MU181040A
12.5 Gbit/s ED
MU181040B
14 Gbit/s ED
Operation Manual

23rd 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 and 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-W2753AE-23.0

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

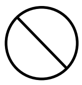
⚠ DANGER This indicates a very dangerous procedure that could result in serious injury or death if not performed properly.

⚠ WARNING This indicates a hazardous procedure that could result in serious injury or death if not performed properly.

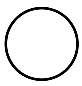
⚠ CAUTION This indicates a hazardous procedure or danger that could result in light-to-severe injury, or loss related to equipment malfunction, if proper precautions are not taken.

Safety Symbols Used on Equipment and in Manual

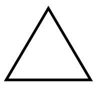
The following safety symbols are used inside or on the equipment near operation locations to provide information about safety items and operation precautions. Ensure that you clearly understand the meanings of the symbols and take the necessary precautions BEFORE using the equipment.



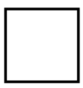
This indicates a prohibited operation. The prohibited operation is indicated symbolically in or near the barred circle.



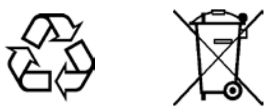
This indicates an obligatory safety precaution. The obligatory operation is indicated symbolically in or near the circle.



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.

MU181040A 12.5 Gbit/s ED
MU181040B 14 Gbit/s ED
Operation Manual

27 November 2006 (First Edition)
25 August 2020 (23rd Edition)

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., and software bug fixes will be performed in accordance with the separate Software End-User License Agreement, provide, however, that 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 or flood, 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 damage or financial loss of the customer due to the use of or a failure to use this equipment, unless the damage or loss is caused due to Anritsu Corporation’s intentional or gross negligence.

Note:
For the purpose of this Warranty, "unusual environments" 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, please 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.

Notes On Export Management

This product and its manuals may require an Export License/Approval by the Government of the product's country of origin for re-export from your country.
Before re-exporting the product or manuals, please contact us to confirm whether they are export-controlled items or not.
When you dispose of export-controlled items, the products/manuals need to be broken/shredded so as not to be unlawfully used for military purpose.

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Please carefully read and accept this Software End-User License Agreement (hereafter this EULA) before using (includes executing, copying, installing, registering, etc.) this Software (includes programs, databases, scenarios, etc., used to operate, set, etc., Anritsu electronic equipment, etc.). By using this Software, you shall be deemed to have agreed to be bound by the terms of this EULA, and Anritsu Corporation (hereafter Anritsu) hereby grants you the right to use this Software with the Anritsu-specified equipment (hereafter Equipment) for the purposes set out in this EULA.

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1. You may not to sell, transfer, rent, lease, lend, disclose, sublicense, or otherwise distribute this Software to third parties, whether or not paid therefor.
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3. You are not permitted to reverse engineer, disassemble, decompile, modify or create derivative works of this Software.
4. This EULA allows you to install one copy of this Software on one piece of Equipment.

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To the extent not prohibited by law, in no event shall Anritsu be liable for direct, or any incidental, special, indirect or consequential damages whatsoever, including, without limitation, damages for loss of profits, loss of data, business interruption or any other commercial damages or losses, and damages claimed by third parties, arising out of or related to your use or inability to use this Software, unless the damages are caused due to Anritsu's intentional or gross negligence.

Article 3. Limitation of Liability

1. If a fault (bug) is discovered in this Software, failing this Software to operate as described in the operation manual or specifications even though you have used this Software as described in the manual, Anritsu shall at its own discretion, fix the bug, or replace the software, or suggest a workaround, free-of-charge, provided, however, that the faults caused by the following items and any of your lost or damaged data whatsoever shall be excluded from repair and the warranty.
   - i) If this Software is deemed to be used for purposes not described in the operation manual or specifications.
   - ii) If this Software has been used in conjunction with other non-Anritsu-approved software.
   - iii) If this Software or the Equipment has been modified, repaired, or otherwise altered without Anritsu's prior approval.
   - iv) For any other reasons out of Anritsu's direct control and responsibility, such as but not limited to, natural disasters, software virus infections, or any devices other than this Equipment, etc.
2. Expenses incurred for transport, hotel, daily allowance, etc., for on-site repairs or replacement by Anritsu engineers necessitated by the above faults shall be borne by you.
3. The warranty period for faults listed in Section 1 of this Article shall be either 6 months from the date of purchase of this Software or 30 days after the date of repair or replacement, whichever is longer.

Article 4. Export Restrictions

You shall not use or otherwise export or re-export directly or indirectly this Software except as authorized by the laws and regulations of Japan and the United States, etc. In particular, this Software shall not be exported or re-exported (a) into any Japan or US embargoed countries or (b) to anyone restricted by the Japanese export control regulations, or the US Treasury Department's list of Specially Designated Nationals or the US Department of Commerce Denied Persons List or Entity List. In using this Software, you warrant that you are not located in any such embargoed countries or on any such lists. You also agree that you will not use or otherwise export or re-export this Software for any purposes prohibited by the Japanese and US laws and regulations, including, without limitation, the development, design and manufacture or production of missiles or nuclear, chemical or biological weapons of mass destruction, and conventional weapons.

Article 5. Change of Terms

Anritsu may change without your approval the terms of this EULA if the changes are for the benefit of general customers, or are reasonable in light of the purpose of this EULA and circumstances of the changes. At the time of change, Anritsu will inform you of those changes and its effective date, as a general rule 45 days, in advance on its website, or in writing or by e-mail.

Article 6. Termination

1. Anritsu may terminate this EULA immediately if you violate any conditions described herein. This EULA shall also be terminated immediately by Anritsu if there is any good reason that it is deemed difficult to continue this EULA, such as your violation of Anritsu copyrights, patents, etc. or any laws and ordinances, or if it turns out that you belong to an antisocial organization or has a socially inappropriate relationship with members of such organization.
2. You and Anritsu may terminate this EULA by a written notice to the other party 30 days in advance.

Article 7. Damages

If Anritsu suffers any damages or loss, financial or otherwise, due to your violation of the terms of this EULA, Anritsu shall have the right to seek proportional damages from you.

Article 8. Responsibility after Termination

Upon termination of this EULA in accordance with Article 6, you shall cease all uses of this Software immediately and shall as directed by Anritsu either destroy or return this Software and any backup copies, full or partial, to Anritsu.

Article 9. Negotiation for Dispute Resolution

If matters of interpretational dispute or items not covered under this EULA arise, they shall be resolved by negotiations in good faith between you and Anritsu.

Article 10. Governing Law and Court of Jurisdiction

This EULA shall be governed by and interpreted in accordance with the laws of Japan without regard to the principles of the conflict of laws thereof, and any disputes arising from or in relation to this EULA that cannot be resolved by negotiation described in Article 9 shall be subject to and be settled by the exclusive agreed jurisdiction of the Tokyo District Court of Japan.

Revision History:

February 29th, 2020

RCM Conformity Marking

Anritsu affixes the RCM marking 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: MU181040A 12.5 Gbit/s ED
MU181040B 14 Gbit/s ED

2. Applied Standards

When the MU181040A 12.5 Gbit/s ED or MU181040B 14 Gbit/s 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 MU181040A/B 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

(shaded box) 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 LAN interface.
- **Module Operation Manual**
  Operation manual for the module. The Module Operation Manual varies depending on the module(s) used.
  - **MU181040A 12.5 Gbit/s ED**
    MU181040B 14 Gbit/s ED
    Operation Manual (shaded)
    Describes how the MU181040A/B is configured as well as how to operate and maintain it.
- **Control Software Operation Manual**
  Operation manual of the software that controls the Signal Quality Analyzer Series.

Table of Contents

Chapter 1 Overview

This chapter provides an overview of the MU181040A 12.5 Gbit/s ED and the MU181040B 14Gbit/s ED (hereinafter, referred to as "MU181040A").

However, this document only explains the MU181040A, unless there is a special item.

1.1 Product Overview

The MU181040A 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 MU181040A. This module is therefore useful for research, development, and production of various types of digital communication equipment, modules, and devices.

The features of the MU181040A are as follows:

- Capable of measuring PRBS, Data, Zero-Substitution, Mixed, and Sequence patterns.
- Provides a large amount of user-programmable patterns (128 Mbits)
- Supports a variety of applications such as research, development, and production of devices, by installing options.
- Flexible for functional expansion in the future, by installing additional options.
- Devices up to 25Gbit/s can be evaluated using two MU181040A modules and up to 28Gbit/s using two MU181040B modules.
- Devices up to 50Gbit/s can be evaluated using four MU181040A modules and up to 56Gbit/s using four MU181040B modules.

1.2 Product Composition

1.2.1 Standard composition

Table 1.2.1-1 and Table 1.2.1-2 show the standard compositions of MU181040A/B.

Table 1.2.1-1 Standard composition of MU181040A

Item	Model name	Product name	Q'ty	Remarks
Mainframe	MU181040A	12.5 Gbit/s ED	1	
Accessories	Z0897A	MP1800A Manual CD	1	CD-ROM version
	Z0918A	MX180000A Software CD	1	CD-ROM version

Table 1.2.1-2 Standard composition of MU181040B

Item	Model name	Product name	Q'ty	Remarks
Mainframe	MU181040B	14 Gbit/s ED	1	
Accessories	Z0897A	MP1800A Manual CD	1	CD-ROM version
	Z0918A	MX180000A Software CD	1	CD-ROM version

1.2.2 Options

Table 1.2.2-1 and Table 1.2.2-2 show the options for the MU181040A/B. Table 1.2.2-3 and Table 1.2.2-4 show the Accessories for options for the MU181040A/B. All options are sold separately.

Table 1.2.2-1 Options for MU181040A

Model name	Product name	Remarks
MU181040A-001	9.8 to 12.5 Gbit/s	Cannot be installed together with MU181040A-002.
MU181040A-002	0.1 to 12.5 Gbit/s	Cannot be installed together with MU181040A-001.
MU181040A-x20	Clock recovery	Can be installed when MU181040A-002 is installed.
MU181040A-x30	Clock phase variable	Can be installed when MU181040A-002 is installed.

Table 1.2.2-2 Options for MU181040B

Model name	Product name	Remarks
MU181040B-002	0.1 to 14 Gbit/s	Necessary option
MU181040B-003*	14.05Gbit/s Extension	
MU181040B-005*	14.1Gbit/s Extension	
MU181040B-x20	Clock recovery	Can be installed when MU181040B-002 is installed.
MU181040B-x30	Clock phase variable	Can be installed when MU181040B-002 is installed.

Note:

Option name format is as follows:

MU181040A- x x x

Indicates function.
This value is recognized by the mainframe.

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

*: Notes on MU181040B Option Model Display
The model and name of the MU181040B-003 option and MU181040B-005 option are recorded on the front panel of each module. Although the screen displaying the option details using software indicates MU181040B-02 (0.1 to 14 Gbit/s) the assured operating bit rates are actually 0.1 to 14.05 Gbit/s or 0.1 to 14.1 Gbit/s.

Table 1.2.2-3 Standard Accessories for MU181040A Options

Applicable Option	Model name/ symbol	Product name	Q'ty	Remarks
MU181040A-001	J1341A	Open	2	
MU181040A-002	J1137	Terminator	2	
	J1359A	Coaxial adapter (compatible among K-P, K-J, SMA-)	2	
	J1341A	Open	3	
MU181040A-x20	J1137	Terminator	1	

Table 1.2.2-4 Standard Accessories for MU181040B Options

Applicable Option	Model name/ symbol	Product name	Q'ty	Remarks
MU181040B-002	J1137	Terminator	2	
	J1359A	Coaxial adapter (compatible among K-P, K-J, SMA-)	2	
	J1341A	Open	3	
MU181040B-x20	J1137	Terminator	1	

1.2.3 Application parts

Table 1.2.3-1 and Table 1.2.3-2 shows the application parts for the MU181040A/B. All application parts are sold separately.

Table 1.2.3-1 Application parts for MU181040A

Model name/ symbol	Product name	Remarks
J1360A	Measurement kit	Coaxial cable 0.8 m × 2 Coaxial cable 1.0 m × 1
J1343A	Coaxial cable, 1 m	SMA connector
J1342A	Coaxial cable, 0.8 m	APC3.5 connector
Z0306A	Wrist strap	
J1137	Terminator	
J1359A	Coaxial adapter (compatible among K-P, K-J, and SMA)	
W2753AE	Operation manual	Printed version
J1678A	ESD Protection Adapter-K	K connector

Table 1.2.3-2 Application parts for MU181040B

Model name/ symbol	Product name	Remarks
J1360A	Measurement kit	Coaxial cable 0.8 m × 2 Coaxial cable 1.0 m × 1
J1343A	Coaxial cable, 1 m	SMA connector
J1342A	Coaxial cable, 0.8 m	APC3.5 connector
Z0306A	Wrist strap	
J1137	Terminator	
J1359A	Coaxial adapter (compatible among K-P, K-J, and SMA)	
W2753AE	Operation manual	Printed version
J1678A	ESD Protection Adapter-K	K connector

1.3 Specifications

1.3.1 Specifications for MU181040A

Table 1.3.1-1 Specifications for MU181040A

<table>
<tr><th colspan="2">Item</th><th>Specifications</th><th>Remarks</th></tr>
<tr><td colspan="2">Operating bit rate</td><td>9.8 to 12.5 Gbit/s</td><td rowspan="5">When MU181040A -001 is installed</td></tr>
<tr><td colspan="2">Resolution</td><td>1 kbits step</td></tr>
<tr><td colspan="2">Clock source</td><td>Recovered Clock</td></tr>
<tr><td colspan="2">Rated frequency selection</td><td>10 GFC over FEC, 10 GbE over FEC, OTU2, G975 FEC, 10 GFC, 10 GbE, and OC192/STM64 can be set.</td></tr>
<tr><td colspan="2">Lock range for clock data recovery</td><td>±500 ppm</td></tr>
<tr><td colspan="4">External clock input</td></tr>
<tr><td colspan="2">Operating frequency range</td><td>0.1 to 12.5 GHz</td><td>When MU181040A -002 is installed</td></tr>
<tr><td colspan="2">Clock source</td><td>External clock and Recovered clock can be set.</td><td rowspan="2">When MU181040A -x20 is installed</td></tr>
<tr><td colspan="2">Rated frequency selection</td><td>10GFC over FEC, 10GbE over FEC, OTU2, G975 FEC, 10GFC, 10GbE, OC192/STM64, SATA 6Gb/s, PCI Express II, 4GFC, XAUI, SATA 3Gb/s, OTU1, PCI Express I, OC48/STM16, 2GFC, SATA1.5Gb/s, GbE, 1GFC, OC12/STM4, OC3/STM1 can be set.</td></tr>
<tr><td colspan="2">Pattern Sequence</td><td>Repeat/Burst</td><td></td></tr>
<tr><td rowspan="3">PRBS</td><td>Pattern length</td><td>$2^n – 1$ (n = 7, 9, 10, 11, 15, 20, 23, 31)</td><td rowspan="8"></td></tr>
<tr><td>Mark ratio</td><td>1/2, 1/4, 1/8, 0/8, 1/2 INV, 3/4, 7/8, 8/8</td></tr>
<tr><td>Number of AND bit shifts at the mark ratio</td><td>1 bit/3 bits (at 1/4, 3/4, 7/8, 1/8)</td></tr>
<tr><td rowspan="4">Zero Substitution</td><td>Pattern sequence</td><td>2^n or $2^n–1$</td></tr>
<tr><td>Additional Bit</td><td>1 or 0 (when 2^n is set for Pattern sequence)</td></tr>
<tr><td>Pattern length</td><td>2^n (n = 7, 9, 10, 11, 15, 20, 23)
$2^n–1$ (n = 7, 9, 10, 11, 15, 20, 23)</td></tr>
<tr><td>Successive-zeros bit length</td><td>1 to “pattern length – 1” bits can be inserted.</td></tr>
<tr><td>Data</td><td>Pattern length</td><td>2 to 134,217,728 bits, in 1-bit steps
In the case of 2 Ch Combination:
4 to 268,435,456 bits, in 2-bit steps
In the case of 4 Ch Combination:
8 to 536,870,912 bits, in 4-bit steps</td></tr>
</table>

Table 1.3.1-1 Specifications for MU181040A (Cont'd)

Item		Specifications	Remarks
Mixed	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 2 Ch Combination 4 for 4 Ch Combination d) (Row Length – Data Length) × Number of blocks ≥ 2^31(2147483648)	
	Pattern	Data	
	Pattern Length	Data length: 512 to 134 217 728 bits, in 1-bit steps In the case of 2 Ch Combination: 1 024 to 268 435 456 bits, in 2-bit steps (Data) In the case of 4 Ch Combination: 2 048 to 536 870 912 bits, in 4-bit steps (Data) PRBS length: 2^n–1 (n = 7, 9, 10, 11, 15, 20, 23, 31)	
	Row Length	768 to 2 281 701 376 bits, in 128-bit steps In the case of 2 Ch Combination: 1 536 to 4 563 402 752 bits, in 256-bit steps In the case of 4 Ch Combination: 3 072 to 9 126 805 504 bits, in 512-bit steps	

Table 1.3.1-1 Specifications for MU181040A (Cont'd)

Item		Specifications	Remarks
Mixed (continued)	Number of rows	1 to the smallest number among a to c, below, in 1-row steps a) 16 b) INT (128 Mbits × 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 2 Ch Combination 4 for 4 Ch Combination	
Sequence	Block number	1 to 128 max.	
	Block length	8 192 to 1 048 576 bits, in 128-bits steps	
	Loop time	1 to 1 024 times, in 1-time steps or repeat	
	Match Pattern	4 to 64 bits per pattern A or B, in 1-bit steps (Settable for each block)	
Block Window		On/Off can be set.	
Bit Window		On/Off can be set.	
External Mask		On/Off can be set.	
Measurement			
Measurement types	Error Rate	0.0001E – 18 to 1.0000E – 00	
	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	100.000 to 12 500.000 MHz	
	Frequency measurement accuracy	±1 ppm ±1 kHz (when the input CK signal and DCS board 10 MHz are calibrated correctly)	
	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	
	CR Unlock Interval	0 to 9999999, 1.0000E07 to 9.9999E17	

Table 1.3.1-1 Specifications for MU181040A (Cont'd)

Item		Specifications	Remarks
Gating	Time, Clock Count, Error Count, and Block Count can be set.		
	Time	1 second to 99 days 23 hours 59 minute 59 seconds	
	Clock Count	1×10^n (n = 4 to 16)	
	Error Count	1×10^n (n = 4 to 16)	
	Block Count	1×10^n (n = 2 to 14)	
	Gating Cycle	Repeat, Single, and Untimed can be set.	
	Current	On/Off can be set.	
		Progressive/Immediate can be set.	
		100-ms/200-ms interval can be set.	
Auto Sync	On/Off can be set.		
	Synchronization threshold	INT, 1×10^{-n} (n = 2, 3, 4, 5, 6, 7, 8)	
Sync Control	Frame ON, Frame OFF, Quick, and Fast can be set. When Frame ON, Frame Length/Frame Mask/Frame Position are valid.		
	Frame length	4 to 64 bits (in 4-bit steps)	
	Frame mask	Available	
	Frame Position	1 to Pattern Length–Frame Length + 1,1 bit Step In the case of 2 Ch Combination: 1 to 1+2n, in 2-bit steps Maximum value of n = INT((Pattern Length – Frame Length)/2) In the case of 4 Ch Combination: 1 to 1+4n, in 4-bit steps Maximum value of n = INT((Pattern Length – Frame Length)/4)	
Error alarm conditions	Error detection mode	Total, Insertion/Omission, or Transition/Non Transition In the case of Combination: Transition/Non Transition cannot be selected	
	EI/EFI interval	1, 10, 100 ms, 1 s	
	Error performance	Available	
Capture function	Number of blocks	1, 2, 4, 8, 16, 32, 64, 128	
	Block length	1 Mbits to 128 Mbits 2 to 256 Mbits for 2 Ch Combination 4 to 512 Mbits for 4 Ch Combination	

Table 1.3.1-1 Specifications for MU181040A (Cont'd)

Item		Specifications	Remarks
Automatic measurement function	ISI analysis	Available. Number of blocks: 64 In the case of 2 Ch Combination, the number of blocks at the lowest layer is 128. In the case of 4 Ch Combination, the number of blocks at the lowest layer is 256.	
	Eye margin	Available	
	Eye diagram	Available	
	Q Analysis	Available	
	Bathtub	Available	
Burst measurement function	Source	Internal, External-Enable, External-Trigger	
	Burst Cycle	25 600 to 2 147 483 648 bits (in 128-bit steps) In the case of 2 Ch Combination: 51 200 to 4 294 967 296 bits, in 256-bit steps In the case of 4 Ch Combination: 102 400 to 8 589 934 592 bits, in 512-bit steps	
	Enable Period	Internal 12 800 to 2 147 483 136 bits, in 128-bit steps Other than Internal 12 800 to 2 147 483 520 bits, in 128-bit steps In the case of 2 Ch Combination: Internal 25 600 to 4 294 966 272 bits, in 256-bit steps Other than Internal 25 600 to 4 294 967 040 bits, in 256-bit steps In the case of 4 Ch Combination: Internal 51 200 to 8 589 932 544 bits, in 512-bit steps Other than Internal 51 200 to 8 589 934 080 bits, in 512-bit steps	
	Delay	Internal 0 to 2 147 483 648 bits, in 16-bit steps Other than Internal 0 to 2 147 483 584 bits, in 16-bit steps In the case of 2 Ch Combination: Internal 0 to 4 294 967 296 bits, in 32-bit steps Other than Internal 0 to 4 294 967 168 bits, in 32-bit steps In the case of 4 Ch Combination: Internal 0 to 8,589,934,592 bits, in 64-bit steps Other than Internal 0 to 8 589 934 336 bits, in 64-bit steps	

Table 1.3.1-1 Specifications for MU181040A (Cont'd)

Item		Specifications	Remarks
Data input	Number of inputs	2 (Data/XData Differential)	When MU181040A-001 is installed
	Input signal format	NRZ	
	Input Condition	Single-ended and Differential can be set. Data and XData can be set.	
	Input amplitude	0.1 to 0.9 Vp-p (when Single-ended is selected)	
	Threshold voltage	Independent, Tracking, and Alternate can be set. –0.350 to +0.350 V (in 1 mV steps) (Tracking/Independent) –0.700 to +0.700 V (in 1 mV steps) (Alternate)	
	Input sensitivity	50 mVp-p Typ. (at 10 or 12.5 Gbit/s, Single-ended input, PRBS: 2^{31}–1, mark ratio: 1/2, 20 to 30°C)	
	Termination	AC/50 Ω	
	Connector	SMA	
Data input	Number of inputs	2 (Data/XData Differential)	When MU181040A-002 is installed
	Input signal format	NRZ	
	Input condition	Single-ended, Differential 50 Ω, and Differential 100 Ω can be set. Data and XData can be set.	
	Input amplitude	0.1 to 2.0 Vp-p (when Single-ended is selected)	
	Threshold voltage	Independent, Tracking, and Alternate can be set. –3.500 to +3.300 V (in 1 mV steps) (Tracking/Independent) –3.000 to +3.000 V (in 1 mV steps) (Alternate)	
	Input sensitivity	10 mVp-p Typ. (at 10 or 12.5 Gbit/s, Single-ended input, PRBS: 2^{31}–1, mark ratio: 1/2, 20 to 30°C)	
	Phase margin	60 ps Typ. at 12.5 Gbit/s 80 ps Typ. at 10 Gbit/s (at Single-ended input, PRBS: 2^{31}–1, mark ratio: 1/2)	
	Termination voltage	–2.50 to 3.50 V, 10 mV step(50 Ω/when Variable setting, load current <60 mA)	
	Termination	NECL, PCML, LVPECL, GND, Variable (–2.5 to +3.5 V)	
	Connector	K	

Table 1.3.1-1 Specifications for MU181040A (Cont'd)

Item		Specifications	Remarks
Clock input (Continued)	Number of input	1 (Single-ended)	
	Input waveform	Rectangular wave (<0.5 GHz), Duty: 50%, Rectangular or sine wave (≥0.5 GHz), Duty: 50%	
	Input amplitude	0.25 to 2 Vp-p	
	Termination	50 Ω/GND, 50 Ω/Variable	
	Termination voltage	–2.50 to +3.50 V (in 10 mV steps) (50 Ω, when set to Variable, load current <60 mA)	
	Termination	NECL, PCML, LVPECL, GND, Variable (–2.5 to +3.5 V)	
	Connector	SMA	
AUX output	Number of outputs	1	
	Output Signal Selection	1/N Clock, Pattern Sync, Sync Gain, Error Output	
	1/N Clock	1/16 Clock, 1/32 Clock, 1/64 Clock	When MU181040A-001 is installed
		1/N: N=8, 9, 10…510, 511	When MU181040A-002 is installed

Table 1.3.1-1 Specifications for MU181040A (Cont'd)

Item		Specifications	Remarks
AUX output	Pattern Sync		
	When PRBS, Data or Zero-sub is set	Position: 1 to {(Least common multiple of Pattern Length* and 64) –79}, in 16-bit steps. The maximum settable number is 68 719 476 657. In the case of 2 Ch Combination: 1 to {(Least common multiple of Pattern Length* and 128) –159}, in 32-bit steps. The maximum settable number is 137 438 953 313. In the case of 4 Ch Combination: 1 to {(Least common multiple of Pattern Length* and 256) –319}, in 64-bit steps. The maximum settable number is 274 877 906 625.	
	When Mixed Data is set	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	
	When Sequence is set	Block No. setting: 1 to Block No. set for Sequence Pattern, in single steps	
		Position: 1 to {(Least common multiple of Pattern Length* and 64) –79}, in 16-bit steps.	
	Output level	0/–1 V H: –0.25 to 0.05 V L: –1.10 to –0.80 V	
	Impedance	50 Ω/GND	
	Connector	SMA	

*: At Independent, when the pattern length is 127 bits or less, specify the length as an integer multiple so that it becomes 128 bits or more.
At 2 Ch Combination, when the pattern length is 255 bits or less, specify the length as an integer multiple so that it becomes 256 bits or more.
At 4 Ch Combination, when the pattern length is 511 bits or less, specify the length as an integer multiple so that it becomes 512 bits or more.

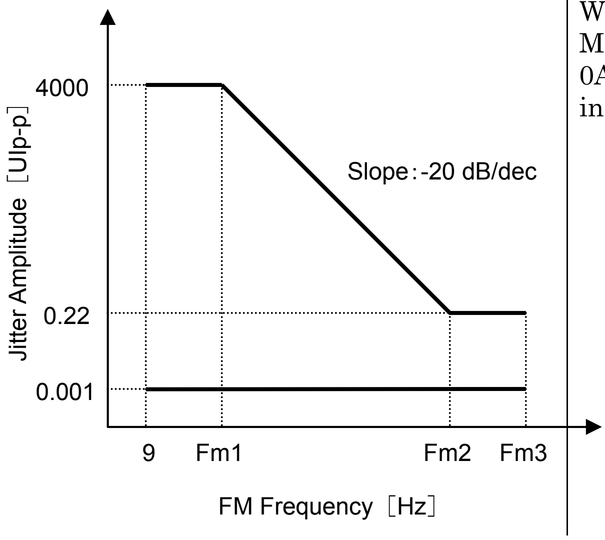
Table 1.3.1-1 Specifications for MU181040A (Cont'd)

Item		Specifications	Remarks
AUX input	Number of inputs	1	
	Input signal	In the case of Combination, input only to Master Module is enabled. Burst: External-Trigger (Data is enabled at rising edge detection) External-Enable (L: Data disabled, H: Data output) External Mask: (L: Measurement masked, H: Measurement) Capture External Trigger: (Start capture at rising edge detection)	
	Minimum pulse width	1/64 of Data rate	
	Input level	0/–1 V H: –0.25 to 0.05 V L: –1.10 to –0.80 V	
	Termination	50 Ω/GND	
	Connector	SMA	
Monitor output	Number of output	2 (Data monitor, XData monitor)	
	Insertion loss	At 6.25 GHz, –6 dB (reference value), and –5 dB to –8 dB (acceptable value). (Data Input to Data Monitor Output, XData Input to XData Monitor Output)	
	Termination	AC/50 Ω	
	Connector	SMA	
Clock Recovery	Operating bit rate	100 Mbit/s 125 to 200 Mbit/s (steps: 125, 140.6, 155.52, 156.3, 171.9, 187.5, 200 Mbit/s) 250 to 400 Mbit/s (steps: 250, 281.3, 312.5, 343.8, 375.0, 400 Mbit/s) 500 to 800 Mbit/s (steps: 500, 562.5, 622.08, 625.0, 687.5, 750.0, 800 Mbit/s) 1.0 to 1.6 Gbit/s (steps: 1.0, 1.0625, 1.125, 1.25, 1.375, 1.5, 1.6 Gbit/s) 2.0 to 3.2 Gbit/s (steps: 2.0, 2.125, 2.25, 2.48832, 2.5, 2.66606, 2.75, 3.0, 3.125, 3.2 Gbit/s) 4.25 Gbit/s, 4.9 to 6.25 Gbit/s (steps: 1 kbit/s), 9.8 to 12.5 Gbit/s (steps: 1 kbit/s)	When MU181040A-x20 is installed
	Preset standards	10 GFC over FEC, 10 GbE over FEC, OTU2, G975 FEC, 10 GFC, 10 GbE, OC192/STM64, SATA 6 Gbit/s, PCI Express II, 4 GFC, XAUI, SATA 3 Gbit/s, OTU1, PCI Express I, OC48/STM16, 2 GFC, SATA 1.5 Gbit/s, GbE, 1 GFC, OC12/STM4, OC3/STM1	
	Input data	PRBS/Data/Zero-Sub/Mixed/Sequence NRZ (equivalent to mark ratio of 1/2)	

Table 1.3.1-1 Specifications (Cont'd)

Item		Specifications	Remarks
Clock Recovery (Cont'd)	Clock polarity switching	POS and NEG can be set. (when MU181040A-x30 is not installed)	
	Maximum length of successive 0	72 bits (Zero-Sub 15 stages, polarity: POS or NEG)	
	Lock range	±500 ppm (at 9.8 to 12.5 Gbit/s, 4.9 to 6.25 Gbit/s), ±100 ppm (at 4.25 Gbit/s)	
Recovered clock	Output count	1	
	Output amplitude	0.55 Vp-p ±0.15 V (at 12.5 GHz)	
	Duty	50 ±15%	
	Termination	50 Ω/GND	
	SSB phase noise	70 dBc/Hz Typ. at 10-kHz offset (2.488/4.25/9.95 GHz)	
	Jitter	<45 ps (p-p) at 2.488 Gbit/s <35 ps (p-p) at 4.25 Gbit/s <20 ps (p-p) at 9.953 Gbit/s (0.25 V (p-p) input PRBS31)	
	Jitter tolerance	2.488 Gbit/s Mask 15 UI (10 to 600 Hz modulation) 15 to 1.5 UI (600 Hz to 6 kHz modulation) 1.5 UI (6 to 100 kHz modulation) 1.5 to 0.15 UI (100 kHz to 1 MHz modulation) 0.15 UI (1 to 80 MHz modulation) 4.25 Gbit/s 0.67 UI Typ. (170 kHz modulation) 9.953 Gbit/s Mask 15.2 UI (10 to 2 kHz modulation) 15.2 to 1.7 UI (2 to 17.9 kHz modulation) 1.7 UI (17.9 to 400 kHz modulation) 1.7 to 0.17 UI (400 kHz to 4 MHz modulation) 0.17 UI (4 to 8 MHz modulation) 0.17 to 0.05 UI (8 to 27.2 MHz modulation) 0.05 UI (27.2 to 80 MHz modulation)	When MU181040A-x20 and x30 are installed
	Connector	SMA	
Clock phase variable	Phase variable range	In the case of 2 or 4 Ch Combination: –1000 to +1000 mUI, in 1-mUI steps In the case of Channel Synchronization: –64 000 to +64 000 mUI, in 1-mUI steps	When MU181040A-x30 is installed
	Phase setting error	Typ. 20 mUIp-p mUI (After executing calibration)	
Auto Adjust Auto Search	Input Format	NRZ (when there is at least one transit bit for every 128 bits, the number of rising/falling edge ratio relative to Pattern Length is 1:5 or more, and the mark ratio is from 1/8 to 7/8)	
	Input Sensitivity	Typ. 200 mVp-p (25°C ±5°C)	

Table 1.3.1-1 Specifications for MU181040A (Cont'd)

Item		Specifications	Remarks
Jitter	Jitter tolerance mask		When MU181040A-x30 is installed

Fc [GHz]	Fm1 [Hz]	Fm2 [Hz]	Fm3 [Hz]
6.4 < Fc ≤ 12.5	220	4 M	80 M
3.2 < Fc ≤ 6.4	110	2 M	40 M
1.6 < Fc ≤ 3.2	55	1 M	20 M
0.8 < Fc ≤ 1.6	27.5	500 k	10 M
0.1 ≤ Fc ≤ 0.8	13.75	250 k	5 M

Measurement conditions

- "Internal" is selected for the modulation of the MU181000A 12.5 GHz Synthesizer (with Option 001 installed) or MU181000B 12.5 GHz 4 port Synthesizer (with Option 001 installed) (hereinafter referred to as MU181000A/B).
- The MU181020A (with Option 002 installed) is used.
- Measurement pattern: PRBS $2^{31} - 1$

Table 1.3.1-1 Specifications for MU181040A (Cont'd)

Item		Specifications	Remarks
Jitter (continued)	Jitter tolerance (80 MHz or higher modulation)		When MU181040A-x20 and x30 are installed

Fc [GHz]	FM Frequency [Hz]	Jitter Amplitude [Uip-p] (Max.)
11.3 < Fc ≤ 12.5	250 M to 1 G	0.1
	80 to 250 M	0.22
8.5 < Fc ≤ 11.3	80 M to 1 G	0.22
8.0 < Fc ≤ 8.5	500 M to 1 G	0.1
	80 to 500 M	0.22
4.0 < Fc ≤ 11.3	80 M to 1 G	0.22
2.4 < Fc ≤ 4.0	80 to 500 M	0.22
1.4 < Fc ≤ 2.4	80 to 100 M	0.22

Measurement conditions:
- "External" is selected for the modulation of the MU181000A/B (with Option 001 installed).
- The MU181020A (with Option 002 installed) is used.
  In this event, Fc ≤ 1.4 GHz and Fm3 of the jitter tolerance mask above must be as follows:

Fc [GHz]	Fm3 [Hz]
0.65 < Fc ≤ 1.4	20 M
0.4 < Fc ≤ 0.65	10 M
0.1 ≤ Fc ≤ 0.4	5 M

- Measurement pattern: PRBS $2^{31} – 1$
- Use Recovered Clock at the clock recovery operation frequency (except 4.25 GHz) of the MU181040A (with Option x20 installed) (At other frequencies, use External input clock to assure the above performance).
- Ambient temperature: 25 ±5°C

Table 1.3.1-1 Specifications for MU181040A (Cont'd)

Item		Specifications	Remarks
Size	Dimension	234 mm(W) × 21 mm(H) × 175 mm(D) (with Compact-PCI 1 slot but excluding protrusions)	
	Mass	2.5 kg max. (including options)	
Environmental performance	Operation temperature	+5 to +40°C (ambient temperature around equipment when installed in the mainframe)	
	Storage temperature	–20 to +60°C (Recommended storage temperature range: +5 to +30°C)	

1.3.2 Specifications for MU181040B

Table 1.3.2-1 Specifications for MU181040B

Item		Specifications	Remarks
Operating frequency range		0.1 to 14 GHz (When MU181040B-002 is installed) 0.1 to 14.05 GHz (When MU181040B-002 and 003 are installed.) 0.1 to 14.1 GHz (When MU181040B-002 and 005 are installed.)	
Clock source		External clock and Recovered clock can be set.	When MU181040B -x20 is installed
Rated frequency selection		10GFC over FEC, 10GbE over FEC, OTU2, G975 FEC, 10GFC, 10GbE, OC192/STM64, SATA 6Gb/s, PCI Express II, 4GFC, XAUI, SATA 3Gb/s, OTU1, PCI Express I, OC48/STM16, 2GFC, SATA1.5Gb/s, GbE, 1GFC, OC12/STM4, OC3/STM1 can be set.	
Pattern Sequence		Repeat/Burst	
PRBS	Pattern length	$2^n - 1$ (n = 7, 9, 10, 11, 15, 20, 23, 31)	
	Mark ratio	1/2, 1/4, 1/8, 0/8, 1/2 INV, 3/4, 7/8, 8/8	
	Number of AND bit shifts at the mark ratio	1 bit/3 bits (at 1/4, 3/4, 7/8, 1/8)	
Zero Substitution	Pattern sequence	2^n or $2^n–1$	
	Additional Bit	1 or 0 (when 2^n is set for Pattern sequence)	
	Pattern length	2^n (n = 7, 9, 10, 11, 15, 20, 23) $2^n–1$ (n = 7, 9, 10, 11, 15, 20, 23)	
	Successive-zeros bit length	1 to “pattern length – 1” bits can be inserted.	
Data	Pattern length	2 to 134 217 728 bits, in 1-bit steps In the case of 2 Ch Combination: 4 to 268 435 456 bits, in 2-bit steps In the case of 4 Ch Combination: 8 to 536 870 912 bits, in 4-bit steps	

Table 1.3.2-1 Specifications for MU181040B (Cont'd)

Item		Specifications	Remarks
Mixed	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 2 Ch Combination 4 for 4 Ch Combination d) (Row Length – Data Length) × Number of blocks ≥ 2^31(2147483648)	
	Pattern	Data	
	Pattern Length	Data length: 512 to 134 217 728 bits, in 1-bit steps In the case of 2 Ch Combination: 1 024 to 268 435 456 bits, in 2-bit steps (Data) In the case of 4 Ch Combination: 2 048 to 536 870 912 bits, in 4-bit steps (Data) PRBS length: 2^n–1 (n = 7, 9, 10, 11, 15, 20, 23, 31)	
	Row Length	768 to 2 281 701 376 bits, in 128-bit steps In the case of 2 Ch Combination: 1 536 to 4 563 402 752 bits, in 256-bit steps In the case of 4 Ch Combination: 3 072 to 9 126 805,504 bits, in 512-bit steps	

Table 1.3.2-1 Specifications for MU181040B (Cont'd)

Item		Specifications	Remarks
Mixed (continued)	Number of rows	1 to the smallest number among a to c, below, in 1-row steps a) 16 b) INT (128 Mbits × 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 2 Ch Combination 4 for 4 Ch Combination	
Sequence	Block number	1 to 128 max.	
	Block length	16 384 to 1 048 576 bits, in 128-bits steps	
	Loop time	1 to 1 024 times, in 1-time steps or repeat	
	Match Pattern	4 to 64 bits per pattern A or B, in 1-bit steps (Settable for each block)	
Block Window		On/Off can be set.	
Bit Window		On/Off can be set.	
External Mask		On/Off can be set.	
Measurement			
Measurement types	Error Rate	0.0001E – 18 to 1.0000E – 00	
	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	100.000 to 14 000.000 MHz (When MU181040B-002 is installed) 100.000 to 14 050.000 MHz (When MU181040B-003 is installed) 100.000 to 14 100.000 MHz (When MU181040B-005 is installed)	
	Frequency measurement accuracy	±1 ppm ±1 kHz(when the input CK signal and DCS board 10 MHz are calibrated correctly)	
	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	
	CR Unlock Interval	0 to 9999999, 1.0000E07 to 9.9999E17	

Table 1.3.2-1 Specifications for MU181040B (Cont'd)

Item		Specifications	Remarks
Gating	Time, Clock Count, Error Count, and Block Count can be set.		
	Time	1 second to 99 days 23 hours 59 minute 59 seconds	
	Clock Count	1×10^n (n = 4 to 16)	
	Error Count	1×10^n (n = 4 to 16)	
	Block Count	1×10^n (n = 2 to 14)	
	Gating Cycle	Repeat, Single, and Untimed can be set.	
	Current	On/Off can be set.	
		Progressive/Immediate can be set.	
		100-ms/200-ms interval can be set.	
Auto Sync	On/Off can be set.		
	Synchronization threshold	INT, 1×10^{-n} (n = 2, 3, 4, 5, 6, 7, 8)	
Sync Control	Frame ON, Frame OFF, Quick, and Fast can be set. When Frame ON, Frame Length/Frame Mask/Frame Position are valid.		
	Frame length	4 to 64 bits (in 4-bit steps)	
	Frame mask	Available	
	Frame Position	1 to Pattern Length–Frame Length + 1,1 bit Step In the case of 2 Ch Combination: 1 to 1+2n, in 2-bit steps Maximum value of n = INT((Pattern Length – Frame Length)/2) In the case of 4 Ch Combination: 1 to 1+4n, in 4-bit steps Maximum value of n = INT((Pattern Length – Frame Length)/4)	
Error alarm conditions	Error detection mode	Total, Insertion/Omission, or Transition/Non Transition In the case of Combination: Transition/Non Transition cannot be selected	
	EI/EFI interval	1, 10, 100 ms, 1 s	
	Error performance	Available	
Capture function	Number of blocks	1, 2, 4, 8, 16, 32, 64, 128	
	Block length	1 Mbits to 128 Mbits 2 to 256 Mbits for 2 Ch Combination 4 to 512 Mbits for 4 Ch Combination	
Automatic measurement function	ISI analysis	Available. Number of blocks: 64 In the case of 2 Ch Combination, the number of blocks at the lowest layer is 128. In the case of 4 Ch Combination, the number of blocks at the lowest layer is 256.	
	Eye margin	Available	
	Eye diagram	Available	
	Q Analysis	Available	
	Bathtub	Available	

Table 1.3.2-1 Specifications for MU181040B (Cont'd)

Item		Specifications	Remarks
Burst measurement function	Source	Internal, External-Enable, External-Trigger	
	Burst Cycle	25 600 to 2 147 483 648 bits (in 128-bit steps) In the case of 2 Ch Combination: 51 200 to 4 294 967 296 bits, in 256-bit steps In the case of 4 Ch Combination: 102 400 to 8 589 934 592 bits, in 512-bit steps	
	Enable Period	Internal 12 800 to 2 147 483 136 bits, in 128-bit steps Other than Internal 12 800 to 2 147 483 520 bits, in 128-bit steps In the case of 2 Ch Combination: Internal 25 600 to 4 294 966 272 bits, in 256-bit steps Other than Internal 25 600 to 4 294 967 040 bits, in 256-bit steps In the case of 4 Ch Combination: Internal 51 200 to 8 589 932 544 bits, in 512-bit steps Other than Internal 51 200 to 8 589 934 080 bits, in 512-bit steps	
	Delay	Internal 0 to 2 147 483 648 bits, in 16-bit steps Other than Internal 0 to 2 147 483 584 bits, in 16-bit steps In the case of 2 Ch Combination: Internal 0 to 4 294 967 296 bits, in 32-bit steps Other than Internal 0 to 4 294 967 168 bits, in 32-bit steps In the case of 4 Ch Combination: Internal 0 to 8 589 934 592 bits, in 64-bit steps Other than Internal 0 to 8 589 934 336 bits, in 64-bit steps	

Table 1.3.2-1 Specifications for MU181040B (Cont'd)

Item		Specifications	Remarks
Data input	Number of inputs	2 (Data/ $\overline{\text{Data}}$ Differential)	When MU181040B-002 is installed
	Input signal format	NRZ	
	Input condition	Single-ended, Differential 50 Ω, and Differential 100 Ω can be set. Data and $\overline{\text{Data}}$ can be set.	
	Input amplitude	0.1 to 2.0 Vp-p (when Single-ended is selected)	
	Threshold voltage	Independent, Tracking, and Alternate can be set. –3.500 to +3.300 V (in 1 mV steps) (Tracking/Independent) –3.000 to +3.000 V (in 1 mV steps) (Alternate)	
	Input sensitivity	10 mVp-p Typ. (at 10 or 12.5 Gbit/s, Single-ended input, PRBS: $2^{31}-1$, mark ratio: 1/2, 20 to 30°C) 20 mVp-p Typ. (at 14 Gbit/s, 14.05Gbit/s*1, 14.1Gbit/s*2, Single-ended input, PRBS: $2^{31}-1$, mark ratio: 1/2, 20 to 30°C)	
	Phase margin	50 ps Typ. at 14 Gbit/s, 14.05Gbit/s*1, 14.1Gbit/s*2 60 ps Typ. at 12.5 Gbit/s 80 ps Typ. at 10 Gbit/s (at Single-ended input, PRBS: $2^{31}-1$, mark ratio: 1/2)	
	Termination voltage	–2.50 to 3.50 V, 10 mV step (50 Ω/when Variable setting, load current <60 mA)	
	Termination	NECL, PCML, LVPECL, GND, Variable (–2.5 to +3.5 V)	
	Connector	K	
Clock input	Number of input	1 (Single-ended)	
	Input waveform	Rectangular wave (<0.5 GHz), Duty: 50%, Rectangular or sine wave (≥0.5 GHz), Duty: 50%	
	Input amplitude	0.25 to 1.5 Vp-p	
	Termination	50 Ω/GND, 50 Ω/Variable	
	Termination voltage	–2.50 to +3.50 V (in 10 mV steps) (50 Ω, when set to Variable, load current <60 mA)	
	Termination	NECL, PCML, LVPECL, GND, Variable (–2.5 to +3.5 V)	
	Connector	SMA	

*1: When MU181040B-003 is installed.

*2: When MU181040B-005 is installed.

Table 1.3.2-1 Specifications for MU181040B (Cont'd)

Item		Specifications	Remarks
AUX output	Number of outputs	1	
	Output Signal Selection	1/N Clock, Pattern Sync, Sync Gain, Error Output	
	Output signal	1/N: N=8, 9, 10 … 510, 511	
	Pattern Sync		
	When PRBS, Data or Zero-sub is set	Position: 1 to {(Least common multiple of Pattern Length*3 and 64) –79}, in 16-bit steps. The maximum settable number is 68 719 476 657. In the case of 2 Ch Combination: 1 to {(Least common multiple of Pattern Length*3 and 128) –159}, in 32-bit steps. The maximum settable number is 137 438 953 313. In the case of 4 Ch Combination: 1 to {(Least common multiple of Pattern Length*3 and 256) –319}, in 64-bit steps. The maximum settable number is 274 877 906 625.	
	When Mixed Data is set	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	
	When Sequence is set	Block No. setting: 1 to Block No. set for Sequence Pattern, in single steps	
		Position: 1 to {(Least common multiple of Pattern Length*3 and 64) –79}, in 16-bit steps.	
	Output level	0/–1 V H: –0.25 to 0.05 V L: –1.10 to –0.80 V	
	Impedance	50 Ω/GND	
	Connector	SMA	

*3: At Independent, when the pattern length is 127 bits or less, specify the length as an integer multiple so that it becomes 128 bits or more.
At 2 Ch Combination, when the pattern length is 255 bits or less, specify the length as an integer multiple so that it becomes 256 bits or more.
At 4 Ch Combination, when the pattern length is 511 bits or less, specify the length as an integer multiple so that it becomes 512 bits or more.

Table 1.3.2-1 Specifications for MU181040B (Cont'd)

Item		Specifications	Remarks
AUX input	Number of inputs	1	
	Input signal	In the case of Combination, input only to Master Module is enabled. Burst: External-Trigger (Data is enabled at rising edge detection) External-Enable (L: Data disabled, H: Data output) External Mask: (L: Measurement masked, H: Measurement) Capture External Trigger: (Start capture at rising edge detection)	
	Minimum pulse width	1/64 of Data rate	
	Input level	0/–1 V H: –0.25 to 0.05 V L: –1.10 to –0.80 V	
	Termination	50 Ω/GND	
	Connector	SMA	
Monitor output	Number of output	2 (Data monitor, $\overline{\text{Data}}$ monitor)	
	Insertion loss	–6 dB (+ 1 dB/–2.5 dB), at 7 GHz. (Data Input to Data Monitor Output, $\overline{\text{Data}}$ Input to $\overline{\text{Data}}$ Monitor Output)	
	Termination	AC/50 Ω	
	Connector	SMA	
Clock Recovery	Operating bit rate	100 Mbit/s 125 to 200 Mbit/s (steps: 125, 140.6, 155.52, 156.3, 171.9, 187.5, 200 Mbit/s) 250 to 400 Mbit/s (steps: 250, 281.3, 312.5, 343.8, 375.0, 400 Mbit/s) 500 to 800 Mbit/s (steps: 500, 562.5, 622.08, 625.0, 687.5, 750.0, 800 Mbit/s) 1.0 to 1.6 Gbit/s (steps: 1.0, 1.0625, 1.125, 1.25, 1.375, 1.5, 1.6 Gbit/s) 2.0 to 3.2 Gbit/s (steps: 2.0, 2.125, 2.25, 2.48832, 2.5, 2.66606, 2.75, 3.0, 3.125, 3.2 Gbit/s) 4.25 Gbit/s, 4.9 to 6.25 Gbit/s (steps: 1 kbit/s), 9.8 to 12.5 Gbit/s (steps: 1 kbit/s)	When MU181040B-x20 is installed

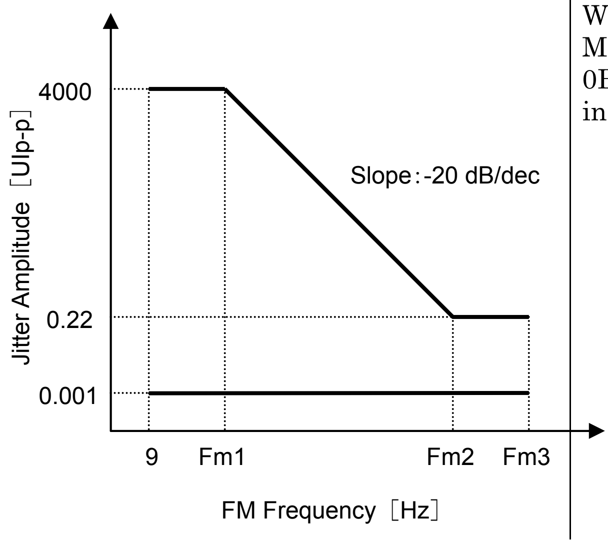
Table 1.3.2-1 Specifications for MU181040B (Cont'd)

Item		Specifications	Remarks
Clock Recovery (Cont'd)	Preset standards	10 GFC over FEC, 10 GbE over FEC, OTU2, G975 FEC, 10 GFC, 10 GbE, OC192/STM64, SATA 6 Gbit/s, PCI Express II, 4 GFC, XAUI, SATA 3 Gbit/s, OTU1, PCI Express I, OC48/STM16, 2 GFC, SATA 1.5 Gbit/s, GbE, 1 GFC, OC12/STM4, OC3/STM1	
	Input data	PRBS/Data/Zero-Sub/Mixed/Sequence NRZ (equivalent to mark ratio of 1/2)	
	Clock polarity switching	POS and NEG can be set. (when MU181040B-x30 is not installed)	
	Maximum length of successive 0	72 bits (Zero-Sub 15 stages, polarity: POS or NEG)	
	Lock range	±500 ppm (at 9.8 to 12.5 Gbit/s, 4.9 to 6.25 Gbit/s) ±100 ppm (at 4.25 Gbit/s)	
Recovered clock	Output count	1	
	Output amplitude	0.55 Vp-p ±0.15 V (at 12.5 GHz)	
	Duty	50 ±15%	
	Termination	50 Ω/GND	
	SSB phase noise	70 dBc/Hz Typ. at 10-kHz offset (2.488/4.25/9.95 GHz)	
	Jitter	<45 ps (p-p) at 2.488 Gbit/s <35 ps (p-p) at 4.25 Gbit/s <20 ps (p-p) at 9.953 Gbit/s (0.25 V (p-p) input PRBS31)	
	Jitter tolerance	2.488 Gbit/s Mask 15 UI (10 to 600 Hz modulation) 15 to 1.5 UI (600 Hz to 6 kHz modulation) 1.5 UI (6 to 100 kHz modulation) 1.5 to 0.15 UI (100 kHz to 1 MHz modulation) 0.15 UI (1 to 80 MHz modulation) 4.25 Gbit/s 0.67 UI Typ. (170 kHz modulation) 9.953 Gbit/s Mask 15.2 UI (10 to 2 kHz modulation) 15.2 to 1.7 UI (2 to 17.9 kHz modulation) 1.7 UI (17.9 to 400 kHz modulation) 1.7 to 0.17 UI (400 kHz to 4 MHz modulation) 0.17 UI (4 to 8 MHz modulation) 0.17 to 0.05 UI (8 to 27.2 MHz modulation) 0.05 UI (27.2 to 80 MHz modulation)	When MU181040B-x20 and x30 are installed
	Connector	SMA	

Table 1.3.2-1 Specifications for MU181040B (Cont'd)

Item		Specifications	Remarks
Clock phase variable	Phase variable range	In the case of 2 or 4 Ch Combination: –1000 to +1000 mUI, in 1-mUI step In the case of Channel Synchronization: –64 000 to +64 000 mUI, in 1-mUI steps	When MU181040B-x30 is installed
	Phase setting error	Typ. 20 mUIp-p mUI (After executing calibration)	
Auto Adjust Auto Search	Input Format	NRZ (when there is at least one transit bit for every 128 bits, the number of rising/falling edge ratio relative to Pattern Length is 1:5 or more, and the mark ratio is from 1/8 to 7/8)	
	Input Sensitivity	Typ. 200 mVp-p (25°C ±5°C)	

Table 1.3.2-1 Specifications for MU181040B (Cont'd)

<table>
<tr><th colspan="2">Item</th><th>Specifications</th><th>Remarks</th></tr>
<tr><td>Jitter</td><td>Jitter tolerance mask</td><td>


<table>
<tr><th>Fc [GHz]</th><th>Fm1 [Hz]</th><th>Fm2 [Hz]</th><th>Fm3 [Hz]</th></tr>
<tr><td>6.4 < Fc ≤ 14*</td><td>220</td><td>4 M</td><td>80 M</td></tr>
<tr><td>3.2 < Fc ≤ 6.4</td><td>110</td><td>2 M</td><td>40 M</td></tr>
<tr><td>1.6 < Fc ≤ 3.2</td><td>55</td><td>1 M</td><td>20 M</td></tr>
<tr><td>0.8 < Fc ≤ 1.6</td><td>27.5</td><td>500 k</td><td>10 M</td></tr>
<tr><td>0.1 ≤ Fc ≤ 0.8</td><td>13.75</td><td>250 k</td><td>5 M</td></tr>
</table>

*: When installing the MU181020B-003, the upper frequency limit is 14.05 GHz can be used.
When installing the MU181020B-005, the upper frequency limit is 14.1 GHz can be used.

