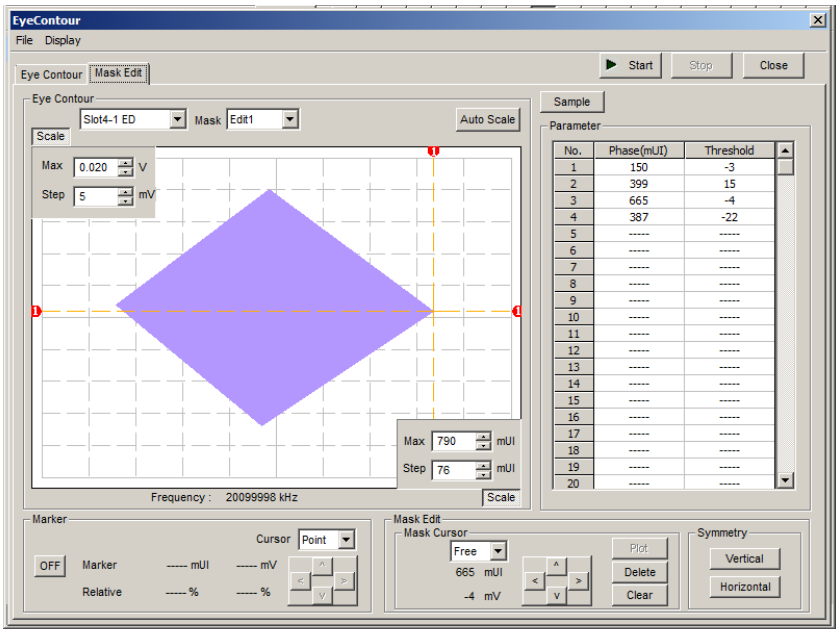
Lower Measuremant Ratio 1E-7

Figure 5.15.6-5 Lower Measurement Ratio setting

7. Setting Mask

   When executing the Mask Test, set the mask on the **Mask Edit** tab. For the setting details, refer to 5.11.7 “Setting items on the Mask Edit tab”.

   Mask can be selected from Edit1 to 4.



EyeContour
File
Display
Eye Contour
Mask Edit
Start
Stop
Close
Eye Contour
Auto Scale
Scale
Sample
Parameter
Marker
Mask Edit
Mask Cursor
Plot
Delete
Clear
Symmetry
Vertical
Horizontal
OFF
Scale

Slot4-1 ED

Mask Edit1

Max 0.020 V

Step 5 mV

Max 790 mUI

Step 76 mUI

Frequency : 20099998 kHz

No.	Phase(mUI)	Threshold
1	150	-3
2	399	15
3	665	-4
4	387	-22
5	-----	-----
6	-----	-----
7	-----	-----
8	-----	-----
9	-----	-----
10	-----	-----
11	-----	-----
12	-----	-----
13	-----	-----
14	-----	-----
15	-----	-----
16	-----	-----
17	-----	-----
18	-----	-----
19	-----	-----
20	-----	-----

Cursor Point

Marker ----- mUI ----- mV

Relative ----- % ----- %

Free

665 mUI

-4 mV

Figure 5.15.6-6 Mask Setting

8. Selecting Mask
   Select Mask from Edit1 to 4 that have been created on the **Mask Edit** tab.

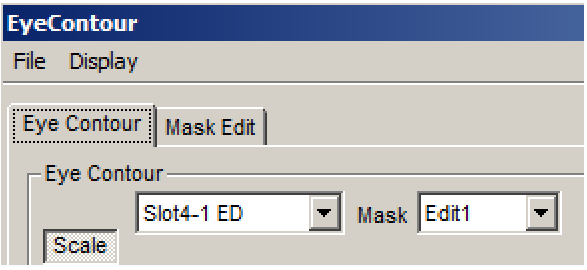

EyeContour
File　Display
Eye Contour
Mask Edit
Eye Contour
Slot4-1 ED
Mask
Edit1
Scale

Figure 5.15.6-7　Selecting Mask

9. Starting measurement
   Click **Start** to start Eye Contour measurement.

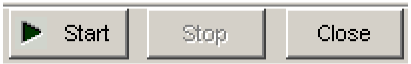

Start
Stop
Close

Figure 5.15.6-8　Measurement start button

10. Stopping measurement
    Click **Stop** to stop the Eye Contour measurement.

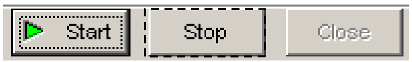
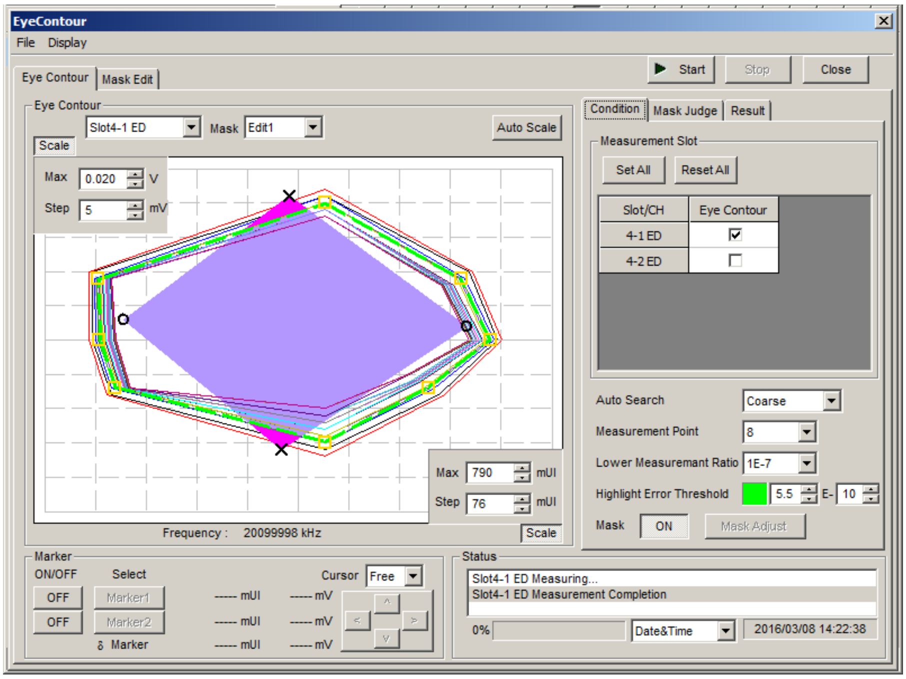

Start
Stop
Close

Figure 5.15.6-9　Measurement stop button

11. Measurement results

    The Eye Contour measurement results are displayed on a graph. Here, contours can be displayed for any error rates by setting Highlight Error Threshold. The yellow squares represent measured values and the voltage and phase assumed from the measured values.


EyeContour
File Display
Eye Contour
Mask Edit
Start
Stop
Close
Auto Scale
Scale
Condition
Mask Judge
Result
Measurement Slot
Set All
Reset All
Mask Adjust
Marker
ON/OFF
Select
Marker1
Marker2
δ Marker
Status

Eye Contour: Slot4-1 ED Mask: Edit1

Max 0.020 V
Step 5 mV

Max 790 mUI
Step 76 mUI

Frequency : 20099998 kHz

Slot/CH	Eye Contour
4-1 ED	☑
4-2 ED	☐

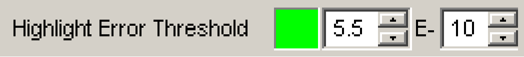
Auto Search: Coarse
Measurement Point: 8
Lower Measuremant Ratio: 1E-7
Highlight Error Threshold: 🟩 5.5 E- 10
Mask: ON

OFF ------ mUI ------ mV
OFF ------ mUI ------ mV
------ mUI ------ mV
Cursor: Free

Slot4-1 ED Measuring...
Slot4-1 ED Measurement Completion

0% Date&Time 2016/03/08 14:22:38

Figure 5.15.6-10 Eye Contour window with measurement results displayed



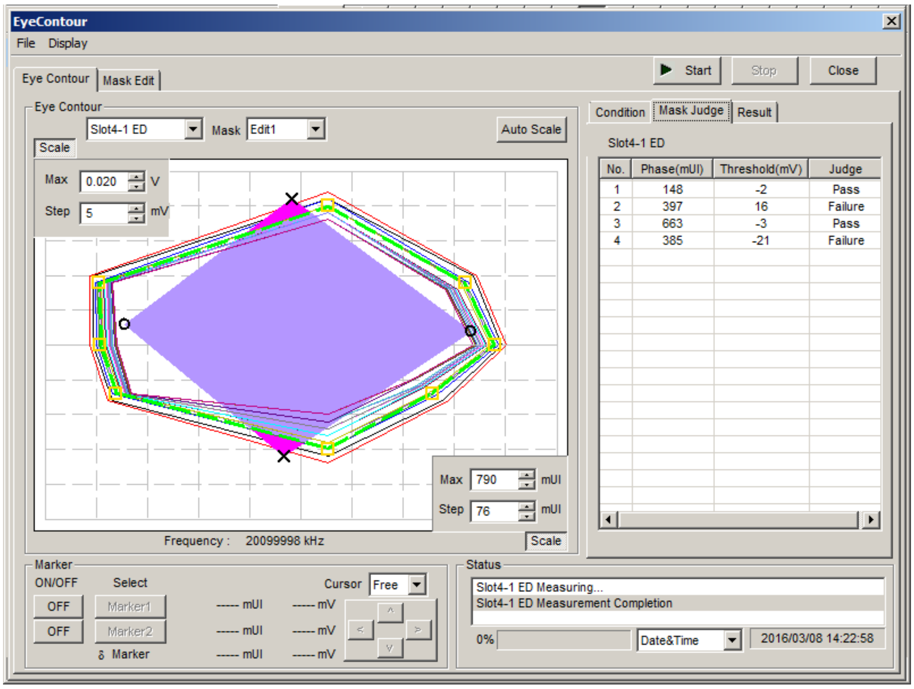
Highlight Error Threshold 🟩 5.5 E- 10

Figure 5.15.6-11 Highlight Error Threshold setting

12. Judgment of each Mask point

    Select the **Mask Judge** tab. Displays judgment results that show if each Mask point is inside the contour lines of error rate specified by **Highlight Error Threshold.**

    Editing **Highlight Error Threshold** updates the judgment results.


EyeContour
File
Display
Eye Contour
Mask Edit
Start
Stop
Close
Condition
Mask Judge
Result
Eye Contour
Mask
Auto Scale
Scale
Max
V
Step
mV
Max
mUI
Step
mUI
Scale
Marker
ON/OFF
Select
Cursor
OFF
Marker1
OFF
Marker2
δ Marker
----- mUI
----- mV
Status
Date&Time

Slot4-1 ED; Mask: Edit1

Max: 0.020 V; Step: 5 mV

Max: 790 mUI; Step: 76 mUI

Frequency : 20099998 kHz

Cursor: Free

Slot4-1 ED

No.	Phase(mUI)	Threshold(mV)	Judge
1	148	-2	Pass
2	397	16	Failure
3	663	-3	Pass
4	385	-21	Failure

Slot4-1 ED Measuring...
Slot4-1 ED Measurement Completion

0%

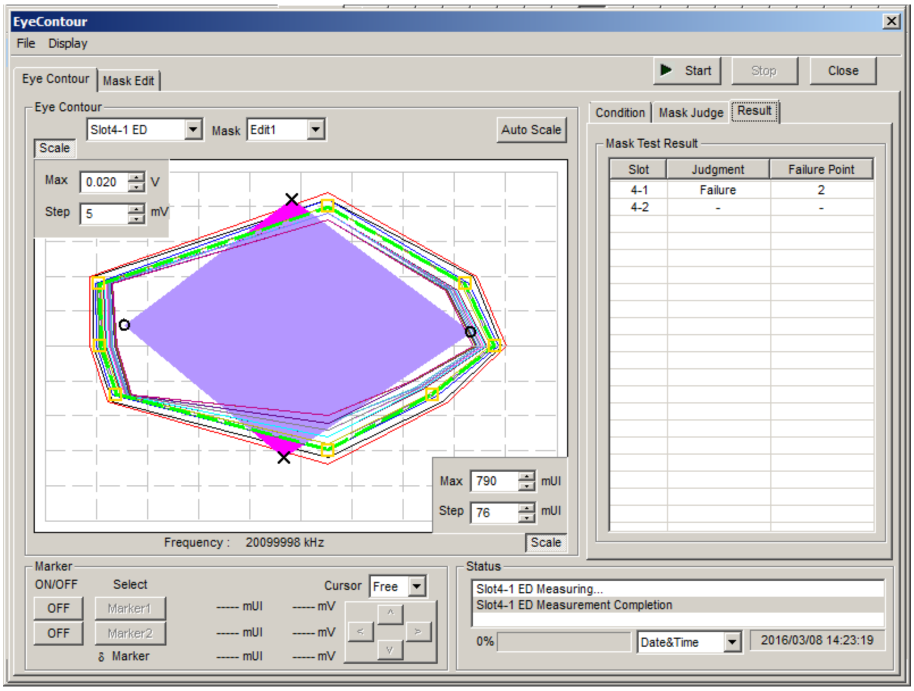
2016/03/08 14:22:58

Figure 5.15.6-12 Mask Judge Tab

13. Judgment results at all Mask points

    Selects the Result tab. Displays judgment results that show if all Mask points are inside the contour lines of error rate specified by **Highlight Error Threshold**.

    Editing **Highlight Error Threshold** updates the judgment results.


EyeContour
File
Display
Eye Contour
Mask Edit
Start
Stop
Close
Condition
Mask Judge
Result
Auto Scale
Scale
Scale
Marker
ON/OFF
Select
OFF
OFF
Marker1
Marker2
δ Marker
----- mUI
----- mV
----- mUI
----- mV
----- mUI
----- mV
Status

Eye Contour: Slot4-1 ED Mask: Edit1

Max: 0.020 V Step: 5 mV

Max: 790 mUI Step: 76 mUI

Frequency : 20099998 kHz

Cursor: Free

Mask Test Result

Slot	Judgment	Failure Point
4-1	Failure	2
4-2	-	-

Slot4-1 ED Measuring...
Slot4-1 ED Measurement Completion

0% Date&Time 2016/03/08 14:23:19

Figure 5.15.6-13 Result Tab

5.15.7 Estimating Eye Contour

This section describes how to estimate Eye Contour. The processing is basically equivalent to that for the Estimate measurement of the Eye Diagram measurement, but is different partially.

Figure 5.15.7-1 shows an example of the Eye Contour of a-b-c-d-e plotted by using the actual measured voltages and phases. The voltage at measurement points a and e matches the Auto Search point. The phase at measurement point c matches the Auto Search point. Neither voltage nor phase of measurement points b and d matches the Auto Search point.

In case of the Eye Diagram measurement, the position estimation of measurement points b and d is performed in a voltage or phase direction only. In Figure 5.15.7-1, the positions of measurement points b and d estimated in a phase direction are indicated by ▲. On the other hand, in case of the Eye Contour measurement, the position estimation of measurement points b and d, etc. is performed toward the Auto Search point. In Figure 5.15.7-1, the estimated positions are indicated by □.

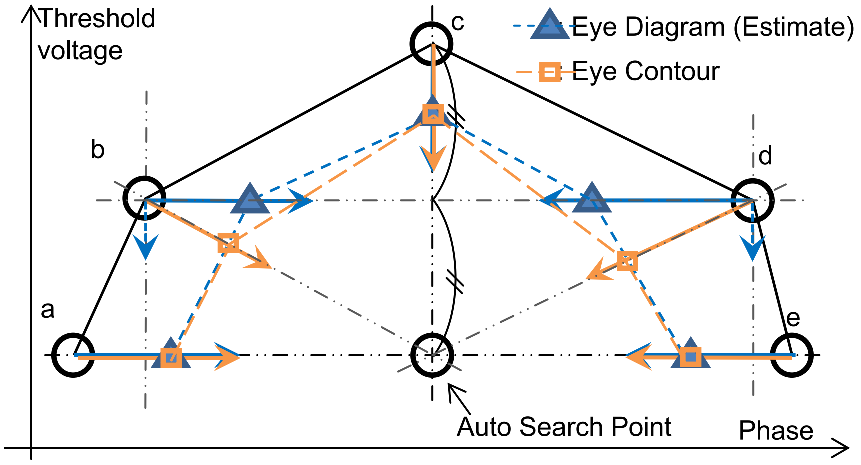


Figure 5.15.7-1 Eye Contour Measurement

Chapter 6 Usage Examples

This chapter describes usage examples of measurement using the MU183041A.

6.1 Measuring Optical Transceiver Module 6-2

6.1 Measuring Optical Transceiver Module

This section describes how to test the electrical interface input sensitivity of a CFP2 optical transceiver module by using MU183021A and MU183041A.

