

**MP2100A BERTWave
MP2101A BERTWave PE
MP2102A BERTWave SS
Operation Manual**

15th Edition




**For safety and warning information, please read this manual before attempting to use the equipment.
Keep this manual with the equipment.**

ANRITSU CORPORATION

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.

MP2100A BERTWave

MP2101A BERTWave PE

MP2102A BERTWave SS

Operation Manual

5 February 2010 (First Edition)

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The contents of this manual may be changed without prior notice.

Printed in Japan

For Safety

WARNING



- ALWAYS refer to the operation manual when working near locations at which the alert mark shown on the left is attached. If the advice in the operation manual is not followed, there is a risk of personal injury or reduced equipment performance. The alert mark shown on the left may also be used with other marks and descriptions to indicate other dangers.
- Overvoltage Category
This equipment complies with overvoltage category II defined in IEC 61010. DO NOT connect this equipment to the power supply of overvoltage category III or IV.
- Laser radiation warning
 - NEVER look directly into the cable connector on the equipment nor into the end of a cable connected to the equipment. There is a risk of injury if laser radiation enters the eye.
 - The Laser Safety label is attached to the equipment for safety use as indicated in "Laser Safety" later in this section.

Electric Shock

- To ensure that the equipment is grounded, always use the supplied 3-pin power cord, and insert the plug into an outlet with a ground terminal. If power is supplied without grounding the equipment, there is a risk of receiving a severe or fatal electric shock or causing damage to the internal components.

Repair



- Only qualified service personnel with a knowledge of electrical fire and shock hazards should service this equipment. This equipment cannot be repaired by the operator. DO NOT attempt to remove the equipment covers or unit covers or to disassemble internal components. There are high-voltage parts in this equipment presenting a risk of severe injury or fatal electric shock to untrained personnel. In addition, there is a risk of damage to precision components.

For Safety

WARNING

Calibration



- The performance-guarantee seal verifies the integrity of the equipment. To ensure the continued integrity of the equipment, only Anritsu service personnel, or service personnel of an Anritsu sales representative, should break this seal to repair or calibrate the equipment. Be careful not to break the seal by opening the equipment or unit covers. If the performance-guarantee seal is broken by you or a third party, the performance of the equipment cannot be guaranteed.

Falling Over

- This equipment should always be positioned in the correct manner. If the cabinet is turned on its side, etc., it will be unstable and may be damaged if it falls over as a result of receiving a slight mechanical shock.
Always set up the equipment in a position where the power switch can be reached without difficulty.

Replacing Battery



- When replacing the battery, use the specified battery and insert it with the correct polarity. If the wrong battery is used, or if the battery is inserted with reversed polarity, there is a risk of explosion causing severe injury or death.

Battery Fluid

- DO NOT short the battery terminals and never attempt to disassemble the battery or dispose of it in a fire. If the battery is damaged by any of these actions, the battery fluid may leak. This fluid is poisonous. DO NOT touch the battery fluid, ingest it, or get in your eyes. If it is accidentally ingested, spit it out immediately, rinse your mouth with water and seek medical help. If it enters your eyes accidentally, do not rub your eyes, rinse them with clean running water and seek medical help. If the liquid gets on your skin or clothes, wash it off carefully and thoroughly.

Battery Disposal

- DO NOT expose batteries to heat or fire. Do not expose batteries to fire. This is dangerous and can result in explosions or fire. Heating batteries may cause them to leak or explode.

For Safety



WARNING

LCD

- This equipment uses a Liquid Crystal Display (LCD). DO NOT subject the equipment to excessive force or drop it. If the LCD is subjected to strong mechanical shock, it may break and liquid may leak.

This liquid is very caustic and poisonous.

DO NOT touch it, ingest it, or get in your eyes. If it is ingested accidentally, spit it out immediately, rinse your mouth with water and seek medical help. If it enters your eyes accidentally, do not rub your eyes, rinse them with clean running water and seek medical help. If the liquid gets on your skin or clothes, wash it off carefully and thoroughly.

For Safety



CAUTION

Cleaning

- Always remove the main power cable from the power outlet before cleaning dust around the power supply and fan.
 - Clean the power inlet regularly. If dust accumulates around the power pins, there is a risk of fire.
 - Keep the cooling fan clean so that the ventilation holes are not obstructed. If the ventilation is obstructed, the cabinet may overheat and catch fire.

Check Terminal



- Never input a signal of more than the indicated value between the measured terminal and ground. Input of an excessive signal may damage the equipment.
-

For Safety

Laser Safety

Class 1 indicates the danger degree of the laser radiation specified below according to IEC 60825-1:2007.

Class 1: Lasers that are safe under reasonably foreseeable conditions of operation, including the use of optical instruments for intrabeam viewing.

Class I indicates the degree of danger of the laser radiation outlined below as defined by 21 CFR 1040.10:1995.

Class I: Class I levels of laser radiation are not considered to be hazardous.



WARNING

The laser in this equipment is classified as Class 1 according to the IEC 60825-1:2007 standard, or as Class I according to the 21 CFR 1040.10:1995 standard.



CAUTION

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

The use of optical instruments with this product will increase eye hazard.

For Safety

Laser Safety

The model names of “recommended SFP/XFP” written on label are listed in following table.

Table 1 Laser Safety Classifications Based on IEC 60825-1:2007

Model Name	Class	Max. Optical Output Power (mW) [*]	Pulse Width (s)/ Repetition Rate	Emitted Wavelength (nm)	Beam Radiation Angle [deg.]	Laser Aperture
G0174A	1	0.78	CW	850	23.0	Figure 2 [1]
G0194A	1	0.8	CW	1310	11.5	Figure 2 [1]
G0195A	1	1.58	CW	1550	11.5	Figure 2 [1]
G0238A	1	0.8	CW	850	23.0	Figure 2 [1]
G0239A	1	1.12	CW	1310	11.5	Figure 2 [1]

*: Indicates the possible optical output power when each and every reasonably foreseeable single-fault condition is included.




Table 2 Specifications of Laser Built into MP2100A/MP2101A

Model Name	Max. Optical Output Power (mW) [*]	Pulse Width (s)/ Repetition Rate	Emitted Wavelength (nm)	Beam Radiation Angle [deg.]
G0174A	0.78	CW	850	23.0
G0194A	0.8	CW	1310	11.5
G0195A	1.58	CW	1550	11.5
G0238A	0.8	CW	850	23.0
G0239A	1.12	CW	1310	11.5

*: Indicates the possible optical output power when each and every reasonably foreseeable single-fault condition is included.

For Safety

Table3 Labels on Product

	Type	Label	Affixed to:	Model Name
1	Explanation		Figure 1, A	MP2100A + MP2100A-050, MP2100A + MP2100A-051, MP2101A + MP2101A-050, MP2101A + MP2101A-051
2	Certification		Figure 1, B	MP2100A + MP2100A-050, MP2100A + MP2100A-051, MP2101A + MP2101A-050, MP2101A + MP2101A-051
3	Identification		Figure 1, C	MP2100A + MP2100A-050, MP2100A + MP2100A-051, MP2101A + MP2101A-050, MP2101A + MP2101A-051

For Safety

Laser Radiation Markings

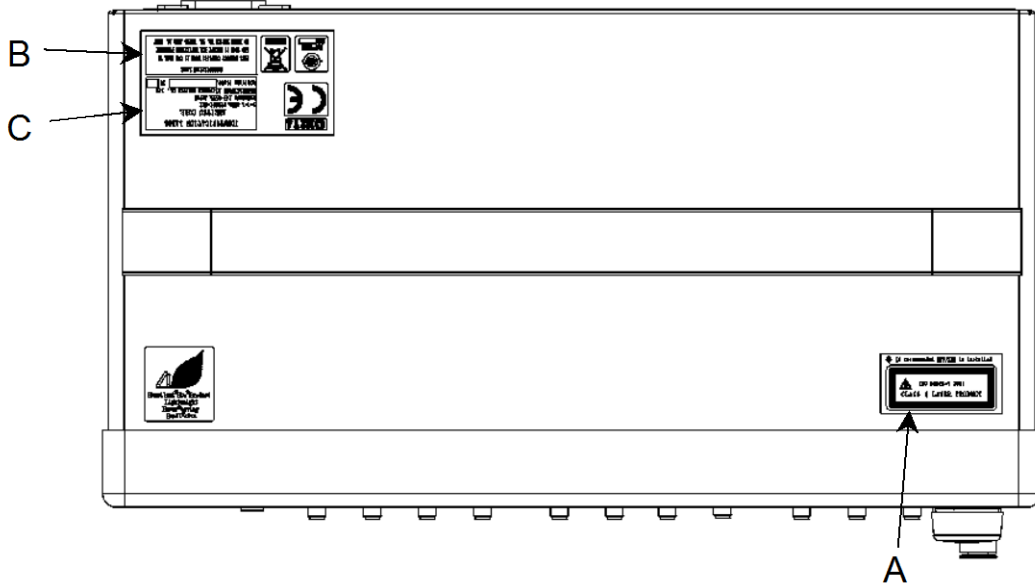


Figure 1 Locations of Affixed Labels

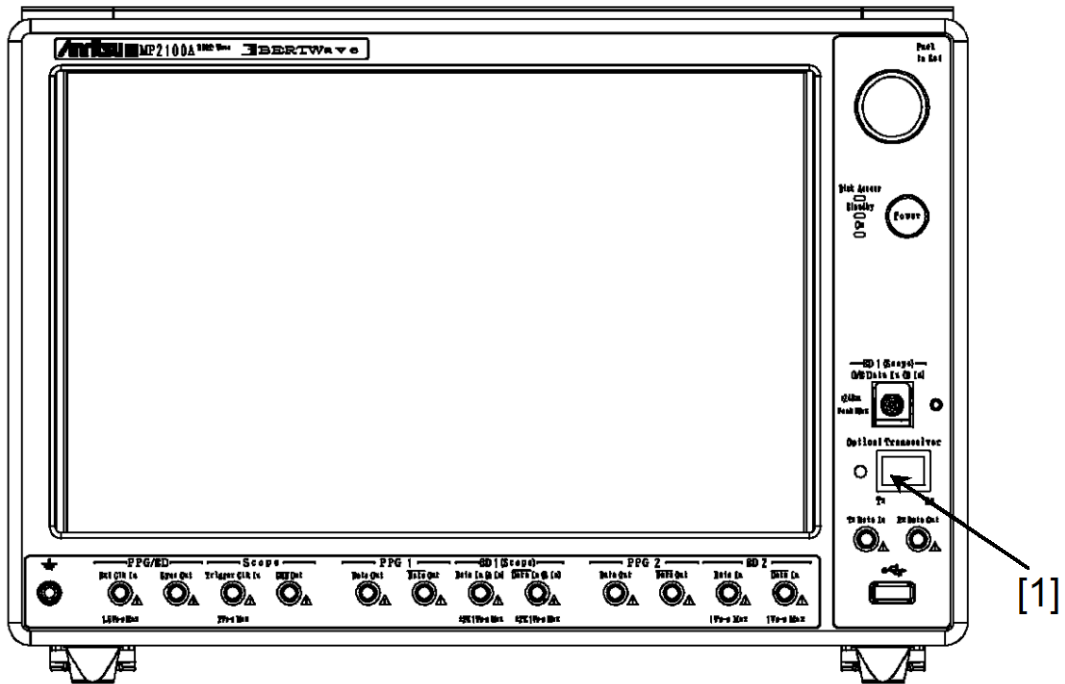


Figure 2 Locations of Laser Beam Apertures

For Safety



CAUTION

Replacing Memory Back-up Battery

This equipment uses a Poly-carbon fluoride lithium battery to backup the memory. This battery must be replaced by service personnel when it has reached the end of its useful life; contact the Anritsu sales section or your nearest representative.

Note: The battery used in this equipment has a maximum useful life of 4 years. It should be replaced before this period has elapsed.

External Storage Media

This equipment uses USB memory devices as external storage media for storing data and programs.

If this media is mishandled or becomes faulty, important data may be lost. To prevent this chance occurrence, all important data and programs should be backed-up.

Anritsu will not be held responsible for lost data.

Pay careful attention to the following points.

- Never remove the USB memory device from the instrument while it is being accessed.
 - The USB memory device may be damaged by static electric charges.
 - Anritsu has thoroughly tested all external storage media such as USB memory, Hard disk drive and DVD drive. Users should note that external storage media may not have been tested by Anritsu, thus Anritsu cannot guarantee the performance or suitability of such media.
-

For Safety



CAUTION

Flash Memory

The instrument is equipped with an internal memory from which, as with any flash memory, data may be lost because of limitation of writing times. The writing limitation of flash memory is approximately one million.

Note: The flash memory used in this equipment has a maximum writing time of one million.

Anritsu can take no responsibility for lost data, and users are recommended to always back up important data at regular intervals. To reduce the possibility of data loss, particular attention should be given to the following points.

- The instrument should only be used within the recommend temperature range, and should not be used in locations where the temperature may fluctuate suddenly.
- Always follow the guidelines to ensure that the instrument is set up in the specified manner.
- Always ensure that the fans at the rear and side of the instrument are not blocked or obstructed in any way.
- Exercise care not to bang or shake the instrument while the power is on.
- Never disconnect the mains power at the plug or cut the power at the breaker with the instrument turned on.

Use in a residential environment

This instrument is designed for an industrial environment.

In a residential environment this instrument may cause radio interference in which case the user may be required to take adequate measures.

Use in Corrosive Atmospheres

Exposure to corrosive gases such as hydrogen sulfide, sulfurous acid, and hydrogen chloride will cause faults and failures.

Note that some organic solvents release corrosive gases.

Equipment Certificate

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

Anritsu Warranty

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

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

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

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

Note:

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

- In places of direct sunlight
- In dusty places
- Outdoors
- In liquids, such as water, oil, or organic solvents, and medical fluids, or places where these liquids may adhere
- In salty air or in places where chemically active gases (sulfur dioxide, hydrogen sulfide, chlorine, ammonia, nitrogen oxide, 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 that this equipment malfunctions, contact an Anritsu Service and Sales office. Contact information can be found on the last page of the printed version of this manual, and is available in a separate file on the CD version.

Crossed-out Wheeled Bin Symbol

Equipment marked with the Crossed-out Wheeled Bin Symbol complies with council directive 2012/19/EC (the “WEEE Directive”) in European Union.



For Products placed on the EU market after August 13, 2005, please contact your local Anritsu representative at the end of the product's useful life to arrange disposal in accordance with your initial contract and the local law.

About Eco label



The label shown on the left is attached to Anritsu products meeting our environmental standards.

Details about this label and the environmental standards are available on the Anritsu website at <http://www.anritsu.com>

Software End-User License Agreement (EULA)

Please read this Software End-User License Agreement (hereafter this EULA) carefully before using (includes executing, copying, registering, etc.) this software (includes programs, databases, scenarios, etc., used to operate, set, etc., Anritsu electronic equipment). By reading this EULA and using this software, you are agreeing to be bound by the terms of its contents 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.

1. Grant of License and Limitations

1. Regardless of whether this Software was purchased from or provided free-of-charge by Anritsu, you agree not to rent, lease, lend, or otherwise distribute this Software to third parties and further agree not to disassemble, recompile, reverse engineer, modify, or create derivative works of this Software.
2. You may make one copy of this Software for backup purposes only.
3. You are not permitted to reverse engineer this software.
4. This EULA allows you to install one copy of this Software on one piece of Equipment.

2. Disclaimers

To the extent not prohibited by law, in no event shall Anritsu be liable for personal injury, 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, arising out of or related to your use or inability to use this Software.

3. Limitation of Liability

- a. If a fault (bug) is discovered in this Software, preventing operation as described in the operation manual or specifications whether or not the customer uses this software as described in the manual, Anritsu shall at its own discretion, fix the bug, or exchange the software, or suggest a workaround, free-of-charge. However, notwithstanding the above, the following items shall be excluded from repair and warranty.
 - i) If this Software is deemed to be used for purposes not described in the operation manual or specifications.
 - ii) If this Software is used in conjunction with other non-Anritsu-approved software.
 - iii) Recovery of lost or damaged data.
 - iv) If this Software or the Equipment has been modified, repaired, or otherwise altered without Anritsu's prior approval.
 - v) For any other reasons out of Anritsu's direct control and responsibility, such as but not limited to, natural disasters, software virus infections, etc.
- b. Expenses incurred for transport, hotel, daily allowance, etc., for on-site repairs by Anritsu engineers necessitated by the above faults shall be borne by you.
- c. The warranty period for faults listed in article 3a above covered by this EULA shall be either 6 months from the date of purchase of this Software or 30 days after the date of repair, whichever is longer.

4. Export Restrictions

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

5. Termination

Anritsu shall deem this EULA terminated if you violate any conditions described herein. This EULA shall also be terminated if the conditions herein cannot be continued for any good reason, such as violation of copyrights, patents, or other laws and ordinances.

6. Reparations

If Anritsu suffers any 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.

7. Responsibility after Termination

Upon termination of this EULA in accordance with item 5, you shall cease all use 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.

8. Dispute Resolution

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

9. Court of Jurisdiction

This EULA shall be interpreted in accordance with Japanese law and any disputes that cannot be resolved by negotiation described in Article 8 shall be settled by the Japanese courts.

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.

Lifetime of Parts

The life span of certain parts used in this instrument is determined by the operating time or the power-on time. Due consideration should be given to the life spans of these parts when performing continuous operation over an extended period. These parts must be replaced at the customer's expense even if within the guaranteed period described in Warranty at the beginning of this manual.

Coaxial switch : 10 million counts (switching count for Low-pass filter)

LCD : 50,000 hours

Notice

The following actions are strictly prohibited for all of the software installed in this product or otherwise provided by Anritsu:

1. Copying, except for archival purposes.
2. Transferring to a third party separately from this product.
3. Analyzing the incorporated software including but not limited to modifying, decompiling, disassembling, and reverse engineering.

Cautions against computer virus infection

- Copying files and data
Only files that have been provided directly from Anritsu or generated using Anritsu equipment should be copied to the instrument.
All other required files should be transferred by means of USB or CompactFlash media after undergoing a thorough virus check.
- Adding software
Do not download or install software that has not been specifically recommended or licensed by Anritsu.
- Network connections
Ensure that the network has sufficient anti-virus security protection in place.

CE Conformity Marking

Anritsu affixes the CE conformity marking on the following product(s) in accordance with the Council Directive 93/68/EEC to indicate that they conform to the EMC and LVD directive of the European Union (EU).

CE marking



1. Product Model

Model: MP2100A BERTWave/ MP2101A BERTWave PE/
MP2102A BERTWave SS

2. Applied Directive

EMC: Directive 2004/108/EC
LVD: Directive 2006/95/EC

3. Applied Standards

- EMC: Emission: EN 61326-1: 2013 (Class A)
Immunity: EN 61326-1: 2013 (Table 2)

	Performance Criteria*
IEC 61000-4-2 (ESD)	B
IEC 61000-4-3 (EMF)	A
IEC 61000-4-4 (Burst)	B
IEC 61000-4-5 (Surge)	B
IEC 61000-4-6 (CRF)	A
IEC 61000-4-11 (V dip/short)	B, C

*: Performance Criteria

A: The equipment shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the equipment is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the equipment if used as intended.

- B: The equipment shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the equipment is used as intended. The performance level may be replaced by a permissible loss of performance. During the test, degradation of performance is however allowed. No change of actual operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the equipment if used as intended.
- C: Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls.

Harmonic current emissions:

EN 61000-3-2: 2006 +A1:2009 A2:2009

(Class A equipment)

: No limits apply for this equipment with an active input power under 75 W.

- LVD: EN 61010-1: 2010 (Pollution Degree 2)

4. Authorized representative

Name: Murray Coleman
Head of Customer Service EMEA
ANRITSU EMEA Ltd.

Address, city: 200 Capability Green, Luton
Bedfordshire, LU1 3LU

Country: United Kingdom

C-Tick Conformity Marking

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

C-Tick marking



1. Product Model

Model: MP2100A BERTWave/ MP2101A BERTWave PE/
MP2102A BERTWave SS

2. Applied Standards

EMC: Emission: EN 61326-1: 2013 (Class A equipment)

About This Manual

The manual set for the BERTWave Series consists of the following five operation manuals:

MP2100B BERTWave Operation Manual
Operation (M-W3772AE)

This manual is intended for those who use the MP2100B BERTWave, and explains the installation procedure, handling precautions, connector connection procedures, panel operations, maintenance procedures, specifications and various functions.

MP2100A/MP2101A/MP2102A BERTWave Operation
Manual Operation (M-W3349AE) (This Manual)

This manual is intended for those who use the MP2100A/MP2101A/MP2102A BERTWave, and explains the installation procedure, handling precautions, connector connection procedures, panel operations, maintenance procedures, specifications and various functions.

BERTWave series Remote Control
Operation Manual (M-W3773AE)

This manual explains the commands to control the BERTWave, status register structure, and sample programs.

MX210001A Jitter Analysis Software
Operation Manual (M-W3569AE)

This manual explains the operation method and remote control commands for the MX210001A Jitter Analysis Software.

MX210002A Transmission Analysis Software
Operation Manual (M-W3571AE)

This manual explains the operation method and remote control commands for the MX210002A Transmission Analysis Software.

For remote control of the MP2100A/MP2101A/MP2102A BERTWave via the remote control, refer to the *BERTWave series Remote Control Operation Manual* (W3773AE).

This operation manual assumes the reader has the following basic knowledge:

- Optical communications, handling optical parts
- Windows file operations and the Windows Control Panel

Manual Notation System

The MP2100A/MP2101A/MP2102A BERTWave series is abbreviated MP2100A/MP2101A/MP2102A in this manual.

The names of panel and function keys are in bold.

Example: **Power**:

The user interface such as button and tag names are in angled parentheses.

Example: [PPG], [System Menu]

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Chapter 1 Outline

This chapter explains the BERTWave types and features, and technical terms used in this manual.

1

Outline

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1.1 Introduction of BERTWave Series

1.1.1 BERTWave Series Types

The MP2100A BERTWave is a measuring instrument that combines the functions of a pulse pattern generator (PPG), bit error detector (ED) and sampling oscilloscope all-in-one instrument.

The PPG creates a digital signal with editable data transmission speed, pulse voltage level, and send data pattern.

The ED compares the received data bit string with the expected data a bit string and calculates the number of different bits (bit error count). It calculates the bit error rate from the number of received bits and the bit error account. The data transmission speed, voltage level for recognizing 0 and 1 of the digital signal, and the data bit string (pattern) can be edited.

The sampling oscilloscope displays the periodic signal waveform. An Eye diagram can be displayed by summing the signal waveforms and signal waveforms can be analyzed and mask tested.

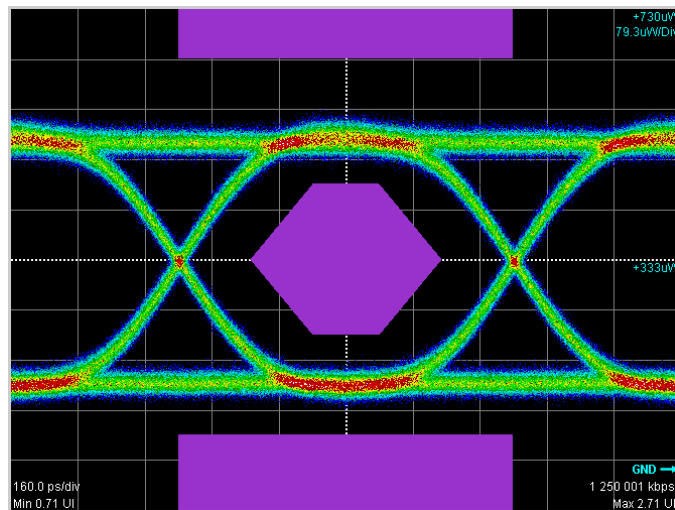


Figure 1.1.1-1 Mask Test Waveform

There are three models in the BERTWave series depending on the installed functions.

Table1.1.1-1 BERTWave Series

Model	Product Name	Pulse Pattern Generator	Error Detector	Sampling Scope
MP2100A	BERTWave	✓	✓	✓
MP2101A	BERTWave PE	✓	✓	—
MP2102A	BERTWave SS	—	—	✓

1.1.2 Options

The BERTWave Series options are shown below.

The usable options vary with the model name.

PPG: Pulse Pattern Generator, ED: Error Detector, SS: Sampling Scope

The option number of the added option is indicated on the label on the rear panel.

MP2100A-107, MP2100A-130, MP2100A-152, MP2100A-176 through 186, and MP2100A-191 are retrofit option. Installing these options requires returning MP2100A to factory.

Table 1.1.2-1 MP2100A Option List

Option Number	Name	Description
MP2100A-001*1	Dual Electrical Receiver	Two electric interfaces in reception part of ED and SS
MP2100A-003*1	Optical/Single-ended Electrical Receiver	One optical interface and one electrical interface of reception parts of ED and SS
MP2100A-005	Extended PPG/ED Channel	Extends PPG and ED to 2 channels
MP2100A-007/107*1	1ch Electrical BERT and Optical/Single-ended Electrical Scope	One electric interface in reception part of ED One optical interface and one electrical interface of reception parts of SS
MP2100A-030/130	GPIO	Interface for remote control
MP2100A-037*2,*3	FC Connector	Optical connector for Option 003, 007
MP2100A-038*2,*3	ST Connector	Optical connector for Option 003, 007
MP2100A-039*2,*3	DIN 47256 Connector	Optical connector for Option 003, 007
MP2100A-040*2,*3	SC Connector	Optical connector for Option 003, 007
MP2100A-050*4	XFP Slot	Slot for installing optical transceiver
MP2100A-051*4	SFP+ Slot	Slot for installing optical transceiver
MP2100A-052/152	Full Rate Clock Output	
MP2100A-055*5	Clock Recovery for EYE/Pulse Scope	Clock recovery unit for SS
MP2100A-056*2,*6	Low Pass Filter Bank (8.5G/10G/10.7G)	Loss pass filter
MP2100A-057*2,*6	Low Pass Filter Bank (2G/4G/8.5G/10G)	Loss pass filter
MP2100A-061*2,*6	High Bit Rate Filter	
MP2100A-062*2,*6	2 High Bit Rate Filter Bank	
MP2100A-063*2,*6	3 to 4 High Bit Rate Filter Bank	
MP2100A-064*2,*6	1 to 2 Low Bit Rate Filter Bank	
MP2100A-065*2,*6	3 to 4 Low Bit Rate Filter Bank	

Table 1.1.2-1 MP2100A Option List (Cont'd)

Option Number	Name	Description
MP2100A-066*2,*6	1 High Bit Rate/1 to 2 Low Bit Rate Filter Bank	
MP2100A-067*2,*6	1 to 2 High Bit Rate/3 to 4 Low Bit Rate Filter Bank	
MP2100A-068*2,*6	2 to 3 High Bit Rate/1 to 2 Low Bit Rate Filter Bank	
MP2100A-069*2,*6	3 High Bit Rate/3 Low Bit Rate Filter Bank	
MP2100A-070*2,*7	LPF for 156M (L)	Low pass filter for option 064-069
MP2100A-071*2,*7	LPF for 622M (L)	
MP2100A-072*2,*7	LPF for 1.0G (L)	
MP2100A-073*2,*7	LPF for 1.2G (L)	
MP2100A-076/176*2,*8	LPF for 2.1G (H)	Low pass filter for option 061-063, 066-069
MP2100A-077/177*2,*8	LPF for 2.5G (H)	
MP2100A-078/178*2,*8	LPF for 2.6G (H)	
MP2100A-079/179*2,*8	LPF for 3.1G (H)	
MP2100A-080/180*2,*8	LPF for 4.2G (H)	
MP2100A-081/181*2,*8	LPF for 5.0G (H)	
MP2100A-082/182*2,*8	LPF for 6.2G (H)	
MP2100A-083/183*2,*8	LPF for 8.5G (H)	
MP2100A-084/184*2,*8,*9	LPF for 9.9 G to 10.3G (H)	
MP2100A-085/185*2,*8	LPF for 10.5G to 11.3G (H)	
MP2100A-086/186*2,*8,*9	LPF for Multi 10G (H)	
MP2100A-090	Bit rate Extension for PPG/ED	Extends the setting range of PPG and ED bit rate.
MP2100A-091/191	ED High Sensitivity	
MP2100A-ES310	3-year Warranty Extended Service	
MP2100A-ES510	5-year Warranty Extended Service	

- *1: Select one from Option 001, 003 or 007.
- *2: Select 037, 038, 039, 040, or 056 to 086 when Option 003 or 007 is selected.
- *3: Select one from Option 037 to 040.
- *4: Select one from Option 050 or 051.
- *5: Clock recovery to analyze Ch B waveform is not available for Option 007.
- *6: Select one from Option 056, 057 or 061 to 069.
- *7: The filter for the low bit rate of Option 064 to 069 is selected from Option 070 to 073.
- *8: The filter for the high bit rate of Option 061 to 063 and 066 to 069 is selected from Option 076 to 086.
- *9: Either one of Option 084/184 or 086/186 can be installed.

MP2101A-130, MP2101A-152, MP2101A-176 to 186 and MP2101A-191 are retrofit option. Installing these options requires returning MP2101A to factory.

Table 1.1.2-2 MP2101A Option List

Option No.	Model Name	Description
MP2101A-011*1	1 CH BERT PPG/ED	PPG:1, ED:1
MP2101A-012*1	2 CH BERT PPG/ED	PPG:2, ED:2
MP2101A-030/130	GPIB	Interface for remote control
MP2101A-050*2	XFP Slot	Slot for installing optical transceiver
MP2101A-051*2	SFP+ Slot	Slot for installing optical transceiver
MP2101A-052/152	Full Rate Clock Output	
MP2101A-090	Bit rate Extension for PPG/ED	The setting range of PPG and ED bit rate is extended.
MP2101A-091/191	ED High Sensitivity	
MP2101A-ES310	3-year Warranty Extended Service	
MP2101A-ES510	5-year Warranty Extended Service	

*1: Select one of either Option 011 or 012.

*2: Select one of either Option 050 or 051.

MP2102A-130, MP2102A-176 through 186 are retrofit option. Installing these options requires returning MP2102A to factory.

Table 1.1.2-3 MP2102A Option List

Option Number	Name	Description
MP2102A-021*1	Dual Electrical Receiver	Two electric interfaces in reception part
MP2102A-023*1	Optical/Single-ended Electrical Receiver	One optical interface and one electrical interface of reception parts
MP2102A-030/130	GPIB	Interface for remote control
MP2102A-037*2,*3	FC Connector	Optical connector for option 023
MP2102A-038*2,*3	ST Connector	Optical connector for option 023
MP2102A-039*2,*3	DIN 47256 Connector	Optical connector for option 023
MP2102A-040*2,*3	SC Connector	Optical connector for option 023
MP2102A-055	Clock Recovery	Clock recovery unit for SS
MP2102A-056*2,*4	Low Pass Filter Bank (8.5G/10G/10.7G)	Low pass filter
MP2102A-057*2,*4	Low Pass Filter Bank (2G/4G/8.5G/10G)	Low pass filter
MP2102A-061*2,*4	1 High Bit Rate Filter	
MP2102A-062*2,*4	2 High Bit Rate Filter Bank	
MP2102A-063*2,*4	3 to 4 High Bit Rate Filter Bank	
MP2102A-064*2,*4	1 to 2 Low Bit Rate Filter Bank	
MP2102A-065*2,*4	3 to 4 Low Bit Rate Filter Bank	
MP2102A-066*2,*4	1 High Bit Rate/1 to 2 Low Bit Rate Filter Bank	
MP2102A-067*2,*4	1 to 2 High Bit Rate/3 to 4 Low Bit Rate Filter Bank	
MP2102A-068*2,*4	2 to 3 High Bit Rate/1 to 2 Low Bit Rate Filter Bank	
MP2102A-069*2,*4	3 High Bit Rate/3 Low Bit Rate Filter Bank	

Table 1.1.2-3 MP2102A Option List (Cont'd)

Option Number	Name	Description
MP2102A-070*2,*5	LPF for 156M (L)	Low-pass filter for Option 064 to 069
MP2102A-071*2,*5	LPF for 622M (L)	
MP2102A-072*2,*5	LPF for 1.0G (L)	
MP2102A-073*2,*5	LPF for 1.2G (L)	
MP2102A-076/176*2,*6	LPF for 2.1G (H)	Low-pass filter for Option 061 to 063 and 066 to 069
MP2102A-077/177*2,*6	LPF for 2.5G (H)	
MP2102A-078/178*2,*6	LPF for 2.6G (H)	
MP2102A-079/179*2,*6	LPF for 3.1G (H)	
MP2102A-080/180*2,*6	LPF for 4.2G (H)	
MP2102A-081/181*2,*6	LPF for 5.0G (H)	
MP2102A-082/182*2,*6	LPF for 6.2G (H)	
MP2102A-083/183*2,*6	LPF for 8.5G (H)	
MP2102A-084/184*2,*6,*7	LPF for 9.9 G to 10.3G (H)	
MP2102A-085/185*2,*6	LPF for 10.5G to 11.3G (H)	
MP2102A-086/186*2,*6,*7	LPF for Multi 10G (H)	
MP2102A-ES310	3-year Warranty Extended Service	
MP2102A-ES510	5-year Warranty Extended Service	

*1: Select one from Option 021 or 023.

*2: Select Option 037, 038, 039, 040, or 056 to 086 when Option 023 is selected.

*3: Select one from Option 037, 038, 039 or 040.

*4: Select one from Option 056, 057 or 061 to 069.

*5: The filter for the low bit rate of Option 064 to 069 is selected from Option 070 to 073.

*6: The filter for the high bit rate of Option 061 to 063 and 066 to 069 is selected from Option 076 to 086.

*7: Either one of Option 084/184 or 086/186 can be installed.

1.1.3 Optional Accessories

Optional Accessories of BERTWave are shown in following table.

Table 1.1.3-1 Optional Accessories

Model/ Order No.	Name	Remarks
MX210001A	Jitter Analysis Software	For MP2100A, MP2102A
MX210002A	Transmission Analysis Software	For MP2100A
B0639A	Carrying Case	
B0650A	Rack Mount Kit	
G0174A	850 nm XFP Module	9.95 to 11.10 Gbit/s
G0177A	850 nm SFP Module	1.062 to 4.25 Gbit/s
G0178A	1310 nm SFP Module	0.155 to 2.67 Gbit/s
G0179A	1550 nm SFP Module	0.155 to 2.67 Gbit/s
G0194A	1310 nm XFP Module	
G0195A	1550 nm XFP Module	
G0238A	SFP+ SR 850 nm	
G0239A	SFP+ LR 1310 nm	
J0619B	Replaceable Optical Connector (SC)	
J1137	Terminator	
J1139A	FC·PC-LC·PC-1M-SM	
J1341A	Open (Coaxial connector cover)	
J1342A	Coaxial Cable 0.8 m	
J1343A	Coaxial Cable 1.0 m	
J1344A	LC·PC-LC·PC-1M-SM	
J1345A	SC·PC-LC·PC-1M-SM	
J1346A	LC·PC-LC·PC-1M-GI (62.5/125)	
J1347A	FC·PC-LC·PC-1M-GI (62.5/125)	
J1348A	SC·PC-LC·PC-1M-GI (62.5/125)	
J1349A	Coaxial Cable 0.3 m	
J1413A	Replaceable Optical Connector (LC)	
J1510A	Pick OFF Tee	
J1512A	7.5G Passive Probe Set	
Z0306A	Wrist Strap	
Z0914A	Ferrule Cleaner	
Z0915A	Replacement Reel for Ferrule Cleaner	6 pcs
Z0916A	Ferrule side face cleaner	Stick type (200pcs)

1.2 Features

The BERTWave has the following features:

- Bit error rate measurement and waveform monitoring in one instrument
- Easy touch panel operation
- Compact size (180 mm deep)
- GPIB interface option for remote control
- Compatibility of remote commands with previous Anritsu measuring instruments

1.3 Intended Use

The BERTWave can be used for the following applications:

- Evaluating optical transceivers used in optical fiber communications
- Evaluating parts for digital communications

Evaluating optical transceivers used in optical fiber communications

Computer-based and public communications systems send and receive digital signals. These signals are converted to electrical or optical signals optimized for passage through the transmission path, which may be either coaxial cable or optical fiber. The device for converting the signal before sending through the transmission path is called the transmitter and the device for converting the signal after passage through the transmission path is called the receiver.

A device incorporating a transmitter and receiver in the same module is called the optical transceiver.

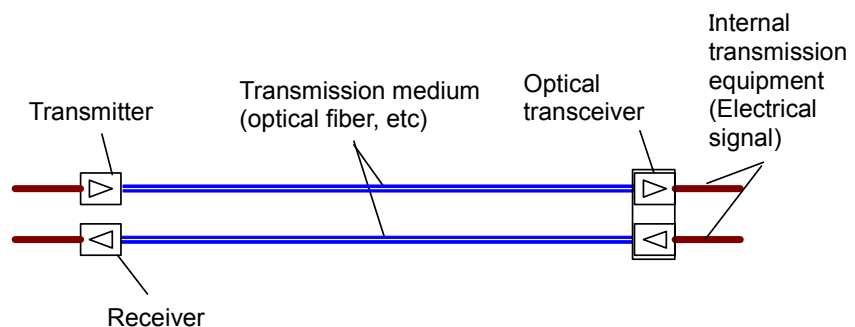


Figure 1.3-1 Uses of Receiver and Transmitter

Transmitters and receivers must have the functions and performance specified by IEEE and ITU-T. Tables 1.3-1 and 1.3-2 list the specifications for computer-based Ethernet communications as an example of the required performance and functions. In these tables, the optical fiber transmission medium has a speed of 10 Gbit/s specified as 10GBASE-L.

Table 1.3-1 Transmitter Optical Output

Item	Specifications
Transmission rate	9.95328 Gbit/s \pm 20 ppm (10GBASE-LR) 10.3125 Gbit/s \pm 20 ppm (10GBASE-LW)
Center wavelength	1260 to 1355 nm
Averaging output	-8.5 to 0.5 dBm
Minimum modulation amplitude	-5.2 dBm
Minimum extinction ratio	3.5 dB
Eye mask pattern (X1, X2, X3, Y1, Y2, Y3)	(0.25, 0.40, 0.45, 0.25, 0.28, 0.40)

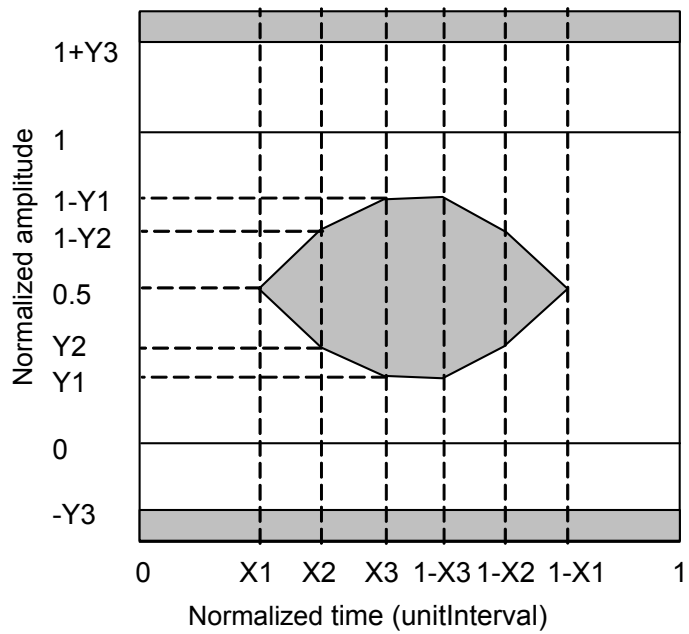


Figure 1.3-2 Definition of Eye Mask Pattern

Table 1.3-2 Receiver Optical Interface

Item	Specifications
Transmission rate	9.95328 Gbit/s \pm 100 ppm (10GBASE-LR) 10.3125 Gbit/s \pm 100 ppm (10GBASE-LW)
Center wavelength	1260 to 1355 nm
Average Rx power	-14.4 to 0.5 dBm
Rx sensitivity based on optical modulation amplitude*1	0.093 mW (-10.3 dBm)

*1: Bit error rate: 10^{-12} or less

Excluding center wavelength, the items in Table 1.3-1 are tested with the MP2100A BERTWave.

The following figure shows a connection example between the DUT and the measurement.

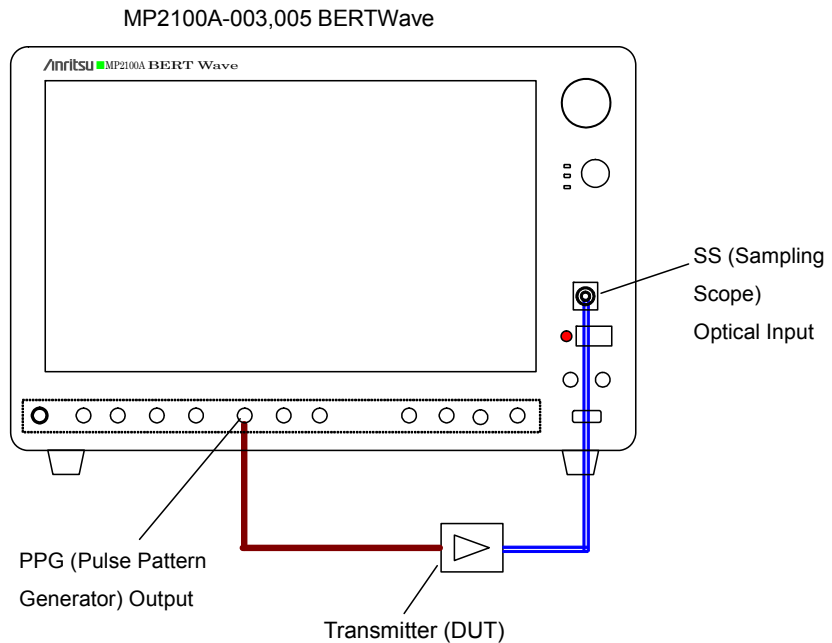


Figure 1.3-3 Transmitter Test Method

The sampling oscilloscope is used to test whether or not the output waveform of the optical transceiver satisfies the standard values in Table 1.3-1.

Excluding center wavelength, the items in Table 1.3-2 are used to test E/O converters, optical power meters, optical attenuator, and optical couplers with the MP2100A BERTWave.

The following figure shows a connection example between the DUT and the measurement.

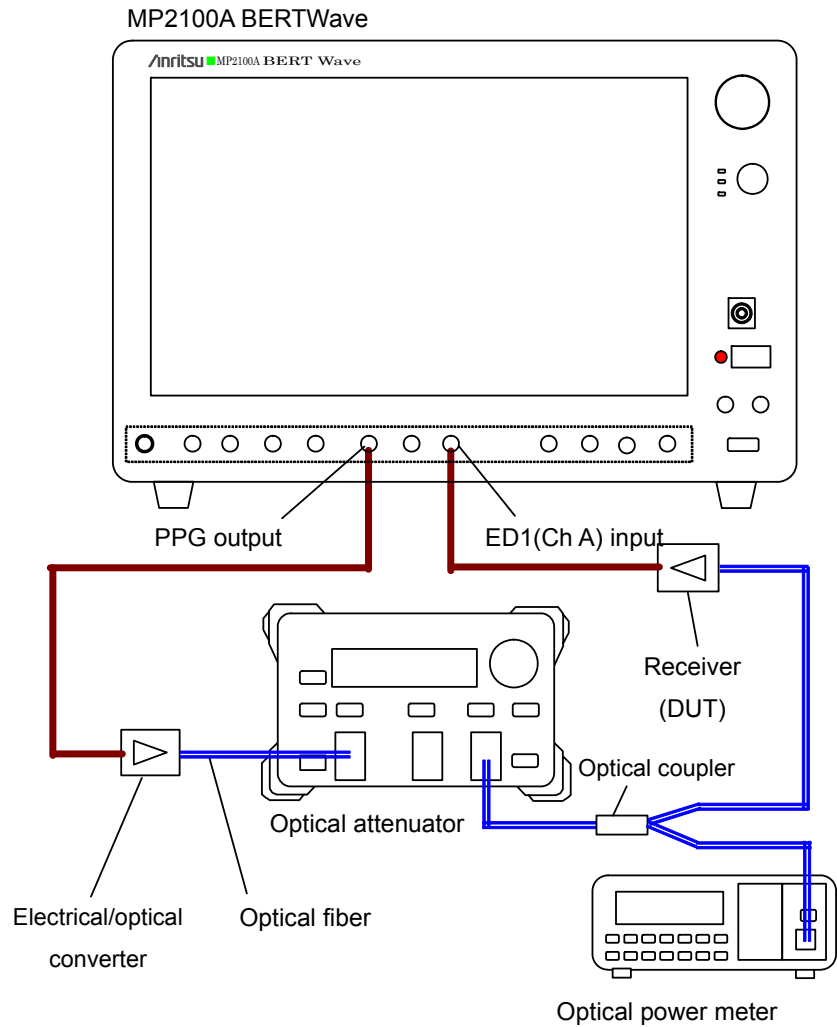


Figure 1.3-4 Receiver Test Method

1.4 Technical Terms

1.4.1 Explanation of Technical Terms

This section explains the technical terms used in this manual.

0 Level (Zero Level)

At Eye pattern measurement, the maximum level at the center 20% of the bit interval is the average value of the low histogram.

1 Level (One Level)

At Eye pattern measurement, the maximum level at the center 20% of the bit interval is the average value of the high histogram.

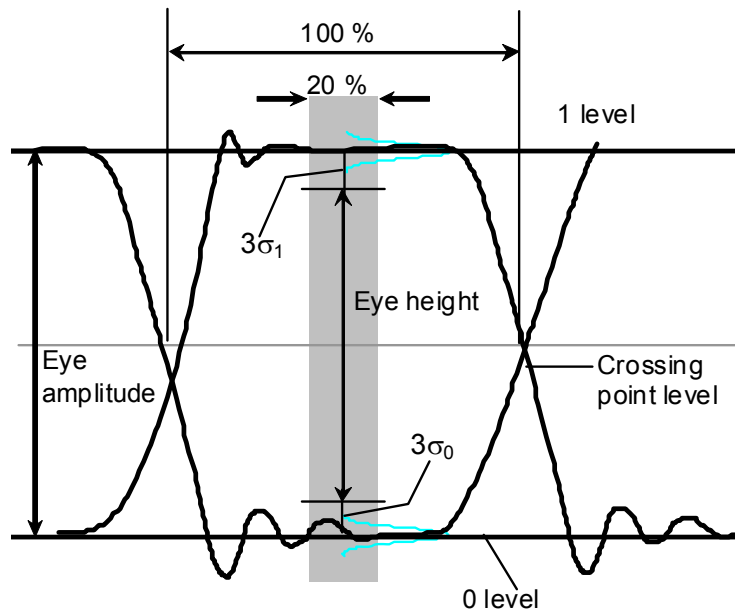


Figure 1.4.1-1 0 Level, 1 Level, Eye Amplitude and Eye Height

p-p (peak to peak)

Indicates difference between maximum and minimum values for signal amplitude and data distribution width

For example, V_{p-p} means the difference between the maximum and minimum values of the AC voltage.

Jitter p-p means the difference between the maximum and minimum values of the jitter time distribution.

PRBS (Pseudo-Random Bit Sequence)

PRBS is the abbreviation for pseudorandom bit sequence. It is a bit string approximating actual communications data with a random distribution of “1” and “0”. In a bit length of 2^n-1 , n is called the number of the PRBS. Using the BERTWave, n can be set to 7, 9, 15, 23, and 31.

Table 1.4.1-1 PRBS Bit Length

n	2^n-1	Remarks
7	127	
9	511	
15	32767	
23	8388607	
31	2147483647	

The number of the PRBS used for measuring the Rx sensitivity is determined by the communications standard.

RMS (root mean square)

This is the DC voltage consuming the equal power the same as the consumed power when impressing AC voltage on a resistance.

In Voltage, RMS is DC voltage consuming the equal power when AC voltage is impressing on a resistance.

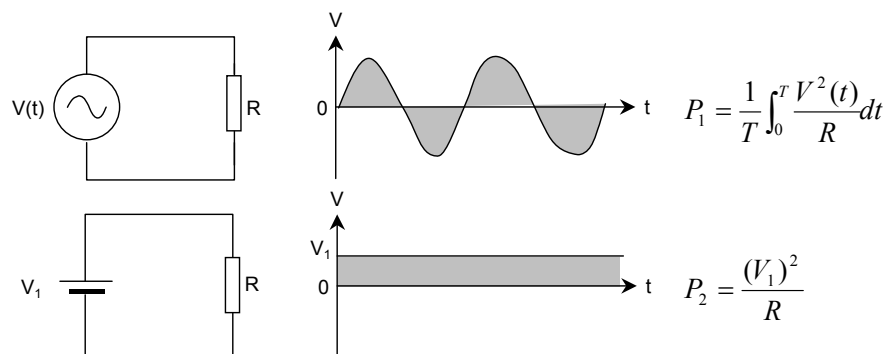


Figure 1.4.1-2 AC and DC Voltage Power Consumption

In the circuit in Figure 1.4.1-2, the voltage V_1 when the power P_1 and P_2 consumed by resistance R is equal is the effective AC voltage $V(t)$. V_1 is the root mean square found using the following equation.

$$V_1 = \sqrt{\frac{1}{T} \int_0^T V^2(t) dt}$$

For a sine wave, the ratio of RMS and p-p is $2\sqrt{2}$.
 V_{rms} means the effective voltage value.

Jitter rms is expressed as the standard deviation of the jitter time domain histogram.

SNR (Signal to Noise Ratio)

This is the ratio of the signal amplitude to the noise amplitude.
The sampling scope can be calculated by the following formula.

$$SNR = (1 \text{ Level} - 0 \text{ Level}) / (\sigma_1 + \sigma_0)$$

σ_1 : 1 Level Standard Deviation

σ_0 : 0 Level Standard Deviation

Eye Crossing Percentage

The Eye Crossing Percentage is the ratio of the Eye amplitude rising and falling waveforms. The calculation formula is as follows. Refer to Figure 1.4.1-1.

$$\text{Crossing} = (\text{crossing point level} - 0 \text{ Level}) / (1 \text{ Level} - 0 \text{ Level})$$

Eye Amplitude

The eye amplitude is the difference between 1 Level and 0 Level. Refer to Figure 1.4.1-1.

Eye Height

The eye height can be calculated by the following formula. Refer to Figure 1.4.1-1.

$$\text{Eye Height} = (1 \text{ Level} - 3 \sigma_1) - (0 \text{ Level} + 3 \sigma_0)$$

σ_1 : 1 Level Standard Deviation

σ_0 : 0 Level Standard Deviation

Eye Pattern

The Eye Pattern is the pattern created by superimposing the digital waveforms sampled at the same timing.