Measurement conditions

• "Internal" is selected for the modulation of the MU181000A 12.5 GHz Synthesizer (with Option 001 installed) or MU181000B 12.5 GHz 4 port Synthesizer (with Option 001 installed) (hereinafter referred to as MU181000A/B).

• The MU181020B (with Option 002 installed) is used.

• Measurement pattern: PRBS $2^{31} – 1$
</td><td>When MU181040B-x30 is installed</td></tr>
</table>

Table 1.3.2-1 Specifications for MU181040B (Cont'd)

Item		Specifications	Remarks
Jitter (continued)	Jitter tolerance (80 MHz or higher modulation)		When MU181040B-x20 and x30 are installed

Fc [GHz]	FM Frequency [Hz]	Jitter Amplitude [Uip-p] (Max.)
11.3 < Fc ≤ 12.5	250 M to 1 G	0.1
	80 to 250 M	0.22
8.5 < Fc ≤ 11.3	80 M to 1 G	0.22
8.0 < Fc ≤ 8.5	500 M to 1 G	0.1
	80 to 500 M	0.22
4.0 < Fc ≤ 11.3	80 M to 1 G	0.22
2.4 < Fc ≤ 4.0	80 to 500 M	0.22
1.4 < Fc ≤ 2.4	80 to 100 M	0.22

Measurement conditions:

- "External" is selected for the modulation of the MU181000A/B (with Option 001 installed).
- The MU181020B (with Option 002 installed) is used.

In this event, Fc ≤ 1.4 GHz and Fm3 of the jitter tolerance mask above must be as follows:

Fc [GHz]	Fm3 [Hz]
0.65 < Fc ≤ 1.4	20 M
0.4 < Fc ≤ 0.65	10 M
0.1 ≤ Fc ≤ 0.4	5 M

- Measurement pattern: PRBS $2^{31} - 1$
- Use Recovered Clock at the clock recovery operation frequency (except 4.25 GHz) of the MU181040A (with Option x20 installed) (At other frequencies, use External input clock to assure the above performance).
- Ambient temperature: 25 ±5°C

Table 1.3.2-1 Specifications for MU181040B (Cont'd)

Item		Specifications	Remarks
Size	Dimension	234 mm(W) × 21 mm(H) × 175 mm(D) (with Compact-PCI 1 slot but excluding protrusions)	
	Mass	2.5 kg max. (including options)	
Environmental performance	Operation temperature	+15 to +35°C (ambient temperature around equipment when installed in the mainframe)	
	Storage temperature	–20 to +60°C (Recommended storage temperature range: +5 to +30°C)	

Chapter 2   Preparation before Use

This chapter describes preparations required before using the MU181040A.

2.1 Installation to Signal Quality Analyzer

For information on how to install the MU181040A 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 MU181040A. Otherwise, the MU181040A may be damaged.

⚠ CAUTION

- **When signals are input to the MU181040A, 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 MU181040A. If you open it and the MU181040A has failed or sufficient performance cannot be obtained, we may decline to repair the MU181040A.**
- **The MU181040A incorporates important parts and circuits, such as a hybrid IC, which are vulnerable to static electricity. Do not open the MU181040A to touch such components.**
- **The hybrid IC incorporated in the MU181040A 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 MU181040A.**
- **To protect the MU181040A 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 MU181040A.

3.1 Panel Layout

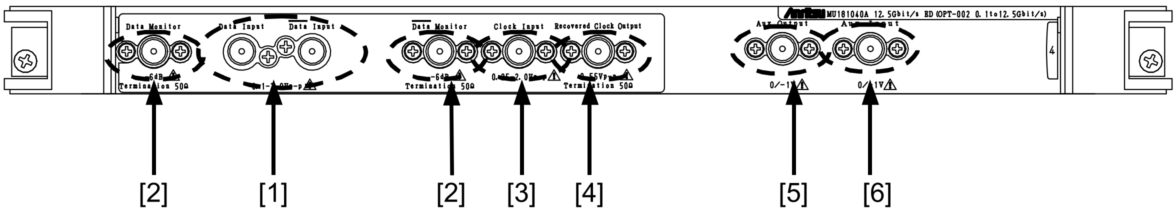


Figure 3.1-1 Panel layout

Table 3.1-1 Connectors on MU181040A panel

Symbol	Name	Description
[1]	Data and XData Input connectors	Input data signals. Support both differential and single-ended input signals.
[2]	Data Monitor and XData Monitor Output connectors	The Data and XData input signals are branched within the MU181040A, and then output from these connectors, respectively. Equipped for MU181040A-002.
[3]	Clock Input connector	Inputs clock signals. Equipped when MU181040A-002 is installed.
[4]	Recovered Clock Output connector	Outputs clock signals generated from data input signals. Equipped when MU181040A-x20 is installed.
[5]	Aux Output connector	Outputs auxiliary signals. 1/N clock, Pattern Sync, Error, and Sync Gain output signals can be selected.
[6]	Aux Input connector	Inputs auxiliary signals. External Mask, Burst, and Capture Ext. Trigger can be selected.

Note:

Connector [2], [3], [4] can be equipped when each option is installed as the description.

3.2 Inter-Module Connection

This section shows an example of connecting the MU181040A, MU181020A 12.5 Gbit/s Pulse Pattern Generator (hereinafter, referred to as “MU181020A”), and MU181000A 12.5 GHz Synthesizer (hereinafter, referred to as “MU181000A”) that are inserted into a mainframe.
Connect these modules using the procedure below and referring to Figure 3.2-1.

Note:

Avoid static electricity when handling the devices.

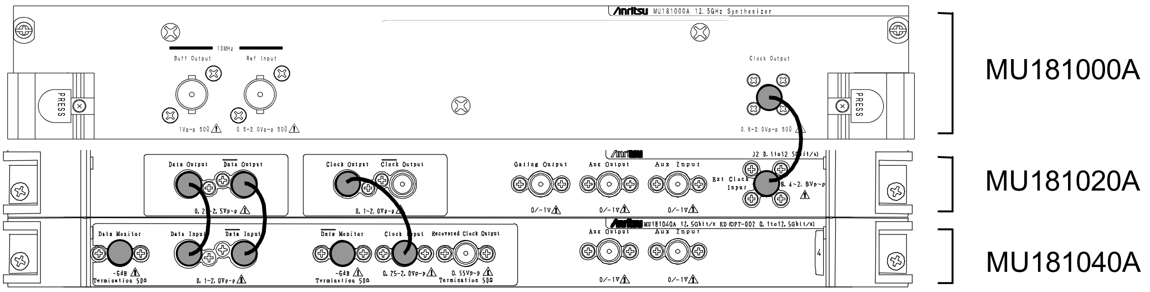


Figure 3.2-1 Inter-module connection example

1. Connect the 3-pin power cord of the mainframe to the power receptacle. Be sure to use the 3-pin power cord supplied with the mainframe and a 3-pin receptacle.
2. Connect the Clock Output connector of the MU181000A and the Ext. Clock Input connector of the MU181020A, using a coaxial cable.
3. Connect the Data Output connector of the MU181020A and the Data Input connector of the MU181040A, using a coaxial cable. Also connect the XData Output connector of the MU181020A and the XData Input connector of the MU181040A, using a coaxial cable.
4. Connect the Clock Output connector of the MU181020A and the Clock Input connector of the MU181040A, using a coaxial cable. This is required only when MU181040A-002 is installed.
5. Connect the provided terminator to the Data Monitor and XData Monitor Output connectors.
This is required only when MU181040A-002 is installed.
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.

⚠ 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.

Chapter 4 Configuration of Setup Dialog Box

This chapter describes the configuration of the MU181040A setup dialog box.

4.1 Configuration of Entire Setup Dialog Box

The configuration of the setup dialog box when the MU181040A is inserted into a mainframe is shown below.

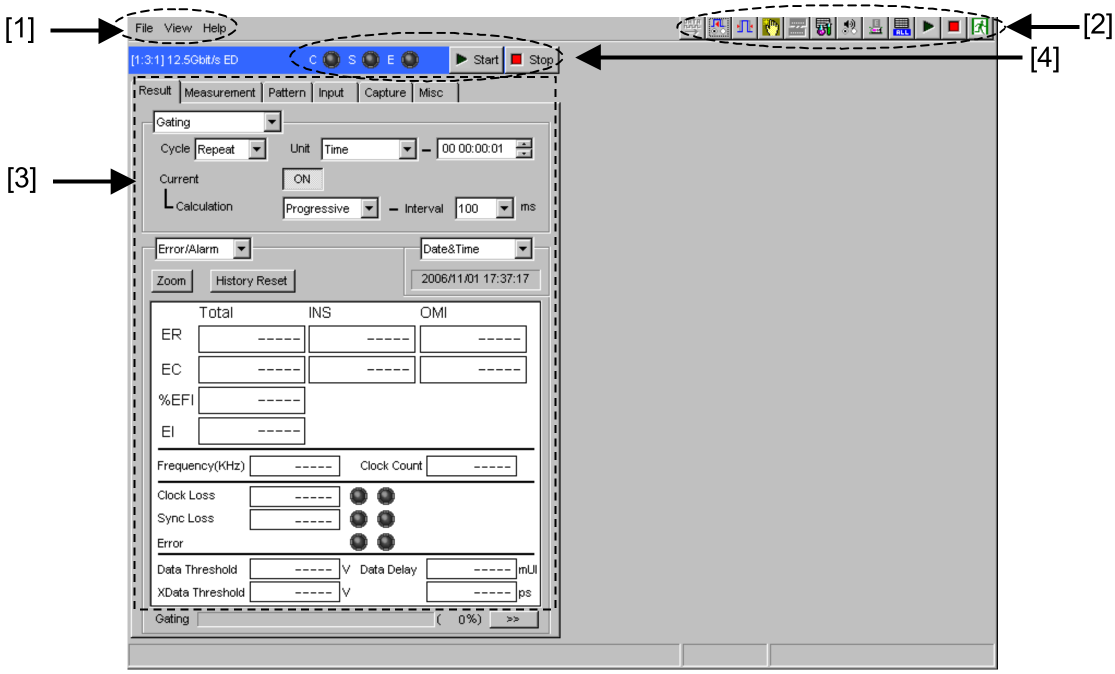


Figure 4.1-1 Configuration of entire setup dialog box for MU181040A

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.
[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

4.2 Operation Tab Windows

The MU181040A 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.
Misc	Other settings can be configured. Pattern generation method setting, auxiliary input/output selection, and other settings can be configured in this tab window.

Chapter 5 Operation Method

This chapter describes the functions provided in the tab windows on the module operation window of the MU181040A.

5.1 Displaying Measurement Result

Click the [Result] tab on the operation tab window to display measurement results. The Result tab window 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 MU181040A.

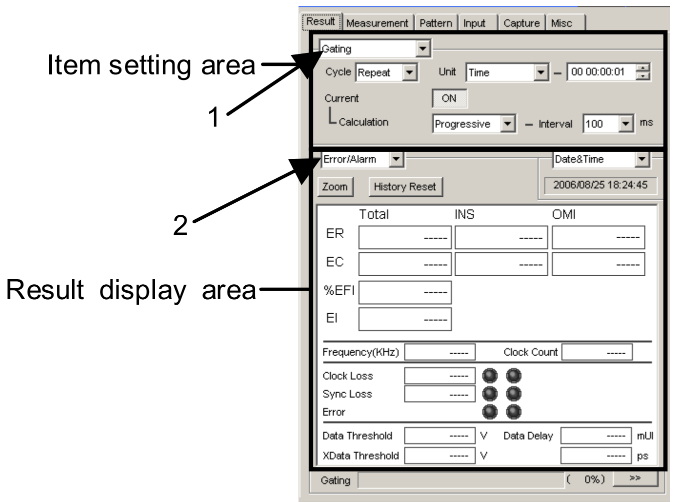


Figure 5.1-1 Result tab window

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

Figure 5.1-2 Item setting area

Table 5.1-1 Setting items in 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 above) in the result display area.

Figure 5.1-3 Result display area

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

Item	Description
Error/Alarm	Select to display the Error/Alarm measurement results.
Logging	Select to display the settings and results of logging.
Histogram	Select to display the settings and results of histogram.

5.1.1 Setting items when Gating is selected

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

Figure 5.1.1-1 Items when Gating is selected

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

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 (see 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 (see Figure 5.1.1-2). When "Untimed" is selected from the Cycle 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 (see Figure 5.1.1-2). When "Untimed" is selected from the Cycle list box, the value set by this parameter becomes invalid.

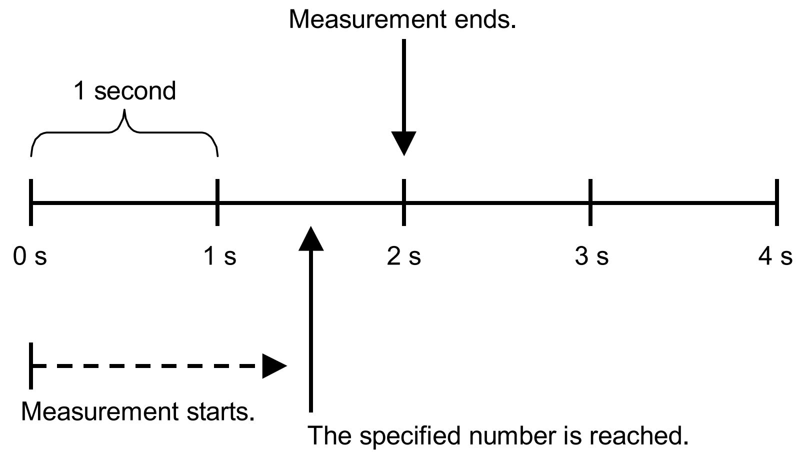


Figure 5.1.1-2 Measurement end timing

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

Table 5.1.1-2 Measurement operation setting

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.

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) or 200 (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.

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.

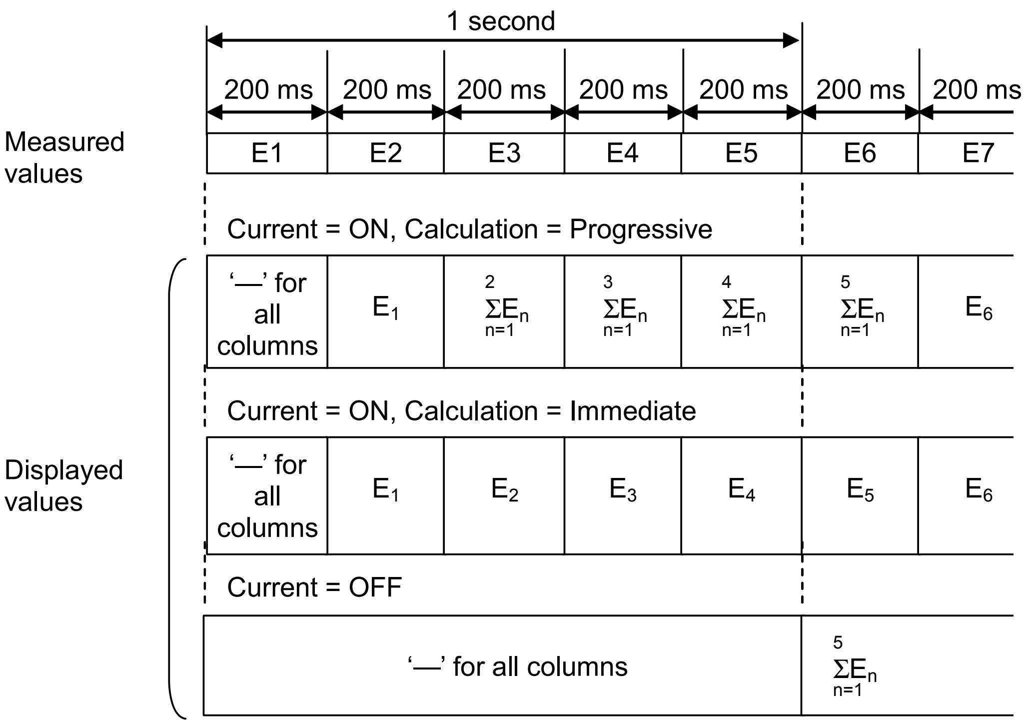


Figure 5.1.1-4 Relationship between measured values and displayed values

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).

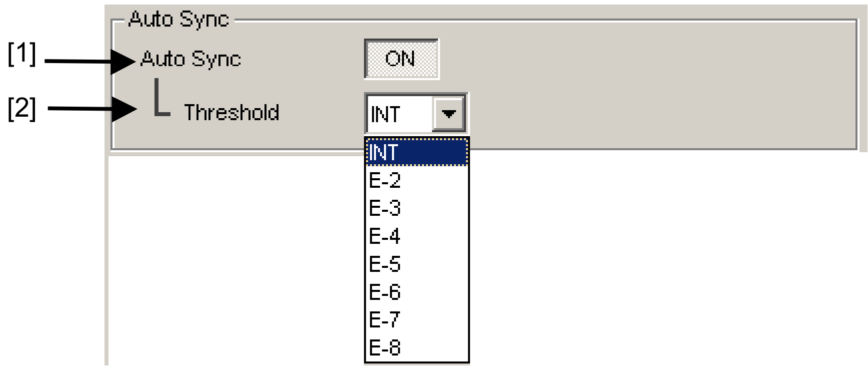


Figure 5.1.2-1　Items when Auto Sync is selected

[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, see 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, and PRBS part of Mixed Pattern	$2^n - 1$ (n = 7, 9, 10, 11, 15, 20, 23, 31)	$\frac{(256)\times 2{,}000}{(4{,}096)\times 5{,}000}$ $=\frac{1}{40}$ = 2.5 E – 2	$\frac{(256)}{(4{,}096)\times 4}$ $=\frac{1}{64}$ = 1.56 E – 2
Frame OFF	Zero-Substitution Data	2 to 16	$\frac{(256)\times 2{,}000}{(4{,}096)\times 5{,}000}$ $=\frac{1}{40}$ = 2.5 E – 2	$\frac{(256)}{(4{,}096)\times 4}$ $=\frac{1}{64}$ = 1.56 E – 2
		17 to 160	$\frac{(256)\times 400}{(4{,}096)\times 5{,}000}$ $=\frac{1}{200}$ = 5.0 E – 3	$\frac{(256)}{(4{,}096)\times 40}$ $=\frac{1}{640}$ = 1.56 E – 3
		161 to 1,600	$\frac{(256)\times 40}{(4{,}096)\times 5{,}000}$ $=\frac{1}{2{,}000}$ = 5.0 E – 4	$\frac{(256)}{(4{,}096)\times 400}$ $=\frac{1}{6{,}400}$ = 1.56 E – 4
		1,601 to 16,000	$\frac{(256)\times 4}{(4{,}096)\times 5{,}000}$ $=\frac{1}{20{,}000}$ = 5.0 E – 5	$\frac{(256)}{(4{,}096)\times 400}$ $=\frac{1}{64{,}000}$ = 1.56 E – 5
		16,001 to 80,000	$\frac{(256)\times 4}{(4{,}096)\times 25{,}000}$ $=\frac{1}{100{,}000}$ = 1.0 E – 5	$\frac{(256)}{(4{,}096)\times 10{,}000}$ $=\frac{1}{160{,}000}$ = 6.25 E – 6
		80,001 to 160,000	$\frac{(256)\times 4}{(4{,}096)\times 50{,}000}$ $=\frac{1}{200{,}000}$ = 5.0 E – 6	$\frac{(256)}{(4{,}096)\times 20{,}000}$ $=\frac{1}{320{,}000}$ = 3.13 E – 6

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 OFF (continued)	Zero-Substitution Data (continued)	160,001 to 320,000	$\frac{(256)\times 4}{(4{,}096)\times 100{,}000} = \frac{1}{400{,}000} = 2.5\ \mathrm{E}-6$	$\frac{(256)}{(4{,}096)\times 40{,}000} = \frac{1}{640{,}000} = 1.56\ \mathrm{E}-6$
		320,001 to 524,288	$\frac{(256)\times 4}{(4{,}096)\times 2} = \frac{1}{524{,}288} = 1.9\ \mathrm{E}-6$	$\frac{(256)}{(4{,}096)\times 80{,}000} = \frac{1}{1{,}280{,}000} = 7.81\ \mathrm{E}-7$
		524,289 to 1,048,576	$\frac{(256)\times 4}{(4{,}096)\times 2} = \frac{1}{1{,}048{,}576} = 9.54\ \mathrm{E}-7$	$\frac{(256)}{(4{,}096)\times 160{,}000} = \frac{1}{2{,}560{,}000} = 3.91\ \mathrm{E}-7$
		1,048,577 to 2,097,152	$\frac{(256)\times 4}{(4{,}096)\times 2} = \frac{1}{2{,}097{,}152} = 4.77\ \mathrm{E}-7$	$\frac{(256)}{(4{,}096)\times 320{,}000} = \frac{1}{5{,}120{,}000} = 1.95\ \mathrm{E}-7$
		2,097,153 to 4,194,304	$\frac{(256)\times 4}{(4{,}096)\times 2} = \frac{1}{4{,}194{,}304} = 2.38\ \mathrm{E}-7$	$\frac{(256)}{(4{,}096)\times 640{,}000} = \frac{1}{10{,}240{,}000} = 9.77\ \mathrm{E}-8$
		4,194,304 to 8,388,608	$\frac{(256)\times 4}{(4{,}096)\times 2} = \frac{1}{8{,}388{,}608} = 1.19\ \mathrm{E}-7$	$\frac{(256)}{(4{,}096)\times 1{,}280{,}000} = \frac{1}{20{,}480{,}000} = 4.88\ \mathrm{E}-8$
		8,388,609 to 16,777,216	$\frac{(256)\times 4}{(4{,}096)\times 2} = \frac{1}{16{,}777{,}216} = 5.98\ \mathrm{E}-8$	$\frac{(256)}{(4{,}096)\times 2{,}560{,}000} = \frac{1}{40{,}960{,}000} = 2.44\ \mathrm{E}-8$

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 OFF (continued)	Zero-Substitution Data (continued)	16,777,217 to 33,554,432	$\frac{(256)\times 4}{(4{,}096)\times 2}$ $=\frac{1}{33{,}554{,}432}$ $= 2.98\text{ E}-8$	$\frac{(256)}{(4{,}096)\times 5{,}120{,}000}$ $=\frac{1}{81{,}920{,}000}$ $= 1.22\text{ E}-8$
		33,554,433 to 67,108,864	$\frac{(256)\times 4}{(4{,}096)\times 2}$ $=\frac{1}{67{,}108{,}864}$ $= 1.49\text{ E}-8$	$\frac{(256)}{(4{,}096)\times 10{,}240{,}000}$ $=\frac{1}{163{,}840{,}000}$ $= 6.10\text{ E}-9$
		67,108,865 to 134,217,728	$\frac{(256)\times 4}{(4{,}096)\times 2}$ $=\frac{1}{134{,}217{,}728}$ $= 7.45\text{ E}-9$	$\frac{(256)}{(4{,}096)\times 20{,}480{,}000}$ $=\frac{1}{327{,}680{,}000}$ $= 3.05\text{ E}-9$
Frame ON, Quick	Mixed Data Part, Zero-Substitution Data	128 to 5,120	$\frac{(256)\times 200}{(4{,}096)\times 64{,}000}$ $=\frac{1}{5{,}120}$ $= 1.95\text{ E}-4$	$\frac{(256)}{(4{,}096)\times 400}$ $=\frac{1}{6{,}400}$ $= 1.56\text{ E}-4$
		5,121 to 10,240	$\frac{(256)\times 200}{(4{,}096)\times 128{,}000}$ $=\frac{1}{10{,}240}$ $= 9.77\text{ E}-5$	$\frac{(256)}{(4{,}096)\times 800}$ $=\frac{1}{12{,}800}$ $= 7.81\text{ E}-4$
		10,241 to 51,200	$\frac{(256)\times 200}{(4{,}096)\times 640{,}000}$ $=\frac{1}{51{,}200}$ $= 1.95\text{ E}-5$	$\frac{(256)}{(4{,}096)\times 4{,}000}$ $=\frac{1}{64{,}000}$ $= 1.56\text{ E}-5$
		51,201 to 102,400	$\frac{(256)\times 200}{(4{,}096)\times 1{,}280{,}000}$ $\frac{1}{102{,}400}$ $= 9.77\text{ E}-6$	$\frac{(256)}{(4{,}096)\times 8{,}000}$ $\frac{1}{128{,}000}$ $= 7.81\text{ E}-5$

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	Threshold error rate = $\left[\frac{\text{Error Count}}{\text{Clock Count}}\right]$ Sync Gain → Sync Loss
Frame ON, Quick (continued)	Mixed Data Part, Zero-Substitution Data (continued)	102,401 to 204,800	$\frac{(256)\times 200}{(4{,}096)\times 2{,}560{,}000} = \frac{1}{204{,}800} = 4.88\text{ E}-6$	$\frac{(256)}{(4{,}096)\times 16{,}000} = \frac{1}{256{,}000} = 3.91\text{ E}-6$
		204,801 to 307,200	$\frac{(256)\times 200}{(4{,}096)\times 3{,}840{,}000} = \frac{1}{307{,}200} = 3.26\text{ E}-6$	$\frac{(256)}{(4{,}096)\times 24{,}000} = \frac{1}{384{,}000} = 2.60\text{ E}-6$
		307,201 to 409,600	$\frac{(256)\times 200}{(4{,}096)\times 5{,}120{,}000} = \frac{1}{409{,}600} = 2.44\text{ E}-6$	$\frac{(256)}{(4{,}096)\times 32{,}000} = \frac{1}{512{,}000} = 1.95\text{ E}-6$
		409,601 to 524,288	$\frac{(256)\times 200}{(4{,}096)\times 6{,}553{,}600} = \frac{1}{524{,}288} = 1.91\text{ E}-6$	$\frac{(256)}{(4{,}096)\times 40{,}960} = \frac{1}{655{,}360} = 1.53\text{ E}-6$
		524,289 to 1,048,576	$\frac{(256)\times 200}{(4{,}096)\times 13{,}107{,}200} = \frac{1}{1{,}048{,}576} = 9.54\text{ E}-7$	$\frac{(256)}{(4{,}096)\times 81{,}920} = \frac{1}{1{,}310{,}720} = 7.63\text{ E}-7$
		1,048,577 to 2,097,152	$\frac{(256)\times 200}{(4{,}096)\times 262{,}144{,}000} = \frac{1}{2{,}097{,}152} = 4.77\text{ E}-7$	$\frac{(256)}{(4{,}096)\times 163{,}840} = \frac{1}{2{,}621{,}440} = 3.81\text{ E}-7$
		2,097,153 to 4,194,304	$\frac{(256)\times 200}{(4{,}096)\times 524{,}288{,}000} = \frac{1}{4{,}194{,}304} = 2.38\text{ E}-7$	$\frac{(256)}{(4{,}096)\times 327{,}680} = \frac{1}{5{,}242{,}880} = 1.91\text{ E}-7$

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 Gain → Sync Loss
Frame ON, Quick (continued)	Mixed Data Part, Zero-Substitution Data (continued)	4,194,305 to 8,388,608	$\frac{(256)\times 200}{(4{,}096)\times 104{,}876{,}000}$ $=\frac{1}{8{,}388{,}608}$ $= 1.19\ \text{E}-7$	$\frac{(256)}{(4{,}096)\times 655{,}360}$ $=\frac{1}{10{,}485{,}760}$ $= 9.54\ \text{E}-8$
		8,388,609 to 16,777,216	$\frac{(256)\times 200}{(4{,}096)\times 209{,}715{,}200}$ $=\frac{1}{16{,}777{,}216}$ $= 5.96\ \text{E}-8$	$\frac{(256)}{(4{,}096)\times 1{,}310{,}720}$ $=\frac{1}{20{,}971{,}520}$ $= 4.77\ \text{E}-8$
		16,777,217 to 33,554,432	$\frac{(256)\times 200}{(4{,}096)\times 419{,}430{,}400}$ $=\frac{1}{33{,}554{,}432}$ $= 2.98\ \text{E}-8$	$\frac{(256)}{(4{,}096)\times 2{,}621{,}440}$ $=\frac{1}{41{,}943{,}040}$ $= 2.38\ \text{E}-8$
		33,554,433 to 67,108,864	$\frac{(256)\times 200}{(4{,}096)\times 838{,}860{,}800}$ $=\frac{1}{67{,}108{,}864}$ $= 1.49\ \text{E}-8$	$\frac{(256)}{(4{,}096)\times 5{,}242{,}880}$ $=\frac{1}{83{,}886{,}080}$ $= 1.19\ \text{E}-8$
		67,108,865 to 134,217,728	$\frac{(256)\times 200}{(4{,}096)\times 1{,}677{,}721{,}600}$ $=\frac{1}{134{,}217{,}728}$ $= 7.45\ \text{E}-9$	$\frac{(256)}{(4{,}096)\times 10{,}485{,}760}$ $=\frac{1}{167{,}772{,}160}$ $= 5.98\ \text{E}-9$

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

Sync Control	Threshold error rate = $\left[\dfrac{\text{Error Count}}{\text{Clock Count}}\right]$	
	Sync Gain → Sync Loss	Sync Loss → Sync Gain
E-2	$\dfrac{(256)\times 2{,}000}{(4{,}096)\times 5{,}000}$ $=\dfrac{1}{40}$ $= 2.5\text{ E} - 2$	$\dfrac{(256)}{(4{,}096)\times 4}$ $=\dfrac{1}{64}$ $= 1.56\text{ E} - 2$
E-3	$\dfrac{(256)\times 2{,}000}{(4{,}096)\times 50{,}000}$ $=\dfrac{1}{400}$ $= 2.5\text{ E} - 3$	$\dfrac{(256)}{(4{,}096)\times 40}$ $=\dfrac{1}{640}$ $= 1.56\text{ E} - 3$
E-4	$\dfrac{(256)\times 2{,}000}{(4{,}096)\times 500{,}000}$ $=\dfrac{1}{4{,}000}$ $= 2.5\text{ E} - 4$	$\dfrac{(256)}{(4{,}096)\times 400}$ $=\dfrac{1}{6{,}400}$ $= 1.56\text{ E} - 4$
E-5	$\dfrac{(256)\times 2{,}000}{(4{,}096)\times 5{,}000{,}000}$ $=\dfrac{1}{40{,}000}$ $= 2.5\text{ E} - 5$	$\dfrac{(256)}{(4{,}096)\times 4{,}000}$ $=\dfrac{1}{64{,}000}$ $= 1.56\text{ E} - 5$
E-6	$\dfrac{(256)\times 2{,}000}{(4{,}096)\times 50{,}000{,}000}$ $=\dfrac{1}{400{,}000}$ $= 2.5\text{ E} - 6$	$\dfrac{(256)}{(4{,}096)\times 40{,}000}$ $=\dfrac{1}{640{,}000}$ $= 1.56\text{ E} - 6$
E-7	$\dfrac{(256)\times 2{,}000}{(4{,}096)\times 50{,}000{,}000}$ $=\dfrac{1}{4{,}000{,}000}$ $= 2.5\text{ E} - 7$	$\dfrac{(256)}{(4{,}096)\times 400{,}000}$ $=\dfrac{1}{6{,}400{,}000}$ $= 1.56\text{ E} - 7$
E-8	$\dfrac{(256)\times 2{,}000}{(4{,}096)\times 50{,}000{,}000}$ $=\dfrac{1}{40{,}000{,}000}$ $= 2.5\text{ E} - 8$	$\dfrac{(256)}{(4{,}096)\times 4{,}000{,}000}$ $=\dfrac{1}{64{,}000{,}000}$ $= 1.56\text{ E} - 8$

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).

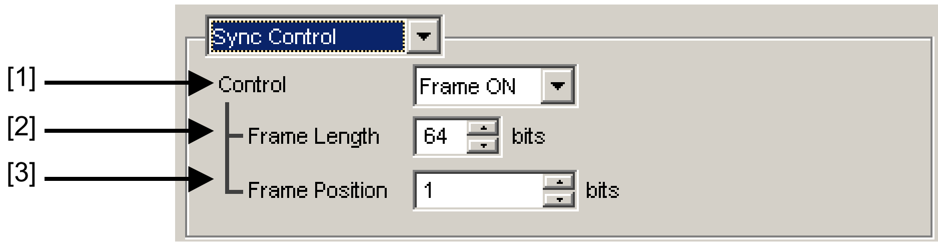


Figure 5.1.3-1 Items when Sync Control is selected

[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.
Frame OFF	Selects the synchronization method without frame detection. This can be selected when the test pattern is Zero-Substitution or Data. This is enabled when the length of the test pattern is short or when there is a pseudo-frame. Synchronization takes a long time 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.
Fast	Selects the fast synchronization method. This can be selected when the test pattern is Sequence. The data transmission timing from the MU181020A/B is internally monitored to establish synchronization.

The test pattern synchronization methods selectable from the Control list box vary depending on the test pattern selected in the Pattern tab window. See the Table 5.1.3-2.

Table 5.1.3-2 Synchronization method setting

Test Pattern	Description		
	Frame ON/OFF*	Quick	Fast
PRBS	Not available	Not available	Not available
Zero-Substitution	Available	Available	Not available
Data	Available	Available	Not available
Mixed	Available	Not available	Not available
Sequence	Not available	Not available	Available

*: When the test pattern is Data, Frame ON becomes invalid if the pattern length is less than 128 bits. When the test pattern is Mixed, only Frame ON is available.

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

***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:

- 1 to "(Length of pattern for frame detection) – (Frame Length)" in 1-bit steps.
- In case of 2 Ch 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 4 Ch 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 in the Pattern tab window. See 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.

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).

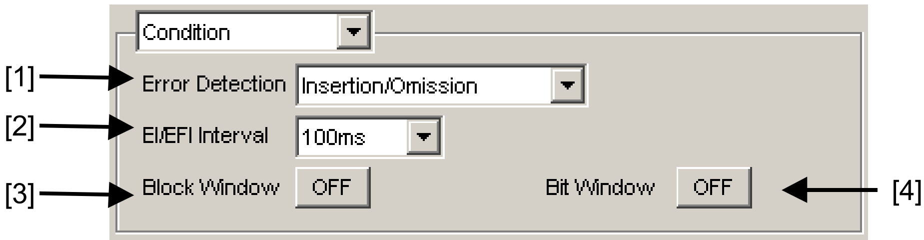


Figure 5.1.4-1 Items when Condition is selected

[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.

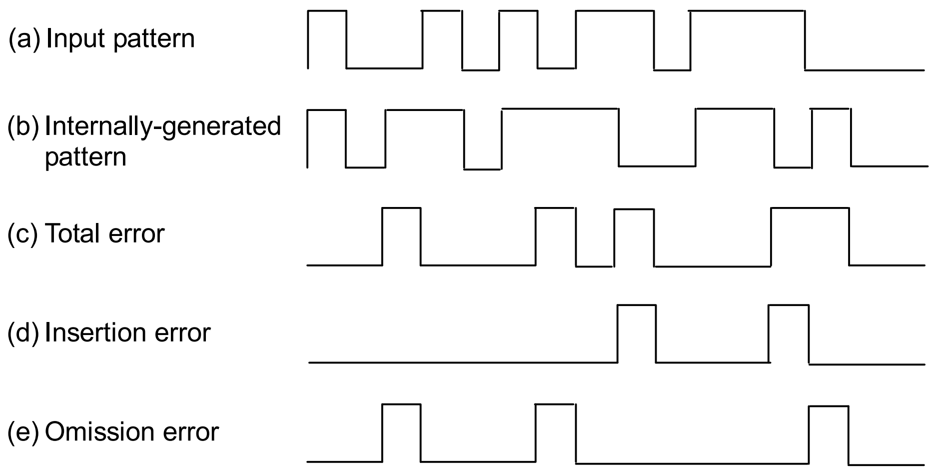


Figure 5.1.4-2 Error detection (Total, Insertion, and Omission errors)

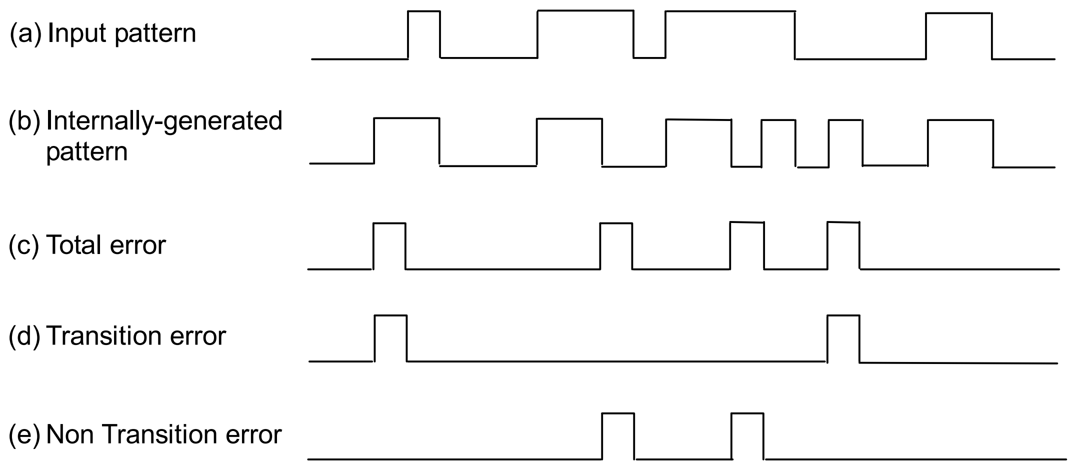


Figure 5.1.4-3 Error detection (Total, Transition, and Non Transition errors)

[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. "1" is applied if the interval counter value is not "0".
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. See Sections 5.3.7 "Mask selection" and 5.3.8 "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 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. See Sections 5.3.7 "Mask selection" and 5.3.8 "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).

The setting range for the setting items is restricted by the input conditions set in the Input tab window. See 5.4.2 “Input setting items (when MU181040A-002 and MU181040B-002 are installed)” for details.

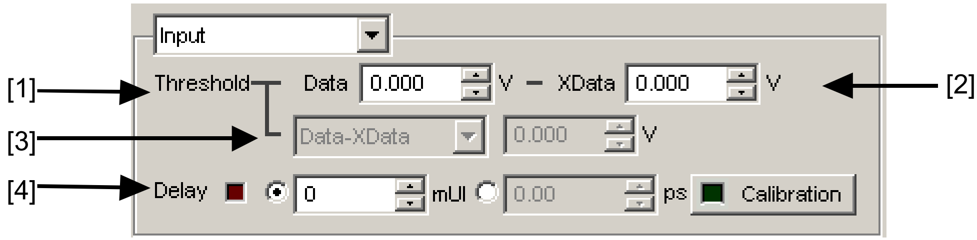


Figure 5.1.5-1 Items when Input is selected

[1], [2] Set the threshold voltage for Data input and XData input. The Data signal is input from the Data Input connector of the MU181040A, and the XData signal is input from the $\overline{\text{Data}}$ Input connector. Hereinafter, the settings for the $\overline{\text{Data}}$ Input connector are described as the settings for XData.

Table 5.1.5-1 Threshold setting

Option	Threshold Voltage Setting
When MU181040A-001 is installed	The threshold voltage can be set within the range from –0.350 to +0.350 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 0.700 V or less if “Differential 50 Ohm” or “Differential 100 Ohm” is selected in the Input tab window.
When MU181040A-002 is installed	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 “Differential 50 Ohm” or “Differential 100 Ohm” is selected in the Input tab window.
When MU181040B-002 is installed	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 “Differential 50 Ohm” or “Differential 100 Ohm” is selected in the Input tab window.

[3] Set the difference between the threshold voltages for Data and XData inputs.
This item is enabled when "Differential 50 Ohm" or "Differential 100 Ohm" is selected and "Alternate" is selected in the Input tab window.

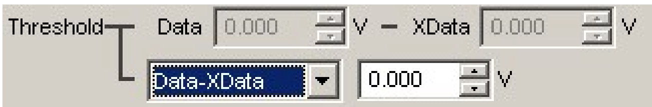


Figure 5.1.5-2 Input voltage threshold difference setting items

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] 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 1 mUI steps.
When either 2 Ch or 4 Ch Combination is installed, setting is supported from –64,000 to 64,000 in 1-mUI steps.

<When ps is selected>

A value can be set in 1 ps unit steps.
The setting range is equivalent to the range when the unit is mUI (–1000 to +1000 mUI), converted into ps units.

During 2 Ch Combination or 4 Ch Combination, the setting range is equivalent to the range when the unit is mUI (–64,000 to 64,000 mUI), converted into ps units.

Example:

Table 5.1.5-2 Clock phase setting (in ps units)

Frequency	**Setting range**	
	Normal	**2 Ch Combination 4 Ch Combination**
12.5 GHz	–80 to 80 ps	–5120 to 5120 ps
4.25 GHz	–235 to 235 ps	–15,040 to 15,040 ps
100 MHz	–10,000 to 10,000 ps	–640,000 to 640,000 ps

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 MU181040A 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).

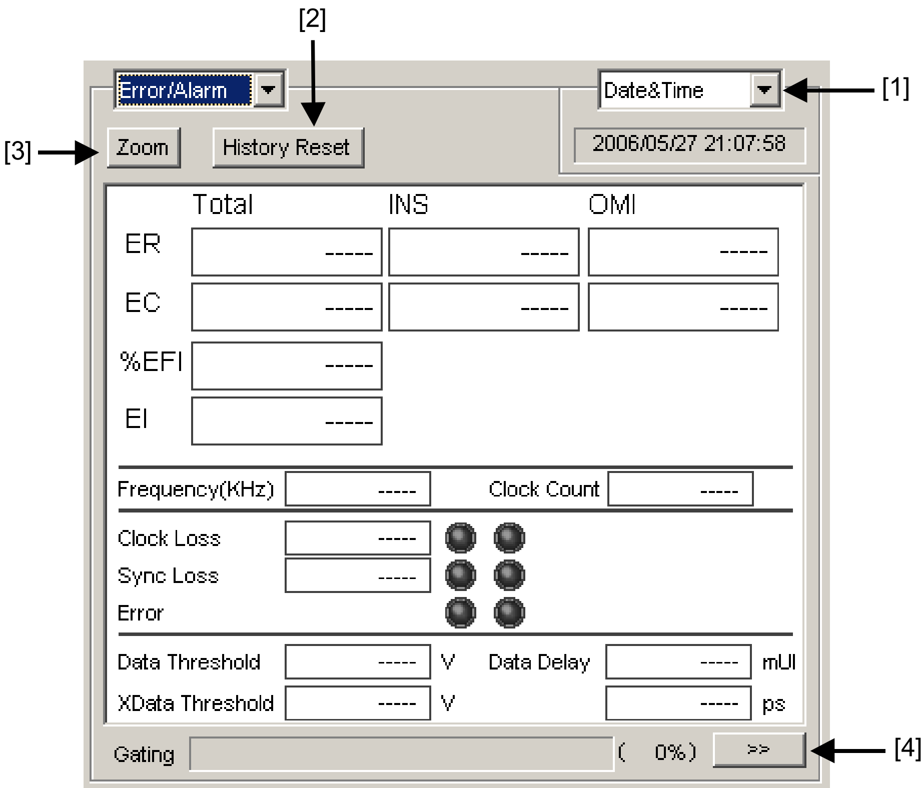


Figure 5.1.6-1 Items when Error/Alarm is selected

[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.

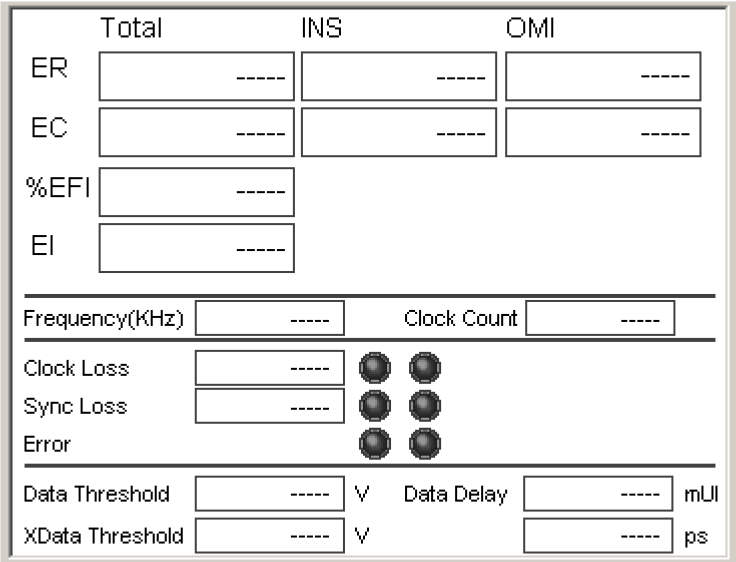


Figure 5.1.6-2 Items when Zoom is not selected

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 (see Section 5.1.4). Also, Clock Loss or CR Unlock is displayed depending on the selected clock.

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
CR Unlock		Displays the CR Unlock (clock recovery unlock) 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.

When the enlarged display is enabled (Zoom is selected), the items shown in Table 5.1.6-2 are displayed in the result display area with Error/Alarm selected.

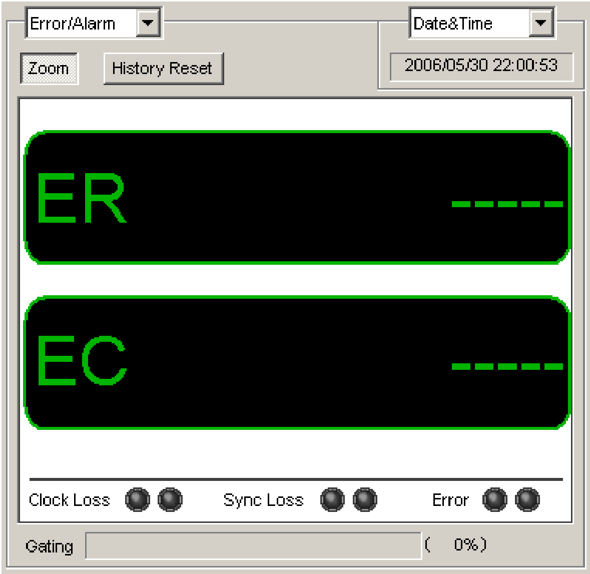


Figure 5.1.6-3 Items when Zoom is selected

Table 5.1.6-2 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
CR Unlock	Displays the CR Unlock (clock recovery unlock) 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] 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 5.1.6-3.

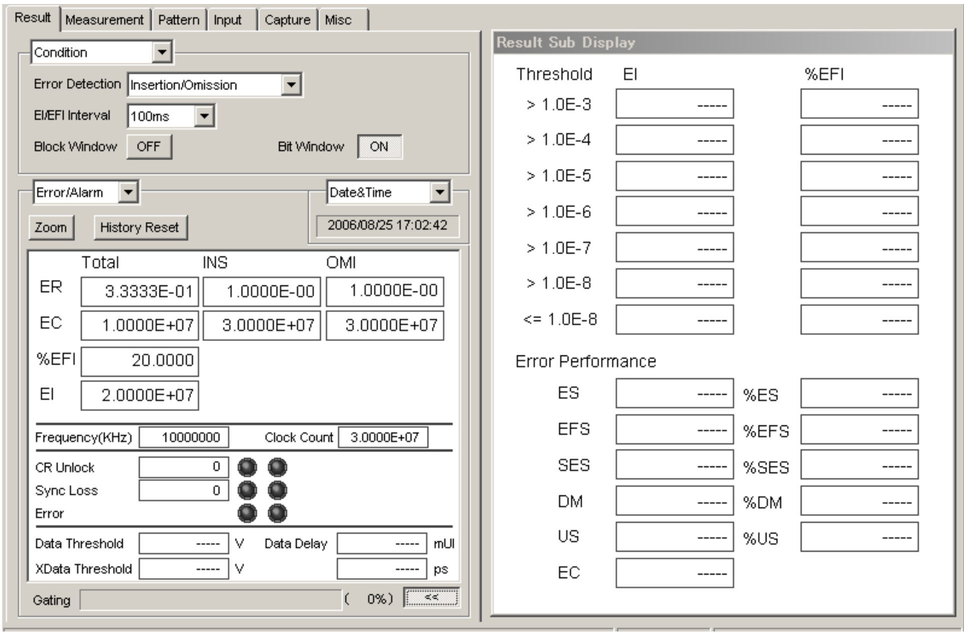


Figure 5.1.6-4 Result Sub Display window

Table 5.1.6-3 Items in Result Sub Display window

Item	Function
Threshold EI %EFI	Displays the threshold EI/%EFI and error performance measurement results.
>1.0E-3	
>1.0E-4	
>1.0E-5	
>1.0E-6	
>1.0E-7	
>1.0E-8	
<= .0E-8	
>1.0E-3	
Error Performance	
ES	
EFS	
SES	
DM	
US	

Table 5.1.6-3 Items in Result Sub Display window (Cont'd)

Item	Function
EC	Displays the threshold EI/%EFI and error performance measurement results.
%ES	
%EFS	
%SES	
%DM	
%US	

5.1.7 Setting items when Logging is selected

This section describes the setting items when Logging is selected from the list box in the result display area ("2" in Figure 5.1-1). With the logging function, the intermediate data for the items set in the Logging setup dialog box can be displayed.

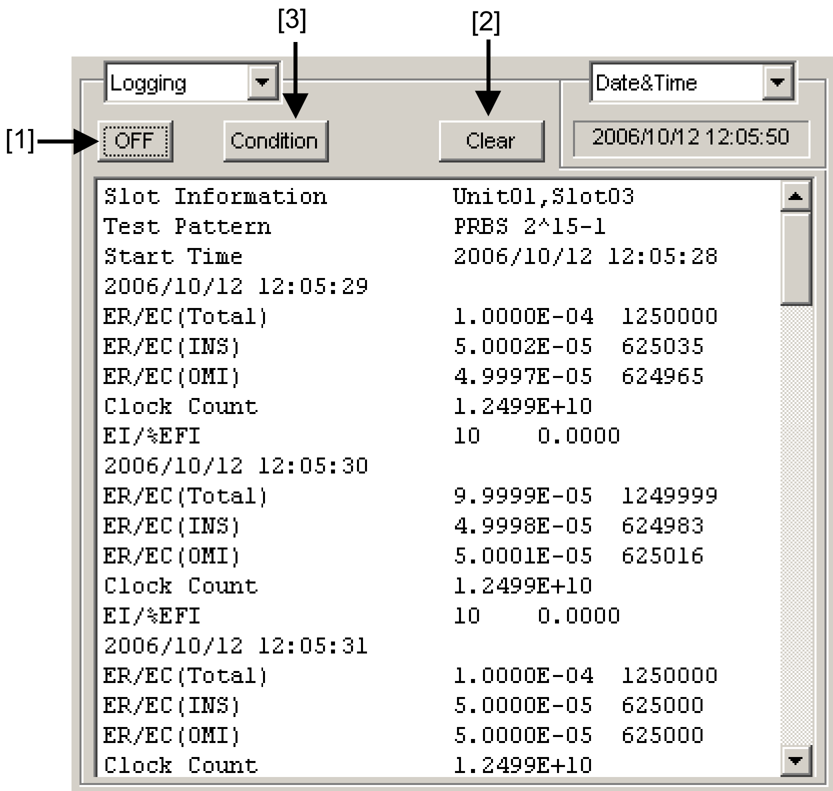


Figure 5.1.7-1 Items when Logging is selected

[1] Click to start/stop logging.

[2] Click to clear the logging results. When this button is clicked, the confirmation window for clearing is displayed.

[3] Click to open the Log Condition setup dialog box for setting the logging conditions.