In the following test example, the MU183021A and MU182041A are mounted onto the MP1800A. The options configuring the test system are as follows:

MP1800A-014

MU181000A

MU183021A-x12

MU183041A

Measurement

1. Connect the MP1800A and DUT to GND.
2. Use a coaxial connector to connect the Clock Output connector of the MU181000A and the Ext. Clock Input connector of the MU183021A.
3. Use a coaxial connector to connect the Clock Output connector of the MU183021A and the Ext. Clock Input connector of the MU183041A.

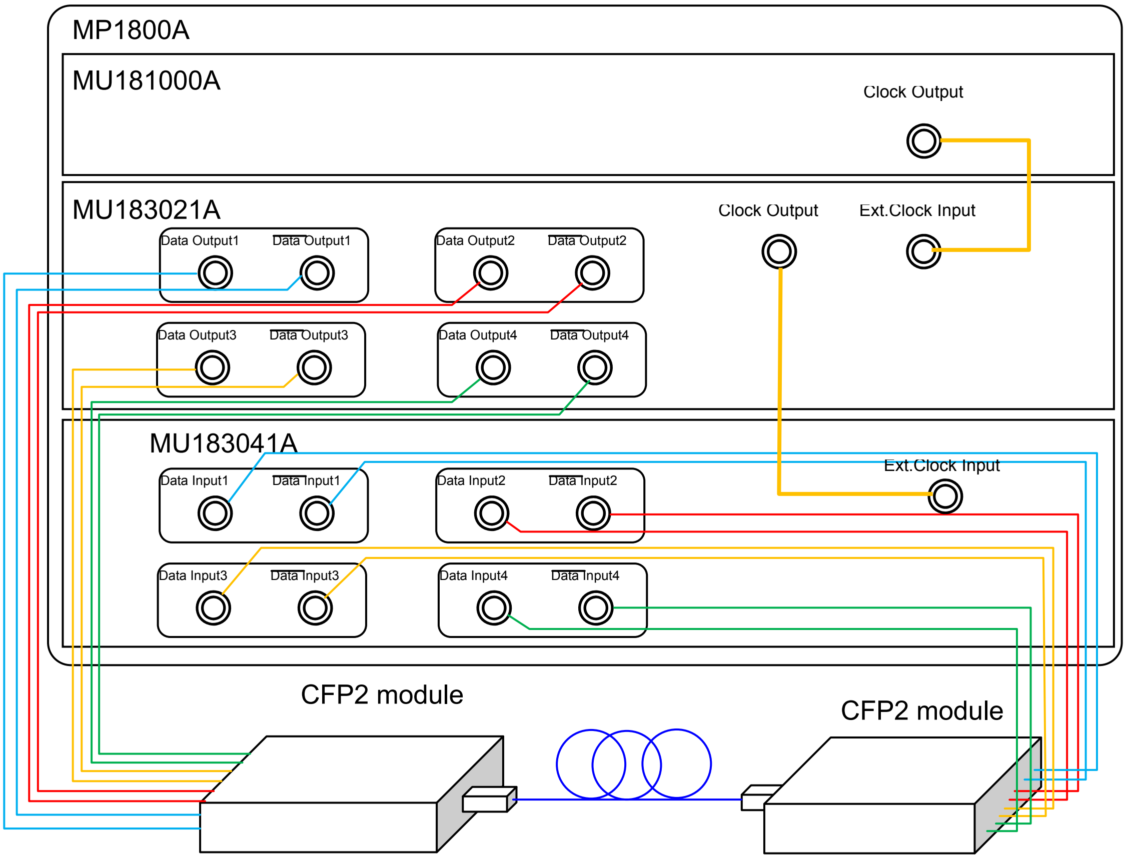

MP1800A
MU181000A
Clock Output
MU183021A
Clock Output
Ext.Clock Input
Data Output1
Data Output1
Data Output2
Data Output2
Data Output3
Data Output3
Data Output4
Data Output4
MU183041A
Ext.Clock Input
Data Input1
Data Input1
Data Input2
Data Input2
Data Input3
Data Input3
Data Input4
Data Input4
CFP2 module
CFP2 module

Figure 6.1-1 Connection diagram for CFP2 module evaluation

4. Use coaxial cables to connect the Data Output 1-4 connectors and $\overline{\text{Data}}$ Output 1-4 connectors of the MU183021A to the Data Input connectors of the CFP2 module (8 connections).
5. Use coaxial cables to connect the Data Input 1-4 connectors and $\overline{\text{Data}}$ Input 1-4 connectors of the MU183041A to the Data Output connectors of the CFP2 module (8 connections).

Test method

1. Plug the power cord of the MP1800A.
2. Turn on the MP1800A.
3. Turn off the Output module function button.
   Adjust the data output interface of the MU183021A to the input interface of the DUT. In the MU183021A Output tab, select Data/XData, and set Tracking to ON. The Data/XData amplitude and offset settings are applied commonly.
4. Set the pattern by selecting a test pattern in the Pattern tab of the MU183021A and MP183041A.
5. Set the operation bit rate at the Bit Rate Setting spin box in the Output tab of the MU183021A.
6. Adjust the data input interface of the MU183041A to the output interface of the DUT.
   Select a terminal condition at the Input Condition in the Input tab of the MU183041A. Since the CFP2 module is connected by the differential interface, select “Differential 100 Ohm,” and then “Tracking.”
7. Turn on the CFP2 module.
   Be sure to turn on the MP1800A first, and then the CFP2 module.

⚠ CAUTION

The DUT may be damaged if a signal line is connected or disconnected while the output is ON. Be sure to turn off the MP1800A before changing the cable connection.

---

8. Set Data/XData to ON in the Output tab of the MU183021A, and then select the Output module function button.
9. Adjust the threshold voltage of the MU183041A.
   Select the Auto Adjust module function button.
10. Start the measurement on the Result screen of the MU183041A, and check the BER measurement result.

11. After checking that the DUT is operating normally, the CFP2 module data input (TD+ and TD−) sensitivity can be measured by decreasing the output level of the MU183021A.

Chapter 7 Remote Command

For the explanation of the command format and status, refer to the *MX180000A Signal Quality Analyzer Control Software Operation Manual Remote Control.*

For remote control commands of MU183040A/41A/40B/41B, refer to Section 7.12 “28G/32G bit/s ED Commands” in the *MX180000A Signal Quality Analyzer Control Software Operation Manual Remote Control*.

Chapter 8 Performance Test

This chapter describes the performance testing of the MU183040A/41A/40B/41B.

8.1 Overview 8-2
8.2 Devices Required for Performance Tests 8-2
8.3 Performance Test Items 8-3
  8.3.1 Operating frequency 8-3
  8.3.2 Input level 8-5
  8.3.3 Pattern 8-7
  8.3.4 Error detection 8-8

8.1 Overview

Performance tests are executed to check that the major functions of the MU183040A/41A/40B/41B meet the required specifications. Execute performance tests at acceptance inspection, operation check after repair, and periodic (once every six months) testing.

8.2 Devices Required for Performance Tests

Before starting performance tests, warm up the MU183040A/41A/40B/41B and the measuring instruments for at least 30 minutes. Table 8.2-1 shows the devices required for performance tests.

Table 8.2-1 Devices required for performance tests

Model name	Required Performance
Pulse Pattern Generator (MP1800A + MU183020A-x01, x30)	Operating frequency: 2.4 to 32.1 GHz Data clock phase variable: 1 UI or more* Other performances must be equivalent to those for the MU183020A.
Sampling Oscilloscope	70 GHz or more band
Signal generator (MP1800A + MU181000B, MG3690 series)	Operating frequency: 1.2 to 14.05 GHz Output level: 400 to 2000 mVp-p Waveform: Sine wave When option x01 is installed, use the MG3690 series in addition to the above. Operating frequency: 14 GHz to 16.05 GHz Output level: 400 to 1500 mVp-p Waveform: Sine wave
41KC-6 Precision Fixed Attenuator	6 dB Attenuation

*: This is not required when the option-x30 is installed.

Note:

Before starting the performance tests, warm up the device under test and the measuring instruments for at least 30 minutes and wait until they become sufficiently stabilized, unless otherwise specified. Additional conditions are required for maximum measurement accuracy: measurements must be performed at room temperature, fluctuations of AC power supply voltage must be small, and noise, vibration, dust, and humidity must be insignificant.

8.3 Performance Test Items

This section describes the following test items.

(1) Operating frequency range

(2) Input level

(3) Pattern

(4) Error detection

8.3.1 Operating frequency

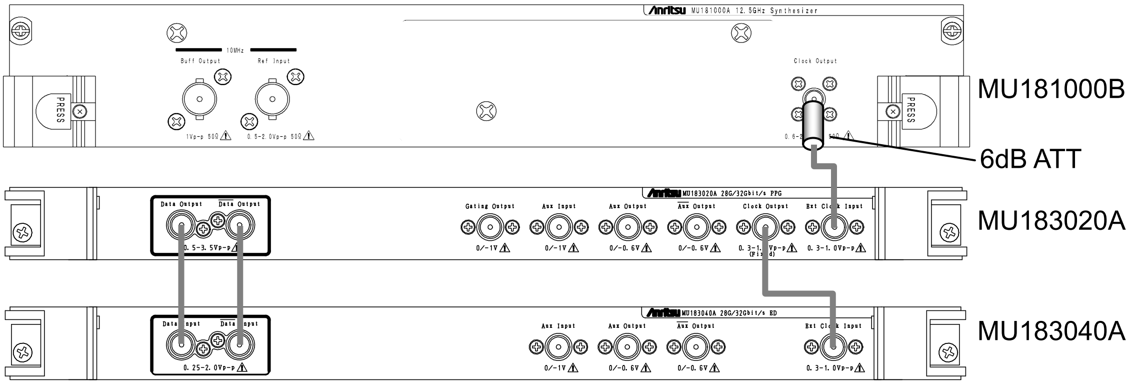
(1) Specifications

Table 8.3.1-1 Specifications

Option	Specifications
MU183040A/40B	2.4 to 28.1 GHz
MU183040A/40B-x01	2.4 to 32.1 GHz
MU183041A/41B	2.4 to 28.1 GHz
MU183041A/41B-x01	2.4 to 32.1 GHz

(2) Connection

Figure 8.3.1-1 shows the connection example that uses MU181000B, MU183020A and MU183040A.
Before connecting the devices, be sure to use a sampling oscilloscope to check if the frequency and level of the signals output from the MU181000B and MU183020A are proper.



Anritsu MU181000A 12.5GHz Synthesizer
10MHz
Buff Output
Ref Input
1Vp-p 50Ω
0.5-2.0Vp-p 50Ω
Clock Output
PRESS
MU181000B
6dB ATT
Anritsu MU183020A 28G/32Gbit/s PPG
Data Output
Data Output
0.5-3.5Vp-p
Gating Output
Aux Input
Aux Output
Aux Output
Clock Output
Ext Clock Input
0/-1V
0/-1V
0/-0.6V
0/-0.6V
(Fixed)
0.3-1.0Vp-p
MU183020A
Anritsu MU183040A 28G/32Gbit/s ED
Data Input
Data Input
0.25-2.0Vp-p
Aux Input
Aux Output
Aux Output
Ext Clock Input
0/-1V
0/-0.6V
0/-0.6V
0.3-1.0Vp-p
MU183040A

Figure 8.3.1-1 Inter-module connection example

When using the MU181000A, attach the 6 dB Coaxial Attenuator to the Clock Output connector.

(3) Procedure

1. Insert the power plug of the mainframe to an outlet. Be sure to use the 3-pin power cord for grounding, and insert the plug into an outlet with a ground terminal.
2. Connect the Clock Output connector of the MU181000B and the Ext. Clock Input connector of the MU183020A, using a coaxial cable.
3. Connect the Clock Output connector of the MU183020A and the Ext. Clock Input connector of the MU183040A/41A/40B/41B, using a coaxial cable.
4. Connect the Data Output connector of the MU183020A and the Data Input connector of the MU183040A/41A/40B/41B, using a coaxial cable. Also connect the XData Output connector of the MU183020A and the XData Input connector of the MU183040A/41A/40B/41B, using a coaxial cable

   Note:

   > When a pulse pattern generator other than the Signal Quality Analyzer Series pulse pattern generator, MU183020A, is used, be sure to connect the connectors with signal output OFF, and configure the settings so that the generated signal does not exceed the specifications for the input amplitude and threshold voltage of the MU183040A/40B/41A/41B.

5. Select **Initialize** from the **File** menu on the menu bar to initialize all the settings for the devices.
   Note that all the settings return to the factory shipment settings after initialization. If you want to keep some settings, save them by selecting **Save** from the **File** menu before executing initialization.
6. Set the Data and Clock outputs of the MU183020A to ON, and then press **Start** of the MU183040A/41A/40B/41B.
7. Set the frequency of the MU181000B to a value within the specification, and adjust the phase of the MU183020A or the MU183040A/41A/40B/41B so that an error does not occur at the set frequency.

8.3.2 Input level

(1) Specifications

Table 8.3.2-1 Specifications

Option	Specifications
MU183040A-x10/x20	Input amplitude: 0.25 to 2.0 Vp-p Threshold voltage: –3.5 to +3.3 V
MU183041A	Input amplitude: 0.25 to 2.0 Vp-p Threshold voltage: –3.5 to +3.3 V
MU183040B-x10/x20	Input amplitude: 0.05 to 1.0 Vp-p Threshold voltage: –3.5 to +3.3 V
MU183041B	Input amplitude: 0.05 to 1.0 Vp-p Threshold voltage: –3.5 to +3.3 V

(2) Connection

Refer to Figure 8.3.1-1 for the device connection.

(3) Procedure

1. Connect devices and configure the settings in the same manner as shown in Steps 1 to 5 in Section 8.3.1.
2. Set the output level of the MU183020A and the threshold voltage of the MU183040A/41A/40B/41B as shown in Table 8.3.2-2 and Table 8.3.2-3. Next, set the output of the MU183020A to ON and press **Start** of the MU183040A/41A/40B/41B. Adjust the phase as required, and check that no error occurs.

Table 8.3.2-2 Input level test setting (MU183040A/41A)

	MU183020A			MU183040A/41A	
No.	Termination	Amplitude [Vp-p]	Offset (Vth) [V]	Termination	Threshold voltage [V]
1	GND	2.0	–3.5	GND	–3.500
2		0.25*	–3.5		–3.500
3		2.0	+3.3		+3.300
4		0.25*	+3.3		+3.300
5	NECL	0.8	–1.3	Variable: –2.0V	–1.300
6	LVPECL	0.8	+2.0	Variable: +1.3V	+2.000
7	PCML	0.5	+3.05	Variable: +3.3V	+3.050

*: For the signals of amplitude 0.25 Vp-p, set the MU183020A to 0.5 Vp-p and use the Precision Fixed Attenuator (6 dB, application part 41KC-6).

Table 8.3.2-3 Input level test setting (MU183040B/41B)

	MU183020A			MU183040B/41B	
No.	Termination	Amplitude [Vp-p]	Offset (Vth) [V]	Termination	Threshold voltage [V]
1	GND	1.0	–3.5	GND	–3.500
2		0.05*	–3.5		–3.500
3		1.0	+3.3		+3.300
4		0.05*	+3.3		+3.300
5	NECL	0.8	–1.3	Variable: –2.0V	–1.300
6	LVPECL	0.8	+2.0	Variable: +1.3V	+2.000
7	PCML	0.5	+3.05	Variable: +3.3V	+3.050

*: For the signals of amplitude 0.05 Vp-p, set the MU183020A to 0.5 Vp-p and use the Precision Fixed Attenuator (20 dB, application part 41KC-20).

Note:

When changing the termination condition, configure the settings of the MU183020A and the MU183040A/41A/40B/41B in the following order. The MU183020A and the MU183040A/41A/40B/41B may be damaged if the settings are configured in an incorrect order or the termination condition is not set correctly.

[1] Set the output of the MU183020A to OFF.

[2] Set the termination condition for the MU183040A/41A/40B/41B to GND.

[3] Change the termination condition for the MU183020A.

[4] Set the termination condition for the MU183040A/41A/40B/41B to that for the MU183020A set in Step [3].

3. Remove the cable from the Data Input connectors, and then connect the XData Input connectors, using a coaxial cable.
   In the MU183040A/41A/40B/41B **Input** tab window, set **Input Condition** to **Single-Ended** and **XData**. Next, set the output level of the MU183020A and the threshold voltage of the MU183040A/41A/40B/41B as shown in Table 8.3.2-2 and Table 8.3.2-3, and check that no error occurs.

8.3.3 Pattern

(1) Specifications

PRBS pattern
Zero Substitution pattern

(2) Connection

Refer to Figure 8.3.1-1 for the device connection.