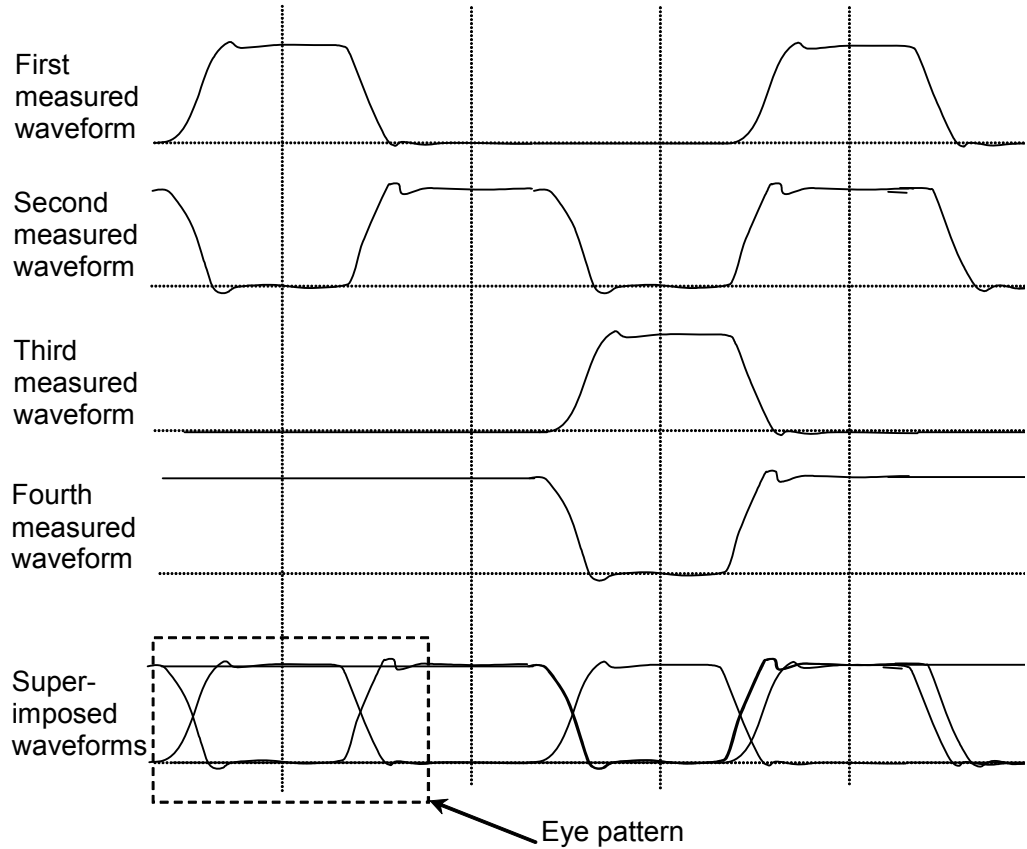


Figure 1.4.1-3 Eye Pattern Drawing Method

Eye Width

Eye Width is equivalent to Eye Height in the horizontal direction. It is calculated from a histogram of the two eye pattern crossing points in the time direction.

$$\text{Eye Width} = (t_2 - 3\sigma_2) - (t_1 + 3\sigma_1)$$

- t_1 : Average time of first crossing point
- t_2 : Average time of second crossing point
- σ_1 : Standard deviation of first crossing point
- σ_2 : Standard deviation of second crossing point

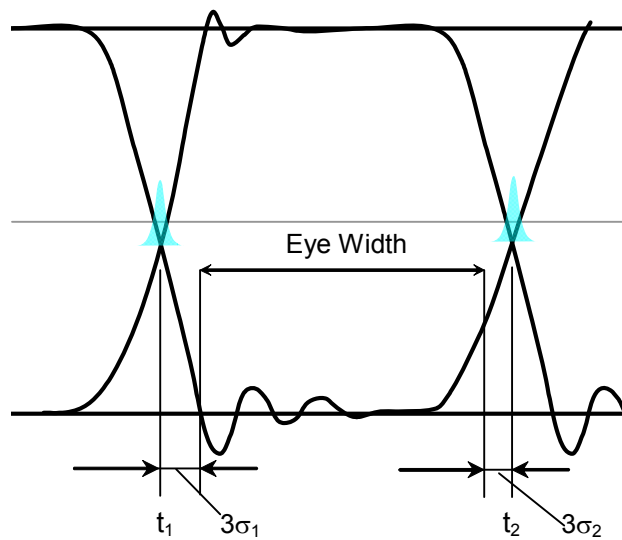


Figure 1.4.1-4 Eye Width

Eye Mask

The Eye Mask is the boundary of the eye pattern waveform time and amplitude. The value and waveform are specified by the communications standards.

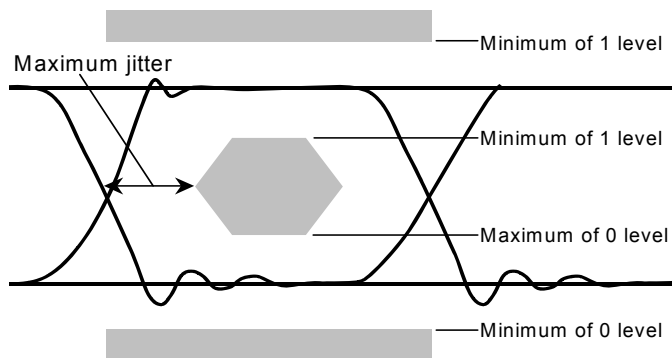


Figure 1.4.1-5 Example of Eye Mask

Sampling Scope

The sampling scope is a function for monitoring the waveform of the input signal. It requires a clock input sampling and the waveform is drawn out of the clock timing. For a periodic signal like PRBS, the waveform data is obtained by slightly varying the sampling timing. This waveform data is drawn by superimposing the waveforms.

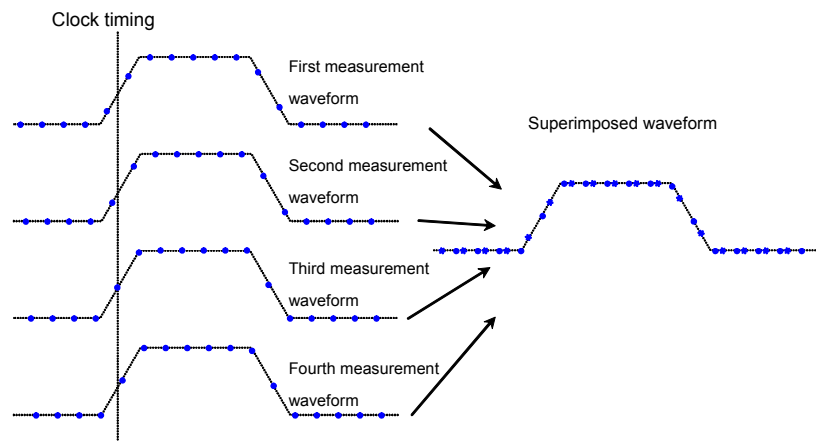


Figure 1.4.1-6 Drawing Method of Sampling Scope

Jitter

Jitter is the variation in the time of the crossover point between the Eye Diagram rising and falling parts of the waveform.

Jitter p-p (Jitter p-p): Full width of histogram in time direction

Jitter RMS (Jitter RMS): Standard deviation of histogram in time direction

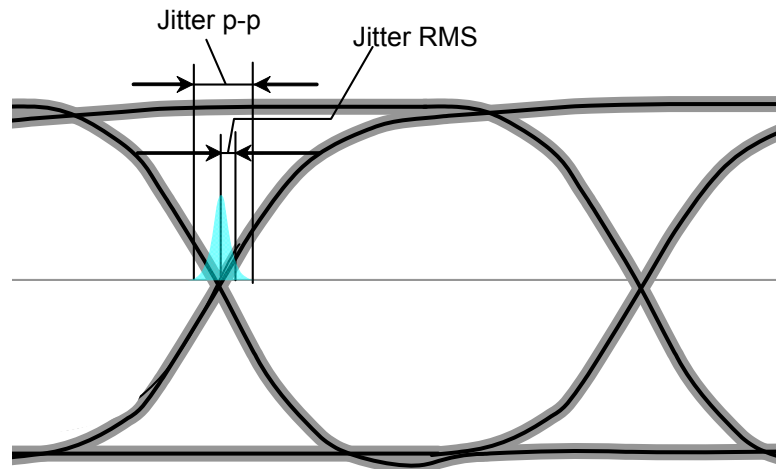


Figure 1.4.1-7 Jitter p-p and Jitter RMS

Extinction Ratio

The extinction ratio is the ratio of 1 Level and 0 Level; it is used for evaluating optical signal waveforms.

The extinction ratio is calculated by the following formula.

$$\text{Extinction Ratio} = 10\log_{10}\{(L_1 - L_D)/(L_0 - L_D)\} \text{ (dB)}$$

L_1 : 1 Level (mW)

L_0 : 0 Level (mW)

L_D : Level without optical input (mW)

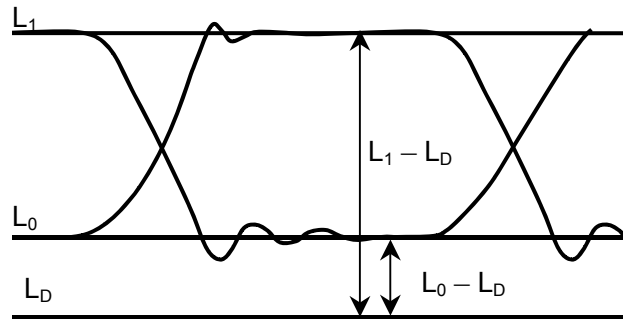


Figure 1.4.1-8 Extinction Ratio Measurement Level

Duty Cycle Distortion: DCD

The duty cycle distortion (DCD) is found from the following equation:

$$\text{DCD} = (t_2 - t_1) / B_p \times 100 \quad (\%)$$

Where,

t_1 : Time at crossing point between Eye Width 50% level and rising waveform

t_2 : Time at crossing point between Eye Width 50% level and falling waveform

B_p : Bit cycle

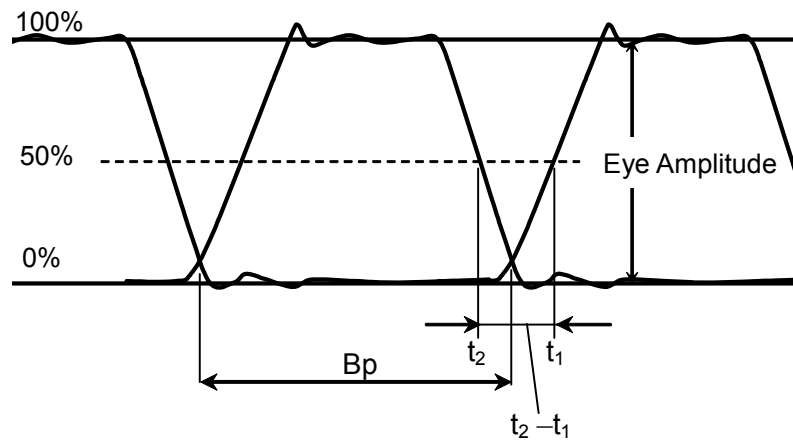


Figure 1.4.1-9 Duty Cycle Distortion

Rise/Fall Time

The Rise Time is time taken for the signal level to change to the next level.

- From 20% level of amplitude to 80%
- From 10% level of amplitude to 90%

The Fall Time is the time taken for the signal level to change to the next level.

- From 80% level of amplitude to 20%
- Form 90% level of amplitude to 10%

In this instrument, the rise and fall time measurement level can be selected from either 10/90% or 20/80%.

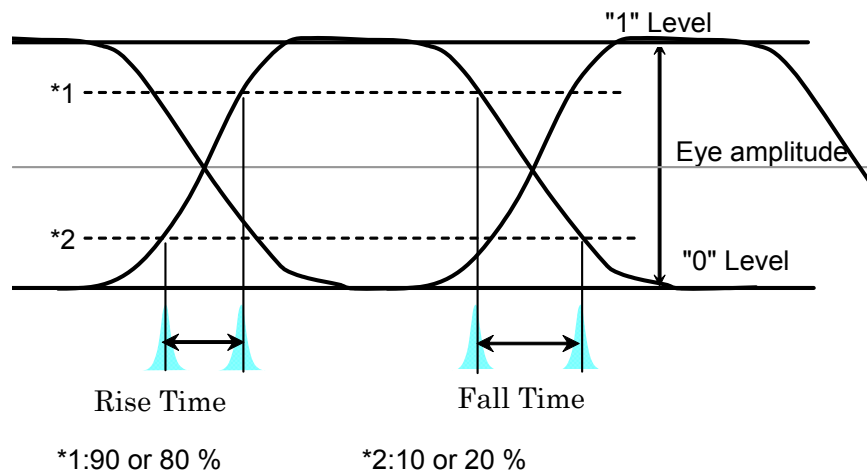


Figure 1.4.1-10 Rise and Fall Time

Total Error

There are two methods as follows for generating bit errors. In both, the bit error measurement is called Total Error.

- Signal "1" bits evaluated as "0" bits (Omission Error)
- Signal "0" bits evaluated as "1" bits (Insertion Error)

Optical amplitude

(OMA: Optical Modulation Amplitude)

This indicates a difference at 1 level and 0 levels of the optical waveform. It is the same as Eye Amplitude.

Bit Error Rate

The Bit Error Rate is the ratio of the total received bits and error bits. It depends on the SNR (signal to noise ratio).

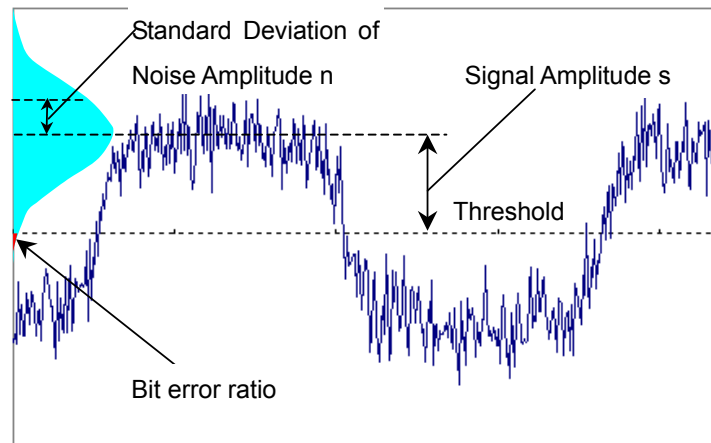


Figure 1.4.1-11 Bit Error Rate

When the distribution of the noise voltage amplitude is assumed to follow a normal distribution, the standard deviation is assumed to be n and the signal amplitude is s . Bit errors occur when the noise amplitude is larger than the signal amplitude. Consequently, the probability of amplitude occurring is the bit error ratio.

The bit error ratio, BER, is calculated by the following formula.

$$BER = \frac{1}{\sqrt{2\pi}} \int_{s/n}^{\infty} \exp\left(-\frac{x^2}{2}\right) dx$$

When the SNR is large (greater than 4), the relationship between SNR and BER becomes linear when plotted on a semi-logarithmic graph.

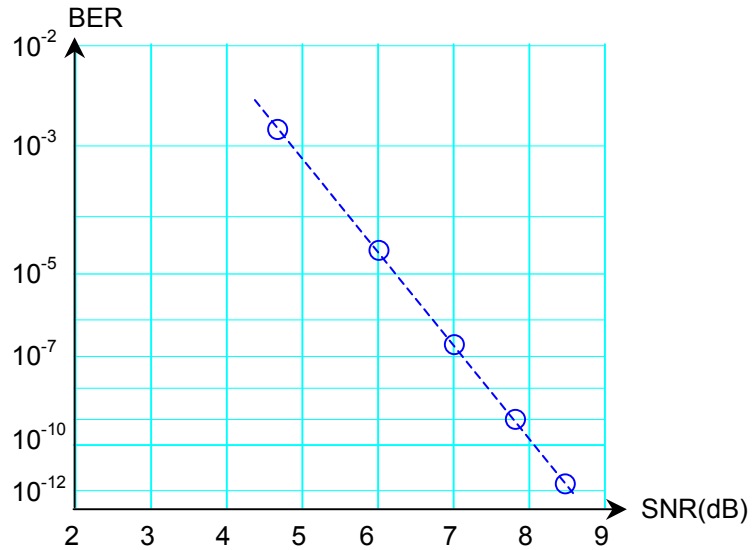


Figure 1.4.1-12 Relationship between SNR and BER

Bit Rate

The Bit Rate is the speed at which the communications interface sends and receives data. It is expressed in its center per second as bit/s or bps.

Mask Margin

This is margin of the masked waveform at the eye pattern mask test. The margin in the amplitude direction is the ratio to the interval from the edge of the eye mask to the 1 Level or the 0 Level.

The margin in the time direction is the ratio to the time from the edge of the eye mask to the cross point.

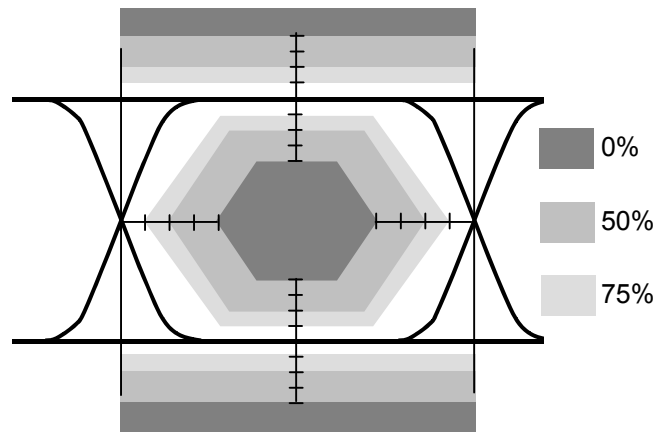


Figure 1.4.1-13 Mask Margin

1.4.2 Abbreviation

The abbreviations used in this manual are listed in Table 1.4.2-1.

Table 1.4.2-1 Abbreviation

Abbreviation	Formal Name
10 GbE	10 Giga bit Ethernet
App	Application
ATT	Attenuator
Avg	Average
BER	Bit Error Rate
BERT	Bit Error Rate Tester
BERTS	Bit Error Rate Test Set
BIN	Binary
bps	bit per second
BW	Band Width
Cal	Calibration
CC	Clock Count
CH	Channel
CLK	Clock
CPRI	Common Public Radio Interface
CRU	Clock Recovery Unit
DCD	Duty Cycle Distortion
DM	Degrade Minutes
DUT	Device Under Test
EC	Error Count
ED	Error Detector
EI	Error Interval
ER	Error Rate
ES	Error Seconds
ESD	Electrostatic Discharge
Ext	External
FC	Fiber Channel
FEC	Forward Error Correction
Freq.	Frequency
GbE	Giga bit Ethernet
GND	Ground
GPIB	General Purpose Interface Bus
IEC	International Electrotechnical Commission
IN	Input

Table 1.4.2-1 Abbreviation (Cont'd)

Abbreviation	Formal Name
INS	Insertion
INT	Internal
ITU	International Telecommunication Union
LAN	Local Area Network
LVDS	Low Voltage Differential Signaling
LVPECL	Low-Voltage Positive Emitter-Coupled Logic
NECL	Negative Emitter Coupled Logic
NEG	Negative
NRZ	Non Return Zero
OBSAI	Open Base Station Architecture Initiative
O/E	Optical to Electrical
OMI	Omission
OTU	Optical Transport Network
OUT	Output
PHY	Physical layer
PCML	Pseudo Current Mode Logic
POS	Positive
PPG	Pulse Pattern Generator
PRBS	Pseudorandom Bit Sequence
Pwr	Power
RMS	Root Mean Square
RP3	Reference Point 3
RX	Receiver
SCFL	Source-Coupled FET Logic
SES	Severely Error Second
SFP	Small Form factor Pluggable
SNR	Signal to Noise Ratio
SS	Sampling Scope
STM	Synchronous Transfer Mode
SYNC	Synchronize, Synchronization
Trig.	Trigger
TX	Transmitter
UI	Unit Interval
VECP	Vertical Eye Closure Penalty
WAN	Wide Area Network
XFP	10 Gigabit Small Form-factor Pluggable

Chapter 2 Before Use

This chapter explains the following items:

- Procedures from unpacking through turning power-on
- Panel name and operation
- Control panel and peripheral devices settings
- Damage prevention measures

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2.1 Unpacking and Installation

2.1.1 Unpacking

Table 2.1.1-1 lists the standard configurations of the BERTWave Series. At unpacking, check that all items are included. Contact your Anritsu Service and Sales Office or agent if any parts are missing or damaged. Keep the original packaging materials. They are required when transporting the MP2100A/MP2101A/MP2102A in future. For how to repack the BERTWave, refer to 10.8, “Transporting and Disposal”.

Table 2.1.1-1 Standard Configurations

Item	Model Number	Product Name	Q'ty	Remarks
Main unit	MP2100A MP2101A MP2102A	BERTWave BERTWave PE BERTWave SS	1	
Accessories	MX210000A	Power Cord BERTWave Control Software (CD-ROM)	1 1	Packed in Accessory Box

*: The quantities vary with the model name and options.

Options for the BERTWave Series are provided. Select one, as you need. For option details, refer to Section 1.1.2 in Chapter 1. To install some options, the BERTWave might be returned to Anritsu factory. For the specifications, refer to Appendix A “Specifications”.

2.1.2 Installation

Install the BERTWave series horizontally as shown in Figure 2.1.2-1.

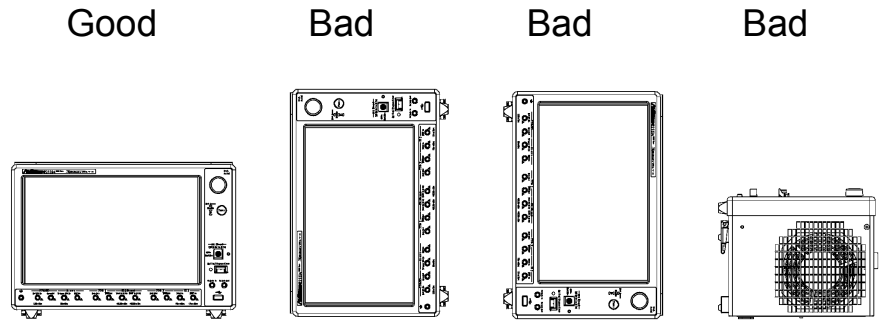


Figure 2.1.2-1 Installation Orientation

CAUTION

If the BERTWave series is not installed in a “good” direction as above, a small shock may turn it over and harm the user.

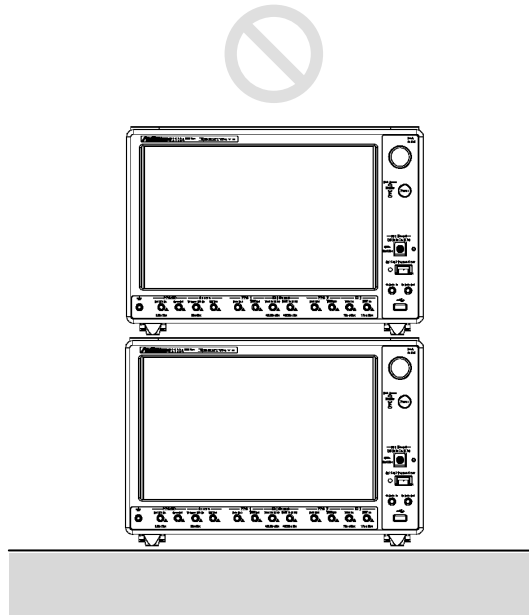


Figure 2.1.2-2 Prohibited Installation—Stacking

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 **CAUTION**

Do not stack multiple BERTWave units one on top of the other when using them. There is a risk of injury, because stacked units are unstable and can fall due to vibration or shock.

A fan is installed in the BERTWave series to prevent the internal temperature from rising. Install the BERTWave series in a location with the vents at least 10 cm away from walls, peripherals or other obstructions so as not to block the fan perimeter.

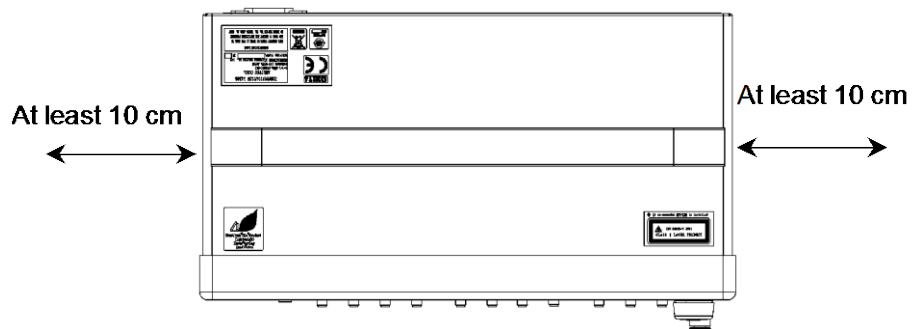


Figure 2.1.2-3 Distance from Surrounding Objects

In the BERTWave series, cooling air is sucked in through the left side panel and hot air is exhausted through the right side panel. When using two or more the BERTWave series side-by-side, make sure that hot air exhausted from one unit is not sucked into the adjacent unit, otherwise overheating may occur.

 **CAUTION**

Although the BERTWave series operates at an ambient temperature of 5 to 40°C, avoid using it in locations, such as the following, since it may cause failure.

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

2.2 Part Names

2.2.1 Front Panel

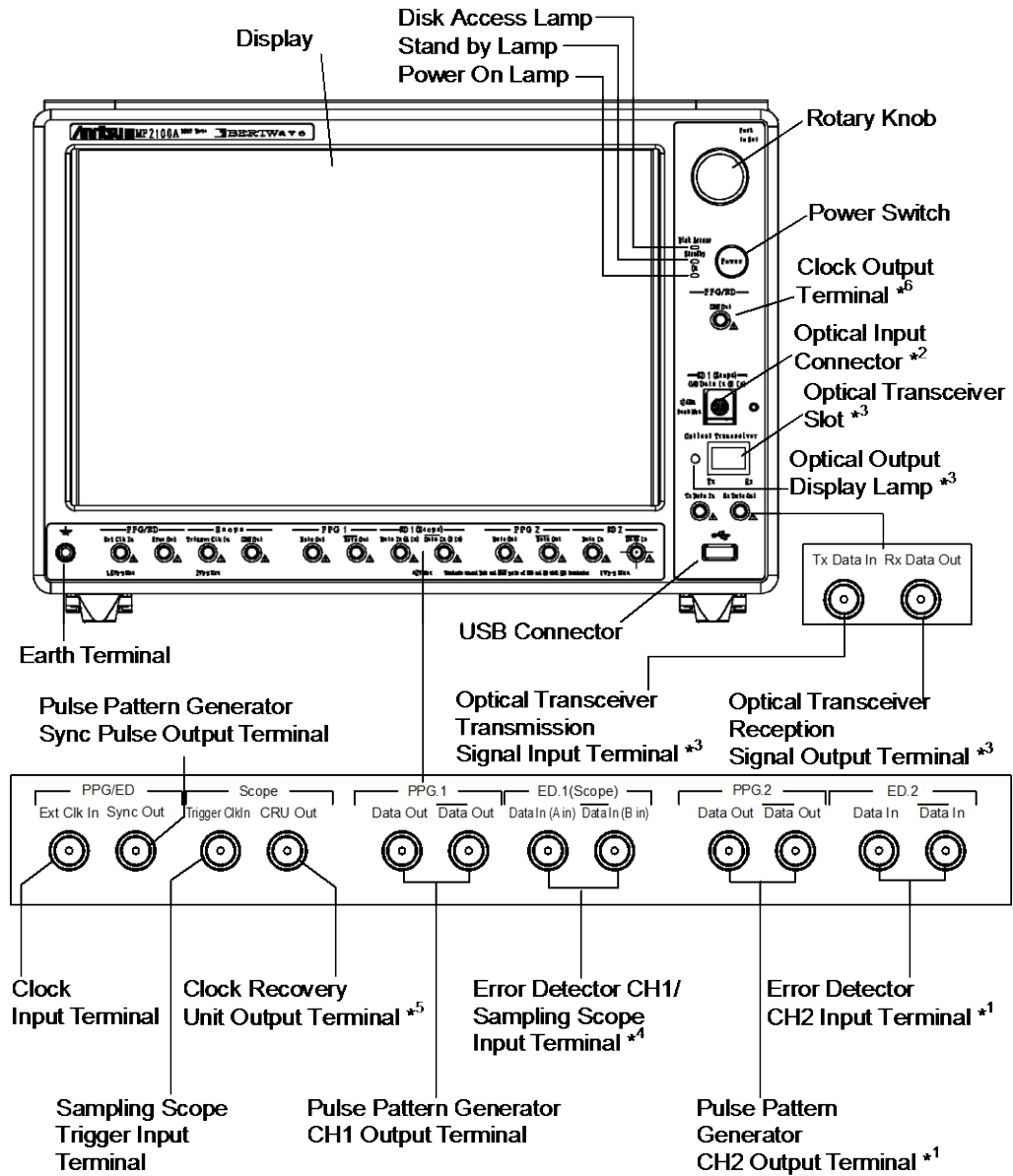


Figure 2.2.1-1 MP2100A Front Panel

- *1: When selecting and installing Option 005
- *2: When selecting and installing Option 003 or Option 007
- *3: When installing Option 050 or 051
- *4: Only Data In (A in) when installing Option 003 or Option 007
- *5: When installing Option 055
- *6: When installing Option 052

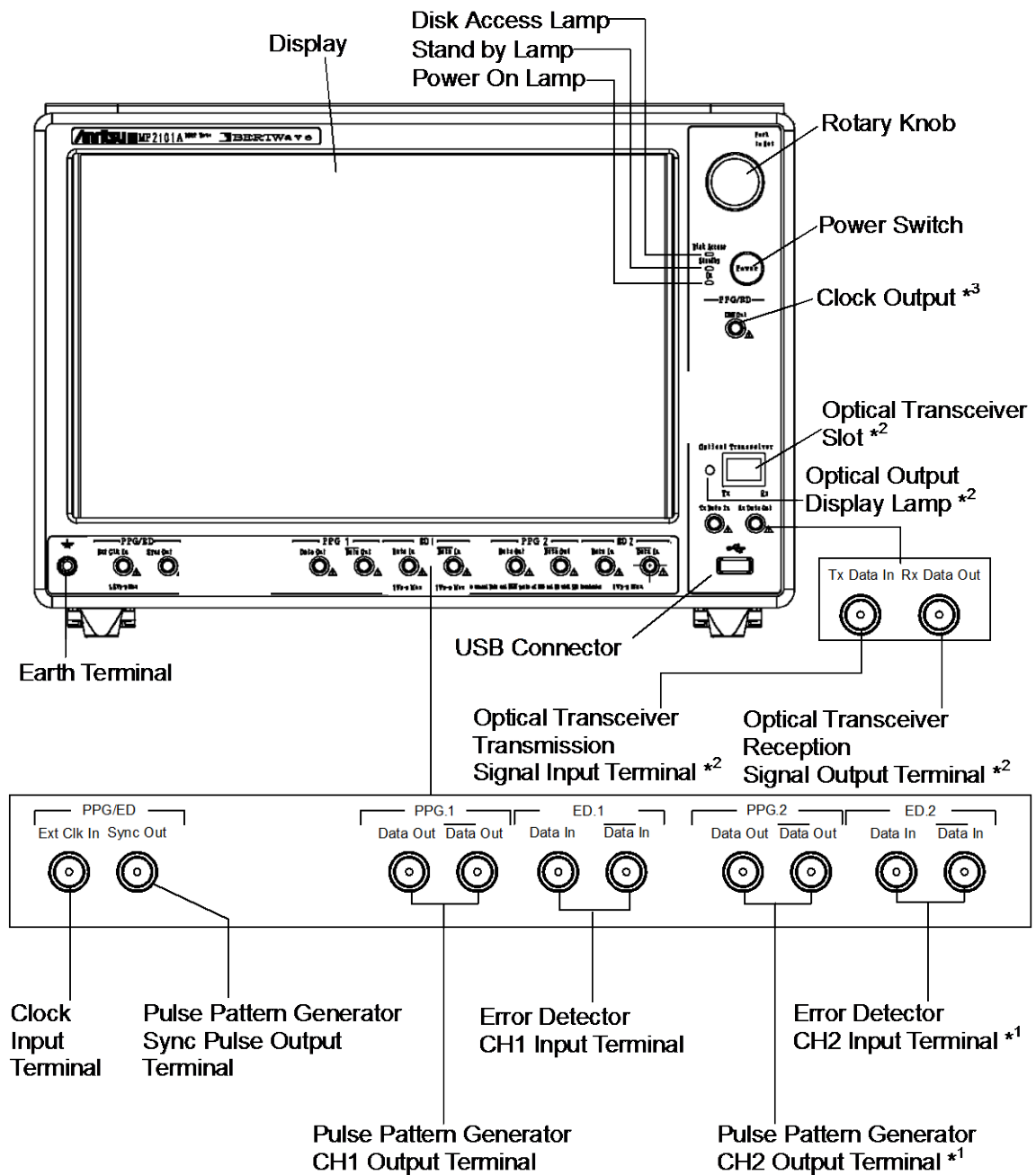


Figure 2.2.1-2 MP2101A Front Panel

*1: When selecting Option 012

*2: When installing Option 050 or 051

*3: When installing Option 052

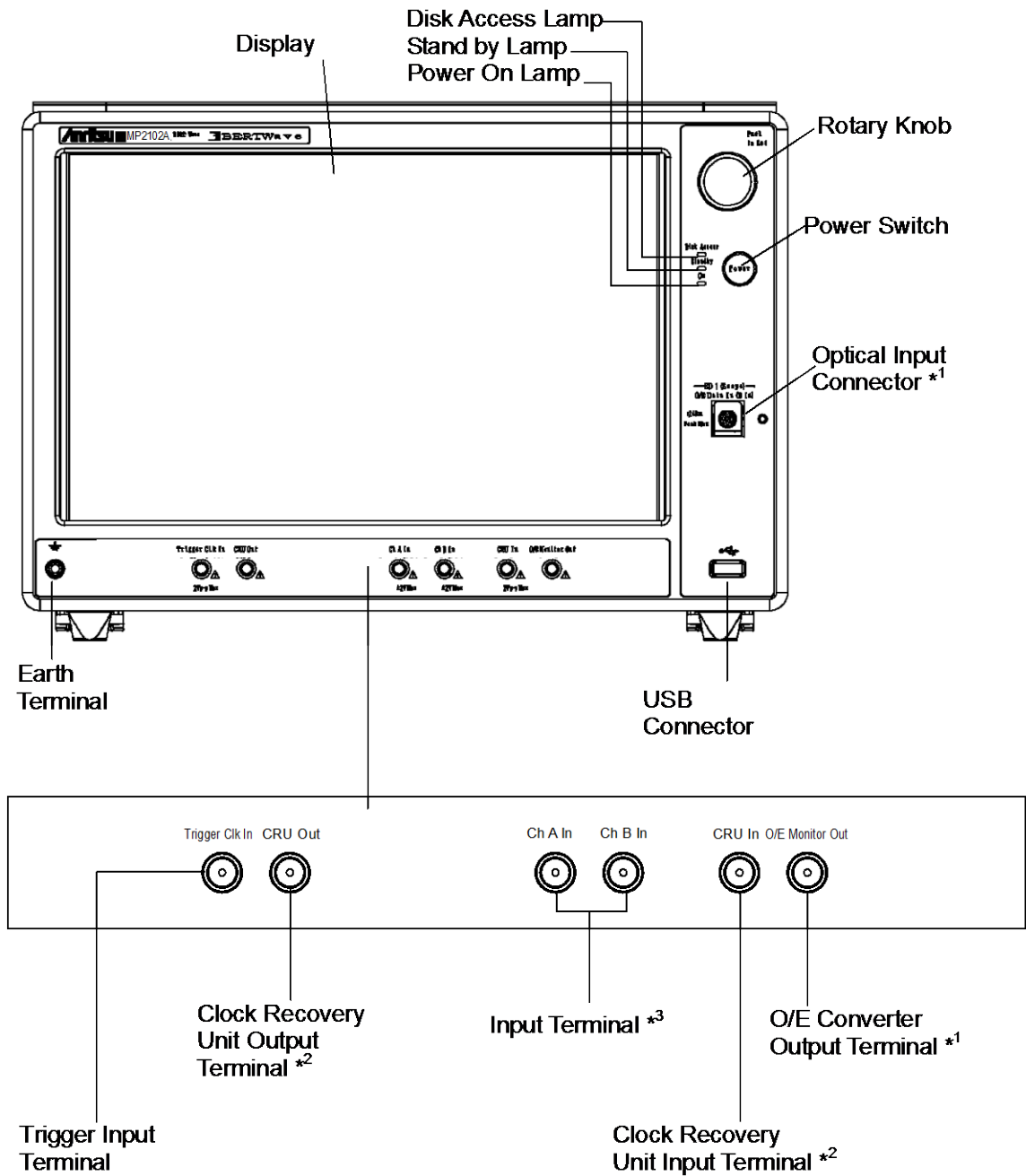
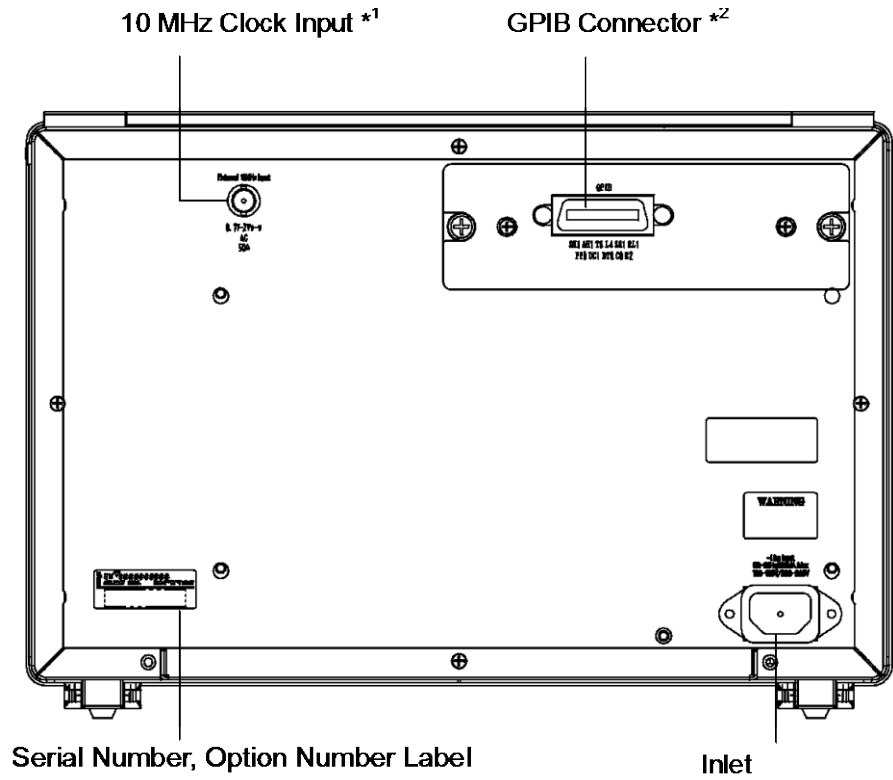


Figure 2.2.1-3 MP2102A Front Panel

- *1: When selecting and installing Option 023 and Option 055
- *2: When installing Option 055
- *3: Only Ch A when selecting Option 023

2.2.2 Rear Panel



2

Before Use

Figure 2.2.2-1 Rear Panel

*1: Only MP2100A and MP2101A

*2: When installing Option 030 or Option 130

2.2.3 Side Panel

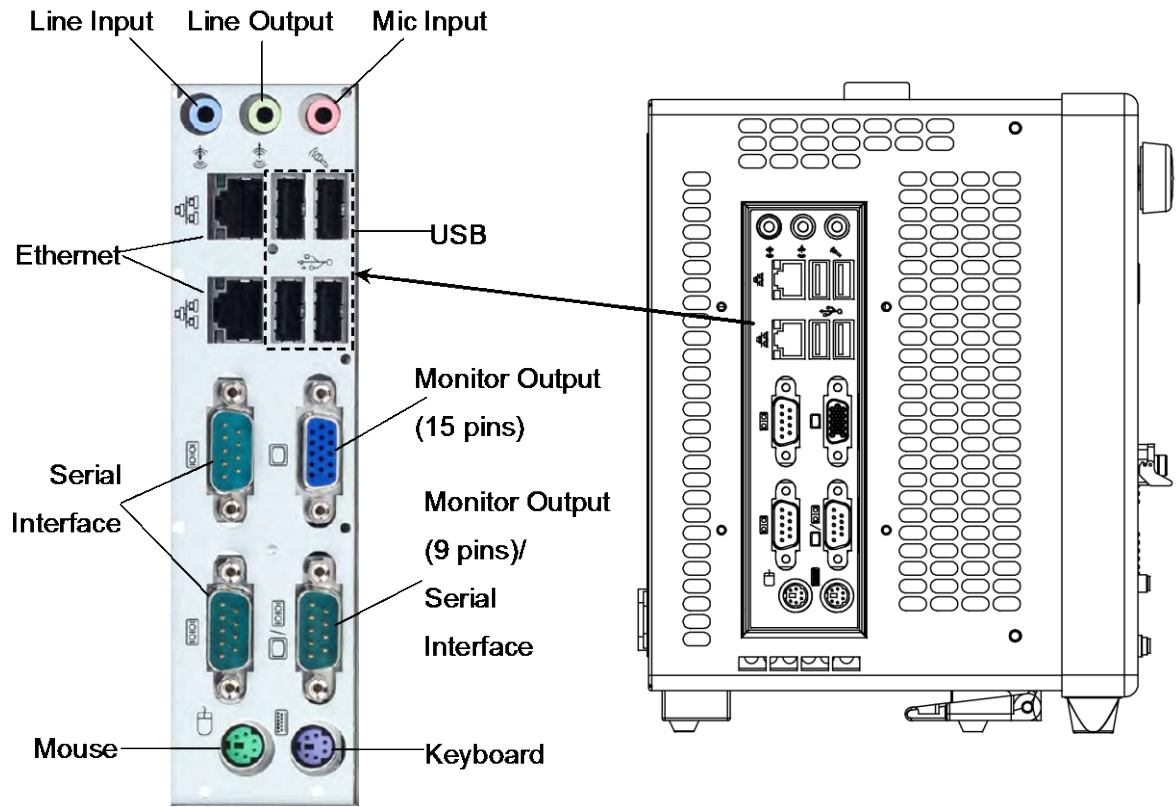


Figure 2.2.3-1 Left Side Panel

2.3 Power Connection

2.3.1 Power Requirements

For normal operation of the BERTWave, use the power voltage range described below.

Table 2.3.1-1 Power Requirements

Power source	Voltage range	Frequency
100 Vac system	100 to 120 V	50 to 60 Hz
200 Vac system	200 to 240 V	50 to 60 Hz

Switching between 100 and 200 V systems is automatic.



CAUTION

Supplying power exceeding the above range may result in electrical shock, fire, failure, or malfunction.

2.3.2 Connecting Power Cord

Insert the power plug into an outlet, and connect the other end to the power inlet on the rear panel. To ensure that the instrument is earthed, always use the supplied 3-pin power cord, and insert the plug into an outlet with an earth terminal.

 **WARNING**

Always connect the instrument to a properly grounded outlet. Do not use the instrument with an extension cord or transformer that does not have a ground wire.

If the instrument is connected to an ungrounded outlet, there is a risk of receiving a fatal electric shock. In addition, the peripheral devices connected to the instrument may be damaged.

Unless otherwise specified, the signal-connector ground terminal, like an external conductor of the coaxial connector, of the instrument is properly grounded when connecting the power cord to a grounded outlet. Connect the ground terminal of DUT to a ground having the same potential before connecting with the instrument. Failure to do so may result in an electric shock, fire, failure, or malfunction.

 **CAUTION**

If an emergency arises causing the instrument to fail or malfunction, disconnect the instrument from the power supply by disconnecting either end of the power cord.

2.4 Connecting Peripheral Devices

USB devices

USB devices such as mouse, keyboard, storage, etc., can be connected to the front-panel and left side panel USB connector.

No panel operations are required before removing USB devices from the BERTWave. USB devices can be removed at any time as long as no files are being written to or read from the USB device.

External Monitor

Connect an external monitor to the connector of the left-side panel monitor.

The supported monitor resolutions are 1280×768 dot or more.

Ethernet

Connect to the Ethernet connectors on the left side panel.

Either one of two connectors can be used, but each connector must have a different IP address.

To set the connector IP address, refer to Section 2.14 “Setting Interface for Remote Control”. However, when cables are connected to both connectors, remote control can be performed from one connector.

When using the Ethernet cable, select a category-5 or better crossover cable.

Keyboard

The PS/2 Keyboard connector is the purple connector on the left side panel. USB keyboards are connected to the USB connector.

Mouse

The PS/2 mouse connector is the right green connector on the left side panel. USB keyboards are connected to the USB connector.

2.5 Connecting Remote Control Devices

Ethernet

Connects to the connector on the either up or down side of the two Ethernet connectors on the left side panel.

Use a category-5 or better crossover cable.

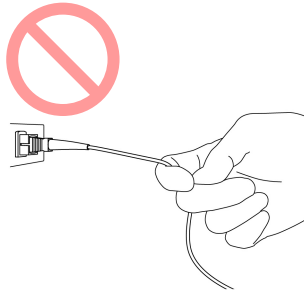
GPIB

GPIB can be used when the GPIB Option 030 is installed. Connect the cable to the rear-panel GPIB connector.

2.6 Cautions on Handling Optical Fiber Cables

Optical fiber cables may degrade in performance or be damaged if handled improperly.

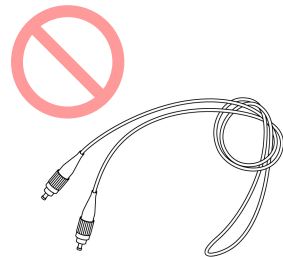
Note the following points when handling them.



CAUTION

Do not pull the cable when removing the connector.

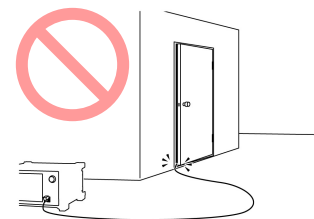
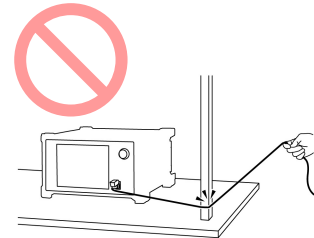
Doing so may break the optical fiber inside the cable, or remove the cable sheath from the optical connector.



CAUTION

Do not excessively bend, fold, or pinch an optical fiber cable.

Doing so may break the optical fiber inside the cable. Keep the bend radius of an optical fiber cable at 30 mm or more. If the radius is less, optical fiber cable loss will increase.

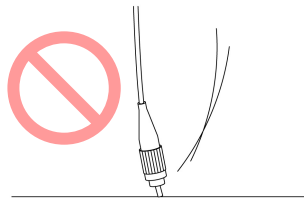




⚠ CAUTION

Do not excessively pull on or twist an optical fiber cable.

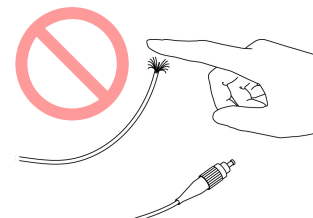
Also, do not hang anything by using a cable. Doing so may break the optical fiber inside the cable.



⚠ CAUTION

Be careful not to hit the end of an optical connector against anything hard such as the floor or a desk by dropping the optical fiber cable.

Doing so may damage the connector end and increase connection loss.



⚠ WARNING

Do not touch the end of a broken optical fiber cable.

The broken optical fiber may pierce the skin, causing injury.

⚠ CAUTION

Do not disassemble optical connectors.

Doing so may cause part to break or the performance to degrade.

2.7 Connecting Coaxial Cable

Connect the coaxial cable to the BERTWave coaxial connector.

Note the following precautions when handling coaxial cable.



CAUTION

- Use the correct coaxial cable for connecting to the coaxial connectors of this instrument, which are either SMA or K connectors. If the wrong coaxial cable for the connector is used, there is a risk of damage to the connector.
- Tighten coaxial connectors to the correct torque. If the coaxial connector is over tightened, there is a risk of damage to the connector, which may prevent disconnection. If the connector is not sufficiently tightened, correct measurement may be impossible.
- The outer conductor and inner core of a coaxial cable can sometimes become charged like a condenser. Discharge any possible charges by touching the outer conductor and inner cores to something metallic.
- When operating the BERTWave with other equipment, arrange so that the co-axial cables are not accidentally pulled; if they are pulled accidentally, BERTWave may be dragged off the bench top and damaged.
- Keep the protective caps fitted to unused coaxial connector.



WARNING

- Always use a coaxial cable with sufficiently low loss matching the signal to be measured. Correct measurement may be impossible if the cable loss is too large.
- Use a coaxial cable with an impedance of 50 Ω . Correct measurement may be impossible if the impedance is incorrect.

2.8 Installing Optical Transceiver

An optical transceiver can be used by adding Option 050 or Option 051.

For recommended optical transceiver model names, refer to Section 8.2.2 “Optical Transceiver Types”.

The optical transceiver can be installed or removed (hot-swap) while the BERTWave power is on.

2.8.1 Installing Optical Transceiver

1. Check that the optical transceiver specifications for wavelength and bit rate match the test conditions.
2. Hold both sides of the optical transceiver between thumb and forefinger.
3. Insert the optical transceiver into the slot on the front panel until it clicks.
4. Remove the protective cover from the optical transceiver.
5. Lift the lever to lock the optical transceiver.



Figure 2.8.1-1 Installing Optical Transceiver

CAUTION

- When inserting the optical transceiver, set the optical transceiver lever to the up position. If the optical transceiver is inserted with the lever down, sometimes the transceiver may not be fully inserted.

 **CAUTION**

- Always fit the protective cover to the installed optical transceiver. If dust enters the optical connector, it may cause measurement problems.
 - Optical transceiver can be damaged by electrostatic discharge. To prevent risk of ESD, touch the frame ground connector on the front panel.
 - If the optical connector ferrule is dirty, clean it as described in section 10.3 “Cleaning Optical Connector Ferrule”.
 - Do not look directly into the optical connector when a fiber cable is not connected, because laser light from the optical transceiver may enter your eyes.
 - Before inserting and removing the optical transceiver always disconnect any connected optical fiber cable. If the transceiver is inserted while optical fiber is connected, there is a risk of damage to the optical connector of the optical transceiver or to the fiber.
 - Do not touch the optical connectors between the optical transceiver and the BERTWave. If they are touched there is a risk of damage to the optical transceiver.
 - Operation is not assured if an optical transceiver other than those recommended by Anritsu is used. Only use recommended modules. Refer to the Anritsu homepage at <http://www.anritsu.com/> for the list of recommended modules.
 - The internal connector for optical transceivers has an insertion/removal life span of 100 times. If optical transceivers are inserted/removed more than 100 times, aging wear may cause connection failures. Make sure to observe this specification.
-

2.8.2 Removing Optical Transceiver

1. Set the optical output of the optical transceiver to OFF.
2. Turn off the signal input to the Tx Data In connector.
3. Disconnect the optical fiber from the optical transceiver.
4. Tilt the optical transceiver lever towards you.
5. Pull the optical transceiver out by the lever.