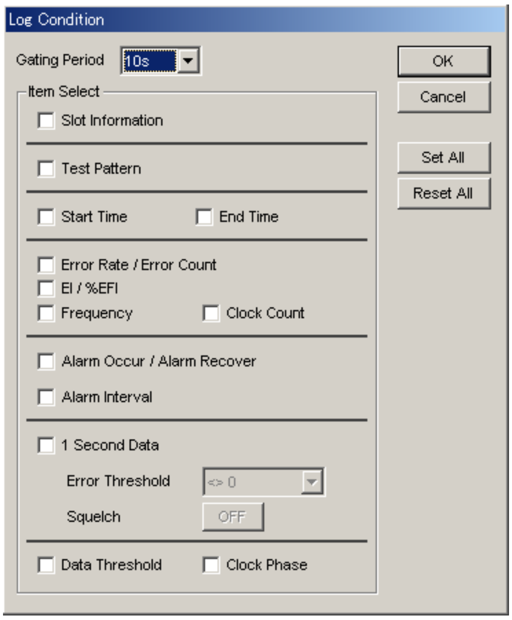


Figure 5.1.7-2 Log Condition setup dialog box

Table 5.1.7-1 Items in Log Condition setup dialog box

Item	Description
Gating Period	Sets the intermediate data logging interval to 10 s, 30 s, 1 min., 10 min., 30 min., or 1 hour.
Slot Information	Adds the slot information to the logging item.
Test Pattern	Adds the test pattern type to the logging item.
Start Time	Adds the measurement start time to the logging item.
End Time	Adds the measurement end time to the logging item.
Error Rate/Error Count	Adds the accumulated intermediate data (error rate and error count) to the logging item.
EI/%EFI	Adds the accumulated intermediate data (error interval rate and error free interval rate) to the logging item.
Frequency	Adds the frequency to the logging item.
Clock Count	Adds the clock count to the logging item.
Alarm Occur/Alarm Recover	Adds the recovery time from alarm (Clock Loss and Sync Loss) occurrence to the logging item.
Alarm Interval	Adds the accumulated intermediate data alarm (Clock Loss, CR Unlock, and Sync Loss) to the logging item.
1Second Data	Adds 1-second measurement data (average error rate in 1 second and error count in 1 second) to the logging item.
Error Threshold	Selects the error rate threshold. “<>0” and “>” (from 1E–3 to 1E–9, in E–1 steps) can be selected. If the error rate threshold is exceeded, it is logged.
Squelch	Enables (ON) or disables (OFF) the logging memory squelch function. ON: 1 Second Data is not logged when the error rate threshold is exceeded for 10 seconds or longer. OFF: 1 Second Data is logged.
Data Threshold	Adds the data input threshold to the logging item.
Clock Phase	Adds the clock phase set value to the logging item. This can be selected only when Variable Clock Delay (MU181040A-x30, MU181040B-x30) is installed.
OK	Finalize the selection.
Cancel	Cancels the selection.
Set All	Selects all the items.
Reset All	Deselects all the items.

Note that the following restrictions apply:

(1) The following items are disabled until 1 Second Data is selected.

a. Error Threshold

b. Squelch

(2) No items in the Log Condition setup dialog box can be selected when logging is executed.

Use the following procedure to save the logging results.

1. Select “Save” from the File menu.
2. Select MU181040A for Module.
3. Select Error/Alarm Logging for Data Type.
4. Specify the file name and save destination, and then click [OK].

5.1.8 Setting items and displayed items when histogram is selected

This section describes the setting items and items displayed when Histogram is selected from the list box in the result display area ("2" in Figure 5.1-1). The error count, error rate, and error interval count are displayed as a histogram.

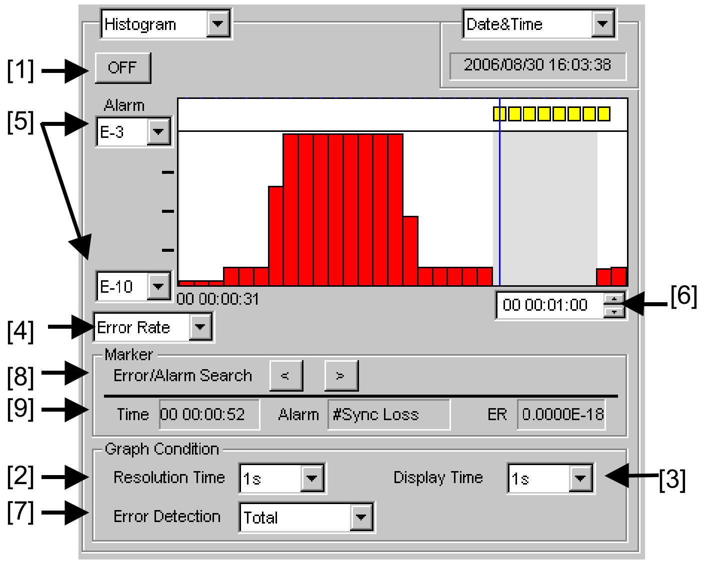


Figure 5.1.8-1 Items when Histogram is selected

[1] Click to ON/OFF the histogram result display.

Table 5.1.8-1 Histogram measurement result display setting

Item	Description
OFF	Stops the histogram result display.
ON	Starts the histogram result display.

[2] Set the histogram calculation resolution from the Resolution Time list box: 1 s, 10 s, 30 s, 1 min., 10 min., 30 min., and 1 hour can be selected.

[3] Set the histogram display resolution from the Display Time list box: 1 s, 10 s, 30 s, 1 min., 10 min., 30 min., and 1 hour can be selected.

[4] Select the measurement item to be added to the histogram.

Table 5.1.8-2 Histogram measurement items

Item	Description
Error Count	Select to calculate the error count and add it to the histogram.
Error Rate	Select to calculate the error rate and add it to the histogram.
EI	Select to calculate the error interval count and add it to the histogram.

[5] Set the maximum and minimum values for the vertical scale on the histogram. The setting range is as follows.

Table 5.1.8-3 Setting range for vertical scale on histogram

	Histogram result type		
	Minimum Value	Maximum Value	Resolution
Error Rate	E – 18	E + 0	1 E – 1
Error Count	E + 0	E + 18	1 E + 1
EI	E + 0	E + 18	1 E + 1

[6] Set the histogram result display time.
The setting range is from 30 points of the histogram calculation resolution to the elapsed time, in steps of the histogram display resolution.

[7] Select the measurement and detection methods for the bit error and alarms to be added to the histogram.
Total/INS/OMI or Transition/Non Transition is set according to the error detection method set in the setting item area when Condition is selected (see Section 5.1.4).

Table 5.1.8-4 Histogram error detection method setting

<table>
<tr><th colspan="2">Item</th><th>Description</th></tr>
<tr><td colspan="2">Total</td><td>Total bit errors where the bit pattern changes between 0 and 1, transition errors, and non-transition errors are added to the histogram.</td></tr>
<tr><td rowspan="4">Error Detection</td><td>Insertion</td><td>Bit errors where the bit pattern changes from 0 to 1 are added to the histogram.</td></tr>
<tr><td>Omission</td><td>Bit errors where the bit pattern changes from 1 to 0 are added to the histogram.</td></tr>
<tr><td>Transition</td><td>Bit errors where the bit pattern transits are counted.</td></tr>
<tr><td>Non Transition</td><td>Bit errors where the bit pattern does not transit are counted.</td></tr>
</table>

[8] Error/Alarm Search
Moves the marker to the error or alarm occurrence time.
The setting range is from “00 00:00:00:00” to the elapsed time. The setting resolution is the histogram display resolution (set in the Display Time list box).

[9] Displays the error or alarm information indicated by the specified marker.

Table 5.1.8-5　Marker error alarm information

Item	Description
Time	Displays the measurement elapsed time at the marker position.
Alarm	Displays the alarm type at the marker position.
Error Rate	Displays the error rate at the marker position.
Error Count	Displays the error count at the marker position.
EI	Displays the error occurrence interval counts at the marker position.

ER or EC is displayed according to the item selected in the histogram target item selection list box (see “[4]” above).

Use the following procedure to save the histogram results.

1. Select “Save” from the File menu.
2. Select MU181040A for Module.
3. Select Histogram Result for Data Type.
4. Select the file saving format from Text or CSV.
5. Specify the file name and save destination, and then click [OK].

5.1.9 When setting 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 (See Figure 5.1.9-1). 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 to ON.
- When executing Calibration of Delay, set jitter modulation of input signal to non-modulation.
- When using the MU181040A-x20 or MU181040B-x40 Clock Recovery, use the following procedure for measurement.
    1. Set the jitter modulation for input signals to OFF or set the modulation amount to 0 mUI.
    2. Confirm that the recovery clock is locked, by checking CR Unlock on the Result tab window (it should be off).
    3. Increase the jitter modulation amount from 0 mUI to set to the value to be measured. If the modulation amount becomes too large, Sync Loss occurs.

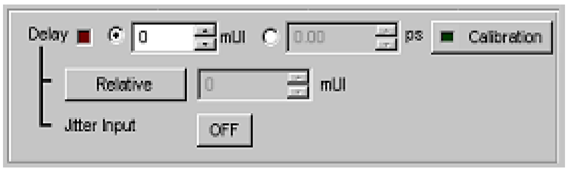


Figure 5.1.9-1 Clock Delay setting items

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.

5.2 Setting Measurement Conditions

The measurement conditions can be set in the Measurement tab window.

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

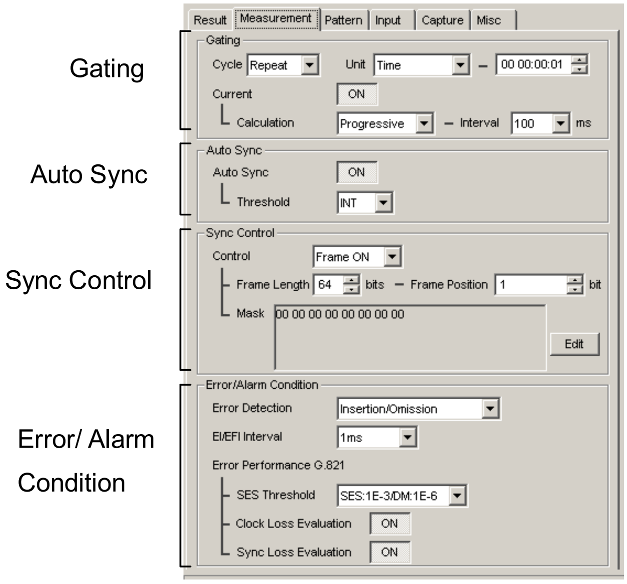


Figure 5.2-1   Measurement tab window

Table 5.2-1   Setting/displaying areas in Measurement tab window

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 in the Result tab window, more detailed settings are possible from the Sync Control and Error/Alarm areas in the Measurement tab window.

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 window when Gating is selected. See Section 5.1.1 “Setting items when Gating is selected” for details.

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 window when Auto Sync is selected. See Section 5.1.2 “Setting items when Auto Sync is selected” for details.

Figure 5.2.2-1 Automatic synchronization establishment function setting items in Auto Sync 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 window when Sync Control is selected.

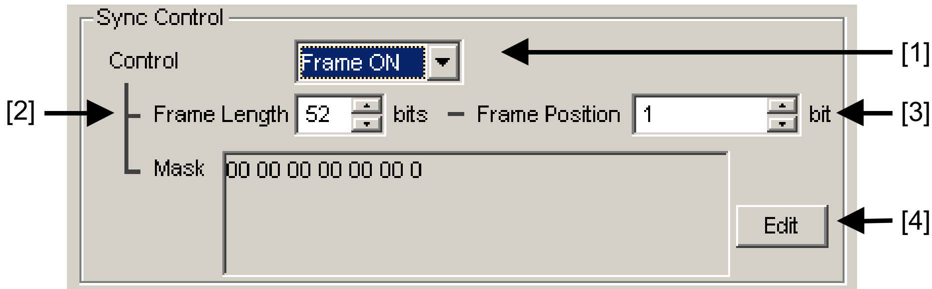


Figure 5.2.3-1 Synchronization establishment method setting items in Sync Control area

[1] Select the test pattern synchronization method.

[2] Set the frame pattern length. Enabled when the synchronization method is Frame ON.

[3] Set the start position of the pattern for frame detection. Enabled when the synchronization method is Frame ON. See Section 5.1.3 “Setting items when Sync Control is selected” for details.

[4] Click to edit the mask pattern.
Enabled when the synchronization method is Frame ON.

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 window when Condition is selected.

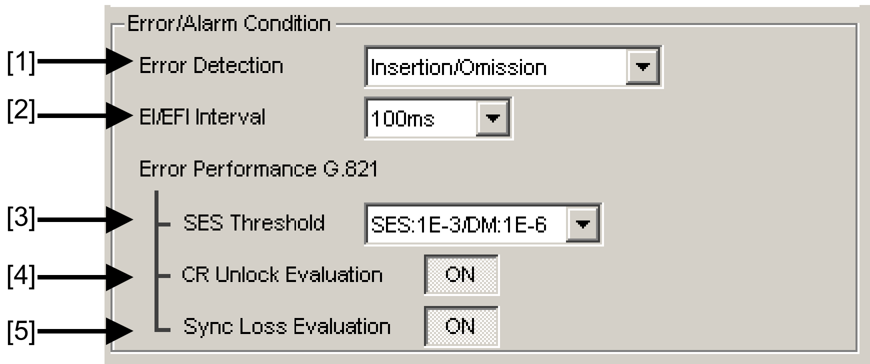


Figure 5.2.4-1 Measurement condition setting items in Error/Alarm area

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

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

[3] Select the severely error second (SES) occurrence threshold (combination of non-performing threshold and degrade minute threshold).

Table 5.2.4-1 SES Threshold setting

SES Threshold	Description
SES: 1E-3/DM:1 E-6	Set the non-performing threshold to 10^{-3} and the degrade minute threshold to 10^{-6}.
SES: 1E-4/DM:1 E-8	Set the non-performing threshold to 10^{-4} and the degrade minute threshold to 10^{-8}.

[4] Select whether to include intervals where CR Unlock or Clock Loss occurs to the Performance calculation target.

Table 5.2.4-2 CR Unlock/Clock Loss Evaluation setting

CR Unlock/Clock Loss Evaluation	Description
ON	Includes intervals where CR Unlock or Clock Loss occurs to the Performance calculation target.
OFF	Excludes intervals where CR Unlock or Clock Loss occurs to the Performance calculation target.

The display and setting vary depending on the clock (Clock Recovery or External Clock) selected in the Clock area on the Input tab window.

[5] Select whether to include intervals where Sync Loss occurs to the Performance calculation target.

Table 5.2.4-3 Sync Loss Evaluation setting

Sync Loss Evaluation	Description
ON	Includes intervals where Sync Loss occurs to the Performance calculation target.
OFF	Excludes intervals where Sync Loss occurs to the Performance calculation target.

5.3 Setting Test Patterns

Click the [Pattern] tab on the operation tab window to display the Pattern tab window. A test pattern can be selected and the settings for the test pattern can be configured in this tab window.

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

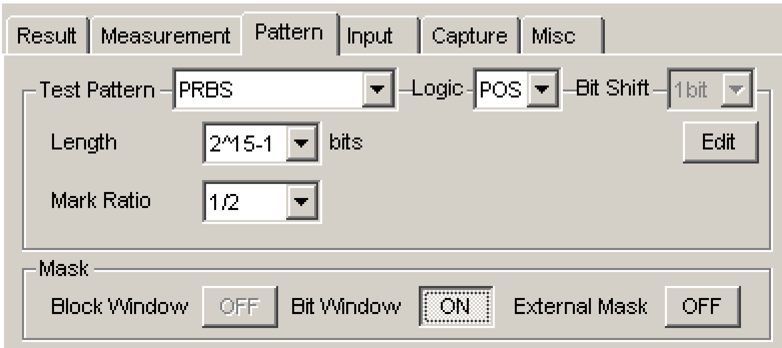


Figure 5.3-1 Pattern tab window

Table 5.3-1 Setting/displaying areas in Pattern tab window

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 five test patterns can be selected.

- PRBS
- Zero-Substitution
- Data
- Mixed
- Sequence

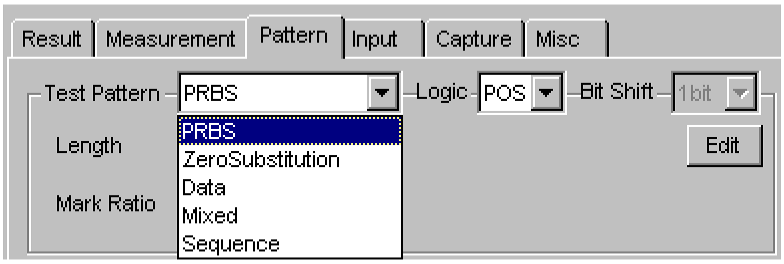


Figure 5.3.1-1 Selecting test pattern

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.

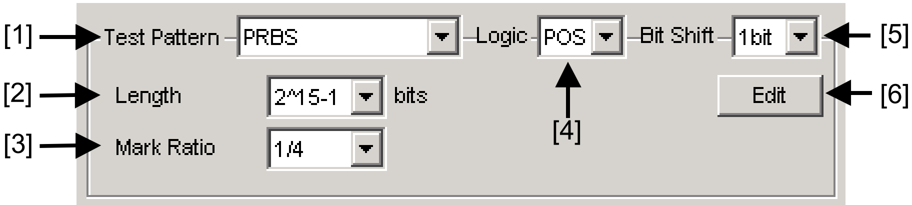


Figure 5.3.2-1 Items for setting PRBS pattern

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

[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, 1/4, 1/8, and 0/8 can be selected.
When Logic is set to NEG, 1/2inv, 3/4, 7/8, and 8/8 can be 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 the bit shift.
In order to change the correlation between the bit patterns at the change of the PRBS signal mark ratio, the pattern is shifted by the value set here when passing through the AND gate.
“1bit” or “3bit” can be selected.
This setting is valid only when the mark ratio setting is valid and set to 1/4 (3/4) or 1/8 (7/8).

For a principle of PRBS generation, refer to Appendix A “Pseudo-Random Pattern”.

[6] 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.

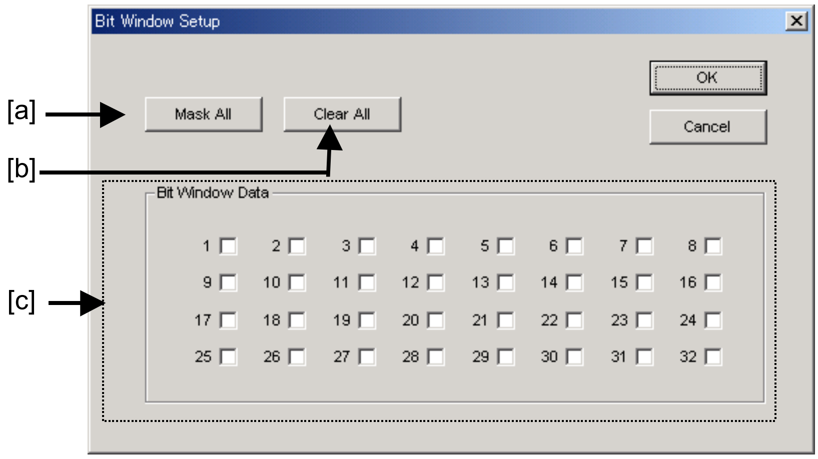


Figure 5.3.2-2 Bit Window Setup dialog box

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

[a] Mask All: All 32 routes of the Bit Window Data are masked when this button is clicked.

[b] Clear All: All 32 routes of the Bit Window Data are unmasked when this button is clicked.

[c] The MU181040A has internal 32 error counters. Select the corresponding checkbox for the route to be masked.

Note:

See Section 5.3.7 "Mask selection" for details on selection in the Bit Window Setup dialog box.

5.3.3 Setting Zero-Substitution pattern

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

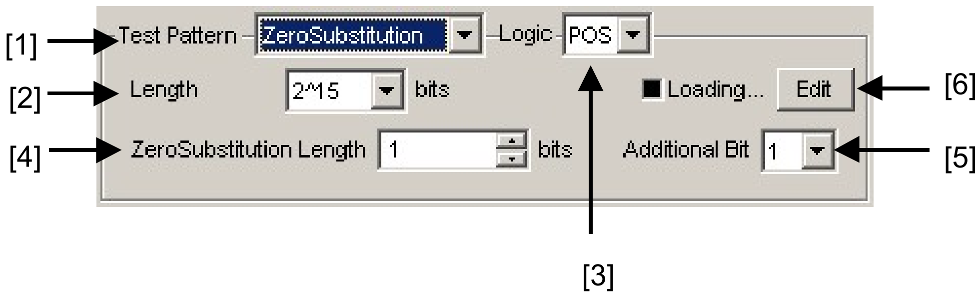


Figure 5.3.3-1 Setting items for Zero-Substitution pattern

[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 2n – 1 is set for Length: 1 to 2n – 2, in 1-bit steps

(b) When 2n is set for Length: 1 to 2n – 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	In order to make an M-series signal, 1 bit of "0" is added to the last of consecutive 0 strings to configure a zero-insertion pattern.

[6] Edit the Block Window and Bit Window.
See Section 5.3.8 "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. See Section 5.3.7 "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.

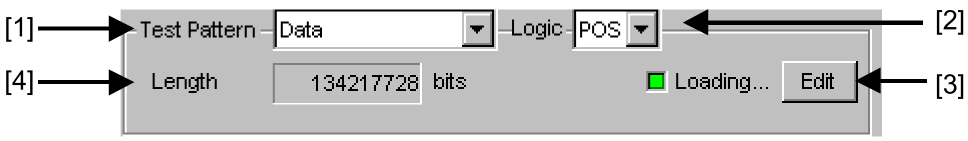


Figure 5.3.4-1 Setting items for Data pattern

[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. See Section 5.3.8 “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. See Section 5.3.7 “Mask selection” for selection of Block Window and Bit Window.

5.3.5 Setting Mixed pattern

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

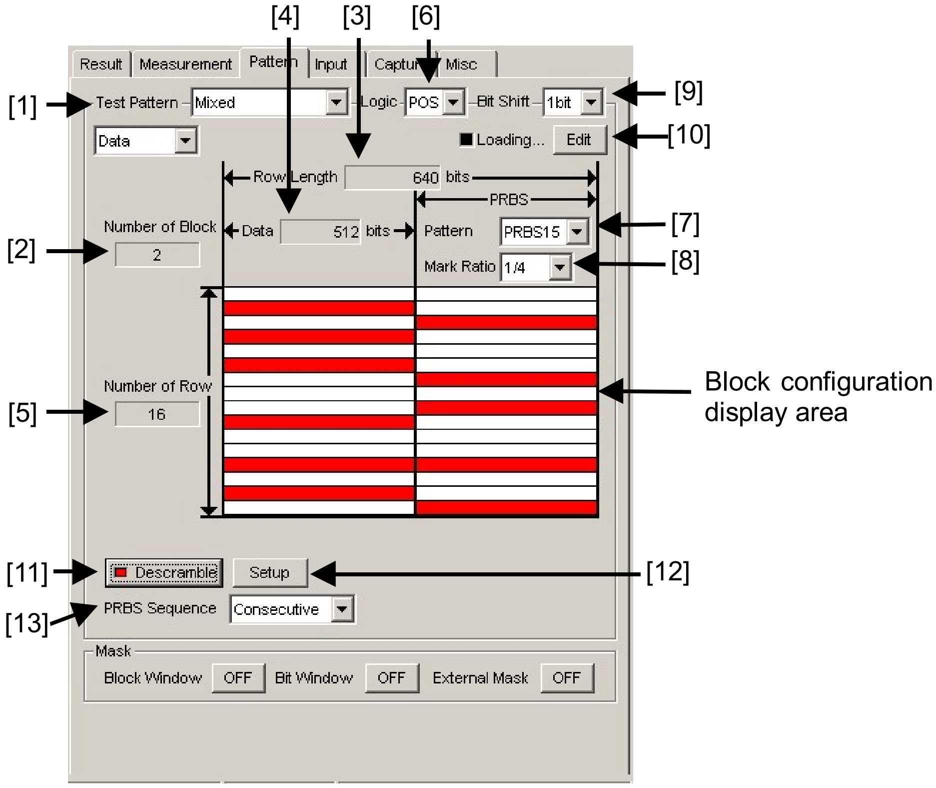


Figure 5.3.5-1 Setting items for Mixed pattern

[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, 1/4, 1/8, and 0/8 can be selected.
When Logic is set to NEG, 1/2inv, 3/4, 7/8, and 8/8 can be selected.

[9] Set the bit shift.
In order to change the correlation between the bit patterns at the change of the PRBS signal mark ratio, the pattern is shifted by the value set here when passing through the AND gate.
“1bit” or “3bit” can be selected.
This setting is valid only when the mark ratio setting is valid and set to 1/4 (3/4) or 1/8 (7/8).

[10] 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. See Section 5.3.8 “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. See Section 5.3.7 “Mask selection” for selection of Block Window and Bit Window.

[11] 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 (see [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.

[12] Configure the descramble settings.

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

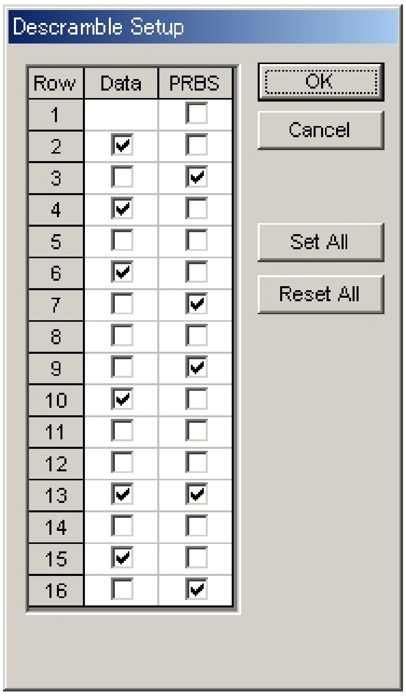


Figure 5.3.5-2 Descramble Setup dialog box

Note:

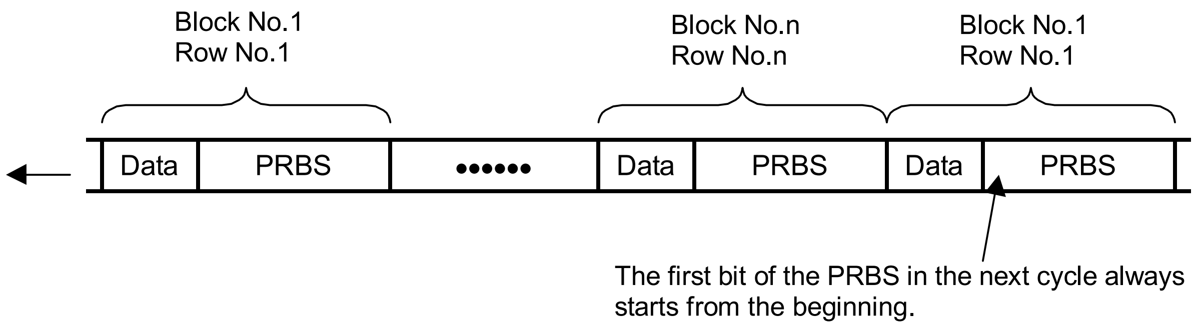
Descramble cannot be set for the data area of the first row in each block.

[13] 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



(b) When Consecutive is selected

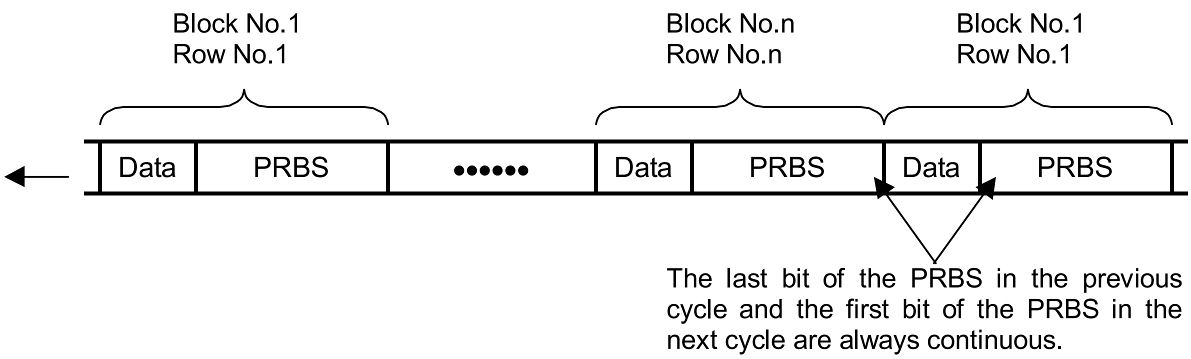


Figure 5.3.5-3 Continuity of PRBS pattern strings

5.3.6 Setting Sequence pattern

When "Sequence" is selected from the Test Pattern list box, it is possible to set a signal pattern that transmits up to 128 patterns (blocks) in the pre-defined order. It is necessary to configure MU181020A or MU181020B (hereinafter, MU181020A/B) and this equipment as a pair for measurement when receiving and transmitting signals using this test pattern. The MU181020A/B and MU181040A to be paired can be selected from the Pair ED list box in the Pattern tab window for sequence test pattern on the MU181020A/B operation tab window. The sequence test pattern must be the same as that set in the Pattern tab window for the sequence test pattern on the MU181020A/B operation tab window. Selection is disabled when Combination or Burst is set.

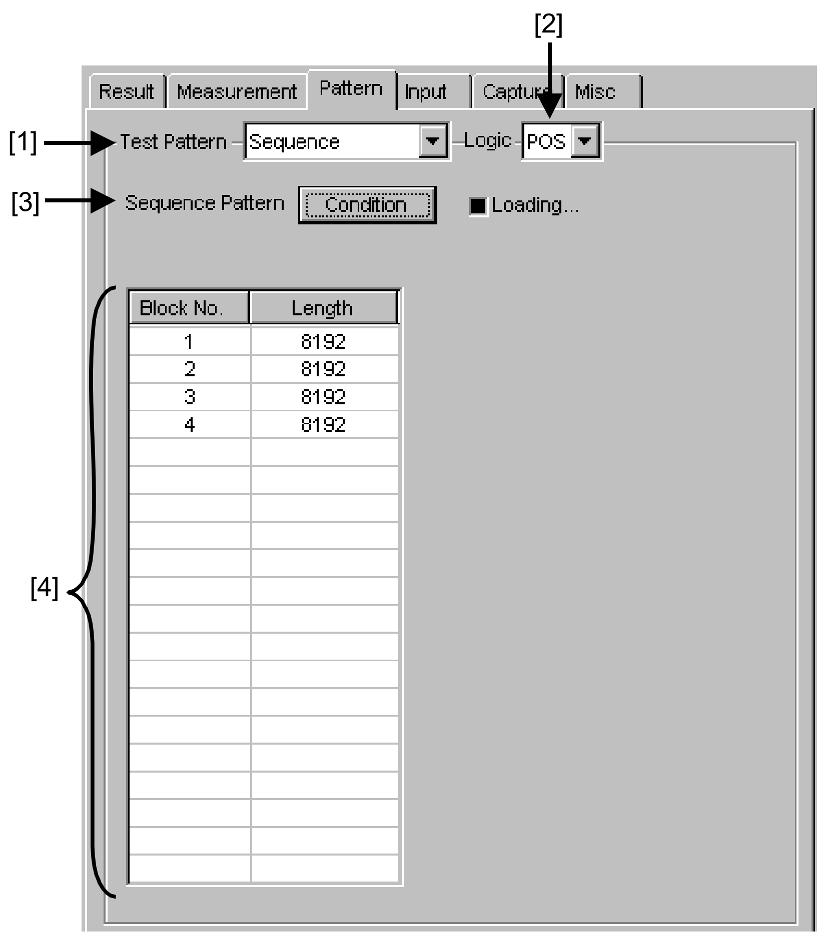


Figure 5.3.6-1 Setting items for Sequence pattern

[1] Select "Sequence" from the Test Pattern list box.

[2] Set the logic of the test pattern.

Table 5.3.6-1 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] Click the [Condition] to display the Sequence Pattern Setting dialog box. Set the same pattern as the test pattern set for each block number in the Test Pattern (Sequence) setting field on the [Pattern] tab of the operation window for the communicating MU181020A/B.

	MU181020A/B	MU181040A
Block No. 1	Pattern A	Pattern A
Block No. 2	Pattern B	Pattern B
Block No. 3	Pattern C	Pattern C
:	:	:

[4] The set sequence pattern is displayed in this area.

Notes:

- Set the same test pattern data for each block and the same number of registered blocks for both the MU181020A/B and the MU181040A. Otherwise, measurement may not be performed correctly.

- The pattern length of each block has to be shorter than the delay time which may occur in the DUT. Also the pattern length has to comply with the below equation, when it does not comply with the equation a “Sync Loss” error may occur.

  Bit delay of the DUT ≤ The pattern length – 2048 bits

5.3.6.1 Setting sequence pattern conditions

Clicking [Condition] on the right of "Sequence Pattern" in the Pattern tab window for sequence pattern opens the Sequence Pattern Setting dialog box.

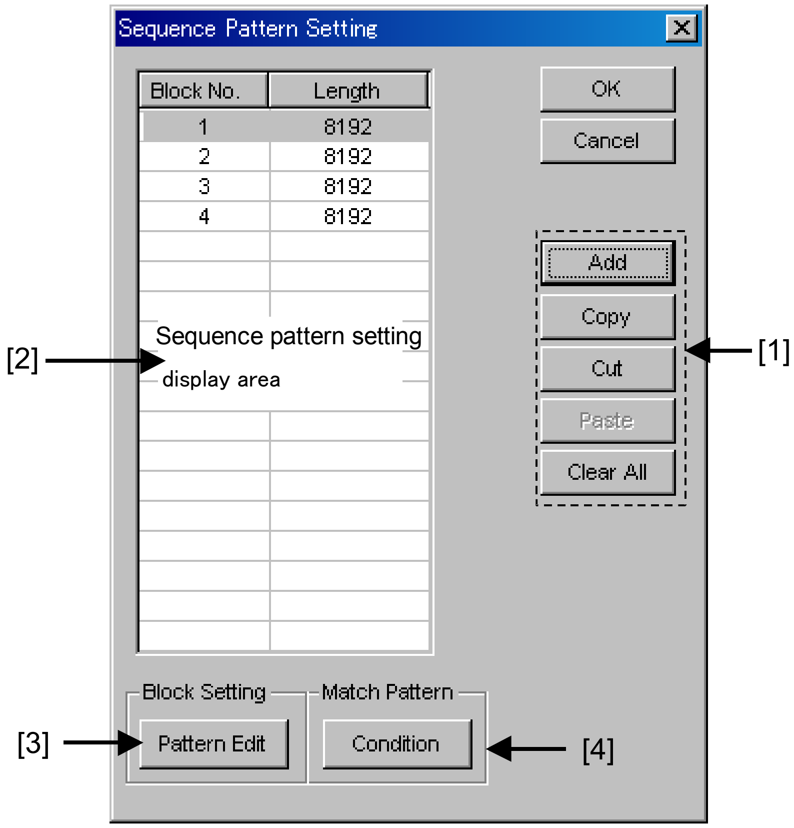


Figure 5.3.6.1-1 Sequence Pattern Setting dialog box

[1] Buttons used to set the blocks.

Table 5.3.6.1-1 Block setting buttons

Button	Description
Add	Click to add a block to the Sequence pattern being set.
Copy	Click to copy the block selected in the sequence pattern setting display area.
Cut	Click to copy and cut out the block selected in the sequence pattern setting display area.
Paste	Click to paste the block that is copied or cut in the sequence pattern setting display area between the selected block and the previous block.
Clear All	Click to delete all the blocks of the sequence pattern displayed in the sequence pattern setting display area.

[2] Sequence pattern setting display area containing the block number and pattern length.

[3] Sets the test pattern for the block selected in the sequence pattern setting display area. Refer to Section 5.3.8 “Editing test pattern in Pattern Editor dialog box” for details on test pattern setting in the Pattern Editor dialog box.

[4] Sets the match pattern for the block selected in the sequence pattern setting display area. Refer to Section 5.3.6.2 “Setting match pattern conditions” for details on match pattern setting.

Note:

See Section 5.3.7 “Mask selection” for selection of Block Window and Bit Window.

5.3.6.2 Setting match pattern conditions

Clicking [Condition] on the right of "Match Pattern" in the Pattern tab window for sequence pattern opens the Match Pattern Condition dialog box.

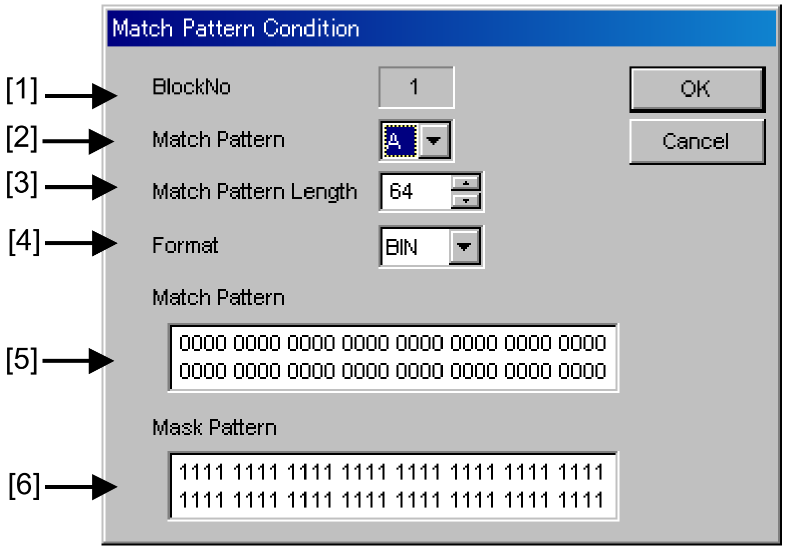


Figure 5.3.6.2-1 Match Pattern Condition dialog box

[1] Displays the block number for Match Pattern setting.

[2] Select whether to use pattern A or pattern B as the match pattern.

[3] Set the length of the match pattern, from 4 to 64 bits in 4-bit steps.

[4] Select the display format for the Match pattern setting area and Mask pattern setting area. It is displayed in binary format when BIN is selected, and is displayed in hexadecimal format when HEX is selected.

[5] Set the pattern to be used for pattern matching in the Match pattern setting area.

[6] In the pattern that is set to be used for pattern matching in the Match pattern setting area, set a pattern to be masked as a mask pattern. Set "1" for bits to be masked.

5.3.7 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.

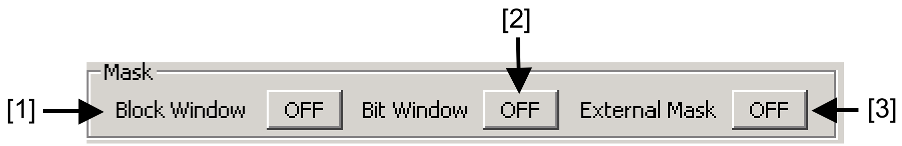


Figure 5.3.7-1 Controls in Mask area

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 5.3.7-1 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. When the test pattern is Mixed, the Block Window specifies enable/disable of the measurement in units of PRBS, but it cannot specify for each bit in the PRBS part.

[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.

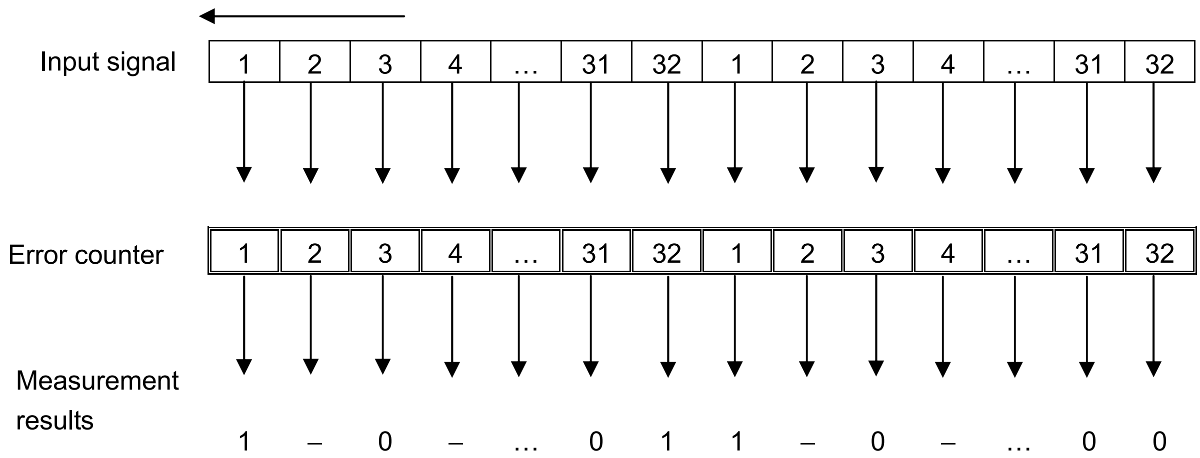


Figure 5.3.7-2 Bit Window function

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 5.3.7-2 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.

Table 5.3.7-3 External Mask ON/OFF setting

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

This button is enabled only when “External Mask” is set in the AUX Input area on the Misc tab window.

5.3.8 Editing test pattern in Pattern Editor dialog box

Editing of test patterns with the following patterns selected in the Pattern tab window is described below.

(1) Zero-Substitution

(2) Data

(3) Mixed

(4) Sequence

5.3.8.1 Common setting items

The Pattern Editor dialog box is displayed when [Edit] or [Pattern Edit] (in the case of Sequence pattern) is clicked.

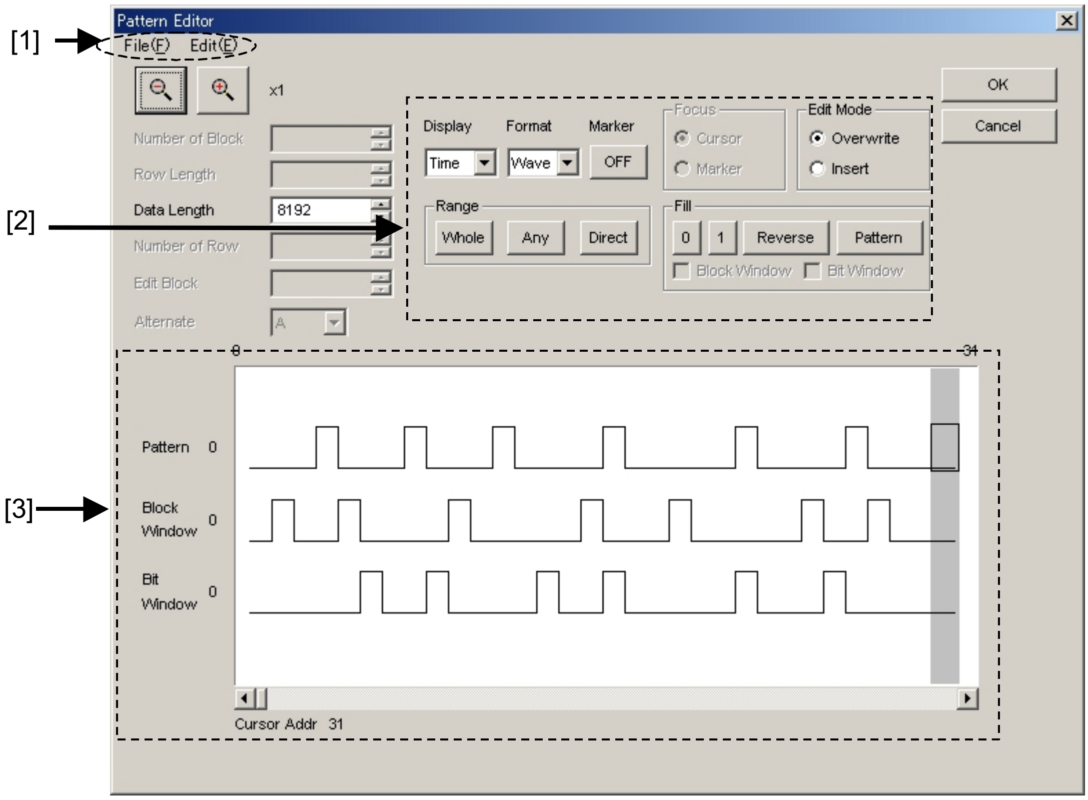


Figure 5.3.8.1-1 Pattern Editor dialog box

[1] Menu items on menu bar

Table 5.3.8.1-1 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. See 5.3.8.11 “Compatibility with test pattern files of existing models” for file compatibility.
	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. ***Note:*** The settings will not be read from the saved file if the file name is changed.
	Screen Copy	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	Cuts the pattern selected in the Pattern View area and transfers it onto the clipboard. The area that has been cut out becomes 0.
	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 setup dialog box. The cursor can be moved to the specified address position.
	Pattern	Opens the Input Pattern setup 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 the [Forward] or [Backward] option button, and then click [OK].
	Forward Next	Searches for a pattern that matches the search pattern set in the Input Pattern setup dialog box in the forward direction. If a matching pattern is found, the cursor moves to that position.
	Backward Next	Searches for a pattern that matches the search pattern set in the Input Pattern setup dialog box in the backward direction. If a matching pattern is found, the cursor moves to that position.

Table 5.3.8.1-1 Menu bar configuration (Cont’d)

Menu	Menu item	Description
Edit (continued)	Line	Specifies the number of characters per line in the Pattern View area. This is enabled when the pattern setting item Display is set to “Table”.

[2] Pattern setting items

Table 5.3.8.1-2 Pattern setting items

Setting item	Description
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 “Time” is selected for Display, “Wave” or “Bit” can be selected. Wave: The pattern is displayed by a waveform. Bit: The pattern is displayed by a bit string. See Section 5.3.8.7 “Editing in Time display mode” for details. When “Table” is selected for Display, “Bin” or “Hex” can be selected. Bin: Binary Hex: Hexadecimal See Section 5.3.8.8 “Editing in Table display mode” for details.
Marker	Click this button to place a marker in the Pattern View area. This is enabled when “Time” is selected for Display.
Focus	This is enabled 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: All editing patterns are selected as the editing range. Any: The Input Range setup dialog box (see Figure 5.3.8.1-2) is displayed when this button is clicked. The editing range can be specified by an address. Direct: Select an arbitrary area by specifying addresses. Use the cursor to specify addresses. See Section 5.3.8.9 “Editing area” for details.

Table 5.3.8.1-2 Pattern setting items (Cont'd)

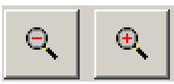
Setting item	Description
Fill	Edits the pattern part highlighted by the cursor. 0: The highlighted part in the Pattern View area is set to "0". 1: The highlighted part in the Pattern View area is set to "1". Reverse: The highlighted part in the Pattern View area is logically inverted. Pattern: The Input Pattern setup dialog box (see Figure 5.3.8.1-3) 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: The Block Window checkbox is enabled when "Table" is selected for Display. Select this checkbox, select a desired position in the Pattern View area, and then click "1" to mask that position or click "0" to unmask it. Bit Window: The Bit Window checkbox is enabled when "Table" is selected for Display. Select this checkbox, select a desired position in the Pattern View area, and then click "1" to mask that position or click "0" to unmask it. ***Note:*** When the synchronization method is set to Frame ON, masking a pattern frame position results in a synchronization loss.
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 "Time" is set for Display and "Wave" is set for Format.

Figure 5.3.8.1-2 Input Range setup dialog box

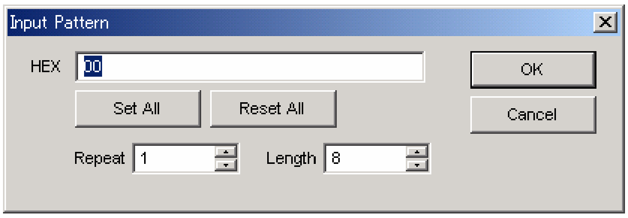


Figure 5.3.8.1-3 Input Pattern setup dialog box

[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.

5.3.8.2 Editing Zero-Substitution pattern

When [Edit] is clicked while Zero Substitution is selected for the test pattern, the Pattern Editor dialog box shown in Figure 5.3.8.2-1 is displayed. Note, however, that only Block Window and Bit Window can be edited, and Data Length and other settings cannot be configured.

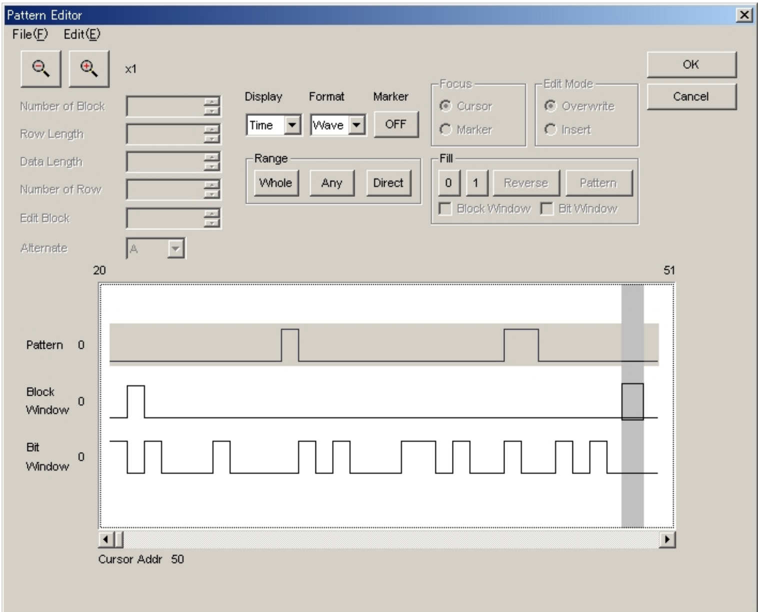


Figure 5.3.8.2-1 Pattern Editor dialog box for Zero-Substitution pattern

5.3.8.3 Editing Data pattern

When [Edit] is clicked while Data is selected for the test pattern, the Pattern Editor dialog box shown in Figure 5.3.8.3-1 is displayed.

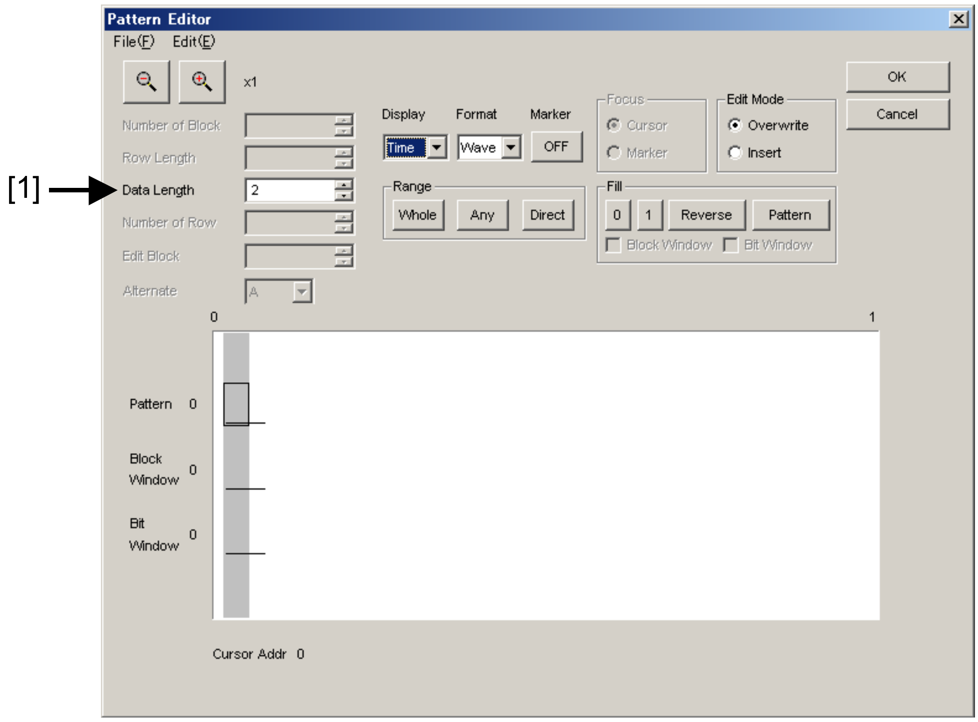


Figure 5.3.8.3-1 Pattern Editor dialog box for Data pattern

[1] Pattern setting item

Table 5.3.8.3-1 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 134,217,728 bits can be set, in 1-bit steps. In the case of 2 Ch Combination, 4 to 268,435,456 bits can be set, in 2-bit steps. In the case of 4 Ch Combination, 8 to 536,870,912 bits can be set, in 4-bit steps.

5.3.8.4 Editing Mixed pattern

When [Edit] is clicked while Mixed is selected for the test pattern, the Pattern Editor dialog box shown in Figure 5.3.8.4-1 is displayed.