(3) Procedure

1. Connect devices and configure the settings in the same manner as shown in Steps 1 to 5 in Section 8.3.1.
2. Set the output of the MU183020A to ON and press **Start** of the MU183040A/41A/40B/41B. Adjust the phase as required, and check that no error occurs.
3. For both the MU183040A/41A/40B/41B and the MU183020A, set the PRBS pattern length to $2^n–1$, changing the value of n to 7, 9, 10, 11, 15, 20, 23, and 31, and check that no error occurs.
   For the MU183040A/41A/40B/41B, the PRBS pattern length can be set in the **Pattern** tab window.
4. Set the PRBS pattern length to $2^{31}–1$.
   For the MU183040A/41A/40B/41B, this operation can be performed by changing Logic POS/NEG on the Pattern tab window. Check that no error occurs.
5. For both the MU183040A/41A/40B/41B and the MU183020A, set the test pattern to Zero Substitution, then, set Length to $2^n–1$, changing the value of n to 7, 9, 10, 11, 15, 20, and 23, and check that no error occurs. Next, set Length to 2^n, changing the value of n to 7, 9, 10, 11, 15, 20, and 23, and confirm that no error occurs.

8.3.4 Error detection

(1) Specifications

Error rate:	0.0000×10^{-16} to 1.0000
Error count:	0 to 1×10^{16}
Error free interval (EFI):	0.0000 to 100.0000%
Error interval (EI):	0 to 1×10^{16}
Clock frequency:	
Option x01 is not installed	1.2 to 14.05 GHz, accuracy: ± (10 ppm + 1 kHz)
Option x01 is installed	1.2 to 16.05 GHz, accuracy: ± (10 ppm + 1 kHz)

(2) Connection

Refer to Figure 8.3.1-1 for the device connection.

(3) Procedure

1. Connect devices and configure the settings in the same manner as shown in Steps 1 to 5 in Section 8.3.1.
2. Set the frequency of the MU181000A to 10 GHz, set the output of the MU183020A to ON, and then press **Start** of the MU183040A/41A/40B/41B. Adjust the phase as required, and check that no error occurs.
3. Enable the error insertion function of the MU183020A, and check that the ER measurement result in the MU183040A/41A/40B/41B Result tab window equals to the value set for error insertion of the MU183020A.
4. Set “Single” for error insertion of the MU183020A (set **Variation** to Single in the MU183020A **Error Addition** tab window). In the Gating field on the MU183040A/41A/40B/41B **Measurement** tab window, set **Cycle** to **Single**, and set the measurement time to 10 seconds.
5. Press the **Start** button of the MU183040A/41A/40B/41B to start measurement. Next, press **Single** button of the MU183020A for the error insertion once during the measurement (10 seconds). When the measurement has finished, check that the measurement results are as follows.

Error rate (ER):	1.0000E–11
Error count (EC):	1.0000E–00
Error free interval (%EFI):	99.9900%
Error interval (EI):	1

Chapter 9 Maintenance

This chapter describes maintenance of the MU183040A/41A/40B/41B.

9.1 Daily Maintenance 9-2
9.2 Cautions on Storage 9-2
9.3 Transportation.. 9-3
9.4 Calibration.. 9-3
9.5 Disposal 9-4

9.1 Daily Maintenance

- Wipe off any external stains with a cloth damped with diluted mild detergent.
- Vacuum away any accumulated dust or dirt with a vacuum cleaner.
- Tighten any loose parts fixed with screws, using the specified tools.

9.2 Cautions on Storage

Wipe off any dust, soil, or stain on the MU183040A/41A/40B/41B prior to storage. Avoid storing the MU183040A/41A/40B/41B in any of the following locations:

- In direct sunlight for extended periods
- Outdoors
- In excessively dusty locations
- Where condensation may occur
- In liquids, such as water, oil, or organic solvents, and medical fluids, or places where these liquids may adhere
- In salty air or in place chemically active gases (sulfur dioxide, hydrogen sulfide, chlorine, ammonia, nitrogen dioxide, or hydrogen chloride etc.) are present
- Where toppling over may occur
- In the presence of lubricating oil mists
- In places at an altitude of more than 2,000 m
- In the presence of frequent vibration or mechanical shock, such as in cars, ships, or airplanes
- Under the following temperature and humidity conditions:
  Temperature range of ≤–20°C or ≥60°C
  Humidity range of ≥85%

Recommended storage conditions

In addition to the abovementioned storage cautions, the following environment conditions are recommended for long-term storage.

- Temperature range of 5 to 30°C
- Humidity range of 40 to 75%
- Slight daily fluctuation in temperature and humidity

9.3 Transportation

Use the original packing materials, if possible, when packing the MU183040A41A/40B/41B for transport. If you do not have the original packing materials, pack the MU183040A/41A/40B/41B according to the following procedure. When handling the MU183040A/41A/40B/41B, always wear clean gloves, and handle it gently so as not to damage it.

<Procedure>

1. Use a dry cloth to wipe off any stain or dust on the exterior of the MU183040A/41A/40B/41B.
2. Check for loose or missing screws.
3. Provide protection for structural protrusions and parts that can easily be deformed, and wrap the MU183040A/41A/40B/41B with a sheet of polyethylene. Finally, cover with moisture-proof paper.
4. Place the wrapped MU183040A/41A/40B/41B into a cardboard box, and tape the flaps with adhesive tape. Furthermore, store it in a wooden box as required by the transportation distance or method.
5. During transportation, place it under an environment that meets the conditions described in Section 9.2 “Cautions on Storage”.

9.4 Calibration

Regular maintenance such as periodic inspections and calibration is essential for the Signal Quality Analyzer Series for long-term stable performance. Regular inspection and calibration are recommended for using the Signal Quality Analyzer Series in its prime condition at all times. The recommended calibration cycle after delivery of the Signal Quality Analyzer Series is twelve months.

If you require support after delivery, contact an Anritsu Service and Sales office. Contact information can be found on the last page of the printed version of this manual, and is available in a separate file on the PDF version.

We may not provide calibration or repair if any of the following cases apply.

- Seven or more years have elapsed after production and parts for the instrument are difficult to obtain, or it is determined that reliability cannot be maintained after calibration/repair due to significant wear.
- Circuit changes, repair, or modifications are done without our approval.
- It is determined that the repair cost would be higher than the price of a new item

9.5 Disposal

Confirm the notes described in the Signal Quality Analyzer Series Installation Guide and observe national and local regulations when disposing of the MU183040A/41A/40B/41B.

Chapter 10 Troubleshooting

This chapter describes how to check whether a failure has arisen when an error occurs during the operation of the MU183040A/41A/40B/41B.

10.1 Problems Discovered during Module Replacement ... 10-2
10.2 Handling Suspected Failure....................................... 10-2

10.1 Problems Discovered during Module Replacement

Table 10.1-1 Remedies for problems discovered during replacement of MU183040A/41A/40B/41B

Symptom	Location to Check	Remedy
A module is not recognized.	Is the module installed properly?	Install the module again by referring to Section 2.3 "Installing and Removing Modules" in the installation guide.
	Are the appropriate modules installed?	To check the appropriate modules and software version of the MU183040A/41A/40B/41B, access to "MP1800 Series Signal Quality" on your Web site (https://www.anritsu.com). Right-click the "MP1800 Series Signal Quality" and you can access to your area website. If the appropriate modulus are not recognized, it may have failed. Contact an Anritsu Service and Sales office. Contact information can be found on the last page of the printed version of this manual, and is available in a separate file on the CD version.

10.2 Handling Suspected Failure

- Synchronization cannot be established (error measurement cannot be performed)

Table 10.2-1 Items to be checked

Item	Location to Check	Remedy
Input conditions	Do the quality, status and length of the connection cables comply with the specifications?	Replace with a suitable cable.
	Is the cable connection correct and secure?	Confirm the destination and check if the connector is tightened securely.
	Are the single and differential (50/100 Ω) inputs set correctly?	Set the correct value.
	Is the input level correct?	Check the level by using an oscilloscope, etc.
	Are the input bit rate and clock frequency set correctly?	Set the bit rate and clock frequency correctly. ***Note:*** Use the frequency counter to check the current clock frequency.
	Is the frequency set near the bit rate when using clock recovery?	Set the frequency near the bit rate to be used.
	Has the clock loss or clock recovery unlock display disappeared?	Check the data and clock signals to be input or clock recovery settings.

Table 10.2-1 Items to be checked (Cont'd)

Item	Location to Check	Remedy
Termination conditions	Was the termination potential adjusted?	Set the termination potential correctly. ***Note:*** Incorrect setting may result in unit failure.
Threshold	During differential input, is the difference between the Data and XData threshold voltages above 3 V?	The difference value should be within 3 V.
	Is the operating limit for Auto Adjust or Auto Search out of range?	Adjust it manually.
Phase	Is the operating limit for Auto Adjust or Auto Search out of range?	Adjust it manually.
Pattern	Are the patterns matched?	Match the patterns.
Synchronization	Is Auto Sync set to On?	Set it to On. Re-synchronization is performed automatically.
	Have you tried with a different Sync Control setting?	Optimal synchronization method varies according to the pattern type. ***Note:*** Can be set for patterns except PRBS.
Other	Is Bit/Block Window set to Off?	Set it to Off.
	Is External Mask set to Off?	Set it to Off.
	Is the Repeat mode set?	Set the Repeat mode.

If a problem cannot be solved using any of the items listed above, perform initialization and check the items again. If the problem still occurs, contact an Anritsu Service and Sales office. Contact information can be found on the last page of the printed version of this manual, and is available in a separate file on the PDF version.

Appendix A Pseudo-Random Pattern

A.1 Pseudo-Random Pattern A-2
A.2 Zero Substitution Pattern A-3

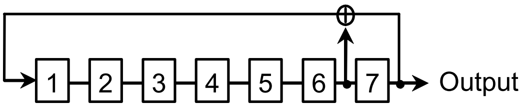
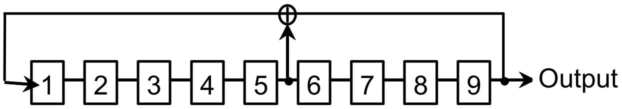
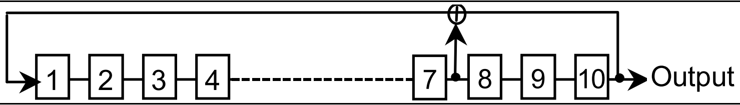
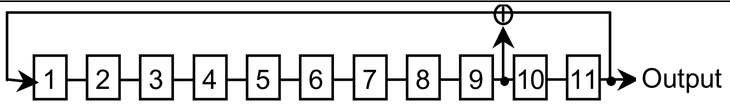
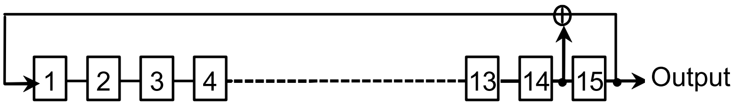
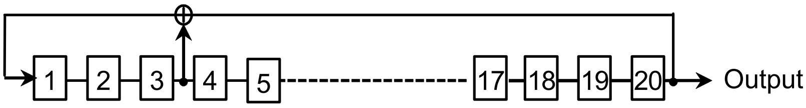
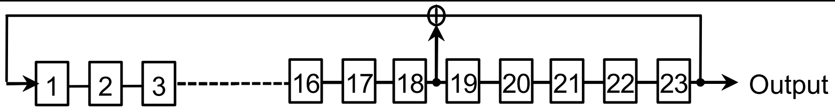
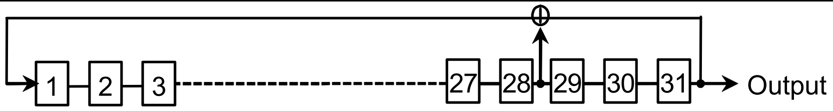
A.1 Pseudo-Random Pattern

Table A.1-1 shows the principle of pseudo-random pattern generation. A pseudo-random pattern is expressed in an N-th degree generating polynomial shown in Table A.1-1, with one cycle of $2^n–1$. For a PRBS pattern with a cycle of $2^n–1$, a pattern of successive “1s” for the number N is generated once in a cycle.

For the output level of the PRBS pattern, “1” indicates the low level and “0” indicates the high level when LOGIC is set to POS (positive).

The mark ratios of the PRBS pattern are generated as shown in the block diagrams of Table A.1-1. There are four types of mark ratios: 1/2, 1/4, 1/8, and 0/8 (all 0). In the case of 1/4 and 1/8, the amount of the bit shift can be selected from 1 bit or 3 bits, according to the generation method.

Table A.1-1 Principle of pseudo-random pattern generation

Cycle	Generating polynominal	Pattern generation block diagram
$2^7–1$	$1 + X^6 + X^7$	 1 2 3 4 5 6 7 Output
$2^9–1$	$1 + X^5 + X^9$	 1 2 3 4 5 6 7 8 9 Output
$2^{10}–1$	$1 + X^7 + X^{10}$	 1 2 3 4 7 8 9 10 Output
$2^{11}–1$	$1 + X^9 + X^{11}$	 1 2 3 4 5 6 7 8 9 10 11 Output
$2^{15}–1$	$1 + X^{14} + X^{15}$	 1 2 3 4 13 14 15 Output
$2^{20}–1$	$1 + X^3 + X^{20}$	 1 2 3 4 5 17 18 19 20 Output
$2^{23}–1$	$1 + X^{18} + X^{23}$	 1 2 3 16 17 18 19 20 21 22 23 Output
$2^{31}–1$	$1 + X^{28} + X^{31}$	 1 2 3 27 28 29 30 31 Output

N : Shift register

⊕ : Exclusive OR

A.2 Zero Substitution Pattern

A string of successive “0s” for the number of set bits is made by substituting “0” for the pattern that follows the longest bit string of successive 0s in a PRBS pattern. In this event, if the bit immediately after the bit substituted to “0” is also “0”, it is inverted to “1”.

Example: For a PRBS pattern with a cycle of 2^7, the largest number of successive 0s is 6 bits (7–1), and zero substitution starts from the following position:

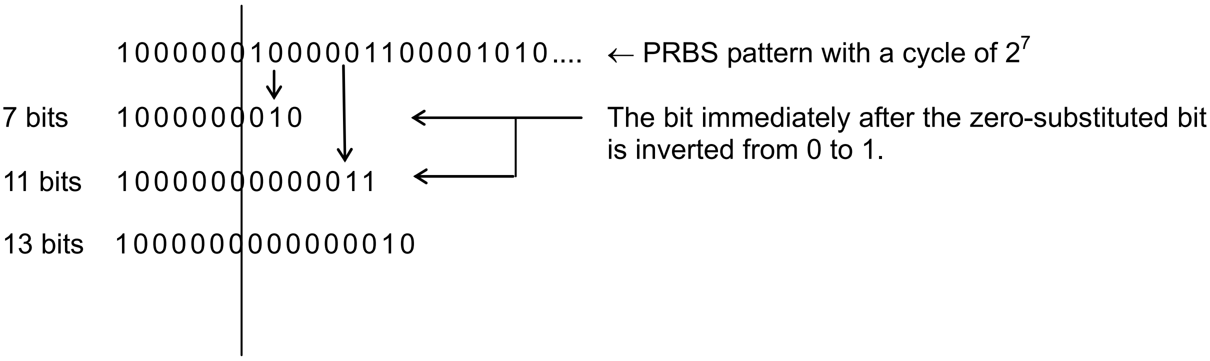

1000000100000011000001010....
← PRBS pattern with a cycle of 2^7
7 bits
1000000010
The bit immediately after the zero-substituted bit is inverted from 0 to 1.
11 bits
10000000000011
13 bits
1000000000000010

Figure A.2-1 Zero-substitution pattern

Appendix B List of Initial Settings

B.1 List of Initial Settings

This section lists the initial values at factory shipment of the setting items related to the MU183040A/41A/40B/41B.