Note:

The optical transceiver cannot be detached without tilting the lever towards you.

2.9 Turning Power On/Off

2.9.1 Power-on

1. Connect the power cord plug, referring to Section 2.3 “Power Connection”.
The BERTWave enters the standby state and the power switch lamp lights orange.
2. Press the power switch.
The power lamp lights green and the Windows start-up begins.
3. In 30 seconds, the selector screen is displayed.



Figure 2.9.1-1 Selector Screen

Notes:

If no button on the selector screen is touched within 15 s, the [Main Application] is executed by default.

Do not press the power switch while the start-up screen is displayed, otherwise the BERTWave Control software may not start normally.

The Selector screen buttons execute the following processing:

[Main Application]: Displays the application screen where you can configure settings for the PPG, ED, sampling scope, and optical interface and view the measurement results.

For details on how to use the screen, refer to the following chapters:

- Chapter 4, Screen Operation
- Chapter 5, Generating Pulse Signal
- Chapter 6, Measuring Bit Error
- Chapter 7, Observing Waveform
- Chapter 8, Operating Optical Interface

[Setup Utility]: Displays the setup window where you can configure the remote interface, view the configuration and version of the software and update the software.

[Exit]: Displays Windows Explorer where you can work with files saved by the Main Application.

[Shut down]: Shuts down the power.

2.9.2 Power-off

Turning off the power in the Selector screen

1. Touch [System Menu] in the application screen.
2. Touch [Exit].
3. Touch [Yes], and the selector screen appears.
4. Touch [Shut Down] at the Selector screen.
5. A dialog confirming shutdown is displayed. Touching the [OK] button quits Windows.
The green Power switch lamp goes off, the standby lamp lights orange, and the power is turned off.

Turning off the power by shutting down Windows

1. Touch [Main Application] at the Selector screen.
2. The measurement screen is displayed, and then touch [System Menu] on the upper-right of the screen.
3. Touch [Minimize].
4. Touch [Start] menu of the Windows task bar.
5. Touch [Shut Down].
6. Confirm that [Shut Down] is displayed and touch [OK].
7. The green Power switch lamp goes off, the sand by lamp lights orange, and the power is turned off.

Forced shutdown

Press the Power switch for 4 seconds or more.

The green Power switch lamp goes off, the sand by lamp lights orange, and the power is turned off.

Notes:

- Only use forced shutdown as an emergency operation when key, mouse, and keyboard operations fail. A fault may have occurred if the power cannot be turned off even by pressing the Power switch for 4 or more seconds. Unplug the power cord from the power outlet and contact your Anritsu Service and Sales Office or agent.
- If the power plug is removed while the panel access lamp is lit, the data may not be saved correctly. Depending on the type of data that was not saved correctly, sometimes the equipment may not start correctly at the next power-on. Remove the power plug after cutting the power.
- The power may not turn on correctly if the power is turned off

and then turned on again immediately after the Stand by lamp illuminates orange.

Wait at least 5 seconds after turning off the power before turning on again.

2.10 Using Touch Panel and Rotary Knob

The BERTWave can be operated using the touch panel and rotary knob.

Touch Panel Operation

- The touch panel has the same hardness as a 3H lead pencil. Touching the screen with anything sharp or hard will damage it.
- Touch the required spot on the touch panel once. If two spots are touched simultaneously, the intermediate point will be detected.

In this manual, touching the touch panel with a finger is called “touch.”

Rotary Knob Operation

- Pressing the Rotary Knob performs the same operation as pressing the Enter key.
- Don't pull or hit the Rotary Knob, otherwise it may be damaged.

2.11 Setting Control Panel

The BERTWave is set to the factory defaults for optimal measurement. Changing the Windows settings is outside the scope of operation warranty. In addition, the performance may drop or functions may not operate correctly if the Windows settings are changed. Read the general notes in this section carefully when changes to the Windows settings are required.

 **CAUTION**

BERTWave operations are not guaranteed if Windows default settings are changed, or if a program not guaranteed by Anritsu Corporation is installed.

BERTWave operations are not guaranteed if program installation or update, including Windows Update, is performed.

Changing registries may cause abnormal operations.

2.11.1 Displaying Windows Desktop

Connect a mouse and a keyboard to operate Windows. Use the accessory USB mouse and a compatible USB keyboard.

The Windows desktop can be displayed as described below.

To display the BERTWave application again, touch [MX210000A] on the Windows taskbar.

When using touch panel and mouse:

1. Touch [Main Application] at the Selector screen.
2. The measurement screen is displayed. Touch [System Menu] on the left upper side of the screen.
3. Touch [Minimize].





When using keyboard:

Press the Windows + [D]. All windows will be minimized to display the Windows desktop.

2.11.2 Setting Control Panel

The system time, external display settings and touch panel settings are set at the Windows Control Panel. Do not change any settings other than those listed in Table 2.11.2-1.

Table 2.11.2-1 Description of Control Panel

Icon	Description
	<p><u>Date & Time</u></p> <ul style="list-style-type: none"> • Change the date, time and time zone as necessary. • Internet Time is set to off at factory shipment. Operation may be affected if this setting is changed.
	<p><u>Display</u> <u>Intel® GMA Driver for Mobile</u></p> <ul style="list-style-type: none"> • This setting must be changed when connecting an external monitor to the BERTWave connector. For details, refer to Section 2.12 “Using External Monitor” for details. • Changing the screen resolution, refresh rate or power management, or enabling the screen saver may cause abnormal BERTWave operation. Figure 2.11.2-1 shows the initial Display Settings.
	<p><u>Power Options</u></p> <ul style="list-style-type: none"> • The setting of the auto monitor off function (Turn off monitor) can be changed. • The setting of the power off function for hard disks (Turn off hard disks) is set to Never by default. Do not change the setting. • For any other settings in the Power Options Properties dialog box, do not change from default. Otherwise, BERTWave cannot operate normally after resuming from hibernation.
	<p><u>Touch Panel</u></p> <ul style="list-style-type: none"> • This calibrates the touch panel detection point. For details refer to Section 10.6 “Touch Panel Position Calibration”.

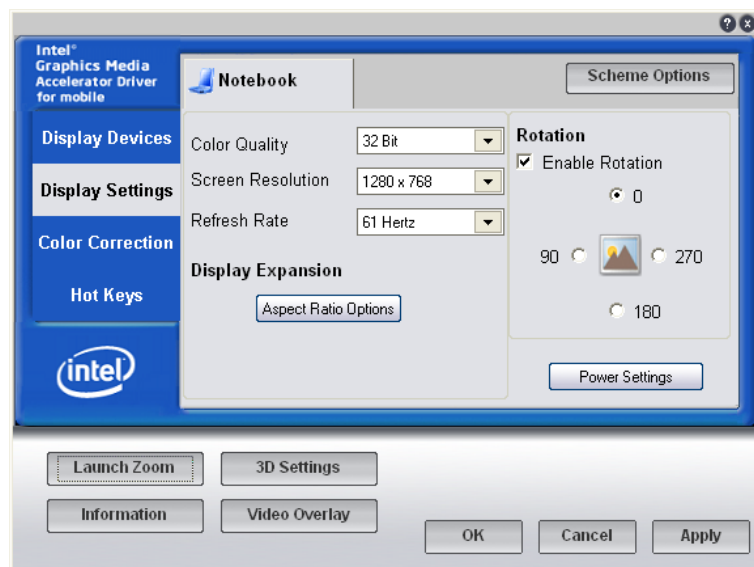
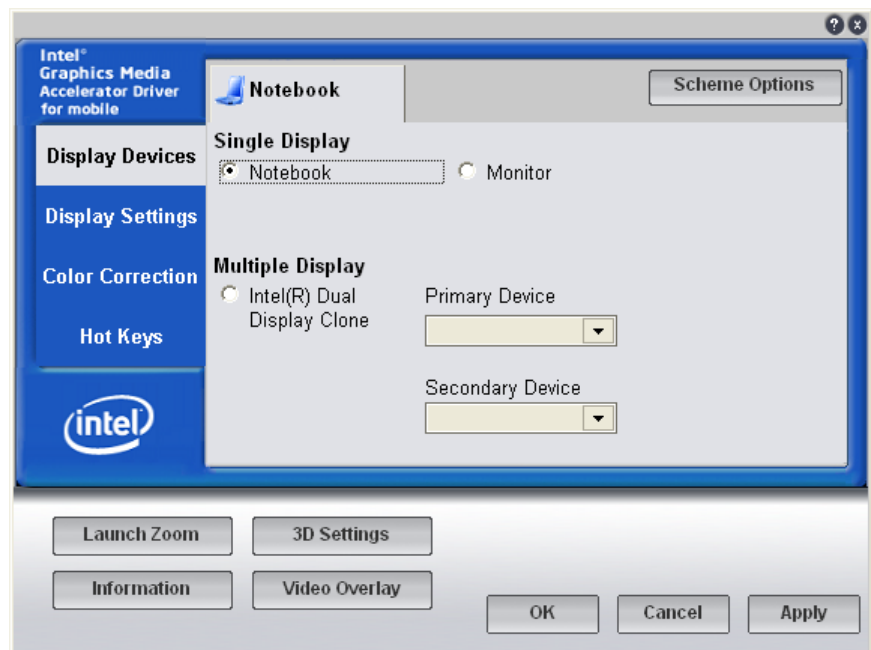


Figure 2.11.2-1 Initial Display Settings

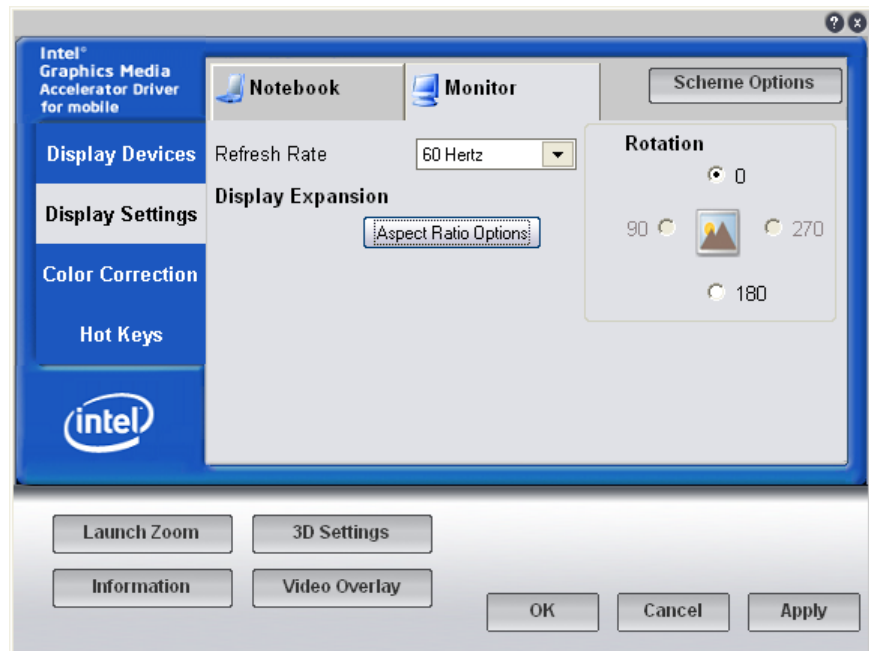
2.12 Using External Monitor

This section explains how to display the BERTWave screen on the external monitor.

1. Connect the external monitor to the monitor connector on the left side panel of the BERTWave.
2. Set the BERTWave and monitor power to On.
3. Touch [Main Application] at the Selector screen.
4. Touch [System Menu].
5. Touch [Minimize].
6. Touch [Start] on the right bottom of the screen.
7. Touch [Control Panel].
8. Touch [Intel(R) GMA Driver for Module] twice to display the following monitor setting screen.



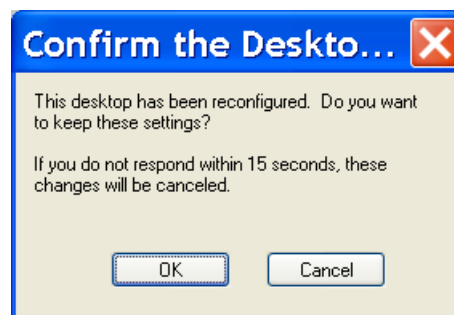
9. Touch [Multiple Displays].
10. Touch [Display Setting].
11. Touch [Monitor].



2

Before Use

12. Touch [Aspect Ratio Options] to open a separate window.
13. Touch [Maintain Aspect Ratio].
14. Touch [OK] to close a separate window.
15. Touch [OK].
16. The dialog is displayed to confirm the changed settings on the desktop.
Touch [OK].



17. Touch [MX210000A] on the task bar.

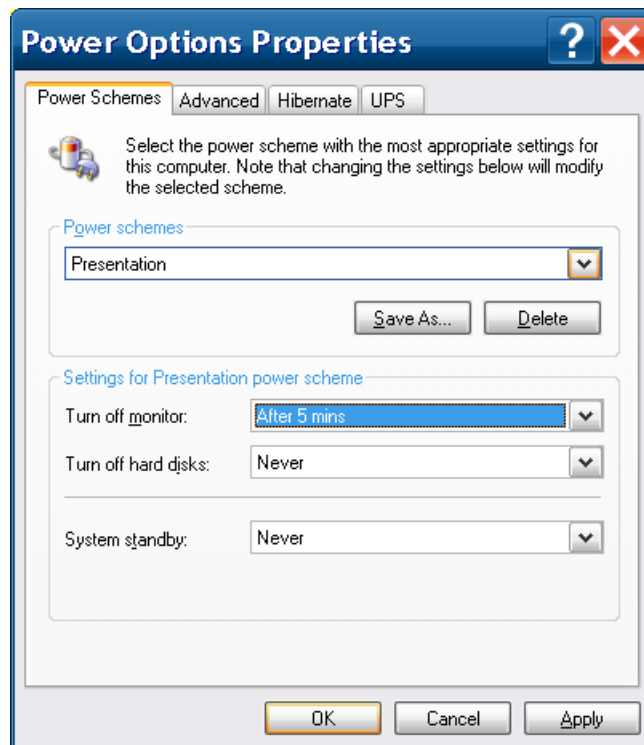
When the monitor is disconnected from the monitor output connector, the screen shown in step 8 returns to [Single Display].

2.13 Configuring Power Options

You can increase the life of the monitor by using the standby feature in Windows. Follow the procedure described below to set to turn off the monitor after a specified period of time.

1. Touch [Start] on the right bottom of the screen.
2. Touch [Control Panel].
3. Touch [Power Option] twice.

The Power Options Properties dialog box appears as shown below.



4. In the [Turn off monitor] list, touch a period of time you want to turn off the monitor after the specified period time.
5. Touch [OK].

CAUTION

In the Power Options Properties dialog box, select “Never” from both of [Turn off hard disks] and [System standby] lists.

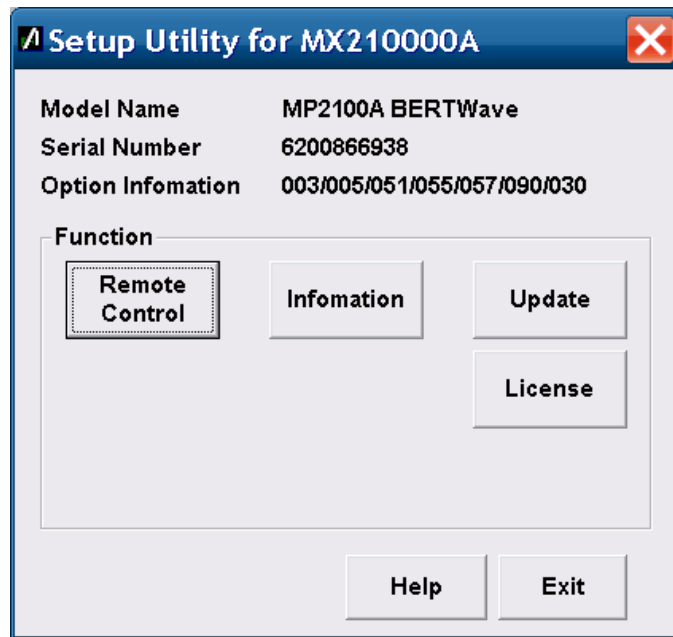
Failure to do so may interrupt measurement or cause malfunction when the BERTWave enters into a standby state.

2.14 Setting Interface for Remote Control

This section describes how to set the type and address of the interface used for remote control of BERTWave.

2.14.1 To display setup window

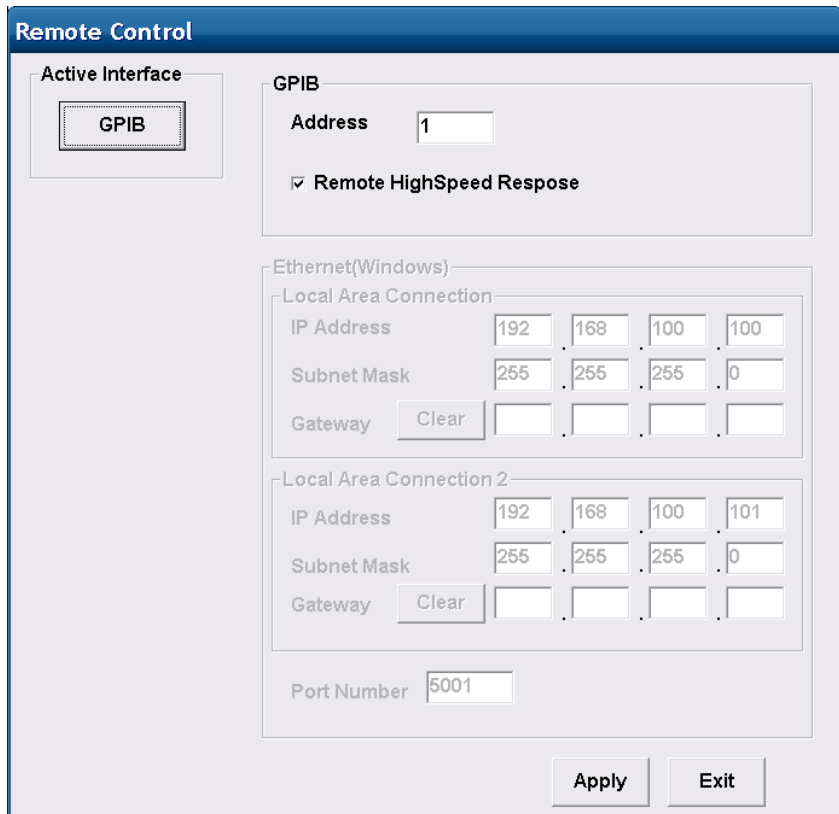
1. Touch [Setup Utility] in the selector screen.



2. Touch [Remote Control].
The window to set the remote interface is displayed.

2.14.2 To set GPIB

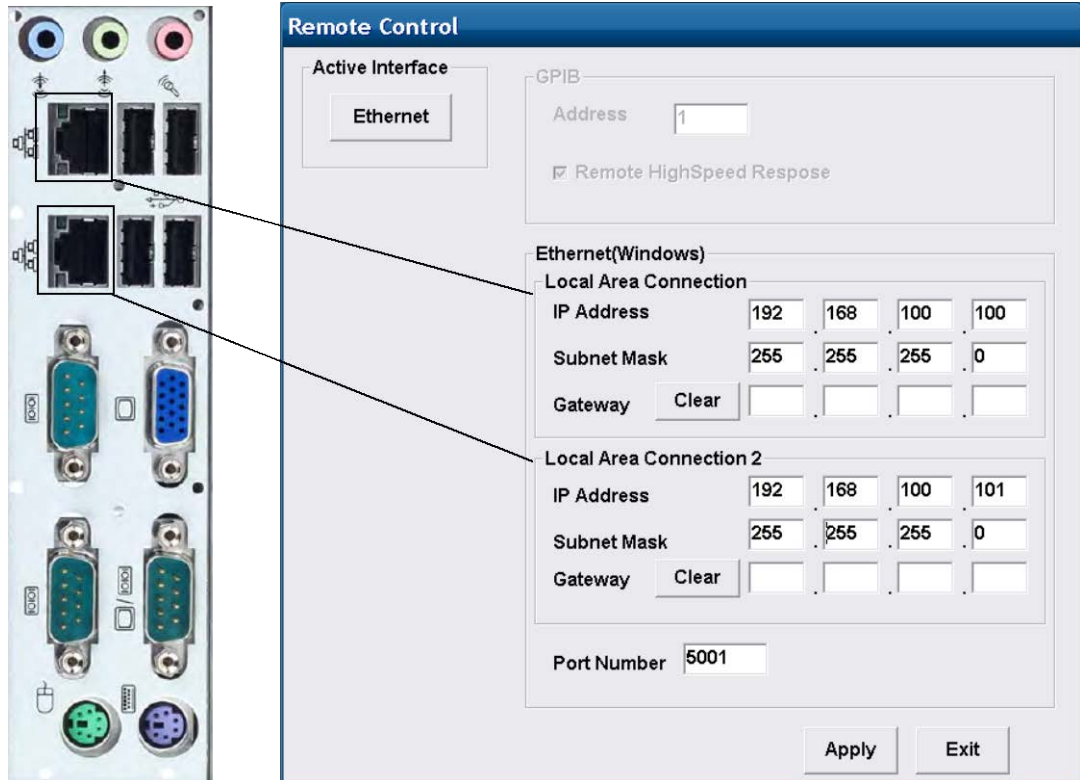
1. In the **Active Interface** area of the Remote Control window, touch the button to change the button name to **GPIB**.
If Option 030 is not installed, GPIB is not displayed.



2. Touch the GPIB Address text box. A dialog for inputting the address is displayed.
3. Enter the GPIB address from 1 to 30.
4. To shorten the time from sending the remote command until receiving the results, select the [Remote High Speed Response] check box.
5. Touching the [Apply] button completes the settings. Touching the [Exit] button deletes the settings made at steps 3 and 4.
6. Touching the [Protect] button protects the GPIB address value from being edited easily. Use this button as required.

2.14.3 To set Ethernet

1. In the **Active Interface** area of the Remote Control window, touch the button to change the button name to **Ethernet**.



2

Before Use

2. Select the Ethernet connector to use.
The top IP address is the address of the Ethernet connector on the top side of the left side panel. The bottom IP address is the address of the Ethernet connector on the bottom side of the left side panel.
3. Set the selected IP address, Subnet Mask and Gateway for the Ethernet connector.
Touch the text box to open the address input window.
4. Enter the IP address and sub-net mask.
The Gateway IP address can be omitted.
5. Touch the Port Number text box to open the port input window.
6. Set the number in the following range:
Port Number: 1024 to 5001
7. Touch the [Apply] button to complete the settings.
Touching [Exit] deletes the settings.
8. Touching the [Protect] button protects the IP address and other values from being edited easily. Use this button as required.

Note:

Do not set the following IP address:

192.168.1.0 to 192.168.1.255

The BERTWave may not work correctly if IP addresses within this range are set.

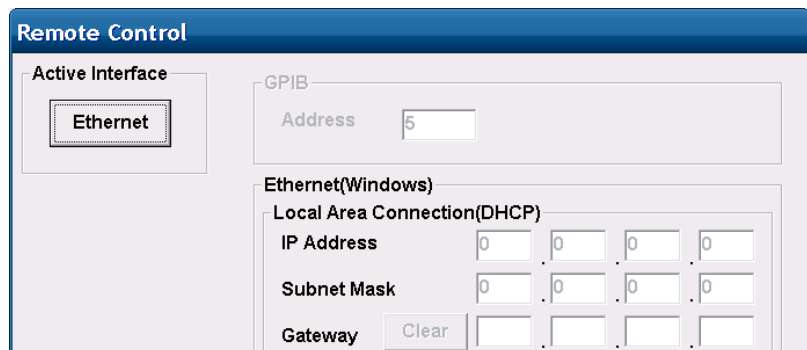
- To automatically acquire the IP address of Local Area Connection, using DHCP, set via the Windows [Control Panel] - [Network Connections].
- Do not change the Windows [Control Panel] - [Network Connections] Internal Connection setting. Otherwise, the BERTWave may not work correctly.

If the IP address has been changed, restore the settings to the following values.

IP address: 192.168.1.1

Subnet mask: 255.255.255.0

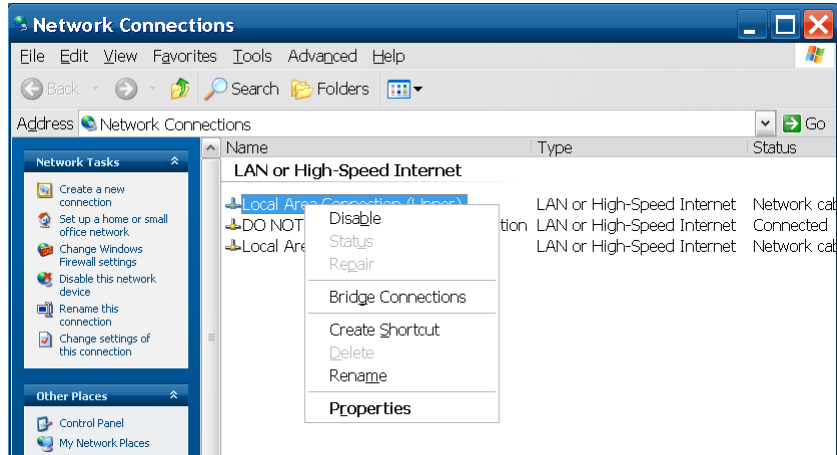
To automatically acquire the Local Area Connection IP address, using DHCP, set via the Windows [Control Panel]. In this case, [Setup Utility] will appear as Local Area Connection (DHCP).



The procedure for changing the setting via the Windows [Control Panel] is as follows.

1. Connect a keyboard and mouse to the BERTWave.
2. Press the Windows key on the keyboard.
If there is no Windows key on the keyboard, press [Ctrl] + [Esc].
3. Click [Control Panel].
4. Double-click [Network Connections].

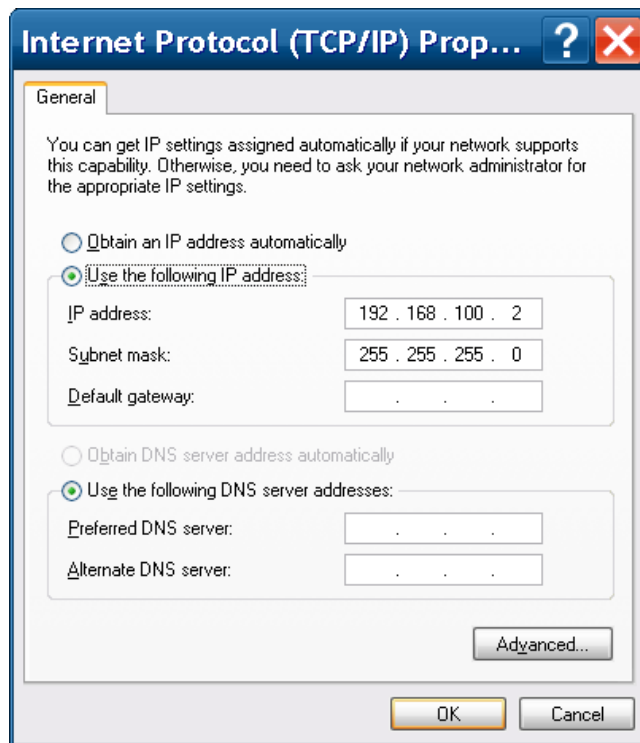
- Right-click [Local Area Connection (Upper)] or [Local Area Connection (Lower)], and then click [Properties].



2

Before Use

- The Local Area Connection Properties dialog box opens. Click [Internet Protocol (TCP/IP)] in the list box, and click the [Properties] button.



- Click [Use the following IP Address] or [Obtain an IP address automatically].
- Click the [OK] button.
- Click the [OK] button for [Local Area Connection Properties].

2.15 Precautions for Preventing Damage

Before connecting signals to the input and output connectors of the BERTWave, always check that the signals are within the specified voltage range.

If an out-of-range signal is input, the BERTWave may be damaged.



CAUTION

- Use a 50 Ω /GND terminator for the device to be connected to the output connector.
 - Never open the case of BERTWave.
If you open it and BERTWave has failed or sufficient performance cannot be obtained, Anritsu may not accept a request for repair.
-

2.15.1 Precautions on Electrostatic Discharge and Electrical Overstress



CAUTION

- When signals are input to BERTWave, avoid excessive voltage beyond the rating. Otherwise, the circuit may be damaged.
 - Never feed any current or input signals to the output connector.
 - As a countermeasure against static electricity, connect the ground structures (for example, frame ground) of external devices, including experimental circuits, to the ground terminal of BERTWave by using ground wires before connecting the IO connector.
Shorten ground wires as much as possible.
 - To the input terminal of BERTWave, connect an attenuator that can protect BERTWave without affecting measurement results. An attenuator with a bandwidth of 25 GHz or more is recommended.
 - 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.
-

 **CAUTION**

- The BERTWave has many important circuits and parts including hybrid ICs. These parts are extremely sensitive to static electric charges, so never open the case of BERTWave.
 - To prevent the risk of damage to BERTWave from static electric charges, always use an antistatic mat on the workbench and ensure that the operator wears a grounded wrist strap. Always ground the wrist strap to the workbench antistatic mat or the frame ground of BERTWave.
 - Always use 3-pin power cords when connecting external devices, including experimental circuits, to AC outlets. Connect the ground wires of external devices and BERTWave to a common ground.
 - Turn on the external devices, including experimental circuits, before connecting them to BERTWave. Use coaxial cables when connecting. On the contrary, disconnect the coaxial cables between external devices and BERTWave before turning off the external devices.
-

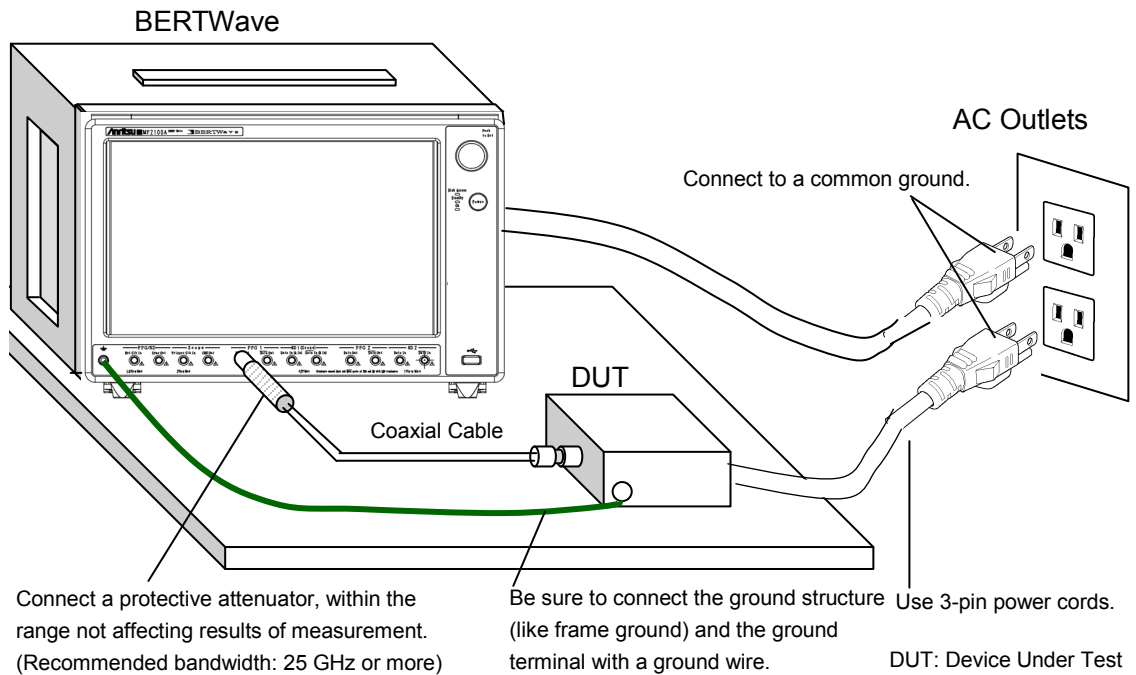


Figure 2.15.1-1 Example of Connection with DUT

Follow the procedure below to check for electrical overstress to BERTWave before connecting DUT (Device Under Test).

Checking the ground connection using a tester

1. Connect DUT and the ground terminal of BERTWave with a ground wire.
2. Turn on the power to DUT and BERTWave without connecting DUT to the I/O terminal of BERTWave.
3. Measure the voltage between DUT's ground structure and ground terminal of BERTWave with a tester in AC mode, and confirm the voltage is 0 V.

If the voltage measured in step 3 is not 0 V, there is a possibility that BERTWave and DUT may not be connected to a common ground. In this condition, do not connect the I/O terminal of BERTWave and DUT. Failure to do so may cause damage to BERTWave due to a voltage exceeding a rated value.

Review the ground wiring by, for example, changing the location of the DUT's ground wire connected to BERTWave so that the voltage measured in step 3 to be 0 V.

Note:

If it is impossible to connect a ground wire to DUT, follow the instructions below so that the voltage to be measured in step 3 becomes 0 V.

If the voltage measured in step 3 is not 0 V, check that the 3-pin power cords described in 2.3.2 “Connecting Power Cord” are used for BERTWave and DUT. When the 3-pin power cords are used, take the following actions:

- There may be a disconnection in the ground terminal of the used power cord. Replace it with a different 3-pin power cord.
- There is a possibility that the ground terminal inside the AC outlets to which the 3-pin power cords of BERTWave and DUT are connected is not connected to ground. Connect the 3-pin power cords to different AC outlets.

Checking the output waveform with an oscilloscope

1. Connect the DUT and the oscilloscope using a cable with an impedance of 50 Ω .
2. Set the input impedance of the oscilloscope to 50 Ω .
3. Observe the waveform with the oscilloscope, and perform the following operations to check the observed waveform for surge voltage exceeding the rated voltage*. There is a risk of damage if a voltage of ± 2 V is generated.
 - Turning On/Off the DUT power
 - Outputting a pulse from DUT
 - Connecting and disconnecting the cable between DUT and the BERTWave

*: Rated voltages are as follows:

	ED 1	ED 2	Ch A	Ch B
MP2100A	± 2 V	1 Vp-p	–	–
MP2101A	1 Vp-p	1 Vp-p	–	–
MP2102A	–	–	± 2 V	± 2 V

2.15.2 Precautions When Using Bias-T

When connecting an external device such as a Bias-T to the output connectors of the BERTWave, if the output signal includes any DC voltage, variations in the output of the DC power supply or load may change the level of the output signal, risking damage to the internal circuits.

CAUTION

- Do not connect or disconnect any external devices while DC voltage is impressed.
- Only switch DC power sources ON and OFF when all equipment connections have been completed.

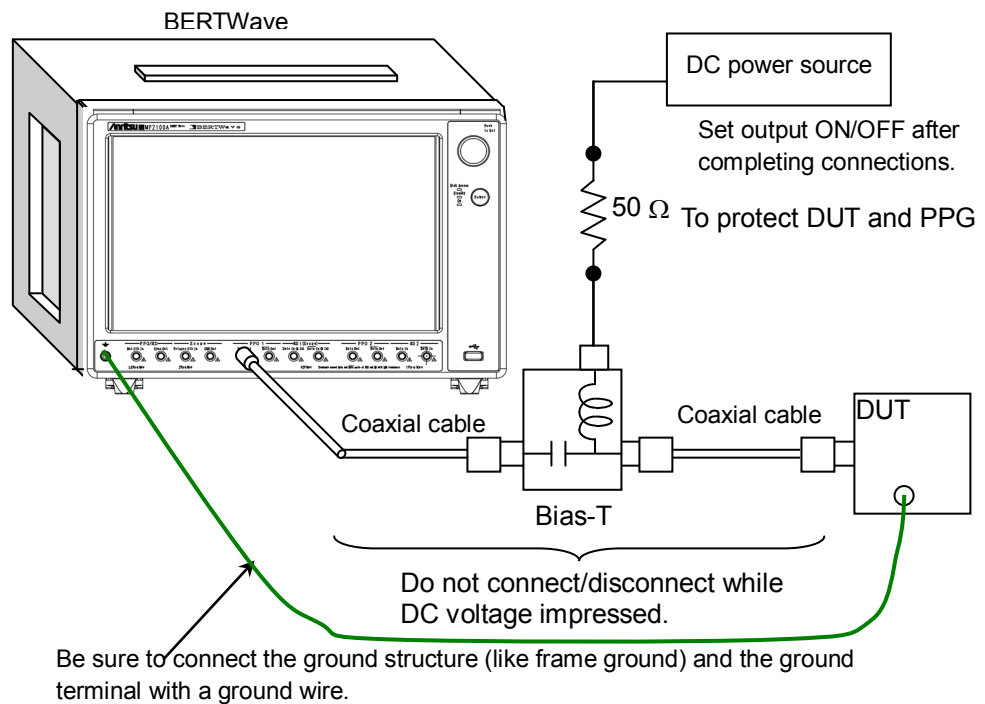


Figure 2.15.2-1 Bias-T Connection Example

<Recommended procedure>

Measurement Preparation 1:

1. Connect the BERTWave and all equipment.
2. Set the DC power supply output to ON.
3. Set the BERTWave output to ON, and start measurement.

Measurement Preparation 2:

1. Set the BERTWave output to OFF.
2. Set the DC power supply output to OFF.
3. Disconnect the BERTWave and all equipment, or change the DUT connections.

Since even unforeseen fluctuations in DC voltage and load (open or short circuits at the BERTWave output side and changes caused by using a high-frequency probe, etc.) can damage the DUT and the BERTWave, we recommend connecting a 50 Ω resistance in series with the DC terminal of the Bias-T to prevent risk of damage.

Chapter 3 Connecting with DUT

The connection methods depend upon either optical or electrical DUT interface.

When changing the optical level input to the DUT such as the reception sensibility measurement, connect other measurement instruments such as optical attenuator.

This chapter explains how to connect the BERTWave and the DUT.

3.1	Measuring Bit Error Rate	3-2
3.2	Measuring Waveform.....	3-8
3.3	Simultaneously Measuring Bit Error Rate and Waveform.....	3-14

3.1 Measuring Bit Error Rate

When the DUT input/output signal is electrical:

1. Connect the DUT input terminal to PPG1 $\overline{\text{Data}}$ Out and Data Out using the coaxial cable.

If only one DUT input connector is conveniently available, connect to the PPG1 Data Out. Also, connect the coaxial terminator, which is attached to the MP2100A standard configuration, to the $\overline{\text{Data}}$ Out.

2. Connect the DUT output terminator to ED1 $\overline{\text{Data}}$ In and Data In using the coaxial cable.

If only one DUT output connector is conveniently available, connect to the ED1 Data In. Also, connect the coaxial terminator, which is attached to the MP2100A standard configuration, to the $\overline{\text{Data}}$ In.

Note:

If the difference between the DC offset component of the DUT signals and the input offset value of the corresponding sampling scope is $\pm 200\text{mV}$ or more, it may affect the ED1 reception sensitivity while using it in the MP2100A.

Set the DC offset component of the DUT signals to the offset value of the sampling scope before error rate measurement. For setting procedure of offset value, refer to 7.10.2 “Adjusting Vertical-axis of Screen”. When the DUT is AC coupling, the DC offset component of the DUT signals is 0 mV.

The MP2101A is free from this phenomenon, for it is without sampling scope.

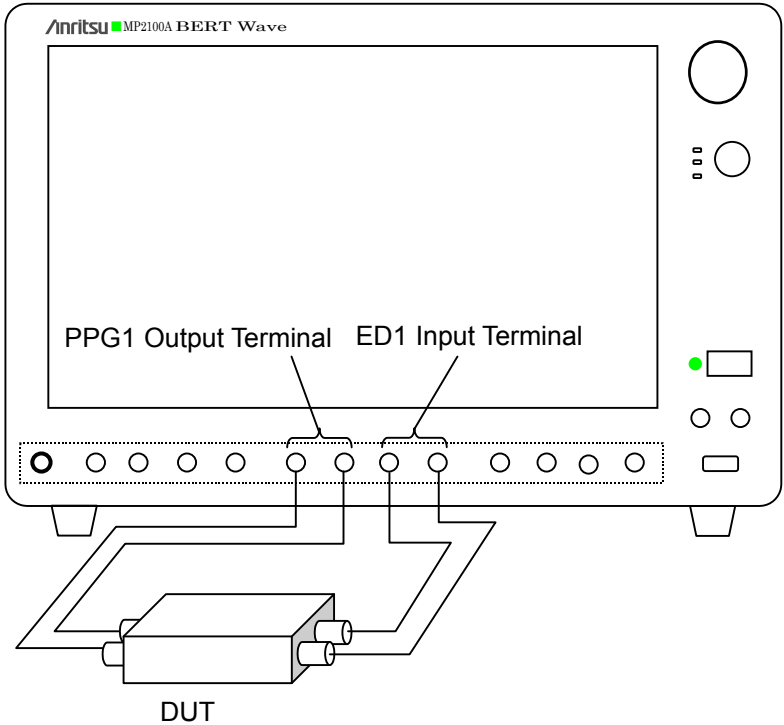


Figure 3.1-1 Making Connections Using Electrical Signal

When DUT is Optical Receiver:

Use Option 050/051 and follow the connection procedures.

1. Connect the PPG1 Data Out and Tx Data In using a coaxial cable.
2. Connect the DUT input connector to the Optical transceiver using an optical fiber.
3. Connect the DUT output connector to ED1 Data In and $\overline{\text{Data}}$ In using a coaxial cable.

If only one DUT output connect is conveniently available, connect to ED 1 $\overline{\text{Data}}$ In. Do not connect anything to Data In.

⚠ CAUTION

Check that the output power for the optical module inserted with the Option 050/051 is within the input level range for the DUT.

There is a risk of damaging the DUT if the optical power out of the input level range is applied.

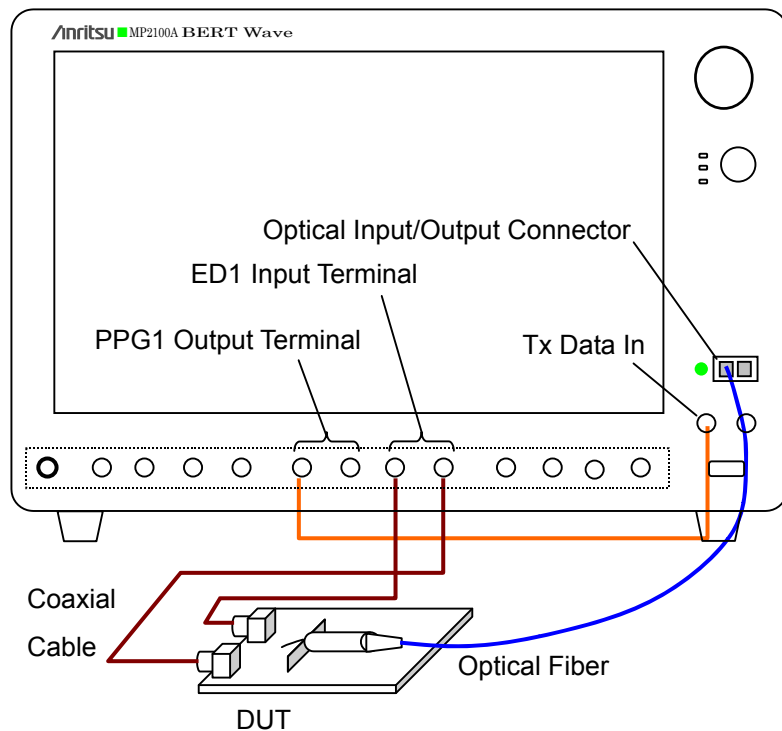


Figure 3.1-2 Connection when DUT is Optical Receiver

When the DUT changes the signal level using the optical receiver:

When measuring the sensibility of the optical receiver, connect to the optical attenuator to change the signal level input to the DUT. Connect to the optical power meter to measure the optical level. Use the optical coupler to bifurcate the optical signal into the optical power meter and DUT.

1. Connect the PPG1 Data and Tx Data In using a coaxial cable.
2. Connect the DUT output connector and ED 1 $\overline{\text{Data}}$ In/Data In using a coaxial cable.
3. Connect the optical output connector of the MP2100A optical transceiver to the input connector of the optical attenuator using an optical fiber.
4. Connect the output connector of the optical attenuator to the optical coupler.
5. Connect one end of the optical coupler to the input connector of the DUT.
6. Connect another end of the optical coupler to the optical power meter.

When measuring the sensitivity of the optical receiver, use the connections as shown in Figure 3.1-3.

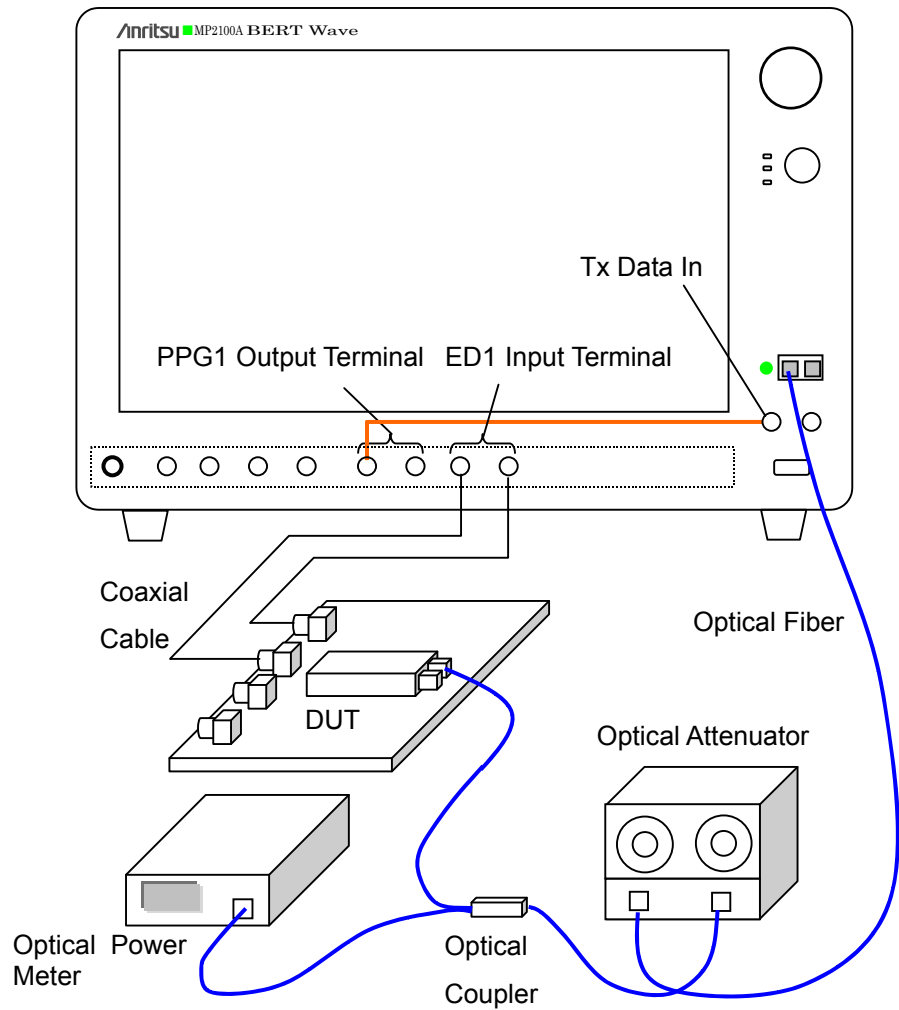


Figure 3.1-3 Connection for Changing Optical Level Input to Optical Receiver

When the DUT is an optical transmitter:

Use Option 050/051 and follow the connection procedures.

1. Connect the PPG1 $\overline{\text{Data}}$ Out and Data Out to the DUT input terminal using a coaxial cable.
2. Connect the DUT output connector to optical transceiver for an optical input connector using an optical fiber.
3. Connect the Rx Data Out to ED1 Data In using a coaxial cable. Do not connect anything to $\overline{\text{Data}}$ In.

CAUTION

Check that the DUT optical output level does not exceed the rated optical input level for the optical module inserted with the Option 050/051.

There is a risk of damaging the optical module if the optical power exceeding the rated optical input level is applied.

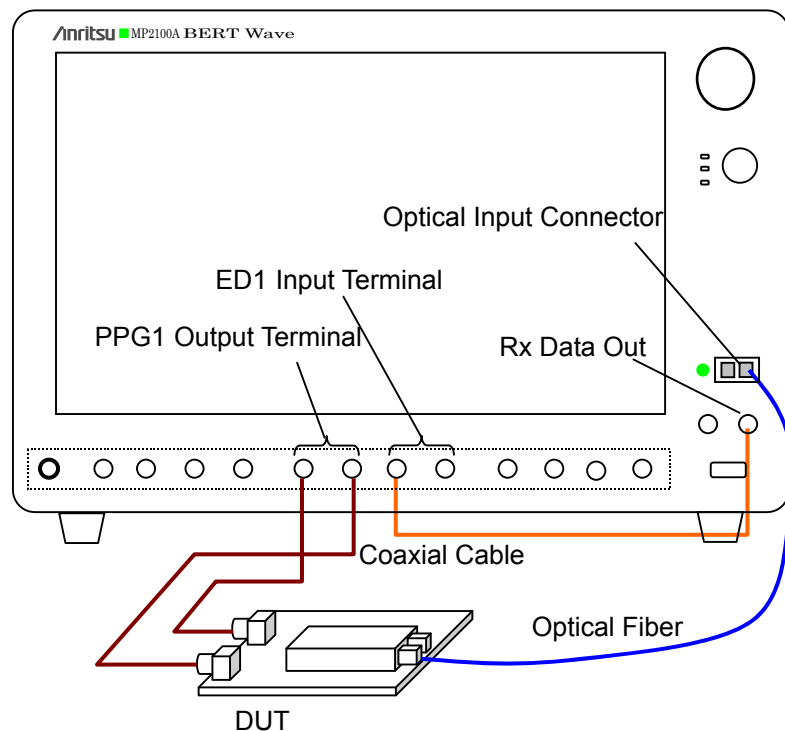


Figure 3.1-4 Connection when DUT is Optical Transmitter

3.2 Measuring Waveform

When the MP2100A DUT input/output signal is electrical:

Input the output of the PPG in the MP2100A to the DUT, and then measure the DUT output using the sampling scope.