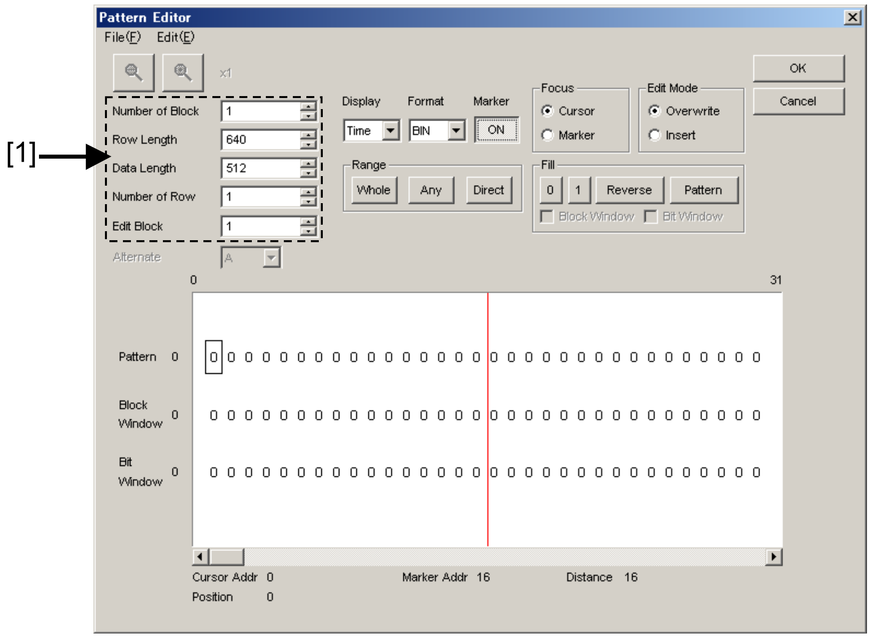


Figure 5.3.8.4-1 Pattern Editor dialog box for mixed pattern

[1] Pattern setting items

Table 5.3.8.4-1 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 768 to 2,281,701,376 bits in 128-bit steps. In the case of 2 Ch Combination, set from 1,536 to 4,563,402,752 bits in 2-bit steps. In the case of 4 Ch Combination, set from 3,072 to 9,126,805,504 bits in 4-bit steps.
Data Length	Set the length of the Mixed pattern. 512 to 134,217,728 bits can be set in 1-bit steps. In the case of 2 Ch Combination, set from 1,024 to 268,435,456 bits in 2-bit steps. In the case of 4 Ch Combination, set from 2,048 to 536,870,912 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 $\times$ x/(Number of rows $\times$ Data Length'))

where Data Length' is:

- When Data Length is indivisible by (128 $\times$ x)

=(INT(Data Length/(128 $\times$ x)) +1) $\times$ 128 $\times$ x

- When Data Length is divisible by (128 $\times$ x)

=Data Length

The maximum number of blocks fulfilling the following formula
applies:
Data Length' $\times$ Number of rows $\times$ Number of blocks $\leq$ 128 Mbits

c) INT((128 Mbits +2^{31}) $\times$ x/(Row Length $\times$ Number of rows))

where x is:

1 for Independent

2 for 2 Ch Combination

4 for 4 Ch Combination

d) Row Length – Data Length) $\times$ Number of blocks $\geq$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 $\times$ x/Data Length') where Data Length' is:

- When Data Length is indivisible by $(128 \times x)$

$=(\mathrm{INT}(\text{Data Length}/(128 \times x))+1) \times 128 \times x$

- When Data Length is divisible by $(128 \times x)$

=Data Length

The maximum number of rows fulfilling the following formula applies:

Data Length' $\times$ Number of rows $\times$ Number of blocks $\leq$ 128 Mbits

c) $\mathrm{INT}((128\ \text{Mbits} + 2^{31}) \times x/\text{Row Length})$

where x is;

1 for Independent

2 for 2 Ch Combination

4 for 4 Ch Combination

5.3.8.5 Editing Sequence pattern

When [Pattern Edit] is clicked while Sequence is selected for the test pattern, the Pattern Editor dialog box shown in Figure 5.3.8.5-1 is displayed.

[1]

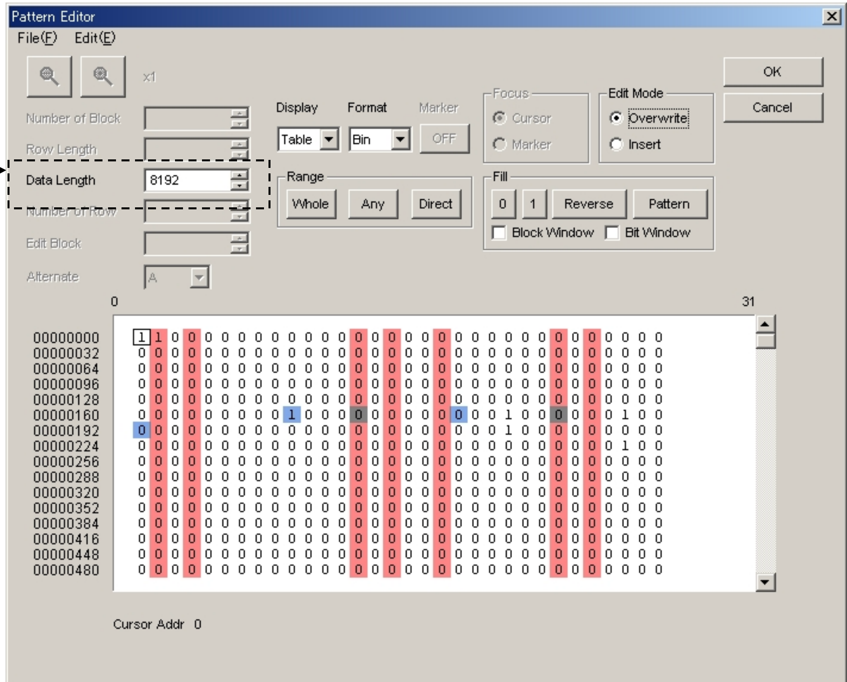


Figure 5.3.8.5-1 Pattern Editor dialog box for Sequence pattern

[1] Pattern setting items

Table 5.3.8.5-1 Pattern setting item (when Sequence is selected)

Setting item	Description
Data Length	Set the length of the Sequence pattern. The setting unit is one bit. The MU181040A can be set from 8,192 to 1,048,576 bits in 128-bit steps. The MU181040B can be set from 16,384 to 1,048,576 bits in 128-bit steps.

Note:

The [Pattern Edit] is enabled only when a block is set in the Sequence Pattern Setting dialog box.

5.3.8.6 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

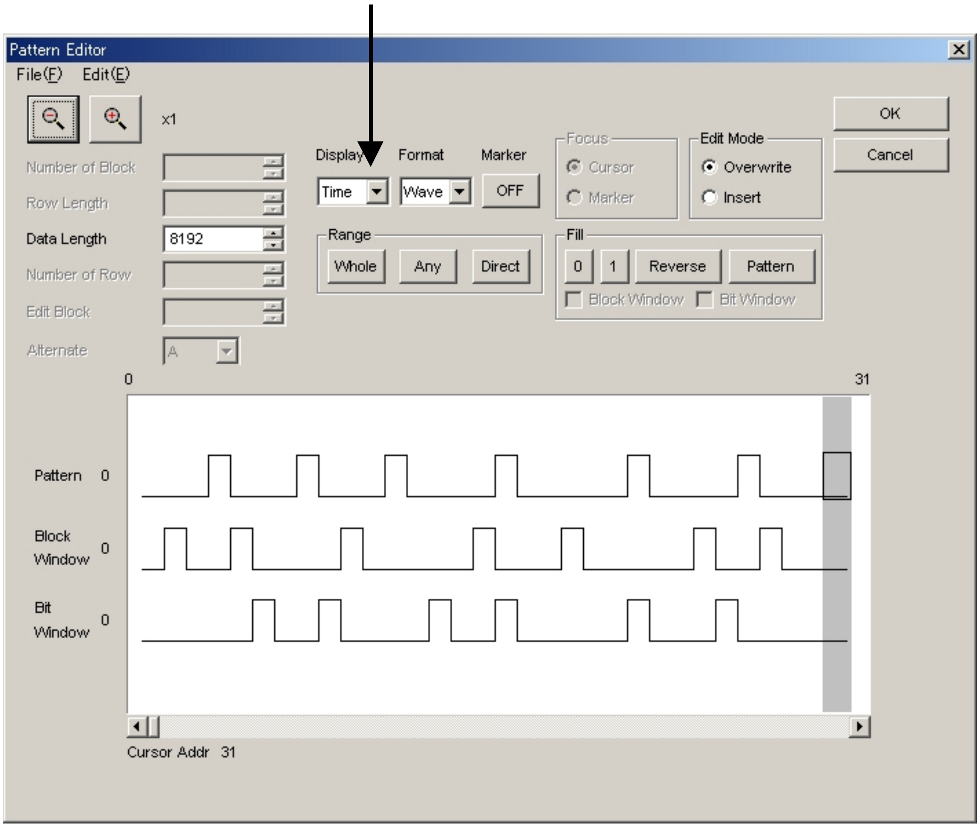


Figure 5.3.8.6-1 Display list box

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

Table 5.3.8.6-1 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, see the corresponding section according to the display mode, as follows:

When Time is selected:	See Section 5.3.8.7 "Editing in Time display mode."
When Table is selected:	See Section 5.3.8.8 "Editing in Table display mode."

5.3.8.7 Editing in Time display mode

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

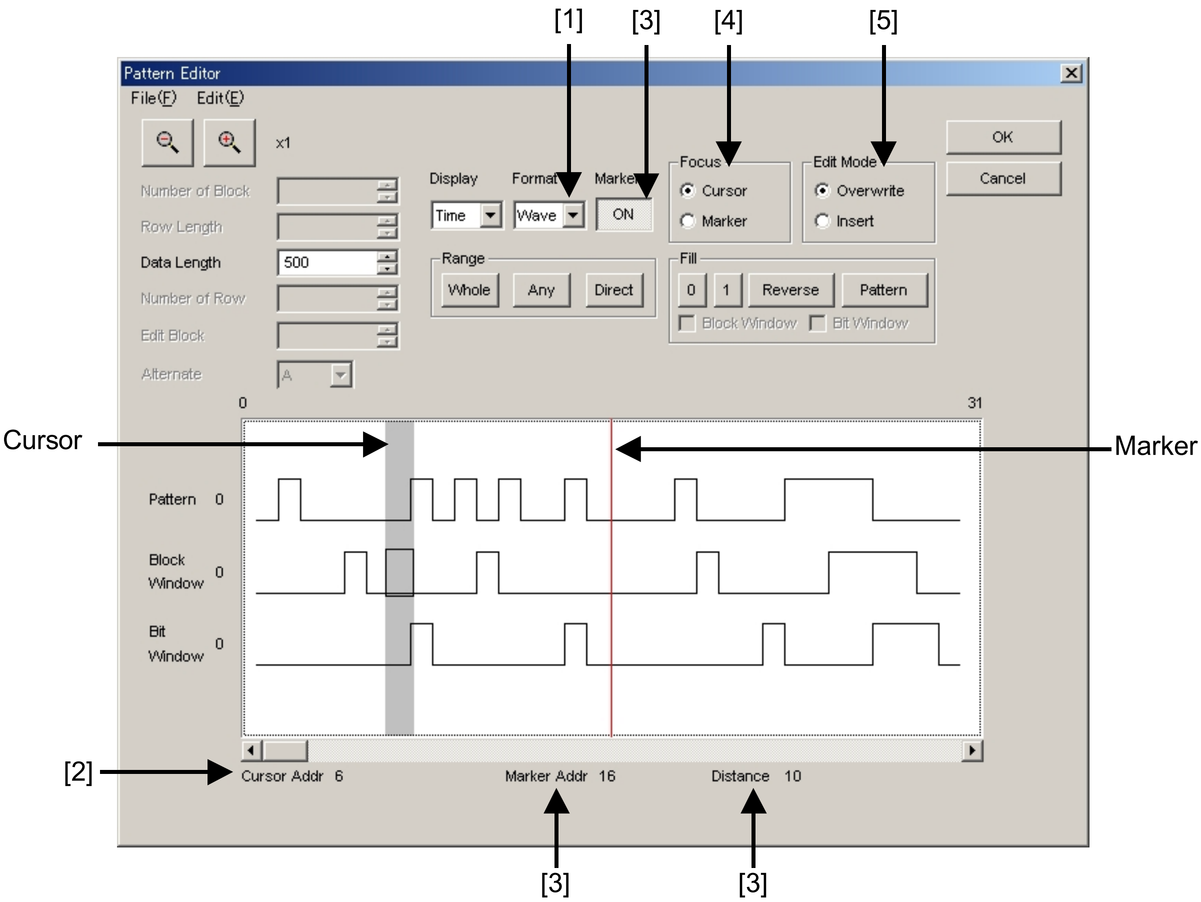


Figure 5.3.8.7-1 Editing in Time display mode

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

Table 5.3.8.7-1 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 the Cursor radio button is selected, and the marker is operated when the Marker radio button is selected.

[5] Set the editing mode. Editing is performed in the insertion mode when the Insert radio button is selected, and is performed in the overwriting mode when the Overwrite radio button is selected.

5.3.8.8 Editing in Table display mode

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

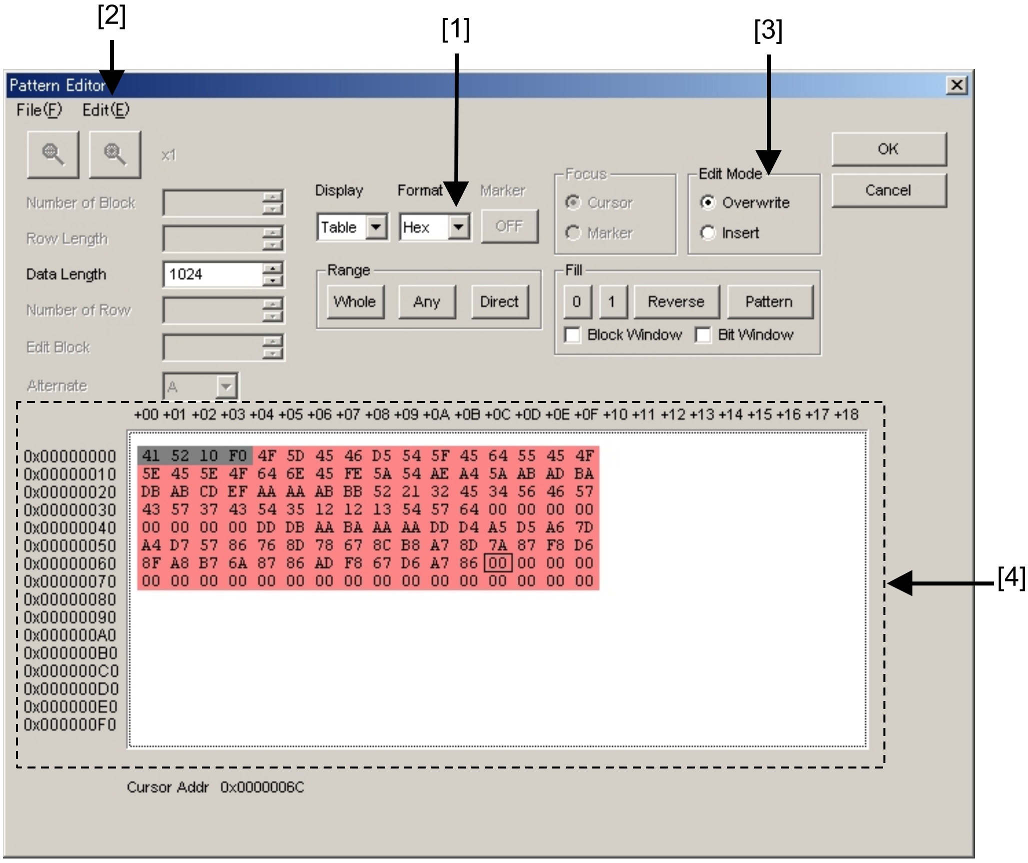


Figure 5.3.8.8-1 Editing in Table display mode

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

Table 5.3.8.8-1 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 textbox, and then click [OK].

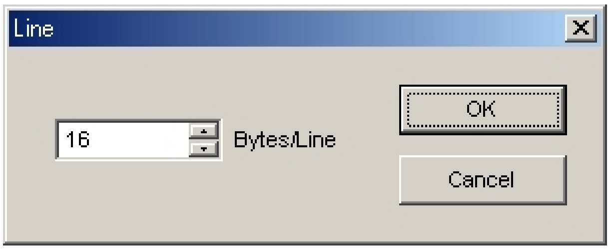


Figure 5.3.8.8-2 Line dialog box

[3] Set the editing mode. Editing is performed in the insertion mode when the Insert radio button is selected, and is performed in the overwriting mode when the Overwrite radio button is selected.

[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.

5.3.8.9 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 5.3.8.9-1 Area specification buttons

Button	Function
Whole	Specifies entire of the pattern as the selection area.
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.

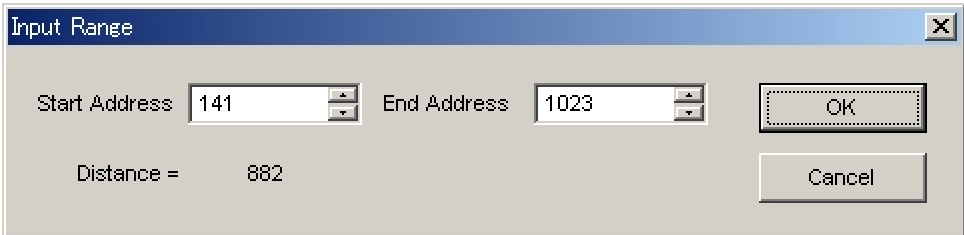


Figure 5.3.8.9-1 Input Range dialog box

1. Enter the Start Address of the selection area in the Start Address textbox.
2. Enter the End Address of the selection area in the End Address textbox.
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.

5.3.8.10 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 5.3.8.10-1 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.

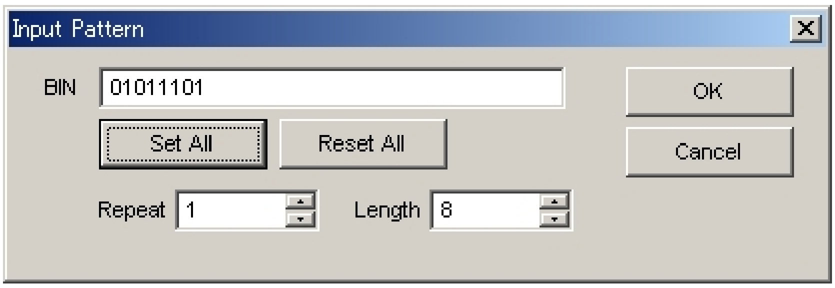


Figure 5.3.8.10-1 Input Pattern dialog box

1. Enter into the Length textbox the number of bits to be input.
2. Enter into the Repeat textbox 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 textbox.
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 textbox.

5.3.8.11 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 MU181040A.

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

5.4 Setting Input Interface

Click the [Input] tab on the operation tab window to set the input interface. The displayed items and setting items on the Input tab window vary depending on the option installed in the MU181040A. Go to the corresponding section according to the option installed as follows:

- For MU181040A-001 (9.8 to 12.5 Gbit/s): See Section 5.4.1.
- For MU181040A-002 (0.1 to 12.5 Gbit/s): See Section 5.4.2.
- For MU181040B-002 (0.1 to 14 Gbit/s): See Section 5.4.2.

5.4.1 Input setting items (when MU181040A-001 is installed)

The Input tab window consists of two areas: Data setting area (upper) and Clock setting area (lower).

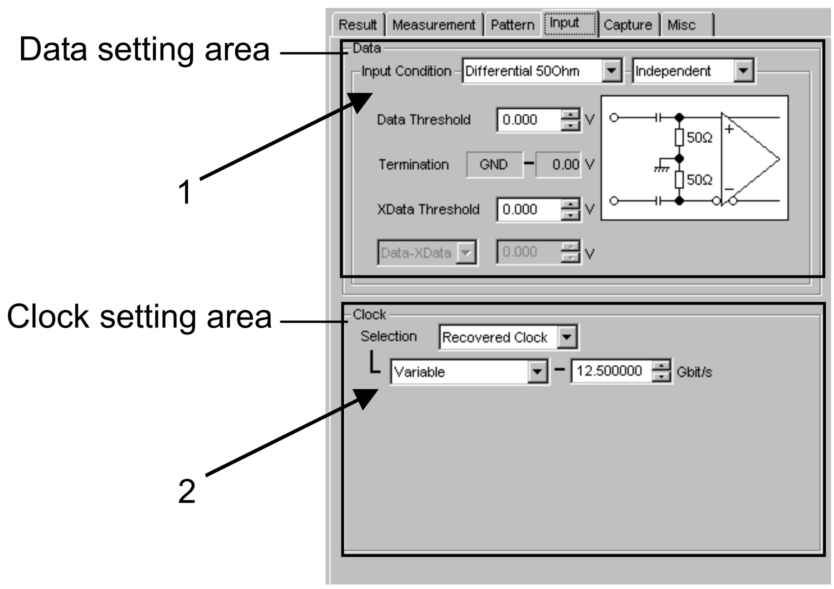


Figure 5.4.1-1 Input tab window

1. Set the data input conditions.
   - When Differential 50 Ohm is selected:
     The differential input setting window is displayed.
   - When Single-Ended is selected:
     The single-end input setting window is displayed.

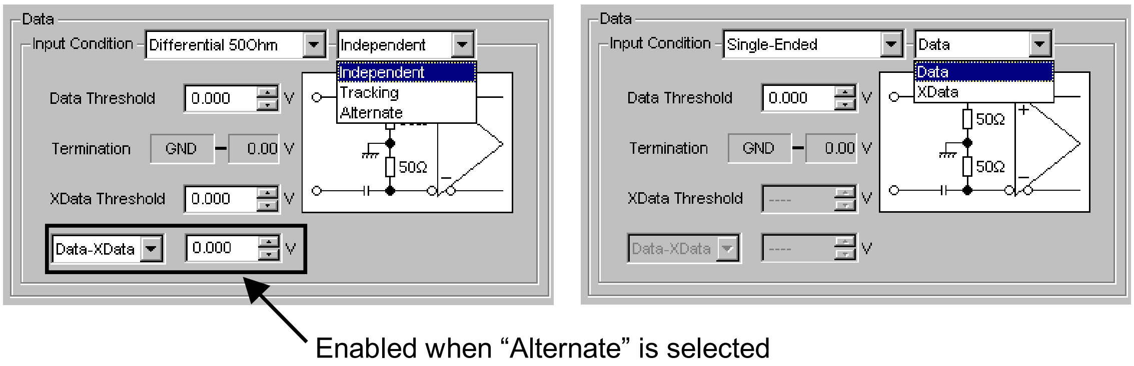


Figure 5.4.1-2 Setting Data input conditions

Table 5.4.1-1 Data input condition setting items

Data input condition setting items			Description
Differential 50 Ohm	Independent		Uses Data and XData as the differential input. The Data threshold and XData threshold can be changed independently
	Tracking		Uses Data and XData as the differential input. The Data threshold and XData threshold can be changed in conjunction.
	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. ***Note:*** Be sure to attach the supplied Open to the unused input connector at the XData side before use. Malfunction may result if a signal is input to the unused connector.
	XData		Used the XData side as single-ended input. ***Note:*** Be sure to attach the supplied Open to the unused input connector at the Data side before use. Malfunction may result if a signal is input to the unused connector.

Note:

If a differential signal is input via the Data or XData connector when Single-Ended is selected, the threshold margin becomes double.

2. Set the clock recovery frequency.

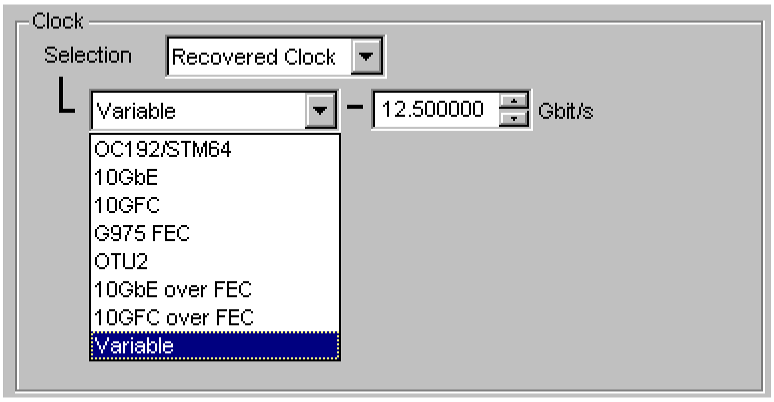


Figure 5.4.1-3 Setting clock recovery frequency

Table 5.4.1-2 Clock recovery frequency setting items

Clock recovery frequency setting items		Description
Recovered Clock	Variable	Sets the operating bit rate for the clock recovery block in the MU181040A. The setting range is from 9.8 to 12.5 Gbit/s, in 1 kbit/s steps. Set a value close to the desired bit rate.
	10 G FC over FEC	Presets the operating bit rate to 11.316800Gbit/s. 10 G FC over FEC becomes available.
	10 GbE over FEC	Presets the operating bit rate to 11.095700 Gbit/s. 10 GbE over FEC becomes available.
	OUT2	Presets the operating bit rate to 10.709225 Gbit/s. OTU2 becomes available.
	G975 FEC	Presets the operating bit rate to 10.664228 Gbit/s. G975 FEC becomes available.
	10 GFC	Presets the operating bit rate to 10.518750 Gbit/s. 10 GFC becomes available.
	10 GbE	Presets the operating bit rate to 10.312500 Gbit/s. 10 GbE becomes available.
	OC-192/STM64	Presets the operating bit rate to 9.953280 Gbit/s. OC-192/STM64 becomes available.

Note:

Be sure to observe the range in which lock is possible when selecting the operating bit rate.

5.4.2 Input setting items (when MU181040A-002 and MU181040B-002 are installed)

The Input tab window consists of two areas: a Data setting area (upper) and a Clock setting area (lower).

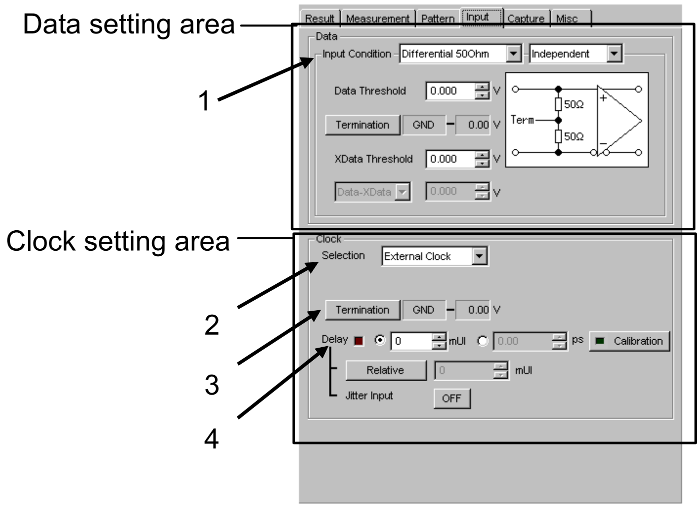


Figure 5.4.2-1 Input tab window (MU181040A-002 + MU181040A-x20 + MU181040A-x30)

1. Set the data input condition.

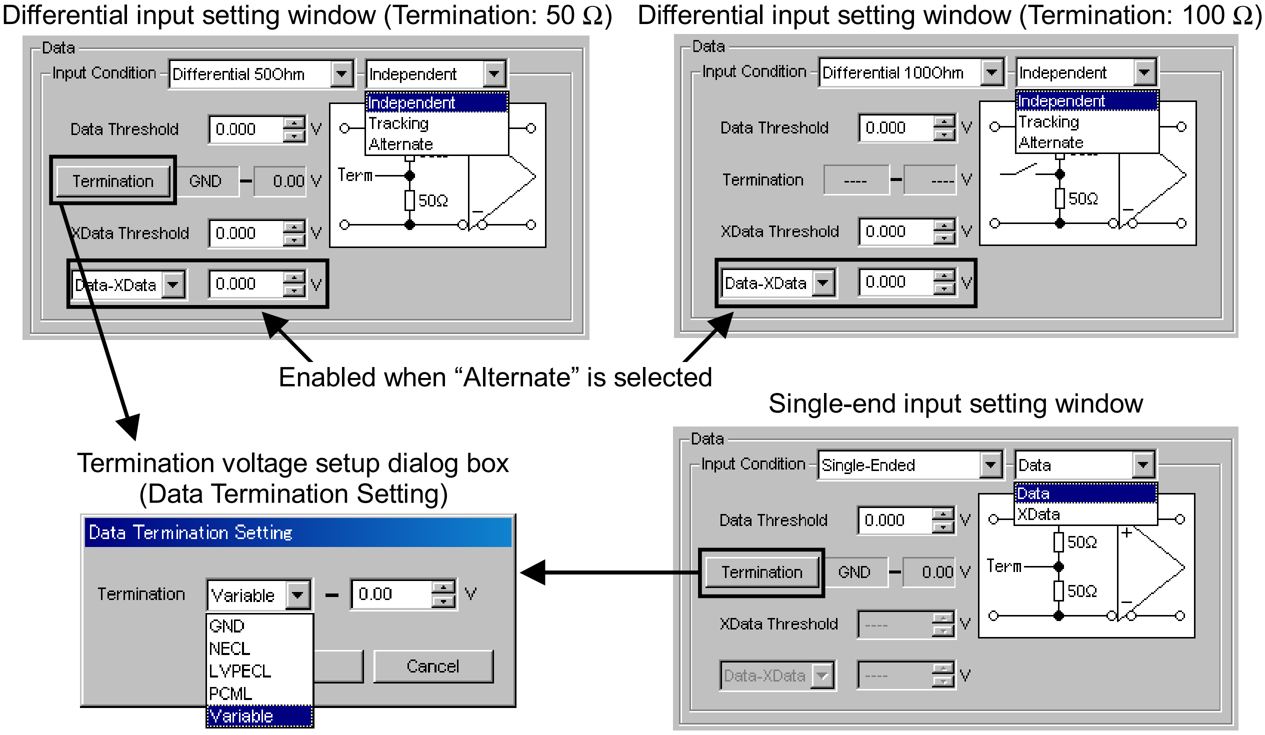


Figure 5.4.2-2 Setting Data input conditions

Table 5.4.2-1 Data input condition setting items

Data input condition setting items			Description
Differential 100 Ohm Differential 50 Ohm	Independent		Uses Data, XData as the differential input. The Data threshold and XData threshold can be changed independently
	Tracking		Uses Data, XData as the differential input. The Data threshold and XData threshold can be changed in conjunction.
	Alternate	Data-XData	Uses Data, 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, 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. ***Note:*** Be sure to attach the supplied Open to the unused input connector at the XData side before use. Malfunction may result if a signal is input to the unused connector.
	XData		Used the XData side as single-ended input. ***Note:*** Be sure to attach the supplied Open to the unused input connector at the Data side before use. Malfunction may result if a signal is input to the unused connector.

Table 5.4.2-2　Setting items in Data Termination Setting dialog box

Setting item		Description
Differential 100 Ohm	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 50 Ohm Single-Ended	GND	Terminates to 50 Ω/GND.
	NECL	Terminates to 50 Ω/–2 V. The threshold voltage is preset to –1.3 V at this time.
	LVPECL (+3.3 V)	Terminates to 50 Ω/+1.3 V. The threshold voltage is preset to 2.0 V at this time.
	PCML	Terminates to 50 Ω/+3.3 V. The threshold voltage is preset to 3.05 V at this time.
	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.

Notes:

- Do not allow an excessively large current to flow to the terminator in the MU181040A.　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. Select whether to use an external input clock or a recovery clock. Note that only External Clock can be selected when the MU181040A-x20 and MU181040B-x20 Clock Recovery is not installed.

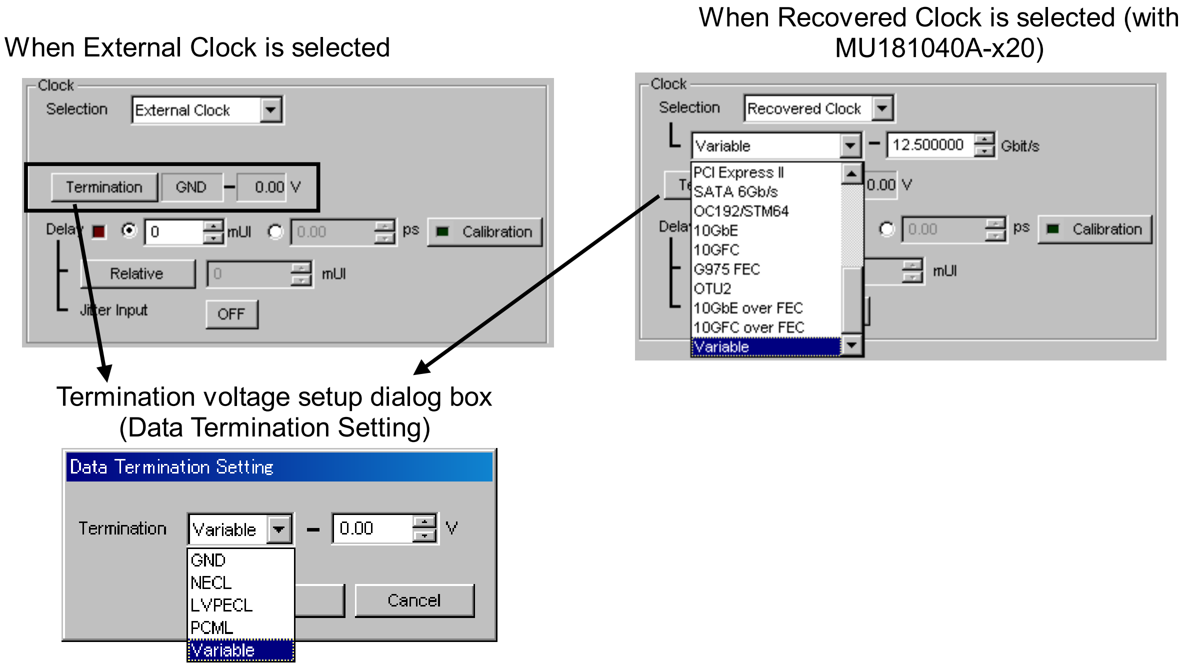


Figure 5.4.2-3 Selecting clock

Table 5.4.2-3 Clock recovery frequency setting items

Clock recovery frequency setting items		Description
Recovered Clock	Variable	Sets the operating bit rate for the clock recovery block in the MU181040A. The settable bit rates are as follows. 0.100000 Gbit/s, 0.125000 Gbit/s, 0.140600 Gbit/s, 0.155520 Gbit/s, 0.156300 Gbit/s, 0.171900 Gbit/s, 0.187500 Gbit/s, 0.200000 Gbit/s, 0.250000 Gbit/s, 0.281300 Gbit/s, 0.312500 Gbit/s, 0.343800 Gbit/s, 0.375000 Gbit/s, 0.400000 Gbit/s, 0.500000 Gbit/s, 0.562500 Gbit/s, 0.622080 Gbit/s, 0.625000 Gbit/s, 0.687500 Gbit/s, 0.750000 Gbit/s, 0.800000 Gbit/s, 1.000000 Gbit/s, 1.062500 Gbit/s, 1.125000 Gbit/s, 1.250000 Gbit/s, 1.375000 Gbit/s, 1.500000 Gbit/s, 1.600000 Gbit/s, 2.000000 Gbit/s, 2.125000 Gbit/s, 2.250000 Gbit/s, 2.488320 Gbit/s, 2.500000 Gbit/s, 2.666060 Gbit/s, 2.750000 Gbit/s, 3.000000 Gbit/s, 3.125000 Gbit/s, 3.200000 Gbit/s, 4.250000 Gbit/s, 4.900000 to 6.250000 Gbit/s, 1 kbit/s Step, 9.800000 to 12.500000 Gbit/s, 1 kbit/s Step Set a value close to the desired bit rate.
	10 G FC over FEC	Presets the operating bit rate to 11.316800 Gbit/s. Available for 10 G FC over FEC.
	10 GbE over FEC	Presets the operating bit rate to 11.095700 Gbit/s. Available for 10 GbE over FEC.
	OUT2	Presets the operating bit rate to 10.709225 Gbit/s. Available for OTU2.
	G975 FEC	Presets the operating bit rate to 10.664228 Gbit/s. Available for G975 FEC.
	10 GFC	Presets the operating bit rate to 10.518750 Gbit/s. Available for 10 GFC.
	10 GbE	Presets the operating bit rate to 10.312500 Gbit/s. Available for 10 GbE.
	OC-192/STM64	Presets the operating bit rate to 9.953280 Gbit/s. Available for OC-192/STM64.
	SATA 6Gb/s	Presets the operating bit rate to 6.000000 Gbit/s. SATA 6 Gb/s becomes available.
	PCI Express II	Presets the operating bit rate to 5.000000 Gbit/s. PCI Express II becomes available.
	4G FC	Presets the operating bit rate to 4.250000 Gbit/s. 4G FC becomes available.
	XAUI	Presets the operating bit rate to 3.125000 Gbit/s. XAUI becomes available.
	SATA 3Gb/s	Presets the operating bit rate to 3.000000 Gbit/s. SATA 3 Gb/s becomes available.
	OTU1	Presets the operating bit rate to 2.666060 Gbit/s. OTU1 becomes available.
	PCI Express I	Presets the operating bit rate to 2.500000 Gbit/s. PCI Express I becomes available.

Table 5.4.2-3 Clock recovery frequency setting items (Cont'd)

Clock recovery frequency setting items		Description
Recovered Clock (continued)	OC-48/STM16	Presets the operating bit rate to 2.488320 Gbit/s. OC-48/STM16 becomes available.
	2G FC	Presets the operating bit rate to 2.125000 Gbit/s. 2G FC becomes available.
	SATA 1.5 Gb/s	Presets the operating bit rate to 1.500000 Gbit/s. SATA 1.5 Gb/s becomes available.
	GbE	Presets the operating bit rate to 1.250000 Gbit/s. GbE becomes available.
	1G FC	Presets the operating bit rate to 1.062500 Gbit/s. 1G FC becomes available.
	OC-12/STM4	Presets the operating bit rate to 0.622080 Gbit/s. OC-12/STM4 becomes available.
	OC-3/STM1	Presets the operating bit rate to 0.155520 Gbit/s. OC-3/STM1 becomes available.

Notes:

- The MU181040A-x20 and MU181040B-x20 Clock Recovery must be installed.
- Be sure to observe the range in which locking is possible when selecting the operating bit rate.

3. Select the external input clock termination condition.

Table 5.4.2-4 Setting items in Data Termination Setting dialog box

Setting item		Description
External Clock	GND	Terminates to 50 Ω/GND.
	NECL	Terminates to 50 Ω/–2 V.
	LVPECL (+3.3 V)	Terminates to 50 Ω/+1.3 V.
	PCML	Terminates to 50 Ω/+3.3 V.
	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.

Note:

Do not allow an excessively large current to flow to the terminator in the MU181040A. Otherwise, performance may become degraded or failure may occur.

4. When the MU181040A-x30 and MU181040B-x30 Clock Phase Variable is installed, the clock delay can be changed.

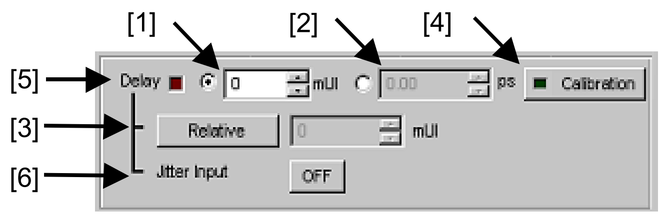


Figure 5.4.2-4 Clock delay setting items

[1] Click this radio button to set the clock delay in 1 mUI units. The MU181040A operates based on the UI units. Setting a greater value increases the clock delay.

[2] Click this radio button to set the clock delay 2 PS units. The frequency counter value is converted into PS units, based on the UI 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 1 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 [Calibration] 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 clock delay is being changed.

[6] Set the Jitter Input. When testing jitter tolerance etc. by inputting jitter-modulated clocks, set Jitter Input of Delay to ON. See 5.1.9 “When setting 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 MU181040A sets phases in mUI units as an internal standard.

- When Burst is selected for Pattern Sequence in the Misc tab window, 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] buttons light up in red continuously. This is not abnormal.

Refer to Section 5.1.9 “When setting jitter-modulated signals” for operation and precautions in case of Combination or inputting jitter-modulated signals.

5.5 Capturing Test Patterns

Click the Pattern tab on the MU181040A module operation window to display the Pattern tab window. In the Pattern tab window, the input test pattern data can be captured into the MU181040A.

5.5.1 Setting items in Pattern tab window

This section describes how to capture and analyze a test pattern in the Pattern tab window.

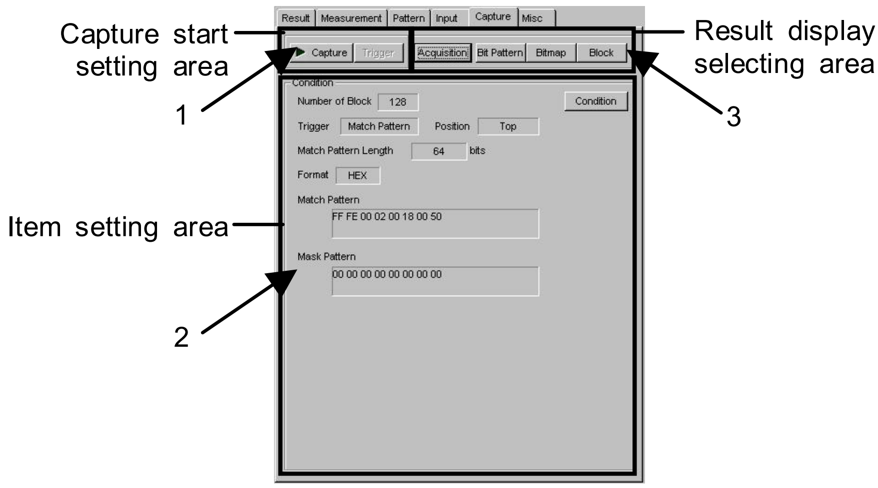


Figure 5.5.1-1 Capture tab window

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. In addition, capturing can not be executed when “Quick” is selected in the Sync control or “Sequence” is selected in a test pattern.

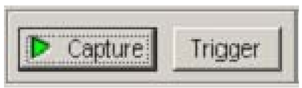


Figure 5.5.1-2 Buttons in capture start setting area

Table 5.5.1-1 Capture/Trigger buttons

Buttons	Description
Capture	Click to start capturing of a test pattern. The LED on the Capture button lights in green during test pattern capturing. The MU181040A 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 the Capture button 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.

Figure 5.5.1-3 Condition button in item setting area

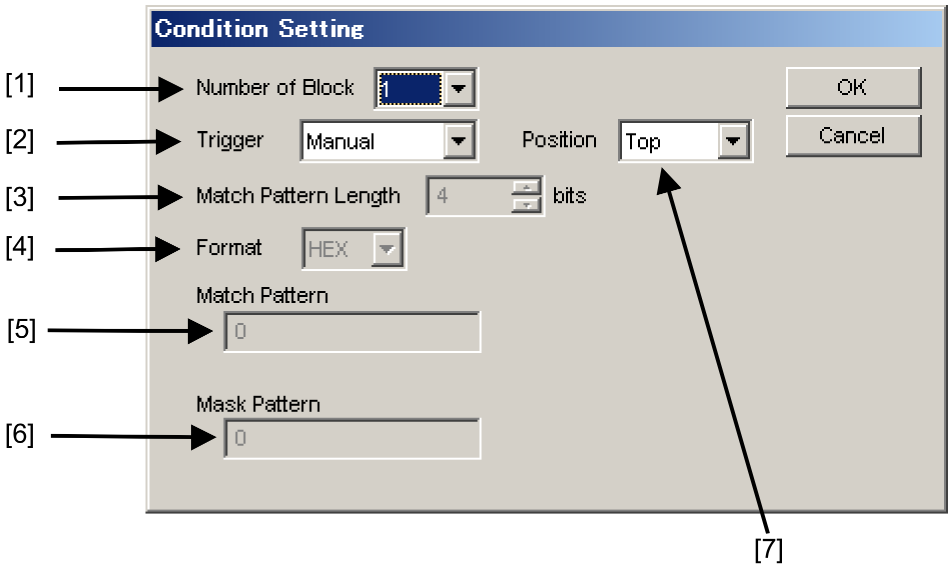


Figure 5.5.1-4 Condition Setting dialog box

[1] Select the number of blocks of the test pattern to be captured into the MU181040A, 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 = 128 Mbits ÷ Number of Block

In the case of 2 Ch Combination, the block size is multiplied by 2.

In the case of 4 Ch Combination, the block size is multiplied by 4.

[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 (see 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

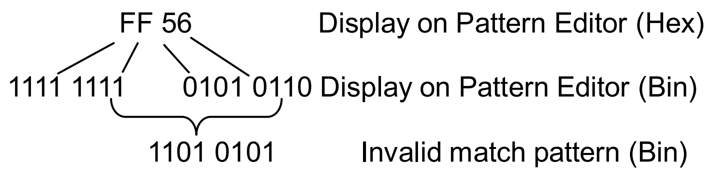
Item	Description
BIN	The match pattern is displayed in binary format.
HEX	The match pattern is displayed in hexadecimal format.

[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 2-bit units, as displayed in the Pattern Editor dialog box of the MU181040A in hexadecimal. Match patterns that cross the delimiter of 2-bit units, in hexadecimal, are invalid, which causes capturing not to start.

When setting a match pattern while the 4Ch Combination is configured, set it in 4-bit units, as displayed in the Pattern Editor dialog box of the MU181040A in hexadecimal. Match patterns that cross the delimiter of 4-bit units, in hexadecimal, are invalid, which causes capturing not to start.



[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.

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 View 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, the Bit Pattern, Bitmap, and Block buttons on the right become enabled 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.

Note:

The capturing results of 512 bits from starting position of the capturing do not contain errors.
For 2 Ch Combination, the capturing results of 1,024 bits from the starting position of the capturing do not contain errors.
For 4 Ch Combination, the capturing results of 2,048 bits from the starting position of the capturing do not contain errors.

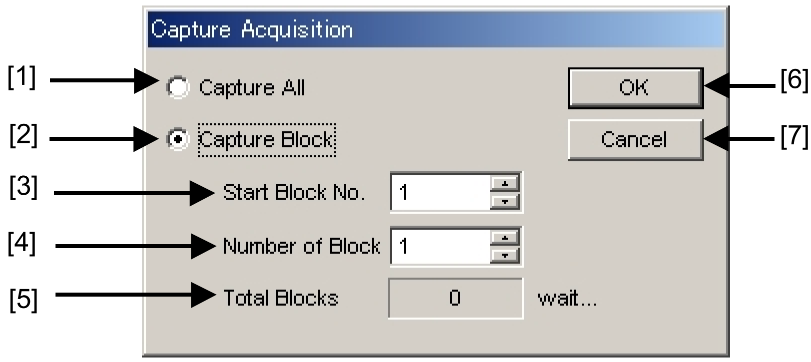


Figure 5.5.1-6 Capture Acquisition dialog box

[1] Select to display all the captured blocks.

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

[3] Specify the number of the block to be displayed first (display start block).

[4] Specify the number of blocks to be displayed following the display start block specified in Start Block No.

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

[6] Clicking [OK] starts acquisition of the captured data for the blocks specified by the parameters [1] through [4]. The acquisition time depends on the number of blocks selected from the Number of Block list box in the Condition Setting dialog box. See the table below.

Table 5.5.1-6 Capture data acquisition time

Selection in Number of Block list box	Acquisition Time for One Block	Acquisition Time for All Blocks
1	About 6 minutes	About 6 minutes
2	About 3 minutes	About 6 minutes
4	About 1.5 minutes	About 6 minutes
8	About 51 seconds	About 6 minutes
16	About 30 seconds	About 6 minutes
32	About 20 seconds	About 6 minutes
64	About 15 seconds	About 6 minutes
128	About 12 seconds	About 6 minutes

Note:

Note that the times provided in the table above should be taken as targets; they are not guaranteed.
However, for reference, the above times are doubled at 2 Ch Combination, and are quadrupled at 4 Ch Combination.

[7] Clicking [Cancel] cancels the captured data acquisition and closes the Capture Acquisition dialog box.

5.5.2　Displaying captured test pattern (Bit Pattern)

After the captured data is acquired by clicking [Acquisition], clicking [Bit Pattern] (see 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.

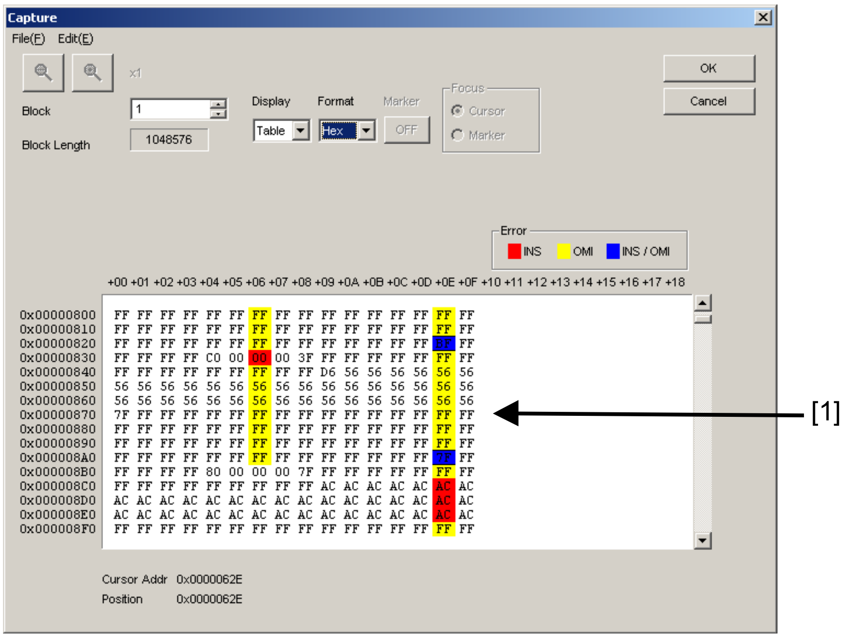


Figure 5.5.2-1　Bit Pattern window

[1]　The captured bit string is displayed in several colors, according to the 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 “Table” is set for Display and “Hex” for Format, 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”.
- Select “Save” from the File menu to save the captured data as a file.　The saved data can be displayed only in the Bit Pattern screen.　Select “Open” from the File menu to display the saved captured data with the filename as the screen title.

5.5.3 Displaying captured test pattern (Bitmap)

After the captured data is acquired by clicking [Acquisition], clicking [Bit Map] (see 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.

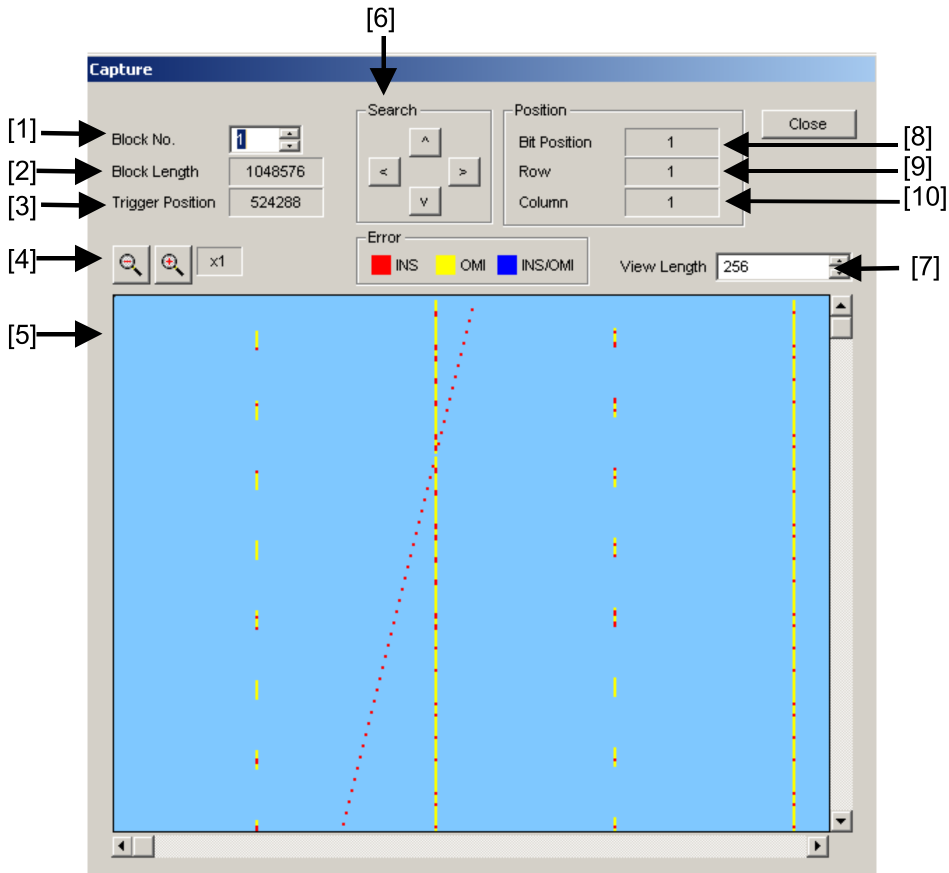


Figure 5.5.3-1 Bitmap window

[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, or ×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 a 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] (see 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.