Selecting “Initialize” from the File menu resets all setting items to their initial values

Table B.1-1 List of initial settings

Function	Main Category	Sub-Category	Individual Setting Item	Initial Setting
Result	Switch of setting items	Setting display format		Gating
		Result display format		Error・Alarm
		Time display format		Date&Time
		Error/Alarm display	Error/Alarm measurement result zoom display	OFF
			Error/Alarm measurement result sub window open/close	OFF
	Start of Error/Alarm measurement			–
	Stop of Error/Alarm measurement			–
Measurement	Measurement Period (Gating)	Measurement period unit (Unit)		Time
		Measurement period time		00 00:00:01
		Clock count for measurement period		>E+10
		Error count for measurement period		>E+10
		Block count for measurement period		E+2
		Measurement processing method (Cycle)		Repeat
		Measurement result data display (Current)		ON
		Known data processing method (Calculation)		Progressive
		Known data display update cycle		100 ms
	Re-synchronization (Auto Sync)	Re-synchronization execution		ON
		Threshold for automatic synchronization function		INT
	Synchronization method (Sync Control)	Synchronization method		Invalid
		Unique pattern length for frame synchronization		64 bits
		PRGM pattern start position		1 bit
		Edit of synchronization mask pattern		All 0
	Measurement Condition (Error/Alarm Condition)	Bit error/alarm measurement processing method		Insertion/Omission
		Interval for EI and EFI measurements		100 ms

Table B.1-1 List of initial settings (Cont'd)

Function	Main Category	Sub-Category	Individual Setting Item	Initial Setting
Pattern*	Mask	Block Window execution		OFF
		Block Window setting		All 0
		Bit Window execution		OFF
		Bit Window bit string setting		All 0
		External Mask ON/OFF		OFF
Input	Data input	Input condition		Single-Ended
		Differential type		Independent
		Data/XData selection		Data
		Data input threshold		–0.500 V
		XData input threshold		–0.500 V
		Data input threshold differential type		Data-XData
		Data input threshold differential		0.000 V
		Data input termination setup dialog box display		–
		Data input termination condition		GND
		Data input termination voltage		0.00 V
	Clock Input	Selection		External Clock
		Standard for Recovered Clock Bitrate		Variable (MU183040B/41B-x22/ x23)
		Recovered Clock Bitrate		28.000 000 Gbit/s (MU183040B/41B-x22/ x23)
		Loop Bandwidth		17 MHz (MU183040B/41B-x22)
		The value of division for calculating the Loop Bandwidth		1667 (MU183040B/41B-x23)
		Clock phase unit		mUI
		Clock phase variable (mUI)		0 mUI
		Clock phase variable		0.00 ps
		Clock phase calibration		–
		Clock phase reference		OFF
		Clock phase variable (reference mUI)		0 mUI
		Clock phase variable (reference ps)		0.00 ps
		Clock phase variable (Jitter Input)		OFF

*: Items shared with the pulse pattern generator are omitted. See Appendix B List of Initial Settings of the MU183020A 28G/32G bit/s PPG MU183021A 28G/32G bit/s 4 ch PPG Operation Manual for details.

Table B.1-1 List of initial settings (Cont'd)

Function	Main Category	Sub-Category	Individual Setting Item	Initial Setting
Capture	Capture Conditions Setting Screen	Capture block division number setting		128
		Capture trigger selection		Match Pattern
		Capture storing position selection		Top
		Capture trigger match pattern length setting		4 bits
		Capture trigger pattern format selection		HEX
		Capture trigger mask pattern editing		All 0
		Capture trigger match pattern editing		All 0
	Capture Result Acquisition	Selection of how to acquire capture result		Capture Block
		Specifying start block to acquire capture result		1
		Specifying block count to acquire capture result		1
	Capture Result Bit Pattern Display	Display		Table
		Format		HEX
	Capture Result Bitmap Display	Setting line wrapping length of capture data		256
		Setting data thinning rate		×1

Table B.1-1 List of initial settings (Cont'd)

Function	Main Category	Sub-Category	Individual Setting Item	Initial Setting
Misc1	Signal generation (Pattern Sequence)	Signal generation method		Repeat
		Burst signal input		External-Enable
		Burst trigger delay		0 bits
		Burst trigger delay automatic adjustment		Manual
		Burst signal interval		128,000 2ch Combination: Default x 2 4ch Combination: Default x 4
		Burst cycle		12,800,000 2ch Combination: Default x 2 4ch Combination: Default x 4
	Synchronized output (Aux Output)	Auxiliary output		1/N Clock
		Setting auxiliary output 1/N Clock		64
		Synchronized output position (for Data, PRBS, and Zero-Substitution pattern)		1
		Block No. of synchronized output position (for Mixed-Data pattern)		1
		Row No. of synchronized output position (for Mixed-Data pattern)		1
	Aux Input	Connector		External Mask (Repeat) Burst (Burst)
	Measurement restart condition (Measurement Restart)	Measurement restart upon input threshold change		OFF
		Measurement restart upon clock phase change		OFF
Misc2	Combination settings	Operation		Independent
		Number of Combination channels		2ch
	Grouping Setting	Grouping item setting		Data1-2 (MU183040A/B) Data1-4 (MU183041A/B)
		Input		OFF
		Pattern		OFF

Note:

When the Initialize function is executed in Combination or Channel Synchronization status, Independent, which is the initial status, is restored.

Appendix C Setting Restrictions

C.1 Restriction on Use of Other Modules C-2
C.2 Combination Function Configuration C-2
C.3 Settings Common in Combination System C-3

C.1 Restriction on Use of Other Modules

When MU183040A/41A/40B/41B or MU183020A/MU183021A is set to slot, following module cannot be used simultaneously.

- MU181020A 12.5 Gbit/s PPG
- MU181020B 14 Gbit/s PPG
- MU181040A 12.5 Gbit/s ED
- MU181040B 14 Gbit/s ED

Note:

For MX180000A Installer Version 7.04.00 or after, simultaneous use is available among some combinations of 32Gbit/s PPG or ED and 12.5/14Gbit/s PPG or ED.
For details, refer to the release notes.

C.2 Combination Function Configuration

This section describes the requirements for executing the Combination function by using multiple MU183040A/41A/40B/41B modules.
The following requirement must be satisfied to execute the Combination function:

Requirement for enabling the Combination function

- The model is the MU183040A/B-x20 or MU183041A/B.

C.3 Settings Common in Combination System

When the MU183040A/41A/40B/41B is used in a Combination system, some setting items will apply to all the other modules in the Combination system.

Table C.3-1 shows whether the setting items are common or independent in a Combination system.

Table C.3-1 Common/Independent Setting Items in Combination System

Setting Function	Main Category	Sub-Category	Individual Setting Item	Common/ Independent
Result	Switch of setting items	Setting display format		Independent
		Result display format		Independent
		Time display format		Independent
		Error/Alarm display	Error/Alarm measurement result zoom display	Independent
			Error/Alarm measurement result sub window open/close	Common
	Start of Error/Alarm measurement			Common
	Stop of Error/Alarm measurement			Common
Measurement	Measurement period (Gating)	Measurement period unit (Unit)		Common
		Measurement period time		Common
		Clock count for measurement period		Common
		Error count for measurement period		Common
		Block count for measurement period		Common
		Measurement processing method (Cycle)		Common
		Measurement result data display (Current)		Common
		Known data processing method (Calculation)		Common
		Known data display update cycle		Common
	Re-synchronization (Auto Sync)	Re-synchronization execution		Common
		Threshold for automatic synchronization function		Common
		Synchronization method		Common
	Synchronization method (Sync Control)	Synchronization method		Common
		Unique pattern length for frame synchronization		Common
		PRGM pattern start position		Common
		Edit of synchronization mask pattern		Common

Table C.3-1 Common/Independent Setting Items in Combination System (Cont'd)

Setting Function	Main Category	Sub-Category	Individual Setting Item	Common/ Independent
Measure-ment (Continued)	Measurement condition (Error/Alarm Condition)	Interval for EI and EFI measurements		Common
Pattern*	Mask	Block Window execution		Common
		Block Window setting		Common
		Bit Window execution		Common
		Bit Window bit string setting		Common
		External Mask ON/OFF		Common
Input	Data input	Input condition		Independent
		Differential type		Independent
		Data/XData selection		Independent
		Data input threshold		Independent
		XData input threshold		Independent
		Data input threshold differential type		Independent
		Data input threshold differential		Independent
		Data input termination setup dialog box display		Independent
		Data input termination condition		Independent
		Data input termination voltage		Independent
	Clock Input	Selection		Common
		Standard for Recovered Clock Bitrate		Common
		Recovered Clock Bitrate		Common
		Loop Bandwidth		Common
		The value of division for calculating the Loop Bandwidth		Common
		Clock phase unit		Independent
		Clock phase variable (mUI)		Independent
		Clock phase variable (ps)		Independent
		Clock phase calibration		Independent
		Clock phase reference		Independent
		Clock phase variable (reference mUI)		Independent
		Clock phase variable (reference ps)		Independent
		Clock phase variable (Jitter Input)		Common

*: Settings shared by the PPG are omitted here. For details, refer to the *MU183020A 28G/32G bit/s MU183021A 28G/32G bit/s 4ch Pulse Pattern Generator Operation Manual.*

Table C.3-1 Common/Independent Setting Items in Combination System (Cont'd)

<table>
<tr><th>Setting Function</th><th>Main Category</th><th>Sub-Category</th><th>Individual Setting Item</th><th>Common/ Independent</th></tr>
<tr><td rowspan="15">Capture</td><td rowspan="7">Capture Conditions Setting Screen</td><td colspan="2">Capture block division number setting</td><td>Common</td></tr>
<tr><td colspan="2">Capture trigger selection</td><td>Common</td></tr>
<tr><td colspan="2">Capture storing position selection</td><td>Common</td></tr>
<tr><td colspan="2">Capture trigger match pattern length setting</td><td>Common</td></tr>
<tr><td colspan="2">Capture trigger pattern format selection</td><td>Common</td></tr>
<tr><td colspan="2">Capture trigger mask pattern editing</td><td>Common</td></tr>
<tr><td colspan="2">Capture trigger match pattern editing</td><td>Common</td></tr>
<tr><td rowspan="3">Capture Result Acquisition</td><td colspan="2">Selection of how to acquire capture result</td><td>Common</td></tr>
<tr><td colspan="2">Specifying start block to acquire capture result</td><td>Common</td></tr>
<tr><td colspan="2">Specifying block count to acquire capture result</td><td>Common</td></tr>
<tr><td colspan="3">Capture Result Bit Pattern Display</td><td>Common</td></tr>
<tr><td rowspan="3">Capture Result Bitmap Display</td><td colspan="2">Setting line wrapping length of capture data</td><td>Common</td></tr>
<tr><td colspan="2">Searching error position</td><td>Common</td></tr>
<tr><td colspan="2">Setting data thinning rate</td><td>Common</td></tr>
<tr><td>Capture Result Block Display</td><td colspan="2">Searching error position</td><td>Common</td></tr>
</table>

Table C.3-1 Common/Independent Setting Items in Combination System (Cont'd)

Setting Function	Main Category	Sub-Category	Individual Setting Item	Common/ Independent
Misc1	Signal generation (Pattern Sequence)	Signal generation method		Common
		Burst signal input		Common
		Burst trigger delay		Common
		Burst trigger delay automatic adjustment		Common
		Burst signal interval		Common
		Burst cycle		Common
	Synchronized output (Aux Output)	Auxiliary output		Common
		Setting auxiliary output 1/N Clock		Common
		Synchronized output position (for Data, PRBS, and Zero Substitution pattern)		Common
		Block No. of synchronized output position (for Mixed-Data pattern)		Common
		Row No. of synchronized output position (for Mixed-Data pattern)		Common
	Aux Input	Connector		Common
	Measurement restart condition (Measurement Restart)	Measurement restart upon input threshold change		Common
		Measurement restart upon clock phase change		Common
Misc2	Combination Setting	Operation		Common
		Combination		Common
	Grouping Setting	Grouping item setting		Common
Auto measurement	Auto Adjust	Item		Common
		Slot selection		Independent
	Auto Search	Measurement mode		Common
		Item		Common
		Slot selection		Independent
	Eye Diagram/ Eye Margin/ Bathtub/Q measurement	All items		Independent

Appendix D Performance Test Record Sheet

D.1 Performance Test Result Sheet

Document number:

Test Location:

Date:

Test person in charge:

Product name:

Serial number:

Software version:

Option:

Power voltage: V

Power frequency: Hz

Ambient temperature °C

Relative humidity %

Instruments used: Model name Serial number

Model name Serial number

Model name Serial number

Model name Serial number

Remarks

D.1.1 MU183040A 28G/32Gbit/s ED

Equipment Name: MU183040A 28G/32G bit/s ED

Serial No.:

Ambient Temperature: °C

Relative Humidity: %

Table D.1.1-1 Operating Frequency Range

Option Configuration	Specification	Results
MU183040A (Without Option x01)	No errors occur within the range from 2.4 to 28.1 GHz.	
MU183040A-x01	No errors occur within the range from 2.4 to 32.1 GHz.	

Table D.1.1-2 Input level range

Option Configuration	Specification	Results
MU183040A-x10/x20	Input amplitude: 0.25 to 2.0 Vp-p Threshold voltage: No error within the range from –3.5 to +3.3 V.	

Table D.1.1-3 Test pattern

Test Pattern settings	Specification	Results	
		Data 1	Data 2
PRBS Length 2^n–1: n = 7, 9, 10, 11, 15, 20, 23, 31 Mark ratio: 1/2	No errors occur.		
Zero-Substitution Length 2^n–1: n = 7, 9, 10, 11, 15, 20, 23 2^n: n = 7, 9, 10, 11, 15, 20, 23	No errors occur.		

Table D.1.1-4 Error detection

Item	Specification	Results	
		Data 1	Data 2
Error rate (ER)	1.0000E–11		
Error count (EC)	1.0000E–00		
Error free interval (EFI)	99.9900%		
Error interval (EI)	1		
Clock frequency (Frequency)	999 500 to 1 005 000 kHz		

D.1.2 MU183041A 28G/32G bit/s 4ch ED

Equipment Name: MU183041A 28G/32G bit/s 4ch ED

Serial No.:

Ambient Temperature: °C

Relative Humidity: %

Table D.1.2-1 Operating Frequency Range

Option Configuration	Specification	Results
MU183041A (Without Option x01)	No errors occur within the range from 2.4 to 28.1 GHz.	
MU183041A-x01	No errors occur within the range from 2.4 to 32.1 GHz.	

Table D.1.2-2 Input level range

Option Configuration	Specification	Results
MU183041A	Input amplitude: 0.25 to 2.0 Vp-p Threshold voltage: No error within the range from –3.5 to +3.3 V.	

Table D.1.2-3 Test pattern

Test Pattern settings	Specification	Results			
		Data 1	Data 2	Data 3	Data 4
PRBS Length 2^n-1: n = 7, 9, 10, 11, 15, 20, 23, 31 Mark ratio: 1/2	No errors occur.				
Zero-Substitution Length 2^n-1: n = 7, 9, 10, 11, 15, 20, 23 2^n: n = 7, 9, 10, 11, 15, 20, 23	No errors occur.				

Table D.1.2-4 Error detection

Item	Specification	Results			
		Data 1	Data 2	Data 3	Data 4
Error rate (ER)	1.0000E–11				
Error count (EC)	1.0000E–00				
Error free interval (EFI)	99.9900%				
Error interval (EI)	1				
Clock frequency (Frequency)	999 500 to 1 005 000 kHz				

D.1.3 MU183040B 28G/32Gbit/s High Sensitivity ED

Equipment Name: MU183040B 28G/32G bit/s High Sensitivity ED

Serial No.:

Ambient Temperature: °C

Relative Humidity: %

Table D.1.3-1 Operating Frequency Range

Option Configuration	Specification	Results
MU183040B (Without Option x01)	No errors occur within the range from 2.4 to 28.1 GHz.	
MU183040B-x01	No errors occur within the range from 2.4 to 32.1 GHz.	

Table D.1.3-2 Input level range

Option Configuration	Specification	Results
MU183040B-x10/x20	Input amplitude: 0.05 to 1.0 Vp-p Threshold voltage: No error within the range from –3.5 to +3.3 V.	

Table D.1.3-3 Test pattern

Test Pattern settings	Specification	Results	
		Data 1	Data 2
PRBS Length 2^n–1: n = 7, 9, 10, 11, 15, 20, 23, 31 Mark ratio: 1/2	No errors occur.		
Zero-Substitution Length 2^n–1: n = 7, 9, 10, 11, 15, 20, 23 2^n: n = 7, 9, 10, 11, 15, 20, 23	No errors occur.		

Table D.1.3-4 Error detection

Item	Specification	Results	
		Data 1	Data 2
Error rate (ER)	1.0000E−11		
Error count (EC)	1.0000E−00		
Error free interval (EFI)	99.9900%		
Error interval (EI)	1		
Clock frequency (Frequency)	999 500 to 1 005 000 kHz		

D.1.4 MU183041B 28G/32G bit/s 4ch High Sensitivity ED

Equipment Name: MU183041B 28G/32G bit/s 4ch High Sensitivity ED

Serial No.:

Ambient Temperature: °C

Relative Humidity: %

Table D.1.4-1 Operating Frequency Range

Option Configuration	Specification	Results
MU183041B (Without Option x01)	No errors occur within the range from 2.4 to 28.1 GHz.	
MU183041B-x01	No errors occur within the range from 2.4 to 32.1 GHz.	

Table D.1.4-2 Input level range

Option Configuration	Specification	Results
MU183041B	Input amplitude: 0.05 to 1.0 Vp-p Threshold voltage: No error within the range from –3.5 to +3.3 V.	