1. Connect the DUT input terminal to PPG1 $\overline{\text{Data Out}}$ /Data Out using a coaxial cable.
If only one DUT input connector is conveniently available, connect to the PPG1 Data Out. Also, connect the coaxial terminator included as a standard accessory to the $\overline{\text{Data Out}}$.
2. Connect the DUT output terminal to ED1 $\overline{\text{Data In}}$ (A In)/Data In (B In) using a coaxial cable.
If only one DUT output connector is conveniently available, connect to the ED1 Data In (A In). Also, connect the coaxial terminator included as a standard accessory to the $\overline{\text{Data In}}$ (B In).
3. Connect the Sync Out to Trigger Clk Input using a coaxial cable.

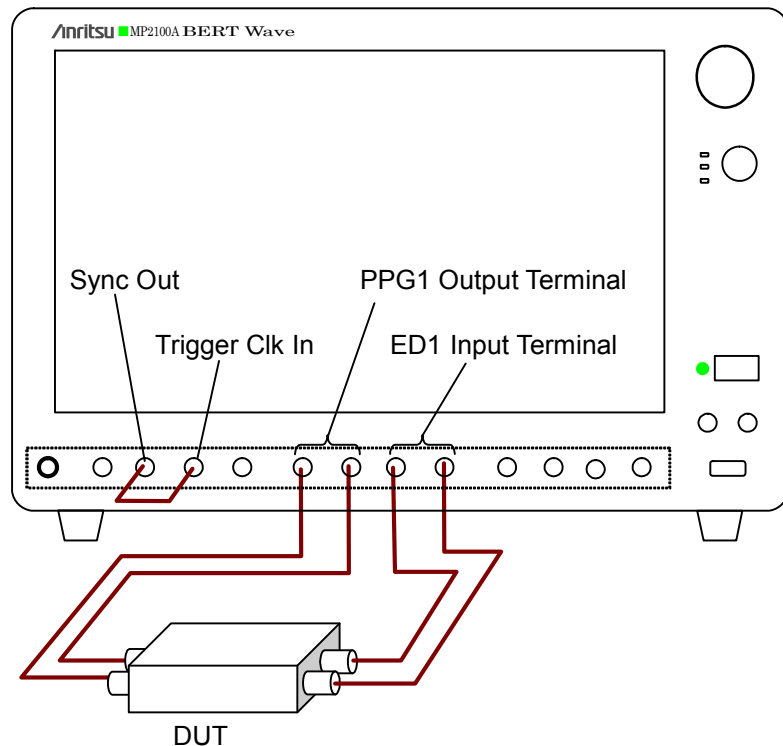


Figure 3.2-1 Electrical Signal Used for DUT Input/Output (MP2100A)

When the MP2100A DUT is an optical transceiver:

When Option 003 is selected, the output waveform of the optical transceiver can be measured using the O/E converter.

Input the output of the PPG in the MP2100A to the DUT, and then connect the DUT optical output to the O/E converter.

1. Connect the DUT input terminal to PPG1 $\overline{\text{Data}}$ Out/Data Out using a coaxial cable.
If only one DUT input connect is conveniently available, connect to the PPG1 Data Out. Also, connect the coaxial terminator included as a standard accessory to the $\overline{\text{Data}}$ Out.
2. Connect the DUT optical output connector to O/E Data In using an optical fiber.
3. Connect the Sync Out to Trigger Clk Input using a coaxial cable.

CAUTION

Check that the DUT optical output level does not exceed the rated optical input level for O/E Data In.

There is a risk of damaging the O/E module if the optical power exceeding the rated optical input level is applied to the O/E Data In connector.

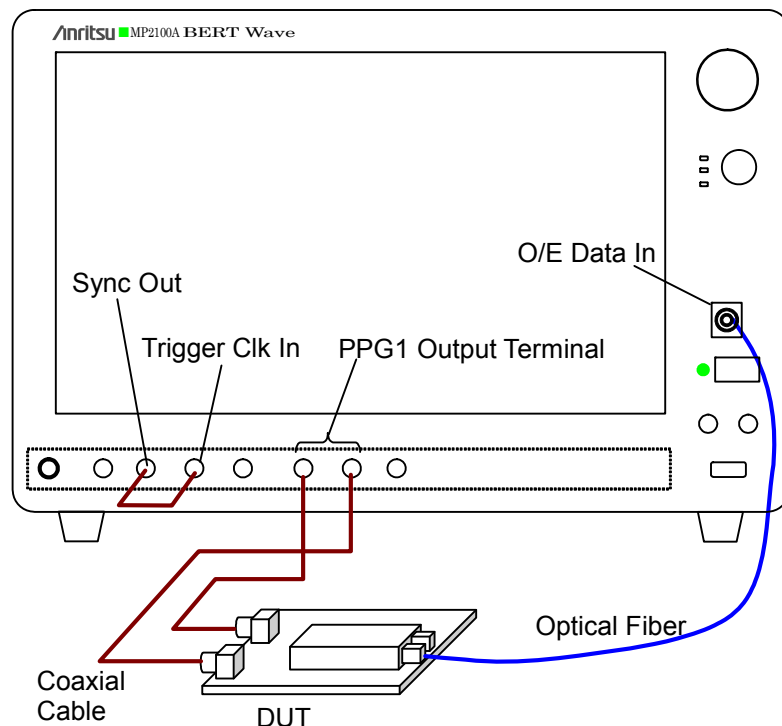


Figure 3.2-2 Optical Transceiver Used as DUT (MP2100A-003)

When the MP2102A DUT is an optical transceiver:

When Option 023 is selected, the output waveform of the optical transceiver can be measured using the O/E converter.

Input the PPG output to the DUT, and then connect the PPG trigger signal to the MP2102A.

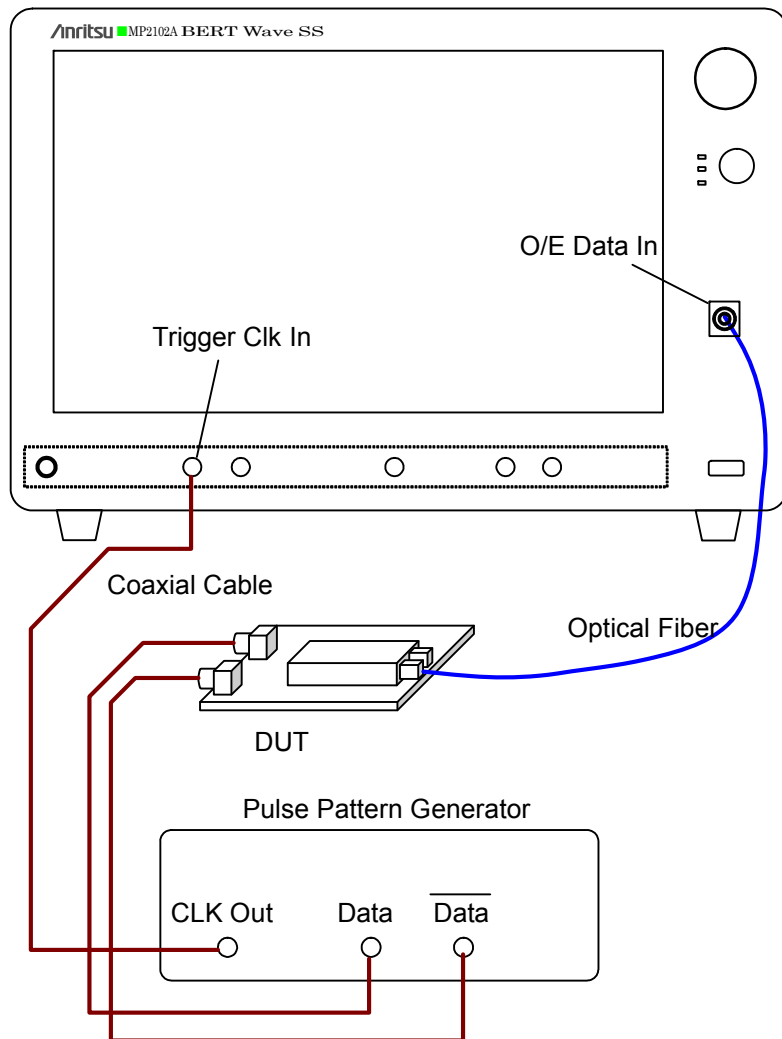
Connect the DUT optical output to the O/E converter.

1. Connect the PPG clock to Trigger CLK In using a coaxial cable.
2. Connect the PPG output to the DUT input connector using a coaxial cable.
3. Connect the DUT output to O/E Data In using an optical fiber

 **CAUTION**

Check that the DUT optical output level does not exceed the rated optical input level for O/E Data In.

There is a risk of damaging the O/E module if the optical power exceeding the rated optical input level is applied to the O/E Data In connector.



3

Connecting with DUT

Figure 3.2-3 Optical Transceiver Used as DUT (MP2102A-023)

When the MP2102A DUT is an optical transceiver (using clock recovery)

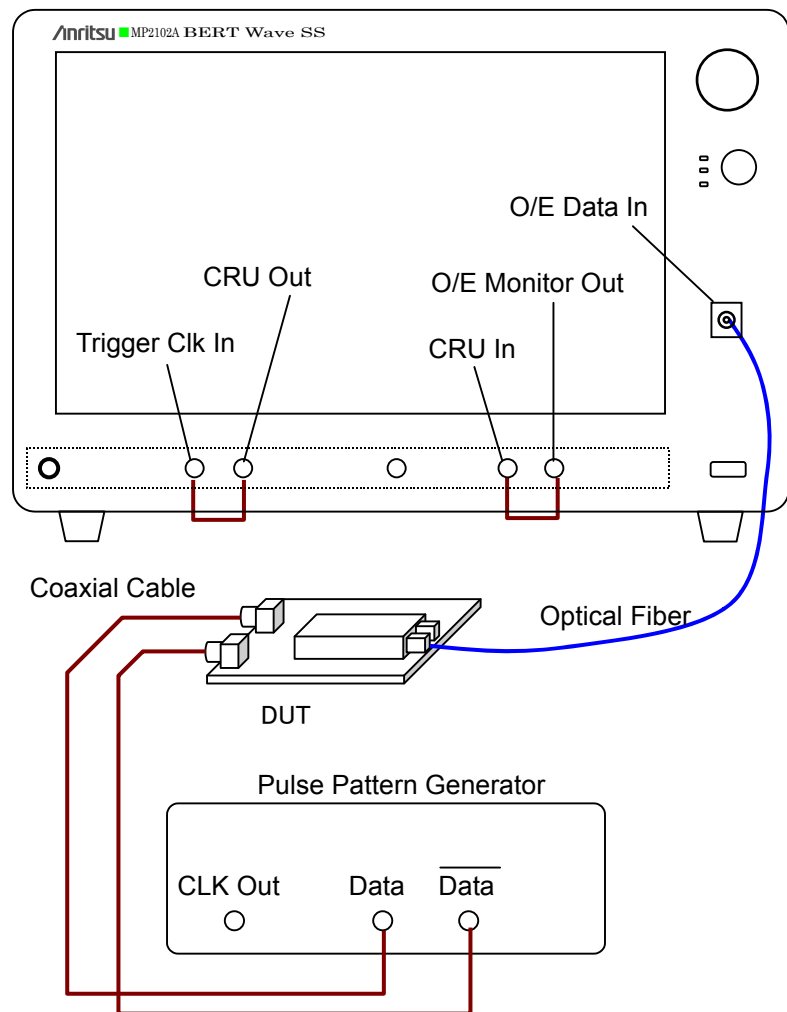
The trigger clock can be generated from the received signal when the MP2102A-023 is installed and Option 055 is added.

1. Connect the O/E Monitor Out to CRU In using a coaxial cable.
2. Connect the CRU Out to Trigger Clk In using a coaxial cable.
3. Connect the PPG output to the DUT input connector using a coaxial cable.
4. Connect the DUT output and O/E Data In using an optical fiber.

 **CAUTION**

Check that the DUT optical output level does not exceed the rated optical input level for O/E Data In.

There is a risk of damaging the O/E module if the optical power exceeding the rated optical input level is applied to the O/E Data In connector.



3

Connecting with DUT

Figure 3.2-4 Optical Transceiver Used as DUT (MP2102A-023,055)

3.3 Simultaneously Measuring Bit Error Rate and Waveform

When the optical transceiver is set as the DUT, the reception sensibility of the optical receiver and the waveform of the optical transmitter can be measured simultaneously. To measure the reception sensibility of the optical receiver, the bit error rate must be measured using the measurement type that can change the optical level input to the DUT.

When using the MP2100A-003+005, and 050/051, follow the below connection procedures.

1. Connect the PPG2 Data Out to Tx Data In using a coaxial cable.
2. Connect the DUT output connect to ED2 $\overline{\text{Data}}$ In/Data In using a coaxial cable.
3. Connect the optical output connector of the MP2100A optical transceiver to the input connector of the optical attenuator using an optical fiber.
4. Connect the optical coupler to the output connector of the optical attenuator.
5. Connect one end of the optical coupler to the DUT input connector.
6. Connect another end of the optical coupler to the optical power meter.
7. Connect the DUT input connector to PPG1 $\overline{\text{Data}}$ Out and Data Out using the coaxial cable.
8. Connect the Sync Out to Trigger Clk Input using a coaxial cable.
9. Connect the DUT optical output connector to O/E Data In using an optical fiber.

CAUTION

- Check the following before connecting the optical fiber:
 - The output power for the optical module inserted with the Option 050/051 is within the input level range for the DUT.
 - The DUT optical output level does not exceed the rated optical input level for O/E Data In.
 - There is a risk of damaging the DUT or optical module if the optical power exceeding the rated optical input level is applied.
-

3.3 Simultaneously Measuring Bit Error Rate and Waveform

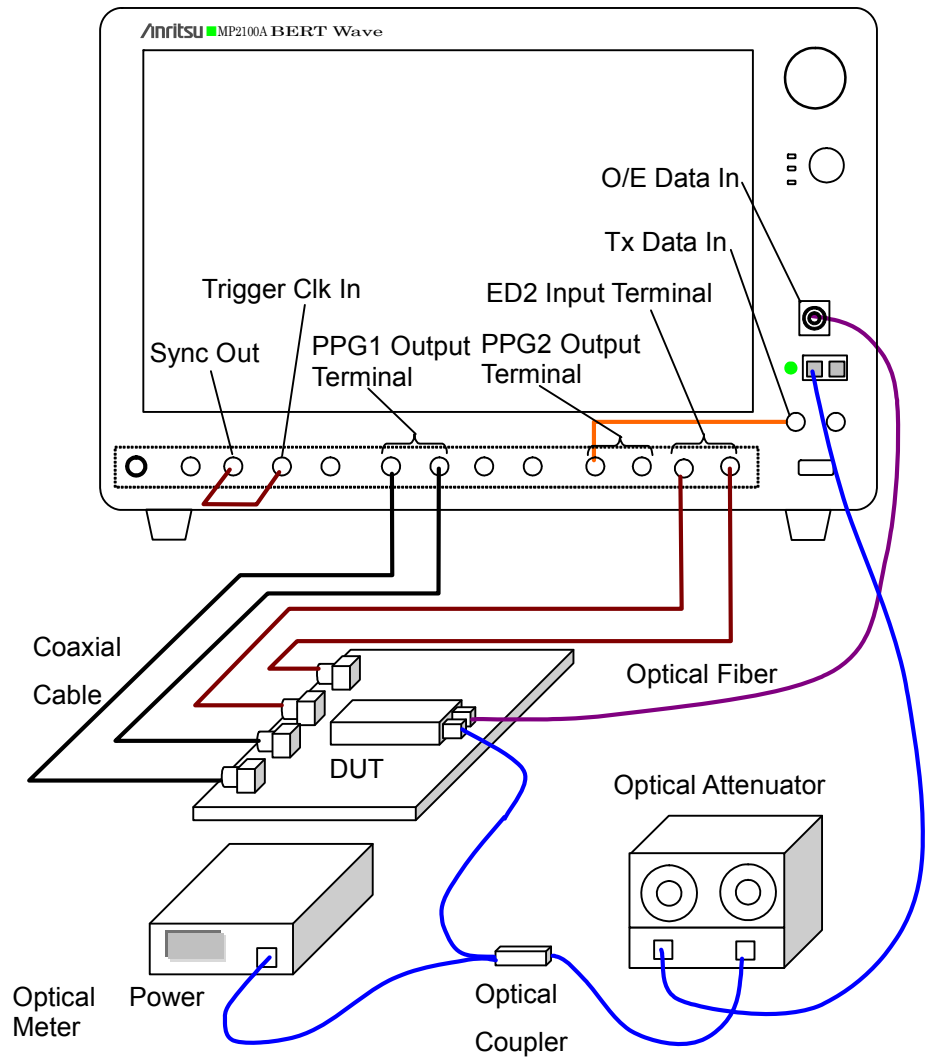


Figure 3.3-1 When Measuring Bit Error Rate and Waveform Simultaneously (MP2100A-003, 005, 050/051)

Chapter 4 Screen Operation

This chapter explains the screen name and common operating method of the BERTWave series.

4.1	Screen Configuration	4-2
4.2	Data Input Method	4-6
4.3	Setting System Menu.....	4-9
4.4	Multi-channel Signal Output.....	4-16
4.5	Simultaneous Measurement Start and Stop at Multi-channels.....	4-17
4.6	Displaying Date/Time and Status	4-18
4.7	Procedures at System Alarm.....	4-19

4.1 Screen Configuration

Touch [Main Application] on the selector screen, and then the application screen is displayed.

The application name is as shown in Figure 4.1-1.

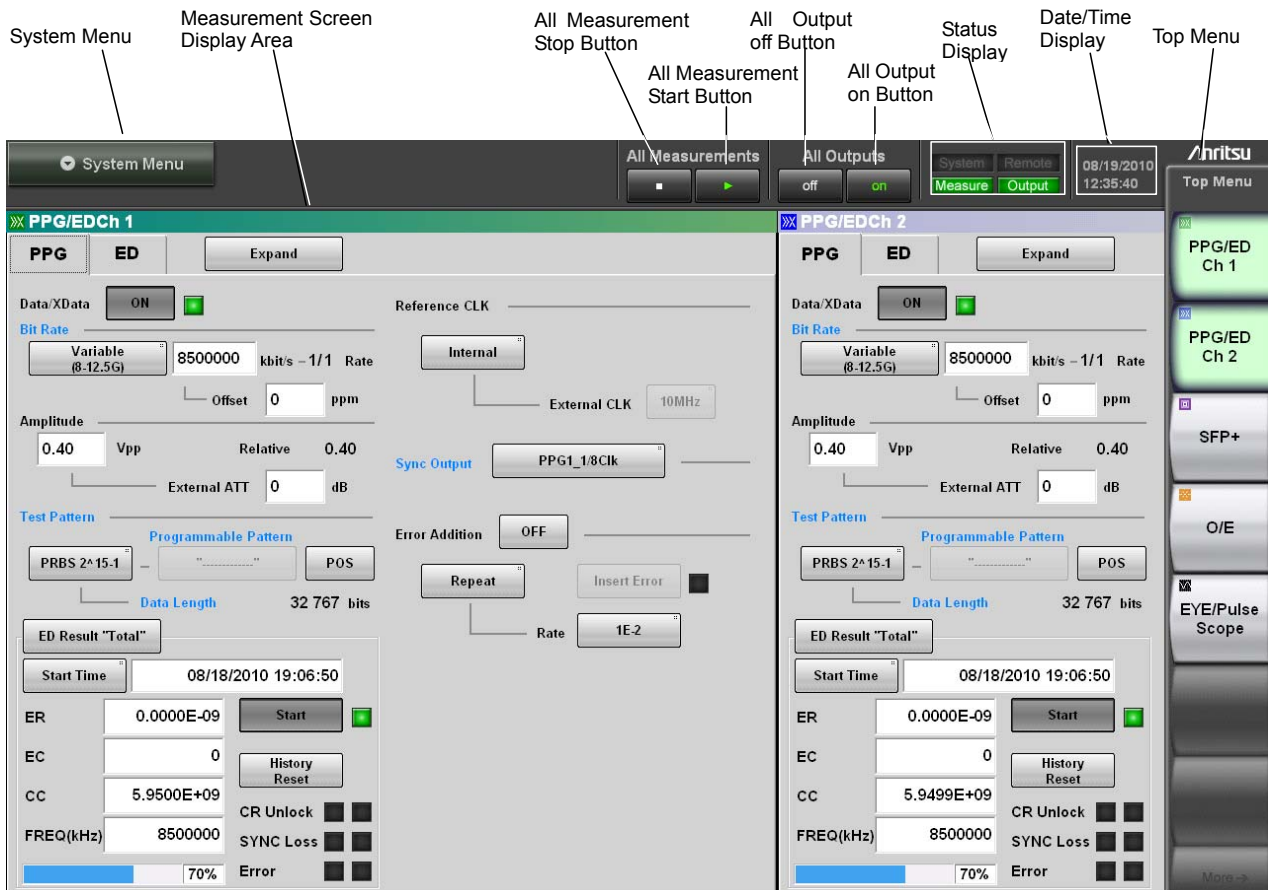


Figure 4.1-1 Application Name (MP2100A-003,005,050)

Table 4.1-1 Setting Items on Application Window

Name	Description
All Measurements	Starts and stops up to two channels of the ED and two channels of sampling waveform data at the same time.
All Outputs	Displays when using the MP2100A/MP2101A. Sets the PPG channel 1 and 2 and optical transceiver output to On/Off.
System Menu	The following setting button can be displayed: <ul style="list-style-type: none"> • Device internal signal connection • Buzzer • Unloading application • File operation • Saving screen image • Setting and unsetting panel lock • Confirming system alarm and deleting record • Initializing device settings • Minimizing screen display
Top Menu	Selects the measurement device to be operated. The displayed measurement device varies depending on the model name and options.
Status display	The following four kinds of the status are displayed: <p>System: System alarm occurs</p> <p>Remote: Remotely controlled</p> <p>Measure: Measuring bit error rate and obtaining waveform data of sampling scope</p> <p>Output: Signal output to the connector of the PPG and optical transceiver</p> <p>This displays when using the MP2100A/MP2101A.</p>
Measurement screen display field	Displays the measurement screen selected at the top menu.
Date/Time display	Displays date and time set in the BERTWave.

Depending on the installed options, buttons available on the top menu vary. The following table shows the relation between available buttons and installed options.

Table 4.1-2 Buttons Displayed on Top Menu (MP2100A)

Displayed Button	MP2100A BERTWave Option Number					
	001	003	005	007	050	051
PPG/ED Ch1	✓	✓	–	✓	–	–
PPG/ED Ch2	–	–	✓	–	–	–
XFP	–	–	–	–	✓	–
SFP+	–	–	–	–	–	✓
O/E	–	✓	–	✓	–	–
EYE/Pulse Scope	✓	✓	–	✓	–	–

Table 4.1-3 Buttons Displayed on Top Menu (MP2101A)

Displayed Button	MP2101A BERTWave PE Option Number			
	011	012	050	051
PPG/ED Ch1	✓	✓	–	–
PPG/ED Ch2	–	✓	–	–
XFP	–	–	✓	–
SFP+	–	–	–	✓
O/E	–	–	–	–
EYE/Pulse Scope	–	–	–	–

Table 4.1-4 Buttons Displayed on Top Menu (MP2102A)

Displayed Button	MP2102A BERTWave SS Option Number	
	021	023
PPG/ED Ch1	–	–
PPG/ED Ch2	–	–
XFP	–	–
SFP+	–	–
O/E	–	✓
EYE/Pulse Scope	✓	✓

The following buttons will appear when software option is added to MP2100A or MP2102A. Available software varies according to the mainframe.

Table 4.1-5 Buttons Displayed on Top Menu (Additional Software)

Displayed Button	Additional software		MP2100A	MP2101A	MP2102A
Jitter	MX210001A	Jitter Analysis Software	✓	–	✓
Transmission	MX210002A	Transmission Analysis Software	✓	–	–

Touching a Top Menu button displays the child screen for displaying the measurement conditions and results. Refer to the following chapters for the child screen operations.

PPG/ED Ch1, PPG/ED Ch2: Chapter 5, 6

SFP+/XFP: Chapter 8

O/E: Chapter 8

EYE/Pulse Scope: Chapter 7

Refer to the manual below for how to operate the software.

Jitter: "MX210001A Jitter Analysis Software Operation Manual"

Transmission: "MX210002A Transmission Analysis Software Operation Manual"

4.2 Data Input Method

The measurement setting item selection, numeric data, and character data are input from the panel displayed on the screen.

The displayed panel varies depending on the input data types.

Arrow Key Entry Panel

Touch the numeric data area when entering the numeric data of the bit rate or power voltage.

The arrow key entry panel as shown in Figure 4.2-1 is displayed.

Touch the right and left arrow keys and select the line to change the value.

Touch the up and down arrow keys or turn the rotary knob to change the value.

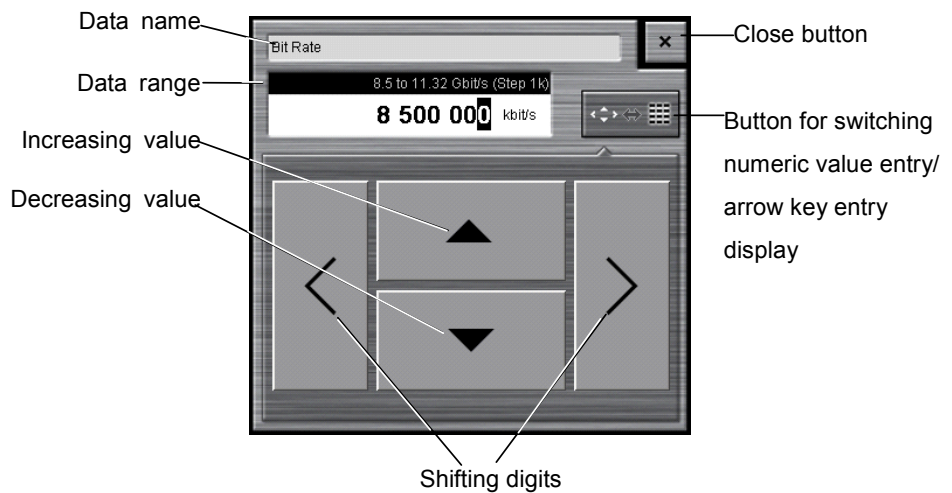


Figure 4.2-1 Arrow Key Entry Panel

Numeric value entry panel

Touch the button for switching the display of the numeric value entry/ arrow key entry panel as shown in Figure 4.2-1, and then the numeric value entry panel as shown in Figure 4.2-2 is displayed. The key type, unit and input range displayed on the panel vary depending on the data.

Touch the arrow key entry panel display button, and then the arrow key entry panel as shown in Figure 4.2-1 is displayed.

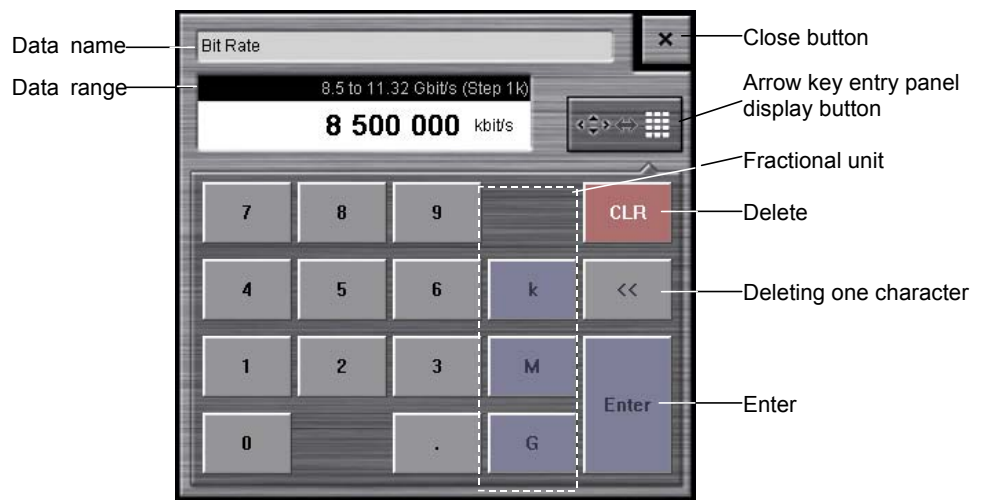


Figure 4.2-2 Numeric Value Entry Panel

Software Keyboard

When entering character string data such as file name, touch the exact character string directly. The keyboard as shown in Figure 4.2-3 is displayed, and then touch the key and enter the character. If you touch [Shift] or [Caps] once, all keys are locked. To unlock them, touch [Shift] or [Caps] again.

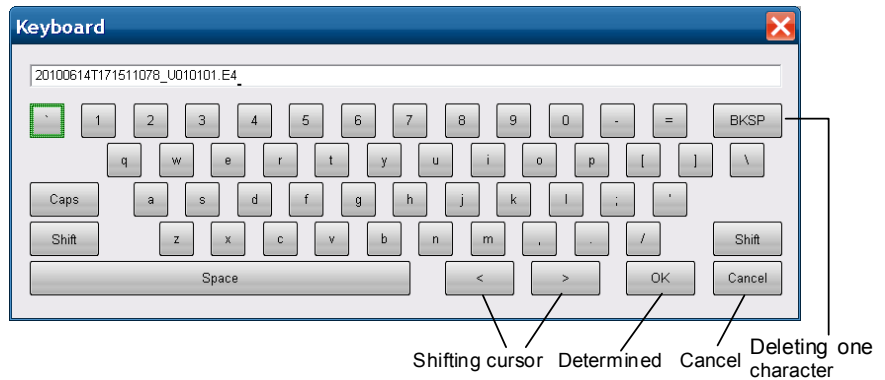


Figure 4.2-3 Software Keyboard



Figure 4.2-4 Software Keyboard (Shift Locked)

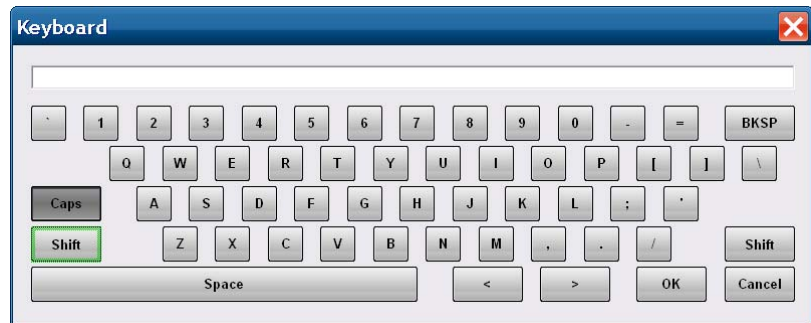


Figure 4.2-5 Software Keyboard (Caps Key Locked)

4.3 Setting System Menu

The following items can be set and confirmed at the system menu.

- Saving measurement conditions and measurement results
- Reading measurement conditions
- Saving screen image
- Initializing device settings
- Buzzer
- Confirming system alarm and deleting records
- Setting panel lock
- Enabling panel lock and remote display
- Connection diagram of device internal signal
- Minimizing screen display
- Terminating application

To set the system menu, touch [System Menu] as shown in Figure 4.3-1.

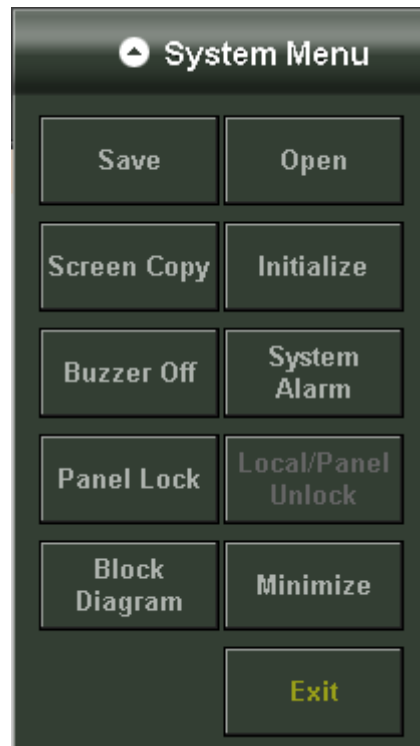
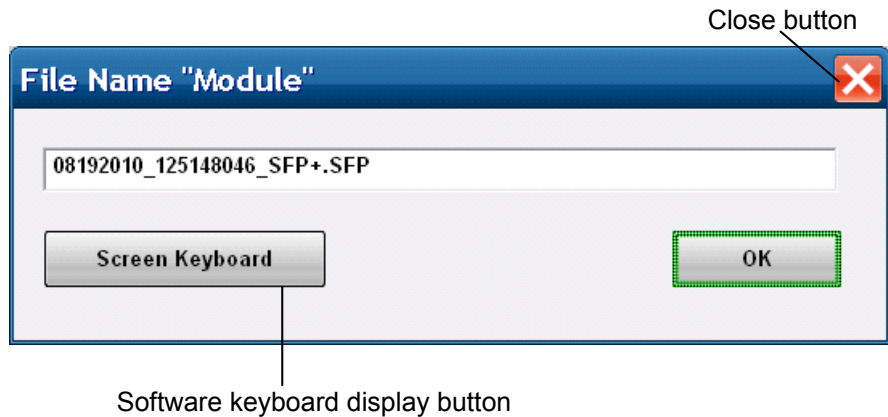


Figure 4.3-1 System Menu

Saving measurement conditions and measurement results

1. Touch [Save] to display the Save panel.
2. Select the save data from the following:
[All Setup] , [PPG/ED Ch1] , [PPG/ED Ch2] , [SFP+], [XFP],
[EYE/Pulse Scope], [O/E], [Jitter], [Transmission]
The displayed module varies with the model name and options.
3. When [PPG/ED Ch1], [PPG/ED Ch2], [EYE/Pulse Scope], [Jitter], or
[Transmission] is saved, select the data type from the following:
[Setting]: Measurement condition
[Result]: Measurement result
4. The file name is displayed. When changing the displayed file name,
touch the keyboard display button.



5. Enter the file name using the software keyboard.
6. When saving the file name, touch [OK]. Also, when canceling the
saving procedure, touch the close button.

The measurement condition file is saved in the following folder.
C:\Program Files\Anritsu\MP2100A\MX21000A\UserData\Setting

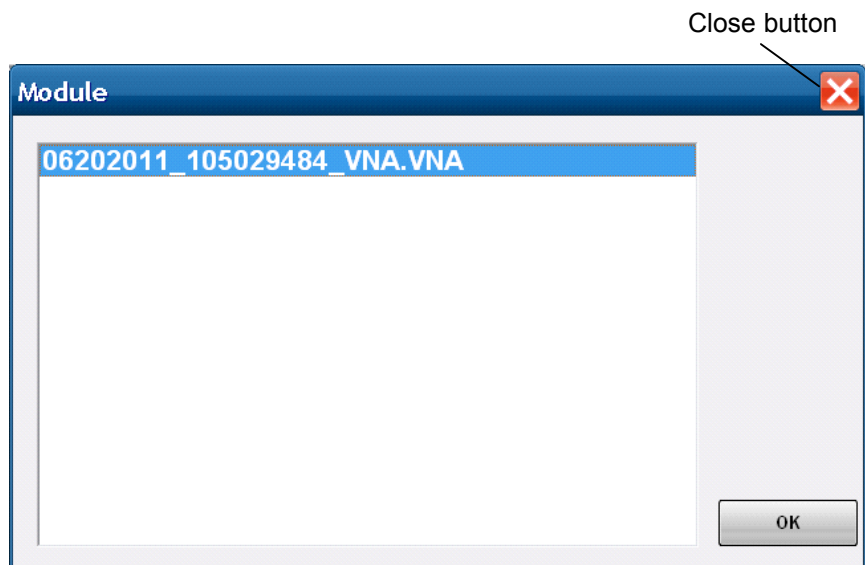
The measurement result file is saved in the following folder.
C:\Program Files\Anritsu\MP2100A\MX21000A\UserData\Result\CSV

C:\Program Files\Anritsu\MP2100A\MX21000A\UserData\Result\TXT

The CSV file cannot be read in the spreadsheet software.
You can confirm the test file details on the test editor.

Reading measurement conditions from file

1. Touch [Open] to display the Open panel.
2. Select the target module form the following:
[All], [PPG/ED Ch1], [PPG/ED Ch2], [SFP+], [XFP],
[EYE/Pulse Scope], [O/E], [Jitter], [Transmission]
The displayed module varies with the model name and options.
3. The file selection screen is displayed.



4. Touch the file to be read.
5. When reading the file, touch [OK]. On the other hand, when canceling the procedure, touch the close button.

Saving a screen to the image file

1. Touch [Screen Copy] .

The file selection screen is displayed.



2. Touch the Drives button and the Directories display to set the saving destination folder. The file name is displayed in the Save to.
3. The file format to be saved is displayed in the right button of the file type. Touching the button can set the file format.
4. When inputting the file name, touch [Screen Keyboard] to set the file name.
5. When overwriting the existence file, touch the file name displayed in the File List.
6. Touch [OK] to save the screen file.
When overwriting the screen file, the confirmation message is displayed.

When touching [Default Name/Root], the folder and file names are set to the initial values.

The initial value of the folder is as follows.

C:\Program Files\Anritsu\MP2100A\MX21000A\UserData\Screen Copy

The initial value of the file name is configured as date and time.

For example, file 523 saved at 12:05:55 on 17 July 2010 will have the following file names:

For [JPEG Files]: 17072010_120555523.jpg

For [PNG Files]: 17072010_120555523.png

Initializing measurement conditions

1. Touch [Initialize]. Then, the dialog box indicating the initialization process is displayed.
2. Touch [OK] to initialize the measurement condition and touch [Cancel] to stop the initialization.

Setting buzzer

This instrument can sound a buzzer when an error occurs at bit rate error measurement.

1. To sound the buzzer at panel operations, touch [Buzzer Off].
2. The button display changes to [Buzzer On].
In this condition, the buzzer sounds when either of the following occurs:
 - Error at bit error rate measurement
 - System Alarm
3. Touch [Buzzer On] to release the buzzer.
The button display changes to [Buzzer Off].

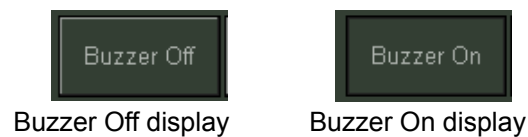


Figure 4.3-2 Buzzer Button

Displaying alarm

1. Touch [System Alarm].
The alarm occurred history is displayed on another window.
2. When closing the window, touch [OK]. On the other hand, when deleting the alarm history, touch [Clear].

Touch the Auto Popup button to set the display to [ON]. When Alarm occurs, the System Alarm screen is displayed automatically.

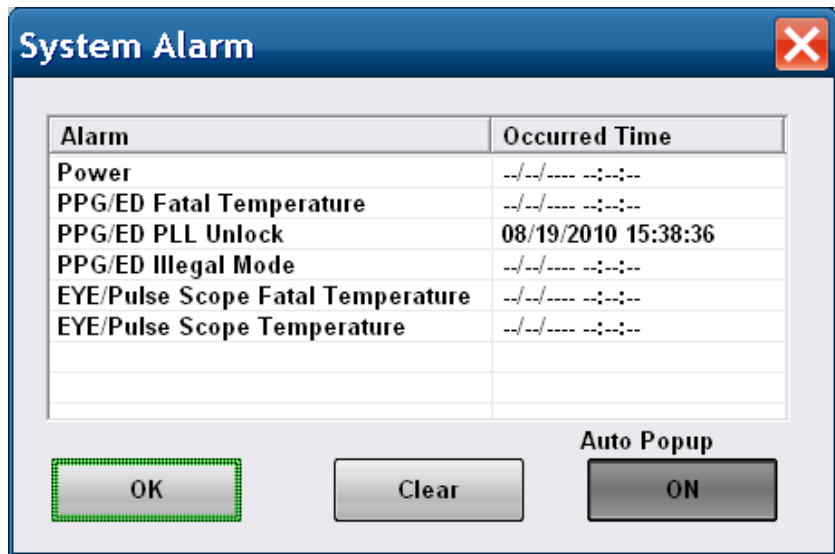


Figure 4.3-3 System Alarm Occurred Time

The displayed time indicates the time when alarm occurred first. If the multiple alarms occur, the time after the second alarm is not record.

Note :

When the system alarm occurs, the system alarm screen is displayed automatically. Also, when the next alarm occurs, the power supply is turned off after 10 seconds

- Power
- PPG/ED Fatal Temperature
- EYE/Pulse Scope Fatal Temperature

Locking panel operation

Preventing changes to data by panel operations at menus other than the System Menu and by using the rotary knob is called panel locking.

1. Touch [Panel Lock] to lock the panel.
2. The screens other than the system menu, status display, and date/time display are shaded and displayed.

Even though the panel is locked, the system menu and power switch are enabled.

If the panel is locked, the [Local/Panel Unlock] button at the system menu can be operated.

When the BERTWave performs the measurement via a remote control, the panel is locked.

Unlocking the panel

1. Touch [Local/Panel Unlock].
2. The Remote lamp at the status display goes off.

Displaying the device internal signal connection

1. Touch [Block Diagram].
2. The device internal block figure is displayed, so the clock and signal connection can be confirmed.
3. Touch [OK] or the close button, and then the block figure is closed.

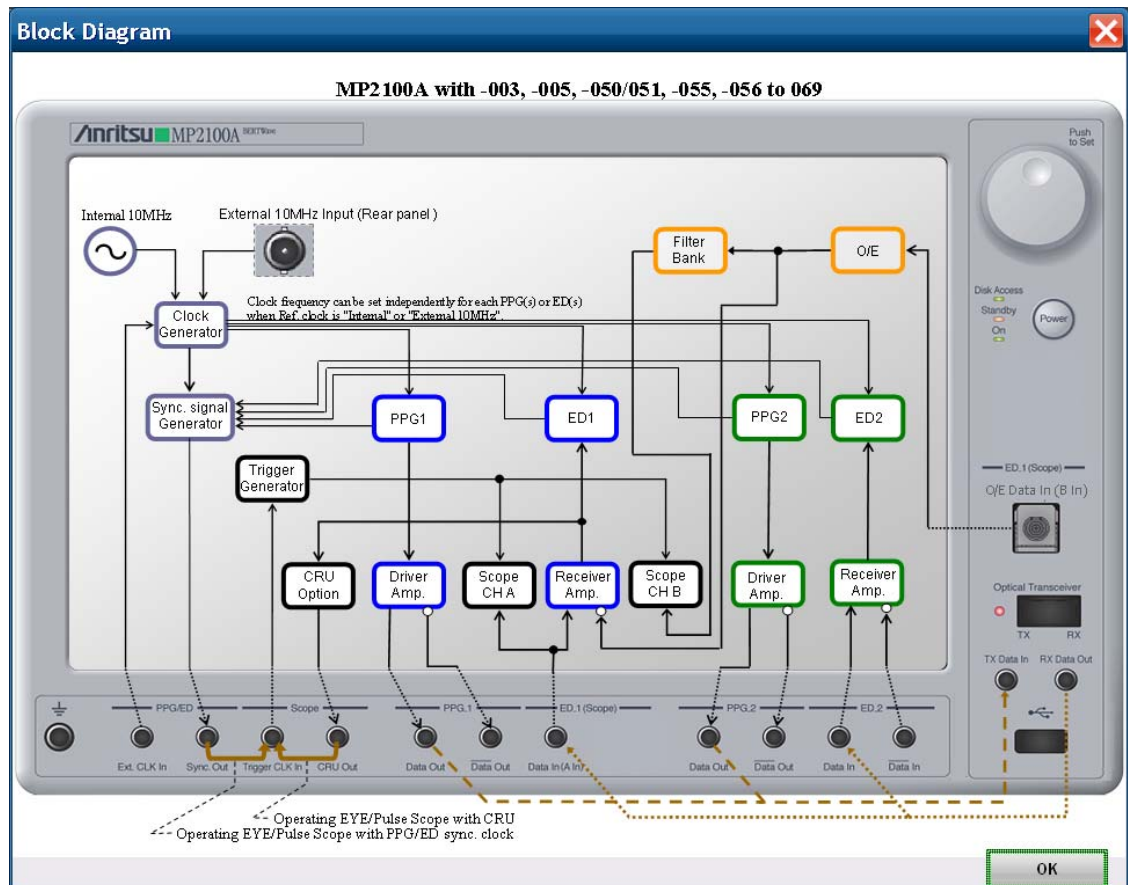


Figure 4.3-4 Display Example of Block Figure

Minimizing the screen display

1. Touch [Minimize] to display the desk top.
[MX210000A] is displayed on the task bar.
2. To display the screen, touch [MX210000A] on the task bar.

Terminating applications

1. Touch [Exit]. The dialog is displayed to confirm the application termination.
2. When terminating the applications, touch [Yes]. On the other hand, when canceling the application termination, touch [No].
3. The selector screen is displayed.

4.4 Multi-channel Signal Output

The MP2100A/MP2101A can set the PPG channel 1 and 2 and optical transceiver output to ON/OFF at the same time.

To output signal of PPG and optical transceiver:

1. Touch [On] as shown in Figure 4.4-1.
2. The characters of [on] are changed to green and then the Output lamp for the status display is turned on.

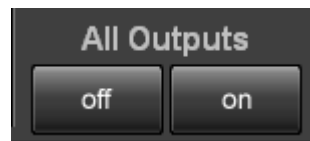


Figure 4.4-1 All Outputs Button

The optical signal of the PPG and optical transceiver is output.

To stop the signal output from the PPG and optical transceiver:

1. Touch [off] as shown in Figure 4.4-1.
2. The characters of [on] are changed to white and then the Output lamp for the status display is turned off.

When outputting the signal to the Channel 1 and 2 connectors, the both signal outputs are stopped. Furthermore, the optical output of the optical transceiver is stopped as well.

Note:

All Output button is set to [off] after starting the Main Application at the Selector screen.

4.5 Simultaneous Measurement Start and Stop at Multi-channels

This instrument can sample waveform data for two channels simultaneously at error rate measurement of two channels.

To start simultaneous measurement, touch the [▶] key shown in Fig. 4.5-1 while the Measure lamp is lit.

To stop simultaneous measurement, touch the [■] key shown in Fig. 4.5-1 while the Measure lamp is lit off.

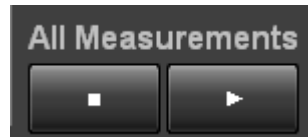


Figure 4.5-1 All Measurements Button

4.6 Displaying Date/Time and Status

To display date and time

Date and time is displayed on the upper right side of the screen.

Date and time can be changed from the Windows control panel.

To display status

The following four kinds of lamps indicate the status.

System: System Alarm

Remote: Remote Control

Measure: Measuring bit error rate or acquiring waveform data of sampling scope

Output: Outputting signal to the connector of the PPG or optical transceiver.

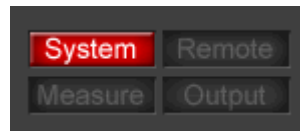


Figure 4.6-1 System Error Occurred



Figure 4.6-2 Remote Control

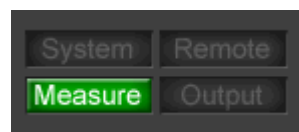


Figure 4.6-3 Displays at Bit Error Rate Measurement and Waveform Data Capture

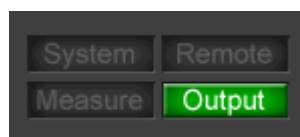


Figure 4.6-4 Display at Signal Output

4.7 Procedures at System Alarm

The following phenomenon cause a system alarm.

Power

Abnormal power supply

The Power alarm is displayed when this system detects a low internal voltage. Windows shuts down automatically after this alarm is displayed. Before using this instrument, check that the voltage of the power supply meets the voltage specifications. If the voltage of the power supply is within specifications and the Power alarm is displayed, contact Anritsu or your sales agent.

PPG/ED Fatal Temperature

Eye/Pulse Scope Fatal Temperature

Eye/Pulse Scope Temperature

High temperature warning (Temperature, Fatal Temperature)

When the internal temperature reaches 85°C, the temperature alarm is displayed.

When Fatal Temperature is displayed, the power of this equipment is shut down.

Verify that the ventilation openings are unobstructed and that the fan is running. Turn off the unit and allow the temperature to cool down. When the EYE/Pulse Scope Temperature is displayed, calibrate the MP2100A/MP2101A/MP2102A referring to 7.5 Calibrating Sampling Scope.

If the fault is not resolved, and if the internal temperature reaches 90°C, the fatal temperature alarm is displayed and then the measurement power supply shut down automatically.

PPG/ED PLL Unlock

Clock Error (PLL Unlock)

The PLL Unlock alarm is displayed when selecting Internal CLK, contact the Anritsu Technical Support Center or your local Anritsu representative.

PPG/ED Illegal Mode

Fatal mode (PPG/ED Illegal Mode)

This error occurs when the software is not installed properly.

If the PPG/ED Illegal Mode occurs, reinstall the software.

You can check the system alarm occurred time from [System Menu] – [System Alarm].

Chapter 5 *Generating Pulse Signal*

To measure the bit error rate or monitor a waveform, first a signal for input to the device under test (DUT) must be generated. In these measurements, a pulse signal with a time cycle is used. This chapter explains how to generate the pulse pattern signal while setting the output waveform and data pattern of the PPG.

5.1	List of Setting Items	5-2
5.2	Setting Restrictions	5-9
5.3	Procedure for Generating Pulse Signal	5-10
5.4	Setting Reference Clock	5-11
5.5	Setting Output Waveform	5-16
5.6	Setting Patterns	5-20
5.7	Inserting Bit Error	5-25
5.8	Setting Sync Output	5-26
5.9	Setting Clock Output	5-30

5.1 List of Setting Items

The following table items can be set using the PPG.

Table 5.1-1 Setting Items of PPG

Item	Description
Data/XData Output	Sets the signal output of the connector.
Bit Rate	When the bit rate standards are Variable, Variable-1/2, Variable-1/4, Variable-1/8, Variable-1/16, Variable-1/32 or Variable-1/64, the bit rate can be set. The setting range varies with the settings of the bit rate standards.
Bit Rate Offset	Changes bit rate in range of -100 to +100 ppm corresponding to value set at Bit Rate
Amplitude	Sets the signal amplitude voltage output to the Data and Data connector.
External Attenuator Factor	Inputs attenuation amount when attenuator inserted at connector
Relative	Displays the amplitude voltage calculated by the set value at External Attenuator Factor.
Test Pattern	Selects the pattern from PRBS or Programmable Pattern. Sets the signal level of the Data connector responding to Pattern 1.
Programmable Pattern	When Test Pattern is set to Programmable Pattern, the selected pattern file name is displayed.
Data Length	Displays the pattern length in the bit unit.
Reference CLK	Selects the clock to be used from the below items: Internal: generating signal inside the device External: signal input to panel connector
External Clock	Selects connector where clock supplied when using external clock
Sync Output	Selects the signal output to the Sync Output connector.
Error Addition	Sets bit error insertion
Error Addition Rate	When Error Addition Variation is Repeat, the generating bit error rate is set.
Insert Error	When Error Addition Variation is Single, insert the 1 bit error to the pattern.
Relative	Displays the amplitude voltage calculated by the set value at External Attenuator Factor.
Sync Output	Selects the signal output to the Sync Output connector.