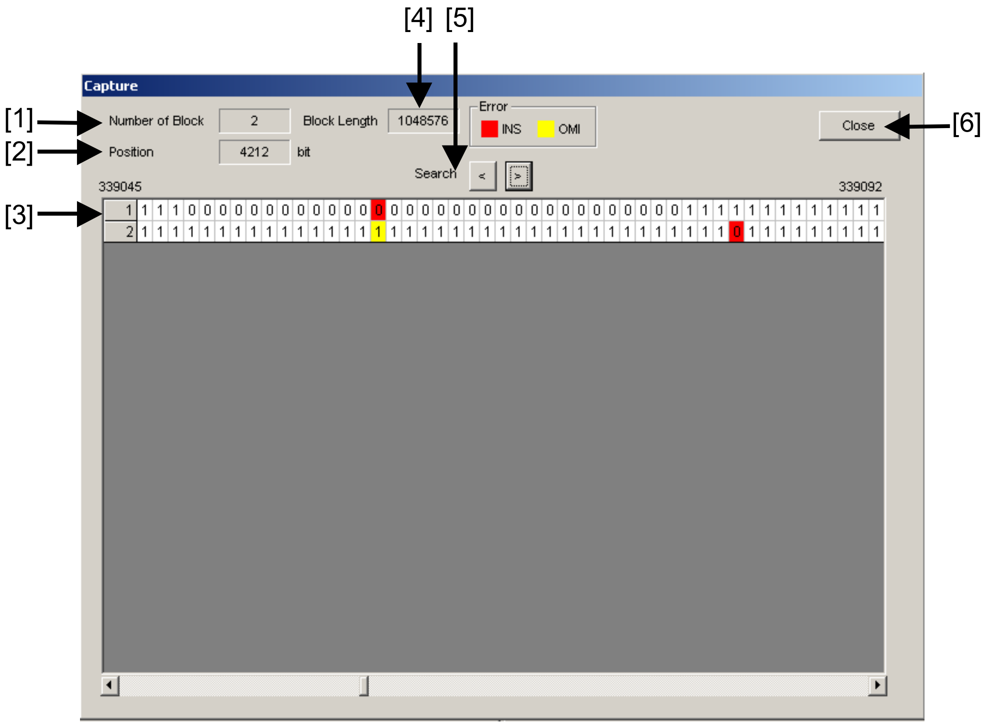


Figure 5.5.4-1 Block window

[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 MP1800A/MT1810A 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 Misc Function

Click the [Misc] tab on the operation tab window to display the Misc tab window. In the Misc tab window, other settings such as auxiliary input/output can be configured.

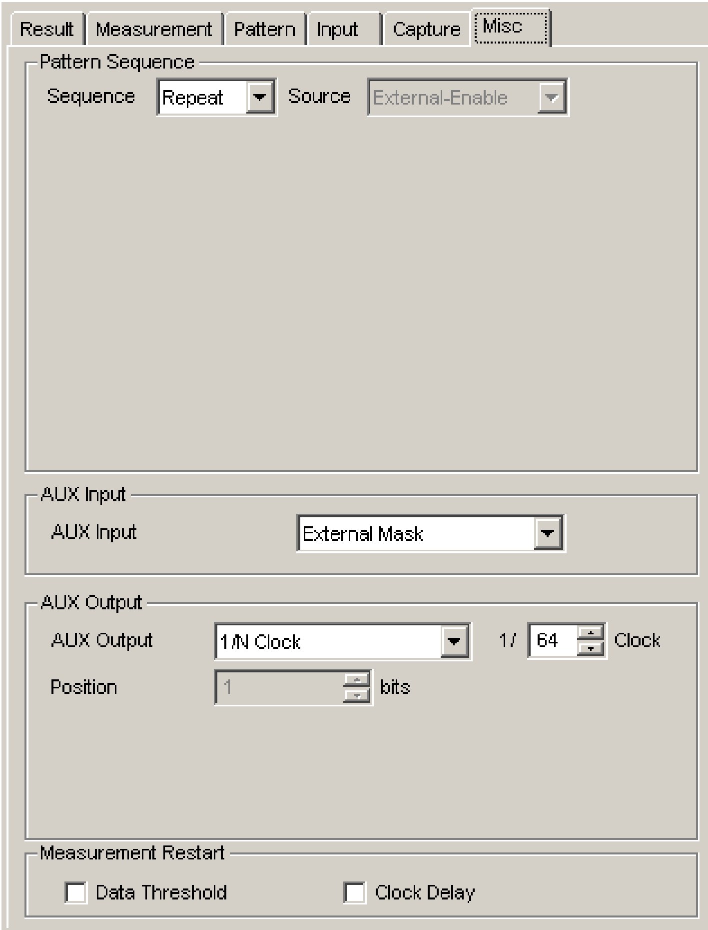


Figure 5.6-1 Misc tab window

Table 5.6-1 Setting items

Setting area	Description
Pattern Sequence	Test pattern receiving method can be set.
AUX Output	The settings for the auxiliary output function can be configured.
AUX Input	The settings for the auxiliary input function can be configured.
Measurement Restart	Item to restart the measurement when its setting is changed can be selected.

5.6.1 Setting Pattern Sequence

Select the method for generating test patterns to be measured.

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.

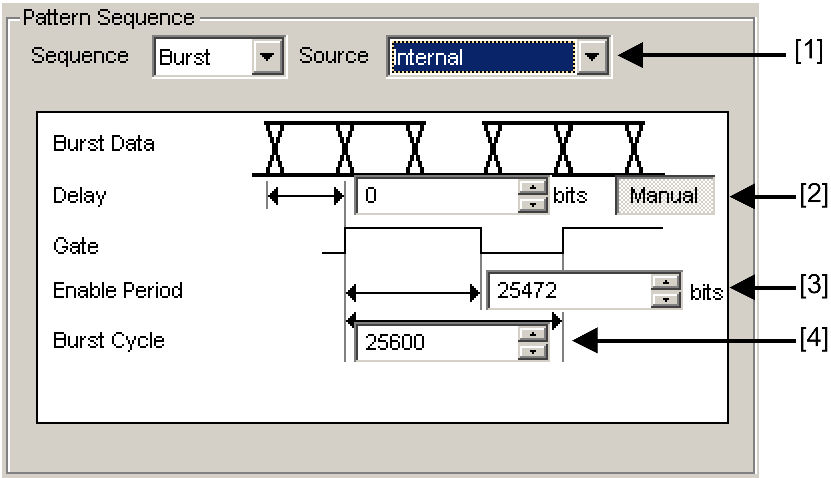


Figure 5.6.1.2-1 Pattern Sequence area when Burst is selected

[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 MU181040A, 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 textbox (see [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 or MU181040A-x01 or MU181040A-x20 are used, select “External-Enable.”

[2] Set the delay for the input test pattern and source signal (selected from the Source list box). When "Auto" is selected, the delay is automatically adjusted within the MU181040A. When "Manual" is selected, set the number of relative delay bits used in the MU181040A. At this time, the signal input from the AUX Input connector indicates the period during which the test pattern is valid.

When Source is Internal:
0 to 2,147,483,648 bits, in 16-bit steps
When Source is other than Internal:
0 to 2,147,483,584bits, in 16-bit steps
In the case of 2 Ch Combination:
When Source is Internal:
0 to 4,294,967,296 bits, in 32-bit steps
When Source is other than Internal:
0 to 4,294,967,168 bits, in 32-bit steps
In the case of 4 Ch Combination:
When Source is Internal:
0 to 8,589,934,592 bits, in 64-bit steps
When Source is other than Internal:
0 to 8,589,934,336 bits, in 64-bit steps

[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 Enable Period 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 Slot Combinations	Enable Period (bits)	Burst Cycle (bits)	Setting Steps (bits)
1	When Internal is set: 12,800 to 2,147,483,136	25,600 to 2,147,483,648	128
	When External-Trigger is set: 12,800 to 2,147,483,520		
2	When Internal is set: 25,600 to 4,294,966,272	51,200 to 4,294,967,296	256
	When External-Trigger is set: 25,600 to 4,294,967,040		

Table 5.6.1.2-2 Setting ranges for Enable Period and Burst Cycle (Cont’d)

No. of Slot Combinations	Enable Period (bits)	Burst Cycle (bits)	Setting Steps (bits)
4	When Internal is set: 51,200 to 8,589,932,544	102,400 to 8,589,934,592	512
	When External-Trigger is set: 51,200 to 8,589,934,080		

Notes:

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

- When “Auto” is selected for the delay setting, set “Frame” for Sync Control.
  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 Output

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

5.6.2.1 Setting 1/N Clock

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

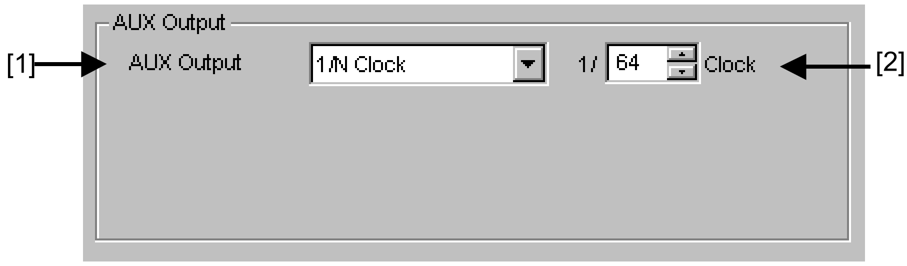


Figure 5.6.2.1-1 Setting items for AUX Output Clock

[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 range for the setting frequency dividing ratio (N) varies depending on the options installed, as follows.

9.8 to 12.5 Gbit/s (for MU181040A-001):	16, 32, or 64
0.1 to 12.5 Gbit/s (for MU181040A-002):	8 to 511, in single steps
0.1 to 14 Gbit/s (for MU181040B-002):	8 to 511, in single steps

5.6.2.2 Setting Pattern Sync

A timing signal can be generated in synchronization with the test pattern period.

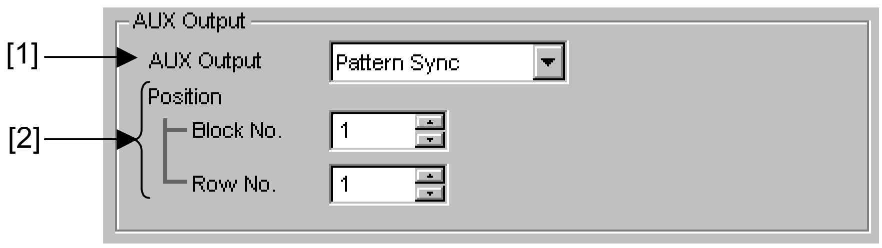


Figure 5.6.2.2-1 Setting items for AUX Output Pattern Sync

[1] When “Pattern Sync” is selected from the AUX Output list box, a pulse signal can be output from the AUX Output connector in synchronization with the set data pattern period.

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

Table 5.6.2.2-1 Synchronization signal pulse generation position setting

Test pattern	Description
PRBS	A signal pulse is generated in a PRBS 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 64) -79}, in 16-bit steps. The maximum settable number is 68,719,476,657 In the case of 2 Ch Combination: 1 to {(Least common multiple of Pattern Length* and 128) -160}, in 32-bit steps. The maximum settable number is 137,438,953,312 In the case of 4 Ch Combination: 1 to {(Least common multiple of Pattern Length* and 256) -319}, in 64-bit steps. The maximum settable number is 274,877,906,625
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 64) -79}, in 16-bit steps. The maximum settable number is 68,719,476,657 In the case of 2 Ch Combination: 1 to {(Least common multiple of Pattern Length* and 128) -160}, in 32-bit steps. The maximum settable number is 137,438,953,312 In the case of 4 Ch Combination: 1 to {(Least common multiple of Pattern Length* and 256) -319}, in 64-bit steps. The maximum settable number is 274,877,906,625
Data	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 64) -79}, in 16-bit steps. The maximum settable number is 68,719,476,657 In the case of 2 Ch Combination: 1 to {(Least common multiple of Pattern Length* and 128) -160}, in 32-bit steps. The maximum settable number is 137,438,953,312 In the case of 4 Ch Combination: 1 to {(Least common multiple of Pattern Length* and 256) -319}, in 64-bit steps. The maximum settable number is 274,877,906,625
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.
Sequence	A signal pulse is generated in the specified block number. 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 64) -79}, in 16-bit steps.

* At Independent, when the pattern length is 128 bits or less, specify the length as an integer multiple so that it becomes 129 bits or more.
At 2 Ch Combination, when the pattern length is 256 bits or less, specify the length as an integer multiple so that it becomes 257 bits or more.
At 4 Ch Combination, when the pattern length is 512 bits or less, specify the length as an integer multiple so that it becomes 513 bits or more.

5.6.2.3 Setting Sync Gain

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

5.6.2.4 Setting Error Output

A signal indicating error detection can be output. When this signal is low, it indicates that an error is detected within the MU1801040A. No setting items are required.

5.6.3 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.

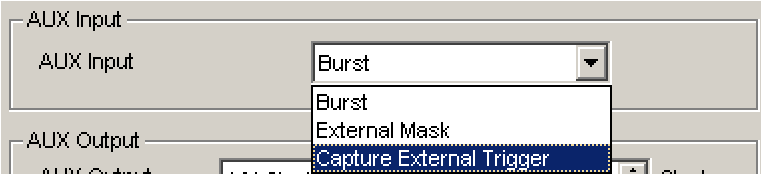


Figure 5.6.3-1 Selecting auxiliary input

Table 5.6.3-1 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.
Capture External Trigger	The input test pattern is captured at the rising edge from low to high.

Notes:

- When using Option 015 during Combination, input data to the MU1801040A in Slot 1, the master module. AUX Input of the MU1801040A in Slots 2 to 4 cannot be used.
- When using Option 016 during Combination, input data to the MU1801040A in Slot 3, the master module. AUX Input of the MU1801040A in Slots 4 to 6 cannot be used.

5.6.4 Measurement Restart area

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

Figure 5.6.4-1 Selecting measurement restart item

Table 5.6.4-1 Items in Measurement Restart area

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

5.7 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 setting items can be set in this 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 ” is displayed for help.

The Auto Search function is enabled only when MU181040A-002 (0.1 to 12.5 Gbit/s) ,MU181040B-002 (0.1 to 14 Gbit/s) is installed, and cannot be used even when MU181040A-001 (9.8 to 12.5 Gbit/s) is installed.

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

Figure 5.7-1 [Auto Search] tool button

5.7.1 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 5.7.1-1 below), operation target slot setting area (lower left of the dialog box, indicated by [3] and [6] in Figure 5.7.1-1), and result display area (lower right of the dialog box, indicated by “[6]” in Figure 5.7.1-1).

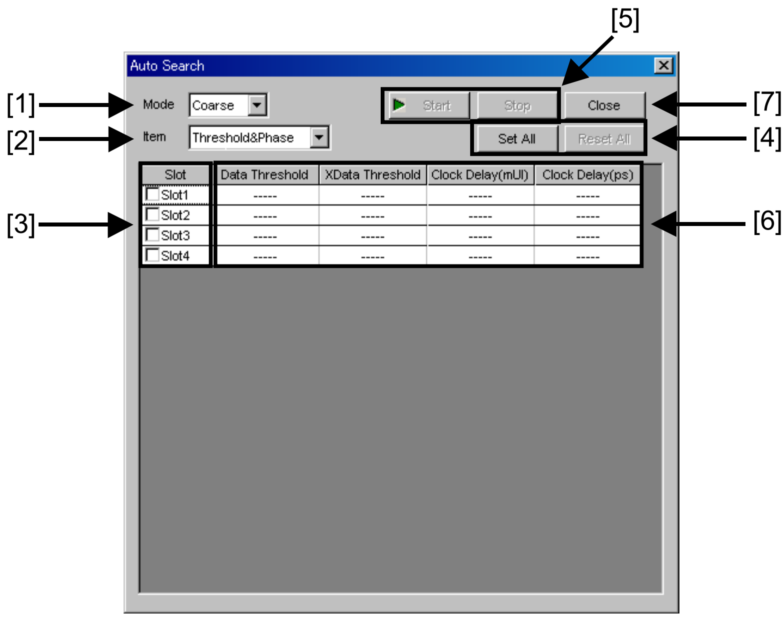


Figure 5.7.1-1 Auto Search dialog box

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

Table 5.7.1-1 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.

[2] Select the Auto Search target item from the Item list box.

Table 5.7.1-2 Execution target setting

Mode	Description
Threshold&Phase	Auto Search is executed for both Threshold and Phase. ***Note:*** Auto Search is executed for Threshold only if the MU181040A-x30 and MU181040B-x30 Clock Phase Variable is not installed in the MU181040A.
Threshold	Auto Search is executed for Threshold.
Phase	Auto Search is executed for Phase. ***Note:*** Auto Search can be executed by selecting the number of the slot in the MU181040A, in which the MU181040A-x30 and MU181040B-x30 Clock Phase Variable is installed, from the Slot checkboxes.

[3] Select the checkboxes of the slot numbers to be targeted for Auto Search. The selectable slot numbers depend on the item set in the Item list box.

[4] Clicking [Set All] selects all the checkboxes of the valid slots in the Slot area. Auto Search will be executed for all valid slots.
Clicking [Reset All] clears all the checkboxes 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 slots. Auto Search does not start if no valid slot is selected.
Clicking [Stop] stops Auto Search.

[6] Auto Search results are displayed.

Table 5.7.1-3 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.

5.8 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 MU181040A 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], " Auto Adjust " is displayed for help.

The Auto Adjust function is enabled only when MU181040A-002 (0.1 to 12.5 Gbit/s) , MU181040B-002 (0.1 to14 Gbit/s) is installed, and cannot be used even when MU181040A-001 (9.8 to 12.5 Gbit/s) is installed.

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

Click the [Auto Adjust] tool button to start and stop the Auto Adjust function.

Figure 5.8-1 [Auto Adjust] tool button

5.8.1 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 5.8.1-1 below) and operation target slot setting area (lower of the dialog box, indicated by "[2]" in Figure 5.8.1-1).

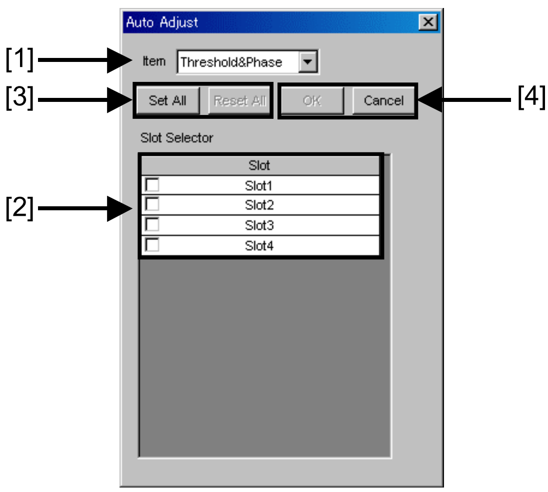


Figure 5.8.1-1 Auto Adjust dialog box

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

Table 5.8.1-1 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. ***Note:*** Auto Adjust is executed for Threshold only if the MU181040A-x30 and MU181040B-x30 Clock Phase Variable is not installed in the MU181040A.
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. ***Note:*** Auto Adjust can be executed by selecting the number of the slot in the MU181040A, in which the MU181040A-x30 and MU181040B-x30 Clock Phase Variable is installed, from the Slot checkboxes.

[2] Select the checkbox of the slot number to be targeted for Auto Adjust. The selectable slot numbers depend on the items set in the Item list box.

[3] Clicking [Set All] selects all the checkboxes of the valid slots in the Slot area. Auto Adjust will be executed for all valid slots.
Clicking [Reset All] clears all the checkboxes of the slots in the Slot area. Auto Adjust will not be executed for any slots.

[4] Clicking [OK] starts Auto Adjust for the specified slots. Auto Adjust does not start if no valid slot 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 window. "----" 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.

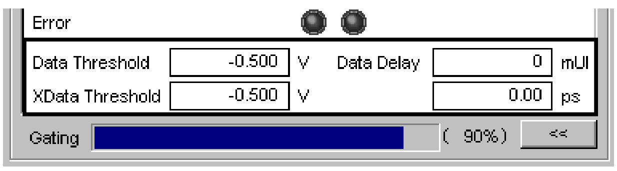


Figure 5.8.1-2 Auto Adjust executing status in Result tab window

5.9 ISI Measurement Function

ISI stands for Inter Symbol Interface. ISI measurement function is used for analysis of interferences between bits and block, by visually displaying a distribution of errors that occur between measuring bits and blocks.

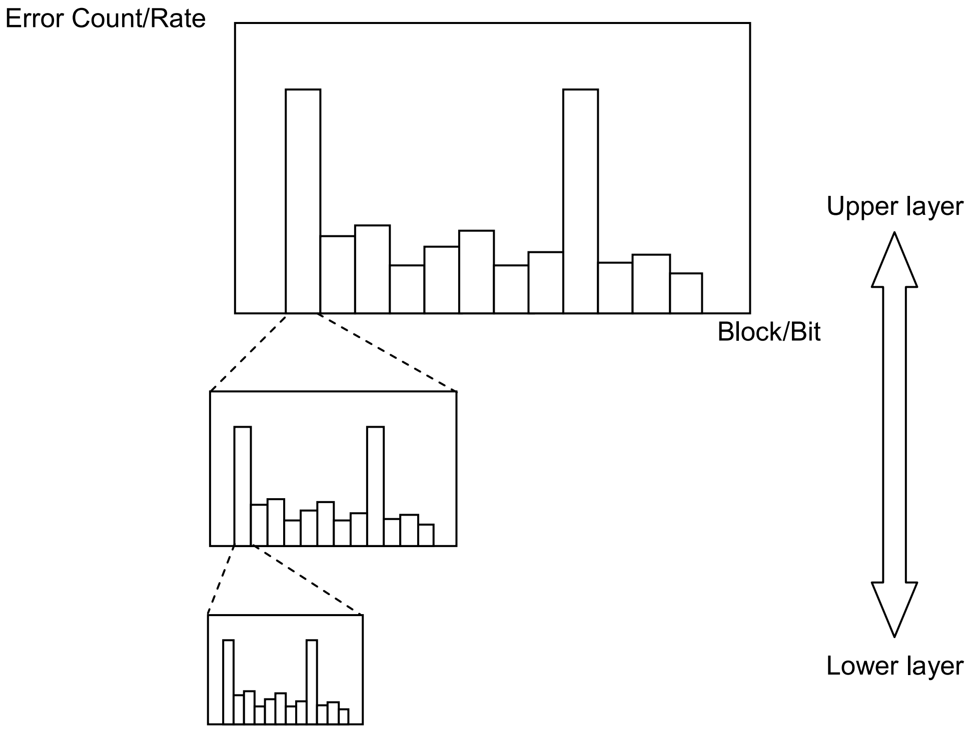


Figure 5.9-1 ISI measurement function

The ISI measurement function has the following features.

- Provides Zoom In and Zoom Out function for switching the test pattern hierarchically, from the entire of the pattern to 1 bit.
- Provides two graph display functions: Error Rate and Error Count.
- Capable of displaying up to a maximum of 64 blocks simultaneously, facilitating to recognize the interferences between bits and blocks visually.

To use the ISI measurement function, click the [Auto Measurement] module function button, and then select “ISI.” Refer to the *MX180000A Signal Quality Analyzer Control Software Operation Manual* for details.

5.9.1 Displaying ISI measurement results in ISI window

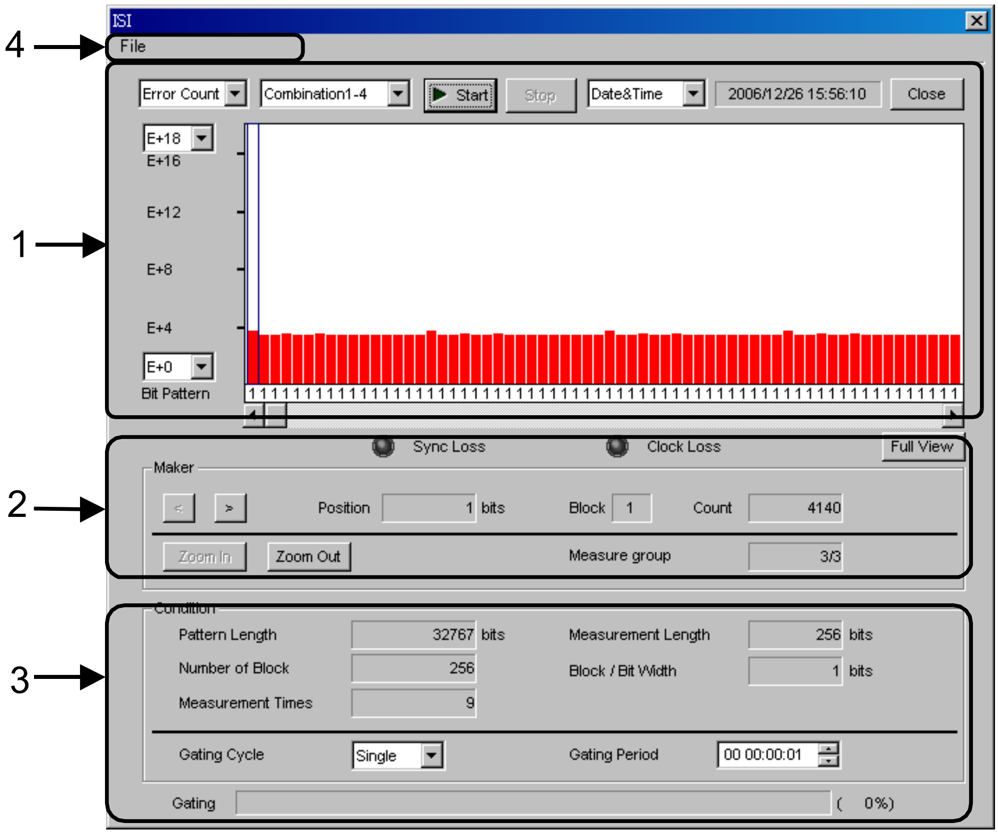


Figure 5.9.1-1 ISI window

The ISI window consists of the following four areas.

1. Measurement graph display area
2. Display control area
3. Measurement status display area
4. Menu bar

The setting items in each area are described below.

1. Measurement graph display area

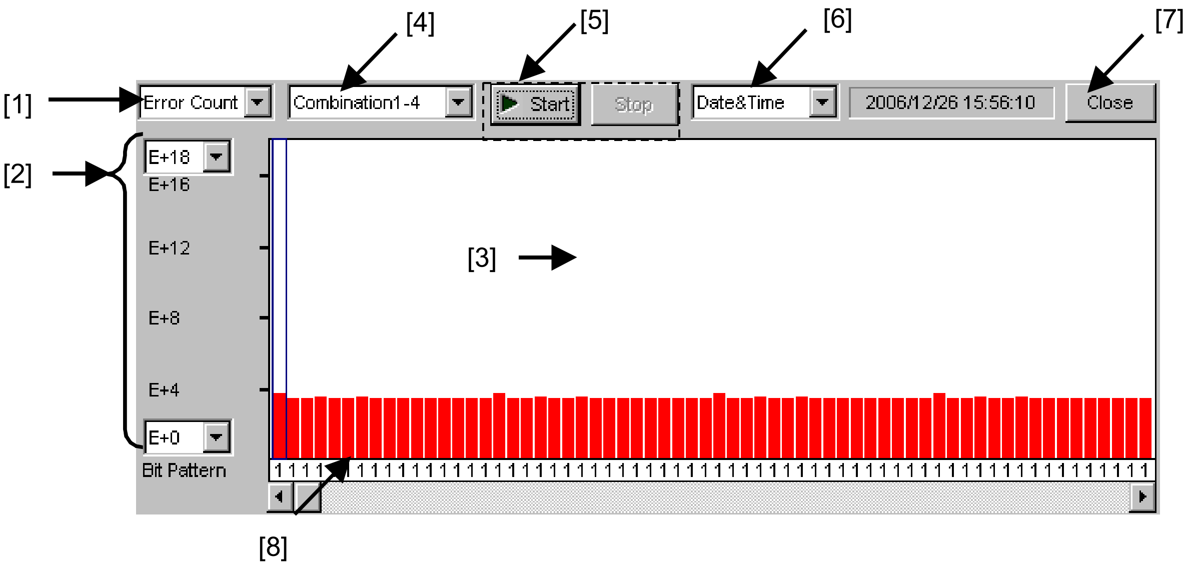


Figure 5.9.1-2 Measurement graph display area

[1] Switch between "Error Rate" and "Error Count" for Y-axis display.

[2] Set the Y-axis display range.

Table 5.9.1-1 Y-axis display range

	Graph display target	Setting range for upper limit	Setting range for lower limit
(1)	Error Rate	E–3 to E–14	E–6 to E–18
(2)	Error Count	E+2 to E+18	0 to E+14

[3] The measurement result display area. Measurement results are displayed in a bar graph. When a one-cycle pattern is separated by 64 blocks, blocks that include a fractional bit are indicated in blue.

[4] Select the target slot number for measurement.
Select from Slots 1 to 6. In the case of Combination, slot numbers that are combined are displayed in the "Combinationx-x" format.

[5] Start/stop the measurement.

[6] Select the time display format for the current time, measurement start time, and measurement elapsed time.

[7] Click to close the ISI window.

[8] Displays the bit pattern of the measurement target when the display is zoomed in to the lowest directory.
In the case of 2 Ch Combination, the number of blocks at the lowest layer is 128.
In the case of 4 Ch Combination, the number of blocks at the lowest layer is 256.

2. Display control area

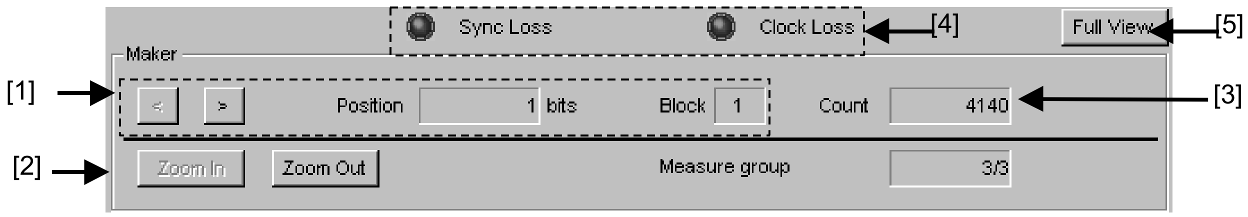


Figure 5.9.1-3 Display control area

[1] Move the cursor horizontally, using these left and right arrow keys. The marker position is displayed in the Position textbox in bit units, and the number of blocks is displayed in the Block textbox.

[2] Switch the display window using [Zoom In] and [Zoom Out].

Zoom In: The display window is switched to the window that displays the block indicated by the marker in detail. When the zoom-in function is activated, another measurement of the selected section will be made to achieve better resolution.

Zoom Out: The display range is returned to the upper layer.

The number of ISI measurement layers is displayed in the Measurement group textbox.

[3] Displays the error count (rate) in the block indicated by the marker.

[4] LEDs turn on when Sync Loss or Clock Loss occurs.

[5] Switches the measurement graph display mode.
Normally, all bits in the lowest layer can be displayed by using the scroll bar below the bit display. Clicking the [Full View] button displays all bits at once. The [Full View] button is enabled at the lowest layer for Combination.

Note:

Note that all the measurement data in the directories lower than the directory being measured currently will be cleared when remeasurement is performed.

3. Measurement status display area

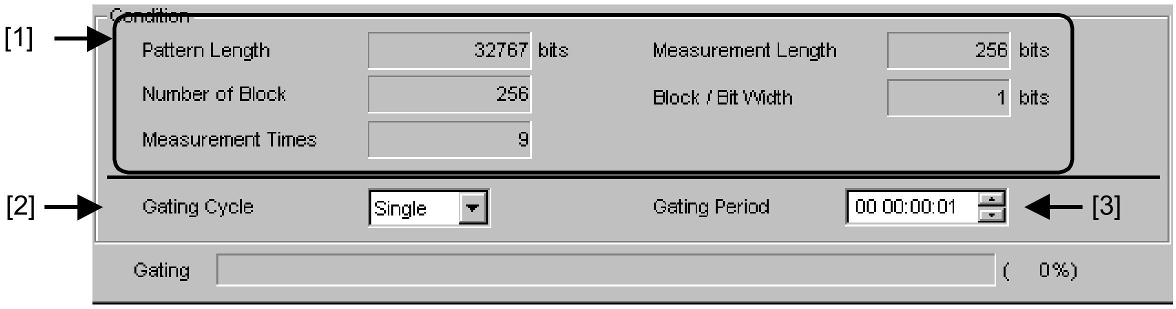


Figure 5.9.1-4 Measurement status display area

[1] Displays the measurement statuses for measuring items in the measurement graph display area.

Table 5.9.1-2 Display items

Item	Description
Pattern Length	Total pattern data length
Measurement Length	Length of the data displayed in the measurement graph display area
Number of Block	Number of blocks that are displayed separately in the measurement graph display area
Block/Bit Width	Number of bits in one block indicated by the marker.
Measurement Times	Repetition number of patters to be measured

[2] Select “Single” or “Untimed” from the Gating Cycle list box to set the Single measurement or Untimed measurement.

Table 5.9.1-3 Gating cycle setting

Gating Cycle	Description
Single	ISI measurement is continuously performed for the time period specified in the Gating Period textbox, and then ended.
Untimed	Measurement is performed continuously from the measurement start instruction to the measurement end instruction.

[3] Set the ISI measurement time for single measurement.

4. Menu bar

Table 5.9.1-4 Menu items on menu bar

Menu	Item				Function
File	Open				Opens a file. The file name is displayed as a screen title.
	Save	Data Type	ISI Result		Saves the ISI 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	ISI Result		Prints ISI measurement results. The printer setting must be configured in advance in the mainframe main window.
	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.
			Out put	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 ISI measurement window.

Note:

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

5.9.2 Restrictions on ISI measurement

The following restrictions for ISI measurement apply.

Table 5.9.2-1 Restrictions on ISI measurement

Pattern	Possible/impossible
PRBS	Impossible when the pattern length is 2^n – 1 (n = 7, 9, 10, 11)
Zero-Sub	Impossible when the pattern length is 2^n or 2^n – 1 (n = 7, 9, 10, 11)
Data	Impossible when the pattern length is 4095 bits or less. In the case of Combination, impossible when the pattern length is 16380 bits or less.
Mixed	Impossible when “Block count × Row count × Row length” is 4095 bits or less. In the case of Combination, impossible when “Block count × Row count × Row length” is 16380 bits or less. Possible in the case of PRBS restart. Impossible when PRBS Sequence is set to Consecutive.
Sequence	Impossible
Burst	Impossible

5.10 Eye Margin Measurement

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

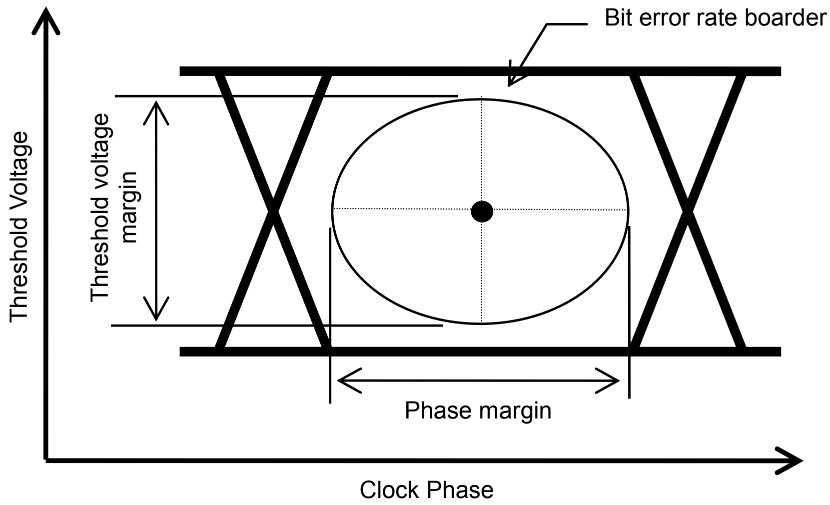


Figure 5.10-1 Schematic diagram of Eye Margin measurement

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 MU181040A 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 MU181040A-001 (9.9 to 12.5 Gbit/s) is installed
- When Burst is selected in the Pattern Sequence area on the Misc tab window
- When Alternate is selected for the test pattern
- During Auto Adjust
- When Auto Sync is set to OFF
- When MU181040A-x30 and/or MU181040B-x30 (Variable Clock Delay) is not installed, Eye Margin measurement can be performed in the threshold voltage direction only. A phase margin cannot be measured.

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.

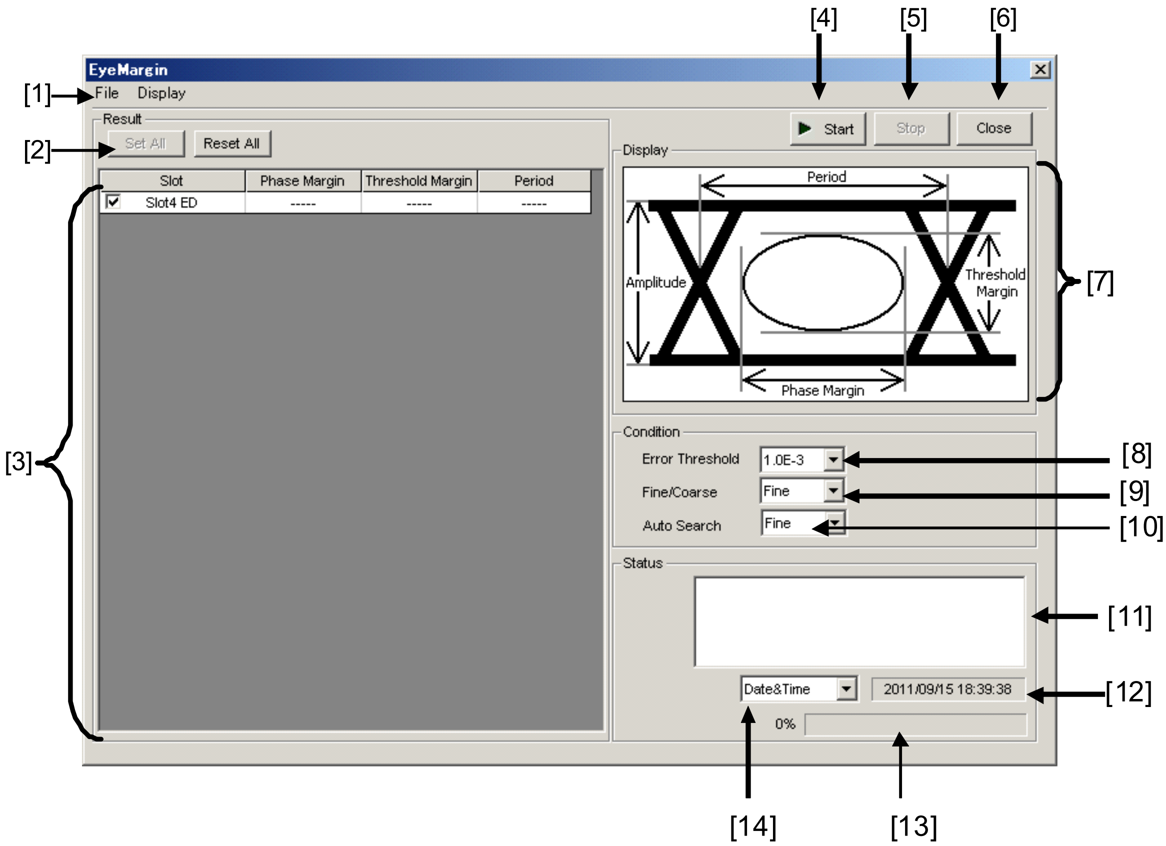


Figure 5.10.1-1 Eye Margin window

[1] Menu bar
Refer to the Section 5.10.2 “Menu items” for details.

[2] Set All and Reset All buttons

Set All: Clicking this button selects all the displayed slots.

Reset All: Clicking this button deselects all the displayed slots.

[3] Displays the slots to be selected for the Eye Margin measurement target, and the measurement results. The number of the slot where the MU181040A is inserted is displayed. Select the checkbox for the slot to be measured. When the Eye Margin measurement is finished, the measurement results of phase margin, threshold margin, and period are displayed.

[4] Start button
Click to start Eye Margin measurement. The Eye Margin measurement is performed for the slots whose checkbox is selected in C, in the slot number order.

[5] Stop button
Click to stop the Eye Margin measurement.

[6] Close button
Click to close the Eye Margin window.

[7] 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	1/1,000	100/100,000
E–4	1/10,000	100/1,000,000
E–5	1/100,000	100/10,000,000
E–6	1/1,000,000	100/100,000,000
E–7	1/10,000,000	100/1,000,000,000
E–8	1/100,000,000	100/10,000,000,000
E–9	1/1,000,000,000	100/100,000,000,000
E–10	1/10,000,000,000	100/1,000,000,000,000
E–11	1/100,000,000,000	100/10,000,000,000,000
E–12	1/1,000,000,000,000	100/100,000,000,000,000

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.

[11] The measurement status and result (whether the measurement was finished normally) are displayed for each slot.

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, CR Unlock, Out of Range, or Illegal Error is detected, it is displayed in this area. All results can be viewed by using the scrollbar.

Table 5.10.1-3 Error display

Displayed Error	Cause
Sync Loss	A Sync Loss error has occurred in the MU181040A.
Clock Loss	A Clock Loss error has occurred in the MU181040A.
CR Unlock	A CR Unlock error has occurred in the MU181040A.
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 MU181040A exceeds the Eye Margin error rate and measurement cannot be performed based on the set value.

Display example:

Slot1: Measuring…
Slot1: Measurement Completion
Slot2: Measuring…
Slot2: Sync Loss

[12] Displays the time related to the measurement.　The displayed time can be selected from the list box on the left (see [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

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 screen 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.
	Print	Type Of Print List	Eye Margin Result		Prints Eye Margin measurement results. The printer setting must be configured in advance in the MP1800A main window.
	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 MU181020A, DUT (Device Under Test), and MU181040A are correctly connected.

   Setting frequency
   Set the frequency by the synthesizer window.

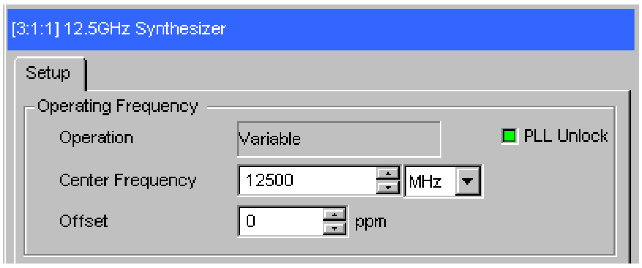


Figure 5.10.3-1 MU181000A 12.5 GHz Synthesizer window

2. Selecting slot to be measured
   Open the Eye Margin window and select the slot to be measured.

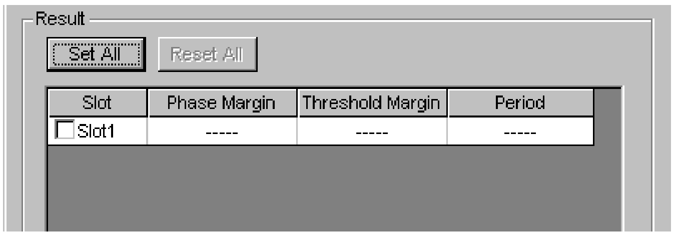


Figure 5.10.3-2 Selecting slot

3. Setting measurement conditions
   Set the conditions for Eye Margin measurement.

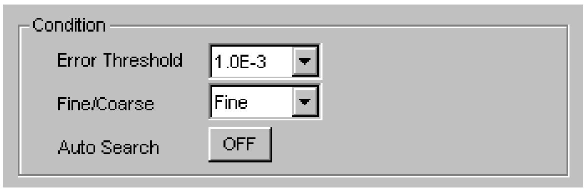


Figure 5.10.3-3 Setting measurement conditions

Select the error threshold for measurement from E–3 to E–12.
Select the measurement accuracy from Fine or Coarse.
Specify whether to execute Auto Search at the start of measurement.

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 MU181040A must be established (i.e., without Sync Loss) before the start of Eye Margin measurement.

4. Starting measurement
   Click [Start] to start Eye Margin measurement.

Figure 5.10.3-4 Measurement start button

5. Stopping measurement
   Click [Stop] to stop the Eye Margin measurement.

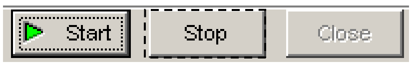


Figure 5.10.3-5 Measurement stop button

6. Checking measurement results
When the Eye Margin measurement is finished, “Measurement Completion” is displayed in the Status field, and the measurement results of phase margin, threshold margin, and period are displayed in the result display area (indicated by [3] in Table 5.10.1-1).

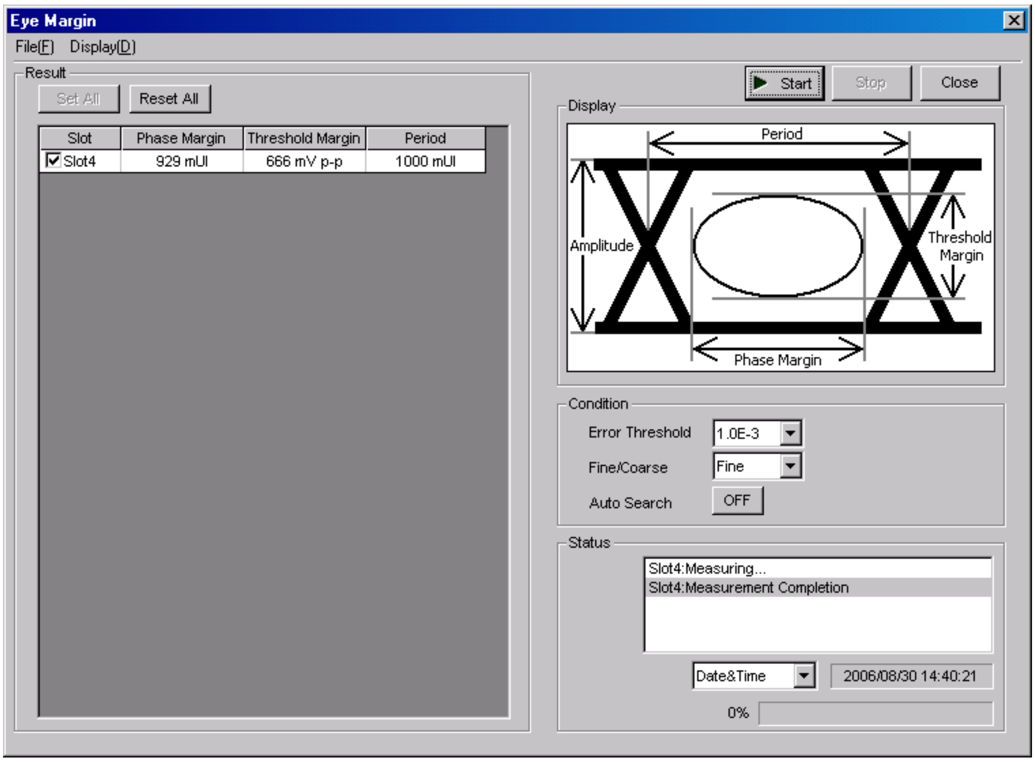


Figure 5.10.3-6 Eye Margin window with measurement results displayed

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.

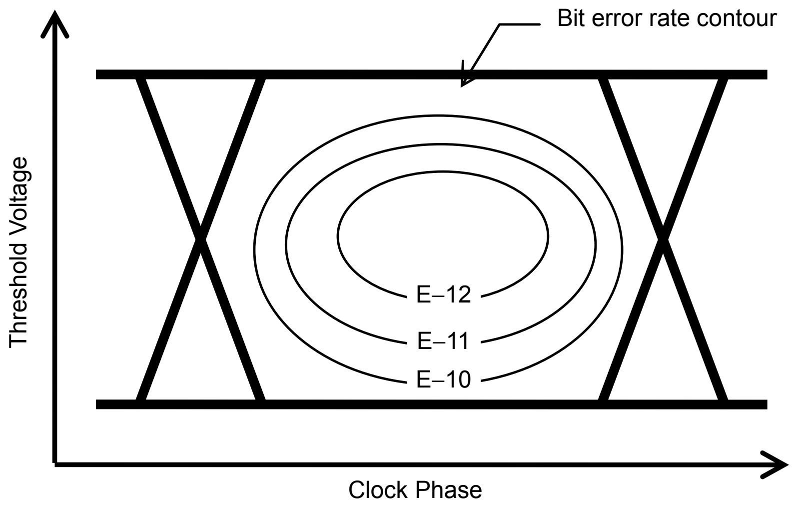


Figure 5.11-1 Schematic diagram of Eye Diagram measurement

To use the Eye Diagram measurement function, click the [Auto Measurement] module function button, and then select “Eye Diagram.” Refer to the *MX180000A Signal Quality Analyzer Control Software Operation Manual* for details.

5.11.1 Eye Diagram window

Figure 5.11.1-1 shows the Eye Diagram window.

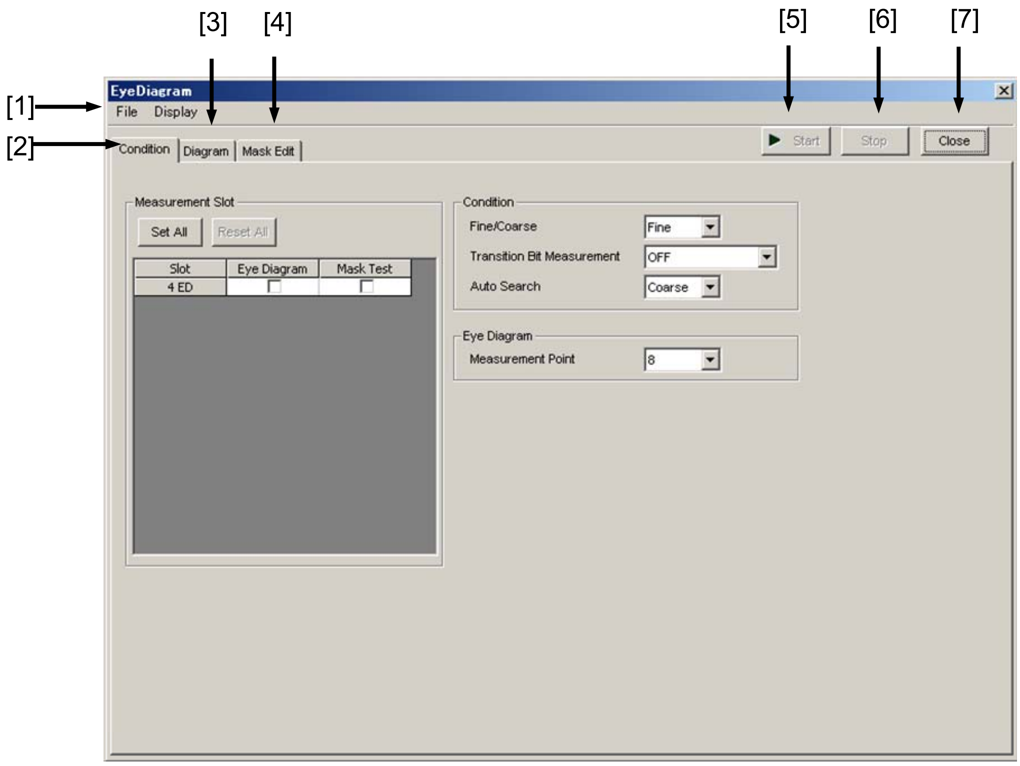


Figure 5.11.1-1 Eye Diagram window

[1] Menu bar
See Section 5.11.9 “Menu items” for details.

[2] [Condition] tab
Click to open the Condition tab window.

[3] [Diagram] tab
Click to open the Diagram tab window.

[4] [Mask Edit] tab
Click to open the Mask Edit tab window.

[5] Start button
Click to start Eye Diagram measurement.

[6] Stop button
Click to stop the Eye Diagram measurement.

[7] Close button
Click to close the Eye Diagram window.

5.11.2 Condition tab window

Figure 5.11.2-1 shows the Condition tab window.

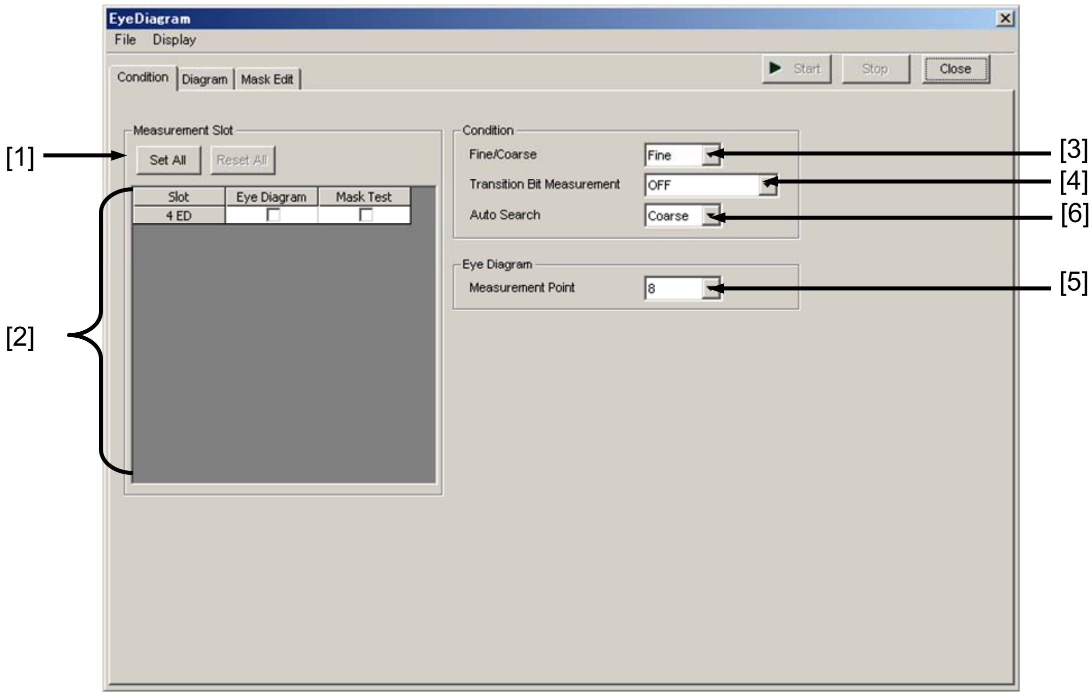


Figure 5.11.2-1 Condition tab window

[1] Set All and Reset All buttons

Set All: Clicking this button selects all the displayed slots.