Table D.1.4-3 Test pattern

Test Pattern settings	Specification	Results			
		Data 1	Data 2	Data 3	Data 4
PRBS Length $2^n–1$: n = 7, 9, 10, 11, 15, 20, 23, 31 Mark ratio: 1/2	No errors occur.				
Zero-Substitution Length $2^n–1$: n = 7, 9, 10, 11, 15, 20, 23 2^n: n = 7, 9, 10, 11, 15, 20, 23	No errors occur.				

Table D.1.4-4 Error detection

Item	Specification	Results			
		Data 1	Data 2	Data 3	Data 4
Error rate (ER)	1.0000E−11				
Error count (EC)	1.0000E−00				
Error free interval (EFI)	99.9900%				
Error interval (EI)	1				
Clock frequency (Frequency)	999 500 to 1 005 000 kHz				

Appendix E Connection Examples for Jitter Measurement

Appendix B describes recommended examples of how to connect MU183020A, MU183040A/B, MU181500B, and/or MP1825B by using applicable coaxial cables. When measurement is performed with jitter added to clock signals by using MU181500B, performance of each instrument is ensured by connecting as described below.

E.1 Jitter-PPG Connection E-2
E.2 Jitter-PPG-ED Connection E-3
E.3 Jitter-PPG-Emphasis Connection E-5
E.4 Jitter-PPG-Emphasis-ED Connection..........................E-7
E.5 Jitter-2ch PPG-Two Emphasis Units Connection E-10
E.6 Jitter-2ch PPG-Two Emphasis Units-ED Connection.E-13

E.1 Jitter-PPG Connection

[Equipment configuration]
MU183020A
MU181500B
DUT

[How to connect instruments, Cable length requirements]

1. Connect a synthesizer and MU181500B's **Ext. Clock Input** connector. The cable length is not especially specified.
2. Connect MU181500B's **Jittered Clock Output** connector and MU183020A's **Ext. Clock Input** connector. The cable length is not especially specified.

3, 4. Use a J1551A coaxial skew match cable (applicable part, pair cable, 0.8 m) to connect MU183020A's **Data Output** and **XData Output** connectors to a DUT.

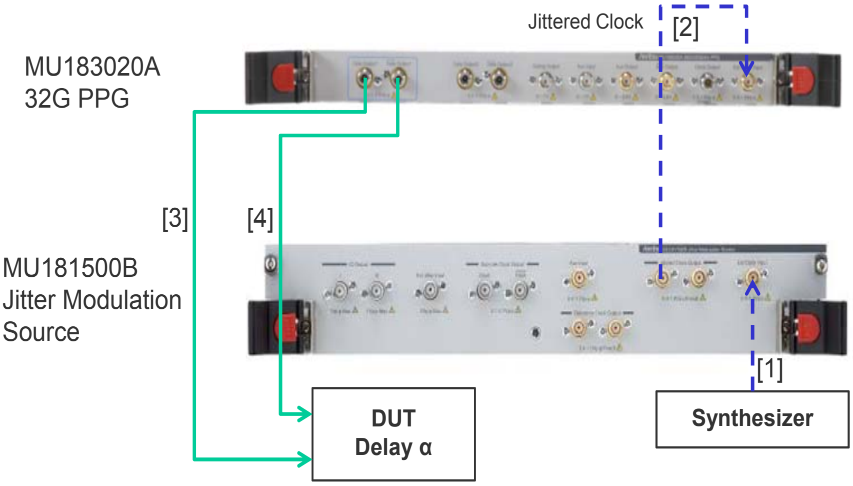

Jittered Clock
[2]
MU183020A
32G PPG
[3]
[4]
MU181500B
Jitter Modulation
Source
[1]
DUT
Delay α
Synthesizer

Figure E.1-1 Jitter-PPG Connection Example

E.2 Jitter-PPG-ED Connection

[Equipment configuration]
MU183020A
MU183040B
MU181500B
DUT

[How to connect instruments, Cable length requirements]

1. Connect a synthesizer and MU181500B's **Ext. Clock Input** connector. The cable length is not especially specified.
2. Connect MU181500B's **Jittered Clock Output** connector and MU183020A's **Ext. Clock Input** connector. The cable length is not especially specified.

3, 4. Use a J1551A coaxial skew match cable (Pair cable, 0.8 m) to connect MU183020A's **Data Output** and **XData Output** connectors to a DUT.

5, 6. Use a J1551A coaxial skew match cable (Pair cable, 0.8 m) to connect MU183040B's **Data Input** and **XData Input** connectors to a DUT.

7. Anritsu recommends use of the MU183040B Clock Recovery Option-x22/x23 to supply clock signals to ED. If the option is used, you don't need to connect Cable [7]. If the option is not used, connect the MU183020A's **Clock Output** connector and MU183040B's **Ext. Clock Input** connector with a cable having a length equivalent to the sum of the following:
   - Length of the cable that connects MU183020A's Data Output connector and MU183040B's Data Input connector.
   - Length of the cable that has a length corresponding to a DUT delay amount.
     In the following example, a cable having a length of (1.6m + α) is used to connect the connectors:

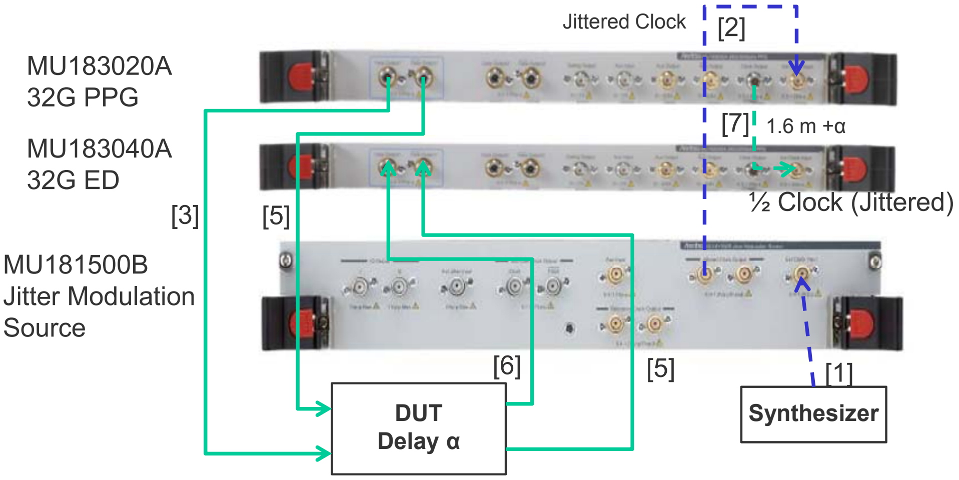

Jittered Clock
[2]
MU183020A
32G PPG
[7]
1.6 m +α
MU183040A
32G ED
½ Clock (Jittered)
[3]
[5]
MU181500B
Jitter Modulation
Source
[6]
[5]
[1]
DUT
Delay α
Synthesizer

Figure E.2-1 Jitter-PPG-ED Connection Example

E.3 Jitter-PPG-Emphasis Connection

[Equipment configuration]
MU183020A
MU181500B
MP1825B
DUT
J1615A Coaxial Cable Set (Jitter-PPG-Emphasis)

[How to connect instruments, Cable length requirements]

1. Connect a synthesizer and MU181500B's **Ext. Clock Input** connector. The cable length is not especially specified.
2. Connect MU181500B's **Jittered Clock Output** connector and MU183020A's **Ext. Clock Input** connector. The cable length is not especially specified.
3. Use a coaxial cable (applicable part, 0.8 m, K connector) to connect MU183020A's **Data Output** connector and MP1825B's **Data Input** connector.
4. Use a coaxial cable (applicable part, 1.3 m, K connector) to connect MU183020A's **Clock Output** connector and MP1825B's **Clock Input** connector. Then, on the **Misc2** tab of MU183020A, select **Full Rate Clock** in the **Output Clock Rate** box. (Figure E.3-2)

5, 6. Use a J1551A coaxial skew match cable (applicable part, pair cable, 0.8 m) to connect MP1825B's **DataOutput** and **XData Output** connectors to a DUT.

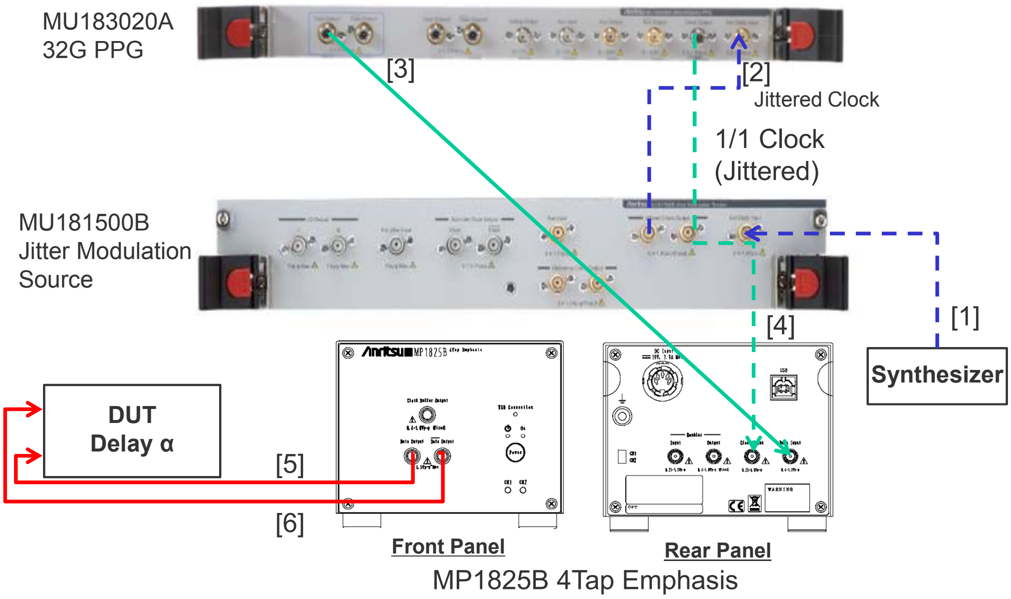
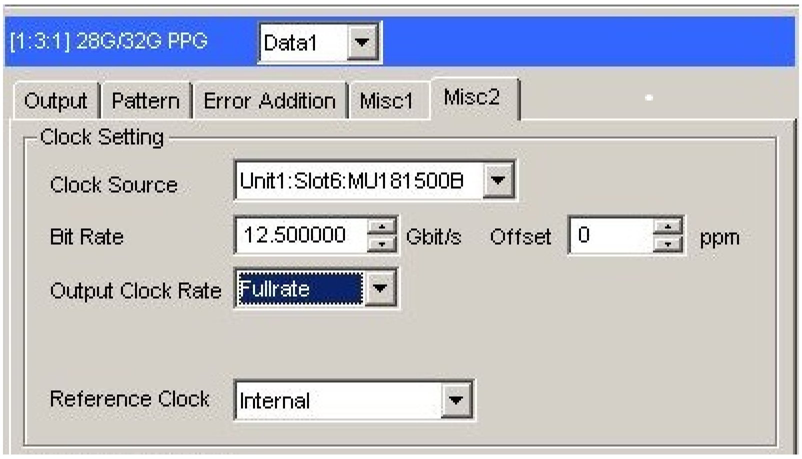

MU183020A
32G PPG
[3]
[2]
Jittered Clock
1/1 Clock
(Jittered)
MU181500B
Jitter Modulation
Source
[1]
[4]
Synthesizer
DUT
Delay α
[5]
[6]
Front Panel
Rear Panel
MP1825B 4Tap Emphasis

Figure E.3-1　Jitter-PPG-Emphasis Connection Example


Output
Pattern
Error Addition
Misc1
Misc2

[1:3:1] 28G/32G PPG　Data1

Clock Setting

Clock Source: Unit1:Slot6:MU181500B

Bit Rate: 12.500000 Gbit/s　Offset: 0 ppm

Output Clock Rate: Fullrate

Reference Clock: Internal

Figure E.3-2　Output Clock Rate Setting on the Misc2 Tab of MU183020A

E.4 Jitter-PPG-Emphasis-ED Connection

[Equipment configuration]
MU183020A
MU183040B
MU181500B
MP1825B
DUT
J1615A Coaxial Cable Set (Jitter-PPG-Emphasis)

[How to connect instruments, Cable length requirements]

1. Connect a synthesizer and MU181500B's **Ext. Clock Input** connector. The cable length is not especially specified.
2. Connect MU181500B's **Jittered Clock Output** connector and MU183020A's **Ext. Clock Input** connector. The cable length is not especially specified.
3. Use a coaxial cable (applicable part, 0.8 m, K connector) to connect MU183020A's **Data Output** connector and MP1825B's **Data Input** connector.
4. Use a coaxial cable (applicable part, 1.3 m, K connector) to connect MU183020A's **Clock Output** connector and MP1825B's **Clock Input** connector. Then, on the **Misc2** tab of MU183020A, select **Fullrate** in the **Output Clock Rate** box. (Figure E.3-2)

5, 6. Use a J1551A coaxial skew match cable (applicable part, pair cable, 0.8 m) to connect MP1825B's **Data Output** and **XData Output** connectors to a DUT.

7, 8. Use a J1551A coaxial skew match cable (applicable part, pair cable, 0.8 m) to connect a DUT with MU183040B's **Data Input** and **XData Input** connectors.

9.10 Anritsu recommends use of the MU183040B Clock Recovery Option-x22/x23 to supply clock signals to ED. If the option is used, you don't need to connect Cables [9] and [10]. If the option is not used, connect MU183020A's **AUX Output** connector and MP1825B's **Doubler Input** connector, and MP1825B's **Doubler Output** connector and MU183040B's **Ext. Clock Input** connector respectively with each cable having a length equivalent to the sum of the following:

- Length of the cable that connects MP1825B's Data Output connector and MU183040B's Data Input connector.
- (Length of the cable that has a length corresponding to DUT delay amount) – 0.5 m.
  In the following example, a cable having a length of (1.6 m – 0.5

$m + \alpha$) is used. Then, on the Misc1 tab of MU183020A, set the clock rate to 1/4 Clock in the AUX Output area. (Figure E.4-2.)

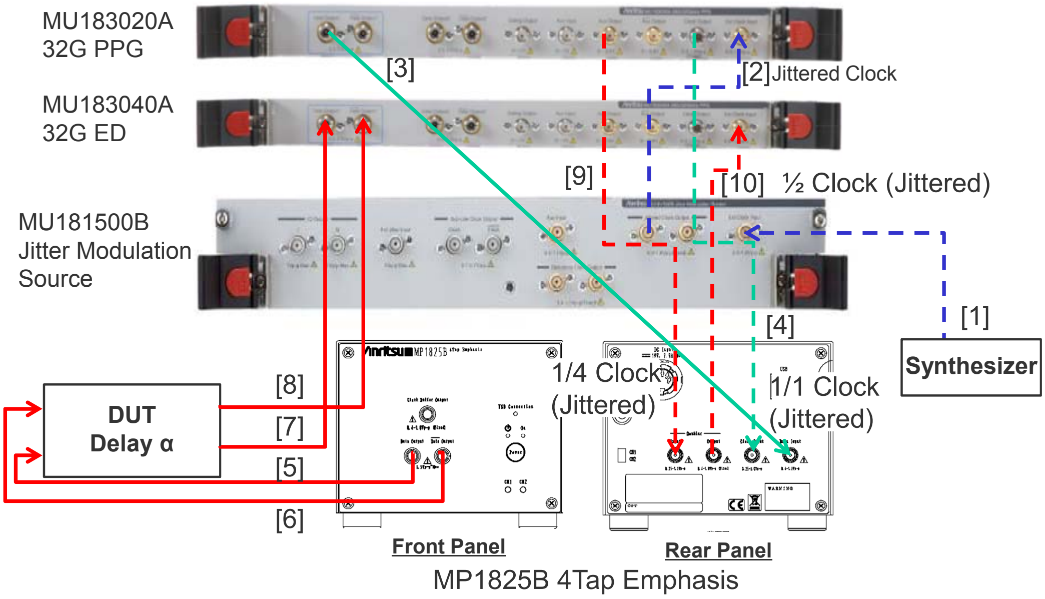
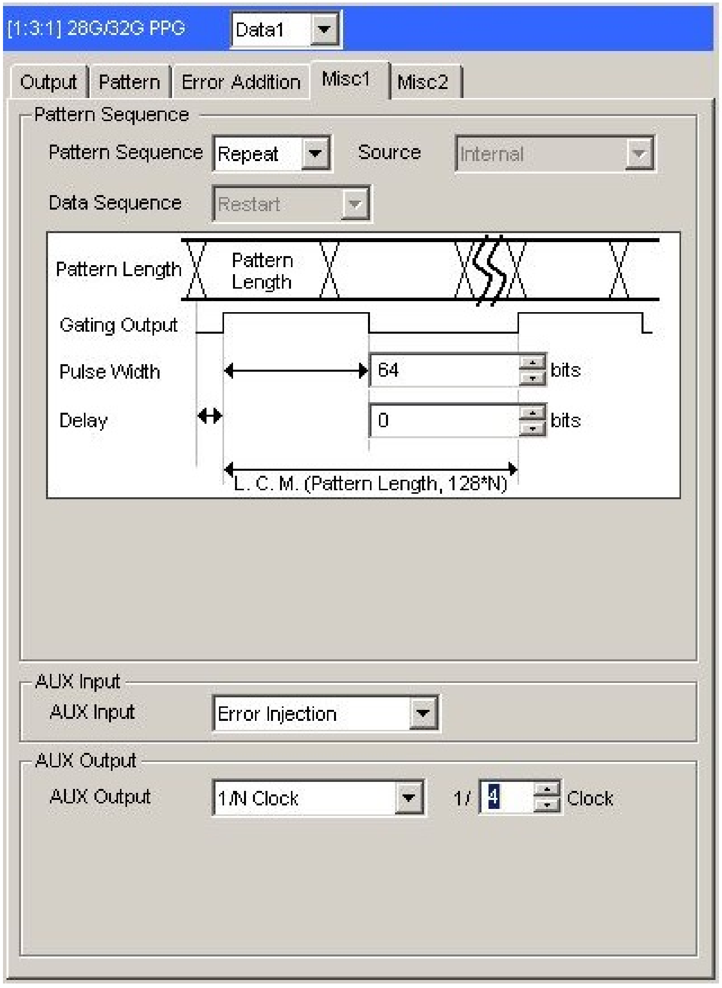