Table 5.1-1 Setting Items of Pulse PPG (Cont'd)

Item	Description
Test Pattern	Selects the pattern from PRBS or Programmable Pattern. Sets the signal level of the Data connector responding to Pattern 1.
Output Display	Displays the signal output status for the Data Out and Data Out connector.
Bit Error Insertion Method	Sets whether to insert bit error continuously or one by one using screen operation.
Bit Rate Specifications	Selects the communication specifications complied with the bit rate.
Divide Ratio	Indicates the ratio between the frequency of the internal frequency synthesizer and the bit rate When Reference CLK is set to [External] or [1/16 Clk], the divide rate can be set by becoming a button display.

To display the PPG setting screen

1. Touch [PPG/ED_Ch1] or [PPG/ED_Ch2] at the top menu.
2. Touch [PPG], and then Figure 5.1-1 is displayed.
3. Touch [Main], and then Figure 5.1-2 is displayed.
4. Touch [Expand], and then the screen is changed to Figure 5.1-1.

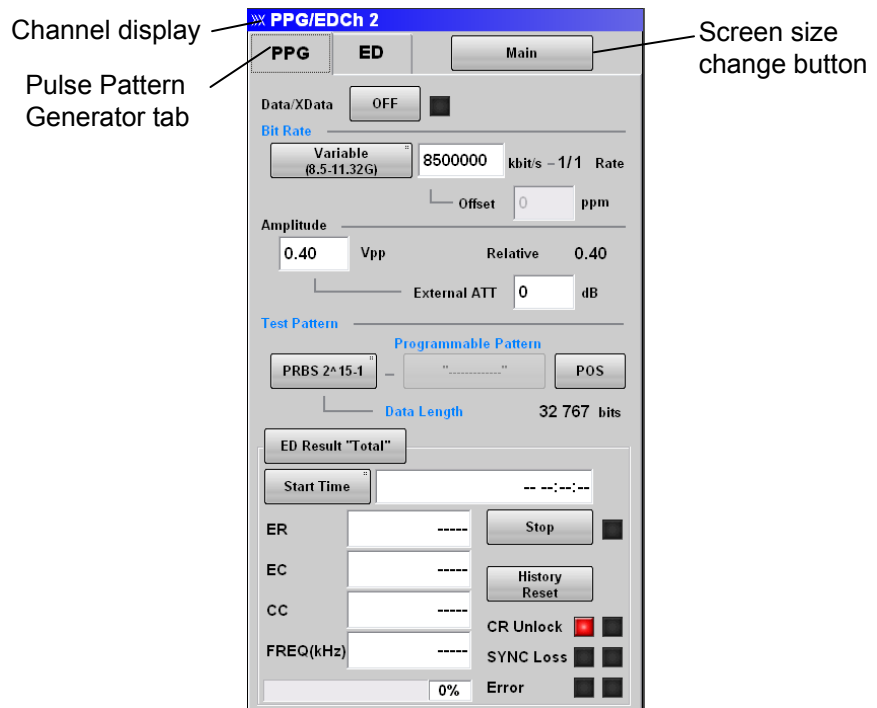


Figure 5.1-1 PPG Setting Panel

XData in Figure 5.1-1 indicates the $\overline{\text{Data}}$ Out connector on the front panel.

For the display and operation of ED Result, refer to 6.6 “Measurement Result”.

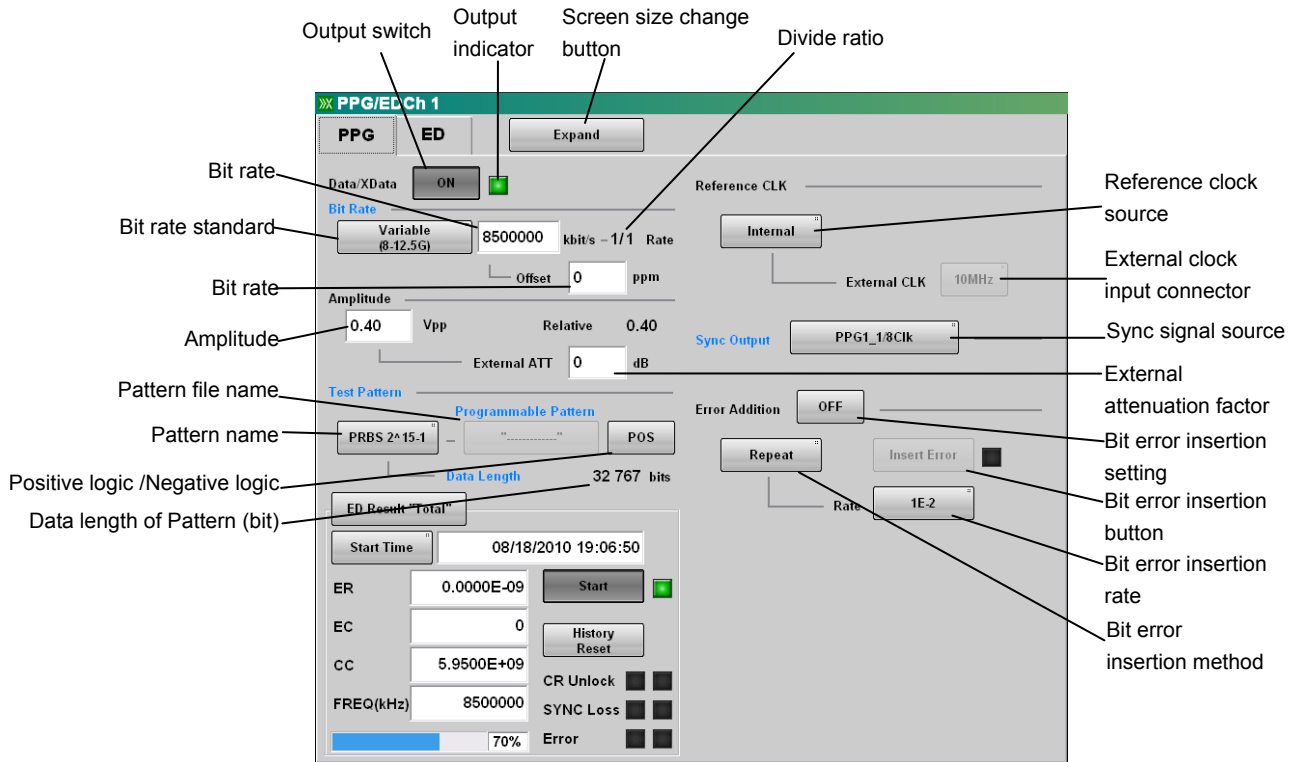


Figure 5.1-2 PPG Setting Panel (Details)

The PPG setting range is as follows:

Amplitude

0.10 to 0.80 V_{p-p}

Bit Rate

Variable

8 500 000 to 11 320 000 kbit/s

8 000 000 to 12 500 000 kbit/s*¹

Offset

-100 to 100 ppm

Variable-1/2

4 250 000 to 5 660 000 kbit/s

4 000 000 to 6 250 000 kbit/s*¹

Offset

-100 to 100 ppm

Variable-1/4

2 125 000 to 2 830 000 kbit/s

2 000 000 to 3 125 000 kbit/s*¹

Offset

-100 to 100 ppm

Variable-1/8

1 062 500 to 1 415 000 kbit/s

1 000 500 to 1 562 500 kbit/s*¹

Offset

-100 to 100 ppm

Variable-1/16

531 250 to 707 500 kbit/s

500 000 to 781 250 kbit/s*¹

Offset

-100 to 100 ppm

Variable-1/32

265 625 to 353 750 kbit/s

250 000 to 390 625 kbit/s*¹

Offset

-100 to 100 ppm

Variable-1/64

132 813 to 176 875 kbit/s

125 000 to 195 313 kbit/s*¹

Offset

-100 to 100 ppm

1GFC

2GFC

4GFC

8GFC

10GFC
10GFC-FEC
1GbE
2GbE
CPRI
CPRI-2
CPRI-4
CPRI-5 *1
CPRI-10 *1
Infiniband
Infiniband×2
Infiniband×4
10GbE WAN
10GbE LAN/PHY
10GbE OTU1e
10GbE OTU2e
OBSAIRP3*1
OBSAIRP3×2*1
OBSAIRP3×4*1
OBSAIRP3×8*1
OC-3/STM-1
OC-12/STM-4
OC-24
OC-48/STM-16
OTU-1
OC-192/STM-64
G.975 EFC
OTU-2
Rate*2
 1/1
 1/2
 1/4
 1/8
 1/16
 1/32
 1/64
Data/XData
 Off
 On
Error Addition
 Off
 On
Repeat
 1E-2

1E-3
 1E-4
 1E-5
 1E-6
 1E-7
 1E-8
 1E-9
 1E-10
 1E-11
 1E-12
 Single
 Insert Error
 External Attenuation
 0 to 30 dB
 Reference Clock
 CH1 External
 1/1 Rate
 1/2 Rate
 1/4 Rate
 1/8 Rate
 1/16 Rate
 1/32 Rate
 1/64 Rate
 CH2 External
 External
 External CLK
 1/16 Clk
 1/1 Rate
 1/2 Rate
 1/4 Rate
 1/8 Rate
 1/16 Rate
 1/32 Rate
 1/64 Rate
 10 MHz
 Internal
 Sync Output
 PPG1_1/1 Clk*3
 PPG1_1/2 Clk*4
 PPG1_1/4 Clk*5
 PPG1_1/8 Clk*6
 PPG1_1/16 Clk*7

PPG1_1/64 Clk*6
PPG2_1/1 Clk*3,*8
PPG2_1/2 Clk*4,*8
PPG2_1/4 Clk*5,*8
PPG2_1/8 Clk*6,*8
PPG2_1/16 Clk*7,*8
PPG2_1/64 Clk*6,*8
ED1_1/4 Clk*9
ED1_1/8 Clk*10
ED1_1/16 Clk
ED2_1/4 Clk*8,*9
ED2_1/8 Clk*8,*10
ED2_1/16 Clk*8
PPG1_Pattern Sync
PPG2_Pattern Sync*8

Test Pattern

NEG
POS
PRBS2^7-1
PRBS2^9-1
PRBS2^15-1
PRBS2^23-1
PRBS2^31-1
Programmable Pattern

- *1: When Option 090 added
- *2: When Reference CLK is External or External CLK is 1/16 Clk
- *3: 1/8, 1/16, 1/32, 1/64 at Rate display
- *4: 1/4 at Rate display
- *5: 1/2 at Rate display
- *6: 1/1 at Rate display
- *7: 1/1, 1/2, 1/4 at Rate display
- *8: Option 005 or 012
- *9: 1/2 at ED rate display
- *10: 1/1 at ED rate display

5.2 Setting Restrictions

The setting items of the PPG have the following restrictions.

Bit Rate

When Option 090 is added, the setting range from 8 000 000 to 8 499 999 and from 11 320 001 to 12 500 000 kbit/s can be set.

Bit Rate Standard

The following specifications can be selected when Option 090 is added.

- CPRI-5
- CPRI-10
- OBSAIRP3
- OBSAIRP3×2
- OBSAIRP3×4
- OBSAIRP3×8

Data/XData

The output signal from $\overline{\text{Data}}$ Out and Data Out connectors cannot be set individually.

Data/XData Amplitude

The output signal amplitude from $\overline{\text{Data}}$ Out and Data Out connectors cannot be set individually.

The amplitude of the Sync Out connector cannot be set.

Reference Clock

The PPG_1ch and PPG_2ch cannot be set separately.

Sync Output

The following settings can be selected when Option 005 or Option 012 is selected.

- | | |
|-----------------|--------------------|
| ● PPG2_1/1 Clk | ● PPG2_1/64 Clk |
| ● PPG2_1/2 Clk | ● PD2_Pattern Sync |
| ● PPG2_1/4 Clk | ● ED2_1/4 Clk |
| ● PPG2_1/8 Clk | ● ED2_1/8 Clk |
| ● PPG2_1/16 Clk | ● ED2_1/16 Clk |

Programmable Pattern

The pattern length is 1305600 bits or less. When the file data length is over 1305600 bits, up to 1305600 bits can be read.

5.3 Procedure for Generating Pulse Signal

The basic procedure is as shown in the following figure.

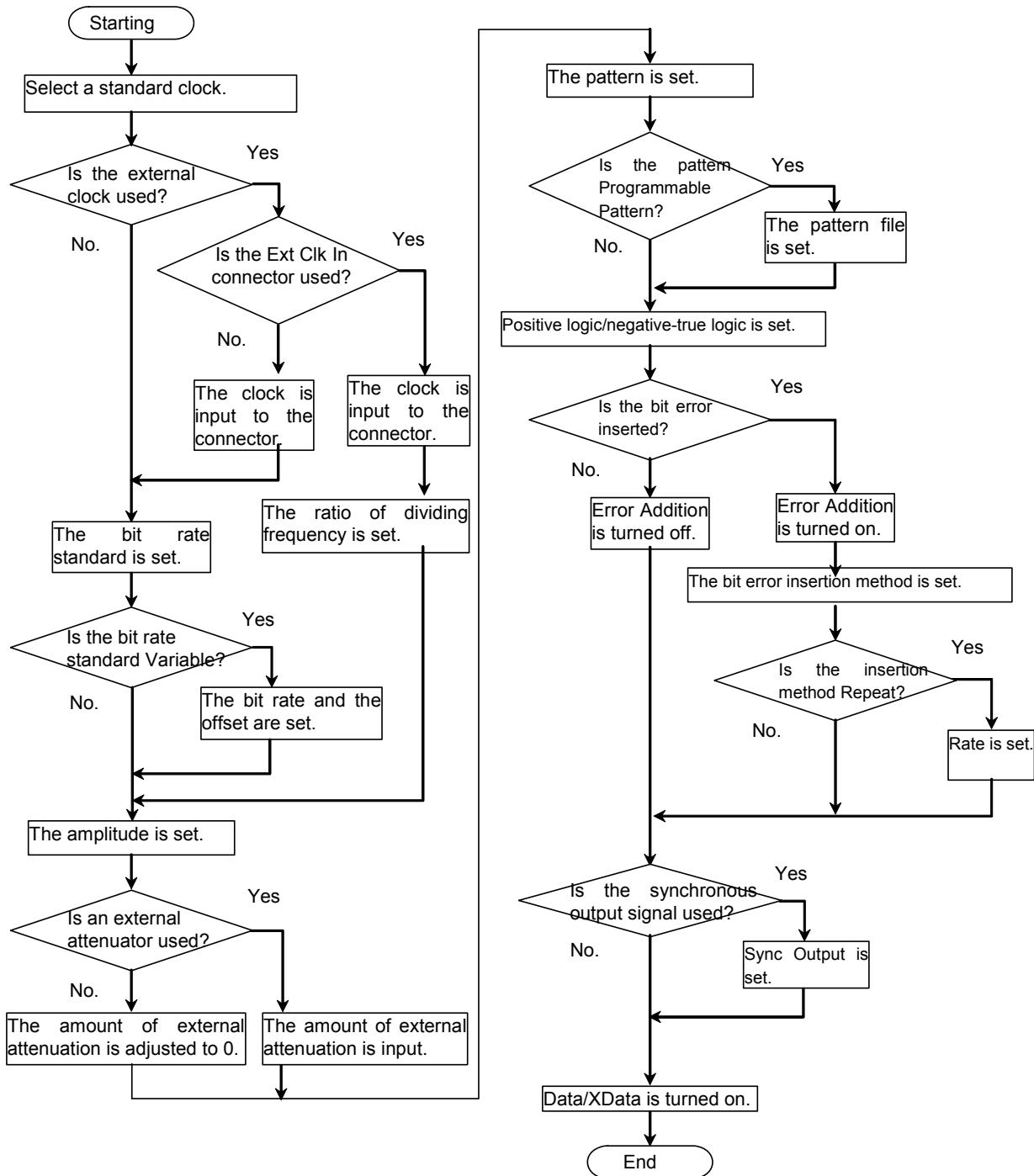


Figure 5.3-1 Basic Procedure of Generating Pulse Signal

5.4 Setting Reference Clock

The PPG uses the reference clock to generate the data.

The reference clock can be selected from the following supply sources:

- Generating clock in the BERTWave
- Input clock from the Ext Clk In connector on the front panel
- Input clock from the External 10 MHz Input connector on the rear panel

The internal clock accuracy is ± 10 ppm after power is applied for 1 hour.

The external clock is used under the following conditions:

- When synchronizing other equipment with clock
- When using clock with higher accuracy than internal clock
- When using the bit rate other than the specified one with the internal clock

The Ext Clk In connector is an AC coupling.

1/16 clock frequency range displayed in the bit rate specifications [Variable] is input to Ext Clk In connector.

The bit rate of the signal output from the MP2100A is calculated by the following formula.

$$Br = f_{EXT} \times 16 \times R$$

Br: Bit rate (kbit/s)

f_{EXT} : Clock frequency (kHz) input to the Ext Clk In connector

R: Divide Ratio (1/1, 1/2, 1/4, 1/8, 1/16, 1/32, 1/64)

Example: When setting the bit rate to 9953280 kbit/s, input the clock frequency (622080 kHz) and set the divide ratio to 1/1.

The External 10 MHz Input connector is a DC coupling.

The 10 MHz clock of the sine wave or short waveform is input to the External 10MHz Input connector.

For the MP2100A-001, MP2100A-005, or MP2101A-012, the reference clocks of the channel 1 and 2 can be set separately. In this case, the external clock is the clock input from the Ext Clk In connector.

Table 5.4-1 Reference CLK Settings

Reference CLK	PPG1	PPG2
Internal	Internal clock	Internal clock
External	External clock	External clock
CH1 External*1	External clock (Ext Clk In)	Internal clock
CH2 External*1	Internal clock	External clock (Ext Clk In)
Synchronized*1,*2	Internal clock	Internal clock (Synchronized clock for CH1)

*1: With MP2100A-001, MP2100A-005, or MP2101A-012

*2: When installing the Option 052

Improving Phase Error between PPGs using Synchronized

When Reference Clock is set to Internal at the MP2100A-005 or MP2101A-012, the data rates of PPG1 and PPG2 become the same but there is phase error in the data. Although phase error between PPG1 and PPG2 has no effect on the measurement results when measuring bit errors, sometimes non-existent jitter may be observed at waveform monitoring.

This data phase error can be improved by setting to Synchronized.

Use the clock synchronized to the PPG1 data as the oscilloscope trigger to display the monitored PPG2 Eye Pattern as follows.

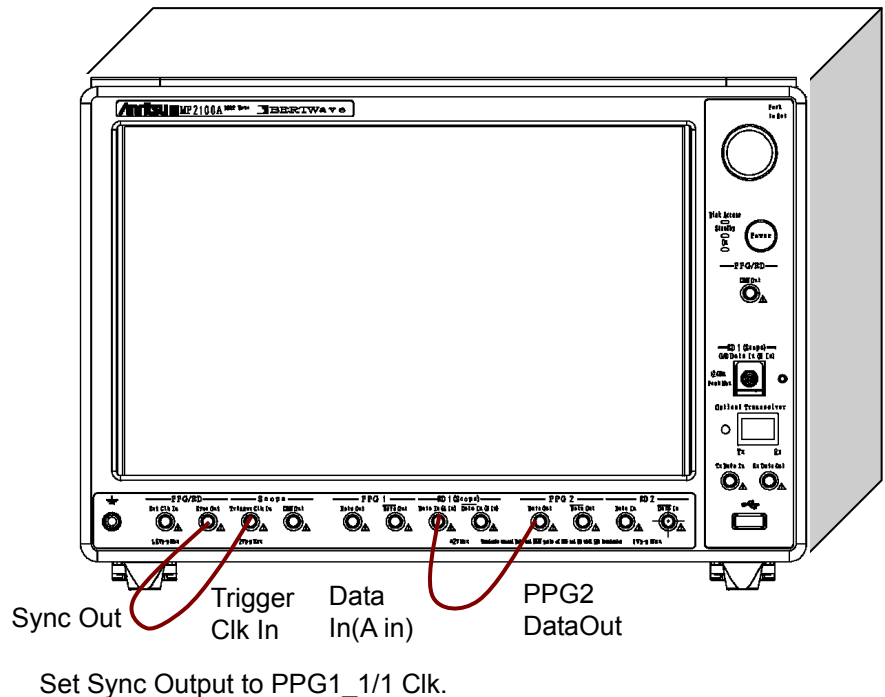


Figure 5.4-1 Eye Pattern Monitoring

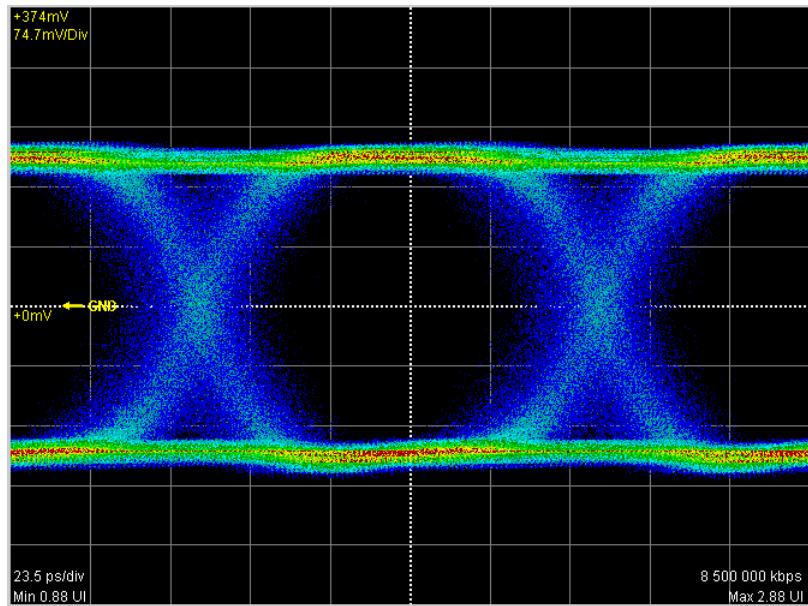


Figure 5.4-2 Eye Pattern when Reference Clock is Internal

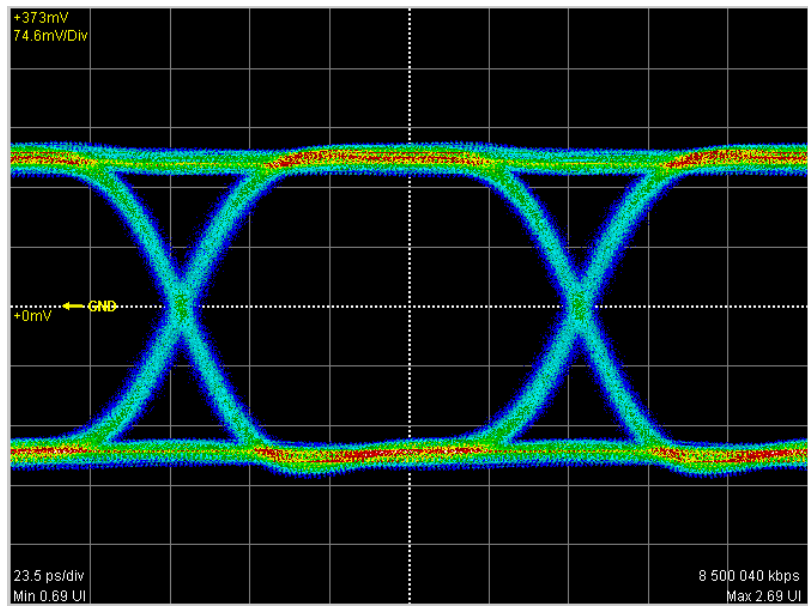


Figure 5.4-3 Eye Pattern when Reference Clock is Synchronized

When monitoring the waveforms of two DUTs simultaneously, make the following connections.

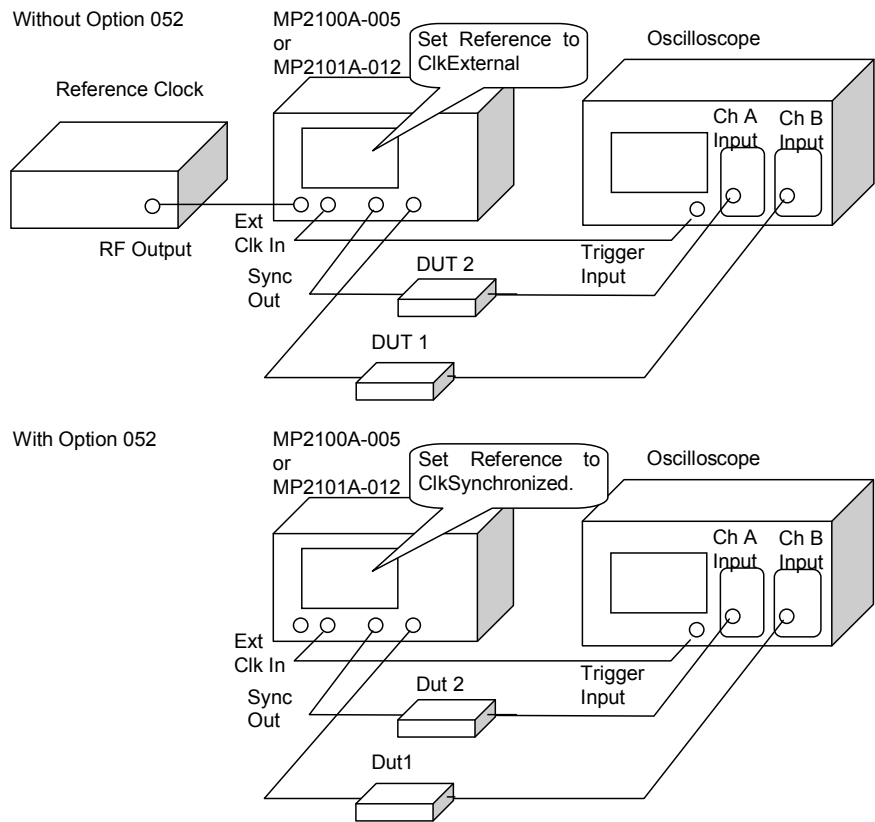


Figure 5.4-4 Setup for Simultaneous Monitoring of Two Channels

Procedures:

1. Touch the screen size change button, and set to [Expand].
2. Touch the Reference CLK button.
The selection screen is displayed. The number of the displayed buttons vary with the option configuration.
3. Touch the reference clock button, referring to Table 5.4-1.
4. When setting to [External] at step 2, touch the External CLK button.
And then, the clock selection screen is displayed.
5. Select the connector to input the reference clock touching the button.
[1/16 Clk]: Ext Clk In connector on the front panel
[10 MHz]: External 10 MHz Input connector on the rear panel

 **CAUTION**

- The impedance of the Ext Clk In and External 10 MHz Input connectors is 50 Ω . Measurement may not be performed correctly if a cable with another impedance is used.
 - The amplitude of the signal input to the Ext Clk In connector is 1.6 Vp-p max. This is equivalent to +8 dBm for a sine-wave signal. Inputting a signal with a larger voltage risks damaging the internal circuits.
 - The signal input to the Ext Clk In connector is 0.2 Vp-p minimum. This is equivalent to -10 dBm for a sine-wave signal. Measurement may not be performed correctly if a signal with a larger voltage is input.
 - The amplitude of the signal input to the External 10 MHz Input is 2 Vp-p max. This is equivalent to +10 dBm for a sine-wave signal. Inputting a signal with a larger voltage risks damaging the internal circuits.
 - The amplitude to the External 10 MHz Input is 0.7 Vp-p minimum. This is equivalent to 0.9 dBm for a sine-wave signal. Measurement may not be performed correctly if a signal with a larger voltage is input.
-

5.5 Setting Output Waveform

The PPG_Ch1 output terminal is the PPG1 $\overline{\text{Data}}$ and Data connectors on the front panel.

The PPG_Ch2 output terminal is the PPG2 Data and $\overline{\text{Data}}$ connectors on the front panel.

The connector block diagram is as shown below.

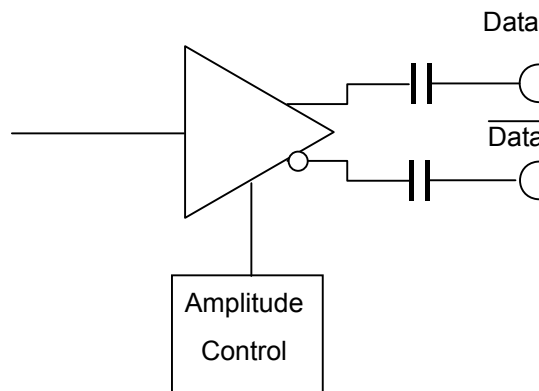


Figure 5.5-1 Output Terminal Block diagram

The connector is an AC coupling.

When it is necessary to impose DC voltage on an output waveform, connect a bias-T.

CAUTION

- The impedance of the Data Out and $\overline{\text{Data}}$ Out connectors is 50 Ω . Measurement may not be performed correctly if a coaxial cable with another impedance is used or if the impedance of the DUT is not 50 Ω .
 - The amplitude of signal output to the Data Out and $\overline{\text{Data}}$ Out connectors is 0.1 to 0.8 Vp-p. Check that the output voltage amplitude does not exceed the DUT maximum input specifications. If it does, connect an attenuator to the output connector.
-

Set the bit rate and amplitude of the waveform output to the $\overline{\text{Data}}$ and $\overline{\text{Data}}$ connectors.

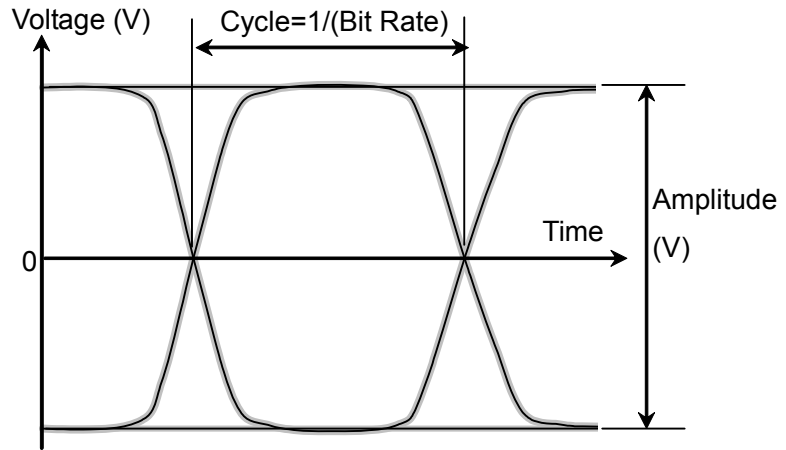


Figure 5.5-2 Waveform Setting Item

To set bit rate

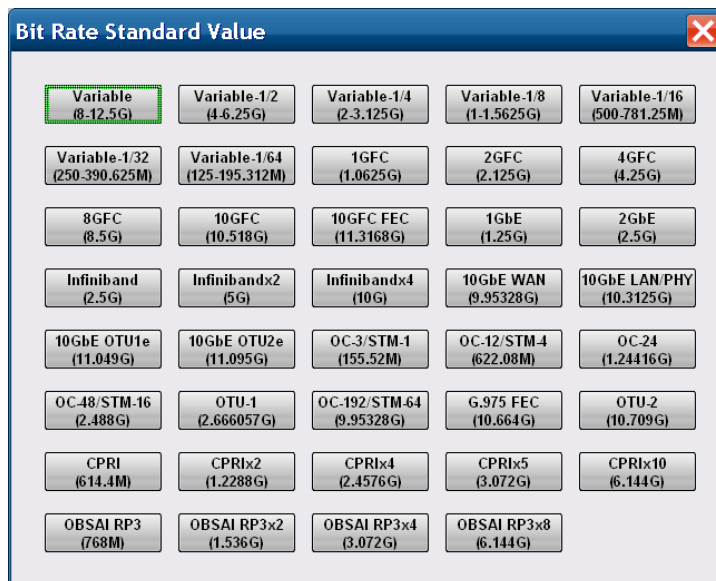
In the following cases, the bit rate can be set:

- when setting Reference CLK to [Internal]
- when setting Reference CLK to [External] and External CLK to [10 MHz].

1. Touch the Bit Rate button.

The window is opened to select the specifications.

The number of the displayed buttons varies with the options.



2. Touch the bit rate specifications button.
The number displayed in the button is the specified bit rate (bit/s).
When indicating 1.25G, this means 1.25 Gbit/s.
3. When selecting [Variable], [Variable-1/2], [Variable-1/4], [Variable-1/8], [Variable-1/16], [Variable-1/32], or [Variable-1/64], touch the text box of the bit rate and offset to input the values. For the setting range, refer to Table 5.5-1.

Table 5.5-1 Bit Rate Specifications and Setting Range

Specifications	Bit Rate (kbit/s)	
	Without Option 090	With Option 090
Variable	8 500 000 to 11 320 000	8 000 000 to 12 500 000
Variable-1/2	4 250 000 to 5 660 000	4 000 000 to 6 250 000
Variable-1/4	2 125 000 to 2 830 000	2 000 000 to 3 125 000
Variable-1/8	1 062 500 to 1 415 000	1 000 000 to 1 562 500
Variable-1/16	531 250 to 707 500	500 000 to 781 250
Variable-1/32	265 625 to 353 750	250 000 to 390 625
Variable-1/64	132.813 to 176 875	125.000 to 195 312

To set amplitude

1. Touch the Amplitude text box and set the amplitude voltage.
2. Insert an attenuator between the Data Out connector and the Data Out connector, and touch the External Attenuation text box and input the attenuation. The amplitude voltage after passage through the attenuator is displayed in Relative.

 **CAUTION**

When inserting attenuator at both the Data Out connector and Data Out connector, use an attenuator with the same amount of attenuation.

If the attenuation amounts are different, the displayed amplitude and the amplitude output at the connector will be different.

The following are the specifications for the voltage level of the high-speed interface.

Table 5.5-2 lists the specified signal amplitude.

Table 5.5-2 Signal Specifications and Amplitude

Specifications	Amplitude (V)
ECL	0.8
LVDS	0.35
LVPECL	0.8
NCML	0.5
NECL	0.8
PCML	0.5
PECL	0.8

5.6 Setting Patterns

The following two test patterns can be selected.

- PRBS
- Programmable Pattern

PRBS

PRBS is the pattern generated at the hardware.

The generated pattern length, maximum length of contiguous 1s, and maximum length of contiguous 0s differ depending on the hardware configuration.

The following block diagram indicates the hardware generating PRBS 2^7-1 .

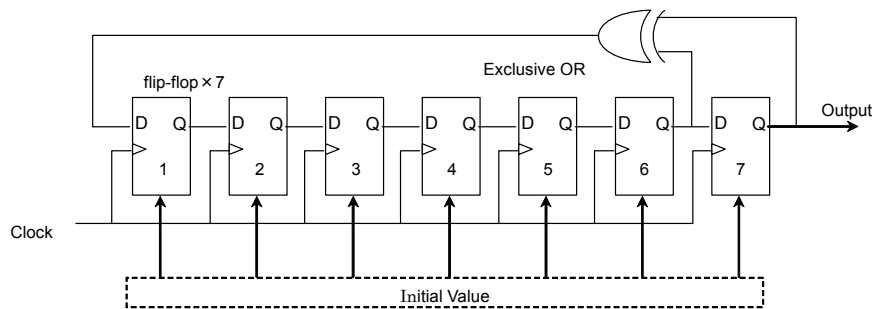


Figure 5.6-1 Block diagram for PRBS Generating Circuit

This block diagram is composed of a shift register composed of a seven-stage flip-flop and an Exclusive OR circuit. A signal of the sixth and seventh stages of the shift register are input to the Exclusive Or and the output of the Exclusive Or is input to the shift register. This type of configuration is described by the following pattern generation polynomial.

$$1+X^6+X^7$$

When inputting the default value of 7 bits and impressing the clock, a pattern with a bit length of $2^7-1 = 127$ its repeatedly generated. The default value of seven bits includes 1 or more “1” bits.

The following table shows the pattern length, maximum number of contiguous 1s, and maximum number of contiguous 0s using the PRBS generation formula of this machine.

PRBS	Pattern Generation Polynomial	Pattern Length	Maximum number of contiguous 1s	Maximum number of contiguous 0
2^7-1	$1+X^6+X^7$	127	7	6
2^9-1	$1+X^5+X^9$	511	9	8
$2^{15}-1$	$1+X^{14}+X^{15}$	32767	15	14
$2^{23}-1$	$1+X^{18}+X^{23}$	8388607	23	22
$2^{31}-1$	$1+X^{28}+X^{31}$	214748647	31	30

The ratio of 1s to the PRBS pattern length is 50%.

Programmable Pattern

The Programmable Pattern is the pattern defined by the pattern file.

The Programmable Pattern is used when the following patterns are required:

- Frame format pattern such as Ethernet and SDH
- Pattern captured from communication circuit data
- Specified test pattern

The restrictions when using the Programmable Pattern are:

- The occurrence ratio of “1” is 50% with ± 1 bit tolerance.
- The maximum pattern length is up to 1305600 bits (163200 bytes). If the pattern sizes larger than this, the first 1305600 bits are used.
- When using pattern files created for existing Anritsu products, use Pattern A only when the pattern file type is Alternate.

Pattern Logic

There are two types of logic: Positive Logic (POS) and Negative Logic (NEG).

With positive logic, the voltage at the Data connector goes High when the data is “1”.

With negative logic, the voltage at the Data connector goes Low when the data is “1”.

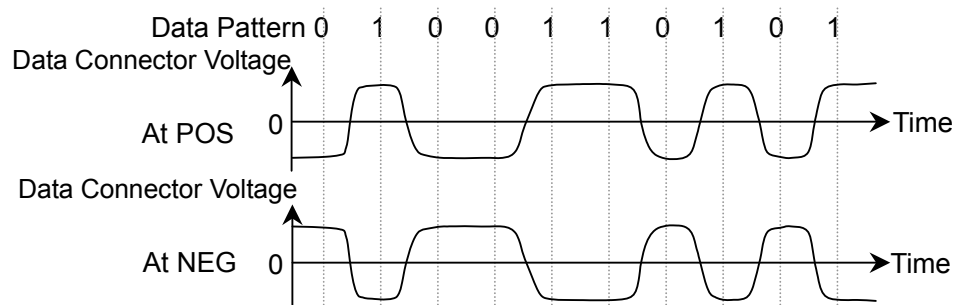
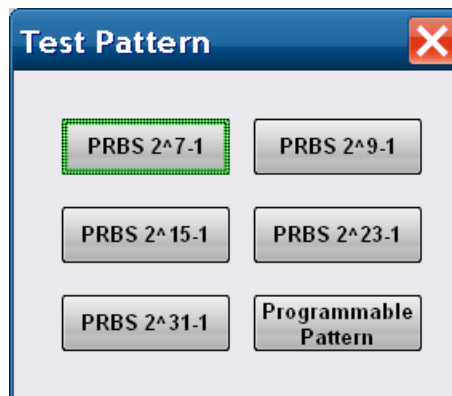


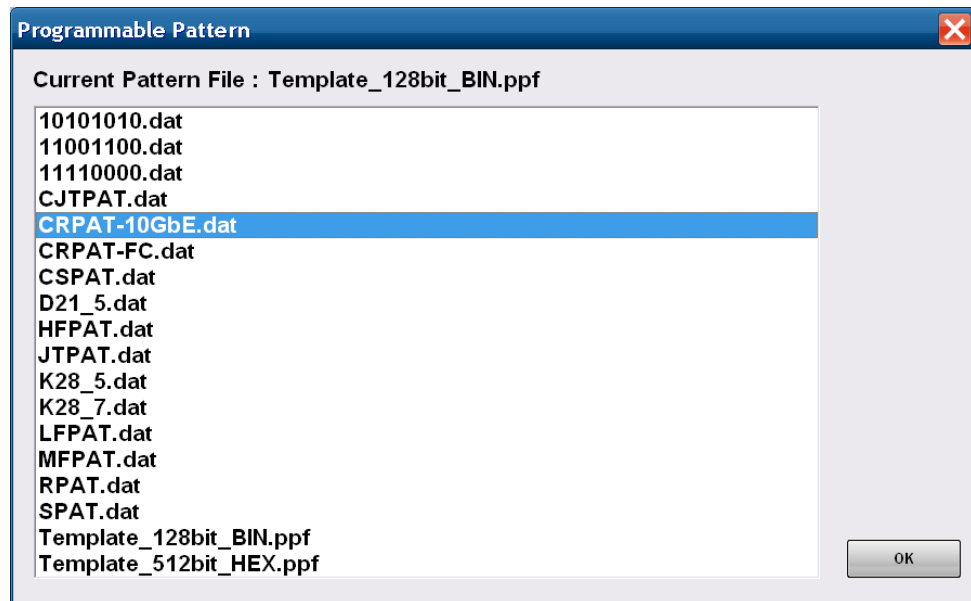
Figure 5.6-2 Relationship between Logic Setting and Output Voltage Waveform at Connector

Set the pattern using the following procedure.

1. Touch the Test Pattern button, and then the pattern list is displayed.



2. Touch the pattern button to be set.
3. When selecting the Programmable Pattern, touch the Programmable Pattern button.
The file selection screen is displayed.



4. Touch the file name.
5. Touch [OK].
When canceling the file selection, touch the close button.
6. Touch the positive/negative logic button to set [POS] or [NEG].

Note:

If "-----" is displayed in the **Programmable Pattern** box, a repeated pattern of "0" and "1" is output.

The MP2100A/MP2101A can read the previous product's pattern file (the file extension is PCP or PTN). The compatibility with the previous product file is as shown in the following table.

The file must be saved in the following folder before reading these files.

C:\Program Files\Anritsu\MP2100A\MX210000A\UserData\Pattern

Table 5.6-1 File Compatibility with Previous Product

Product Name	File extension	Pattern	Supported/Not supported
MU181020A MU181020B	PTN	Data	✓
		Alternate	✓ *
		Mixed(Data)	✓
		Mixed (Alternate)	✓ *
		Sequence	✓
MP1758A	PTN	PRGM 1ch	✓
		PRGM 2ch	✓
		PRGM 4ch	✓
		PRBS	—
MP1761A MP1761B MP1761C	PTN	ALT	✓
		Data	✓
		PRBS	—
		Zero-Subst	—
MP1775A MP1776A	PTN	PRGM 1ch	✓
		PRGM 2ch	✓
		PRGM 4ch	✓
		PRBS	—
		Zero-Subst 1ch	—
		Zero-Subst 2ch	—
		Zero-Subst 4ch	—
MP1632A MP1632C	PTN	PRGM	✓
		Zero-Subst	—
		PRBS	—
	PCP	PRGM	✓

*: Only pattern A can be read.

5.7 Inserting Bit Error

Insert a bit error when confirming whether to detect the bit error at the ED. Bit errors can be inserted either by inserting bits one at a time using screen operation or by inserting a fixed rate to the bit string.

Inserting bit errors one bit at a time using screen operation

1. Touch the button under Error Addition and set to [Single].
2. Touch the Error Addition button and set the button display to [On].
3. Touch [Insert Error], and then 1 bit error is inserted.
When inserting the bit error, the lamp on the right side of [Insert Error] lights green.

Inserting fixed proportion of bit errors

1. Touch the button under Error Addition to set to [Repeat].
2. Touch the Rate button. Select the bite error rate from the following list:

[1E-2]: 10^{-2}	[1E-8]: 10^{-8}
[1E-3]: 10^{-3}	[1E-9]: 10^{-9}
[1E-4]: 10^{-4}	[1E-10]: 10^{-10}
[1E-5]: 10^{-5}	[1E-11]: 10^{-11}
[1E-6]: 10^{-6}	[1E-12]: 10^{-12}
[1E-7]: 10^{-7}	
3. Set Error Addition to [On].

To stop bit error insertion, set Error Addition to [Off].

The average time interval for generating bit errors depends on the Rate and Bit Rate as shown in the following table.

Table 5.7-1 Average Time Interval for Generating Bit Errors

Rate	Bit Rate (kbit/s)					
	155520	622080	1250000	2488320	4250000	10000000
1E-4	64.3 μ s	16.1 μ s	8 μ s	4.02 μ s	2.35 μ s	1 μ s
1E-6	6.43 ms	1.61 ms	800 μ s	402 μ s	235 μ s	100 μ s
1E-8	643 ms	161 ms	80 ms	40.2 ms	23.5 ms	10 ms
1E-10	64.3 s	16.1 s	8 s	4.02 s	2.35 s	1 s
1E-12	6430 s	1608 s	800 s	402 s	235 s	100 s

5.8 Setting Sync Output

Set the type of signal output at the front-panel Sync Out connector. Sync Output connector outputs either a pulse synchronized to the data generated by the PPG, or a pulse synchronized to the data received by the ED, and outputs it at the front-panel Sync Out connector. When measuring the bit error rate and waveform using another error detector or sampling scope, the Sync Out signal is connected to the measurement equipment. The Sync Out Connector is a DC coupling.

The output of the Sync Output connector is input either to a sampling scope or an oscilloscope trigger to monitor the PPG waveform.

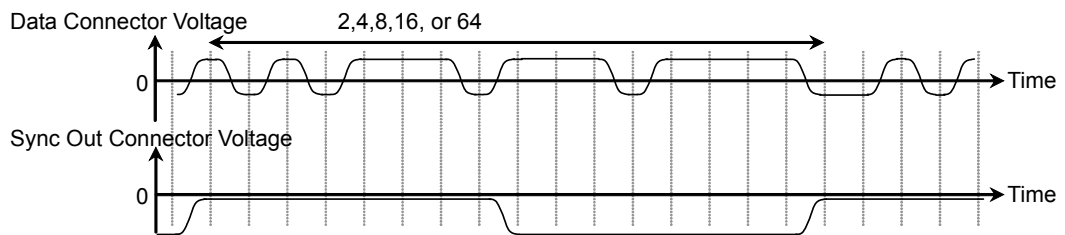


Figure 5.8-1 Correspondence between Sync Output Setting and Output Voltage Waveform at Connector using PPG or ED Rate Division

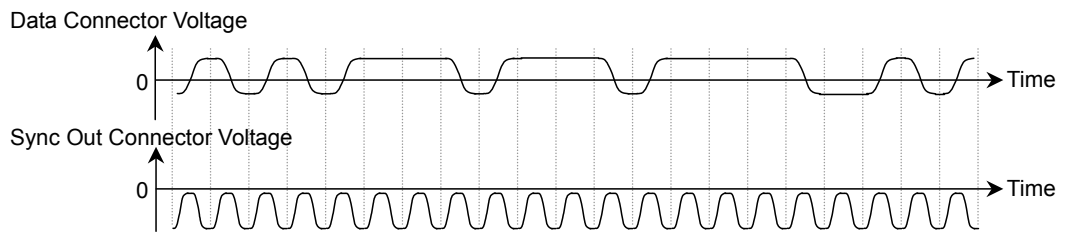


Figure 5.8-2 Correspondence between Sync Output Setting and Output Voltage Waveform at Connector using PPG1_1ch_1/1 or PPG2_2ch_1/1

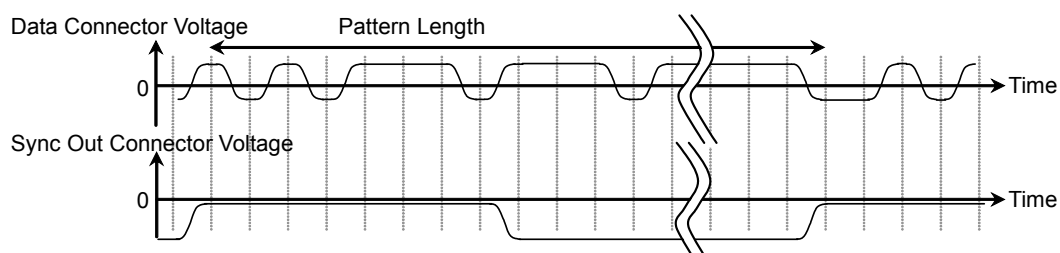


Figure 5.8-3 Correspondence between Sync Output Setting and Output Voltage Waveform at Connector using PPG Interval Cycle

The time interval outputting the pulse varies depending on the pattern length and bit rate when Sync Output is Pattern.

Select the pattern for the measurement referring to Table 5.8-1.

Table 5.8-1 Cycle of Sync Output

Pattern Name	Bit Rate (kbit/s)					
	155520	622080	1250000	2488320	4250000	10000000
PRBS 2 ⁷ -1	52.3 μ s	13.1 μ s	6.5 μ s	3.27 μ s	1.91 μ s	812 ns
PRBS 2 ⁹ -1	210 μ s	52.6 μ s	26.2 μ s	13.1 μ s	7.70 μ s	3.27 μ s
PRBS 2 ¹⁵ -1	13.48 m s	3.37 ms	1.68 ms	843 μ s	493 μ s	210 μ s
PRBS 2 ²³ -1	3.45 s	863 ms	429 ms	216 ms	126 ms	53.7 ms
PRBS 2 ³¹ -1	884 s	221 s	110 s	55.2 s	32.3 s	13.7 s



CAUTION

- The impedance of the Sync Out connector is 50 Ω . Measurement may not be performed correctly if a coaxial cable with another impedance is used or if the impedance of the DUT is not 50 Ω .
- The output voltage of the Sync Out connector is -0.5 to 0 V. Check that the output voltage does not exceed the DUT maximum input specifications. If it does, connect an attenuator to the Sync Out connector.

The selectable signal types vary with the divide rate displayed in the bit rate.

The following table shows the PPG/ED Ch1 Sync Output Combinations. When using PPG/ED Ch2, substitute PPG2 and ED2 for PPG1 and ED1.

Table 5.8-2 PPG/ED Ch1 Sync Output Combinations (Synchronous with PPG)

PPG Divide Rate	Signal Type						
	PPG1_1/1 Clk	PPG1_1/2 Clk	PPG1_1/4 Clk	PPG1_1/8 Clk	PPG1_1/16 Clk	PPG1_1/64 Clk	PPG1_1/Pattern Sync
1/1	-	-	-	✓	✓	✓	✓
1/2	-	-	✓	-	✓	-	✓
1/4	-	✓	-	-	✓	-	✓
1/8	✓	-	-	-	-	-	✓
1/16	✓	-	-	-	-	-	✓
1/32	✓	-	-	-	-	-	✓
1/64	✓	-	-	-	-	-	✓

- ✓: Can be set
- : Cannot be set

Table 5.8-3 Combination of Signals Set to Sync Output (Synchronous with ED)

ED Divide Rate	Signal Type		
	ED1_1/4 Clk	ED1_1/8 Clk	ED1_1/16 Clk
1/1	-	✓	✓
1/2	✓	-	✓

- ✓: Can be set
- : Cannot be set

Note:

With the MP2100A, when EYE/Pulse Scope is set as follows, neither PPG_1ch_Pattern Sync nor PPG_2ch_Pattern Sync can be set.