Reset All: Clicking this button deselects all the displayed slots.

[2] Select the slot targeted for the Eye Diagram measurement. The number of the slot where the MU181040A is inserted is displayed. Select the checkbox for the slot to be measured. The Eye Diagram measurement is performed for the Eye Diagram and Mask Test of the selected slot.

[3] Fine/Coarse

Select the measurement accuracy from the Fine/Coarse list box. In Eye Diagram 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 coarse measurement and fine measurement. Table 5.11.2-1 lists the actual values of the error count and the clock count. The measuring quantity becomes greater when Fine is selected, so the Eye Diagram measurement takes longer than when Coarse is selected.

Table 5.11.2-1 Error count and clock count for each error threshold

Error Threshold	Error Count/Clock Count	
	Coarse	Fine
E–3	1/1,000	100/100,000
E–4	1/10,000	100/1,000,000
E–5	1/100,000	100/10,000,000
E–6	1/1,000,000	100/100,000,000
E–7	1/10,000,000	100/1,000,000,000
E–8	1/100,000,000	100/10,000,000,000
E–9	1/1,000,000,000	100/100,000,000,000
E–10	1/10,000,000,000	100/1,000,000,000,000
E–11	1/100,000,000,000	100/10,000,000,000,000
E–12	1/1,000,000,000,000	100/100,000,000,000,000

The setting resolutions for Threshold and Phase also differ between coarse and fine measurement. Table 5.11.2-2 shows the differences in the setting resolutions for Threshold and Phase.

Table 5.11.2-2 Setting resolutions for Threshold and Phase

	Coarse	Fine
Threshold	5 mV	1 mV
Phase	10 mUI	1 mUI

[4] 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 ($0 \rightarrow 1$ or $1 \rightarrow 0$) from that of the previous bit. A non-transition bit is a bit whose level is the same as that of the previous bit.

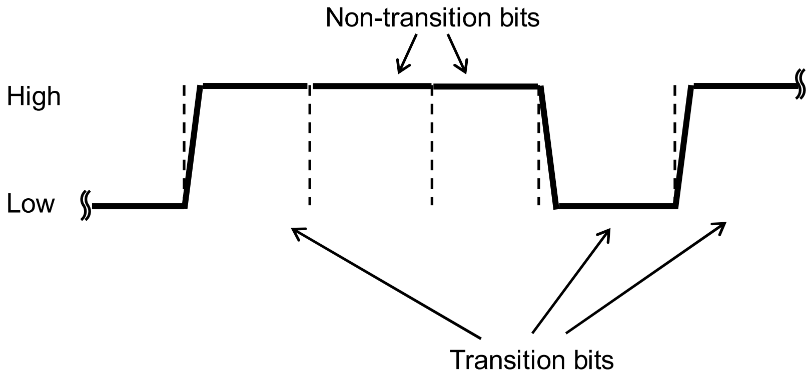


Figure 5.11.2-2 Transition bits and non-transition bits

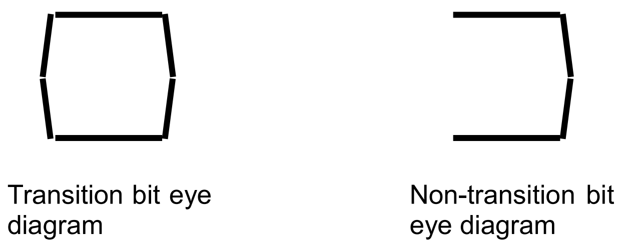


Figure 5.11.2-3 Eye diagrams of transition and non-transition bits

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.

[5] Measurement Point

Set the number of Eye Diagram measurement points from 8, 16, 32, 64, and 132. 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.

[6] 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.

5.11.3 Diagram tab window

Figure 5.11.3-1 shows the Diagram tab window.

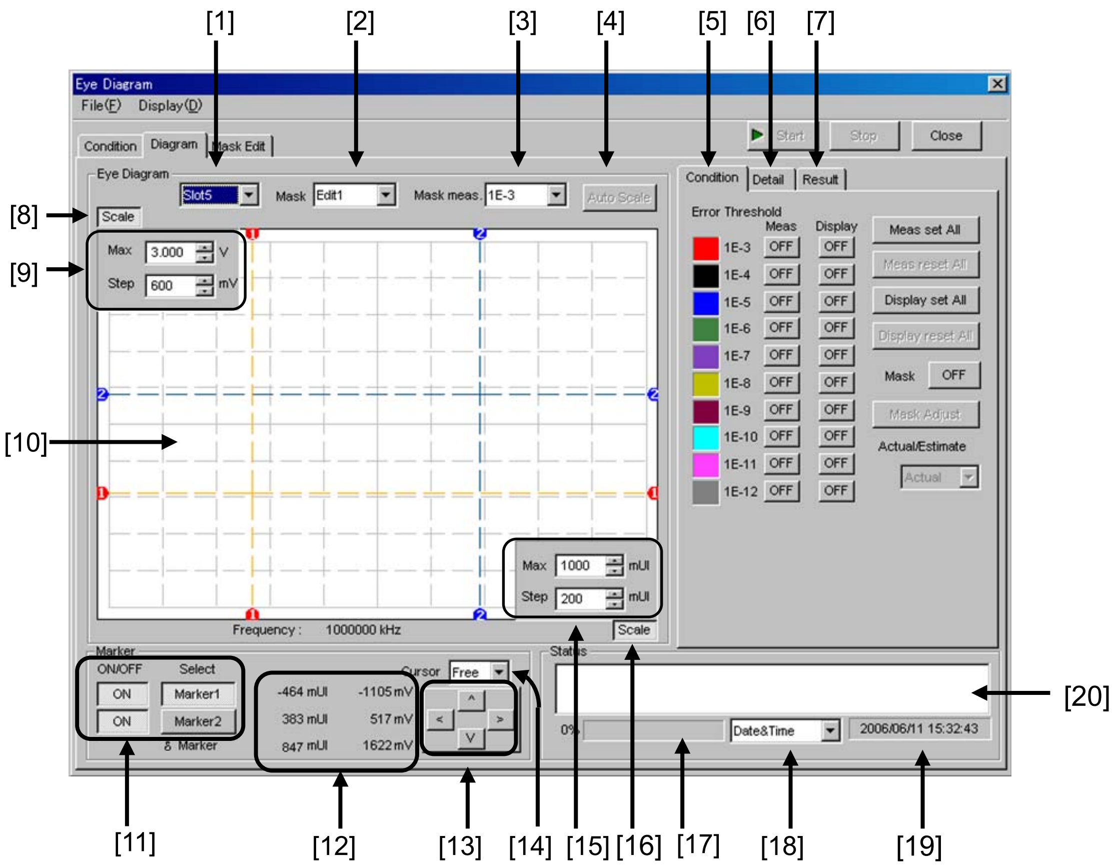


Figure 5.11.3-1 Diagram tab window

[1] Select the number of the slot where the MU181040A to be measured is inserted. Only slots where an MU181040A is inserted can be selected.

[2] Mask
Select a mask to be displayed in the graph (“[10]” in Figure 5.11.4-1) from Edit1 through Edit4, which are created in the Mask Edit tab window.

[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 ([10] in Figure 5.11.3-1) are automatically adjusted to be suitable for Diagram and Mask to be displayed.

[5] [Condition] tab
Click to open the Condition tab window.

[6] [Detail] tab
Click to open the Diagram tab window.

[7] [Result] tab
Click to open the Result tab window.

[8] Scale button
When this button is clicked and depressed, the Max and Step textboxes (indicated by "[9]" in Figure 5.11.4-1) are displayed. The threshold scale on the vertical axis can be set by entering a value into these textboxes. When this button is raised, the Max and Step textboxes are not displayed, and the Max and Step values of the vertical axis are displayed on the right of this button.

[9] Max and Step textboxes
These are displayed when the Scale button (indicated by "[8]" in Figure 5.11.3-1) is depressed.

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: 0.001 to 0.800 V
Resolution: 0.001 V

[10] Graph
Eye Diagram and Mask are displayed.

[11] Marker
Specify whether to display or hide Marker1 and Marker2. The selected marker can be moved using the arrow keys (indicated by [13] in Figure 5.11.3-1). 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.

[12] 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.

[13] Arrow keys
Click an arrow key to move the marker selected in [11] in the corresponding direction (up/down/left/right). When "Fine" is selected from the Fine/Coarse list box in the Condition tab window, the marker moves by 1 mUI or 1 mV each time a key is clicked once. When "Coarse" is selected, the marker moves by 10 mUI or 5 mV each time a key is clicked once.

[14] Cursor

Select the Marker1/2 operation.

Free: The Marker operation is not restricted.

Point: The Marker can select the measured diagram points only.

[15] Max and Step textboxes

These are displayed when the Scale button (indicated by [16] in Figure 5.11.3-1) is depressed.

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

[16] Scale button

When this button is clicked and depressed, the Max and Step textboxes (indicated by [15] in Figure 5.11.3-1) are displayed. The phase value scale on the horizontal axis can be set by entering a value in these textboxes. When this button is raised, the Max and Step textboxes are not displayed, and the Max value and Step value of the horizontal axis are displayed on the left of this button.

[17] Indicates the measurement progress as a percentage and a gauge.

[18] Select the time to be displayed.

Date&Time: Current time
Start Time: Measurement start time
Elapsed Time: Time elapsed from the measurement start time

[19] Displays the time related to the measurement. The displayed time can be selected from the list box on the left (see [18]).

[20] 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 scrollbar.

Display example:

1-Slot1: Measuring…
1-Slot1: Measurement Completion
1-Slot2: Measuring…
1-Slot2: Sync Loss

5.11.4 Condition tab window

Figure 5.11.4-1 shows the Condition tab window.

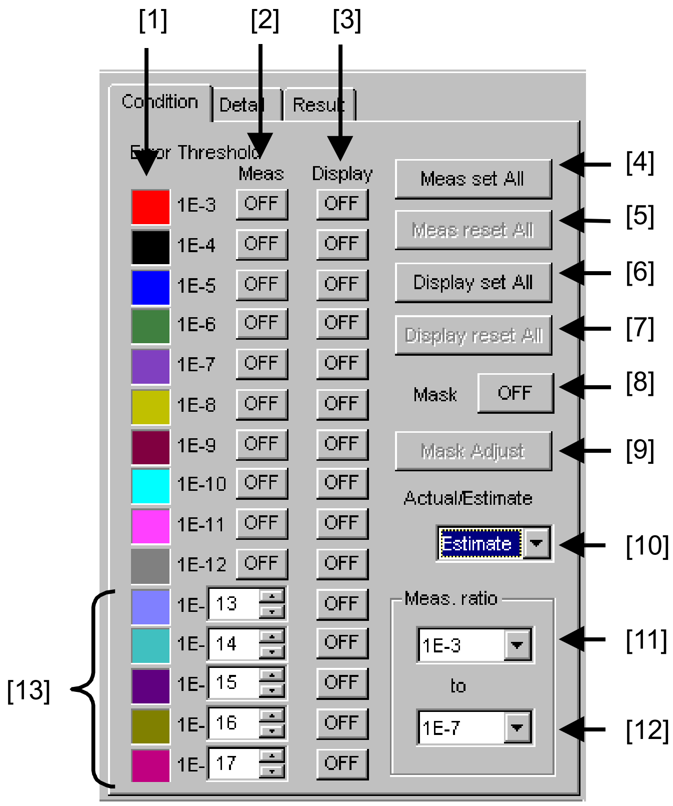


Figure 5.11.4-1 Condition tab window

[1] Error rate
Shows the correspondence between the color of a diagram displayed in the graph and the error rate.

[2] Meas.
Specify whether to perform measurement for each error rate.

ON: Measures.
OFF: Does not measure.

[3] Display
Specify whether to display a measurement result diagram in the graph for each error rate.

ON: Displays.
OFF: Does not display.

[4] Meas. set All
Eye Diagram measurement is performed for all error rates when this button is clicked.

[5] Meas. reset All
Eye Diagram measurement is not performed for all error rates when this button is clicked.

[6] Display set All
A measurement result diagram is displayed in the graph for all error rates when this button is clicked.

[7] Display reset All
A measurement result diagram is not displayed in the graph for any error rates when this button is clicked.

[8] Mask
Specify whether to display a mask created in the Mask Edit tab window 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. See Sections 5.11.2 “Condition tab window” 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.

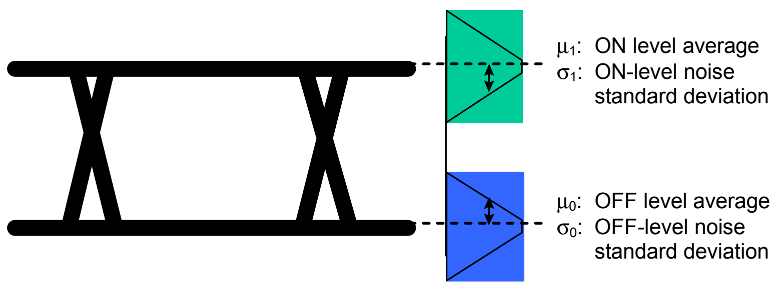
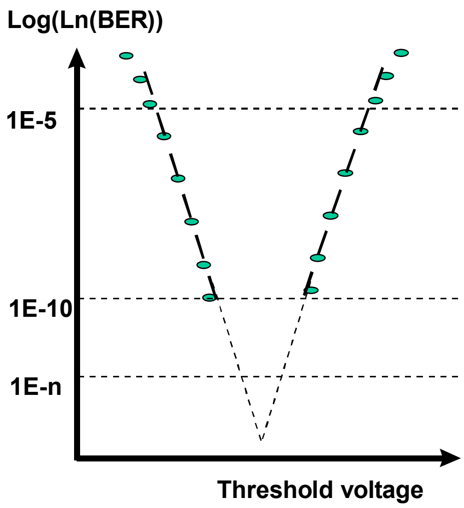


Figure 5.11.5-1 Eye pattern and Gaussian distribution noise

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 (see 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.

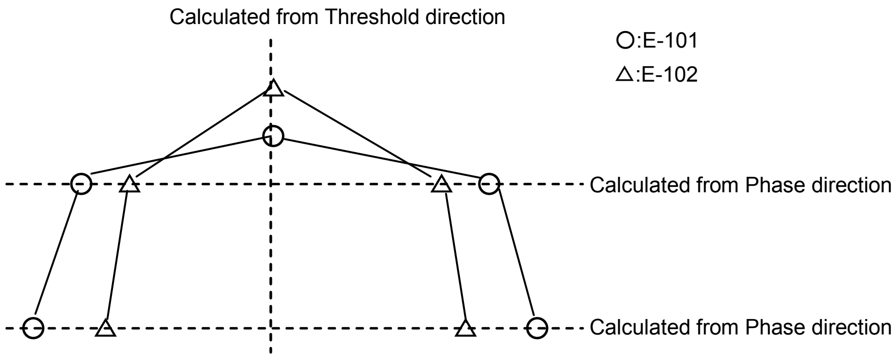


Figure 5.11.5-3　Example of tracing Estimate Eye diagram

5.11.6 Detail tab window

5.11.6.1 When Point Test is selected

Figure 5.11.6.1-1 shows the Detail tab window when Point Test is selected.

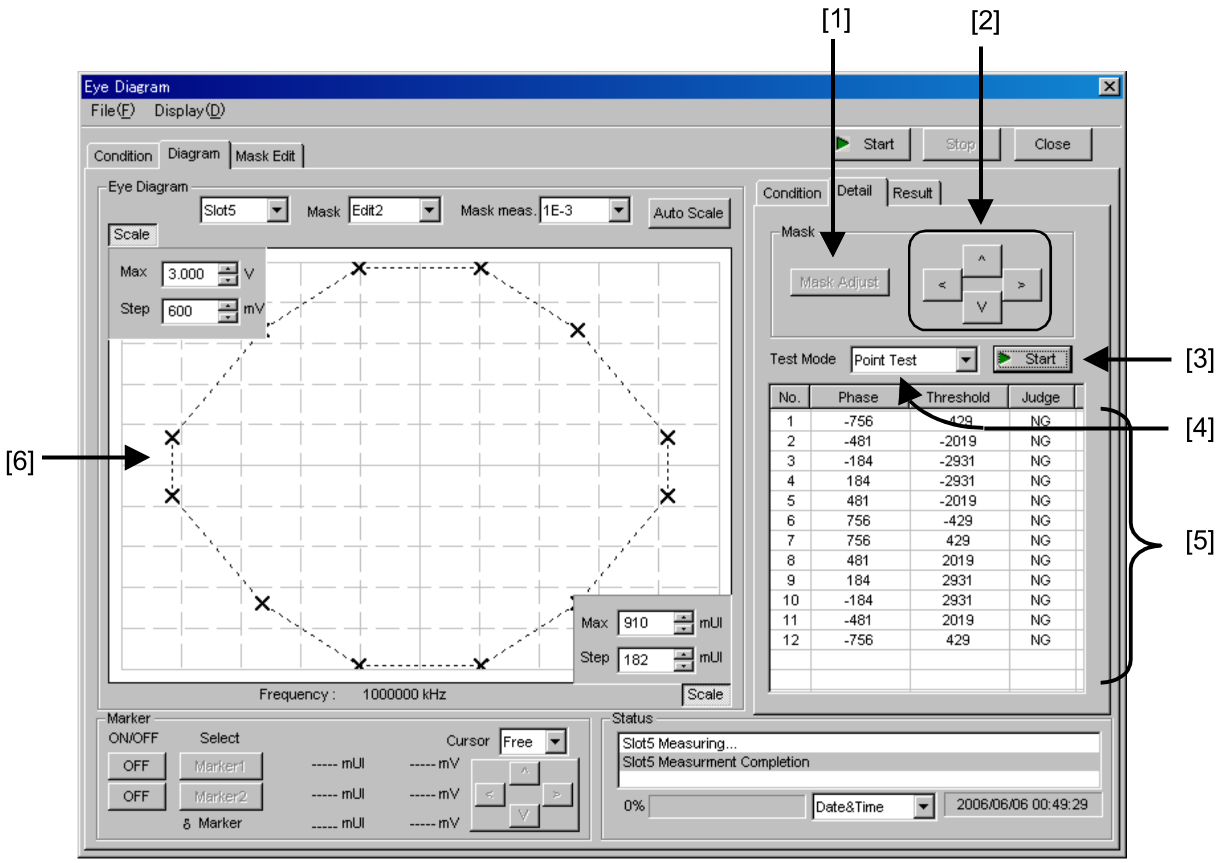


Figure 5.11.6.1-1 Detail tab window when Point Test is selected

[1] 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.

[2] Arrow keys

Click an arrow key to move the marker in the corresponding direction (up/down/left/right).

[3] Start button

Click to start the measurement selected in the Test Mode list box. Clicking this button during measurement stops the measurement. Measurement is performed for the mask point displayed in the graph. Note that only the measurement selected in the Test Mode list box is performed, and the Eye Diagram measurement is not performed.

[4] Test Mode
Select the test mode.

Point Test: Eye Diagram measurement is performed at all the points of the mask displayed in the graph.

Mask Line Test: See Section 5.11.6.2 “When Mask Line Test is selected” for details.

[5] The Point Test measurement results are displayed.

[6] Graph
Eye Diagram and Mask are displayed.

5.11.6.2 When Mask Line Test is selected

Figure 5.11.6.2-1 shows the Detail tab window when Mask Line Test is selected.

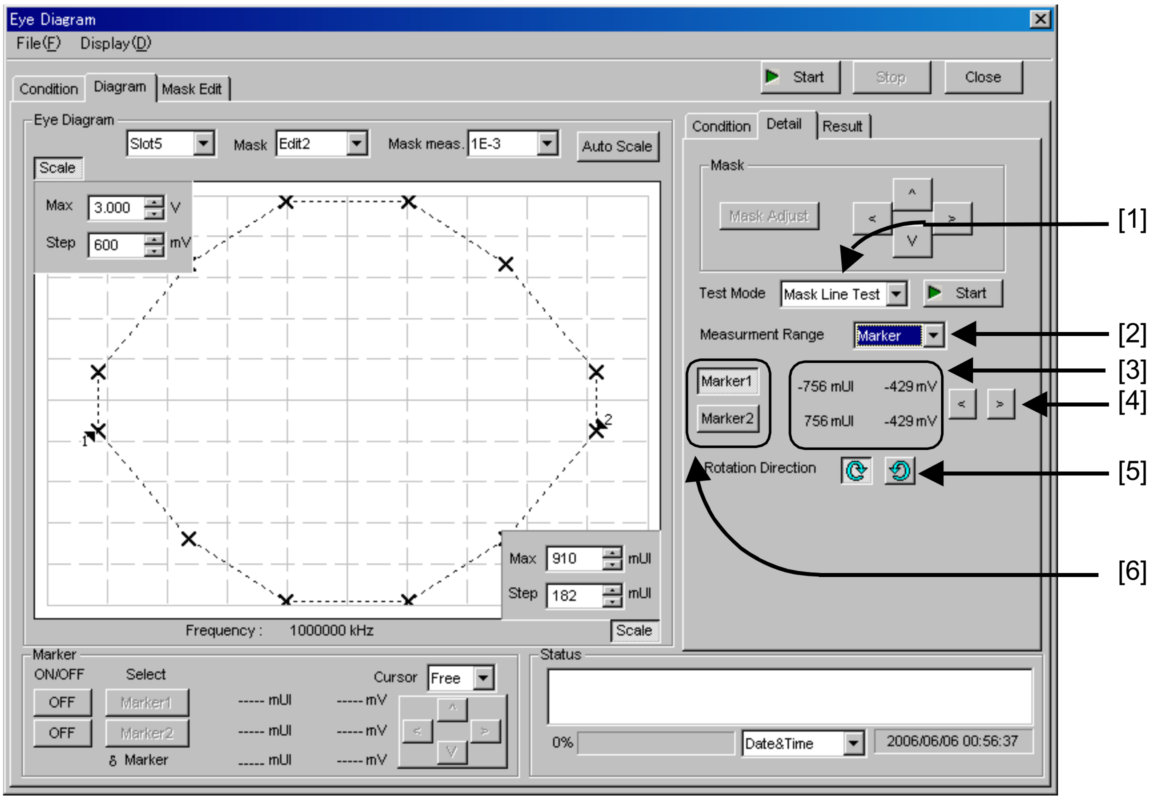


Figure 5.11.6.2-1 Detail tab window when Mask Line Test is selected

[1] Test Mode

Select the test mode.

Mask Line Test: Measurement is performed for the sides of the displayed mask. The number of measurement points is greater than for Point Test measurement, because it depends on the Fine/Coarse setting in the Condition tab window. See Section 5.11.6.1 "When Point Test is selected" for details on the Pint test.

[2] Measurement Range

Select the measurement range.

All: Measurement is performed for all sides on the displayed mask.

Marker: Measurement is performed for the range from Marker1 to Marker2 on the sides of the displayed mask.

[3] The phase values and threshold voltages of Marker1 and Marker2 are displayed.

[4] Click to move the marker selected by the button indicated by [6] in Figure 5.11.6.2-1.

<: The marker moves clockwise when clicked.

>: The marker moves counterclockwise when clicked. from left to right.

[5] Rotation Direction
Select the measuring direction from Marker1 to Marker2, clockwise or counterclockwise.

[6] Select the marker that is moved when the button indicated by [4] in Figure 5.11.6.2-1 is clicked.

5.11.7 Result tab window

Figure 5.11.7-1 shows the Result tab window.

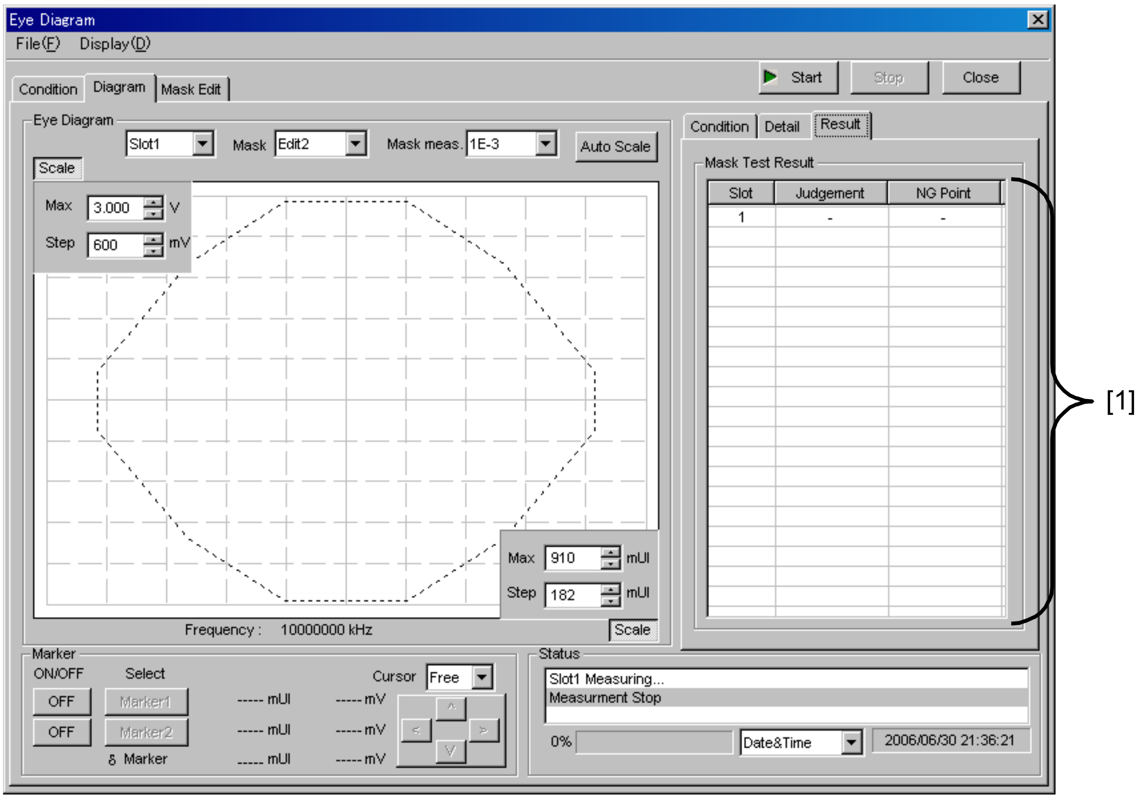


Figure 5.11.7-1 Result tab window

[1] Mask Test Result

Slot column:

The mask test results for each slot are displayed.

Judgment column

OK: Displayed when all the mask points satisfy the set error rate.

NG: Displayed when a mask point that does not satisfy the set error rate exists.

NG Point column

The number of points that are evaluated as “NG” is displayed.

5.11.8 Mask Edit tab window

Figure 5.11.8-1 shows the Mask Edit tab window.

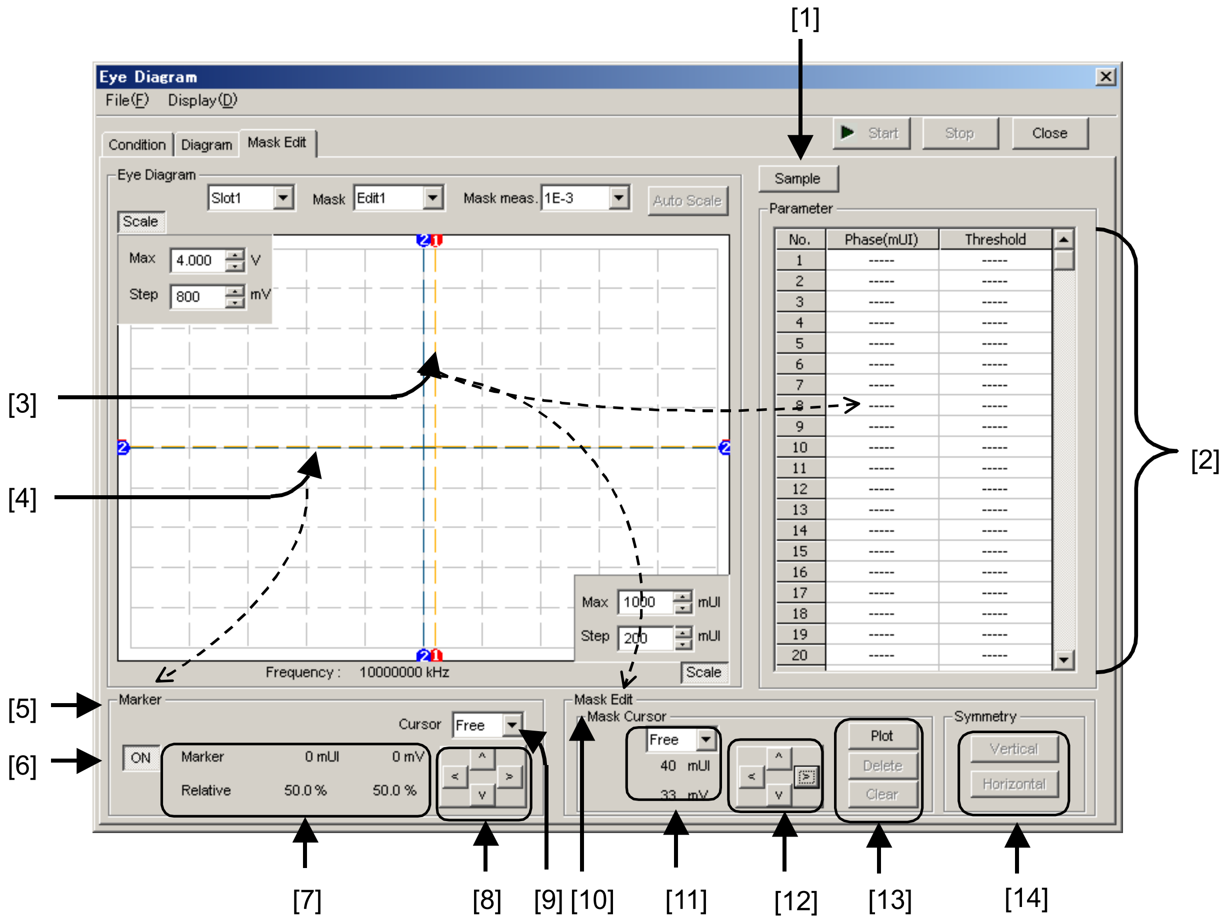


Figure 5.11.8-1 Mask Edit tab window

[1] Sample button

Click to open 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 in the Mask Edit tab window, 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 5.11.8-1).

[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 5.11.8-1). 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 5.11.8-1). The marker can 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.

[4] Marker (blue)
Indicates the marker displayed in the Marker field ([5] in Figure 5.11.8-1).

[5] Marker field
Displays the information on the marker displayed in the graph when the button indicated by [6] in Figure 5.11.8-1 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 5.11.8-1 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). When “Fine” is selected from the Fine/Coarse list box in the Condition tab window, the marker moves by 1 mUI or 1 mV each time a key is clicked once. When “Coarse” is selected, the marker moves by 10 mUI or 5 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 5.11.8-1) 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 1 mUI or 1 mV each time a key is clicked once.

[13] These buttons are used to edit the mask cursor.

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.

5.11.9 Menu items

Table 5.11.9-1 lists the menu items provided in the Eye Diagram window. No menu items can be selected during measurement.

Table 5.11.9-1 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 Detail Result		Saves Eye Mask Detail 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.
	Print	Type Of Print List	Eye Diagram Result		Prints Eye Diagram measurement results.*
			Eye Mask Point Result		Prints Eye Mask Point measurement results.*
			Eye Mask Detail Result		Prints Eye Mask Detail 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.

*: The printer setting must be configured in advance in the mainframe main window.

Table 5.11.9-1 Menu items in Eye Diagram window (Cont’d)

Menu	Menu Item	Function
File(Cont’d)	Exit	Closes the Eye Diagram 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.

5.11.10 How to perform Eye Diagram measurement

This section provides a basic procedure for performing Eye Diagram measurement.

1. Checking connection
   Check that the MU181020A, DUT, and MU181040A are correctly connected.
2. Setting frequency
   Set the frequency by the synthesizer.

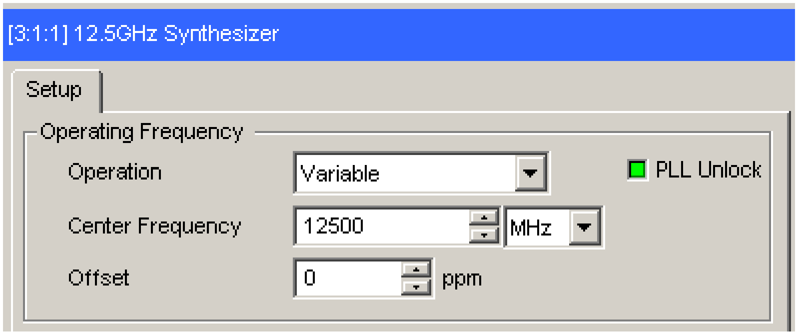


Figure 5.11.10-1 MU181000A 12.5 GHz Synthesizer window

3. Selecting slot to be measured
   Start the Eye Diagram window in automatic measurement, then select the Eye Diagram checkbox of the slot to be measured, and then set Fine or Coarse, Transition Bit Measurement, and Measurement Point.

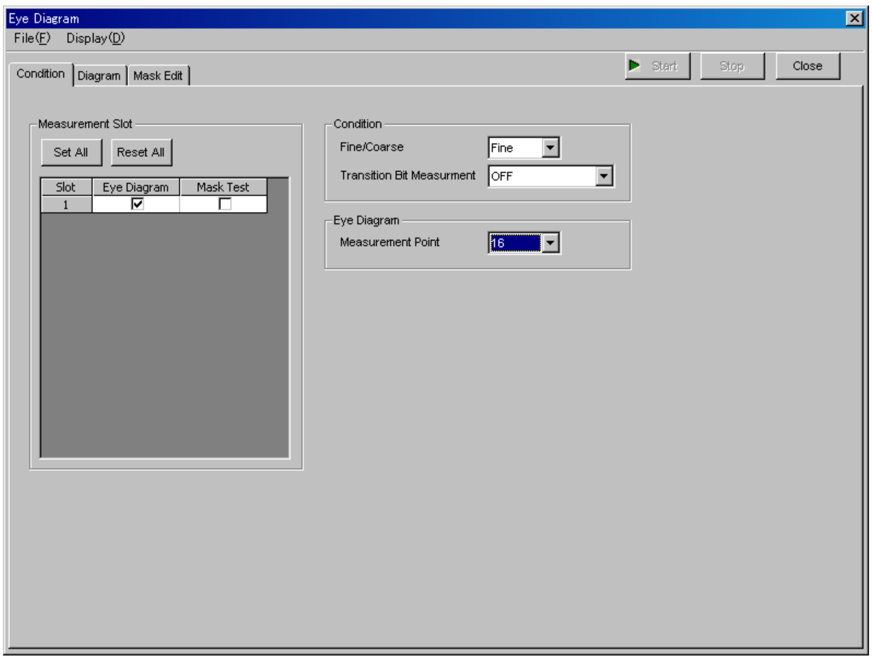


Figure 5.11.10-2 Eye Diagram window

4. Setting measurement conditions
   Set Error Threshold and Actual/Estimate.

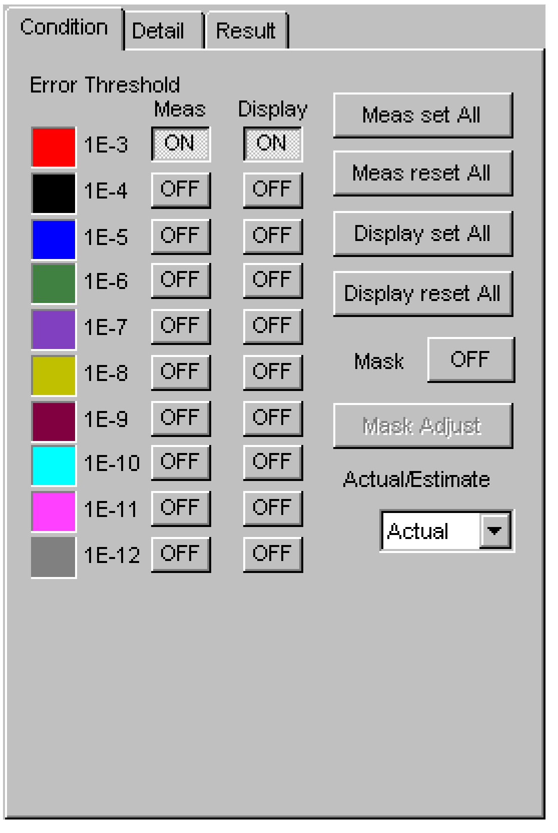


Figure 5.11.10-3 Setting measurement conditions

5. Starting measurement
   Click [Start] to start Eye Diagram measurement.

Figure 5.11.10-4 Measurement start button

6. Stopping measurement
   Click [Stop] to stop the Eye Diagram measurement.

Figure 5.11.10-5 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 whose Display button is set to ON are displayed. The color of a displayed Eye diagram accords to the color selected in the Condition tab window.

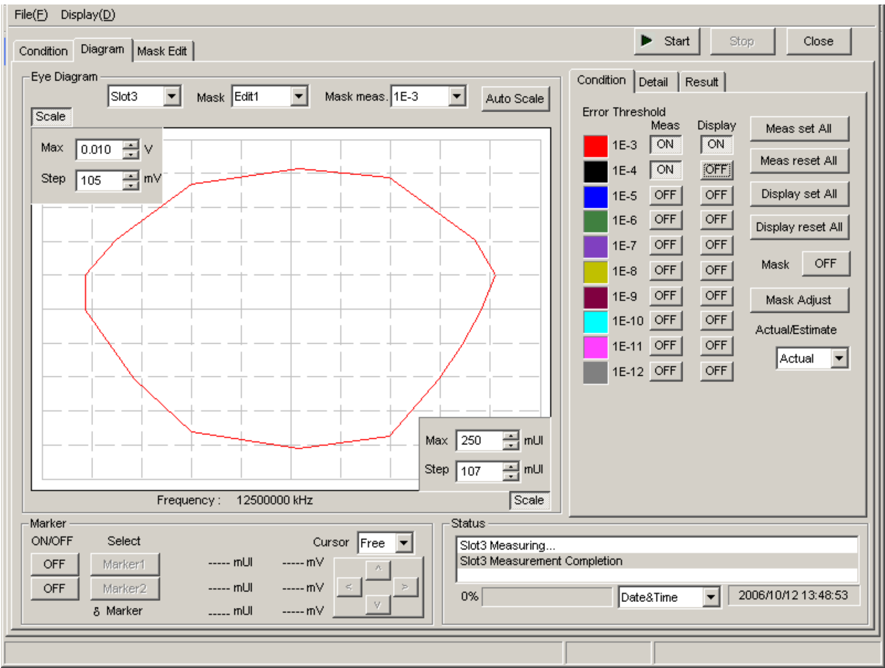


Figure 5.11.10-6 Eye Diagram window with measurement results displayed

5.11.11 How to perform Mask Test measurement

This section provides a basic procedure for performing Mask Test measurement.

1. Checking connection
   Check that the MU181020A, DUT, and MU181040A are correctly connected.
2. Setting frequency
   Set the frequency by the synthesizer.

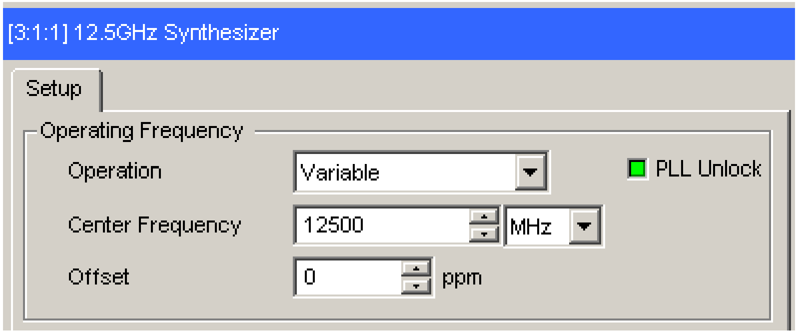


Figure 5.11.11-1 Setting frequency

3. Selecting slot to be measured
   Select the Mask Test checkbox of the slot to be measured into the condition tab of Eye Diagram measurement window in MU18140A, and then set Fine or Coarse, Transition Bit Measurement, and Measurement Point.

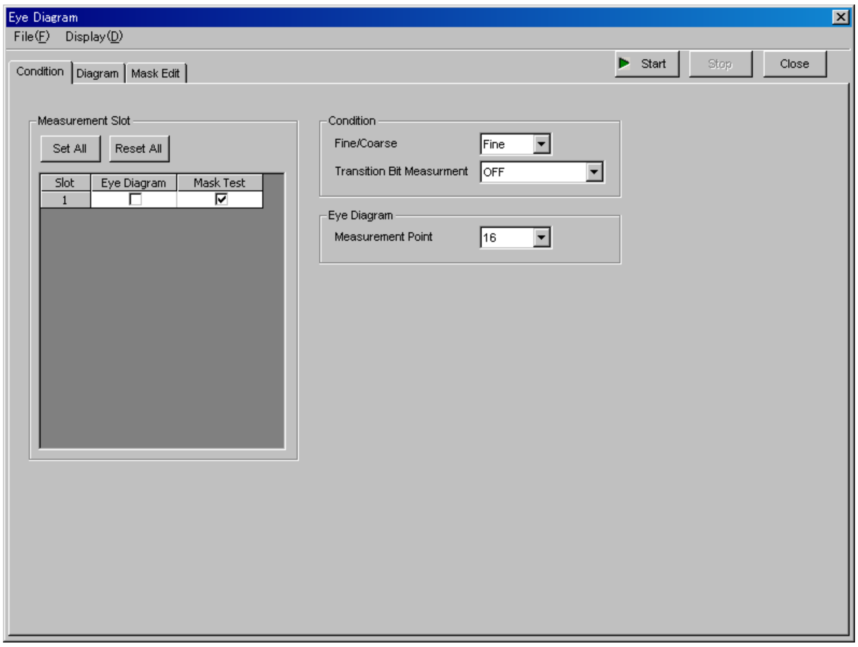


Figure 5.11.11-2 Selecting slot

4. Setting a mask
   Configure the mask settings in the Mask Edit tab window. One of Edit1 to Edit4 can be set as the mask.

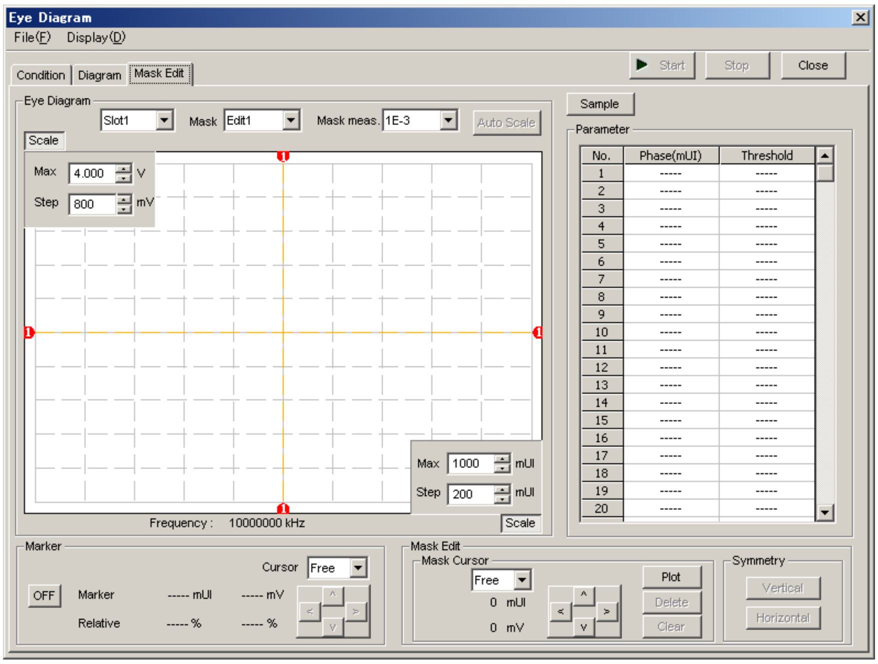


Figure 5.11.11-3 Mask Edit tab window

Set a mask for each slot, and set the error threshold.

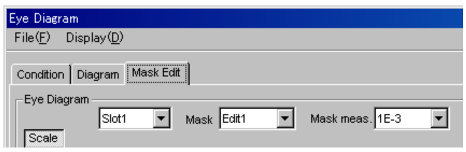


Figure 5.11.11-4 Selecting mask

5. Starting measurement
   Click [Start] to start Eye Diagram measurement.

Figure 5.11.11-5 Measurement start button

6. Stopping measurement
   Click [Stop] button to stop the Eye Diagram measurement.

Figure 5.11.11-6 Measurement stop button

7. Checking measurement results
   When the measurement is finished, the measurement results for each slot are displayed in the Result tab window.

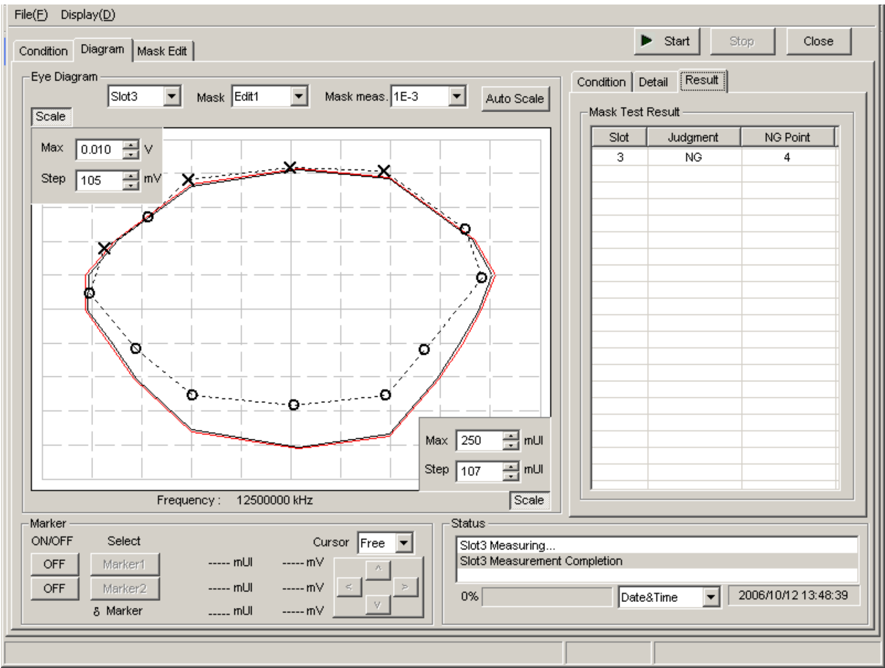


Figure 5.11.11-7 Eye Diagram window with measurement results displayed

5.12 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.” Refer to the *MX180000A Signal Quality Analyzer Control Software Operation Manual* for details.

5.12.1 Displaying results of Threshold vs. Q measurement in Threshold vs Q tab window

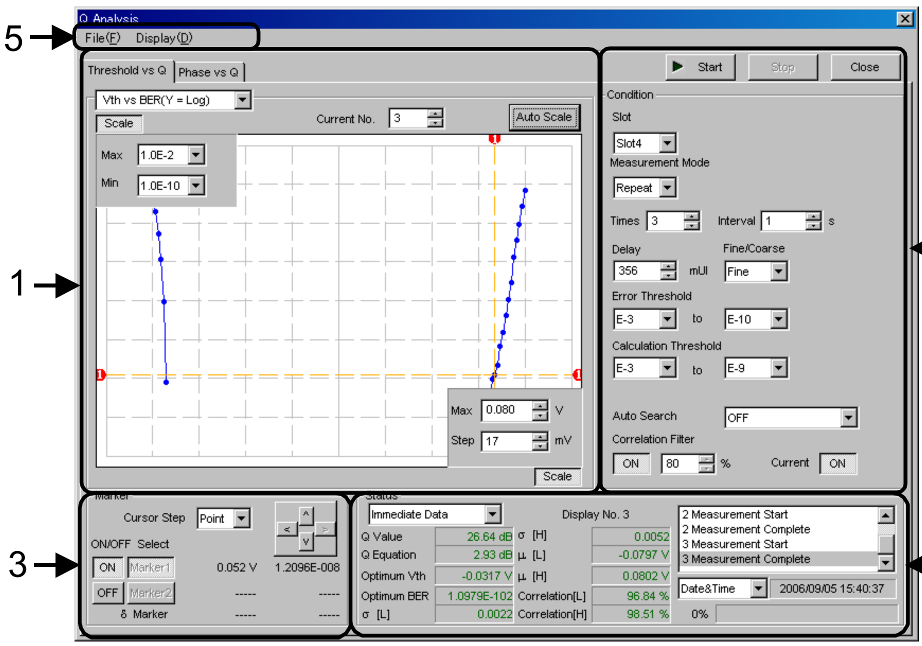


Figure 5.12.1-1 Threshold vs Q tab window

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

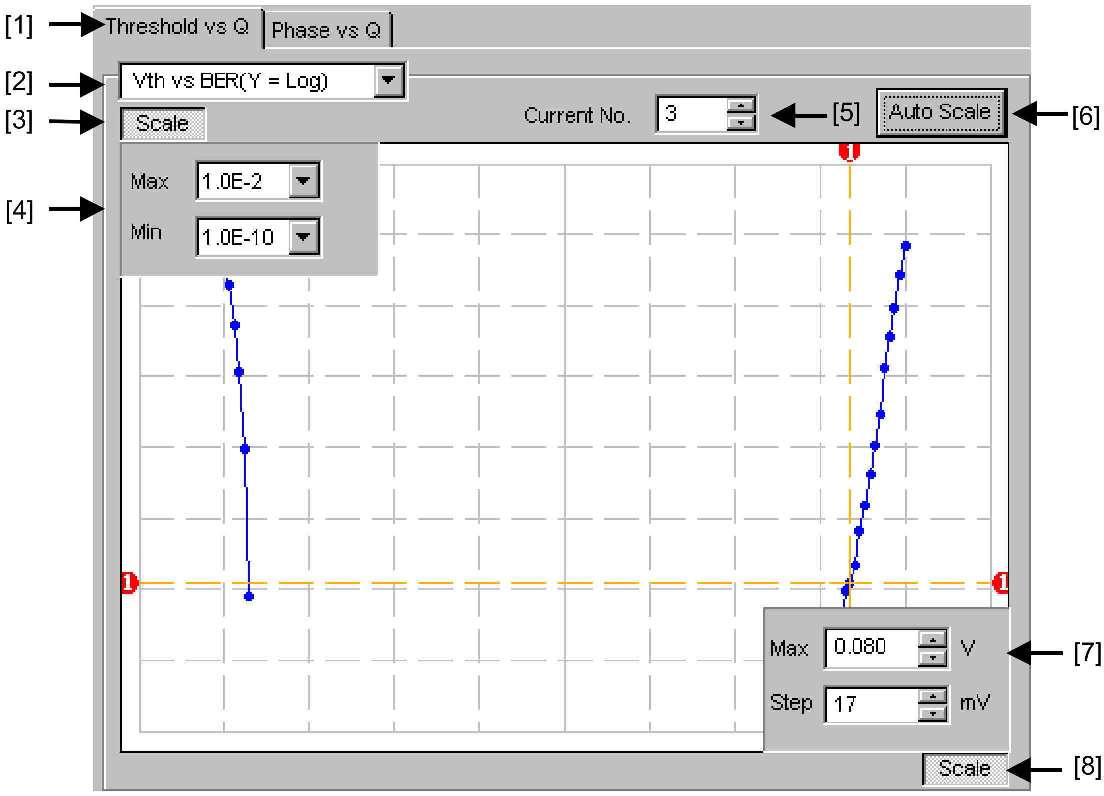


Figure 5.12.1-2 Measurement graph display area

[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 5.12.1-1 Graph display items

	Item	X-axis (Setting range)	Y-axis (Setting range)
(1)	Vth vs BER (Y = Log)	Threshold voltage (–3.990 to 4.0 V)	Log (BER) (1.0 E–2 to 1.0 E–14)
(2)	Vth vs BER (Y = Log (–Ln))	Threshold voltage (–3.990 to 4.0 V)	$\mathrm{Log}(\sqrt{-\mathrm{Ln}(\mathrm{BER})})$ (1.0 E–2 to 1.0 E–14)
(3)	Vth vs Q	Threshold voltage (–3.990 to 4.0 V)	Q value –40 to 60 (dB) 10 to 1000 (Linear)
(4)	Times vs Q	Measurement count (100 to 1000)	Q value –40 to 60 (dB) 10 to 1000 (Linear)
(5)	Histogram	Q value –49.84 to 60.00 (dB) 0.16 to 1000.00 (Linear)	Repetition (50 to 1000)

[3] Specify whether to show the Max and Min value display indicated by [4] in Figure 5.12.1-2.