MU183020A
32G PPG
MU183040A
32G ED
MU181500B
Jitter Modulation
Source
[3]
[2]Jittered Clock
[9]
[10] ½ Clock (Jittered)
[1]
Synthesizer
[4]
DUT
Delay α
[8]
[7]
[5]
[6]
1/4 Clock
(Jittered)
1/1 Clock
(Jittered)
Front Panel
Rear Panel
MP1825B 4Tap Emphasis

Figure E.4-1 Jitter-PPG-Emphasis-ED Connection Example


Output
Pattern
Error Addition
Misc1
Misc2
Pattern Length
Pattern Length
L. C. M. (Pattern Length, 128*N)

[1:3:1] 28G/32G PPG Data1

Pattern Sequence

Pattern Sequence Repeat

Source Internal

Data Sequence Restart

Gating Output

Pulse Width 64 bits

Delay 0 bits

AUX Input

AUX Input Error Injection

AUX Output

AUX Output 1/N Clock 1/ 4 Clock

Figure E.4-2 AUX Output Setting on the Misc1 Tab of MU183020A

E.5 Jitter-2ch PPG-Two Emphasis Units Connection

[Equipment configuration]
MU183020A-22/23 2ch PPG
MU181500B
MP1825B-02 (Two units)
DUT
J1618A Coaxial Cable Set (Jitter-2chPPG-Emphasis)

[How to connect instruments, Cable length requirements]

1. Connect a synthesizer and MU181500B's **Ext. Clock Input** connector. The cable length is not especially specified.
2. Use a coaxial cable (applicable part, 0.9 m, K connector) to connect MU181500B's **Jittered Clock Output** connector and MU183020A's **Ext. Clock Input** connector.

3, 4. Use coaxial cables (applicable part, 0.8 m, K connector) to connect MU183020A's **Data Output1** and **Data Output2** connectors respectively with the **Data Input** connector of each MP1825B No.1 and 2. Then, on the **Misc2** tab of MU183020A, select **Halfrate** in the **Output Clock Rate** box. (Figure E.5-2)

5. Use a coaxial cable (applicable part, 0.3 m, APC 3.5mm connector) to connect MU181500B's **Jittered Clock Output** connector and **AUX Input** connector.

6, 7. Use coaxial cables (applicable part, 0.8 m, APC 3.5 mm connector) to connect MU181500B's **Reference Clock Output** connectors respectively with the **Doubler Input** connector of each MP1825B No.1 and 2.Then, connect MP1825B's **Doubler Output** and **Clock Input** connectors with the semi-rigid coaxial cable that comes with MP1825B. After that switch MU181500B's AUX clock input signal to **AUX Input** and set the Reference Clock to **1/1**. (Figure E.5-3)

8, 9. Use J1439A coaxial cables (applicable part, 0.8 m) to connect the **Data Output** connector of each MP1825B No.1 and 2 to a DUT.

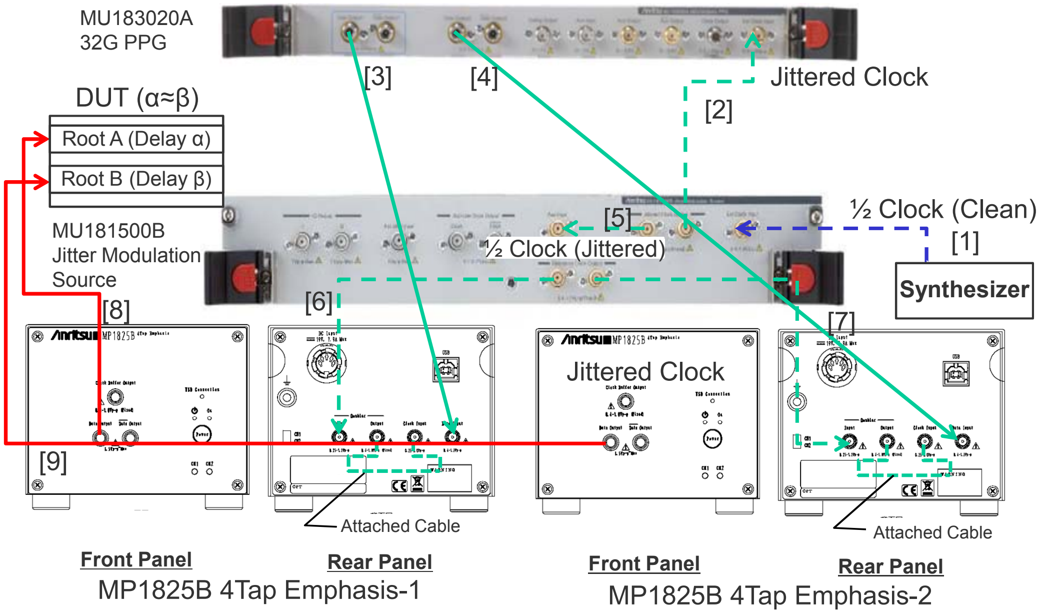
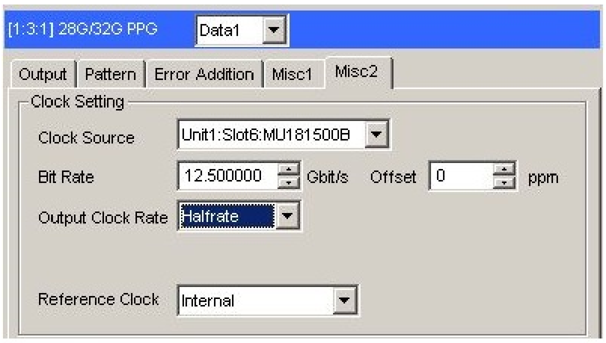

MU183020A
32G PPG
DUT (α≈β)
Root A (Delay α)
Root B (Delay β)
MU181500B
Jitter Modulation
Source
[3]
[4]
Jittered Clock
[2]
[5]
½ Clock (Jittered)
½ Clock (Clean)
[1]
Synthesizer
[6]
[7]
[8]
[9]
Jittered Clock
Attached Cable
Attached Cable
Front Panel
Rear Panel
MP1825B 4Tap Emphasis-1
Front Panel
Rear Panel
MP1825B 4Tap Emphasis-2

Figure E.5-1 Jitter-2ch PPG-Two Emphasis Units Connection Example


Output
Pattern
Error Addition
Misc1
Misc2

[1:3:1] 28G/32G PPG Data1

Clock Setting

Clock Source Unit1:Slot6:MU181500B

Bit Rate 12.500000 Gbit/s Offset 0 ppm

Output Clock Rate Halfrate

Reference Clock Internal

Figure E.5-2 Output Clock Rate Setting on the Misc2 Tab of MU183020A

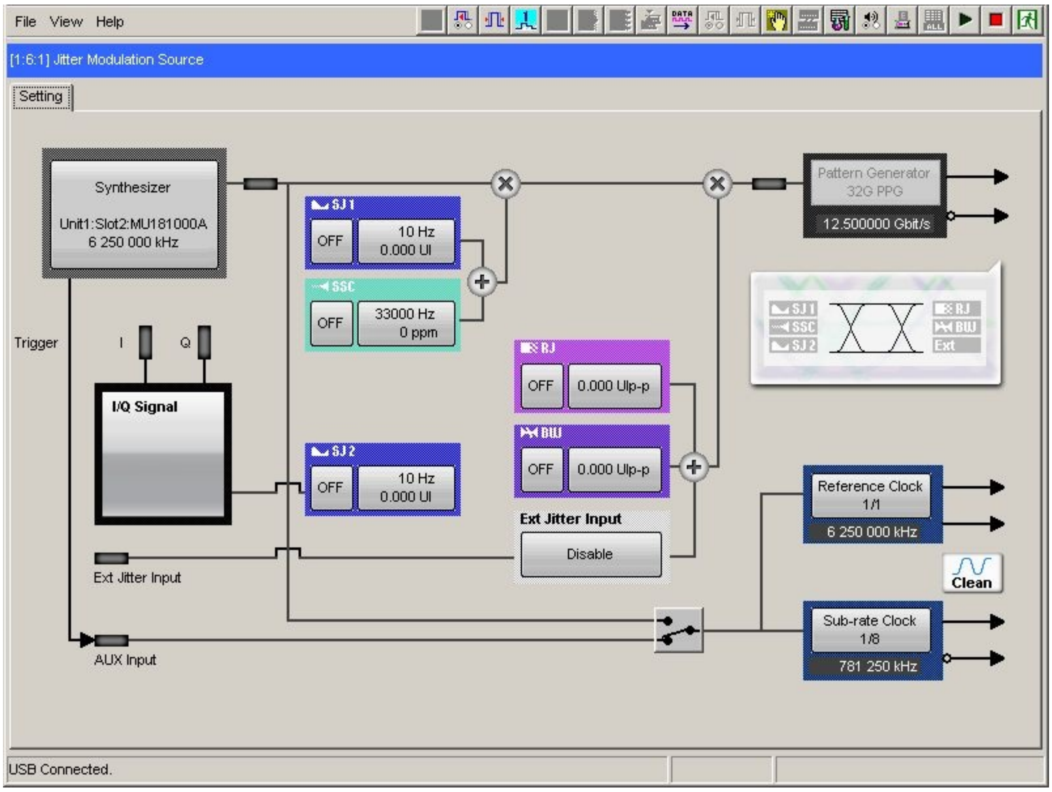

File View Help
[1:6:1] Jitter Modulation Source
Setting
Synthesizer
Unit1:Slot2:MU181000A
6 250 000 kHz
SJ1
OFF
10 Hz
0.000 UI
SSC
OFF
33000 Hz
0 ppm
Pattern Generator
32G PPG
12.500000 Gbit/s
SJ1
SSC
SJ2
RJ
BUJ
Ext
Trigger
I
Q
I/Q Signal
RJ
OFF
0.000 UIp-p
BUJ
OFF
0.000 UIp-p
SJ2
OFF
10 Hz
0.000 UI
Ext Jitter Input
Disable
Reference Clock
1/1
6 250 000 kHz
Clean
Ext Jitter Input
AUX Input
Sub-rate Clock
1/8
781 250 kHz
USB Connected.

Figure E.5-3 Setting MU181500B’s AUX and Reference Clock

E.6 Jitter-2ch PPG-Two Emphasis Units-ED Connection

[Equipment configuration]
MU183020A-22/23 2ch PPG
MU181500B
MP1825B-02 (Two units)
MU183040B-20 2ch ED
DUT
J1618A Coaxial Cable Set (Jitter-2chPPG-Emphasis)

[How to connect instruments, Cable length requirements]

1. Connect a synthesizer and MU181500B's **Ext. Clock Input** connector. The cable length is not especially specified.

2. Use a coaxial cable (applicable part, 0.9 m, K connector) to connect MU181500B's Jittered Clock Output connector and MU183020A's Ext. Clock Input connector.

3, 4. Use coaxial cables (applicable part, 0.8 m, K connector) to connect MU183020A's **Data Output1** and **Data Output2** connectors respectively with the **Data Input** connector of each MP1825B No.1 and 2. Then, on the **Misc2** tab of MU183020A, select **Halfrate** in the **Output Clock Rate** box. (Figure E.5-2)

5. Use a coaxial cable (applicable part, 0.3 m, APC 3.5mm connector) to connect MU181500B's **Jittered Clock Output** connector and **AUX Input** connector.

6, 7. Use coaxial cables (applicable part, 0.8 m, APC 3.5 mm connector) to connect MU181500B's **Reference Clock Output** connectors respectively with the **Doubler Input** connector of each MP1825B No.1 and 2. Then, connect MP1825B's **Doubler Output** and **Clock Input** connectors with the semi-rigid coaxial cable that comes with MP1825B. After that switch MU181500B's AUX clock input signal to **AUX Input** and set the Reference Clock to **1/1**. (Figure E.5-3)

8, 9. Use J1439A coaxial cables (applicable part, 0.8 m) to connect the **Data Output** connector of each MP1825B No.1 and 2 to a DUT.

10, 11. Use J1439A coaxial cables (applicable part, 0.8 m) to connect a DUT with MU183040B's **Data Input1** and **Data Input2** connectors.

12. Anritsu recommends use of the MU183040B Clock Recovery Option-x22/x23 to supply clock signals to ED. If the option is used, you don't need to connect Cable [12]. If the option is not used, connect the MP1825B's **Clock Buffer Output** connector and MU183040B's **Ext. Clock Input** connector with a cable having a length equivalent to the sum of the following:

- Length of the cable that connects MP1825B’s Data Output connector and MU183040B’s Data Input connector.
- (Length of the cable that has a length corresponding to DUT delay amount (α ≈ β)) + 0.5 m.

  In the following example, a cable having a length of (1.6 m + 0.5 m + α) is used.

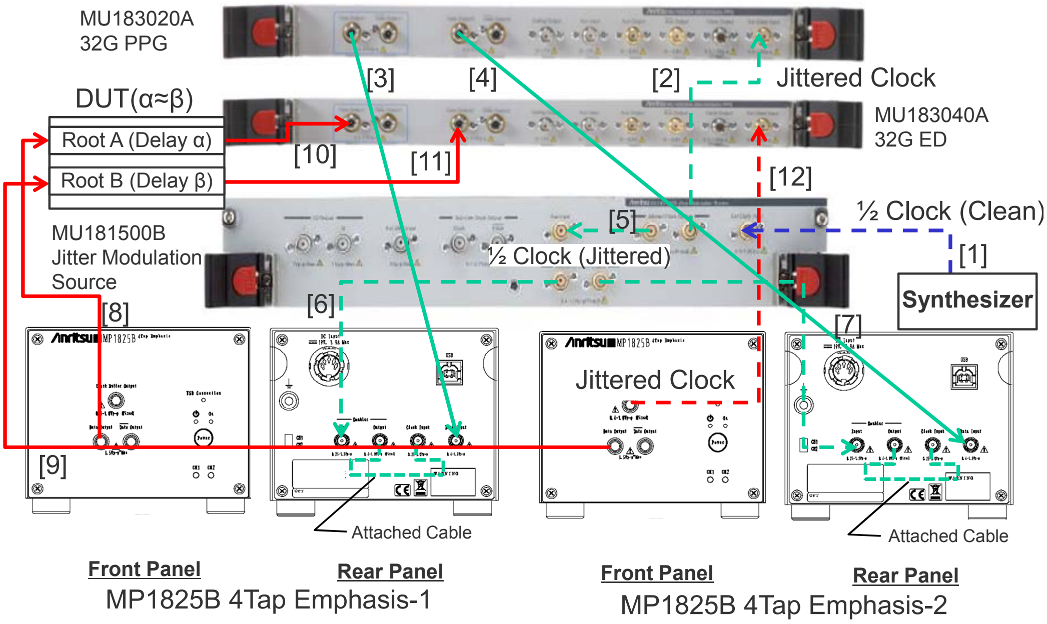

MU183020A
32G PPG
DUT(α≈β)
Root A (Delay α)
Root B (Delay β)
[3]
[4]
[2]
Jittered Clock
MU183040A
32G ED
[10]
[11]
[12]
½ Clock (Clean)
[5]
MU181500B
Jitter Modulation
Source
½ Clock (Jittered)
[1]
Synthesizer
[8]
[6]
[7]
Jittered Clock
[9]
Attached Cable
Attached Cable
Front Panel
Rear Panel
MP1825B 4Tap Emphasis-1
Front Panel
Rear Panel
MP1825B 4Tap Emphasis-2

Figure E.6-1 Jitter-2ch PPG-Two Emphasis Units-ED Connection Example

Appendix F How to Use PAM Function

This section explains how to use the PAM (Pulse Amplitude Modulation) function.