Time dialog

Data Clock Rate: Tracking On

Procedures

1. Touch [Sync Output].
2. Select the signal type.

The following table shows the divide ratio corresponding to the signal type and clock signal source.

Table 5.8-4 Correspondence between Clock Signal Source and Divide Ratio for Signal Types

Sync Output	Clock Signal Source	Divide Ratio
PPG1_1/1	PPG Channel 1	1
PPG1_1/2		2
PPG1_1/4		4
PPG1_1/8		8
PPG1_1/16		16
PPG1_1/64		64
PPG1_ Pattern Sync		Data Length value
PPG2_1/1	PPG Channel 2	1
PPG2_1/2		2
PPG2_1/4		4
PPG2_1/8		8
PPG2_1/16		16
PPG2_1/64		64
PPG2_ Pattern Sync		Data Length value
ED1_1/4	ED Channel 1	4
ED1_1/8		8
ED1_1/16		16
ED2_1/4	ED Channel 2	4
ED2_1/8		8
ED2_1/16		16

5.9 Setting Clock Output

When Option 052/152 is installed in the MP2100A or MP2101A, a clock synchronized with the PPG data output is output at the Clk Out connector on the front panel.

This clock output at the Clk Out connector is called the "Full Rate Clock" to distinguish it from the clock output at Sync Output.

Note:

Depending on the PPG division rate, the full rate clock is not output.

Table 5.9-1 Divide Rates Supporting Full Rate Clock

Divide (Rate display)	Clk Out connector output
1/1, 1/2, 1/4, 1/8	Available
1/16, 1/32, 1/64	Not available

The following settings are supported by the full rate clock.

- Clock signal source
- Frequency

Clock signal source

The signal source synchronized with the full rate clock is the same as the clock signal source for Sync Output.

When setting Sync Output, the signal source for full rate clock is also set at the same time.

Refer to Table 5.8-4 Correspondence between Clock Signal Source and Divide Ratio for Signal Types.

Note:

The clock is output at the Clk Out connector on the front panel when setting Sync Output to [PPG1_Pattern Sync] or [PPG2_Pattern Sync].

Frequency

The frequency setting method varies with the reference clock settings.

Table 5.9-2 Full Rate Clock Frequency Setting Methods

Reference Clock	External Clock	Description
Internal	–	Changes Bitrate of PPG/ED panel.
External	10 MHz	The set bit rate becomes the clock frequency. However, no clock is output when the divide rate is 1/16, 1/32, or 1/64. Example: When the bit rate is 1 250 000 kbit/s and the rate is 1/8, the full rate clock frequency is 10 000 000 kHz.
External	1/16 Clk	The clock frequency input changes to the Ext Clk In connector. The value of 16 times the clock frequency input to the Ext Clk In connector on the front panel multiplied by the divide rate becomes the full rate clock frequency.
CH1 External	1/16 Clk	The clock frequency input changes to the Ext Clk In connector. The value of 16 times the clock frequency input to the Ext Clk In connector on the front panel multiplied by the divide rate becomes the full rate clock frequency.
CH2 External	1/16 Clk	The clock frequency input changes to the Ext Clk In connector. The value of 16 times the clock frequency input to the Ext Clk In connector on the front panel multiplied by the divide rate becomes the full rate clock frequency.

Note:

Input a clock frequency within the following range to the Ext Clk In connector.

Option 090: 500 000 to 781 250 kHz

Chapter 6 Measuring Bit Error

This chapter explains how to set the interface of the ED and the measurement conditions and the conditions of the error detection for measuring the bit error rate.

6.1	Function List.....	6-2
6.2	Setting Restrictions.....	6-11
6.3	Procedure of Measuring Bit Error Rate	6-13
6.4	Setting Conditions for Error Detection	6-14
6.5	Setting Measurement Conditions.....	6-26
6.6	Measurement Result.....	6-29
6.7	Saving Measurement Results.....	6-30

6.1 Function List

The bit error rate can be measured at the Error Detector (ED).
The ED has the following functions.

Table 6.1-1 Items Set at ED

Item	Description
Tracking	Sets bit rate standards and test pattern setting at PPG.
Bit Rate	When the bit rate standards are Variable, Variable-1/2, Variable-1/4, Variable-1/8, Variable-1/16, Variable-1/32 or Variable-1/64, the bit rate can be set. The setting range varies with the settings of the bit rate standards.
Data Input Condition	Sets connector used for inputting signal.
Threshold (Data Input Condition)	Sets threshold voltage for evaluating “0” and “1” at $\overline{\text{Data In}}$ and Data In connectors. The setting voltage range varies depending on the value of the External Attenuator Factor.
External ATT	When inserting attenuator at connector, that attenuation is entered.
Test Pattern	Selects PRBS or Programmable Pattern.
Programmable Pattern	When Test Pattern set to Programmable Pattern, displays pattern file name.
Data Length	Displays pattern length in bit units.
Auto SYNC	Sets whether or not to execute resynchronization processing when pattern sync lost
Threshold (Auto SYNC)	When Auto SYNC is On, sets bit error rate judging pattern sync loss.
SYNC Control	When the pattern is Programmable Pattern, set the synchronization method.
Frame Position	At Programmable Pattern, sets bit string header position used in sync frame.
ED Result	Displays measurement result for bit error rate.
History Reset	Deletes history of warning display.
Gating Cycle	Sets single measurement, repeat measurement or continuous measurement.
Current	Sets whether to update measurement result to 100 ms.

Table 6.1-1 Items Set at ED (Cont'd)

Item	Description
Start	Measuring bit errors.
Stop	Stopping bit error measurement
Warning display	Displays invalid data detection, invalid pattern synchronization, and alarm of bit error detection.
Bit Rate standard	Selects communication standard complying with transmission speed.
Measurement Processing Ratio	Displays measurement processing ratio in % units.
Measurement cycle	Sets measurement time.
Logic	Sets signal level of data connector responding to pattern "1".

To display the ED setting screen

1. Touch [PPG/ED_Ch1] or [PPG/ED_Ch2] at the top menu.
2. Touch [ED] to display the screen as shown in Figure 6.1-1.
3. Touch [Main] to display the screen as shown in Figure 6.1-2.
4. Touch [Expand] to change the screen as shown in Figure 6.1-1.

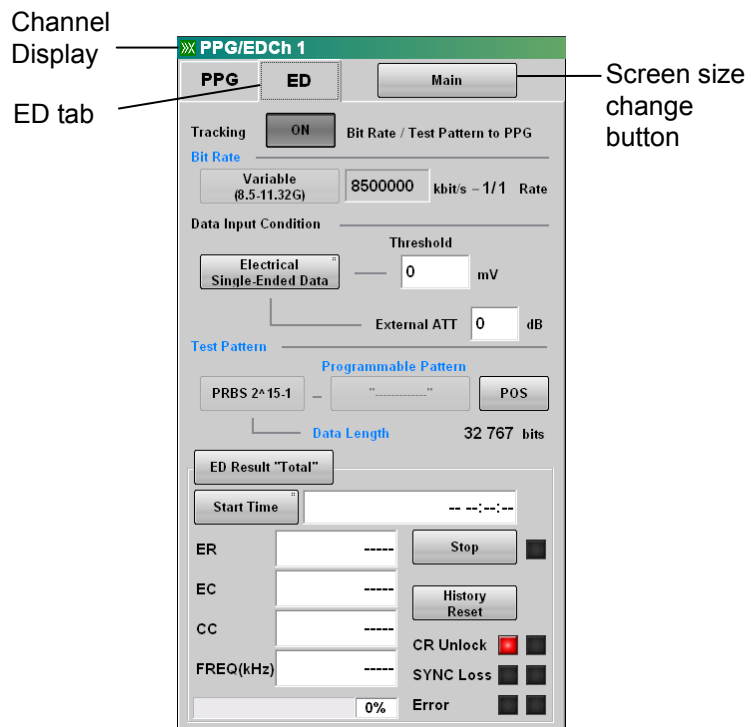


Figure 6.1-1 ED Setting Panel

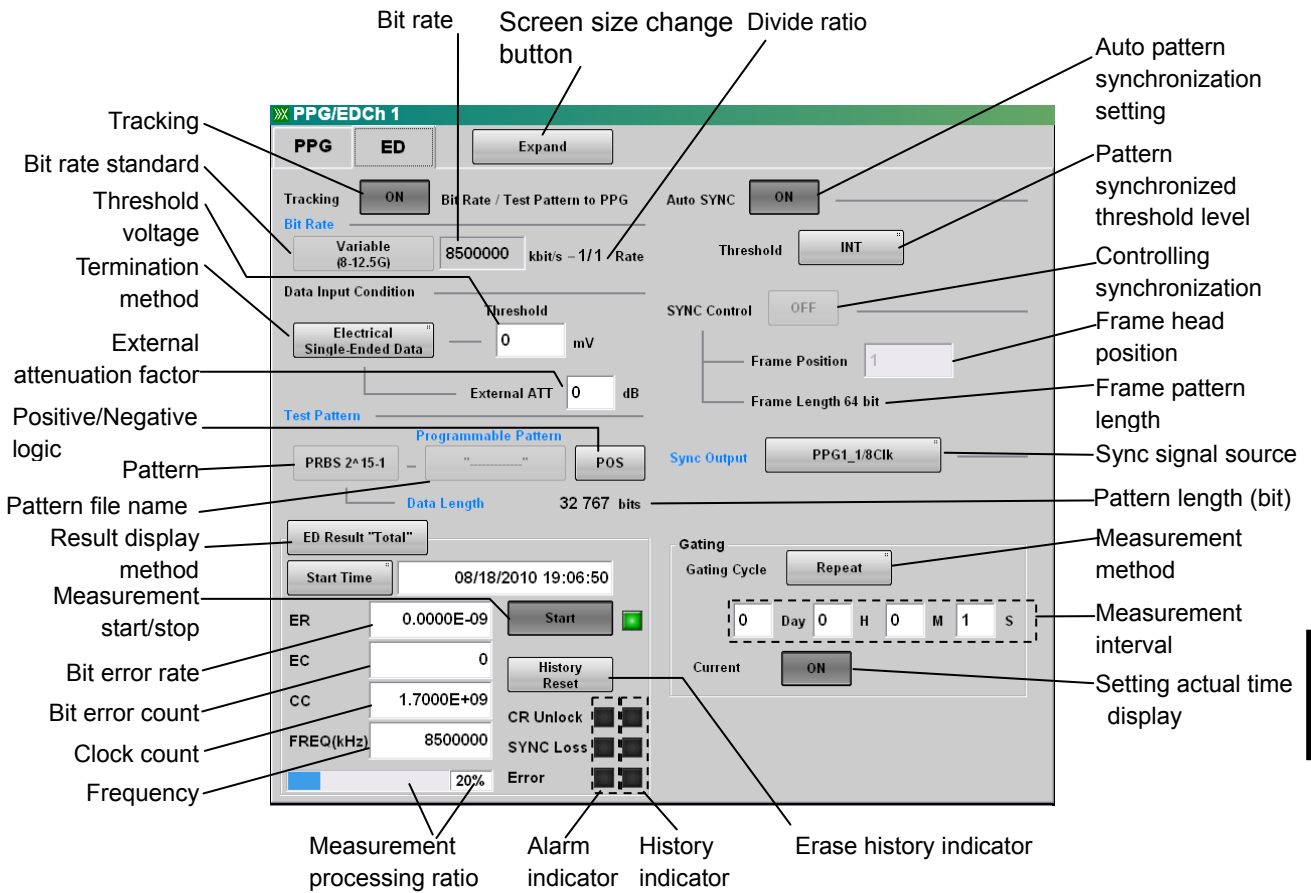


Figure 6.1-2 ED Setting Panel (Details)

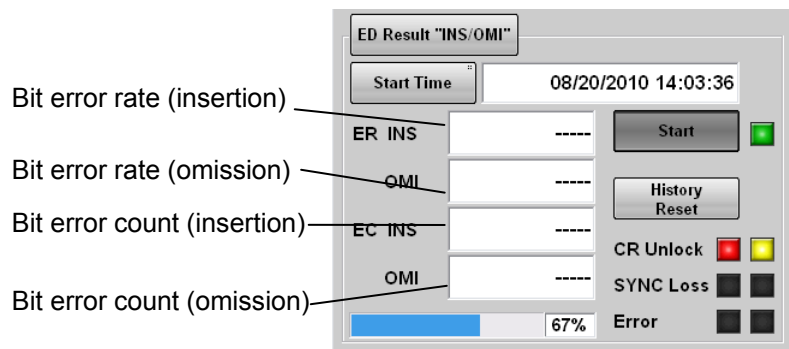


Figure 6.1-3 ED Panel Result Display 2

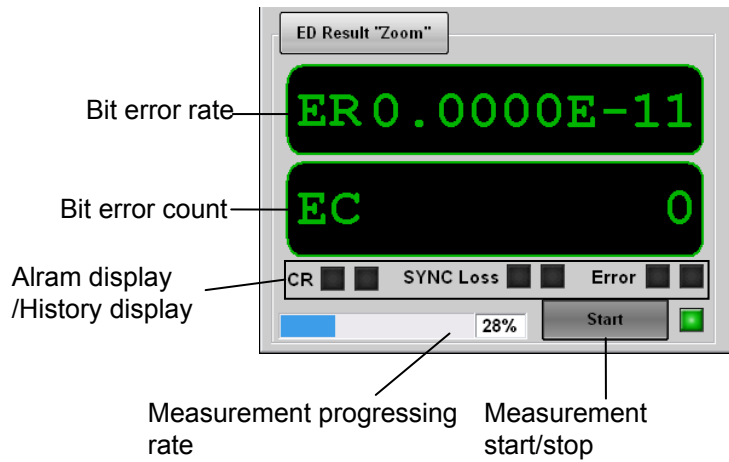


Figure 6.1-4 ED Panel Result Display 3

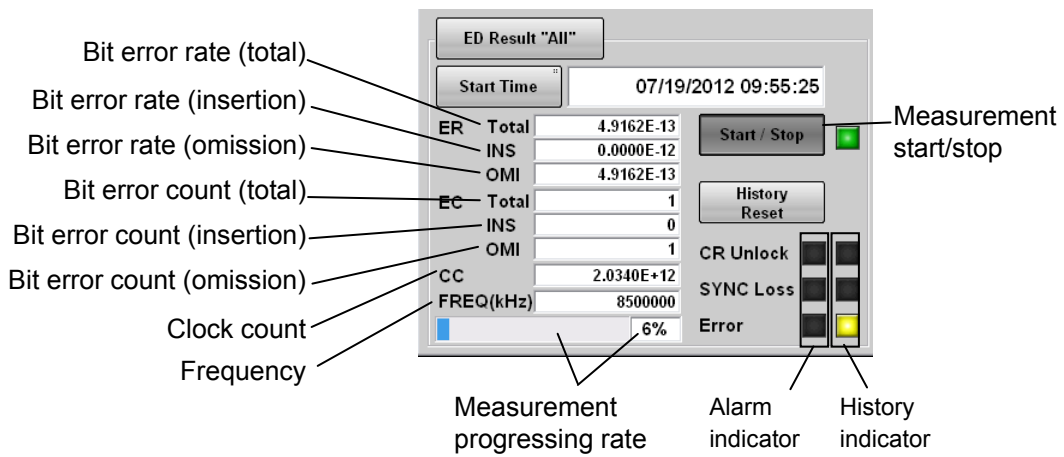


Figure 6.1-5 ED Panel Result Display 4

The setting range of the ED is as follows:

Auto Sync

Off

On

Threshold

INT

1E-2

1E-3

1E-4

1E-5

1E-6

1E-7

1E-8

Bit Rate

Variable

8 500 000 to 11 320 000 kbit/s

8 000 000 to 12 300 000 kbit/s*1

Variable-1/2

4 250 000 to 5 660 000 kbit/s

4 000 000 to 6 250 000 kbit/s*1

Variable-1/4*1

2 000 000 to 3 125 000 kbit/s

Variable-1/8*1

1 000 000 to 1 562 500 kbit/s

Variable-1/16*1

500 000 to 781 250 kbit/s

Variable-1/32*1

250 000 to 390 625 kbit/s

Variable-1/64*1

125 000 to 195 312 kbit/s

1GFC*1

2GFC*1

4GFC

8GFC

10GFC

10G-FC-FEC

1GbE*1

2GbE*1

CPRI*1

CPRI-2*1

CPRI-4*1

CPRI-5*1

CPRI-10*1

Infiniband *1
Infiniband×2
Infiniband×4
10GbE WAN
10GbE LAN/PHY
10GbE OTU1e
10GbE OTU2e
OBSAIRP3*1
OBSAIRP3×2*1
OBSAIRP3×4*1
OC-3/STM-1*1
OC-12/STM-4*1
OC-24*1
OC-48/STM-16*1
OTU-1*1
OC-192/STM-64
G.975 FEC
OTU-2

Data Input Condition

- Differential 50 Ohm*2
- Optical*3
- Electrical Single-Ended Data
- Electrical Single-Ended XData*4
- Threshold
 - 85 to 85 mV (External Attenuator Factor = 0 dB)
- External Attenuation
 - 0 to 30 dB

ED Result

- All
- INS/OMI
- Total
- Zoom

Gating	
Current	
Off	
On	
Gating Cycle	
Repeat	1 second to 9 day 23 hour 59 minute 59 second
Single	1 second to 9 day 23 hour 59 minute 59 second
Untimed	
Result Time	
Elapsed Time	
Remaining Time	
Start Time	
SYNC Control	
Off	
On	
Frame Position	1 to Data Pattern Length-64
Sync Output	
PPG1_1/1 Clk ^{*5}	
PPG1_1/2 Clk ^{*6}	
PPG1_1/4 Clk ^{*7}	
PPG1_1/8 Clk ^{*8}	
PPG1_1/16 Clk ^{*9}	
PPG1_1/64 Clk ^{*10}	
PPG1_1/1 Clk ^{*5}	
PPG2_1/2 Clk ^{*6,*11}	
PPG2_1/4 Clk ^{*7,*11}	
PPG2_1/8 Clk ^{*8,*11}	
PPG2_1/16 Clk ^{*9,*11}	
PPG2_1/64 Clk ^{*10,*11}	
ED1_1/4 Clk ^{*12}	
ED1_1/8 Clk ^{*13}	
ED1_1/16 Clk	
ED2_1/4 Clk ^{*11,*12}	
ED2_1/8 Clk ^{*11,*13}	
ED2_1/16 Clk ^{*11}	
PPG1_Pattern Sync	
PPG2_Pattern Sync	

Test Pattern

NEG

POS

PRBS2⁷-1

PRBS2⁹-1

PRBS2¹⁵-1

PRBS2²³-1

PRBS2³¹-1

Programmable Pattern

Programmable Pattern

Tracking

Off

On

- *1: When installing Option 090
- *2: Excluding Ch1 of the following configuration
MP2100A-003 and MP2100A-003+005,
MP2100A-007 and MP2100A-007+005
- *3: Excluding MP2100A-003, MP2100A-003+005Ch1
- *4: Excluding Ch1 of the following configuration
MP2100A-007 and MP2100A-007+005
- *5: 1/8, 1/16, 1/64 at PPG Rate display
- *6: 1/4 at PPG Rate display
- *7: 1/2 at PPG Rate display
- *8: 1/1 at PPG Rate display
- *9: 1/1, 1/2, 1/4, 1/8, 1/16 at PPG Rate display
- *10: 1/1, 1/2, 1/4 at PPG Rate display
- *11: When installing Option 005 or 012
- *12: 1/2 at ED Rate display
- *13: 1/1 at ED Rate display

6.2 Setting Restrictions

The setting items of the ED have the following restrictions.

Bit Rate

The bit rate range varies with the bit rate specifications and the availability of the Option 090.

The bit rate setting range indicates the following table.

Table 6.2-1 Bit Rate Specifications and Bit Rate Setting Range

Bit Rate Specifications	Bit Rate (kbit/s)	
	Without Option 090	With Option 090
Variable	8 500 000 to 11 320 000	8 000 000 to 12 500 000
Variable-1/2	4 250 000 to 5 660 000	4 000 000 to 6 250 000
Variable-1/4	–	2 000 000 to 3 125 000
Variable-1/8	–	1 000 000 to 1 562 500
Variable-1/16	–	500 000 to 781 250
Variable-1/32	–	250 000 to 390 625
Variable-1/64	–	125 000 to 195 312

When Option 090 is not installed and PPG bit rate is 3 075 000 kbit/s or under, ED bit rate does not follow PPG even if Tracking is set to On.

Bit Rate Standard

The following specifications can be selected when Option 090 is added.

- Variable-1/4
- Variable-1/8
- Variable-1/16
- Variable-1/32
- Variable-1/64
- 1GFC
- 2GFC
- 1GbE
- 2GbE
- Infiniband
- OC3/STM-1
- OC12/STM-4
- OC24
- OC48/STM-16
- OTU-1
- CPRI
- CPRI-2
- CPRI-4
- CPRI-5
- CPRI-10
- OBSAIRP3
- OBSAIRP3×2
- OBSAIRP3×4
- OBSAIRP3×8

Threshold

The threshold power voltage for $\overline{\text{Data}}$ In or Data In connectors cannot be set individually.

Data Input Condition

When the following model name and options are used, only Optical and Electrical Single-Ended Data can be selected at Ch1.

- MP2100A-003
- MP2100A-003+005

Optional cannot be selected when Ch2 and the model name and options other than the above at Ch1 are used.

When the following model and options are used, only Electrical Single-Ended Data can be selected at Ch1.

- MP2100A-007
- MP2100A-007+005

External Attenuation

When [Optical] is selected at Data Input Condition, the values cannot be entered.

Programmable Pattern

The pattern length is 1305600 bits or less. When the file data length exceeds 1305600 bits, up to 1305600 bits test patterns are used.

6.3 Procedure of Measuring Bit Error Rate

The following figure shows the basic procedure for measuring the bit error rate.

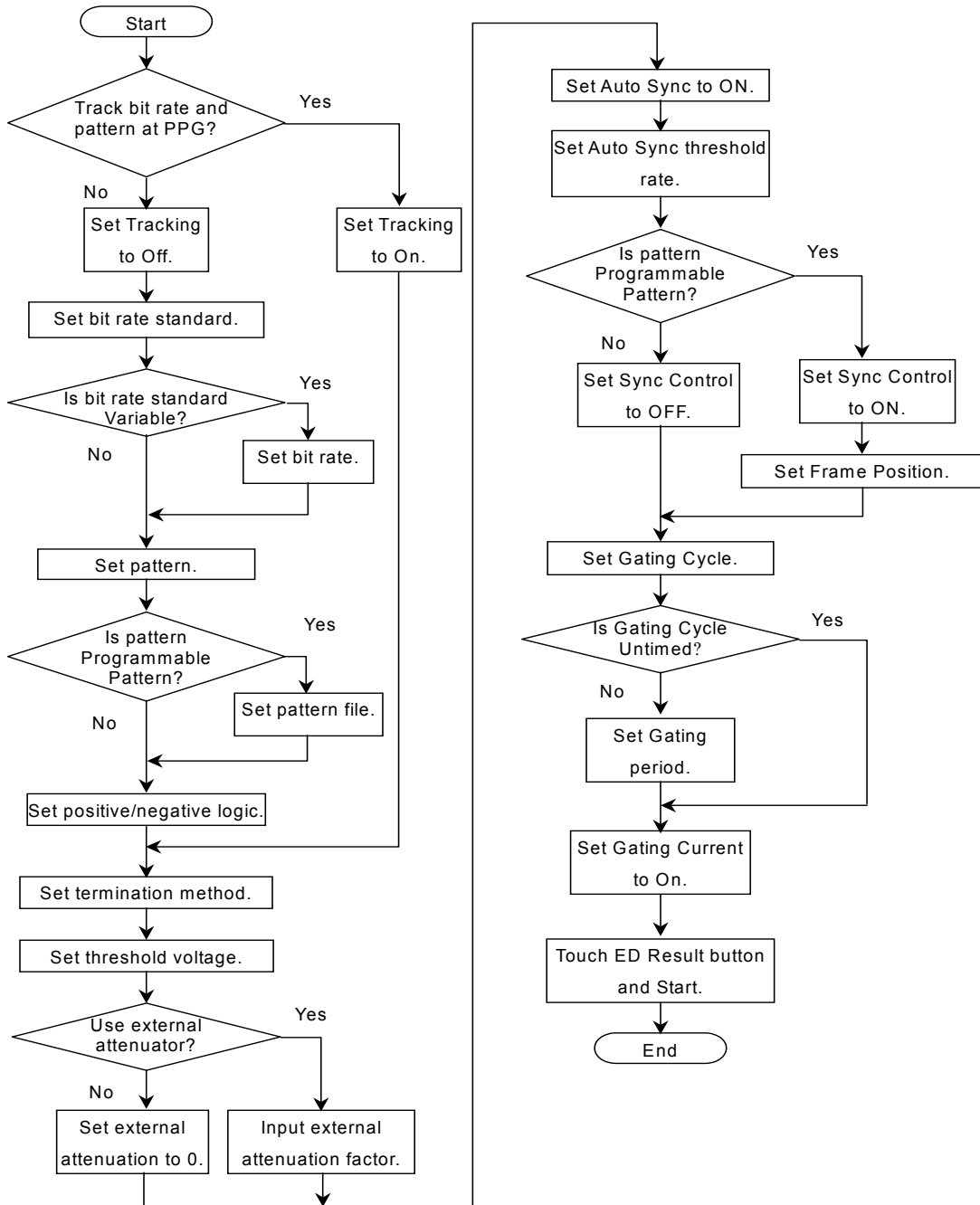


Figure 6.3-1 Basic Procedure of Bit Error Rate Measurement

6.4 Setting Conditions for Error Detection

The conditions for detecting bit errors must be set.

Signal input terminal

The signal input terminals for the ED are the ED1 and ED2 $\overline{\text{Data}}$ In connectors and Data In connector on the panel.

The ED1 connector supports ED_Ch1 and the ED2 connector supports ED_Ch2.

When using the MP2100A-003 and MP2100A-003+005, the optical input connector can be selected as the ED_Ch1 signal input terminal.

In the case of the MP2101A, only the electrical input connector is supported.

The signal input terminals for ED1 and ED2 are AC coupling. The block diagram for input terminal is as shown below.

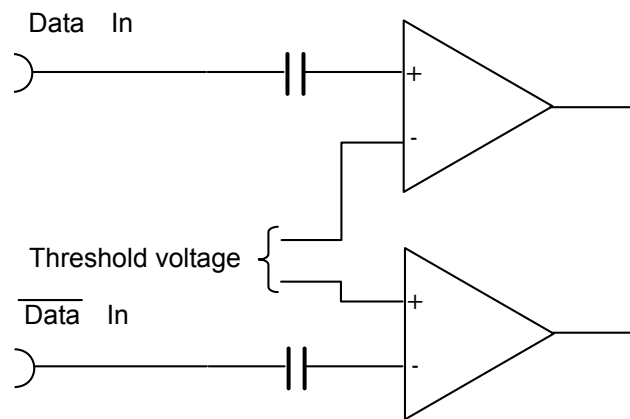


Figure 6.4-1 Input Terminal Block Diagram

⚠ CAUTION

The impedance of the electrical input connector is 50 Ω . Measurement may not be performed correctly if a coaxial cable with another impedance is used.

Do not impress a DC voltage of more than 2 V at the ED1 Data In and Data In connectors.

Do not impress a DC voltage of more than 1 V at the ED2 Data In and Data In connectors.

The internal circuit may be damaged.

The optical inputs for MP2100A-003 and MP2100A-003+005 are AC coupling.

The input terminal block diagram is as shown in the below figure.

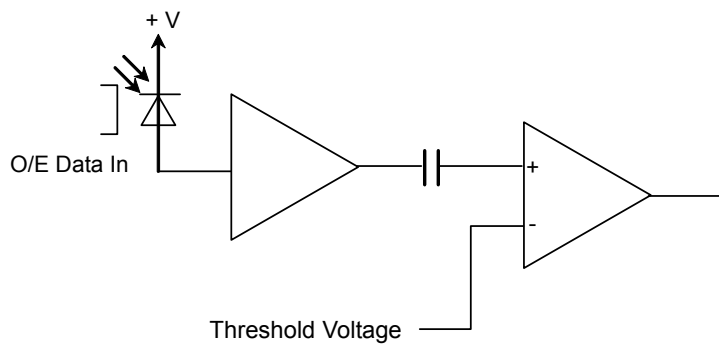


Figure 6.4-2 Optical Input Terminal Block Diagram (MP2100A-003)

Select the signal input terminal depending on the Data Input Condition [Differential 50 Ohm]: Signal input terminal for both Data In and $\overline{\text{Data}}$ In connectors. The differential voltage of each signal input to two connectors is the input voltage.

[Electrical Single-Ended Data]:
Signal input terminal for Data In connector

[Electrical Single-Ended XData]:
Signal input terminal for $\overline{\text{Data}}$ In connector

[Optical]: Signal input terminal for optical connector (O/E Data In)

Attenuator Factor (External Attenuation)

When installing the fixed attenuator in the Data In and $\overline{\text{Data}}$ In connectors of the MP2100A/MP2101A, input the attenuation (dB) of the fixed attenuator.

The threshold voltage calculated to the input voltage of the attenuator is displayed.

The calculation formula is as follows:

$$\text{Calculated Threshold Voltage} = \text{Threshold Voltage} \times 10^{(\text{attenuation}/20)}$$

Threshold Level

Voltage level for evaluating “1” and “0”.

The input terminals are AC coupled, so set a voltage corresponding to the signal waveform excluding the DC components.

The following figure shows the waveform input to the connector and the waveform excluding DC components when the input signal level is LVPECL.

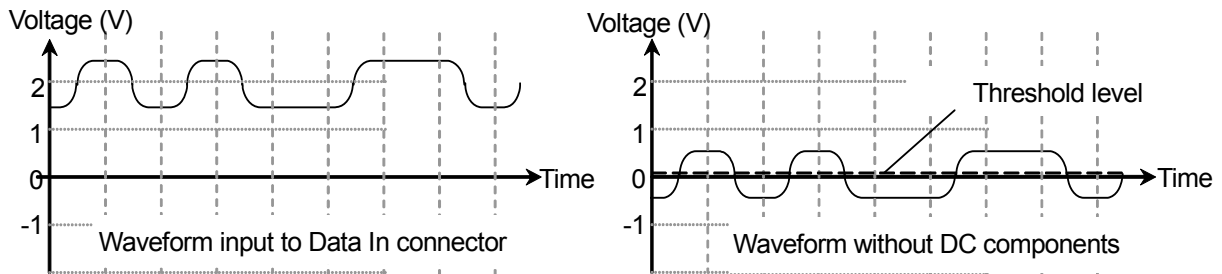


Figure 6.4-3 Waveform with Target Threshold Level

Logic

Select the positive logic (POS) or negative logic (NEG).

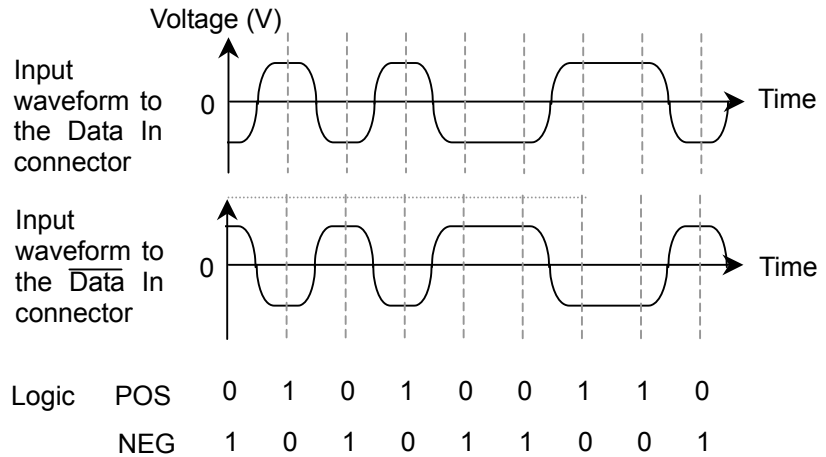


Figure 6.4-4 Values Defined as Input Waveform

Pattern

The ED compares the received bit string and the internally generated bit stream bit-by-bit and evaluates its differences as errors.

As a result, set the same pattern at the PPG and ED.

For PRBS, since it is possible to predict the bits received next from the received bit string, the time required for pattern synchronization can be much shorter than for a Programmable Pattern.

There are two synchronization methods depending on the pattern length for Programmable Pattern.

SYNC Control: OFF The entire pattern bits and received bit string are compared.

SYNC Control: ON When the pattern length is 128 bits or more, 64 bits starting from the bit specified at Frame Position and the received bit string are compared. When all 64 bits are in agreement, the data from bit 65 is compared. When the pattern length is 127 bits or less, the entire received bit string and data are compared.

All data bits are compared and when the obtained bit error rate is lower than the bit error rate is set at Auto Sync Threshold, pattern synchronization is evaluated as having been obtained.

To shorten the pattern sync time when SYNC Control is ON, set the value of the 64-bit string which is not duplicate in other portion in the same string to Frame Position in programmable pattern.

The pattern synchronization takes much time if there are multiple 64-bit strings, which is the same as 64-bit string used for the same string synchronization detection.

	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+A	+B	+C	+D	+E	+F
000000	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
000010	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
000020	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
000030	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
000040	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
000050	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
000060	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F
000070	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F
000080	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F
000090	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F
0000A0	60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F
0000B0	70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F

Figure 6.4-5 Programmable Pattern Example 1

Figure 6.4-5 shows an example of programmable pattern when pattern length is 1536 bits.

In this example, 64 bytes from the programmable pattern header have the same value of 0x55, so the header 512 bits is a repeating pattern of alternating 1s and 0s.

When Frame Position is set to 1 in this programmable pattern, the 8 bytes of data from address 0x000000 to address 0x000007 are used to detect pattern synchronization.

There are 224 points between address 0x000000 and address 0x000038 with these 8 bytes match. The data remaining after these 8 byte data matches is compared and the proportion of matched bits in the entire programmable pattern is 1:224. When pattern synchronization processing is performed with this type of pattern, the time required to obtain synchronization becomes longer.

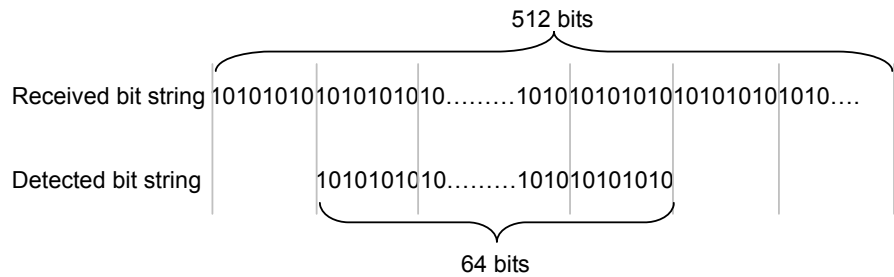


Figure 6.4-6 Pattern Detection Bit String when Frame Position is 1

The bit string used at pattern synchronization must occur at least once within the programmable pattern.

In the example in Figure 6.4-5, when the Frame Position is 513, the bit string between addresses 0x000040 and 0x000047 is used to detect pattern synchronization. This 8-byte bit string appears once in the programmable pattern. As a result, if these 64 bits and the received bit string match, pattern synchronization is obtained.

If there is no bit string appearing at least once in the programmable pattern, the bit string appearing the least number of times is set at Frame Position.

	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+A	+B	+C	+D	+E	+F
000000	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
000010	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
000020	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F
000030	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F
000040	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F
000050	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F
000060	60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F
000070	70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F
000080	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
000090	10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
0000A0	20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F
0000B0	30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F
0000C0	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F
0000E0	50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F
0000E0	60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F
0000F0	70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7E

Figure 6.4-7 Programmable Pattern Example 2

Sometimes pattern synchronization is obtained at the wrong position depending on the user data pattern.

An example is shown in Figure 6.4-7. There is just one bit different between data addresses 0x000000 to 0x00007F and addresses 0x000080 to 0x0000FF.

When Frame Position is set to 1 at this programmable pattern, the 8 bytes of data from address 0x000000 to 0x000007 are used to detect pattern synchronization.

The matches for these data bytes are between received bit string addresses 0x000000 and 0x000007, and addresses 0x000080 and 0x000087. There is no bit error in the former but there is one bit error at bit 1024 in the latter. In this case, the bit error rate is 9.77×10^{-4} .

When the bit error rate (Sync Threshold) used to evaluate pattern synchronization is set to 10^{-3} , since the generated bit error rate is lower than this value, the equipment evaluates pattern synchronization as having been obtained.

To prevent obtaining pattern synchronization at the incorrect position like this, the Sync Threshold bit error rate must be smaller than the reciprocal number of the programmable pattern length. For example, when the pattern length is 16,384 bits, Sync Threshold should be $1E-5$.

Pattern Sync

Auto SYNC sets the pattern sync method.

[On]: If the bit error rate set at Sync Threshold is exceeded, patterns synchronization is evaluated as lost and synchronization processing is performed.

[Off]: Pattern synchronization processing is not performed.

Set Auto Sync to [On] at measurement start.

After pattern synchronization processing, if there are bit errors exceeding the bit error rate set at Sync Threshold, leave pattern synchronization processing set to [On].

After pattern synchronization processing, even if there are bit errors exceeding the bit error rate set as Sync Threshold, set to [Off] when not processing the pattern synchronization.

Bit error rate for executing pattern synchronization processing

Auto SYNC Threshold sets the bit error rate for starting or stopping pattern synchronization processing.

The bit error rate for starting pattern synchronization processing (sync processing start level) must be set to a larger value than the bit error rate for stopping pattern sync processing (sync processing stop level). This offers a method for starting/stopping pattern sync processing using

hysteresis.

The following figure shows the sync processing start and stop levels when 1E-2 are selected at Sync Threshold.

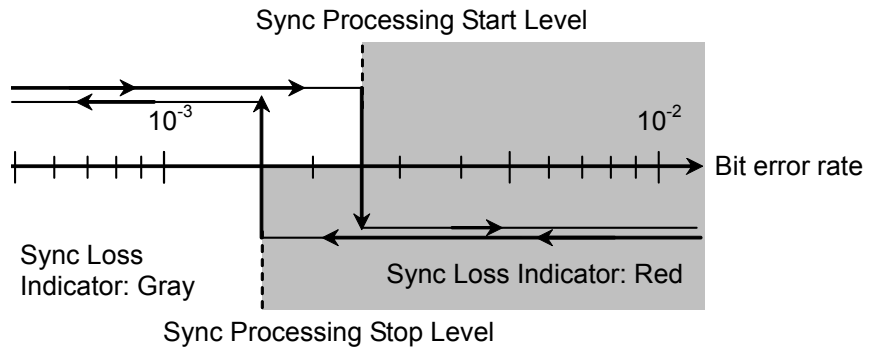


Figure 6.4-8 Bit Error Rate at Pattern Sync Processing Start/Stop Level

When selecting [INT], the bit error rates vary depending on the Test Pattern types, pattern length and Sync control settings.

The following table shows the sync processing start and stop levels for each Sync Threshold selection.

Table 6.4-1 Bit Error Rate when Threshold setting is INT

Test Pattern	Sync Control	Pattern Length	Bit Error Rate	
			Sync Processing Start Level	Sync Processing Stop Level
PRBS	–	2^n-1 (n=7, 9, 15, 23, 31)	2.5×10^{-2}	1.56×10^{-2}
Programmable Pattern	OFF	2 to 16	2.5×10^{-2}	1.56×10^{-2}
		17 to 160	5.0×10^{-3}	1.56×10^{-3}
		161 to 1,600	5.0×10^{-4}	1.56×10^{-4}
		1,601 to 16,000	5.0×10^{-5}	1.56×10^{-5}
		16,001 to 80,000	1.0×10^{-5}	6.25×10^{-6}
		80,001 to 160,000	5.0×10^{-6}	3.13×10^{-6}
		160,001 to 320,000	2.5×10^{-6}	1.56×10^{-6}
		320,001 to 524,288	1.9×10^{-6}	7.81×10^{-7}
		524,289 to 1,048,576	9.54×10^{-7}	3.91×10^{-7}

Table 6.4-1 Bit Error Rate when Threshold setting is INT (Cont'd)

Test Pattern	Sync Control	Pattern Length	Bit Error Rate	
			Sync Processing Start Level	Sync Processing Stop Level
Programmable Pattern	ON	128 to 5,120	1.95×10^{-4}	1.56×10^{-4}
		5,121 to 10,240	9.77×10^{-5}	7.81×10^{-4}
		10,241 to 51,200	1.95×10^{-5}	1.56×10^{-5}
		51,201 to 102,400	9.77×10^{-6}	7.81×10^{-5}
		102,401 to 204,800	4.88×10^{-6}	3.91×10^{-6}
		204,801 to 307,200	3.26×10^{-6}	2.60×10^{-6}
		307,201 to 409,600	2.44×10^{-6}	1.95×10^{-6}
		409,601 to 524,288	1.91×10^{-6}	1.53×10^{-6}
		524,289 to 1,048,576	9.54×10^{-7}	7.63×10^{-7}

Table 6.4-2 Threshold Settings and Bit Error Rate (at 1E-2 to 1E-8)

Sync Threshold	Bit Error Rate	
	Sync Processing Start Level	Sync Processing Stop Level
1E-2	2.5×10^{-2}	1.56×10^{-2}
1E-3	2.5×10^{-3}	1.56×10^{-3}
1E-4	2.5×10^{-4}	1.56×10^{-4}
1E-5	2.5×10^{-5}	1.56×10^{-5}
1E-6	2.5×10^{-6}	1.56×10^{-6}
1E-7	2.5×10^{-7}	1.56×10^{-7}
1E-8	2.5×10^{-8}	1.56×10^{-8}

The setting procedure of the error detection conditions is as follows:

1. When changing the bit rate and pattern of the PPG and applying the changing settings to the ED touch the Tracking button and set to [On].
When setting to [On], go to the step 6.
When setting to [Off], go to the step 2.
2. Touch the Bit Rate button and select the standard.
Set the same standard of the PPG.
3. When setting the bit rate standards to Variable, Variable-1/2, Variable-1/4, Variable-1/8, Variable-1/16, or Variable-1/32, touch the Bit Rate test box. And then, enter the same value of the PPG.
For the setting range of the bit rate, refer to Table 5.5-1 “Bit Rate Specifications and Setting Range”.
4. Touch the Test Pattern button and select the pattern.
Set the same pattern of the PPG.
5. Set Logic to [POS] or [NEG].
6. Touch the Data Input Condition button.
7. Select the connector receiving the signal from the followings:
 - MP2100A-003, MP2100A-003+005 Ch1
[Optical]: O/E Data In connector
[Electrical Single-Ended Data]: Data In connector
 - MP2100A-001, MP2100A-001+005, MP2101A Ch1, Ch2
[Differential 50 Ohm]: Data In and $\overline{\text{Data}}$ In connector
[Electrical Single-Ended Data]: Data In connector
[Electrical Single-Ended XData]: $\overline{\text{Data}}$ In connector
 - MP2100A-003+005, MP2100A-007+005, Ch2
[Differential 50 Ohm]: Data In and $\overline{\text{Data}}$ In connector
[Electrical Single-Ended Data]: Data In connector
[Electrical Single-Ended XData]: $\overline{\text{Data}}$ In connector
8. Touch the External ATT test box.
9. When inserting the fixed attenuator to the $\overline{\text{Data}}$ In and Data In connectors, enter the attenuation (dB). When not inserting the attenuator, enter 0.
10. Touch the Threshold text box.
11. Enter the threshold voltage.
When Test Pattern is set to Programmable Pattern, follow the procedure below.
12. Touch the Programmable Pattern button and open the file dialog box.

13. Select the same file as that of the Programmable Pattern of the PPG.
14. Touch the Frame Position text box.
15. Enter the frame head position.

 **CAUTION**

When attenuators are connected to both the Data In and $\overline{\text{Data In}}$ connectors, use attenuators with the same attenuation. If the amount of attenuation is different, the displayed threshold voltage and the actual threshold voltage may be different.

If the input voltage to the attenuators is either more than 5 V or less than -5 V, check that the power consumed by the attenuators does not exceed the rated power.

Check that the voltage of the signal attenuated by the attenuators does not exceed the voltage displayed at the Data In and $\overline{\text{Data In}}$ connectors.

6.5 Setting Measurement Conditions

To set how to measure bit error:

Set Gating Cycle at Gating.

[Single]: Performs measurement until the time set at the measurement period is exceeded.

[Repeat]: Performs measurement until ER Result button display becomes [Stop].

The bit error rate returns to 0 at each measurement period.

[Untimed]: Performs measurement until ER Result button display becomes [Stop].

The bit errors are accumulated.

The following figure shows the relationship between the Gating Cycle setting and the change in the displayed bit error count.

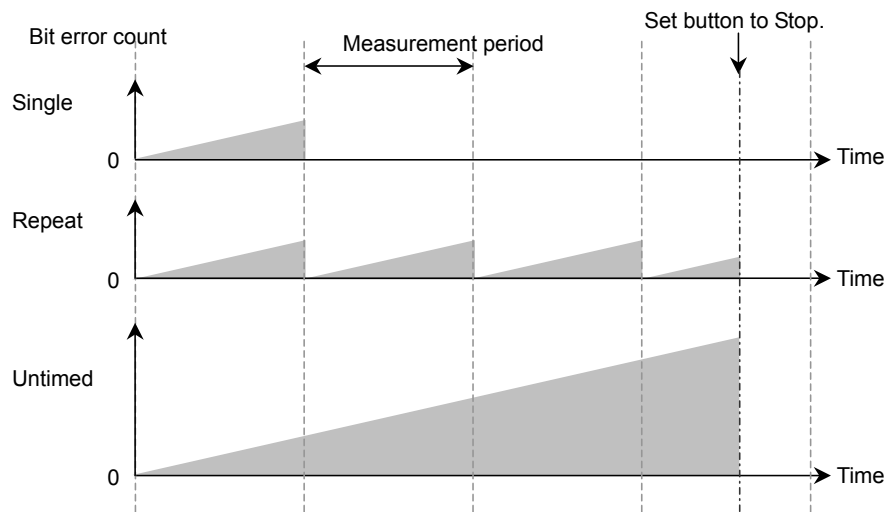


Figure 6.5-1 Gating Cycle Settings and Bit Error Count

Bit error measurement Period

The Gating Period can be set when Gating Cycle is Single or Repeat. The time can be set from 1 second to 9 days 23 hours 59 minutes 59 seconds.

Measurement method

The ED Result display can be refreshed either in real time (approx. 1 s intervals) or when the progress bar reaches 100%. The display method is set at Current of Gating.

[On]: Updates measurement results in real time.

[Off]: Updates measurement results when progress reaches 100% for either Single or Repeat Gating Cycle.

Updates measurement results when measurement stops for Untimed Gating Cycle.

The setting procedure of the measurement conditions is as follows:

1. Touch the Gating Cycle button and select the measurement method as follows:
[Repeat]
[Single]
[Untimed]
2. When Gating Cycle is Repeat or Single, touch the text box under the Gating Cycle and enter the numeric value.
The measurement cycle can be set from 1 second to 9 days 23 hours 59 minutes 59 seconds.
3. Touch [Current] to set the timing for the measurement result.
[On]: Updates measurement results per 100 ms.
[Off]: Displays measurement results per measurement results or when measurement stops
4. Touch the measurement start/stop button, and set the display to [Start].
The right lamp of the button is changed to green.
Measure is displayed at the status display.
The measurement processing rate is displayed.

When pattern synchronization is obtained, the CR Unlock and SYNC Loss displays are erased.

When Gating Cycle is set to [Untimed], the measurement cycle progress is displayed every 5 seconds.

When CR Unlock is displayed in red

The signal input to the connector is not detected. Confirm the following:

- The signal amplitude inputs to the $\overline{\text{Data}}$ In and Data In connectors are 0.1 V or more.
- The signal transmission bit rate matches the value set at Bit Rate.
- When the signal is input to the O/E Data In connector, the option Low Pass Filter settings are not applicable.

Example :when the bit rate standard is 10 GbE WAN, Low Pass Filter is set to 2GFC.

When SYNC Loss is displayed in red

Pattern synchronization has not been obtained; check the following:

- The PPG Test Pattern and ED Test Pattern settings are matched.
- The Logic POS and NEG settings are correct.
- The amplitude of the input signals to the Data In and $\overline{\text{Data}}$ In connectors is at least twice the threshold voltage.

6.6 Measurement Result

The following measurement result is displayed in the ED Result.

Start Time: Time when bit error measurement started

Elapsed Time: Time elapsed from start of bit error rate measurement

When Gating Cycle is Single or Repeat, when time exceeds the Time setting at Gating, the time is reset back to 0.

Remaining Time: Bit error measurement elapsed time subtracted from time set at Gating Time setting.

ER: The bit error rate is displayed from 0.0001E-18 to 1.0000E-0. Mantissa is 0.0000 when the bit error does not occur.

At this time, the numeric part varies depending on the clock number.

Example:0.0000E-3 Clock count 1000 or more, 9999 or less
0.0000E-4 Clock count 10000 or more, 99999 or less

EC: The occurred bit errors are displayed from 0 to 9999999 or from 1.0000E07 to 9.9999E17.

CC: The received bit count is displayed from 0 to 9999999 or from 1.0000E07 to 9.9999E17.

FREQ (kHz): Clock frequency calculated by the received bit count. It is the same as the transmission speed (kbit/s) of the received data.

Alarm Indicator

Error: Displays red when detecting bit error.

CR Unlock: Displays red when clock not generated from received data in the case of Rate=1/1 or 1/2.

When Option 090 is installed and bit rate is 3 125 000 kbit/s or less, CR Unlock is not detected. .

SYNC Loss: Displays red when pattern not synchronized.

When the alarm indicator goes red once, the History Indicator goes yellow when the cause of the alarm is removed, indicating that an alarm occurred.

When the [History Reset] button is pressed when the History Indicator is yellow, the yellow display disappears.