[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 5.12.1-2.

2. Measurement control area

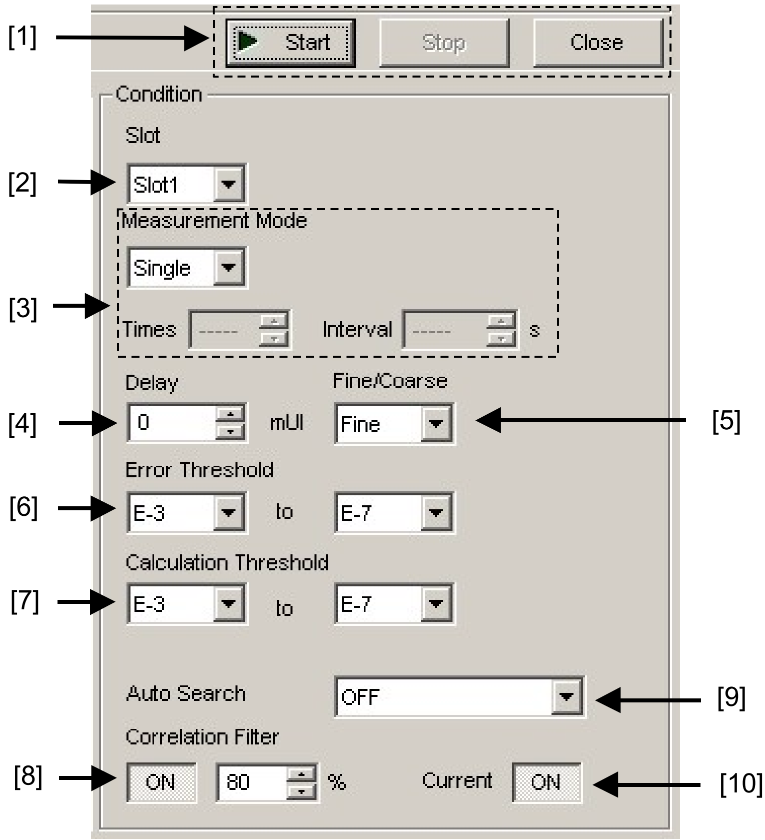


Figure 5.12.1-3 Measurement control area

[1] Start button: Start measurement.

Stop button: Stop measurement.

Close button: 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 1 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 the graph update timing.

ON: The graph is updated for each second.
OFF: The graph is updated at the end of measurement.

3. Display control area

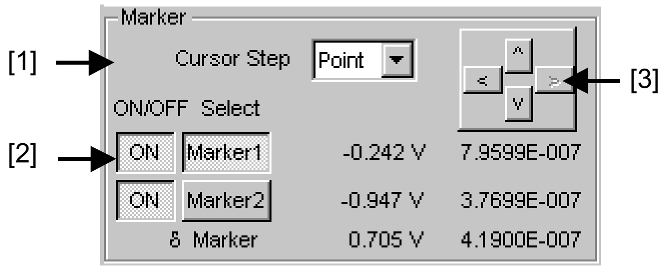


Figure 5.12.1-4 Display control area

[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 5.12.1-4). 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

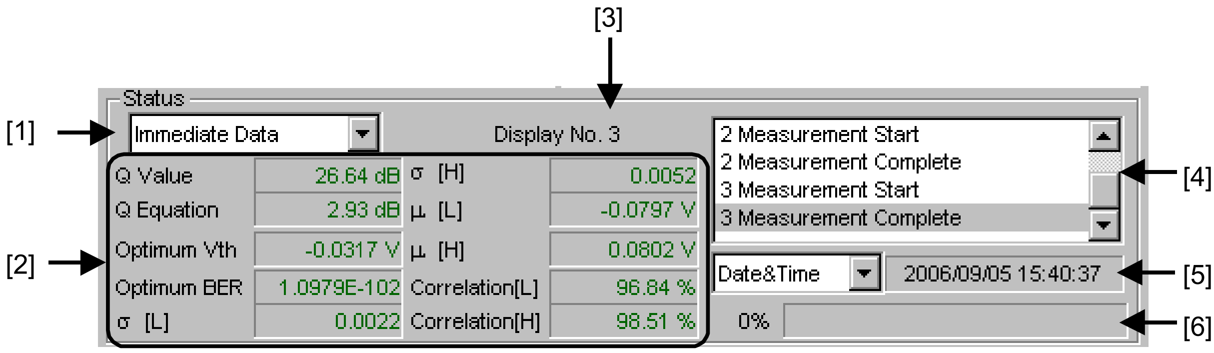


Figure 5.12.1-5 Measurement result display area (for Immediate Data)

[1] Select "Immediate Data" or "Statistic Data".

[2] Displays the results when a Q value is measured once.

Table 5.12.1-2 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.

[7]

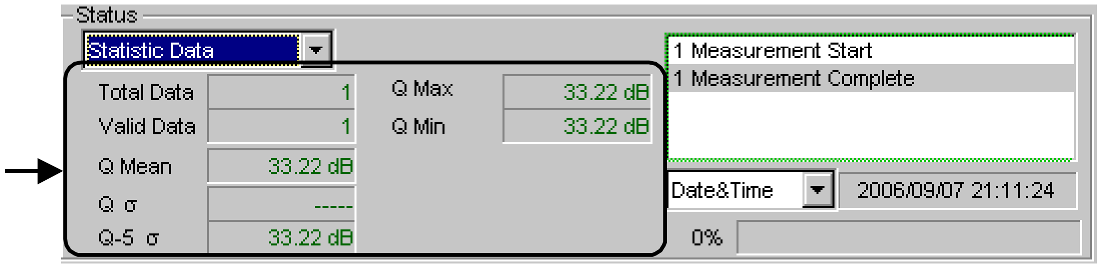


Figure 5.12.1-6 Measurement result display area (for Statistic Data)

[7] Displays the statistical measurement results obtained when a Q value is measured several times.

Table 5.12.1-3 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/–)
Qσ	Standard deviation of valid Q values (Unit: dB/–)
Q-5σ	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

[1]

Figure 5.12.1-7 Menu bar

[1] Menu bar
Select a File and Display menu item.

Table 5.12.1-4 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.
			Out put	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.

Table 5.12.1-4 Menu bar configuration (Cont' d)

Menu	Item	Function
File (continued)	Initialize	Initializes all the settings and measurement results.
	Exit	Closes the Q Analysis window.
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.

Note:

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

5.12.2 Displaying results of Phase vs Q measurement in Phase vs Q tab window

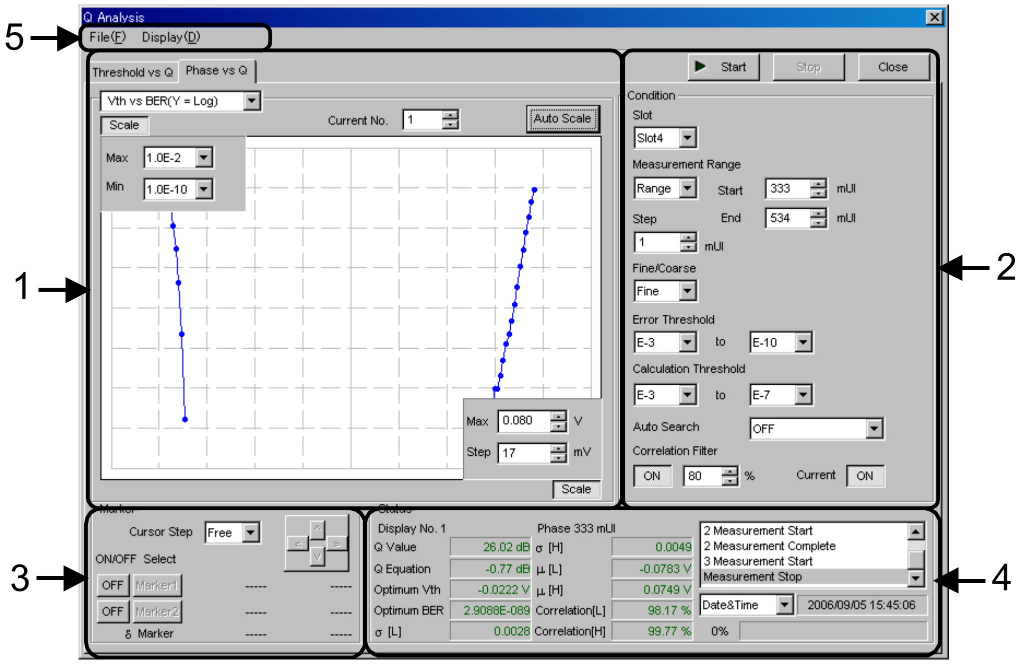


Figure 5.12.2-1 Phase vs Q tab window

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 5.12.1 “Displaying results of Threshold vs. Q measurement in Threshold vs Q tab window”.

1. Measurement graph display area

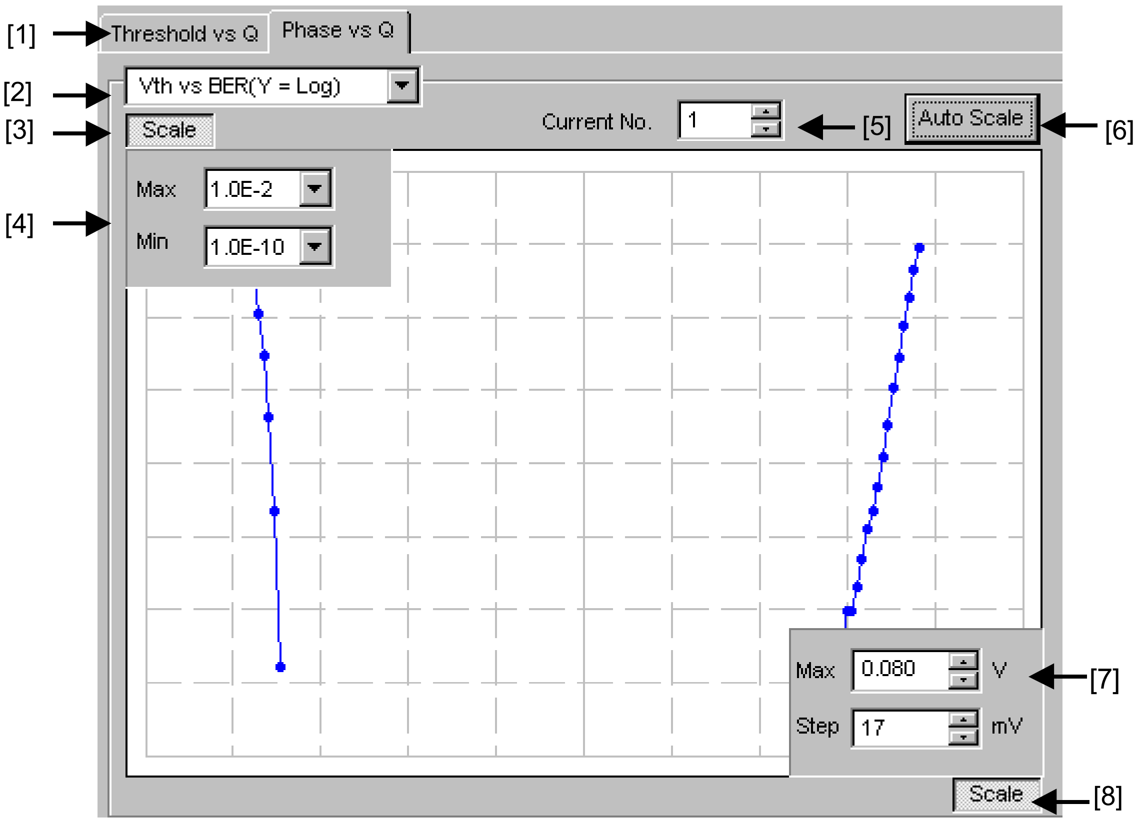


Figure 5.12.2-2 Measurement graph display area

[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 5.12.2-1 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))		$\mathrm{Log}(\sqrt{-\mathrm{Ln}(\mathrm{BER})})$ (1.0 E–2 to 1.0 E–14)
Vth vs Q		Q value –40 to 60 (dB) 10 to 1000 (Linear)

Table 5.12.2-1 Graph display items (Cont' d)

Item	X-axis (Setting range)	Y-axis (Setting range)
Phase vs Q	Phase (–900 to 1000 mUI)	Q value –40 to 60 (dB) 10 to 1000 (Linear)
Phase vs σ		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 5.12.2-2.

[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 5.12.2-2.

2. Measurement control area

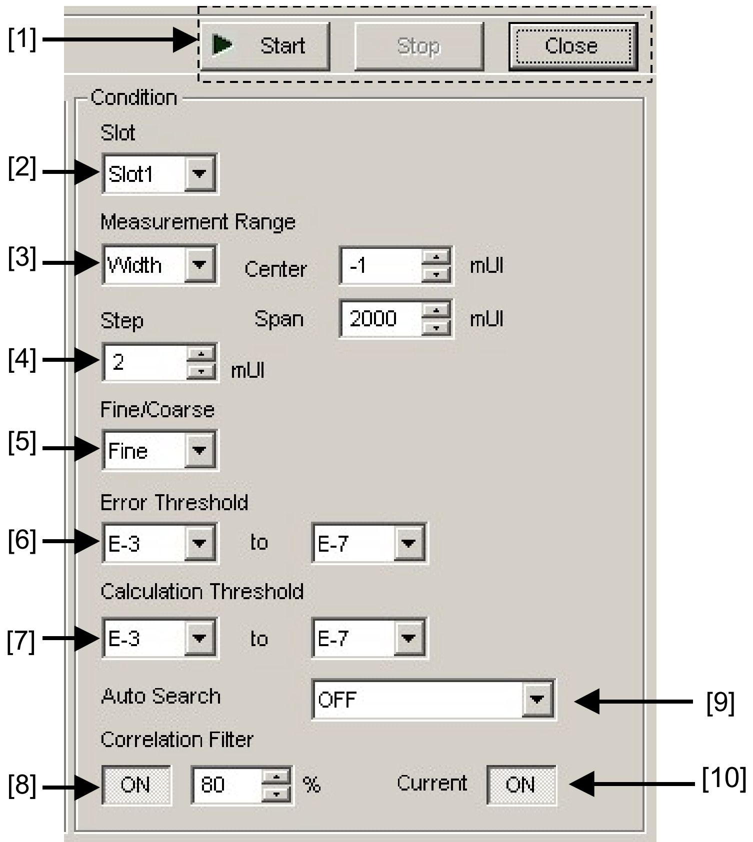


Figure 5.12.2-3 Measurement control area

[1] Start button: Start measurement.

Stop button: Stop measurement.

Close button: Close 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 999 mUI, in 1 mUI steps).

End: Set the measurement end position when Range is selected
(–999 to 1000 mUI, in 1 mUI steps).

Center: Set the center position when Width is selected
(–999 to 999 mUI, in 1 mUI steps).

Span: Set the span when Width is selected
(2 to 2000 mUI, in 1 mUI steps I)

[4] Set the measurement step in the Step textbox.
Setting range: 1 to 200 mUI, in 1 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 the graph update timing.

ON: The graph is updated for each second.
OFF: The graphs is updated at the end of measurement.

3. Measurement result display area

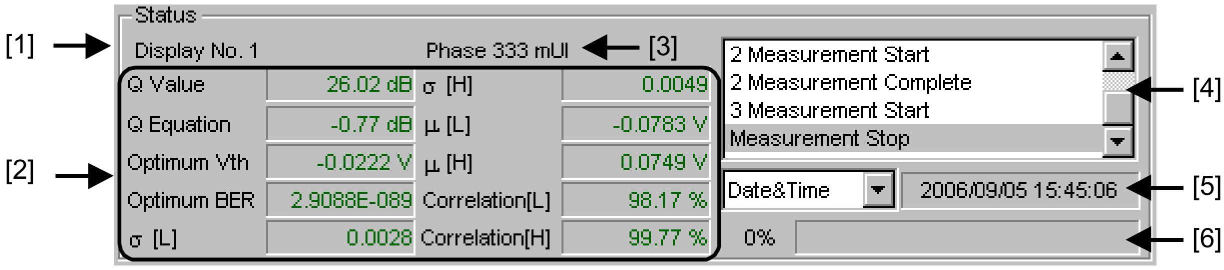


Figure 5.12.2-4 Measurement result display area

[1] Displays the measurement number of the displayed measurement result.

[2] Displays the results of each phase measurement.

Table 5.12.2-2 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.

Date&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.

5.13 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 for Bathtub measurement.

Notes:

- Bathtub measurement cannot be performed for the following cases.

  - When **Burst** is selected in the Pattern Sequence area on the **Misc** tab.
  - During Auto Adjust
  - When **Auto Sync** is set to **OFF**.
  - When **Input Condition** is set to **Differential 100 Ohm**.

- For accuracy, start Bathtub measurement after the operations below.

  - Execute **Calibration** in the Clock delay setting items.
  - Turn Off **Jitter Input** in the Clock delay setting items.

5.13.1 Displaying Bathtub measurement results in Bathtub window

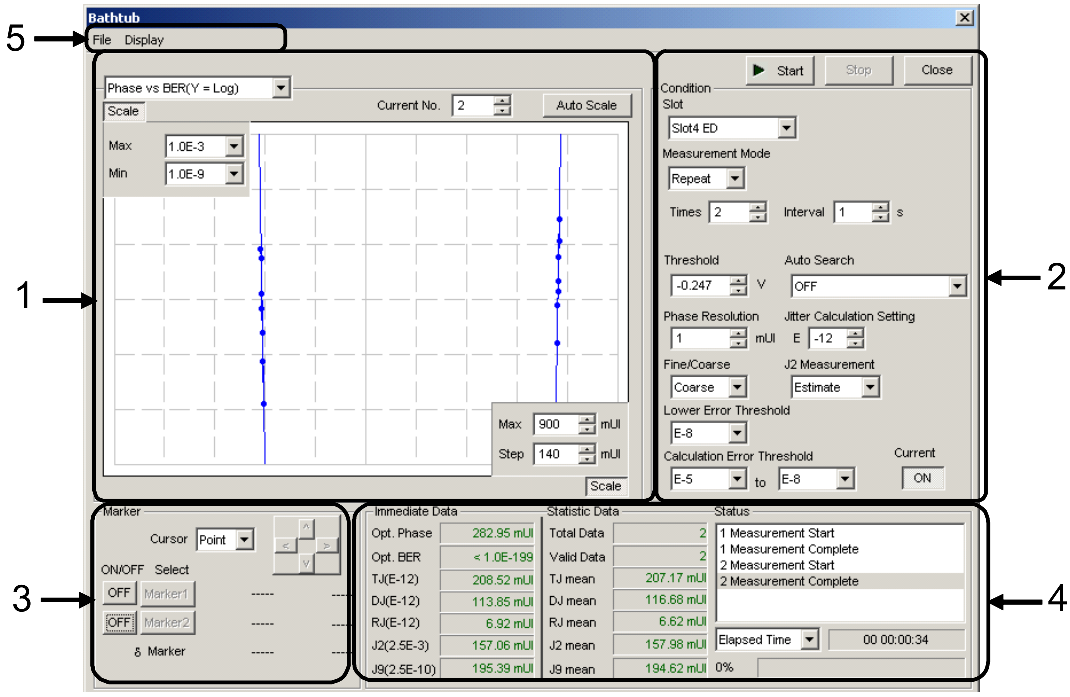


Figure 5.13.1-1 Bathtub window

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.

1. Measurement graph display area

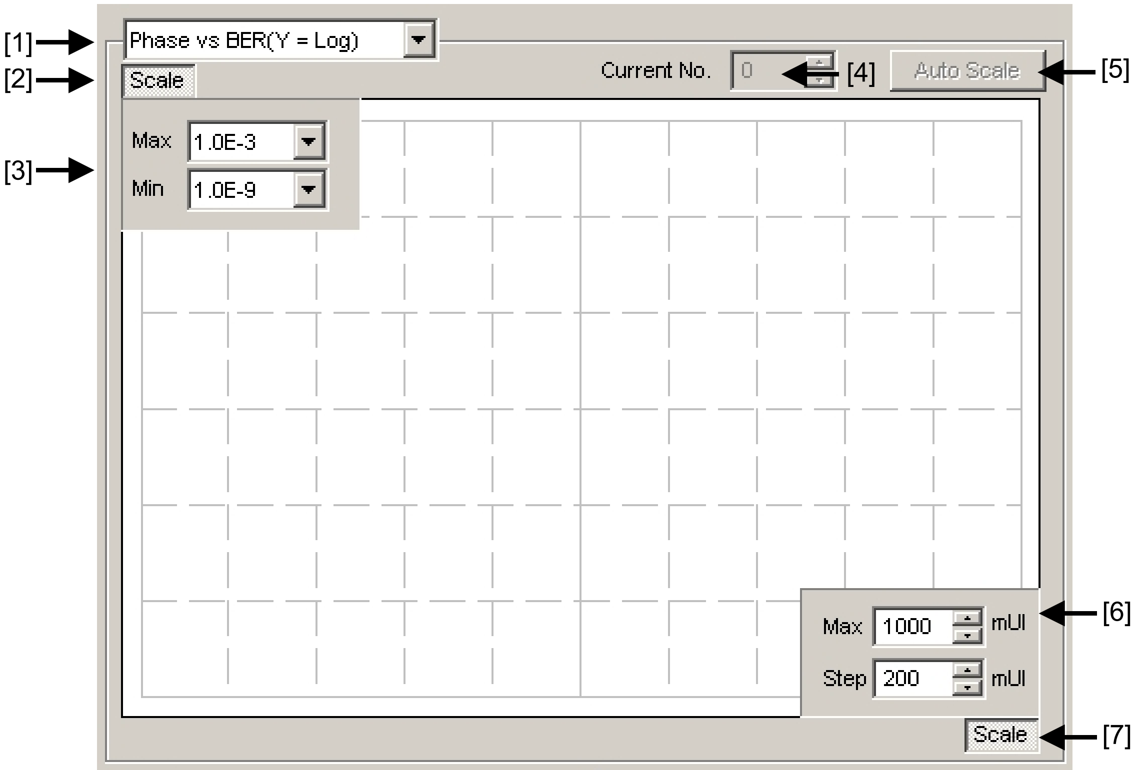


Figure 5.13.1-2 Measurement graph display area

[1] Select the graph display method.

Table 5.13.1-1 Graph display items

Item	X-axis (Setting range)	Y-axis (Setting range)
Phase vs BER (Y = Log)	Phase (–900 to 1000 mUI)	Log (BER) (1.0 E–2 to 1.0 E–14)
Phase vs BER (Y = Log (–Ln))		$\mathrm{Log}(\sqrt{-\mathrm{Ln(BER)}})$ (1.0 E–2 to 1.0 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 5.13.1-2.

[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 5.13.1-2.

2. Measurement control area

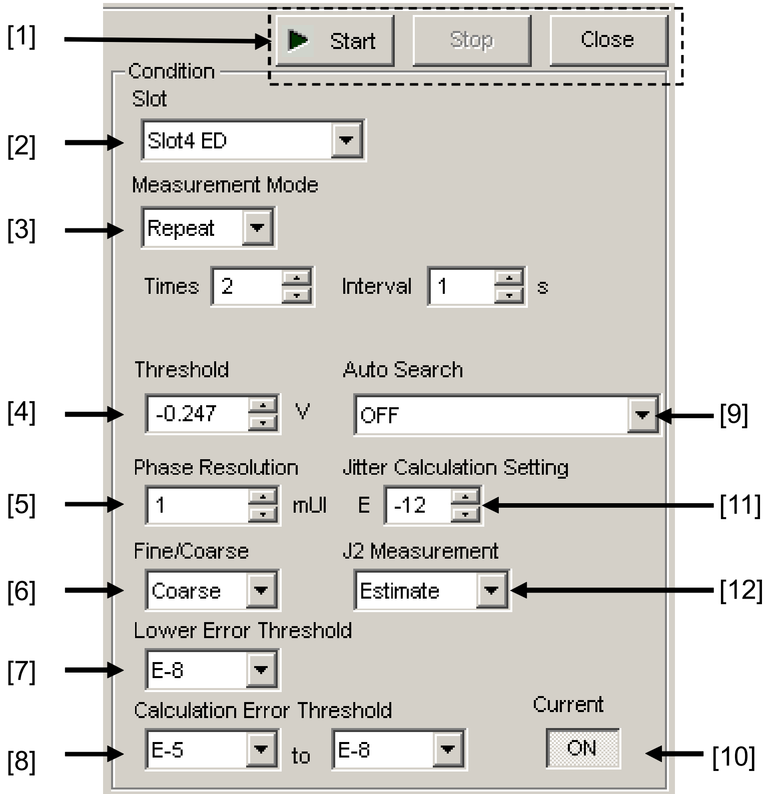


Figure 5.13.1-3 Measurement control area

[1] Start button: Start measurement.

Stop button: Stop measurement.

Close button: 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 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 seconds).

[4] Set the data threshold position for measurement in the Delay textbox.

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 the Phase Resolution textbox.

Setting range: 1 to 100 mUI, in 1 mUI steps

[6] Select "Fine" or "Coarse" from the list box to set the error count.

Fine: Error count: 100

Coarse: Error count: 3

[7] Specify the error rate range for the measurement from the 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 Best Fit Line, from 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 Auto Search measurement.

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): Phase Auto Search is executed in the Fine mode.
Threshold&Phase (Fine): Threshold and Phase Auto Search are executed in the Fine mode.

[10] Select the graph update timing.

ON: The graph is updated for each 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**.

Setting range: E-7 to E-20

[12] When setting **J2 Measurement**, select calculation method for J2.

Estimate: Estimates J2 value using Best Fit Line calculated by the setting of **Calculation Error Threshold**.

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 5.13.1-4.

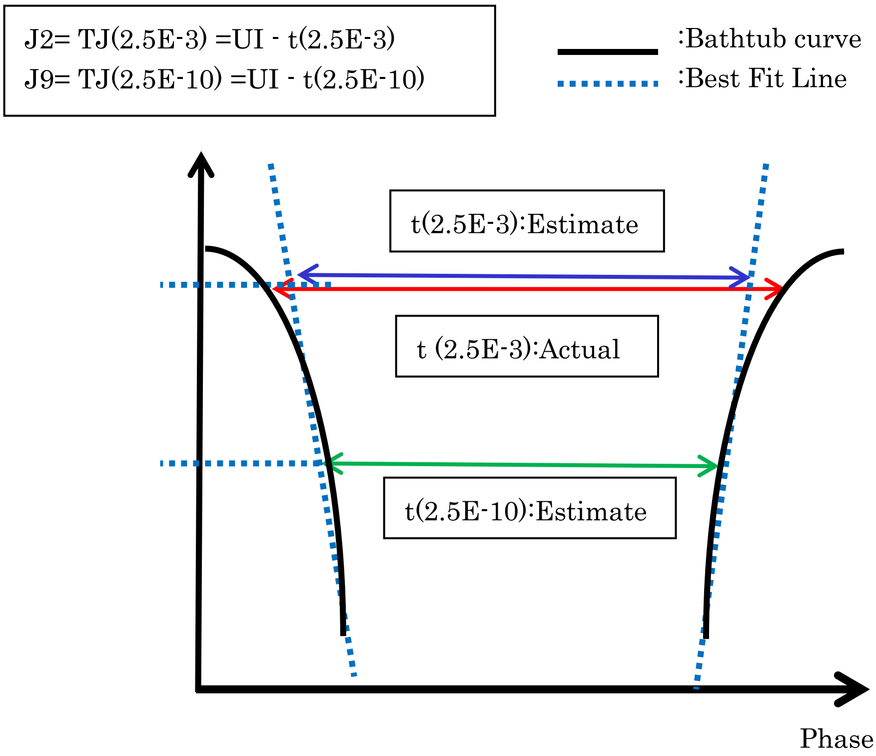


Figure 5.13.1-4 J2 Calculation

3. Display control area

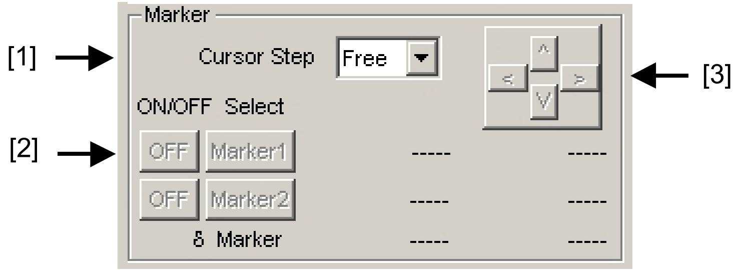


Figure 5.13.1-5 Display control area

[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.

4. Measurement result display area

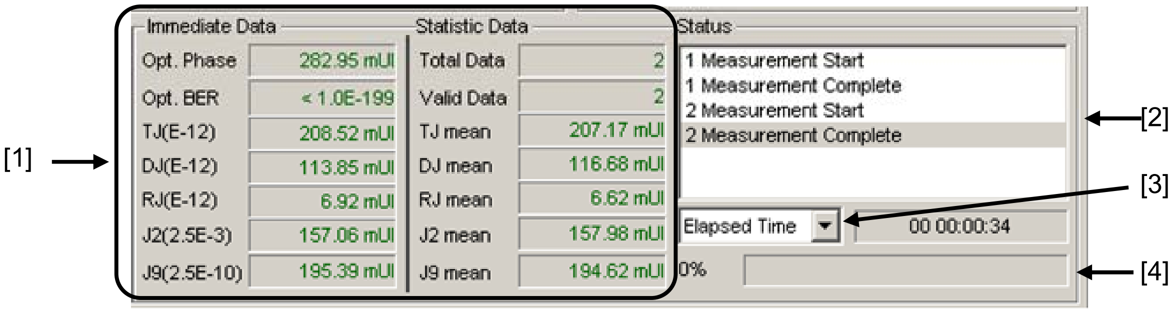


Figure 5.13.1-6 Measurement result display area

[1]-1 Immediate Data field

Displays the results when Bathtub measurement is performed once.

Table 5.13.1-2 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(Total Jitter)	Total jitter calculated from Bathtub curve (Display format: XXX.XX (ps) or XXX.XX (mUI))
DJ(Deterministic Jitter)	Deterministic jitter calculated from Bathtub curve (Display format: XXX.XX (ps) or XXX.XX (mUI))
RJ(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) J2 calculated from BER measurement point. (Actual) (Display format: XXX.XX (ps) or XXX.XX (mUI))
J9(2.5E-10)	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.

[1]-2 Statistic Data field

Displays the statistical measurement results obtained when Bathtub measurement is performed several times.

Table 5.13.1-3 Result display items (Statistic Data)

Item	Description
Total Data	Total measurement count (Display format: XXXX)
Valid Data	Number of valid measurement results (Display format: XXX.XX(ps) or XXXX)
TJ mean	Average of total jitter measurement (Display format: XXX.XX(ps) or XXX.XX)
DJ mean	Average of deterministic jitter measurement (Display format: XXX.XX(ps) or XXX.XX)
RJ mean	Average of random jitter measurement (Display format: XXX.XX(ps) or XXX.XX)
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))

[2] Displays the measurement state as a comment.

[3] 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.

[4] Displays the measurement progress as Gating.

5. Menu bar

[1]


Figure 5.13.1-7 Menu bar

[1] Select 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	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.
	Print	Type Of Print List	Phase vs Q BER Result		Prints Phase vs Q BER Result measurement results. The printer setting must be configured in advance in the mainframe main window.
	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.
			Out put	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.

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.
	Best Fit Line	Select 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.

Note:

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

5.14 Multi Channel Function

When multiple MU181040A modules are installed into the MP1800A/MT1810A, synchronized operation of multiple channels is enabled. Multi-channel functions include the Combination function.

Combination Function Types

(1) 4ch Combination: when four PPG/ED modules installed

(2) 25Gx2ch Combination: when four PPG/ED modules installed

(3) 2ch Combination: when two or more PPG/ED modules installed

Channel Synchronization Function Types

(1) 12.5G Channel Synchronization: when two or more PPG modules installed

(2) 25G Channel Synchronization: when four PPG modules installed

5.14.1 Combination function

Using multiple MU181020A and/or MU181040A/B modules, the Multi-channel function synchronizes the generation and reception of patterns between modules, to evaluate 25 Gbit/s, 40 Gbit/s and PON applications. For the 25 Gbits/s MUX/DEMUX, refer to the *MU182020/21A Operation manual* or *MU182040/41A Operation Manual*.

5.14.2 Combination Setting

To use the Multi-channel function, click the [Combination Setting] module function button to open the Combination Setting dialog box for setting. For details, refer to Section 5.3.3 "Combination setting" in the *MX180000A Operation Manual*.

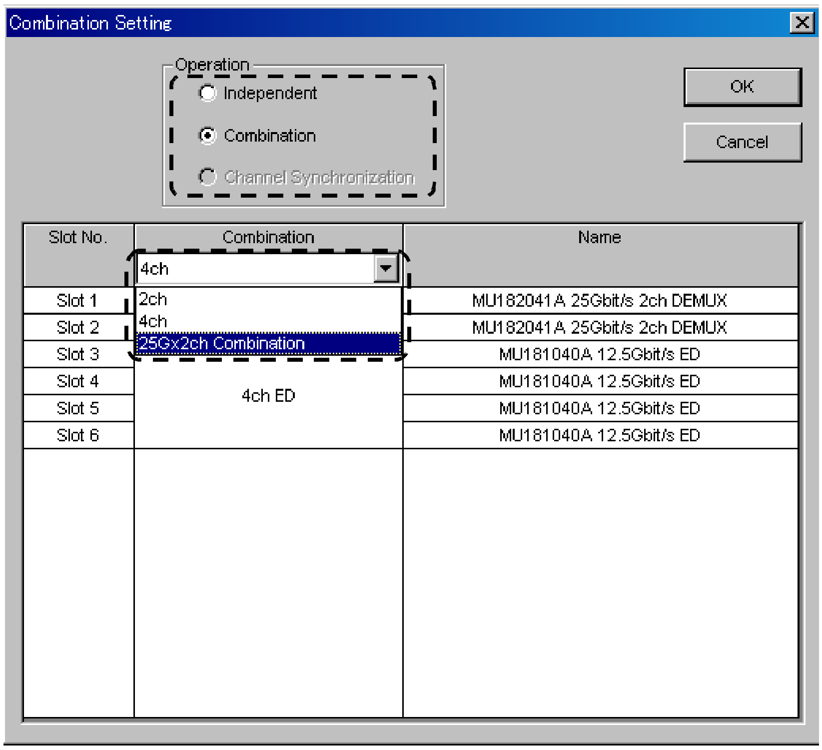


Figure 5.14.2-1 Combination Setting dialog box

Table 5.14.2-1 Screen Layout of Combination Setting

Operation Settings		Contents
Independent		Select when performing MU181020A/B or MU181040A/B independently
Combination	2ch	Select when performing 25G tests
	4ch	Select when performing 40 tests
	25Gx2ch Combination	Select when generating/receiving 25G 2 Ch data
Channel Synchronization	12.5G CH Sync	Select when always outputting with synchronized header bit for PON applications, etc.
	25G CH Sync	Select when always outputting with synchronized header bit between two 25G channels.

Confirm the selected operation by pressing the [OK] button.

5.14.3 ED Result All dialog box

The ED Result All dialog box shows the error measurement results for each MU181040A module inserted, Combination measurement results, and Logging results.　Click the [ED Result All] module function button.

Figure 5.14.3-1　ED Result All button

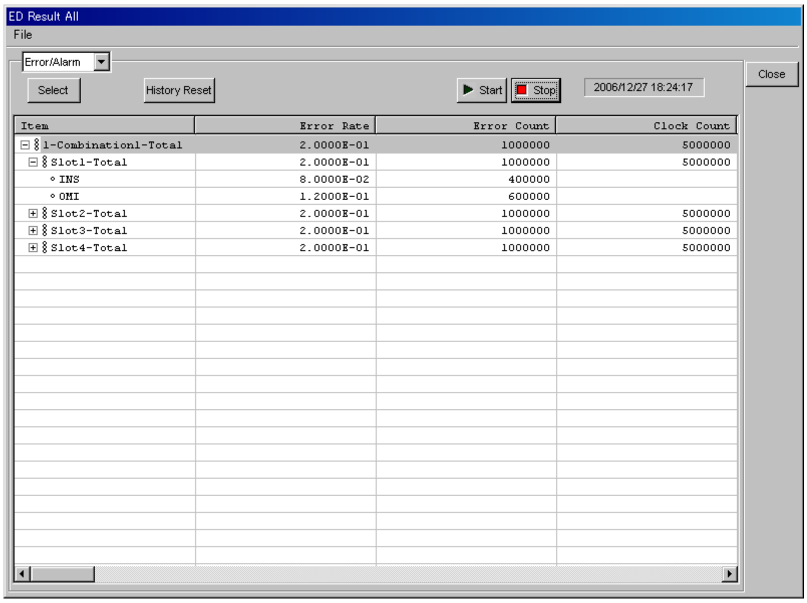


Figure 5.14.3-2　ED Result All dialog box

5.14.3.1 Setting and result display of Error/Alarm measurement

This section describes the setting and result display of Error/Alarm measurement.

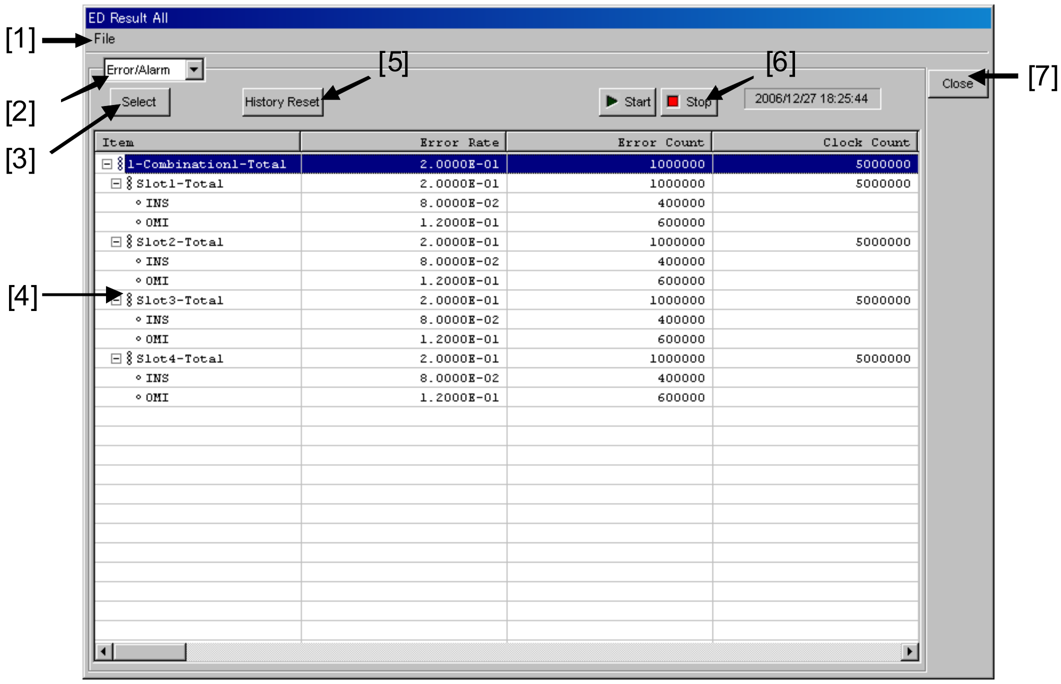


Figure 5.14.3.1-1 Error/Alarm measurement results

[1] Menu bar

Table 5.14.3.1-1 Menu bar configuration

Menu	Item			Function
File	Save	Data Type	Error/Alarm Result	Saves the Error/Alarm Result measurement results.
			Error/Alarm Logging	Saves the Error/Alarm Logging measurement results.
		File Type	CSV	Saves the results in CSV format.
			Text	Saves the results in text format.
	Print	Type Of Print List	Error/Alarm Result	Prints the Error/Alarm Result measurement results. The printer setting must be configured in advance in the mainframe main window.
			Error/Alarm Logging	Prints the Error/Alarm Logging measurement results. The printer setting must be configured in advance in the mainframe main window.

Note:

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

[2] Switches display between Error/Alarm and Logging.

[3] Click the [Select] to display the dialog box for selection of the display items for Error/Alarm measurement. The items selected here appear in the measurement results display area [4]. Use the up/down cursor buttons to change the display order of the measurement items.

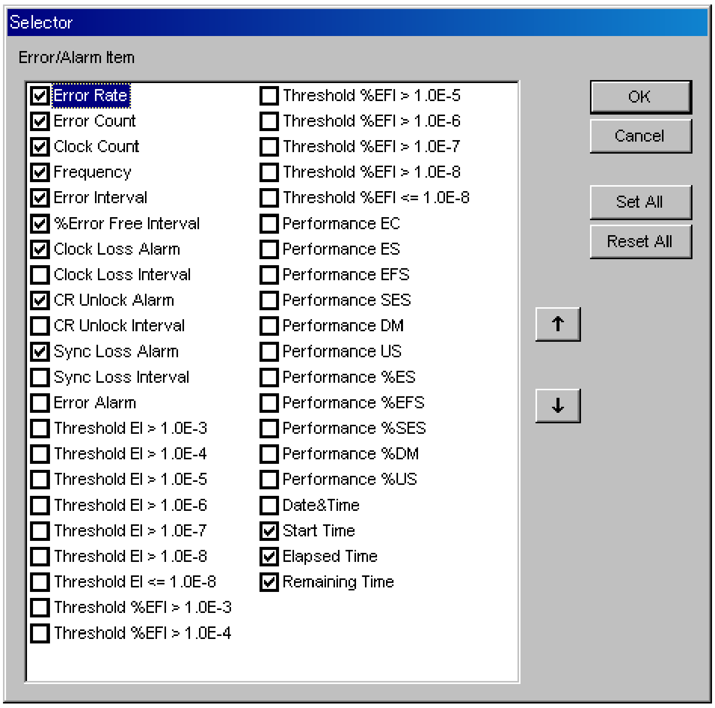


Figure 5.14.3.1-2 Error/Alarm measurement item selection dialog box

Table 5.14.3.1-2 Error/Alarm measurement display item list

Item	Function
Error Rate	Displays the error rate.
Error Count	Displays the error count.
Clock Count	Displays the clock count.
Frequency	Displays the frequency.
Error Interval	Displays the error interval count.
%Error Free Interval	Displays the error free interval rate.
Clock Loss Alarm	Displays the monitored Clock Loss occurrence state.
Clock Loss Interval	Displays the Clock Loss interval count.
CR Unlock Alarm	Displays the monitored clock recovery unlock occurrence state.
CR Unlock Interval	Displays the clock recovery unlock interval count.
Sync Loss Alarm	Displays the monitored Sync Loss occurrence state.
Sync Loss Interval	Displays the Sync Loss interval count and monitored occurrence state.
Error Alarm	Displays the monitored error occurrence state.
Threshold EI %EFI	Displays the threshold EI %EFI measurement results.
Error Performance	Displays the error performance measurement results.
Date&Time	Displays the current time.
Start Time	Displays the measurement start time.
Elapsed Time	Displays the measurement elapsed time.
Remaining Time	Displays the measurement remaining time

[4] Measurement result display area
Displays the measurement items selected in [3]. Use the scroll bar to view all display items if some of them are not displayed. Combination status and result for each slot are displayed as shown below.

ex.: In case of 4 Ch Combination
1 – Combination1 – Total
Slot1 – Total
INS
OMI
Slot2 – Total
:
:

[5] Resets the Error/Alarm display history data.

[6] Starts/stops measurement.
The same function as the [Start/Stop] module function button.

[7] Close button
Closes the ED Result All dialog box.

5.14.3.2 Setting and result display of logging

This section describes the setting and result display of Logging.

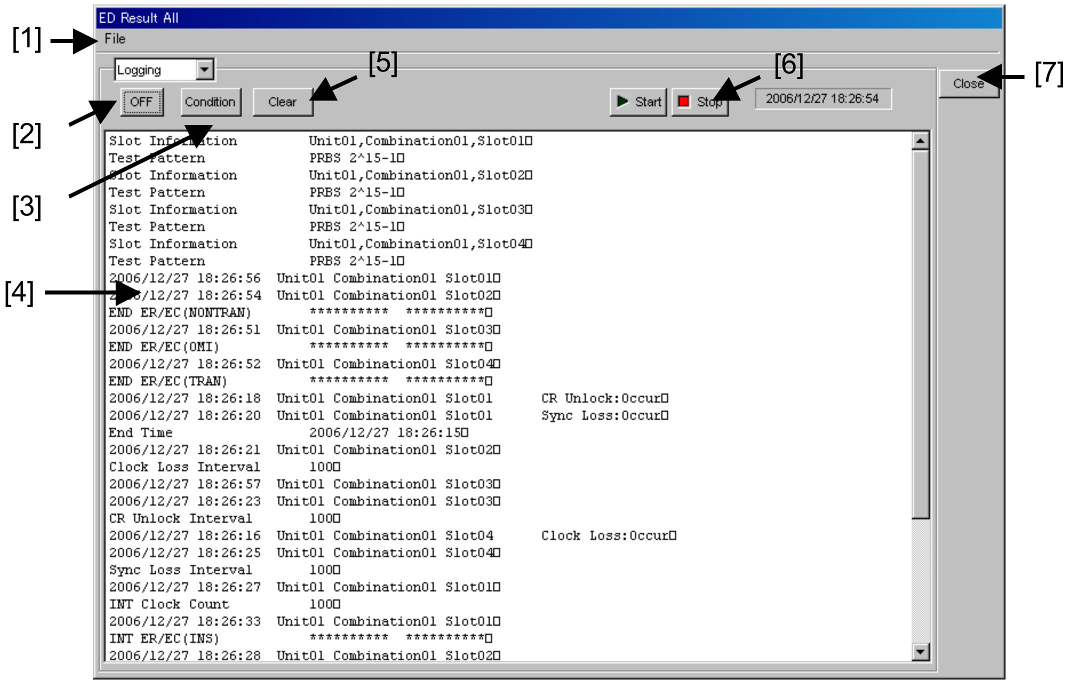


Figure 5.14.3.2-1 Logging results

[1] Menu bar
Refer to Table 5.14.3.1-1 “Menu bar configuration.”

[2] Turns the logging function on/off.

[3] Click the [Condition] to display the dialog box for selection of the logging items. The items selected here appear in the measurement results display area [4].
Refer to Table 5.1.7-1 "Items in Log Condition setup dialog box" for details on the logging items.

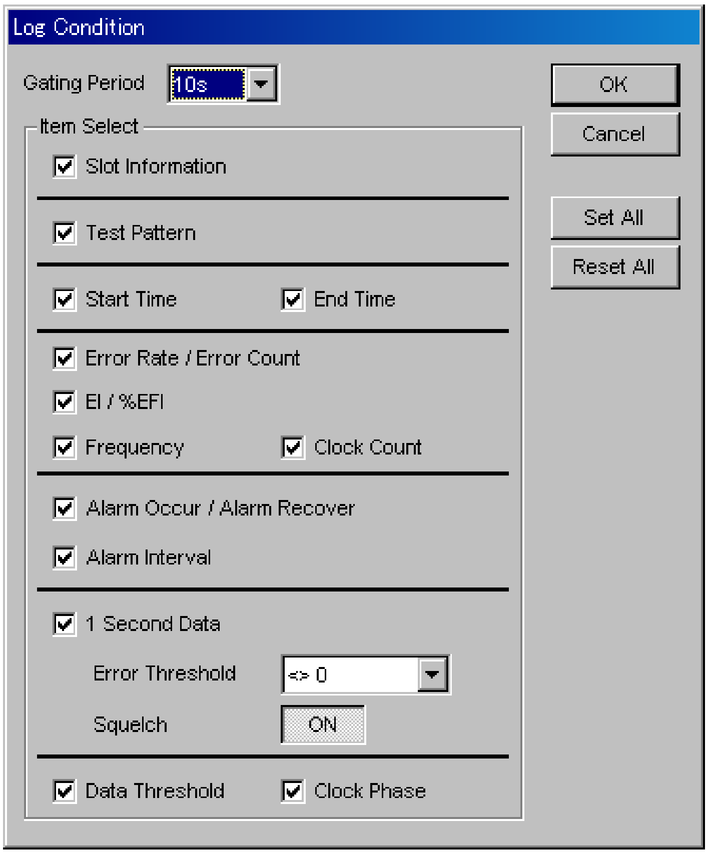


Figure 5.14.3.2-2 Logging item selection dialog box

[4] Displays the logging results.

[5] Deletes the logging results.
Clicking this button displays the confirmation window for clearing.

[6] Starts/stops measurement.
The same function as the [Start/Stop] module function button.

[7] Close button
Closes the ED Result All dialog box.

Chapter 6 Measurement Example

This chapter provides measurement examples using the MU181040A.

6.1 Measuring Optical Transceiver Module (error rate measurement using PRBS pattern)

This section provides an example of how to test the light receiving sensitivity at the reception side of an XFP optical transceiver module by using the MP1800A Signal Quality Analyzer (hereafter, referred to as "MP1800A").

6.1.1 Test method

The following shows a test example where the MU181020A, MU181040A, and MU181600A Optical Transceiver (XFP) (hereinafter, referred to as "MU181600A") are mounted onto the MP1800A.
The options configuring the test system are as follows:

MP1800A-014
MU181020A-001/-x11
MU181040A-002/-x20/-x30

1. Ground the MP1800A and the device under test (DUT).
2. Connect the power cables.
3. Turn on the MP1800A, and set the measurement conditions as follows.
    1) Adjust the data output interface for the MU181020A to the input of the MU181600A. In the Output tab window of the MU181020A, select Data/XData and set Tracking to ON. The Data/XData amplitude and offset setting are applied commonly after this. At this time, be sure to set Output to Off.
    2) Set a test pattern.
    Select a test pattern in the Pattern tab windows of the MU181020A and MU18040A.
    3) Connect the MU181600A and MU181020A. If the XFP module of the MU181600A requires the reference clock, make the setting on the Misc tab window of the MU181020A so that a 1/64 divided clock is output from the AUX Output connector.
    4) Select CMU Bit Rate for the operating bit rate in the Output tab window of the MU181020A.

5) Input an optical signal from the MU181600A to the DUT, and input the electrical differential data from the DUT to the MU181040A.
Select the termination condition by using the Data Amplifiers setting on the Input screen of the MU181040A. Since the XFP module is connected with the differential interface, select "Differential 100 ohm" and "Tracking".

6) Specify the clock for error measurement.
In the Clock field on the Input tab window of the MU181040A, select "Recovered Clock" from the Selection list box and specify the operating bit rate.

7) When the setting procedure is completed, turn off the MP1800A.

4. Connect the MP1800A and DUT.
Connect the I/O signals using the supplied coaxial cables (cables equivalent to the supplied ones can also be used). At this time, short the core of the cables using a thin pointed metal stick, such as tweezers, before connection. See Figure 6.1.1-1 for connection of the instruments.
Check that the reception data output level of the XFP module (DUT) falls within the data input range of the MU181040A. If not, adjust the output level using an attenuator.

5. Turn on the measuring instruments in the following order:
MP1800A → DUT

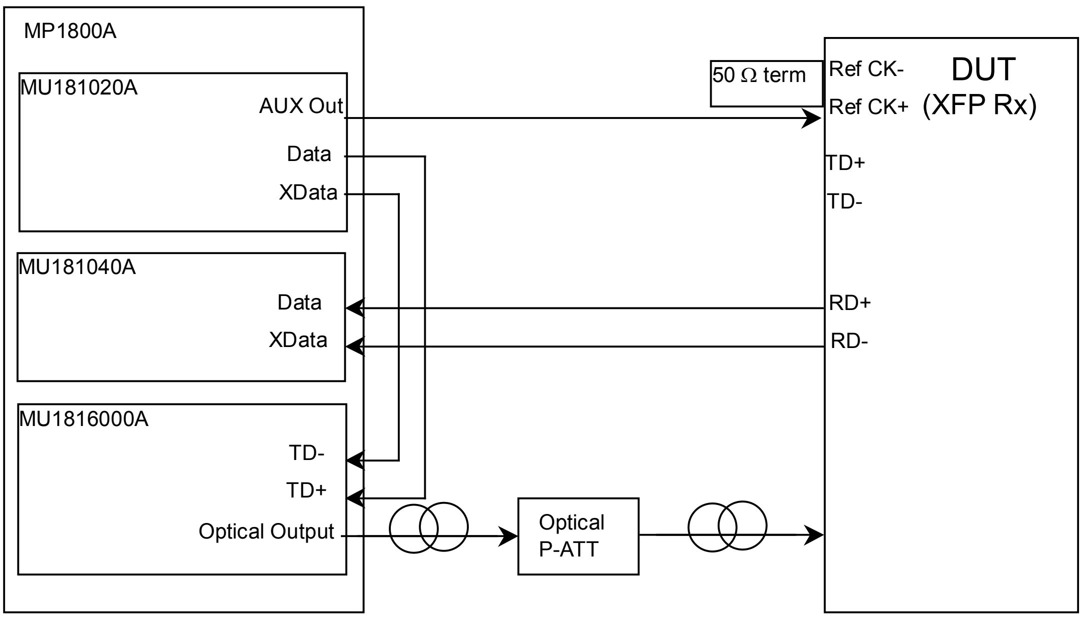


Figure 6.1.1-1 Connection diagram for XFP module evaluation

⚠ CAUTION

The DUT may be damaged if a signal line is connected or disconnected while the output is ON. Be sure to set the output OFF before changing the cable connection.