F.1 BER Measurement of PAM Signal F-2
F.2 Setting PPG F-6
F.3 Setting ED F-10

F.1 BER Measurement of PAM Signal

This section explains PAM4 signal generation and BER measurement. In the example here, the MU183020A 32G 2ch PPG and the MZ1834B 4PAM Converter are used to generate PAM signal, and the MU183040B 32G High Sensitivity ED is used for BER measurement of PAM signal.

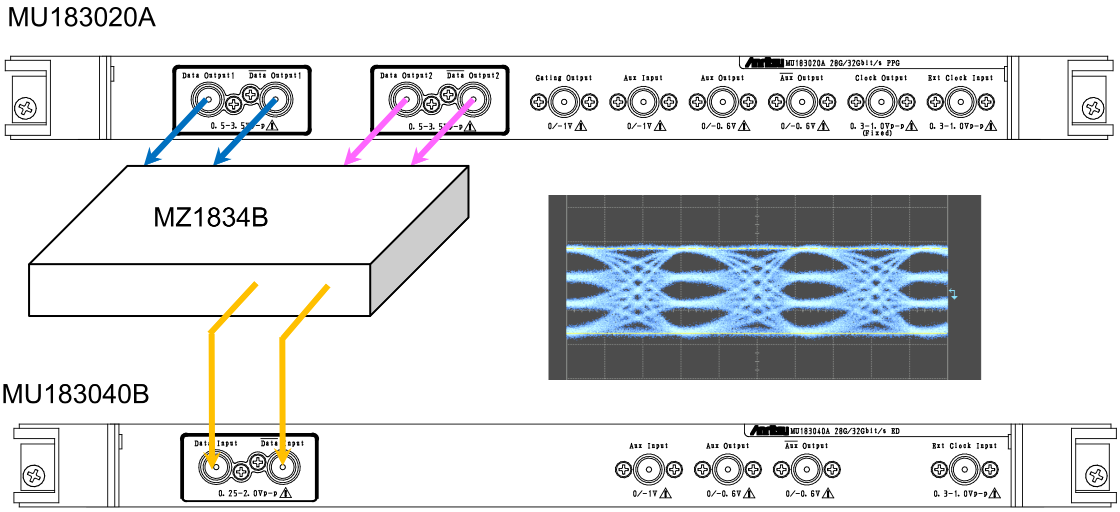


Figure F.1-1 PAM Signal and Connection Example for BER Measurement

Figure F.1-2 shows PAM4 signals generated in PPG1 and PPG2 patterns. 32G PPG Data output is PPG1, Data2 output is PPG2, and MZ1834B output is PAM4.

Threshold1 to Threshold3 on the left side of the PAM4 waveform are the threshold voltages to judge PAM4 amplitude values. For PAM4 has four values, three different threshold voltages, Threshold1 to 3, are required to distinguish each voltage value. The 32G ED measures the BER of these three threshold values.

When using one ED, perform BER measurement three times changing the threshold voltage from Threshold1 to Threshold3.

If divide and input PAM4 signals into three EDs, the BER can be measured at only one time by setting values of Threshold1 to 3 for the three EDs respectively.

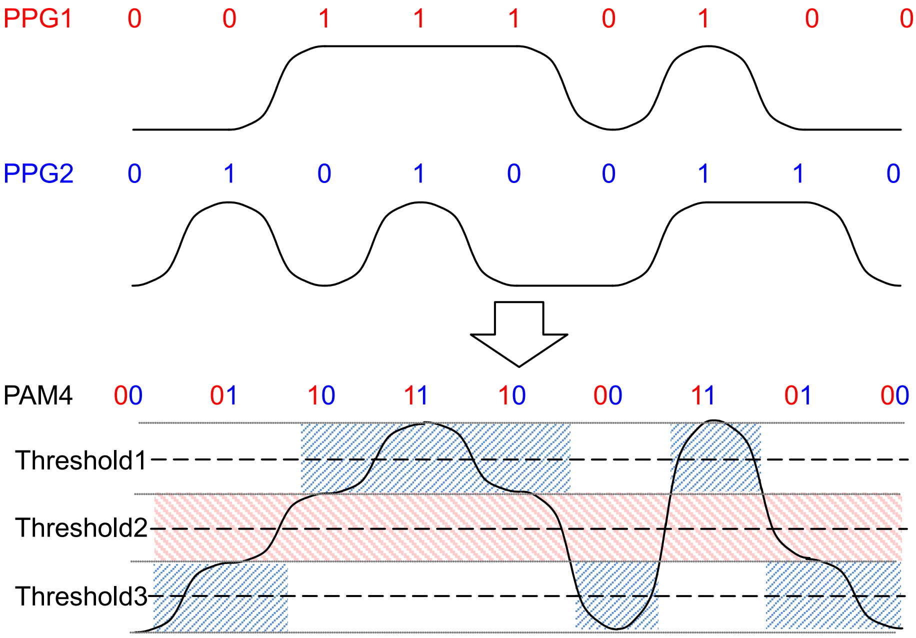


Figure F.1-2 PAM Signals and Thresholds at BER Measurement

The Threshold2 pattern is the same as the PPG1 pattern. The PPG2 pattern appears half in the Threshold1 area and half in the Threshold3 area.

The PPG2 pattern is marked with blue shaded areas in Figure F.1-2. The PPG2 pattern appears in the Threshold3 area when Threshold2 is 0 (low) and in the Threshold1 area when Threshold2 is 1 (high).

Because the data patterns for Threshold1 and 3 are generated from one PPG and divided into two, the BER measured by these thresholds is incorrect. However, when patterns expected for each threshold are already known, the BER of PAM signal can be measured by setting the patterns on the ED.

For details of PAM signal generation, refer to the Application Note entitled *PAM (Pulse Amplitude Modulation) Signal Generation for QAM Transmission*.

The following describes how a non-linear PAM4 signal is generated by using two MU183020A 2ch PPGs and one MZ1838A 8PAM Converter.

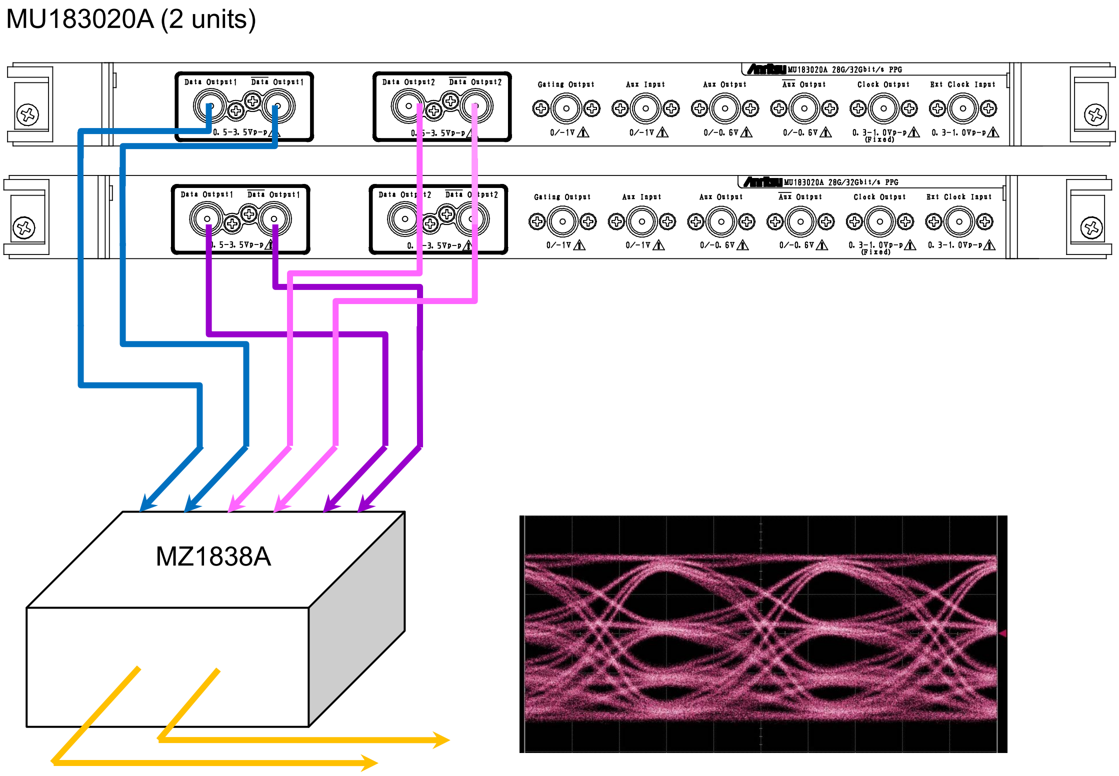


Figure F.1-3 Non-Linear PAM4 Signal Connection Example

Figure F.1-4 shows a non-linear PAM4 signal generated from PPG1, PPG2, and PPG3 patterns. Depending on where patterns are output, they are called as follows:

- PPG1: Data 1 of 32G PPG 1
- PPG2: Data 2 of 32G PPG 1
- PPG3: Data 1 of 32G PPG 2
- PAM4: MZ1838A

When increasing the eye opening of the Upper pattern that corresponds to Threshold1, the PPG3 pattern, which emphasizes only the blue-shaded portions shown in Figure F.1-4, is added to the non-linear PAM4 signal.

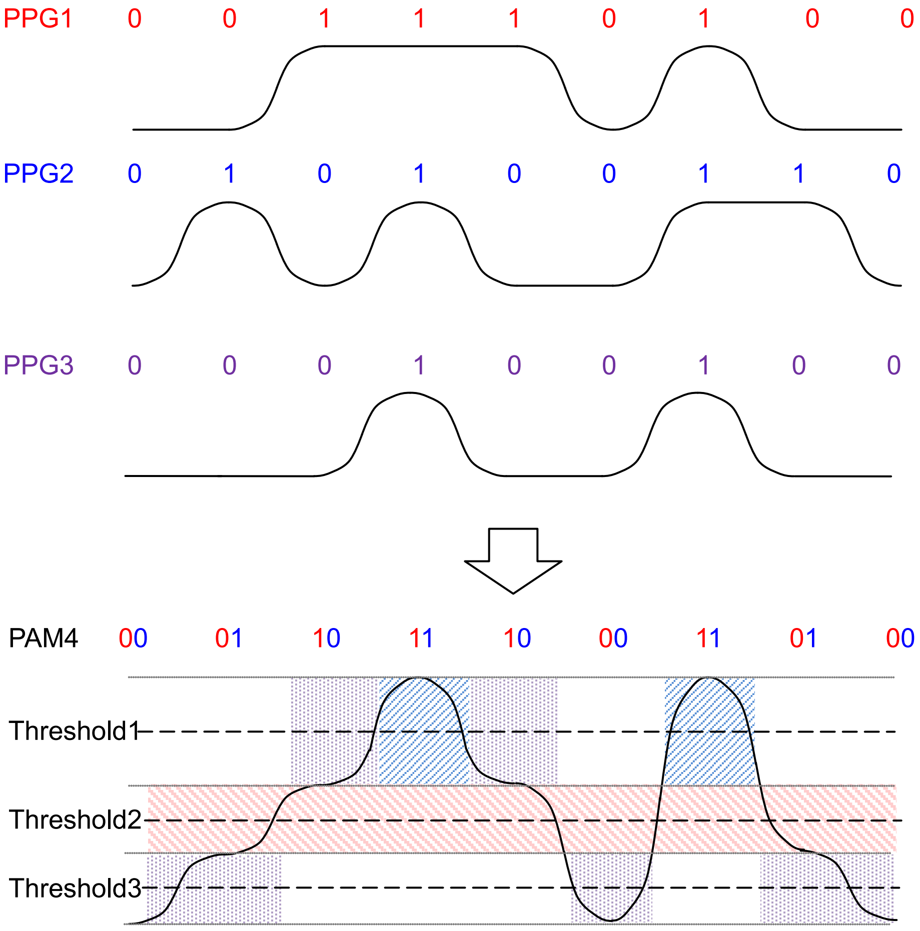
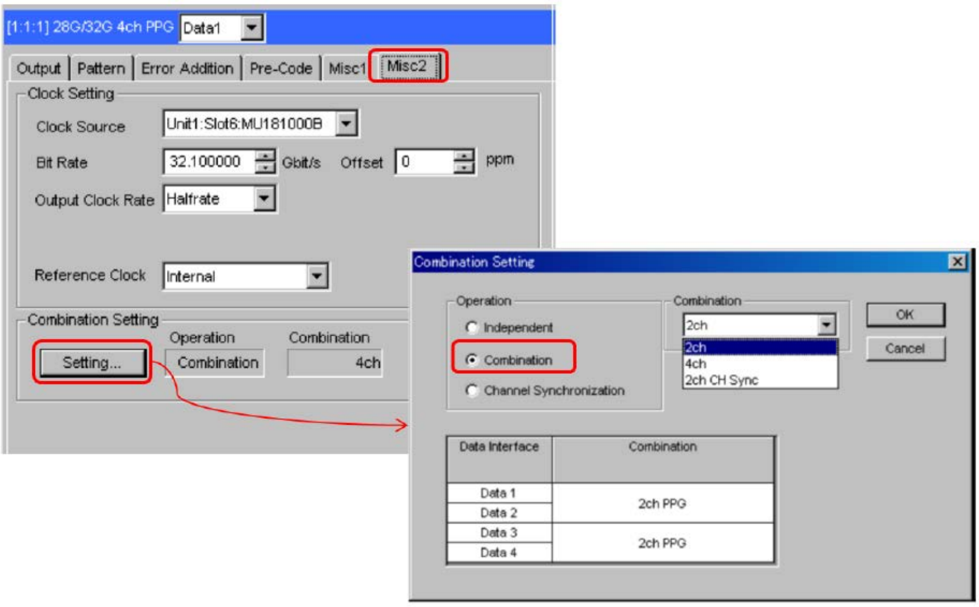

PPG1
0 0 1 1 1 0 1 0 0
PPG2
0 1 0 1 0 0 1 1 0
PPG3
0 0 0 1 0 0 1 0 0
PAM4
00 01 10 11 10 00 11 01 00
Threshold1
Threshold2
Threshold3

Figure F.1-4 Image of How Non-Linear PAM4 Signal Is Generated

F.2 Setting PPG

This section explains how to set PPG when generating PAM waveform.