6.7 Saving Measurement Results

The measurement result of the saved bit error is as follows:

Bit Error Measurement Result

CC (Clock Count)

EC (Error Count)

ER (Error Rate)

Frequency

Start Time

Stop Time

Test Pattern

```
Anritsu;MP2100A;01.00;TXT-----
Pattern PRBS2^23-1
Option 03,05,90
Start 2009/12/06 11:50:47      End 2010/07/06 16:05:55

      | Total      INS      OMI
-----+-----
ER    | 2.0000E-08  8.0000E-02  1.2000E-0
EC    | 1.0000E+09  4.0000E+08  6.0000E+08

Frequency      Clock Count
-----
10312500kHz    6.1875E+11
```

Figure 6.7-1 Text File Example


```

Anritsu;MP2100A;01.00;CSV
Pattern,PRBS2^23-1
Option,01,05
Start,2010/07/06 11:50:47,End,2010/07/06 11:51:47

,Total
ER,2.0000E-08
EC,12375

Frequency,Clock Count
10312500kHz,6.1875E+11

```

Figure 6.7-2 CVS File Example

Procedure

1. Touch [System Menu].
2. Touch [Save].
3. Select from [All], [PPG/ED Ch1], or [PPG/ED Ch2].
When selecting [All], the measurement results for the PPG/ED Ch1 and PPG/ED Ch2 are saved.
4. Touch [Result].
The file name input dialog box is displayed.
5. When saving the file as the displayed file name, touch [OK].
6. Touch the right button of the text box when editing the file name.
The software keyboard is displayed.
7. Input the file name.
8. When changing the file name, touch [OK], and when canceling the procedure, touch [Cancel] and go back to the step 4.

The measurement result file is saved in the following folder.

```

C:\Program Files\Anritsu\MP2100A\MX210000A\UserData\Result\CSV
C:\Program Files\Anritsu\MP2100A\MX210000A\UserData\Result\TXT

```


Chapter 7 Observing Waveform

This chapter explains how to measure waveforms of periodic signal in time.

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7.1 EYE/Pulse Scope Screen

7.1.1 Sampling scope features

The sampling scope, measuring the waveform, has the following main features.

- Data collection method
Trigger clock frequency setting, eye mode/pulse mode display, and waveform cumulative display
- Clock Recovery
Frequency bandwidth of clock recover unit and loop filter settings
The clock recovered from the input data is output at the panel CRU Out connector.
- Screen Scale settings
Screen vertical and horizontal axis scales
- Waveform analysis
Measuring Parameters for evaluation of the waveform such as rise time and jitter

7.1.2 Description of items on the EYE/Pulse Scope window

Touch [EYE/Pulse Scope] at the top menu, and then the EYE/Pulse Scope result window is displayed.

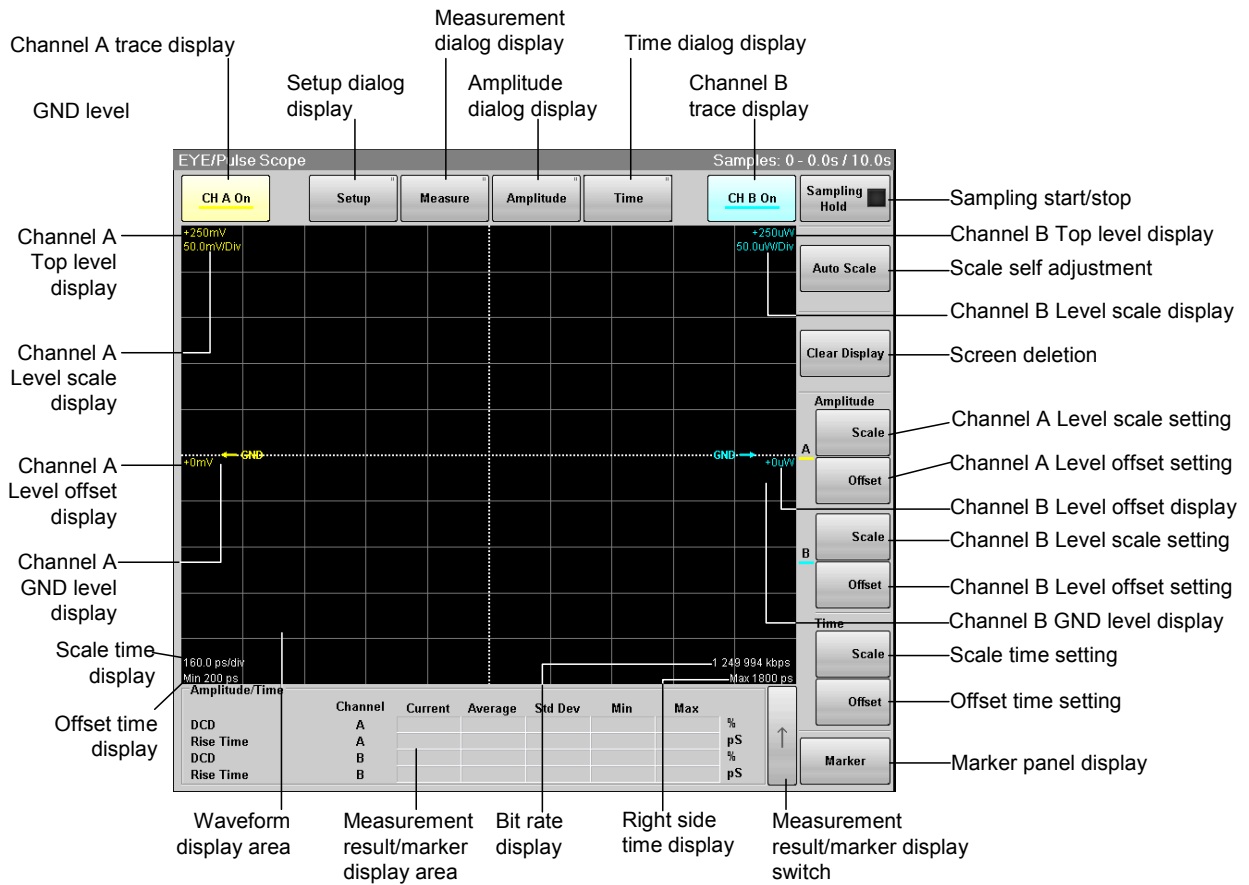


Figure 7.1.2-1 Result Window

Touching [Setup] – [Measure] – [Amplitude] – [Time] displays the dialog box.

Touching [Marker] displays the marker panel.

Setup Dialog

Touch [Setup] shown in Figure 7.1.2-1 to display the Setup dialog shown in Figure 7.1.2-2.

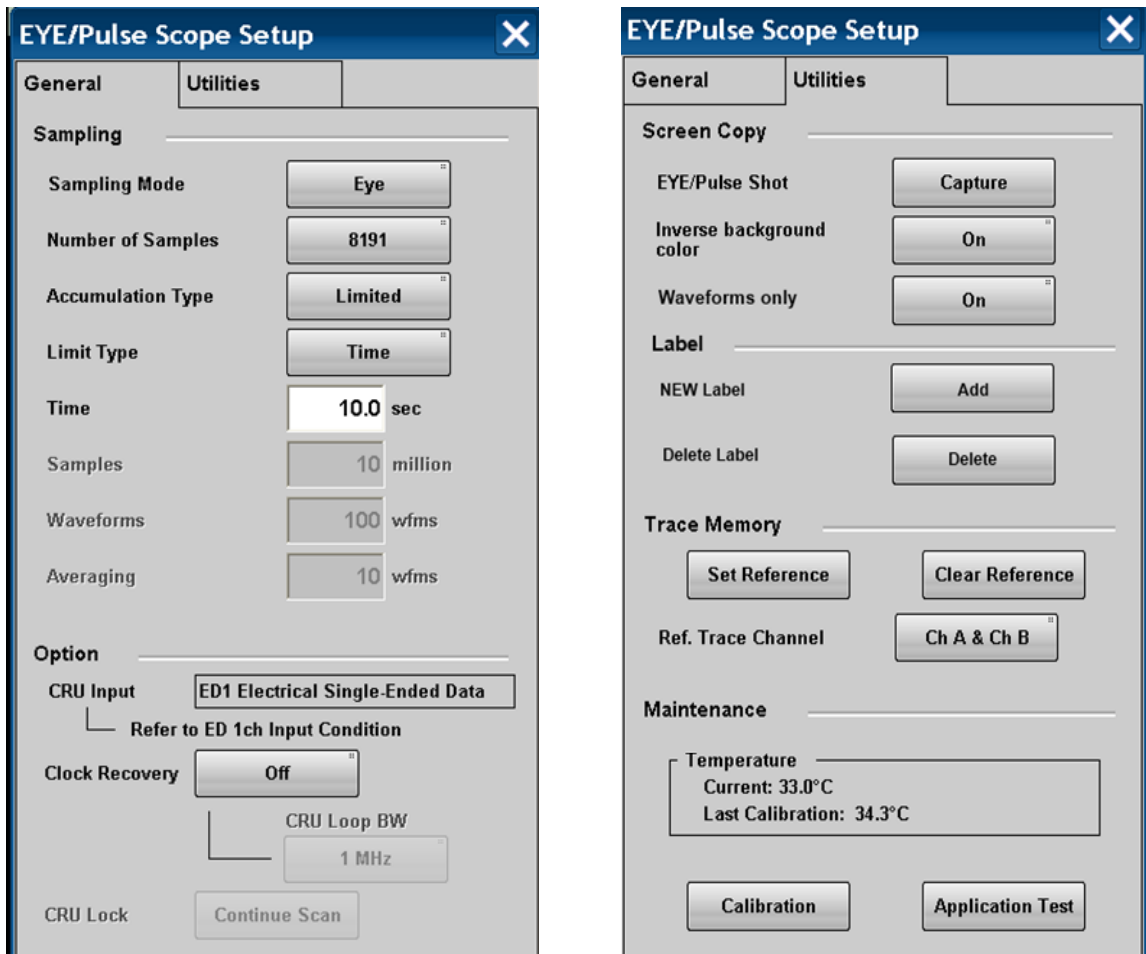


Figure 7.1.2-2 Setup Dialog

Tab	Item	Description
General	Sampling Mode	Switches to Eye/Pulse/ Coherent Eye mode.
	Number of Samples	Sets the number of samples.
	Accumulation Type	Sets the accumulation method of the sampling data.
	Limit Type	Selects the sampling end conditions from time, sampling count, or frequency.
	Time	Sets the sampling time.
	Sample	Sets the number of samples.
	Waveforms	Sets the waveforms.
	Averaging	When measuring the pulse mode, set the averaging process count.
	CRU Input	In the case of the MP2100A, the input connector of the clock recovery is displayed.
	Clock Recovery	When Option 055 is added, the frequency bandwidth of the clock recovery is set. The input connector is set at the Data Input Condition of the ED.
	CRU Loop BW	Sets the bandwidth of the loopback filter when Clock Recovery is set to [$>8.5\text{G}$].
	CRU Lock	When Option 055 is added, touch [Continue Scan] to detect the clock recovery frequency.
Utilities	EYE/Pulse Shot	Touching [Capture] saves the screen file in the result window.
	Inverse background color	Sets the color of the save screen at EYE/Pulse Shot.
	Waveform Only	On: Saves only the waveform displayed in the Result window to a file. Off: Saves the whole Result window to a file.
	NEW Label	Adds a new label.
	Delete Label	Deletes the displayed label.
	Set Reference	Saves the displayed waveform as the reference trace.
	Clear Reference	Deletes the reference trace.
	Ref.Trace Channel	Sets the channel saved in the reference trace.
	Temperature	Displays current temperature of the sampling scope and the temperature when the level is calibrated.
	Calibration	Calibrates the amplitude level of the sampling scope.
	Application Test	Runs the self test for the sampling scope.

Measure Dialog

Touch [Measure] as shown in Figure 7.1.2-1 to display the Measure dialog box as shown in Figure 7.1.2-3.

Touch the buttons on the Measure Item screen to set the items to be measured.



Figure 7.1.2-3 Measure Dialog



Figure 7.1.2-4 Selection Screen of Measure Item

Item	Description
Active Channel Selection	Selects channel to execute histogram measurement or mask test.
Measure Item	Selects items to be measured.
Off	Sets display of measurement item to Off.
Amplitude/Time	Displays screen to select measurement items for waveform amplitude and time.
Mask Test	Displays screen to set mask test pattern, eye margin, and measurement method.
Histogram	Displays screen to set measurement direction and range of histogram measurement.
Amplitude/Time&Mask	Displays screen to set waveform amplitude/time and measurement method of mask test.
Amplitude/Time&Histogram	Displays screen to set waveform amplitude/time and measurement method of histogram.

For more information about the measurement setting screen, refer to 7.11 “Measuring Waveform”.

Amplitude dialog

Touch [Amplitude] as shown in Figure 7.1.2-1 to display the Amplitude dialog box as shown in Figure 7.1.2-5.

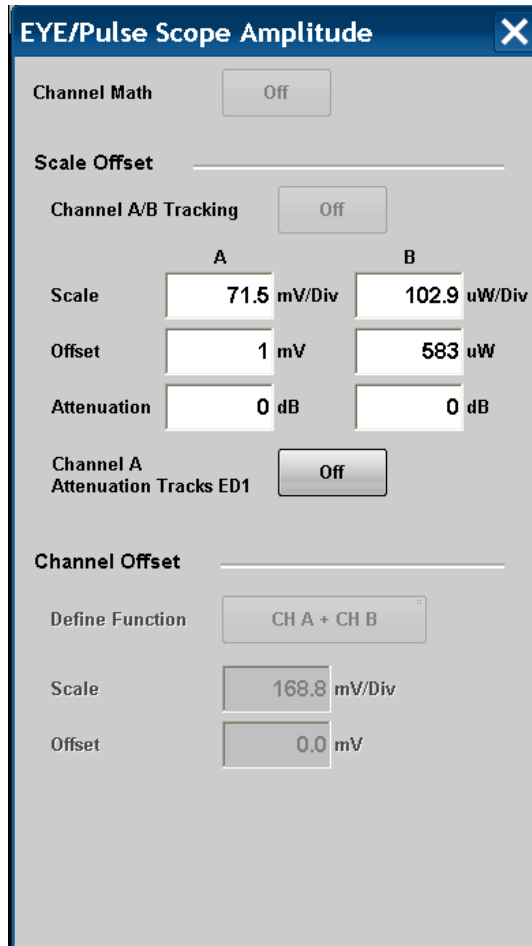


Figure 7.1.2-5 Amplitude Dialog (Optical/Single End Electrical Receiver)

Item	Description
Channel Math	[Off]: Displays waveforms for Channel A and B separately. [On]: Calculates waveforms for Channel A and B, and then that calculated result is displayed as Channel A.
Scale Offset	Sets the level scale for Channel A and B.
Channel A/B Tracking	[Off]: Sets scales for Channel A and B separately. [On]: Sets scales for Channel A and B as the same value.
Scale	Sets vertical scale.
Offset	Sets vertical offset.
Attenuation	Inputs attenuation amount for external attenuation.
Channel A Attenuation Tracks ED1	Sets Channel A Attenuation value to same value as set at ED1 External ATT.
Channel Offset	Sets Channel A and Channel B waveform calculation method and level scale for calculation results waveform.
Define Function	Sets calculation method between channels.
Scale	Sets vertical scale for calculation result between channels.
Offset	Sets vertical offset for calculation result between channels.

Time Dialog

Touch [Time] as shown in Figure 7.1.2-1, and then the Time dialog box as shown in Figure 7.1.2-6 is displayed.

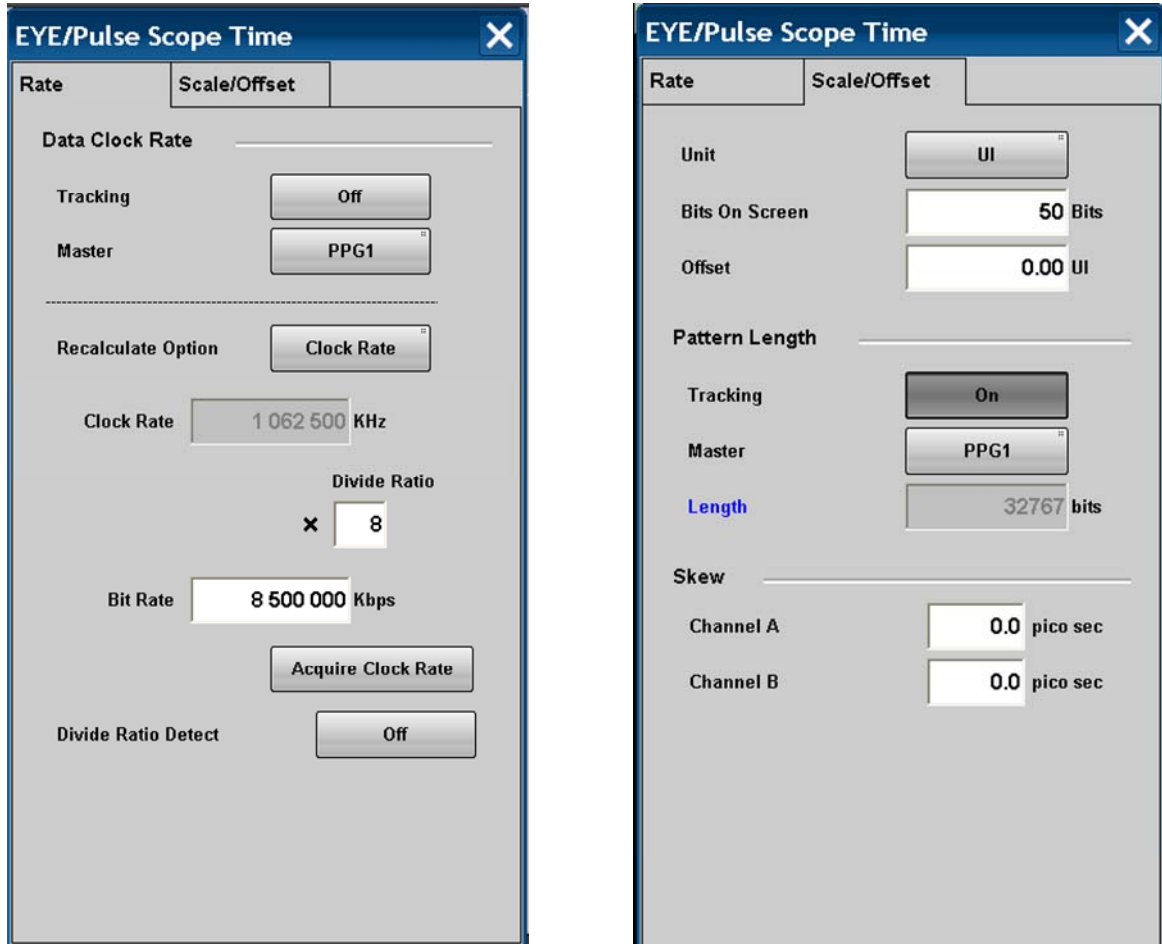


Figure 7.1.2-6 Time Dialog

Tab	Item	Description
Rate	Data Clock Rate	Sets input data speed, clock frequency, and frequency dividing rate.
	Tracking	[Off]: Inputs bit rate to Bit Rate [On]: Applies bit rate selected at Master to Bit Rate
	Master	Sets items affecting clock and bit rate.
	Recalculate option	[Clock Rate]: Calculates Clock Rate from Bit Rate and Divide Rate [Bit Rate]: Calculates Bit Rate from Clock Rate and Divide Rate.
	Clock Rate	Sets clock frequency input to Trigger Clk In connector.
	Divide Rate	Sets frequency dividing rate (Bit Rate/Clock Rate).
	Bit Rate	Sets signal bit rate to be measured.
	Acquire Clock Rate	Measures clock frequency input to Trigger Clk In connector.
	Divide Ratio Detect	Sets whether to detect frequency dividing ratio of clock signal input to Trigger Clk In connector.
Scale/Offset	Unit	Sets units of horizontal axis on screen.
	Bits on Screen	Sets bit count of the scale horizontal axis on screen.
	Offset	Sets time on left side of screen.
	Pattern Length	Sets input data pattern length.
	Tracking	[Off]: Input pattern length to Length [On]: Sets pattern length selected at Master to Length
	Master	Sets items affecting clock and Bit Rate.
	Length	Inputs pattern bit length. When measuring in Pulse mode, this value is used.
	Skew	Sets time offset. Setting positive values moves the waveform to the right. Setting negative values moves the waveform to the left.

7.2 Setting Item List

The setting item is listed as follows.

```

Amplitude
  Channel Math
    Off
      Channel A/B Tracking
        Off
          Attenuation
            A
            B
          Offset
            A
            B
          Scale
            A
            B
        On*1
          Attenuation  A/B
          Scale      A/B
          Offset     A/B
      Channel A Attenuation Tracks ED1*2
        Off
        On
    On*1
      Define Function
        CH A+CH B
        CH A-CH B
        CH B-CH A
      Offset
      Scale
Auto Scale
CH A
  Off
  On
CH A
  Offset
  Scale
CH B
  Off
  On
CH B
  Offset
  
```

Scale
Clear Display

Marker
Off
On
All Off
Center
X1
Off
On
X2
Off
On
Y1
Off
On
Y2
Off
On

Measure
Active Channel Selection
Channel A
Channel B
Measurement Item
Amplitude/Time
Amplitude/Time&Histogram
Amplitude/Time&Mask
Histogram
Mask Test
Off

Amp/Time
Add

Average Power (dBm)*3
Average Power (mW)*3
Crossing
DCD
Extinction Ratio*3
Eye Amplitude
Eye Height
Eye Width
Fall Time
Jitter p-p

- Jitter RMS
- OMA (dBm)
- OMA (mW)
- One Level
- Rise Time
- SNR
 - Zero Level
- Correction Factor
- Delete
- Eye Boundary
 - Offset from Crossing
 - Width
- Measuring Area Marker
 - Item
- Move
- Rise/Fall Time
 - 10/90%
 - 20/80%
- Rise/Fall Time Correction
 - Off
 - On
- Histogram
 - Axis
 - Amplitude
 - Time
 - Histogram Marker Center
 - Marker
 - X1
 - X2
 - Y1
 - Y2
- Mask Test
 - Eye Mask Select
 - 10GbE FEC
 - 10GbE LAN
 - 10GbE WAN
 - 10GFC
 - 10GFC FEC
 - 1GbE
 - 1GFC
 - 2GbE
 - 2GFC
 - 4GFC
 - 8GFC

8GFC_Elect_Rx
 8GFC_Elect_Tx
 OC12/STM4
 OC192/STM64
 OC192/STM64 FEC (G.975)
 OC3/STM1
 OC48/STM16
 OTU-1
 OTU-2 1310nm
 OTU-2 1550nm
 OTU-2 1550nm Expand
 OTU-2 Amplified
 User Defined
 Mask Area Restriction
 Off
 On
 Angle
 -90 to 90
 Width
 0.01 to 1.00
 Align Method
 Zero/One/ Crossing
 Mask Alignment
 Update
 User Defined
 Alignment Marker
 Display Off
 Display On
 ΔX
 ΔY
 X1
 Y1
 Mask Margin
 -100 to 100 %
 Mask Margin Test
 Continuous
 One Shot
 Margin Type
 Hit Count
 Hit Ratio

Setup
 Accumulation Type
 Averaging

Waveforms
Infinite
Limited
Limit Type
Sample
Samples
Time
Time
Waveform
Waveforms
None
Persistency
Persistence Time
Clock Recovery
<2.7G*4
>8.5G*4
CRU Loop BW
1 MHz
2 MHz
4 MHz
8 MHz
Off
CRU Lock
Continue Scan
Label
Delete Label
Delete
NEW Label
Add
Maintenance
Calibration
Application Test
Number of Sampling
509*5
512*6
1021*5
1024*6
1350*5
2039*5
2048*6
4093*5
4096*6
8191*5
8192*6

16381*5
 16384*6
 Sampling Mode
 Coherent Eye
 Eye
 Pulse
 Screen Copy
 Eye/Pulse Shot
 Capture
 Inverse background color
 Off
 On
 Waveform Only
 Off
 On
 Trace Memory
 Clear Reference
 Ref.Trace Channel
 Ch A
 Ch A & Ch B
 Ch B
 Set Reference
 Time
 Bit on Screen
 Data Clock Rate
 Tracking
 Off
 Acquire Clock Rate
 Auto Divide Ratio
 Clock Rate
 Bit Rate
 Divide Rate
 Recalculate Option
 Clock Rate
 Bit Rate
 Bit Rate
 Clock Rate
 On*2
 Master
 PPG1
 PPG2*7
 ED1
 ED2*7
 Offset

Pattern Length
Tracking
Off
Length
2 to 16777216
On*2
Master
PPG1
PPG2*7
ED1
ED2*7
Skew
Channel A
Channel B
Unit
Time
UI

- *1: Only MP2100A-001 and MP2102A-021 applicable
- *2: Only MP2100A applicable
- *3: Only MP2100A-003, MP2100A-007 and MP2102A-023 applicable
- *4: When MP2100A-055 or MP2102A-055 installed
- *5: When Sampling Mode is Eye
- *6: When Sampling Mode is Coherent Eye or Pulse
- *7: Only MP2100A-005 applicable

7.3 Setting Restrictions

The settings restrictions vary depending on the model name and options.

MP2100A-001, MP2102A-021

The measurement results of Average Power (dBm), Average Power (mW), Extinction Rate, OMA (mW), and OMA (dBm) at Amplitude/Time of the Measurement dialog are invalid.

MP2100A-003, MP2100A-007, MP2102A-023

Channel A/B Tracking and Channel Math at the Amplitude dialog are not displayed.

MP2102A-021/023

Data Clock Rate at the Time dialog can only be set to **Off**.

Pattern Length at the Time dialog can only be set to **Off**.

Attenuation Tracking at the Amplitude dialog can only be set to **Off**.

MP2100A-052

- Set Master of Data Rate Tracking to PPG1 when setting Reference Clock of PPG to Synchronized. When setting Master of Data Rate Tracking to PPG2, the waveform is not displayed properly with the different bit rate at CHA and CHB.
- If connecting the full-rate clock of Option 052 to the Trigger Clk terminal, set Tracking of Data Clock Rate in Time dialog to **Off**. Setting to **On** will result in loss the trigger synchronization.

MP2100A-055, MP2102A-055

Clock Recovery, CRU loop BW and CRU Lock of the Setup dialog can only be set when Option 055 is installed.

7.4 Measurement Procedure

The following figure shows the basic measurement procedure.

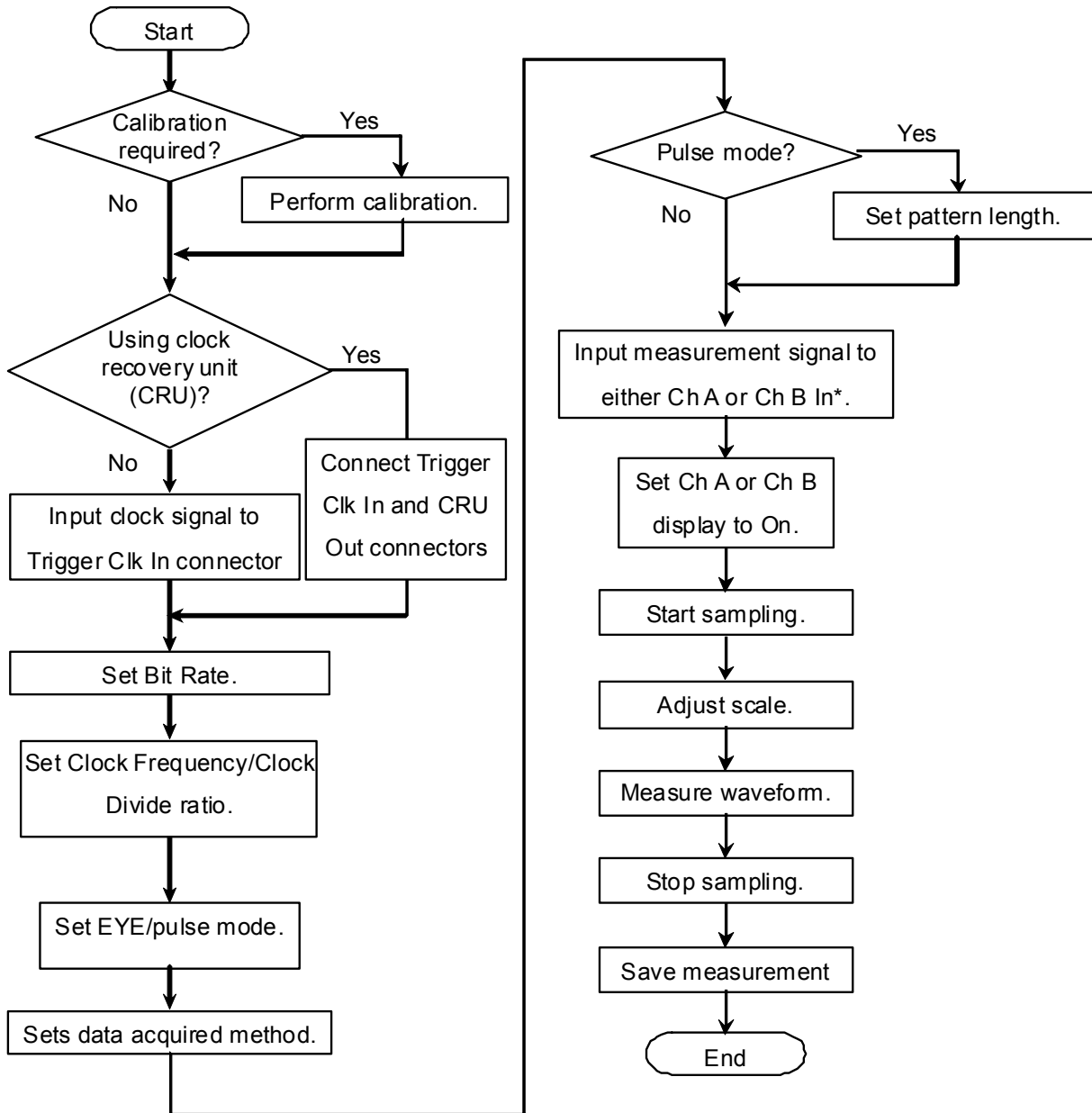


Figure 7.4-1 Basic Measurement Procedures

7.5 Calibrating Sampling Scope

7.5.1 Calibrating Level

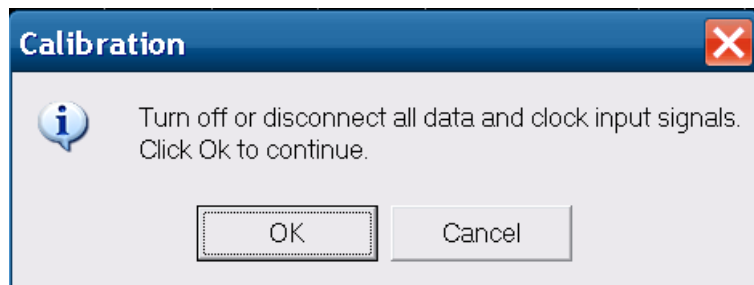
The amplitude accuracy of the sampling scope is guaranteed after performing calibration.

When the calibration is required, the error message "Calibration is required" is displayed at the Setup dialog in red.

Perform the calibration, when using the MP2100A/MP2102A initially or the message is displayed.

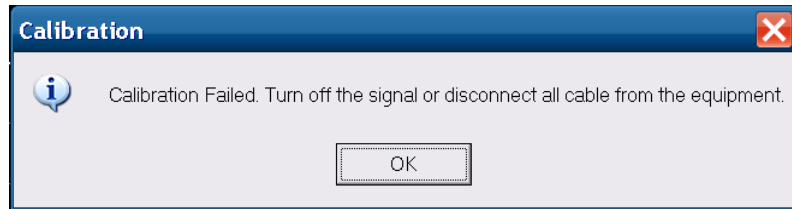
The calibration procedures are as follows:

1. Check that no signals are input to the front-panel Data In (A In) or Ch A In, $\overline{\text{Data}}$ In(B In) or Ch B In, Trigger Clk In connectors.
2. Touch [Setup] to display the Setup dialog.
3. Touch the [Utilities] tab.
4. Touch [Calibration], and then the message is displayed to confirm that the signal is not input to the connector.

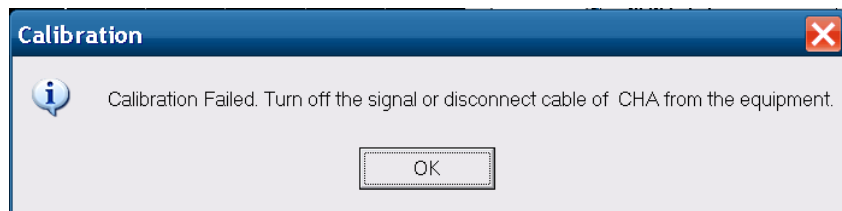


5. Touch [OK].

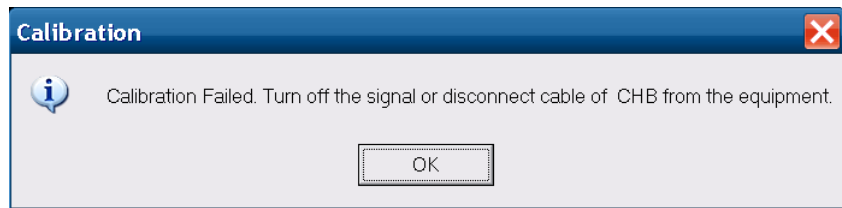
Upon completion of the calibration, a dialog box appears and gives you the calibration result.



When the Calibration of CHA and CHB Fails



When the Calibration of CHA Fails



When the Calibration of CHB Fails

Figure 7.5.1-1 Calibration Result Display (When Calibration Fails)

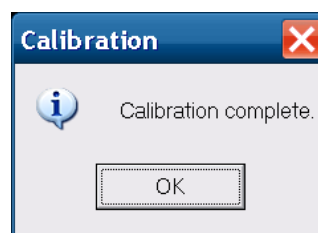


Figure 7.5.1-2 Calibration Result Display (When Calibration Is Successful)

If the calibration fails, follow the instruction that applies to your situation, and then retry from step 2.

When your instrument is the MP2100A BERTWave:

- Check that the coaxial cable is not connected to any of the Data In(A In), $\overline{\text{Data}}$ In(B In) and Trigger Clk In connectors on the front panel.
- If it is required to keep the coaxial cables connected to the Data In(A In), $\overline{\text{Data}}$ In(B In) and Trigger Clk In connectors on the front panel, check that the connectors do not receive any incoming signal.

When your instrument is the MP2102A BERTWaveSS:

- Check that the coaxial cable is not connected to any of the Ch A In, Ch B In and Trigger Clk In connectors on the front panel.
- If it is required to keep the coaxial cables connected to the Ch A In, Ch B In and Trigger Clk In connectors on the front panel, check that the connectors do not receive any incoming signal.

After the following operations, CAL alarm is displayed on the screen. When the CAL alarm is displayed, calibrate the level.

- Change [Sampling Model] on the Setup dialog.
- When Sampling Mode is [Pulse] or [Coherent Eye], change [Pattern Length] on the Time dialog.

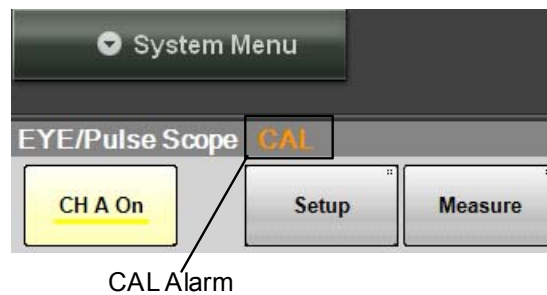


Figure 7.5.1-3 CAL Alarm Display

7.5.2 Performing Self Test

Perform the self test in the following cases:

- When the error message is displayed after level calibration referring to 7.5.1 Calibrating Level
- When the noise voltage is over the specified value shown in Appendix A when the signal is not input
- When the waveform is not displayed, the displayed waveform amplitude and bit cycle is different from the expected value, and the equipment operation and measurement results are abnormal.

The application self test runs following items.

- Power
- Frequency
- Amplitude

If the test result is normal, “passed” is displayed, on the other hand, if the test result is abnormal, “failed” is displayed.

The self test procedures are as follows.

1. Check that no signals are input to the front-panel Data In (A In) or Ch A In, $\overline{\text{Data}}$ In (B In) or Ch B In, Trigger Clk In connectors.
2. Touch [Setup] to display the Setup dialog.
3. Touch the [Utilities] tab.
4. Touch [Application Test]. The self test dialog is displayed while the self test is running.
5. After the self test is completed, the result is displayed.

When the power supply test result is failed:

1. When the power voltage is displayed, record the value.
2. Turn off the power supply.
3. Confirm that the power voltage supplied to the MP2100A/MP2102A is 100 to 120 VAC or 200 to 240 VAC.
4. When the power voltage does not have any faults, turn on the power supply.
5. Perform the self test again.
6. If the power supply test result shows “failed”, contact an Anritsu Service and Sales office.

When the frequency test result is failed:

1. Check that no signals are input to the Trigger Clk In connector.
2. Perform the self test again.
3. If the frequency test result shows “failed”, calibrate the sampling scope again. And then, perform the self test again. Nonetheless, in cases where the test result fails, contact an Anritsu Service and Sales office.

When the amplitude test result is failed:

1. Check that no signals are input to the Data In (A In) or Ch A In, $\overline{\text{Data}}$ In (B In) or Ch B In connectors.
2. Perform the self test again.
3. If the amplitude test result shows “failed”, calibrate the sampling scope again.
4. Perform the self test again.
5. Nonetheless, in cases where the test result fails, contact an Anritsu Service and Sales office.

7.6 Setting Clock Recovery and Rate

The trigger clock synchronized with the input signal is required to collect data.

The MP2100A can use the synchronized clock (Sync Out) of the internal PPG and ED.

When using the MP2100A with Option 055, the clock can be generated from the signal input to Data In (A In) or $\overline{\text{Data}}$ In (B In).

When using the MP2102A with Option 055, the clock can be generated from the signal input to CRU In.

When using Option 055 Clock Recovery Unit, connect the CRU Out and Trigger Clk In on the front panel using a coaxial cable.

After the trigger clock is input to the MP2100A/MP2102A, the bit rate, clock rate, and divide rate is set.

The bit rate is the signal input to Ch A or Ch B.

The clock rate is the frequency of the trigger clock.

Divide Rate is the rate between data bit rate and clock rate.

The value should be inputted to complete the following formula.

$$\text{Bit Rate} = \text{Clock Rate} \times \text{Divide Rate}$$

CAUTION

- The impedance of the Trigger Clk In connector is 50 Ω . Measurement may not be performed correctly if a cable with another impedance is used.
 - The amplitude of the signal input to the Trigger Clk In connector is 2 Vp-p max. This is equivalent to + 10 dBm for a sine-wave signal. Inputting a signal with a larger voltage risks damaging the internal circuits.
-

7.6.1 Setting Clock Recovery Unit

The Option 055 Clock Recover Unit (CRU) can generate a clock from the signal collecting data.

The waveform can be measured using the generated clock.

The following can be set using the clock recovery unit.

- CRU Input (MP2100A only)
- Clock Recovery
- CRU Loop BW

CRU Input sets the input connector for the clock recovery unit.

Clock Recovery sets the output On/Off and frequency range.

CRU Loop BW is the loop filter bandwidth used at the frequency control circuit for CRU.

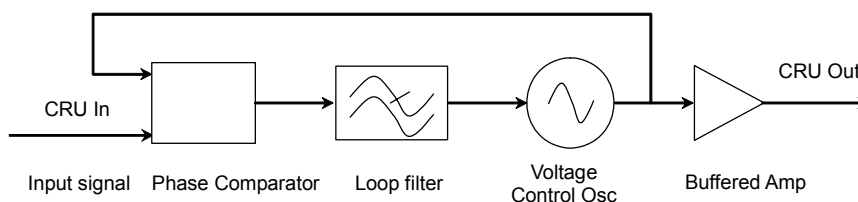


Figure 7.6.1-1 Block Diagram of Clock Recovery Unit

Although the frequency band is wide, instantaneous frequency fluctuations can be buffered. The communications standards specify the loop filter bandwidth used to measure jitter.



CAUTION

- The impedance of the CRU In and CRU Out connectors is 50 Ω . Measurement may not be performed correctly if a cable with another impedance is used or if the impedance of the connected device is not 50 Ω .
- The output voltage of the CRU Out connector is 0.5 to 1.5 Vp-p. Check that the output voltage does not exceed the connected device maximum input specifications. If it does, connect an attenuator to the CRU Out connector.

 **CAUTION**

- **The amplitude of the signal input to the CRU In connector is 2 Vp-p max. This is equivalent to + 10 dBm for a sine-wave signal. Inputting a signal with a larger voltage risks damaging the internal circuits.**
-

Procedure (MP2100A)

1. Connect the Trigger CLK In and CRU Out connectors on the front panel using a coaxial cable.
2. Touch [PPG/ED 1ch].
3. Touch [ED].
4. Select the Data Input Condition button for Clock Recovery from the following:
[Electrical Single-Ended Data]: Data In(A In) as input connector
[Electrical Single-Ended XData]: $\overline{\text{Data}}$ In(B In) as input connector
[Optical]: O/E Data In as input connector
5. Touch [EYE/Pulse Scope].
6. Touch [Setup].
7. Touch the Clock Recovery button to select CRU Band from the following items.
[Off]: Turn off the clock output to CRU Out connector
[<2.7]: Sets the CRU from 0.1 to 2.7 GHz.
[>8.5]: Sets the CRU from 8.5 to 12.5 GHz.
When setting to [<2.7] or [>8.5], “*CRU Valid” is displayed.
8. When Clock Recovery is [>8.5], select the CRU loop BW from the following:
[1 MHz], [2 MHz], [4 MHz], [8 MHz]
9. Touch [Time].
10. Set the divide rate to 1.
11. Touch [Acquire Clock Rate] at Acquire Clock Rate.

Procedure (MP2102A)

1. Connect the Trigger CLK In and CRU Out connectors on the front panel using a coaxial cable.
2. Input the signal to the CRU In connector of the front panel.
3. Touch [Setup].
4. Touch the Clock Recovery button to select CRU Band from the following items.
[Off]: Interrupts clock output to CRU Out connector
[<2.7]: Sets the CRU from 0.1 to 2.7 GHz.
[>8.5]: Sets the CRU from 8.5 to 12.5 GHz.
When setting to [<2.7] or [>8.5], “*CRU Valid” is displayed.
5. When Clock Recovery is [>8.5], select the CRU loop BW from the following:
[1 MHz], [2 MHz], [4 MHz], [8 MHz]
6. Touch [Time].
7. Set the divide rate to 1.
8. Touch [Acquire Clock Rate] at Acquire Clock Rate.

Note:

When not using the clock recovery unit, set CRU Band to [OFF]. The clock recovery may not be generated if the input signal frequency to the clock recovery is out of CRU Band. In that case, the [PLL Unlocked] is displayed.

When using the clock recovery unit, the bit rate displayed on the right bottom side of the waveform area might not be an expected value. In this case, touch [Continue Scan] at the CRU Lock.

7.6.2 Setting Bit Rate

1. Touch [Time].
2. Touch the Tracking button at Data Clock Rate, and set to [Off].
3. Touch the Recalculate Option button to select [Clock Rate].
4. Touch the Divide Rate text box.
5. Input the divide rate.
6. Touch the Bit Rate text box to input the bit rate.

The clock rate is calculated using the divide rate and bit rate.

The bit rate and divide rate are set so that the clock rate is set to 15 000 000 kHz or less.

When using the MP2100A, the bit rate for the PPG and the ED can be set to the bit rate for the sampling scope using the following procedures.

1. Touch [Time].
2. Touch the Tracking button at Data Clock Rate, and set to [Tracking On].
3. Touch the Master button of Data Clock Rate and select from the following units matching the bit rate.

[PPG1]: PPG/ED Ch1 PPG

[PPG2]: PPG/ED Ch2 PPG

When the MP2100A-005 is added, this can be selected.

[ED1]: PPG/ED Ch1 ED

[ED2]: PPG/ED Ch2 ED

When the MP2100A-005 is added, this can be selected.

When selecting Master, the bit rate, divide rate, and clock rate values are reflected.

7.6.3 Setting Clock Rate and Divide Rate

The bit rate can be set by measuring the clock rate from the signal input to the Trigger Clk In connector of the front panel.

1. Touch [Time].
2. Touch the Tracking button of the Data Clock Rate to set to [Off].
3. Touch the Recalculate Option button to select [Bit Rate].
4. Touch [Acquire Clock Rate].

The frequency is displayed in the Clock Rate text box.

Confirm the waveform and signal level input to the Trigger Clk In connector when the frequency is not displayed.

5. When the clock frequency is not displayed at Clock Rate or the displayed frequency is not correct, touch the Clock Rate text box and input the frequency.
6. Touch the Divide Rate text box and input the divide rate.
The bit rate is calculated by the divide rate and clock rate.

When using the MP2100A/MP2101A Sync Out as an external clock, the divide rate is set as follows.

Sync Output settings	Divide Rate
PPG1_1/1 CLK	1
PPG1_1/2_CLK	2
PPG1_1/4_CLK	4
PPG1_1/8 CLK	8
PPG1_1/16 CLK	16
PPG1_1/64_CLK	64
PPG2_1/1 CLK	1
PPG2_1/2 CLK	2
PPG2_1/4 CLK	4
PPG2_1/8 CLK	8
PPG2_1/16 CLK	16
PPG2_1/64 CLK	64
ED1_1/4 CLK	4
ED1_1/8 CLK	8
ED1_1/16 CLK	16
ED2_1/4 CLK	4
ED2_1/8 CLK	8
ED2_1/16 CLK	16

When setting Sync Output to PPG_1Ch_Pattern Sync or PPG_2Ch_Pattern Sync, the data cannot be collected.

7.7 Setting Data Collection Method

The data collection method is composed of the following types.

Data synchronized method: Eye mode, Pulse mode, Coherent eye mode

Cumulative display for waveform: None, Infinite, Limited, Persistency, Average

Note:

In this document, measurement of one data item on the screen is described as “data capture” while obtaining one screen of data is described as “data collection”.

To switch to Eye/Pulse/Coherent mode

1. Touch [Setup].
2. Touch the Sampling Mode button at the Setup dialog to set [Eye], [Pulse], or [Coherent Eye].

The Coherent Eye mode is used when calculating the waveform of Channel A and Channel B.

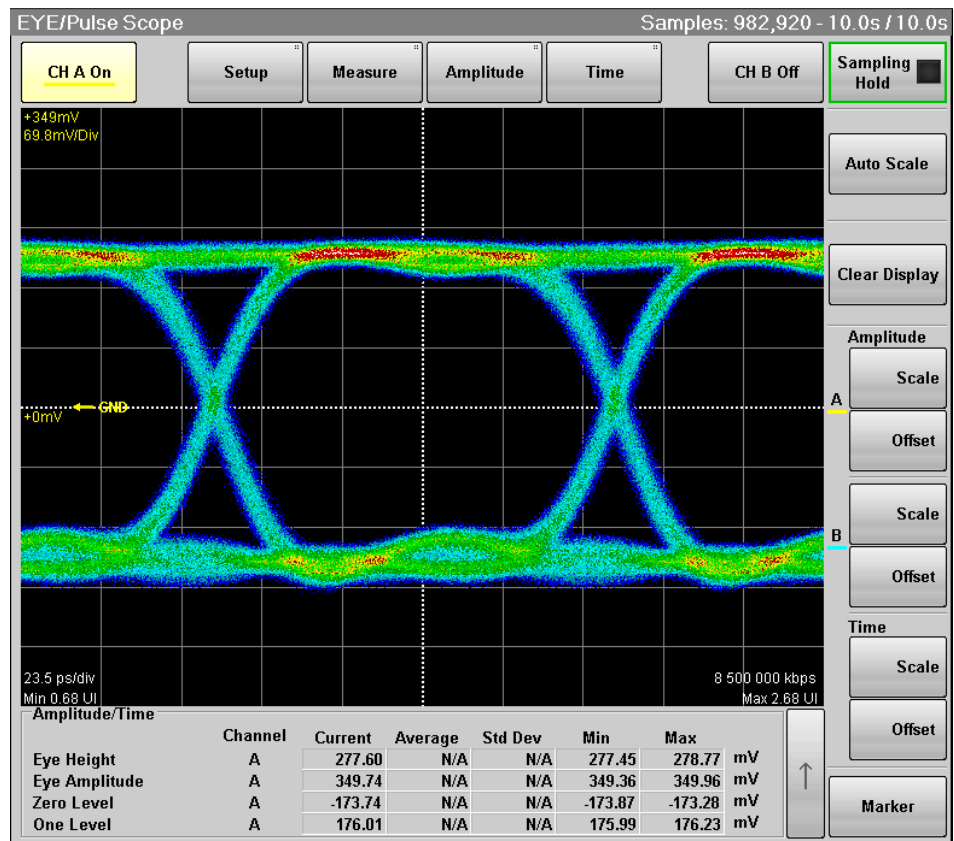


Figure 7.7-1 Eye Mode/Coherent Mode Display Example

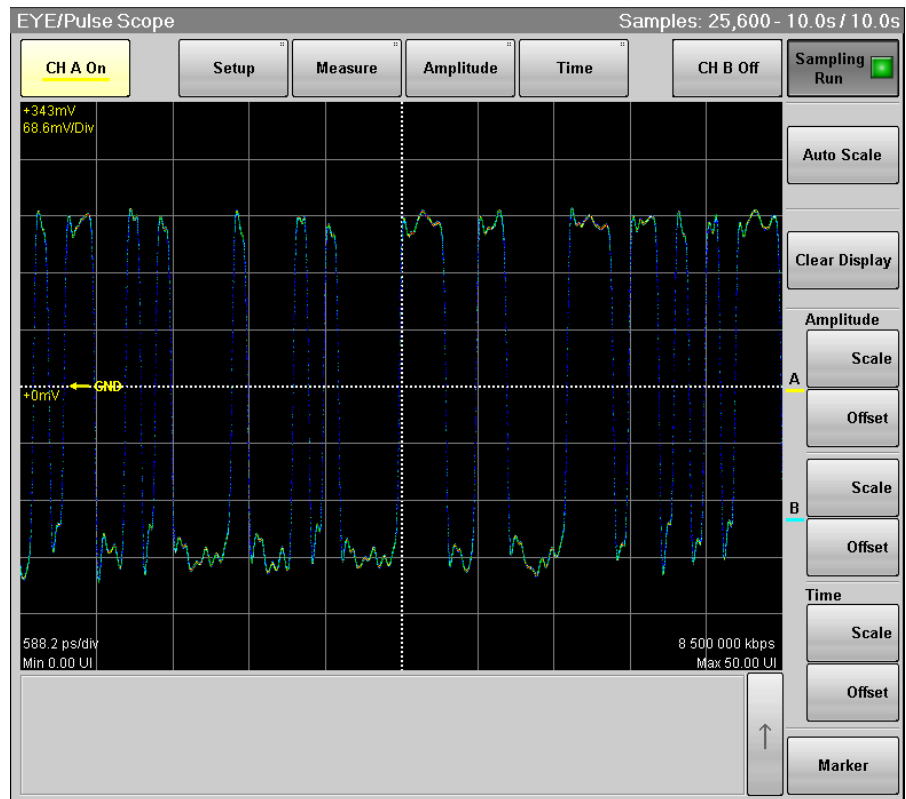


Figure 7.7-2 Pulse Mode Display Example

Setting overwritten waveform display

When setting the display method to [Infinite], [Limited] or [Persistency], the acquired data is overwritten on the screen.