6. Enable the signal output.
   Set Data/XData to ON in the Output tab window of the MU181020A. Also, in the Setup tab window of the MU181600A, select “ON” from the Optical Output list box and set the [Output] module function button to “ON”.
7. Set the optimum thresholds for the MU181040A. When the Auto Adjust function is enabled by clicking the [Auto Adjust] module function button, the thresholds are automatically adjusted and set to optimum values for the DUT.
8. Open the Result tab window of the MU181040A. Measurement can be started and the BER measurement results can be viewed from this window.
9. To measure the light receiving sensitivity of the DUT, confirm that the DUT operates normally, change the optical power to the DUT using an Optical P-ATT, and measure the BER at this time using the MU1801040A.

6.2 Measuring 1:4 DEMUX (reception of 40 Gbit/s PRBS pattern using four MU181040A units)

This section provides an example of how to test the performance of the 40 GHz band 1:4 DEMUX IC by using two MP1800A units.

6.2.1 Test method

The following shows a test example where two MP1800A mainframes are prepared. In this example, four MU181020A units and one MU181800A 12.5 GHz Clock Distributor (hereinafter, referred to as "MU181800A") are mounted onto an MP1800A unit, and four MU181040A units are mounted onto the other MP1800A mainframe.
The units and options configuring the test system are as follows:

MG3695C Synthesizer (hereinafter, MG3695C)
MP1803A 43.5 G Multiplexer (hereinafter, MP1803)

Tx: MP1800A, MP1800A-015, MU181020A-002/x30 × 4, MU181800A
Rx: MP1800A, MP1800A-015, MU181040A-001 × 4

1. Ground the MP1800A, device under test (DUT), multiplexer, and synthesizer.
2. Connect the power cables.
3. Turn on the MP1800A on which the MU181020A units are mounted, and set the measurement conditions as follows.
   1) Click the [Combination] module function button to open the Combination Setting dialog box. In this dialog box, select "Combination" for Operation and set "4ch Combination."
   2) Connect the MG3695C, MP1803A, and MP1800A. Be sure to set the output of each measuring instrument to OFF before connection.
   3) Set a test pattern to PRBS31.
      Set a test pattern to be transmitted. Select PRBS31 in this example. In the MU181020A Pattern tab window, select "PRBS" from the Test Pattern list box and select "2^{31} – 1" from the Length list box.
   4) Set the operating frequency for the MG3695C. Set 39.81312 GHz in this example.

4. Turn on the MP1800A, on which the MU181040A units are mounted, and set the measurement conditions as follows.
    1) Adjust the data input interface for the MU181040A to the output of the DUT.
    2) Set a test pattern. In the MU181040A Pattern tab window, select the test pattern that is selected in the MU181020A Pattern tab window.
    3) In the MU181040A Input tab window, select “Recovered Clock” from the Selection list box in the Clock area and set the Clock frequency to 9.9540 Gbit/s.
5. Connect the measuring instruments and the DUT.

   Be sure to set the output of the DUT to Off before connection.

   Connect the I/O signals using the supplied coaxial cables (cables equivalent to the supplied ones can also be used). At this time, short the core of the cables using a thin pointed metal stick such as tweezers before connection.

   See Figure 6.2.1-1 for connection of the instruments.

   Check that the input level of the 1:4 DEMUX IC (DUT) falls within the data input range for DUT. If not, adjust the input level, using the MP1803A level variable or attenuator.

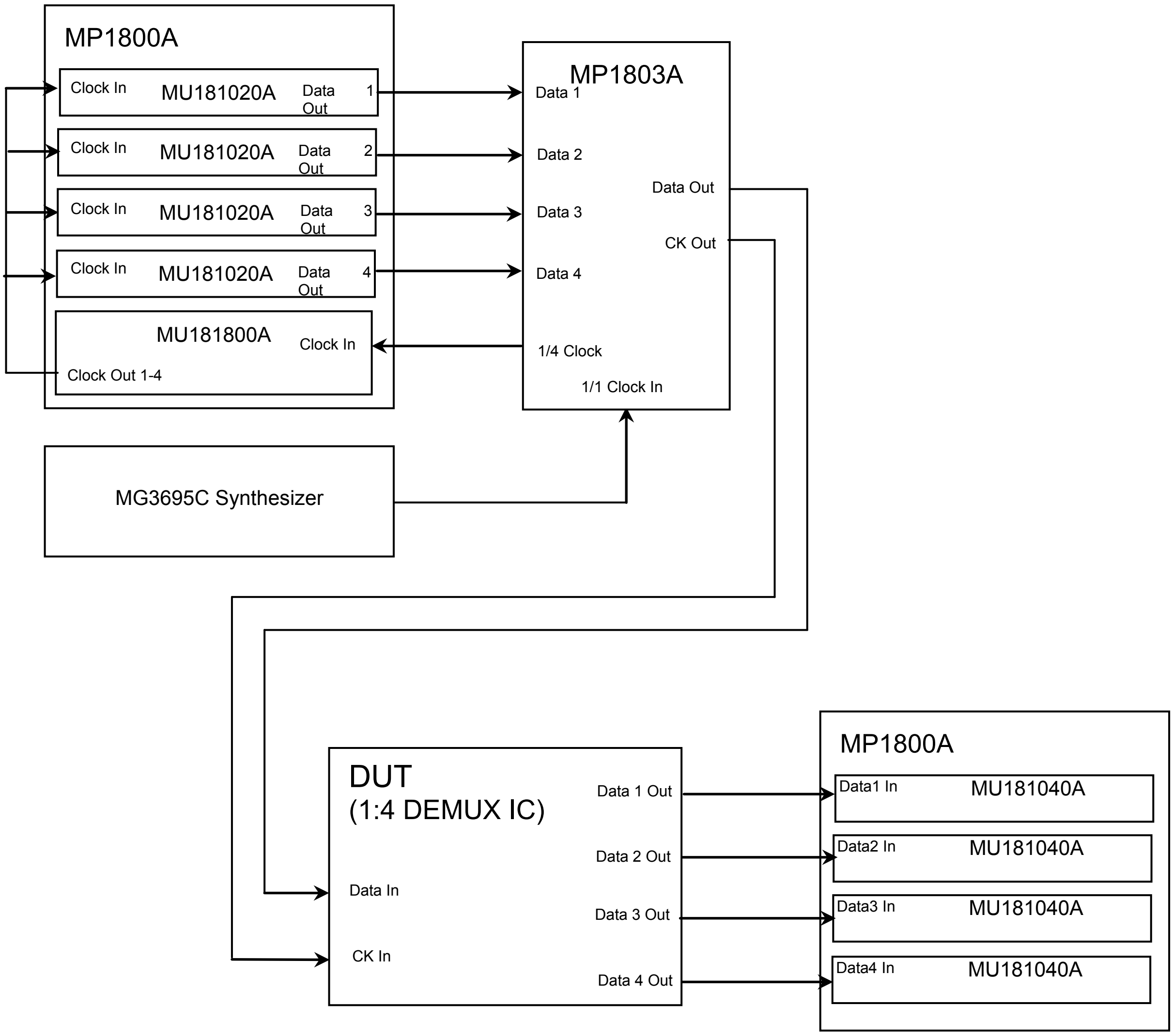


Figure 6.2.1-1 Connection diagram for 1:4 DEMUX IC evaluation

6. Turn on the measuring instruments in the following order:
   MP1800A, on which the MU181040A units are installed → DUT → MP1803A → MP1800A on which the MU181020A units are installed

⚠ CAUTION

The DUT may be damaged if a signal line is connected or disconnected while the output is ON. Be sure to set the output OFF before changing the cable connection.

7. Enable the signal output of the MU181020A (ON).
   Set Data/XData to ON in the MU181020A Output tab window, and click the [Output ON/OFF] module function button to set it to "ON".
8. Adjust the threshold voltage and phase of the MP1803A to the optimum values, using the 1/1Clock and V_{TH} knobs of the MP1803A.
9. Set the threshold voltage for the MU181040A.
10. The BER measurement results are displayed in the MU181040A Result tab window. No error is detected if there is no failure and the connection and settings are correct.
11. Confirm that the DUT operates normally. If so, margin measurement can be performed for the DUT by changing the output level and offset of the MP1803A Multiplexer.

6.3 Burst Measurement

This section provides an example of how to execute an optical circulating loop test by using the MP1800A.

6.3.1 Test method

A typical system for the optical circulating loop test is shown in Figure 6.3.1-1. The following shows a test example where the MU181000A, MU181020A, and MU181040A are mounted onto one MP1800A mainframe.
The options configuring the test system are as follows:

MP1800A-014,
MU181020A-002/x11/x30,
MU181040A-002/x30

1. Ground the MP1800A and device under test (DUT).
2. Connect the power cables.
3. Turn on the MP1800A and set the measurement conditions as follows.
   1) Set the frequency for the MU181000A to 9.95328 GHz.
   2) In the MU180120A Misc tab window, set as follows.

      In the Pattern Sequence area:

      - Select “Burst” from the Pattern Sequence list box
      - Select “Internal” from the Source list box
      - Select “Consecutive” from the Data Sequence list box

        In the AUX Output area:

      - Select “Burst Output2” from the AUX Output list box

        In the Timing area:

      - Set the Data output, Burst output, and Gating output timings according to the DUT
   3) From the Test Pattern area in the MU181020A Pattern tab window, set a test pattern to be transmitted. Set “PRBS31” in this example.

      First, select “PRBS” from the Test Pattern list box, and then select “2^{31} – 1” from the Length list box.
   4) Click the [Output ON/OFF] module function button to set it to OFF. The output from the MU181020A is now stopped.
   5) In the MU180140A Misc tab window, set as follows.

      In the Pattern Sequence area:

      - Select “Burst” from the Sequence list box

- Select “Internal” from the Source list box

In the Burst timing setting area:

- Select “Auto” for Delay
- Set the Enabled Period
  It must be shorter than the Burst data to be received.
- Set the Burst Cycle

6) From the Test Pattern area in the MU181040A Pattern tab window, set a test pattern to be received. Set “PRBS31” in this example.

   First, select “PRBS” from the Test Pattern list box, and then select “2^{31} – 1” from the Length list box.

7) In the MU181040A Input tab window, adjust the data input interface for the MU181040A to the output of the DUT.

4. Connect the measuring instruments and the DUT. See Figure 6.3.1-1 for connection of the instruments.

   Connect the I/O signals using the supplied coaxial cables (cables equivalent to the supplied ones can also be used). At this time, short the cores of the cables, using a thin pointed metal stick such as tweezers before connection.

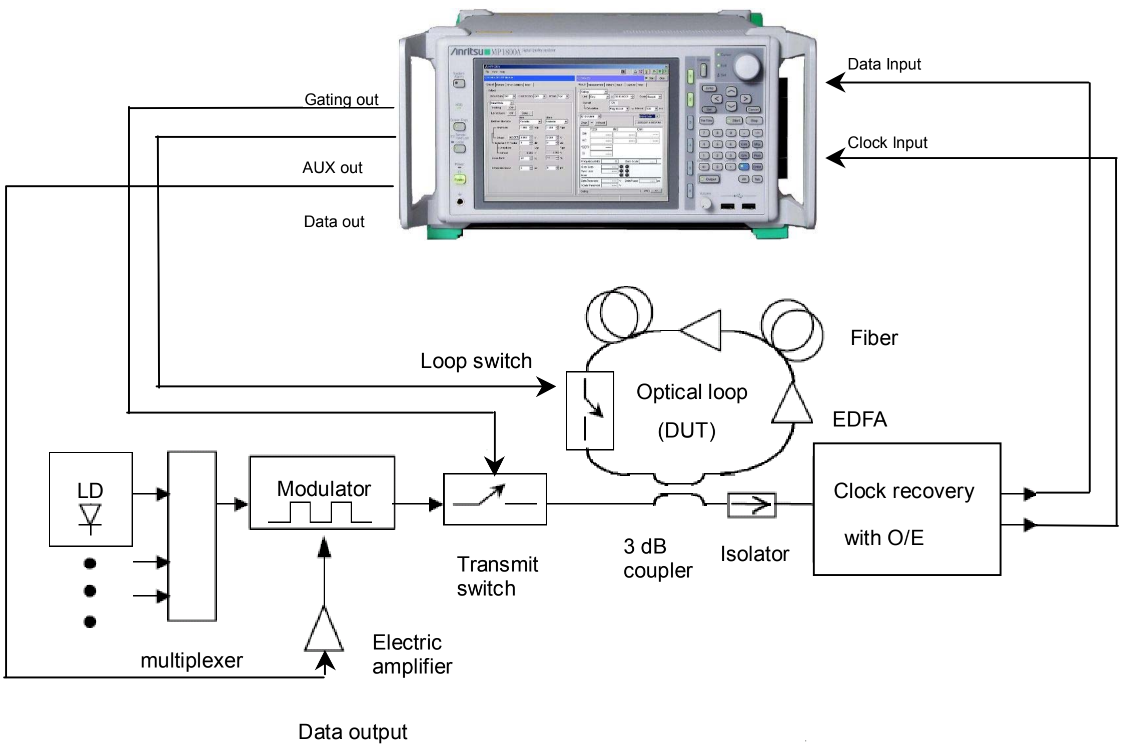


Figure 6.3.1-1 Connection diagram for optical circulating loop test

5. In the MU181020A Output tab window, set Data/XData to ON and set the Output function button to “ON” to enable signal output. Next, click the measurement start button to start measurement.

⚠ CAUTION

The DUT may be damaged if a signal line is connected or disconnected while the output is ON. Be sure to set the output to OFF before changing the cable connection.

6. Adjust the threshold voltage and phase of the MU181040A to the optimum values.
7. The BER measurement results are displayed in the MU181040A Result tab window. No error is detected when there is no failure and the connection and settings are correct.

6.4 ONU-OLT Uplink Test (Burst signal error rate measurement)

This section provides an example of how to execute an ONU-OLT uplink test in the PON system by using the MP1800A.

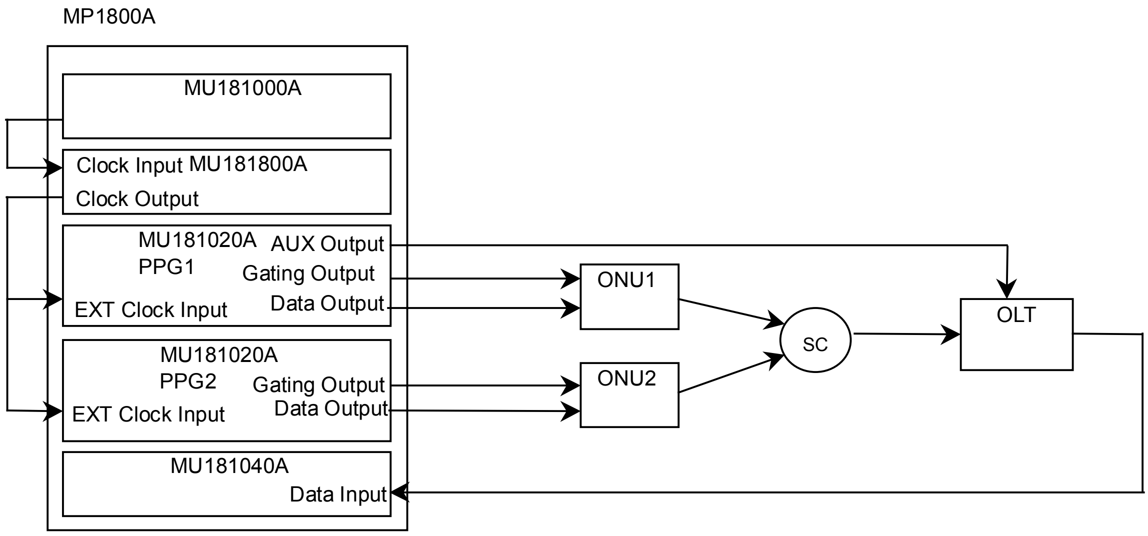


Figure 6.4-1 Connection diagram for ONU-OLT uplink test

6.4.1 Test method

The following shows a test example where the MU181000A, MU181800A, MU181020A, and MU181040A are mounted onto one MP1800A mainframe.
The options configuring the test system are as follows:

MP1800A-015,
MU181020A-002/x11/x30,
MU181040A-002/x30/x20

1. Connect the MP1800A, MU181000A, MU181800A, MU181020A, MU181040A, ONU1, ONU2, and OLT as shown in Figure 6.4-1.
2. Set the frequency of the MU181000A to 1.25 GHz, and set the output signal level of the MU181020A according to the input levels of the ONU1, ONU2, and OLT.
3. In the Combination Setting dialog box, select “Channel Synchronization.”

4. Configure the setting for the transmission side.
   Set the output pattern and data timing of the MU181020A PPG 1 and PPG2 as shown in Figure 6.4.1-1. In the MU181020A Misc tab window, set as follows:

Pattern Sequence:	Burst
Source:	Internal
Data Sequence:	Restart
AUX Output:	Burst Output2
Burst Cycle:	131,072 bits
Enable Period:	36,864 bits

   Then, set the pulse width and delay of the gate signal according to the ONU1, ONU2, and OLT.

Test Pattern:	Data
Data Length:	36,864 bits (a "0" pattern is inserted to fill the data area of the PPG1 and PPG2, as shown in Figure 6.4.1-1)

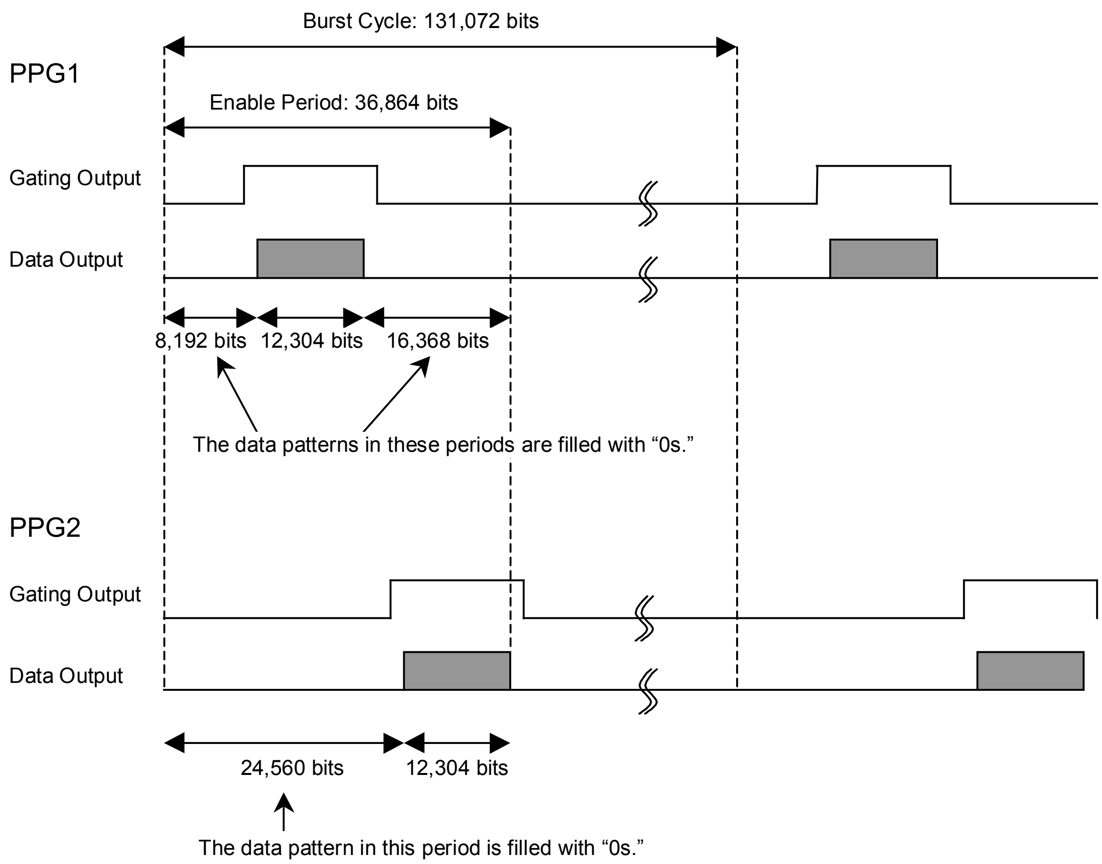


Figure 6.4.1-1 Timing

5. In order to measure BER for the signal at the PPG1 side, configure the settings for the MU181040A as follows.

   In the MU181040A Misc tab window:

   Pattern Sequence: Repeat

   In the MU181040A Pattern tab window:

   Test Pattern: Data (Set the same test pattern as that set for the MU181020A.)

   Data Length: 131,072 bits (adjusted to Burst Cycle)

   Set the period to be filled with a “0” pattern and the data pattern, according to the PPG1 data.

6. In the Clock area on the MU181040A Input tab window, select “Recovered Clock” from the Selection list box and set the clock rate to 12.5000 Gbit/s. Next, execute Auto Search.

7. Click the measurement start button to start the BER measurement. Execute a load test for ONU and OLT as required, by changing the timing of the PPG1 and PPG.

Chapter 7 Performance Test

This chapter describes the performance testing of the MU181040A.

7.1 Overview

Performance tests are executed to check that the major functions of the MU181040A meet the required specifications. Execute performance tests at acceptance inspection, operation check after repair, and periodic (once every six months) testing.

7.2 Devices Required for Performance Tests

Before starting performance tests, warm up the MU181040A and the measuring instruments for at least 30 minutes. Table 7.2-1 shows the devices required for performance tests.

Table 7.2-1 Devices required for performance tests

Model name	Required Performance
Pulse Pattern Generator (MP1800A+MU181020A/B)	Operating frequency: 100 MHz to 12.5 GHz*1 Data clock phase variable: 1 UI or more*2 Other performances must be equivalent to those for the MU181020A.
Pulse Pattern Generator (MP1800A+MU181020B)	Operating frequency: 100 MHz to 14.0 GHz Data clock phase variable: 1 UI or more*3 Other performances must be equivalent to those for the MU181020B.
Sampling Oscilloscope	50 GHz or more band
Signal generator (MP1800A＋MU181000A/B, MG3690 series)	At MU181040A evaluation Operating frequency: 100 MHz to 12.5 GHz Output level: 400 to 2000 mVp-p Waveform: 100 to 500 MHz rectangular wave > 500 MHz rectangular wave or sine wave When evaluating the MU181040B, use the MG3690 series in addition to the above. Operating frequency: 12.5 GHz to 14 GHz Output level: 400 to 1500 mVp-p Waveform: Rectangular wave or sine wave

*1: The operating frequency range must be 9.8 to 12.5 GHz when the MU181040A-001 is installed.

*2: This is not required when the MU181040A-001 or MU181040A-x30 is installed.

*3: Not required when MU181040B-x30 installed

Notes:

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.

7.3 Performance Test Items

This section describes the following test items.

1. Operating frequency range
2. Input level
3. Pattern
4. Error detection

7.3.1 Operating frequency

(1) Specifications

Table 7.3.1-1 Specifications

Option	Specifications
MU181040A-001	9.8 to 12.5 GHz
MU181040A-002	0.1 to 12.5 GHz
MU181040B-002	0.1 to 14.0 GHz
MU181040B-003	0.1 to 14.05 GHz
MU181040B-005	0.1 to 14.1 GHz

(2) Operating frequencies for MU181040A-x20, MU181040B-x20 Clock Recovery:

100 MHz,
125 to 200 MHz,
250 to 400 MHz,
500 to 800 MHz,
1000 to 1600 MHz,
2000 to 3200 MHz,
4250 MHz,
4.9 to 6.25 GHz,
9.8 to 12.5 GHz

(3) Connection

Figure 7.3.1-1 shows a connection example when the MU181040A (installed MU181040A-002), MU181000A, and MU181020A (with MU181020A-x12 and -x21 installed) are used.
Before connecting the devices, be sure to use a sampling oscilloscope to check if the frequency and level of the signals output from the MU181000A and MU181020A are proper.

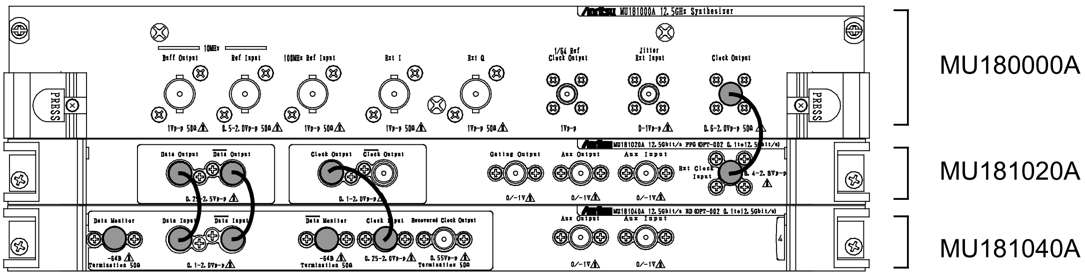


Figure 7.3.1-1 Inter-module connection example

(4) Procedure

(a) 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.

(b) Connect the Clock Output connector of the MU181000A and the Ext. Clock input connector of the MU181020A, using a coaxial cable.

(c) Connect the Data output connector of the MU181020A and the Data input connector of the MU181040A, using a coaxial cable. Also connect the XData output connector of the MU181020A and the XData input connector of the MU181040A, using a coaxial cable.

Note:

When a pulse pattern generator other than the Signal Quality Analyzer Series pulse pattern generator, MU181020A, 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 MU181040A.

(d) Connect the Clock Output connector of the MU181020A and the Clock Input connector of the MU181040A, using a coaxial cable. Also attach the coaxial 50-Ohm terminator supplied with the MU181040A to the Data and XData Monitor output connectors of the MU181040A. (Connection of Clock Input and Monitor output connectors is required only when MU181040A-002 is installed into the MU1801040A.)

(e) 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.

(f) Set the Data and Clock outputs of the MU181020A to ON, and then press **Start** of the MU181040A.

(g) Set the frequency of the MU181000A to a value within the specification, and adjust the phase of the MU181020A and the MU181040A (when MU181040A-x30 is installed) so that an error does not occur at the set frequency.
When MU181040A-001 is installed, the clock frequency setting on the Input tab window must be the same with the input frequency. Phase adjustment is not required in this event.

(h) When MU181040A-x20 is installed, in the Input tab window, select “Recovered Clock” for the clock and set the clock recovery frequency to the input frequency value. Next, set the MU181000A’s frequency and adjust the phase as in Step (g), and check that no error occurs.

7.3.2 Input level

(1) Specifications

Table 7.3.2-1 Specifications

Option	Specifications
MU181040A-001	Input amplitude: 0.1 to 0.9 Vp-p Threshold voltage: –0.35 to +0.35 V
MU181040A-002	Input amplitude: 0.1 to 2.0 Vp-p Threshold voltage: –3.5 to +3.3 V
MU181040B-002	Input amplitude: 0.1 to 2.0 Vp-p Threshold voltage: –3.5 to +3.3 V

(2) Connection

See Figure 7.3.1-1 for the device connection.

(3) Procedure

(a) Connect devices and configure the settings in the same manner as shown in Steps (a) to (e) in Section 7.3.1, except for the following operations:

- In Step (c), connection between the XData output connector and the XData Input connector is not required.
- In the Input tab window, set **Input Condition** to **Single-Ended** and **Data**.

(b) Set the output level of the MU181020A and the threshold voltage of the MU181040A as shown in Table 7.3.2-2 or Table 7.3.2-3. Next, set the output of the MU181020A to ON and press **Start** of the MU181040A. Adjust the phase as required, and check that no error occurs.

Table 7.3.2-2 Input level test setting when MU181040A-001 is installed

No.	MU181020A			MU181040A	
	Termination	Amplitude [Vp-p]	Offset (Vth) [V]	Termination	Threshold voltage [V]
1	GND	0.9	–0.35	GND	–0.350
2		0.1	–0.35		–0.350
3		0.9	+0.35		+0.350
4		0.1	+0.35		+0.350

Table 7.3.2-3 Input level test setting when MU181040A-002 is installed

	MU181020A			MU181040A	
No.	Termination	Amplitude [Vp-p]	Offset (Vth) [V]	Termination	Threshold voltage [V]
1	GND	2.0	–3.5	GND	–3.500
2		0.1	–3.5		–3.500
3		2.0	+3.5		+0.350
4		0.1	+3.5		+0.350
5	NECL	0.8	–1.3	NECL	–1.300
6	LVPECL	0.8	+2.0	LVPECL	+2.000
7	PCML	0.5	+3.05	PCML	+3.050

Notes:

When changing the termination condition, configure the settings of the MU181020A and the MU181040A in the following order. The MU181020A and the MU181040A 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 MU181020A to OFF.

[2] Set the termination condition for the MU181040A to GND.

[3] Change the termination condition for the MU181020A.

[4] Set the termination condition for the MU181040A to that for the MU181020A set in Step [3].

(c) Remove the cable from the Data Input connectors, and then connect the XData Input connectors, using a coaxial cable. In the Input tab window, set **Input Condition** to **Single-Ended** and **XData**. Next, set the output level of the MU181020A and the threshold voltage of the MU181040A as shown in Table 7.3.2-2 or Table 7.3.2-3, and check that no error occurs.

7.3.3 Pattern

(1) Specifications

- PRBS pattern
- Zero Substitution pattern

(2) Connection

Refer to Figure 7.3.1-1 for the device connection.

(3) Procedure

1. Connect devices and configure the settings in the same manner as shown in (a) to (b) in Section 7.3.1 (4).
2. Set the output of the MU181020A to ON and press **Start** of the MU181040A. Adjust the phase as required, and check that no error occurs.
3. For both the MU181040A and the MU181020A, 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 MU181040A, the PRBS pattern length can be set in the Pattern tab window.
4. Set the PRBS pattern length to $2^{31} - 1$, changing the mark ratio to 1/8, 1/4, 1/2, 3/4, and 7/8. For the MU181040A, this operation can be performed by changing **Mark Ratio** and **Logic** (POS/NEG) on the Pattern tab window. Check that no error occurs.
5. For both the MU181040A and the MU181020A, 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 check that no error occurs.

7.3.4 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: 0.1 to 12.5 GHz, accuracy: ±(10 ppm + 1 kHz)

(2) Connection

See Figure 7.3.1-1 for the device connection.

(3) Procedure

1. Connect devices and configure the settings in the same manner as shown in Steps (a) to (e) in Section 7.3.1 (4).
2. Set the frequency of the MU181000A to 10 GHz, set the output of the MU181020A to ON, and then press **Start** of the MU181040A. Adjust the phase as required, and check that no error occurs. When MU181040A-001 is installed, set **Recovered Clock** in the Input tab window to 10 Gbit/s.
3. Enable the error insertion function of the MU181020A, and check that the ER measurement result in the MU181040A Result tab window equals to the value set for error insertion of the MU181020A.
4. Set Single for error insertion of the MU181020A (set **Variation** to **Single** in the MU181020A Error Addition tab window). In the Gating field on the MU181040A Measurement tab window, set **Cycle** to **Single**, and set the measurement time to 10 seconds.
5. Press the **Start** of the MU181040A to start measurement. Next, press the error insertion **Single** button of the MU181020A 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 8 Maintenance

This chapter describes maintenance of the MU181040A.

8.1 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.

8.2 Cautions on Storage

Wipe off any dust, soil, or stain on the MU181040A prior to storage.
Avoid storing the MU181040A in any of the following locations:

- Where there is direct sunlight
- Where there is dust
- Where humidity is high and dew may accumulate
- Where chemically active gases are present
- Where the MU181040A may become oxidized.
- Where strong vibrations are present
- 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

8.3 Transportation

Use the original packing materials, if possible, when packing the MU181040A for transport. If you do not have the original packing materials, pack the MU181040A according to the following procedure. When handling the MU181040A, 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 MU181040A.
2. Check for loose or missing screws.
3. Provide protection for structural protrusions and parts that can easily be deformed, and wrap the MU181040A with a sheet of polyethylene. Finally, cover with moisture-proof paper.
4. Place the wrapped MU181040A 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 8.2 “Cautions on Storage”.

8.4 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.

8.5 Disposal

Confirm the notes described in the Signal Quality Analyzer Series Installation Guide and observe national and local regulations when disposing of the MU181040A.

Chapter 9 Troubleshooting

This chapter describes how to check whether a failure has arisen when an error occurs during the operation of the MU181040A.

9.1 Problems Discovered during Module Replacement

Table 9.1-1 Remedies for problems discovered during replacement of MU181040A

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 MU181040A/B, access to “MP1800 Series Signal Quality” on your Web site (http://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.

9.2 Handling Suspected Failure

- Synchronization cannot be established (error measurement cannot be performed)

Table 9.2-1 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 9.2-1 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 CD version.

Appendix A Pseudo-Random Pattern

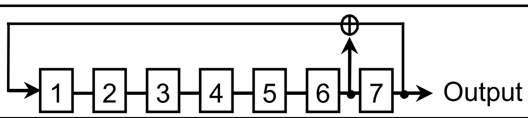
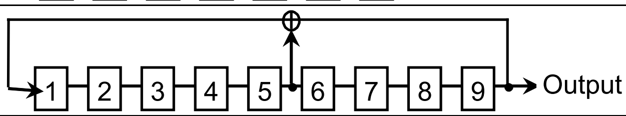
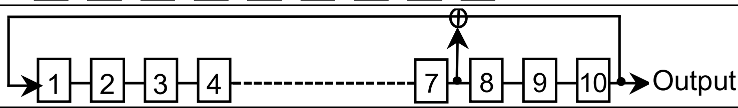
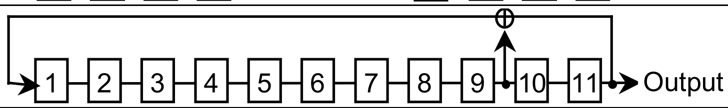
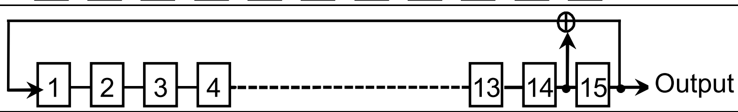
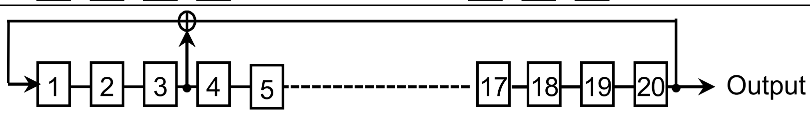
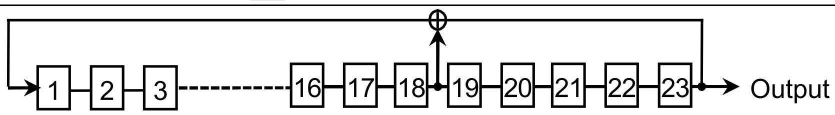
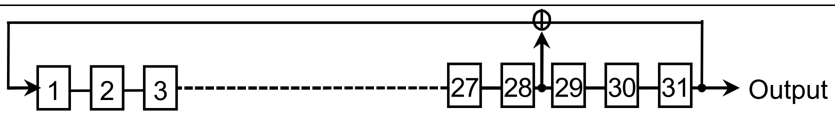
A.1 Pseudo-Random Pattern

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
$2^7 - 1$	$1 + X^6 + X^7$	
$2^9 - 1$	$1 + X^5 + X^9$	
$2^{10} - 1$	$1 + X^7 + X^{10}$	
$2^{11} - 1$	$1 + X^9 + X^{11}$	
$2^{15} - 1$	$1 + X^{14} + X^{15}$	
$2^{20} - 1$	$1 + X^3 + X^{20}$	
$2^{23} - 1$	$1 + X^{18} + X^{23}$	
$2^{31} - 1$	$1 + X^{28} + X^{31}$	

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    100000000000011

13 bits    1000000000000010
```

Figure A.2-1 Zero-substitution pattern

B.1 List of Initial Settings

This section lists the initial values at factory shipment of the setting items related to the MU181040A.
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
		Settings and result display for Logging	Logging execution	OFF
			Logging result display	–
			Log condition setup dialog box display	
		Settings and result display for histogram	Histogram execution	OFF
			Histogram calculation resolution	1 s
			Histogram display resolution	1 s
			Histogram result type	Error Count
			Histogram vertical scale settings	Error Count: TOP E+11 Bottom 0 Error Rate: TOP E+0 Bottom E-11 EI: TOP E+11 Bottom 0
			Histogram result time	00 00:00:30
			Error detection method	Total
			Error alarm search	Time: 00 00:00:00 Alarm/EC: -----
			Error alarm search	Time: 00 00:00:00 Alarm/ER: -----
			Error alarm search	Time: 00 00:00:00 Alarm/EI: -----
	Start of Error/Alarm measurement			–
	Stop of Error/Alarm measurement			–

Table B.1-1 List of initial settings (Cont'd)

Function	Main Category	Sub-Category	Individual Setting Item	Initial Setting
Measure-ment	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
		SES generation threshold		SES:1E–3 DM:1E–6
		Clock Loss generation interval for Performance measurement		ON
		CR Unlock generation interval for Performance measurement		ON
		Sync Loss generation interval for Performance measurement		ON

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		Differential 50 Ω
		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 Recovered Clock (MU181040A-001)
		Recovered clock frequency selection		Variable
		Recovered clock frequency setting		12.500000 Gbit/s
		Recovered clock output polarity		POS (MU181040A-x20)
		Clock phase unit		mUI (MU181040A-x30)
		Clock phase variable (mUI)		0 mUI (MU181040A-x30)
		Clock phase variable (ps)		0.00 ps (MU181040A-x30)
		Clock phase calibration		– (MU181040A-x30)
		Clock phase reference		OFF (MU181040A-x30)
		Clock phase variable (reference mUI)		0 mUI (MU181040A-x30)
		Clock phase variable (reference ps)		0.00 ps (MU181040A-x30)
		Clock input termination setup dialog box display		–
		Clock input termination condition		GND
		Clock input termination voltage		0.00 V

*: Items shared with the pulse pattern generator are omitted. See Appendix B List of Initial Settings of the MU181020A 12.5 Gbit/s 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 condition dialog box display	Capture block division number	1
		Capture trigger	Match Pattern
		Capturing start position	Top
		Capture trigger match pattern length	4 bits
		Capture trigger pattern format	HEX
		Edit of capture trigger mask pattern	All 0
		Edit of capture trigger match pattern	All 0
	Capture result acquisition	Capture result acquisition method	Capture All
		Capture result acquisition start block	1
		Capture result acquisition block count	1
	Capture result bit pattern display	Display	Table
		Format	HEX
	Capture result bit map display	Capture data turning point	256
		Capture data display scale	×1
Misc	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 In the case of 2 ch combination: Initial value × 2 In the case of 4 ch combination: Initial value × 4
		Burst cycle	25,600 In the case of 2 ch combination: Initial value × 2 In the case of 4 ch combination: Initial value × 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
		Block No. of synchronized output position (for Sequence pattern)	1

Table B.1-1 List of initial settings (Cont'd)

Function	Main Category	Sub-Category	Individual Setting Item	Initial Setting
Misc (Cont'd)	Synchronized output (Aux Output) (Cont'd)	Synchronized output position (for Sequence pattern)		1
	Aux Input	Connector		External Mask (Repeat) Burst (Burst)
	Measurement restart condition (Measurement Restart)	Measurement restart upon input threshold change		False
		Measurement restart upon clock phase change		False

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 Combination Function Configuration

The conditions required to execute the Combination function by using multiple MU181040A modules are described below.

All of the following conditions must be satisfied to execute the Combination function.

Enabling conditions for Combination function

- Two or more MU181040A modules are mounted on one mainframe. When the mainframe option is 015, they shall be mounted from Slot 1, from the top downward; while in the case of 016 they shall be mounted from the bottom upward starting from Slot 6.
- Do not mix the MU181040A and MU181040B.
- Supported installed modules are the MU181040A-001, MU181040A-002, and MU181040B-002.
  However. execution is not possible when the MU181040A-001 and MU181040A-002 modules are mixed.
- The mainframe option must be either option 015 or 016

In addition, the following restriction is added for the Combination function.

Restriction for Combination function

- The Sequence pattern cannot be used as the test pattern.

C.2 Restrictions on operations when multiple modules are mounted

This section describes the restrictions on operations for executing the Independent function when two or more MU181020A/B and/or MU181040A modules are mounted on the MP1800A/MT1810A. These restrictions apply only when generating Data, Zero-substitution, Mixed, or Sequence patterns, and do not apply when generating PRBS patterns.

Restrictions on Independent function operations

- When two or more MU181020A/B or MU181040A modules are mounted on one MP1800A/MT1810A unit, two frequency bands of 0.1 to 6 Gbit/s and 6 to 12.5 Gbit/s must not be mixed between MU181020A/B modules and between MU181040A modules. However, the frequency band for the MU181020A/B modules and that for the MU18040A modules can exist within the MP1800A/MT1810A.
  Operations at different frequencies are allowed as long as the frequencies fall within the same frequency band.
- When two or more MU181020A/B modules and this equipment are installed in the mainframe, the following modules become the master module for Clock input.
  MP1800A-016 Master Module
  MU181020A,MU181020B: Slot1
  MU181040A,MU181040B: Slot6

  MP1800A-015 or MT1810A-015 Master Module
  MU181020A,MU181020B: Slot1
  MU181040A,MU181040B: Slot1
  However, the following modules become the master module, when the MU181020A/B is installed in Slot1 and 2 and when the MU181040A/B is installed in Slot 3 and 4. (Refer to Figure C.2-3 Restrictions of the case c)
  MU181020A, MU181020B: Slot1
  MU181040A, MU181040B: Slot3

  MP1800A-014 or MT1810A-014 Master Module
  MU181020A, MU181020B: Slot3
- When the module configuration is reconfigured or when the MU181020A/B or MU181040A/B is retrofitted, input the clock signal in the master module of the MU181020A/B and MU18040A/B.

- If the MU181040A-x20 or MU181040B-x20 Clock Recovery option is mounted and selected in an MU181040A/B module, adjust the clock recovery setting bit rate according to the frequency band for the other MU181040A/B modules.

a) MP1800A-016 with four MU181020A and two MU181040A modules mounted

Example:

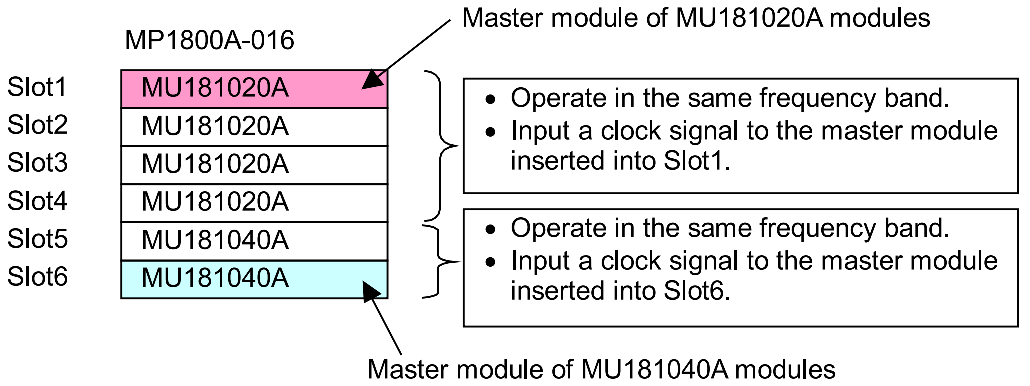


Figure C.2-1 Restrictions of the case a)

b) MP1800A-015/MT1810A-015 with four MU181040A modules mounted

Example:

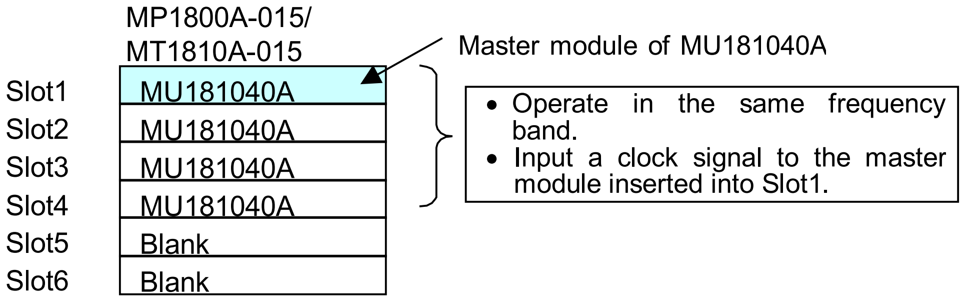


Figure C.2-2 Restrictions of the case b)

c) MP1800A-015/MT1810A-015 with two MU181020A and two MU181040A modules mounted

Example:

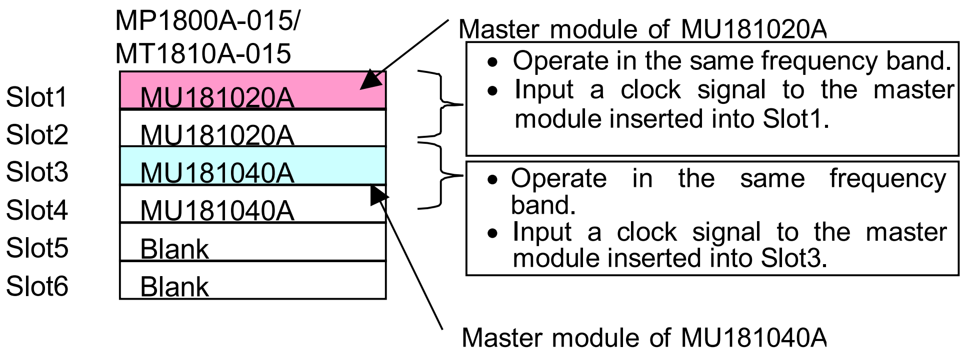


Figure C.2-3 Restrictions of the case c)

When mounting MU181020A/B or MU181040A modules onto the MP1800A/MT1810A, note that the number of modules that can be mounted and the mounting positions (slots) vary depending on the option additionally installed in the MP1800A/MT1810A.
For details, refer to the release note included in this equipment or refer to the Anritsu homepage (http://www.anritsu.com).

C.3 Settings Common in Combination System

When the MU181040A 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

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	Independent
		Settings and result display for Logging	Logging execution	Common
			Logging result display	Common
			Log condition setup dialog box display	Common
		Settings and result display for histogram	Histogram execution	Independent
			Histogram calculation resolution	Common
			Histogram display resolution	Independent
			Histogram result type	Independent
			Histogram vertical scale settings	Independent
			Histogram result time	Independent
			Error detection method	Independent
			Error alarm search	Independent
	Start of Error/Alarm measurement			Common
	Stop of Error/Alarm measurement			Common

Table C.3-1 Common/Independent Setting Items in Combination System (Cont'd)

Function	Main Category	Sub-Category	Individual Setting Item	Common/ Independent
Measure-ment	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 (Sync Control)	Synchronization method		Common
		Unique pattern length for frame synchronization		Common
		PRGM pattern start position		Common
		Edit of synchronization mask pattern		Common
	Measurement condition (Error/Alarm Condition)	Interval for EI and EFI measurements		Common
		SES generation threshold		Common
		Clock Loss generation interval for Performance measurement		Common
		CR Unlock generation interval for Performance measurement		Common
		Sync Loss generation interval for Performance measurement		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		Independent

*: Settings shared by the PPG are omitted here. For details, read the MU181020A 12.5 Gbit/s･MU181020B 14 Gbit/s Pulse Pattern Generator Operation Manual.

Table C.3-1 Common/Independent Setting Items in Combination System (Cont'd)

Function	Main Category	Sub-Category	Individual Setting Item	Common/ Independent
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
		Recovered clock frequency selection		Common
		Recovered clock frequency setting		Common
		Recovered clock output polarity		Independent
		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 input termination setup dialog box display		Independent
		Clock input termination condition		Independent
		Clock input termination voltage		Independent
Capture	Capture condition setup dialog box display	Capture block division number		Common
		Capture trigger		Common
		Capturing start position		Common
		Capture trigger match pattern length		Common
		Capture trigger pattern format		Common
		Edit of capture trigger mask pattern		Common
		Edit of capture trigger match pattern		Common
	Capture result acquisition	Capture result acquisition method		Common
		Capture result acquisition start block		Common
		Capture result acquisition block count		Common
	Capture result bit pattern display			Independent
	Capture result bit map display	Capture data turning point		Common
		Capture error point		Independent
		Capture data display scale		Common
	Capture result Block display	Capture error point		Common

Table C.3-1 Common/Independent Setting Items in Combination System (Cont'd)

Function	Main Category	Sub-Category Individual Setting Item	Common/ Independent
Misc	Signal generation (Pattern Sequence)	Signal generation method	Common
		Burst signal input	Common
		Burst trigger delay	Independent
		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

Table C.3-1 Common/Independent Setting Items in Combination System (Cont'd)

Function	Main Category	Sub-Category	Individual Setting Item	Common/ Independent
Auto measure ment	Auto Adjust	Item		Common
		Slot selection		Independent
	Auto Search	Measurement mode		Common
		Item		Common
		Slot selection		Independent
	ED Result All	Switching all measurement results display		Common
		Error/ Alarm	Measurement result display item selection	Common
			History reset	Common
		Logging	Logging execution selection	Common
			Logging condition setting	Common
			Logging result delete	Common
		Start of measurement		Common
		Stop of measurement		Common
	ISI	File menu		Independent
		Measurement target slot selection		Independent
		Measurement processing method selection (Gating Cycle)		Independent
		Measurement period time setting (Gating Period)		Independent
		Measurement type selection		Independent
		Start of measurement		Independent
		Stop of measurement		Independent
		Time display selection		Independent
		Marker movement		Independent
		Transition between layers	Upper (Zoom In)	Independent
			Lower (Zoom Out)	Independent
	Eye Diagram/ Eye Margin/ Bathtub/Q measurement	All items		Independent

D.1 Performance Test Result Sheet

D.1.1 MU181040A 12.5Gbit/s

Equipment Name: MU181040A 12.5Gbit/s ED Module

Serial No.:

Ambient Temperature: °C

Relative Humidity: %

Table D.1.1-1 Operating Frequency Range

Option Configuration	Operating Frequency Range Specification	Results
MU181040A-001	No error occurs within the range from 9.8 to 12.5 GHz	
MU181040A-002	No error occurs within the range from 0.1 to 12.5 GHz	

Table D.1.1-2 Input level range

Option Configuration	Specification	Results
MU181040A-001	Input amplitude: 0.1 to 0.9 Vp–p Threshold voltage: No error occurs within the range from –0.35 to +0.35 V.	
MU181040A-002	Input amplitude: 0.1 to 2.0 Vp–p Threshold voltage: No error occurs within the range from –3.5 to +3.3 V.	

Table D.1.1-3 Test pattern

Option Configuration	Specification	Results
PRBS, Length: 2n–1 (n = 7, 9, 10, 11, 15, 20, 23, 31), Mark ratio: 1/2	No error	
PRBS, Length: 2^{31}–1, Mark ratio: 1/8, 1/4, 3/4, 7/8	No error	
Zero Substitution, Length: 2n–1 (n = 7, 9, 10, 11, 15, 20, 23) or 2n (n = 7, 9, 10, 11, 15, 20, 23)	No error	

Table D.1.1-4 Error detection

Option Configuration	Specification	Results
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)	999500 to 1005000 kHz	

D.1.2 MU181040B 14Gbit/s

Equipment Name: MU181040B 14Gbit/s ED Module

Serial No.:

Ambient Temperature: °C

Relative Humidity: %

Table D.1.2-1 Operating Frequency Range

Option Configuration	Operating Frequency Range Specification	Results
MU181040B-002	No error occurs within the range from 0.1 to 14 GHz	
MU181040B-003	No error occurs within the range from 0.1 to 14.05 GHz	
MU181040B-005	No error occurs within the range from 0.1 to 14.1 GHz	

Table D.1.2-2 Input level range

Option Configuration	Specification	Results
MU181040B-002	Input amplitude: 0.1 to 2.0 Vp–p Threshold voltage: No error occurs within the range from –3.5 to +3.3 V.	

Table D.1.2-3 Test pattern

Option Configuration	Specification	Results
PRBS, Length: 2n–1 (n = 7, 9, 10, 11, 15, 20, 23, 31), Mark ratio: 1/2	No error	
PRBS, Length: 2^{31}–1, Mark ratio: 1/8, 1/4, 3/4, 7/8	No error	
Zero Substitution, Length: 2n–1 (n = 7, 9, 10, 11, 15, 20, 23) or 2n (n = 7, 9, 10, 11, 15, 20, 23)	No error	

Table D.1.2-4 Error detection

Option Configuration	Specification	Results
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)	999500 to 1005000 kHz	