1. Click the **Misc2** tab.
2. Click **Setting**.


[1:1:1] 28G/32G 4ch PPG
Data1
Output
Pattern
Error Addition
Pre-Code
Misc1
Misc2
Clock Setting
Combination Setting
Setting...
Combination Setting
OK
Cancel
Independent
Channel Synchronization
2ch
4ch
2ch CH Sync

Clock Source Unit1:Slot6:MU181000B

Bit Rate 32.100000 Gbit/s Offset 0 ppm

Output Clock Rate Halfrate

Reference Clock Internal

Operation Combination Combination 4ch

Operation ● Combination

Combination 2ch

Data Interface	Combination
Data 1 Data 2	2ch PPG
Data 3 Data 4	2ch PPG

Figure F.2-1 Combination Setting

3. Check **Combination** and select **2ch**.

Table F.2-1 PPG Setting for Pattern

Pattern	Pattern File for PPG1 and PPG2	Pattern File for PPG3 (For Upper Variable)	Pattern File for PPG3 (For Lower Variable)
PRBS7	No file. Test Pattern [PRBS] is used.	PN7_TxUpper.txt	PN7_TxLower.txt
PRBS9		PN9_TxUpper.txt	PN9_TxLower.txt
PRBS10		PN10_TxUpper.txt	PN10_TxLower.txt
PRBS11		PN11_TxUpper.txt	PN11_TxLower.txt
PRBS15		PN15_TxUpper.txt	PN15_TxLower.txt
PRBS20		PN20_TxUpper.txt	PN20_TxLower.txt
PRBS23		–	–
PRBS31		–	–

Table F.2-1 PPG Setting for Pattern (Cont'd)

Pattern	Pattern File for PPG1 and PPG2	Pattern File for PPG3 (For Upper Variable)	Pattern File for PPG3 (For Lower Variable)
PRBS13Q*1,*2	PRBS13Q.txt	–	–
GrayPRBS13Q*1,*3	GrayPRBS13Q.txt	–	–
PRQS10	PRQS10.txt	PRQS10_TxUpper.txt	PRQS10_TxLower.txt
SSPR	SSPR.txt	SSPR_Tx_Upper.txt	SSPR_Tx_Lower.txt
JP03A	JP03A.txt	–	–
JP03B	JP03B.txt	–	–
Squarewave	Squarewave.txt	–	–
QPRBS13-CEI	QPRBS13-CEI.txt	QPRBS13-CEI_TxUpper.txt	QPRBS13-CEI_TxLower.txt
GrayQPRBS13-CEI	GrayQPRBS13-CEI.txt	GrayQPRBS13-CEI_TxUpper.txt	GrayQPRBS13-CEI_TxLower.txt
QPRBS13-IEEE100GBASE-KP4_LaneX (X=0 to 3)	QPRBS13-IEEE100GBASE-KP4_LaneX.txt	QPRBS13-IEEE100GBASE-KP4_LaneX_TxUpper.txt	QPRBS13-IEEE100GBASE-KP4_LaneX_TxLower.txt
GrayQPRBS13-IEEE100GBASE-KP4_LaneX (X=0 to 3)	GrayQPRBS13-IEEE100GBASE-KP4_LaneX.txt	GrayQPRBS13-IEEE100GBASE-KP4_LaneX_Upper.txt	GrayQPRBS13-IEEE100GBASE-KP4_LaneX_TxLower.txt
GrayPreQPRBS13-IEEE100GBASE-KP4_LaneX (X=0 to 3)	GrayPreQPRBS13-IEEE100GBASE-KP4_LaneX.txt	GrayPreQPRBS13-IEEE100GBASE-KP4_LaneX_TxUpper.txtt	GrayPreQPRBS13-IEEE100GBASE-KP4_LaneX_TxLower.txt
Transmitter_Linearity	Transmitter_Linearity.txt	–	–
GrayPRBS7	GrayPN7.txt	GrayPN7_TxUpper.txt	GrayPN7_TxLower.txt
GrayPRBS9	GrayPN9.txt	GrayPN9_TxUpper.txt	GrayPN9_TxLower.txt
GrayPRBS10	GrayPN10.txt	GrayPN10_TxUpper.txt	GrayPN10_TxLower.txt
GrayPRBS11	GrayPN11.txt	GrayPN11_TxUpper.txt	GrayPN11_TxLower.txt
GrayPRBS15	GrayPN15.txt	GrayPN15_TxUpper.txt	GrayPN15_TxLower.txt
GrayPRBS20	GrayPN20.txt	GrayPN20_TxUpper.txt	GrayPN20_TxLower.txt
GrayPRQS10	GrayPRQS10.txt	GrayPRQS10_TxUpper.txt	GrayPRQS10_TxLower.txt
GraySSPR	GraySSPR.txt	GraySSPR_TxUpper.txt	GraySSPR_TxLower.txt

*1: This pattern can be used when using MX180000A Ver. 8.02.04 or earlier.

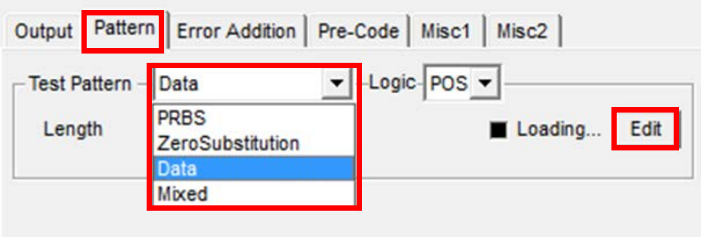
*2: Use QPRBS13-CEI instead, when using MX180000A Ver. 8.03.00 or later.

*3: Use GrayQPRBS13-CEI instead, when using MX180000A Ver. 8.03.00 or later.

4. Click the **Pattern** tab. Setting a pattern varies according to a PAM pattern generated.

5. Set **Test Pattern** as follows.

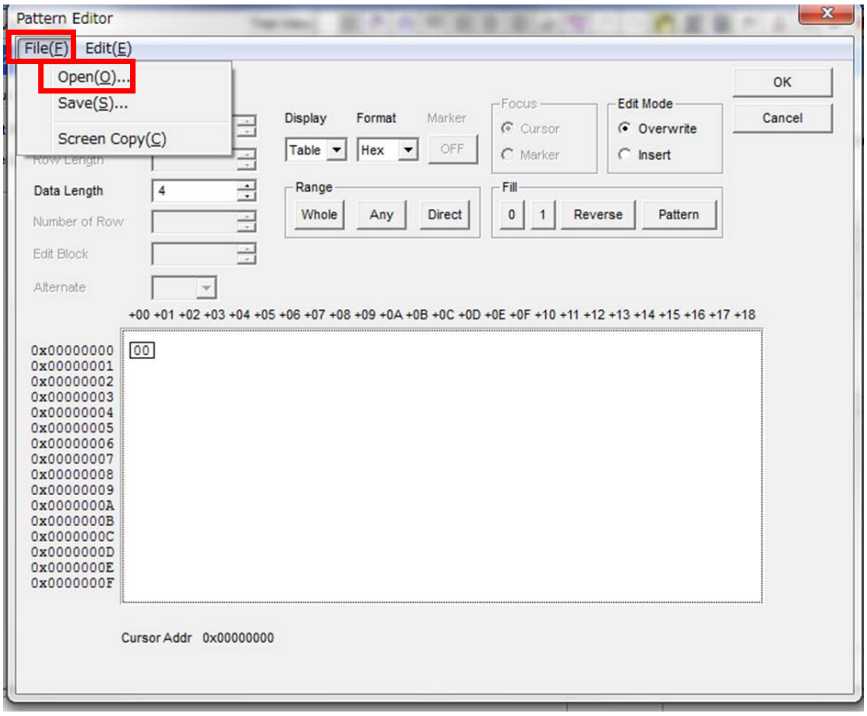
   - For PRBS7 to PRBS23, select **PRBS** and set **Length**.
   - For other than PRBS, select **Data** and click **Edit**.
     Load a pattern file from the File menu on the Pattern Editor dialog box in Figure F.2-3.


Output
Pattern
Error Addition
Pre-Code
Misc1
Misc2
Length
PRBS
ZeroSubstitution
Data
Mixed
Loading...
Edit

Test Pattern: Data

Logic: POS

Figure F.2-2 Pattern Setting


Pattern Editor
File(F)
Edit(E)
Open(O)...
Save(S)...
Screen Copy(C)
Row Length
Number of Row
Edit Block
Alternate
Focus
Cursor
Marker
Edit Mode
Overwrite
Insert
OK
Cancel
Range
Whole
Any
Direct
Fill
0
1
Reverse
Pattern
+00 +01 +02 +03 +04 +05 +06 +07 +08 +09 +0A +0B +0C +0D +0E +0F +10 +11 +12 +13 +14 +15 +16 +17 +18
0x00000000
0x00000001
0x00000002
0x00000003
0x00000004
0x00000005
0x00000006
0x00000007
0x00000008
0x00000009
0x0000000A
0x0000000B
0x0000000C
0x0000000D
0x0000000E
0x0000000F
00

Data Length 4

Display Table

Format Hex

Marker OFF

Cursor Addr 0x00000000

Figure F.2-3 Pattern Editor File Menu

Setting Examples

- To set PRBS15:

1. Click **Settings** on the **Misc2** tab.
2. On the **Combination Setting** dialog box, select **Combination** and **2ch**.
3. Select **PRBS** from the **Test Pattern** pull down menu.
4. Set **Length** to **2^15-1**.

- To set QPRBS13-CEI:

1. Click **Settings** on the **Misc2** tab.
2. Select **Combination** on the Combination Setting dialog box, and select **2ch**.
3. Click the **Pattern** tab of Data1.
4. Select **Data** from the **Test Pattern** pull down menu.
5. Click **Edit**.
6. Click **File** > **Open**.
7. Click QPRBS13-CEI.txt in the following folder:
   \Pattern Files\PAM_Pattern\QPRBS13-CEI

- To set QPRBS13-CEI non-linear pattern (Upper variable):

1. Configure the Combination setting.
   - When using MU183020A 2ch PPG, click **File** > **Combination Setting**, and then in the **Channel Synchronization** box, select **2ch Combination**.
   - When using MU183021A 4ch PPG, click **Setting** on the **Misc2** tab, and then select **2ch CH Sync**.
2. Configure the Pattern settings.
   - When using MU183020A 2ch PPG, click the **Pattern** tab for Data 1 of Slot 2.
   - When using MU183021A 4ch PPG, click the **Pattern** tab for Data 3.
3. In the **Test Pattern** box, select **Data**.
4. Click **Edit**.
5. Click **File** > **Open**.
6. Click QPRBS13-CEI_TXUpper.txt in the following folder:
   \Pattern Files\PAM_Pattern\QPRBS13-CEI

F.3 Setting ED

This section explains how to set the ED when executing BER measurement of PAM waveform.

As explained in F.1 “BER Measurement of PAM Signal”, an ED pattern should be changed for Threshold1 to Threshold 3 individually.

For the ED screen operation, refer to 5.14 “PAM BER Measurement”.

1. Click the **Misc2** tab of the ED.
2. Click **Setting**.
3. Click **Independent**.
4. Click the **Pattern** tab. How to set a pattern varies according to a threshold type and a PAM pattern to measure.
   - To set Threshold2 pattern to PRBS7 to PRBS23:
     Select **PRBS** and set **Length**.
   - Other cases:

     Select **Data** and click **Edit**.

     Load a pattern file from the File menu on the Pattern Editor dialog box in Figure F.2-3.

Table F.3-1 ED Setting According to Threshold Type/Pattern

Pattern Type	Pattern for Threshold1	Pattern for Threshold2	Pattern for Threshold3
PRBS7	PRBS7_Upper_bin.txt	No file. Test Pattern [PRBS] is used.	PRBS7_Lower_bin.txt
PRBS9	PRBS9_Upper_bin.txt		PRBS9_Lower_bin.txt
PRBS10	PRBS10_Upper_bin.txt		PRBS10_Lower_bin.txt
PRBS11	PRBS11_Upper_bin.txt		PRBS11_Lower_bin.txt
PRBS15	PRBS15_Upper_bin.txt		PRBS15_Lower_bin.txt
PRBS20	PRBS20_Upper_bin.txt		PRBS20_Lower_bin.txt
PRBS23*[1]	PRBS23_Upper_bin.txt		PRBS23_Lower_bin.txt
PRBS13Q*[2]	PRBS13Q_Upper.txt	PRBS13Q_Middle.txt	PRBS13Q_Lower.txt
GrayPRBS13Q*[3]	GrayPRBS13Q_Upper.txt	GrayPRBS13Q_Middle.txt	GraeyPRBS13Q_Lower.txt
PRQS10	PRQS10_Upper.txt	PRQS10_Middle.txt	PRQS10_Lower.txt
SSPR	SSPR_Upper.txt	SSPR_Middle.txt	SSPR_Lower.txt

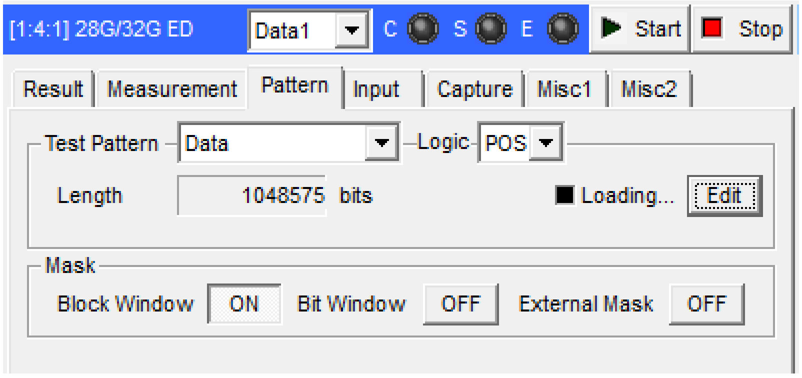
*1: The BER value cannot be measured correctly due to the limits of the Block Window function. The error count of each Threshold 1 and Threshold 3 will be greater than the expected value because the Block Window does not mask some of the bits that are not objects of measurement.

*2: Use QPRBS13-CEI instead, when using MX180000A Ver. 8.03.00 or later.

*3: Use GrayQPRBS13-CEI instead, when using MX180000A Ver. 8.03.00 or later.

Table F.3-1 ED Setting According to Threshold Type/Pattern (Cont'd)

Pattern Type	Pattern for Threshold1	Pattern for Threshold2	Pattern for Threshold3
JP03A	JP03A_RX.txt		
JP03B	JP03B_RX.txt		
Squarewave	Squarewave_RX.txt		
QPRBS13-CEI	QPRBS13-CEI_Upper.txt	QPRBS13-CEI_Middle.txt	QPRBS13-CEI_Lower.txt
GrayQPRBS13-CEI	GrayQPRBS13-CEI_Upper.txt	GrayQPRBS13-CEI_Middle.txt	GrayQPRBS13-CEI_Lower.txt
QPRBS13-IEEE100GBASE-KP4_LaneX (X=0 to 3)	QPRBS13-IEEE100GBASE-KP4_LaneX_Upper.txt	QPRBS13-IEEE100GBASE-KP4_LaneX_Middle.txt	QPRBS13-IEEE100GBASE-KP4_LaneX_Lower.txt
GrayQPRBS13-IEEE100GBASE-KP4_LaneX (X=0 to 3)	GrayQPRBS13-IEEE100GBASE-KP4_LaneX_Upper.txt	GrayQPRBS13-IEEE100GBASE-KP4_LaneX_Middle.txt	GrayQPRBS13-IEEE100GBASE-KP4_LaneX_Lower.txt
GrayPreQPRBS13-IEEE100GBASE-KP4_LaneX (X=0 to 3)	GrayPreQPRBS13-IEEE100GBASE-KP4_LaneX_Upper.txt	GrayPreQPRBS13-IEEE100GBASE-KP4_LaneX_Middle.txt	GrayPreQPRBS13-IEEE100GBASE-KP4_LaneX_Lower.txt
Transmitter_Linearity	Transmitter_Linearity_Upper.txt	Transmitter_Linearity_Middle.txt	Transmitter_Linearity_Lower.txt
GrayPRBS7	GrayPN7_Upper.txt	GrayPN7_Middle.txt	GrayPN7_Lower.txt
GrayPRBS9	GrayPN9_Upper.txt	GrayPN9_Middle.txt	GrayPN9_Lower.txt
GrayPRBS10	GrayPN10_Upper.txt	GrayPN10_Middle.txt	GrayPN10_Lower.txt
GrayPRBS11	GrayPN11_Upper.txt	GrayPN11_Middle.txt	GrayPN11_Lower.txt
GrayPRBS15	GrayPN15_Upper.txt	GrayPN15_Middle.txt	GrayPN15_Lower.txt
GrayPRBS20	GrayPN20_Upper.txt	GrayPN20_Middle.txt	GrayPN20_Lower.txt
GrayPRQS10	GrayPRQS10_Upper.txt	GrayPRQS10_Middle.txt	GrayPRQS10_Lower.txt
GraySSPR	GraySSPR_Upper.txt	GraySSPR_Middle.txt	GraySSPR_Lower.txt



[1:4:1] 28G/32G ED

Data1

Test Pattern: Data

Logic: POS

Length: 1048575 bits

Mask

Block Window: ON

Bit Window: OFF

External Mask: OFF

Figure F.3-1 Setting Pattern

5. Click the **Block Window** button to turn it **ON**.

Setting Examples

- To measure BER of PRBS15 at Threshold1:

1. Click **Settings** on the **Misc2** tab.
2. Select **Independent**.
3. Click the **Pattern** tab.
4. Select **Data** from the **Test Pattern** pull down menu.
5. Click **Edit**.
6. Click **File** > **Open** on the Pattern Editor dialog box.
7. Select PN15_Upper_bin.txt in the following folder:
   \Pattern Files\PAM_Pattern\PRBS15
8. Click **OK**.
9. Click the **Block Window** button to turn it **ON**.

- To measure BER of PRBS15 at Threshold2:

1. Click **Settings** on the **Misc2** tab.
2. Select **Independent**.
3. Click the **Pattern** tab.
4. Select **PRBS** for **Test Pattern**.
5. Set **Length** to **2^15-1**.

- To measure BER of QPRBS13-CEI at Threshold3:

1. Click **Settings** on the **Misc2** tab.
2. Select **Independent**.
3. Click the **Pattern** tab.
4. Select **Data** from the **Test Pattern** pull down menu.
5. Click **Edit**.
6. Click **File** > **Open** on the **Pattern Editor** dialog box.
7. Select QPRBS13-CEI_Lower.txt in the following folder:
   \Pattern Files\PAM_Pattern\QPRBS13-CEI
8. Click **OK**.
9. Click the **Block Window** button to turn it **ON**.