1. Touch [Setup] to display the Setup dialog.
2. Select the single waveform data collection count from the following number of samples.
For [Eye]: [509], [1021], [1350], [2039], [4093], [8191], [16381]
For [Pulse], [Coherent Eye]:
[512], [1024], [2048], [4096], [8192], [16384]
When there is only a small amount of captured data, the screen refresh time is short.
3. Touch the Accumulation Type button, and set the items from the following lists:
[Infinite]: Unlimited time to overwrite waveform
[Limited]: The waveform is overwritten at the set time until it reaches the number of data or the numbers of waveforms. Data collection stops at the set time or when the data count is reached.
[Persistency]: Deletes overwritten data after fixed time elapsed

4. When selecting [Limited] at step 3, set the at-end condition.
 - To end overwriting waveform when the set time is passed, set Limit Type to [Time].
Touch the Time text box to input the time.
 - To end overwriting waveform when the data count set at the screen is reached, set Limit Type to [Sample].
Touch the Samples text box to input the number of data.
 - To stop waveform overwriting when the set time has elapsed, set Limit Type to [Waveform].
Touch the Waveforms text box to input the number of waveforms.
5. When [Persistency] is selected at step 3, set the time for saving the overwritten data.
Touch the Time text box to input the time.

Deleting overwritten waveform display

1. Touch [Setup] to display the Setup dialog.
2. Touch the Accumulation Type button to select [None].
3. Touch the Number of samples button to select the number of data displayed on the screen from the following:
For [Eye]: [509], [1021], [1350], [2039], [4093], [8191], [16381]
For [Pulse], [Coherent Eye]:
[512], [1024], [2048], [4096], [8192], [16384]

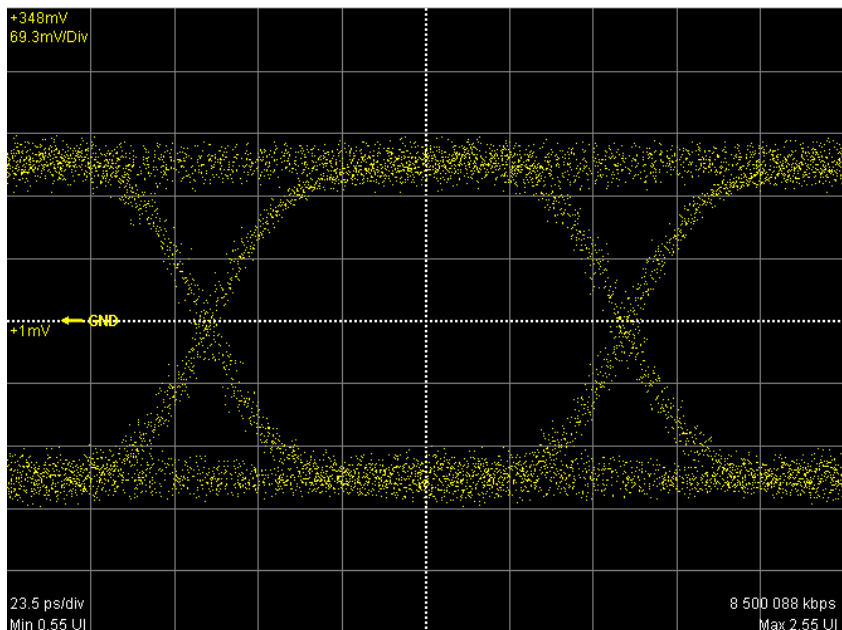


Figure 7.7-3 Accumulation Type Settings (None)

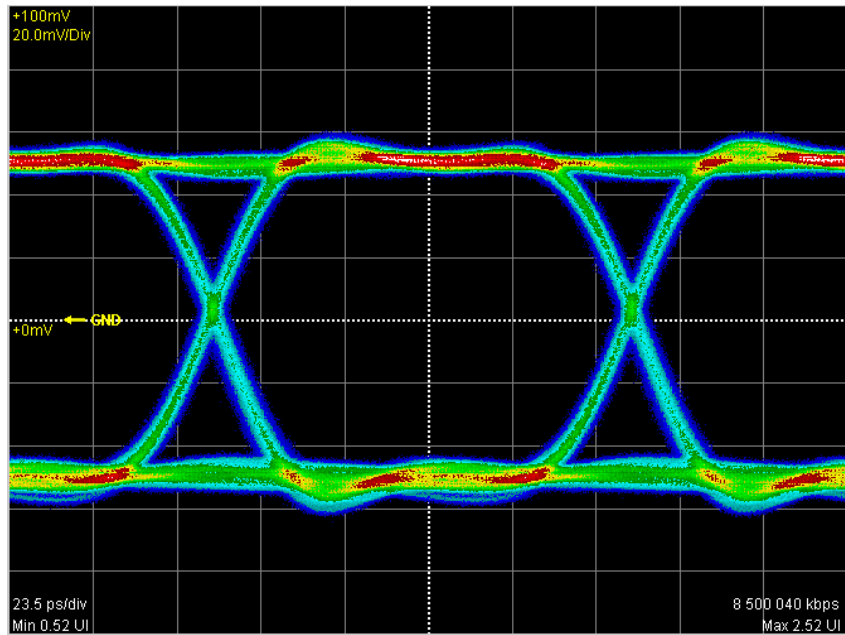


Figure 7.7-4 Accumulation Type Settings (Infinite)

Displaying averaging waveform

When setting the display method to [Averaging] at the pulse mode, the averaging process is performed. Averaging process is used to suppress waveform noise.

1. Touch [Setup] to display the Setup dialog.
2. Touch the Accumulation Type button to select [Averaging].
3. Touch the Number of samples button to select the number of data displayed on the screen from the following:
[512], [1024], [2048], [4096], [8192],[16384]
4. Touch the Averaging text box to set the number of waveforms to perform averaging.

In averaging, the mean value of the data count input at Averaging is calculated and the results are displayed on the screen. However, when 1 is input, no averaging is performed.

The number of averaging waveforms is displayed on the screen while executing averaging.

The waveform is captured ten times when the following condition is set, and ten averaging waveforms are displayed.

- Accumulation Type Average
- Averaging 100 wfms

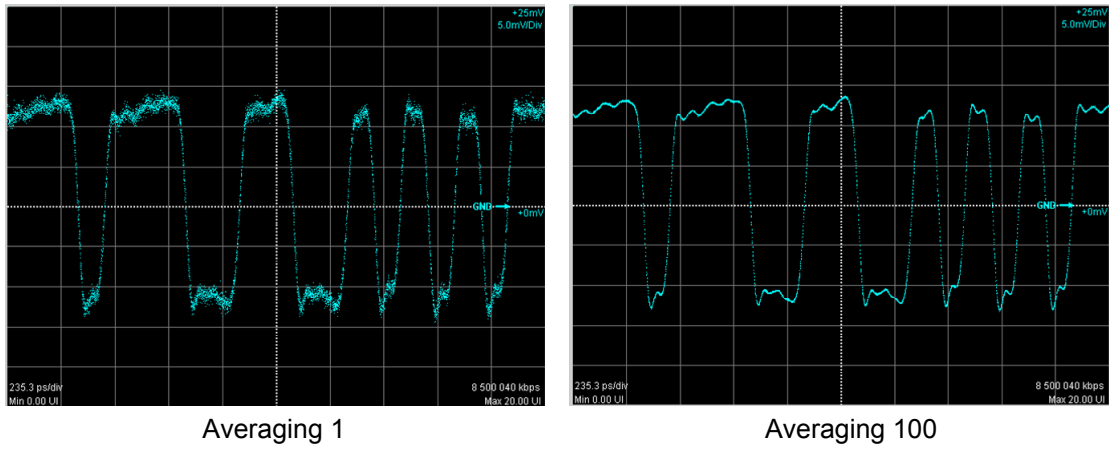


Figure 7.7-5 Example of Averaging Process

The averaging is calculated using the following formula.

Number of waveforms \leq Averaging setting count:

$$Ave(n) = \frac{(n-1) \times Ave(n-1) + S(n)}{n}$$

Averaging setting count \leq Number of waveforms:

$$Ave(n) = \frac{(M-1) \times Ave(n-1) + S(n)}{M}$$

Ave(n): Averaging value, S(n): Measurement value, M: Averaging setting count, n: Number of waveforms

The size of the noise is inversely proportional to the square root of the averaging setting count.

For example, if M is set to 100, the noise amplitude is compressed to about 1/10 compared to when M is set to 1.

7.8 Setting Pattern Length

When the Pulse mode is set as described in Section 7.7 Setting Data Collection Method, the pattern length can be set.

In the Pulse mode, the pattern is synchronized by collecting data at the pattern length time cycle.

1. Touch [Time].
2. Touch the Tracking button at Pattern Length to set to [Off].
3. Touch the Length text box at Pattern Length.
4. Input the pattern length by the bit unit.

Note:

The settable pattern length is up to 1677216 (2^{24}).

When Text Pattern at PPG/ED is $2^{31}-1$, [Tracking On] cannot be set to Tracking at Pattern Length.

When Pattern Length is set to [Tracking On], Test Pattern at PPG/ED cannot be set to $2^{31}-1$.

When changing the PPG/ED pattern length settings using the MP2100A, the changed setting values can be set to the sampling scope automatically.

1. Touch [Time].
2. Touch the Tracking button at Pattern Length, and then set to [On].
3. Touch the Master button at Pattern Length.
4. Select the PPG and ED with equal pattern lengths.

7.9 Collecting Data

Once the data collection is started, the waveform is displayed on the screen.

Starting data collection

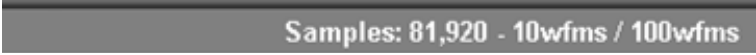
1. The waveform of the channel with the monitor signal input is displayed.

When monitoring the signal input to the Data In (A In) or Ch A In connector, touch the Channel A trace display button to set the button display to [CH A On].

When monitoring the signal input to the $\overline{\text{Data}}$ In (B In) or Ch B In connector, touch the Channel B trace display button to set the button display to [CH B On].

2. Touch the sampling start/stop button to display [Sampling at the button display.

The elapsed time, number of samples and number of waveforms are displayed in the title bar when [Accumulation Type] is set to [Limited].



Samples: 81,920 - 10wfms / 100wfms

When [Averaging] is set to 2 or more in the Pulse mode, the number of waveforms is displayed in the title bar.

The data collection can be started by touching all measurement start button as shown in Figure 4.1-1.

Stopping data collection

Touch the sampling start/stop button, and then set to [Sampling Hold]. When Accumulation Type at the Setup dialog is set to [Limited], the data collection is stopped once the at-end conditions are satisfied.

The data collection can be started by touching all measurement stop button as shown in Figure 4.1-1.

Discarding screen display

When temporarily deleting screen display:

Touch the Channel A trace display button, and then set the button display to [CH A Off].

Touch the Channel B trace display button, and then set the button display to [CH B Off].

The waveform is displayed when setting the button display to [CH A On] or [CH B On].

When discarding collected data:

Touch [Clear Display].

The waveform is deleted even when the button display is set to [CH A On] or [CH B On].

The discarded data cannot be displayed again.

7.10 Adjusting Screen Scale

7.10.1 Adjusting scale automatically

Measure the waveform amplitude and period, and then set to the easily viewable scale.

For Eye/Pulse/Coherent Mode

1. Touch [Auto Scale].
2. The waveform is displayed at the center of the screen.

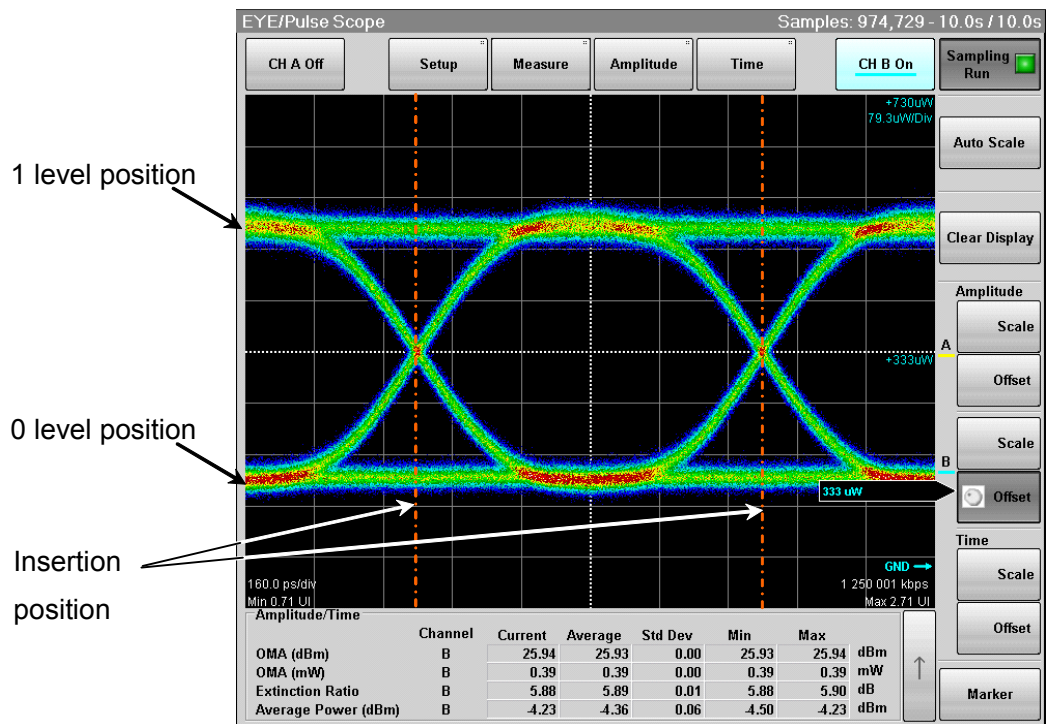


Figure 7.10.1-1 Waveform Display after Auto Scale (Eye/Pulse/Coherent Mode)

When adjusting scale automatically, the two-bit waveform is displayed on the horizontal axis.

The Eye pattern waveform crossing points are 2.5 and 7.5 scale divisions from the left side.

At the vertical axis, “one” level 2.5 gridlines above center of grid, “zero” level 2.5 gridlines below center of grid.

Note:

When both CH A and CH B are set to ON, the offset at the time axis is adjusted according to the channel signal selected at Active Channel Selection.

For Pulse Mode

1. Touch [Auto Scale].
2. The waveform is displayed at the screen center.

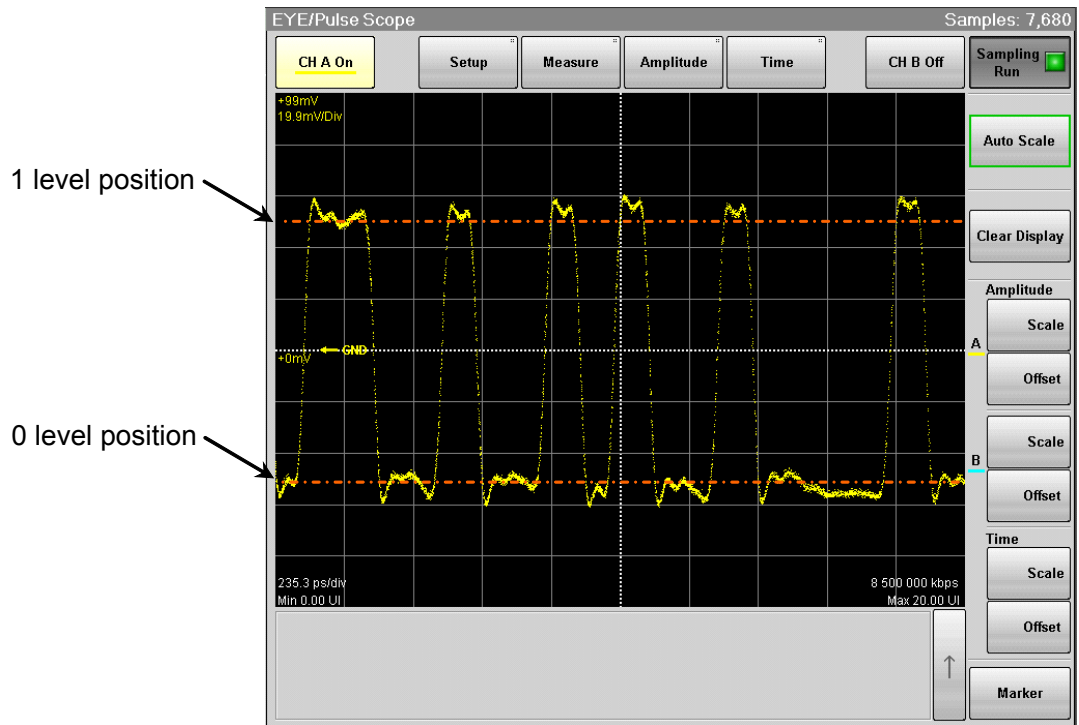


Figure 7.10.1-2 Waveform Display after Auto Scale (Pulse Mode)

When the pattern length is 127 bits or less, a 20-bit waveform is displayed.

When the pattern length is 128 bits or more, a 50-bit waveform is displayed.

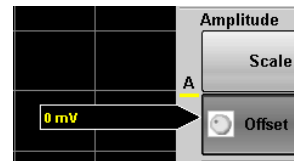
The 1 level is adjusted on the vertical scale to the 2.5th scale up from the screen center and the 0 level is adjusted to the 2.5th scale down from the screen center.

7.10.2 Adjusting Vertical-axis of Screen

To adjust voltage or optical power at center of vertical axis

1. Touch [Offset] at Amplitude on the left side of the waveform display area.

The rotary knob icon is displayed in the button.



2. Input the power voltage or optical power at the screen center position using the rotary knob.
3. When using the trace A, the input value is displayed at the left center of the waveform display area.
When using the trace B, the input value is displayed at the right center of the waveform display area.

To adjust voltage or optical power per scale:

1. Touch [Scale] at Amplitude in the right side of the waveform display area.

The rotary knob icon is displayed in the button.

2. Input the voltage or optical power per scale using the rotary knob.
3. When using the trace A, the input value is displayed at the left upper corner of the waveform display area.
When using the trace B, the input value is displayed at the right upper corner of the waveform display area.

The vertical-axis can be also adjusted by using the method for setting the Amplitude dialog.

1. Touch [Amplitude].
2. Touch the Offset text box.
3. Input the voltage or optical power at the screen center position.
4. Touch the Scale text box.
5. Input the voltage or optical power per scale.

Setting same vertical scale for two waveforms

The vertical scales at Channel A and Channel B can be set to the equal value using the MP2100A-001 or MP2102A-021.

1. Touch [Amplitude].
2. Touch the Channel A/B Tracking button, and set to [On].
And then, the text box for Channel A is only available.
3. Touch the Scale, Offset, and Attenuation text boxes, and then set the value.

Note:

When the Channel A/B Tracking is set to [On], the CH B scale, offset, and attenuator value are changed to the CH A values.

Touch [Scale] and [Offset] at Amplitude on the right side of the screen, and then the value set using the rotary knob will be valid. In this case, the CH B scale and offset values are not displayed on the Amplitude dialog.

7.10.3 Adjusting Horizontal-axis of Screen

Adjusting time at left edge of screen

1. Touch [Offset] at Time in the right side of the waveform display area.
The rotary knob icon is displayed in the button.
2. Input the time at left edge of screen using the rotary knob.
3. The time entered is displayed at the left lower corner of the waveform display.

To switch the horizontal position units between UI (unit interval) and time (ps), touch [Time] and the Unit button.

To adjust number of bits displayed on the screen

Procedure to set number of bits from Result window

1. Touch [Scale] at Time in the right side of the waveform display area.
The rotary knob icon is displayed in the button.
2. Input the number of bits per scale using the rotary knob.
3. The sum of the value at the bottom left of the screen and the input value is displayed at the bottom right.

Procedure to set number of bits from Time dialog

1. Touch [Time].
2. Touch the [Scale/Offset] tab.
3. Touch Bit on Screen text box.
4. Input the number of bits.

To adjust the waveform position

1. Touch [Time].
2. Touch the [Scale/Offset] tab.
Changing Offset can adjust the position of single waveform,
3. Touch the Skew text box and input the values.

The waveform moves right when a positive value is set.

The waveform moves left when a negative value is set.

7.10.4 Adjusting External Attenuator

Adjusting attenuation of external attenuator

The attenuation amount of an external attenuator connected to the Data In (A In) and $\overline{\text{Data}}$ In (B In) connectors can be adjusted as described below.

1. Touch [Amplitude].
2. Touch the Attenuation text box.
3. Input the attenuation.

The attenuation set at the error detector (ED1) can be set to the Channel A attenuation when using the MP2100A.

1. Touch [Amplitude].
2. Touch the Channel A Attenuation Tracks ED1 button, and set to [On].

The n dB attenuation is calculated by the following formula:

$$\text{Electrical input: } 10^{\frac{n}{20}}$$

$$\text{Optical input: } 10^{\frac{n}{10}}$$

7.11 Measuring Waveform

The waveform measurement methods are as follows.

For the explanation of the measurement items, refer to 1.4 “Glossary”.

- Amplitude and time measurements

Select the measurement items from the following:

Average power, Crossing%, Duty cycle distortion, Extinction rate, Eye amplitude, Eye height, Eye width, Fall time, Jitter p-p, Jitter RMS, One level, Rise time, SNR, Zero level, Optical amplitude

The extinction rate, average optical power, and optical amplitude can be measured when using the O/E converter.

- Histogram

Sets the screen field and displays the data distribution in the time or amplitude direction and the measurement results.

- Mask test

Sets the mask pattern and mask margin, and then measures the data count in the mask.

The set data count can measure the mask margin within the mask.

The amplitude and time measurements are only available in the Eye mode.

Table 7.11-1 Measurement Method per Displayed Mode

Measurement Method	Eye Mode	Pulse Mode	Coherent Mode
Measurement for amplitude and time	✓	–	✓
Histogram	✓	✓	✓
Mask test	✓	✓	✓

7.11.1 Amplitude and Time Measurements

When collecting data in the Eye pattern mode, up to 4 amplitude and time measurements can be performed.

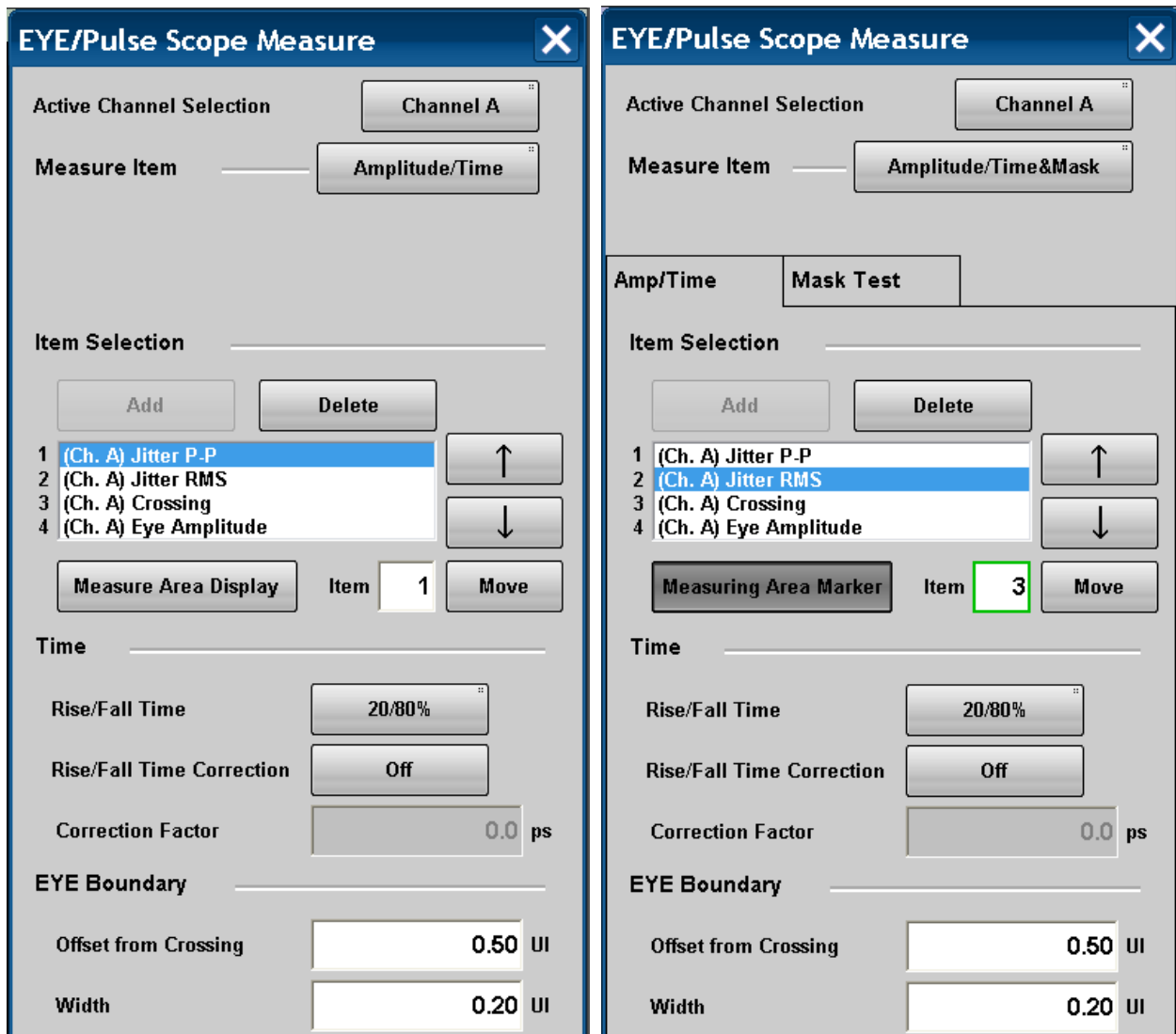


Figure 7.11.1-1 Setting Example of Amplitude/Time Measurement

To set measurement items:

1. Touch [Measure] to display the Measure dialog.
2. Touch the Measure Item button.
3. Touch [Amplitude/Time], [Amplitude/Time&Mask], or [Amp/Histogram].
4. When selecting [Amplitude/Time&Mask] or [Amp/Histogram], touch the [Amp/Time] tab.
5. Touch [Add] at Item Selection.
The screen for selecting the measurement items is displayed.
6. Touch the measurement item.
7. The screen for selecting the channel is displayed.
Touch [Channel A] or [Channel B].
8. The item selected for the Item Selection list is added.
9. The measurement result is displayed in the button of the screen.

Up to 4 items can be selected. If you want to change the item, delete one of the selected items first.

If the added item is the same as an item selected already for the same channel, that item cannot be added using Item Selection.

To display measurement area

The marker shows which part of the waveform is measured.

1. Touch [Measuring Area Marker]. The display changes when the button is pressed. The measurement area is indicated by the marker (EYE Boundary).
2. The measurement number displayed in the measurement area can be set by touching the Item text box.
3. The measurement item in the measurement result display area is displayed in blue characters.

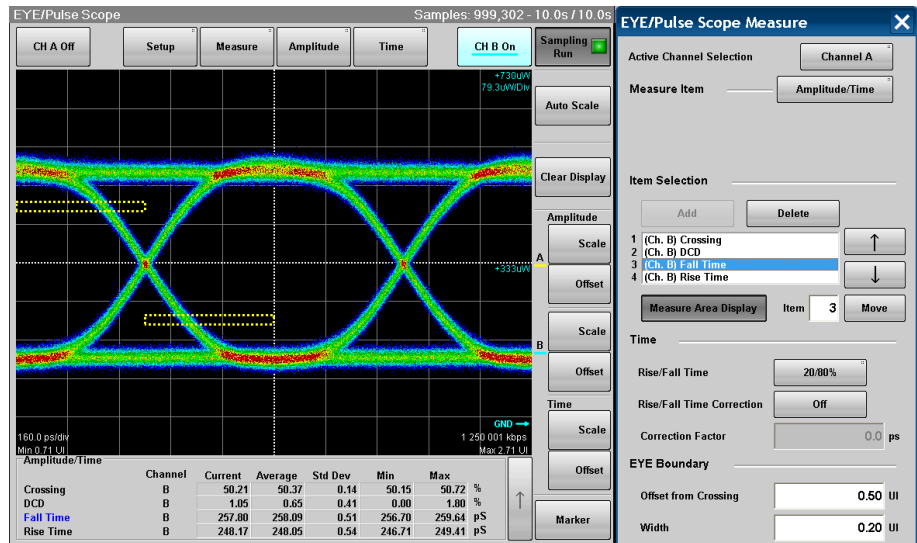


Figure 7.11.1-2 Display Example of EYE Boundary

When there is a possibility the waveform may not have been measured correctly due to too small amplitude or too large jitter, “EYE?” and channel name (CHA/CHB/CHA,CHB)” in red is indicated as shown below.

In this case, check the settings for the amplitude and trigger of the measured signal and make sure the connectors are secure.

Amplitude/Time		
EYE? CHA	Channel	Current
Extinction Ratio *Corrected	B	N/A dB
Eye Amplitude	A	376.25 mV
Rise Time	A	23.26 pS
Fall Time	A	22.55 pS

Figure 7.11.1-3 Appearance of Amplitude/Time Area (When Measurement Results May Be Incorrect)

To change EYE Boundary

The 1 and 0 level measurement area can be changed.

1. Touch the Offset in the Crossing text box to set the area center position.
2. Touch the Width text box to set the area width.

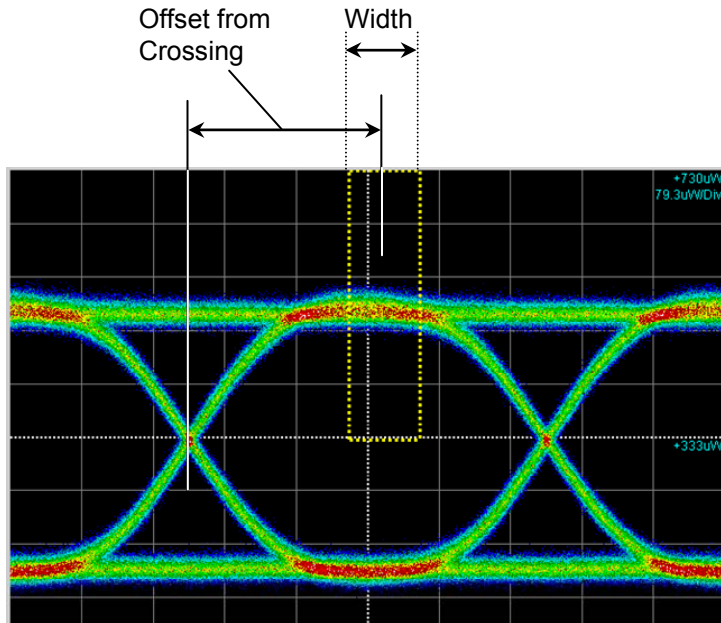


Figure 7.11.1-4 Setting Item of EYE Boundary

To set measurement method of rise/fall time

When measuring the rise time and fall time levels, select from amplitude 10/90% level or 20/80% level.

1. Touch the Rise/Fall Time button to display [10/90%] or [20/80%].

The bandwidth of the sampling scope is corrected with the measurement value of the Rise/Fall time, and the corrected bandwidth is displayed.

1. Touch [Rise/Fall Time Correction] to set the button display to [On].
2. Touch the Correction Factor text box.
3. Input the correction value in ps.

The calculation formula is as follows:

$$Td = \sqrt{Tm^2 - Tc^2}$$

Td: display value(ps), Tm: measurement value(ps), Tc: correction value (ps)

If the measurement value is larger than the correction value, the result displays N/A.

"Corrected" is displayed in red at the Rise/Fall time when Rise/Fall Time Correction is set to [On].

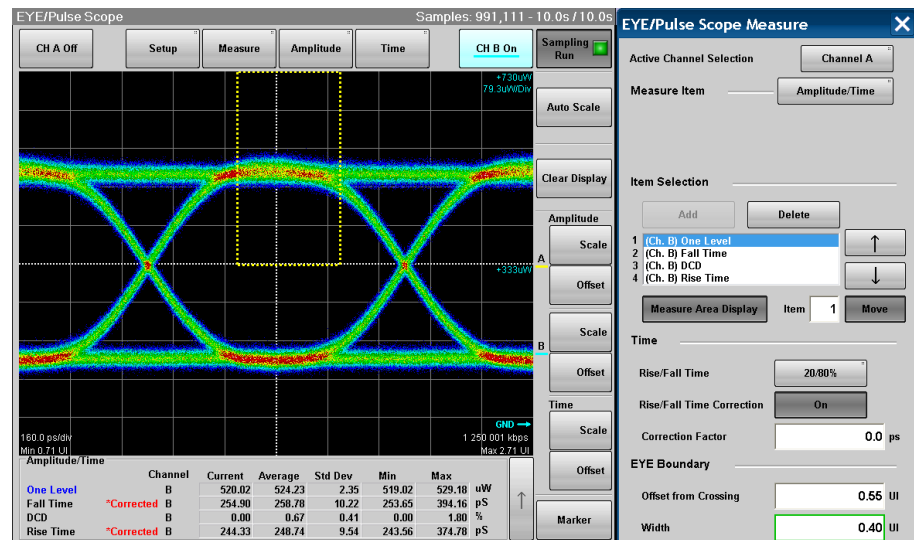


Figure 7.11.1-5 Display Example of Measurement Result

To change display order

The display order of the measurement result is the same as that of Item Selection. The display order of Item Selection can be changed using the following procedures.

1. Touch [↑] or [↓] at Item Selection to highlight the item for changing the display order.
2. Touch [Move], and then the button display is changed to the in-use display.
3. Touch [↑] or [↓] to move the highlighted items.
4. Touch [Move], and then the button display is restored to the normal display.

To delete items

1. Touch [↑] or [↓] at Item Selection to highlight the deleting items.
2. Touch [Delete] to delete the item from the list.

7.11.2 Displaying Histogram

The histogram display displays the data distribution in the set field to measure the mean, standard deviation, and dispersion width. To display histogram, set the axis, time, or amplitude for measuring histogram. And then, set the screen area to display histogram using the histogram marker. Also, the histogram marker position can be set by touching the screen or using the mouse.

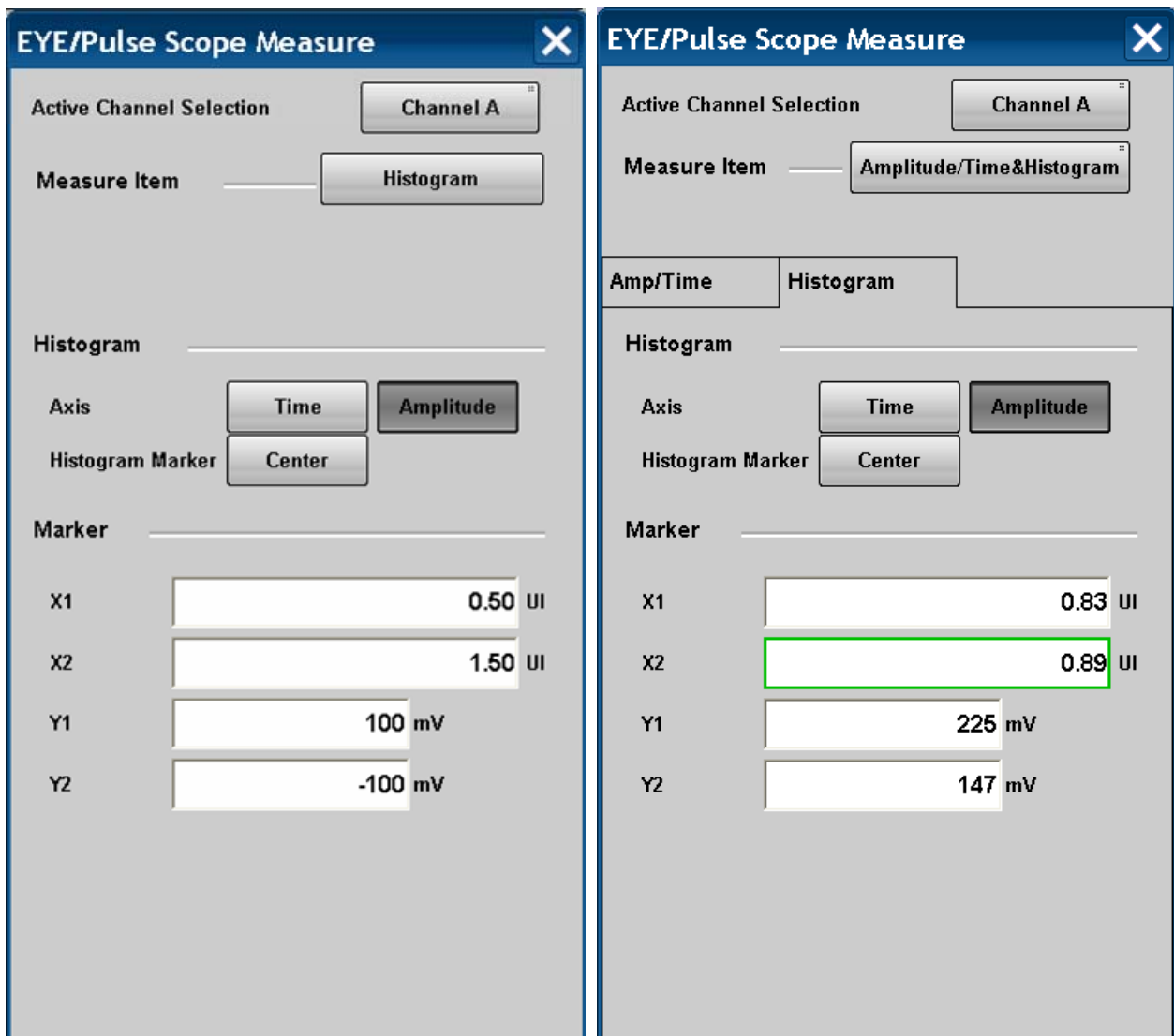
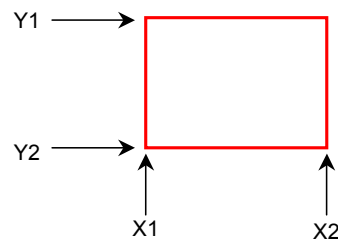


Figure 7.11.2-1 Setting Example of Histogram Measurement

1. Touch [Measure] to display the Measure dialog.
2. Touch the Active Channel Selection button, and then select the channel to be measured.
3. Touch the Measure Item button.
4. Touch [Histogram], or [Amp/Histogram].
5. When selecting [Amp/Histogram], touch the [Histogram] tab.
6. When measuring histogram for time direction, touch [Time] at [Axis].
When measuring histogram for amplitude direction, touch [Amplitude] at [Axis].
7. Input the value to the histogram marker X1, X2, Y1, and Y2, and then set the area.

The area border to set the histogram marker is as shown in the following figure.



Toughing the screen and dragging the marker change the histogram marker position.

8. The measurement result of the data within the area is displayed.
Mean: average value
std Dev: standard deviation
P-P: difference between maximum value and minimum value (Peak to Peak)
Hits: data count within area

To display marker at screen center:

Touch [Center] at Histogram Marker to center the marker in the middle of screen.

When histogram measurement is turned on, depending upon the previous settings, the X and Y coordinates of the histogram window may be set beyond the boundaries of the current display screen. If this occurs, touching [Center] at Histogram Marker makes it easy to set the area.

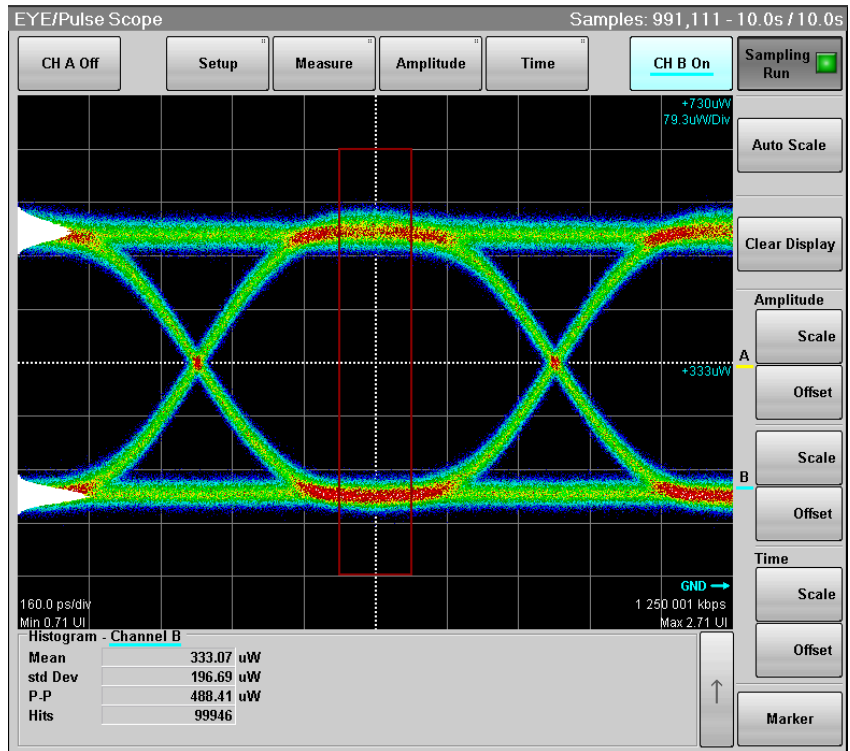


Figure 7.11.2-1 Histogram Measurement Example (Amplitude)

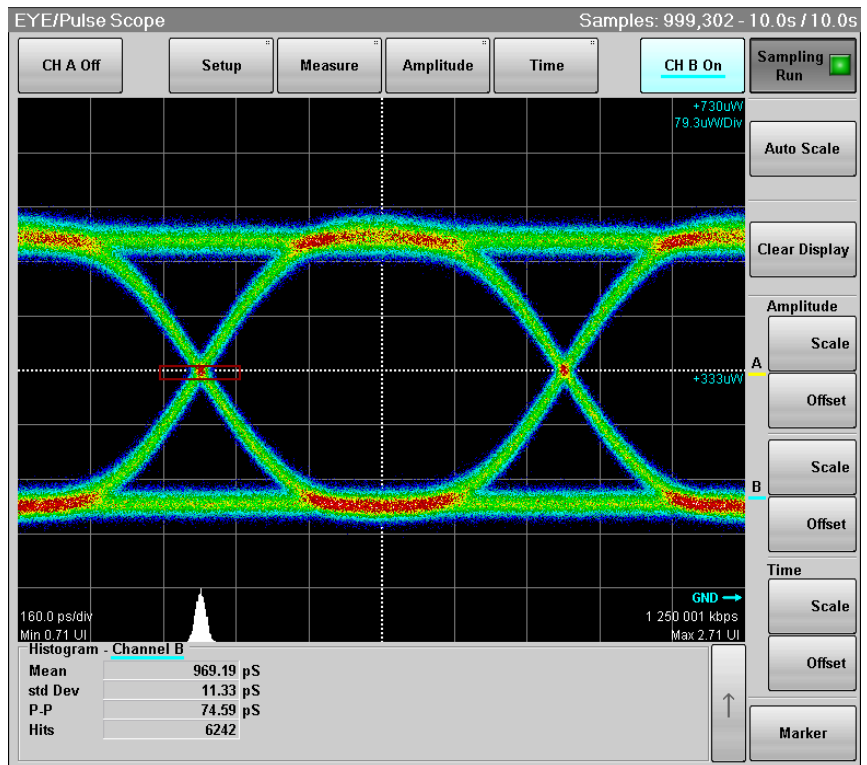


Figure 7.11.2-2 Histogram Measurement Example (Time)

7.11.3 Executing Mask Test

To execute the mask test, first select measurement channel and mask. There are two types of mask tests as follows:

- Set the upper data error count and measure the mask margin.
- Set the mask margin and measure the error data count.

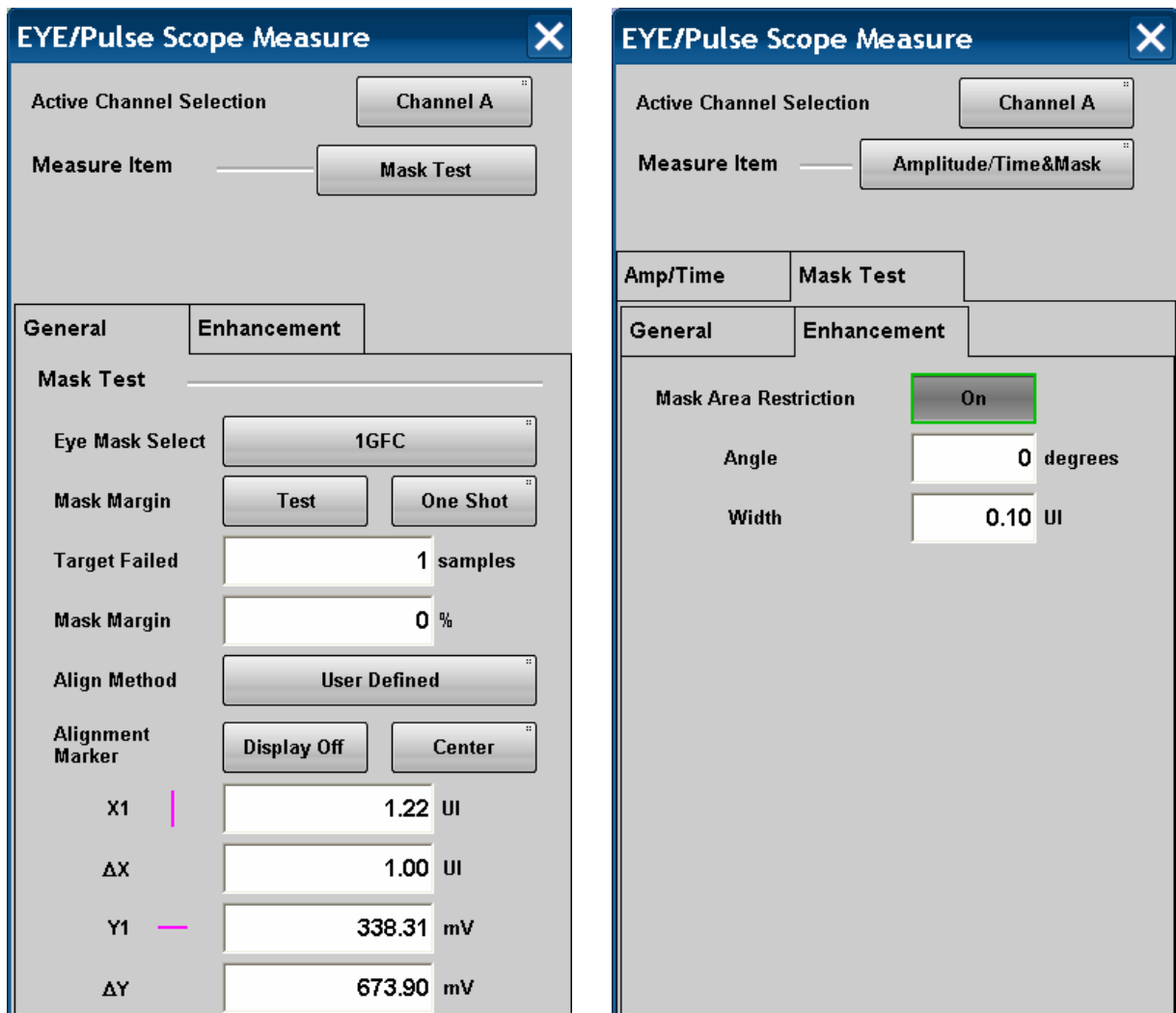


Figure 7.11.3-1 Setting Example of Mask Test

To select channel and mask

1. Touch [Measure] to display the Measure dialog.
2. Touch the Active Channel Selection button, and then select the channel to be measured.
3. Touch the Measure Item button.
4. Touch [Mask Test] or [Amplitude/Time&Mask].
5. When selecting [Amplitude/Time&Mask], touch the [Mask Test] tab.
6. Touch the [General] tab.
7. Touch the Eye Mask Select button to select the mask.
8. When selecting [User defined], the file selection dialog is opened. Touch the mask file and [OK].

For more information about the mask file, refer to D.2 “Mask File Specifications”.

The selected mask or mask file is displayed in the [Current Mask] box of the measurement results. Refer to Figure 7.11.3-2 “Mask Test Example”.

Table 7.11.3-1 Mask List

Mask Name	Bit Rate
1GFC	1.0625 Gbit/s
2GFC	2.125 Gbit/s
4GFC	4.25 Gbit/s
8GFC	8.5 Gbit/s
8GFC_Elect_Rx	8.5 Gbit/s
8GFC_Elect_Tx	8.5 Gbit/s
10GFC	10.52 Gbit/s
10GFC FEC	11.3 Gbit/s
1GbE	1.25 Gbit/s
2GbE	2.5 Gbit/s
10GbE_WAN	9.953 Gbit/s
10GbE_LAN/PHY	10.3125 Gbit/s
10GbE_FEC	11.10 Gbit/s
OC48/STM16	2.488 Gbit/s
OC192/STM64	9.953 Gbit/s
OC192/STM64 FEC(G.975)	10.664 Gbit/s
OTU-1	2.666057 Gbit/s

Table 7.11.3-1 Mask List (Cont'd)

Mask Name	Bit Rate
OTU-2 1310nm	10.709 Gbit/s
OTU-2 1310nm	10.709 Gbit/s
OTU-2 1550nm	10.709 Gbit/s
OTU-2 1550nm Expanded	10.709 Gbit/s
User Defined	*

*: This value varies depending on the selected file.

Table 7.11.3-2 Files That Can Be Selected When User Defined Is Selected

File Name	Supported Standard	Bit Rate
10GE-LX4.txt	10G Ethernet LX4	*1
10G_LAN.txt	10 LAN	10.3125 Gbit/s
10xGE.txt	10 x 1 Gbit/s Ethernet	12.5 Gbit/s
100BASE-BX_LX10.txt	100BASE-BX LX10	100 Mbit/s
HDMI_TP1.txt*2 HDMI_TP2.txt*3	HDMI	*1
InfiniBand.txt	InfiniBand	*1
OC12_STM4.txt	OC-12/STM-4	622.08 Mbit/s
OC192_STM64+FEC(G.709).txt	OC-192/STM-64 ITU-T G.709 FEC	10.709 Gbit/s
OC24_STM8.txt	OC-24/STM-8	1.244 Gbit/s
OC3_STM1.txt	OC-3/STM-1	155.52 Mbit/s
OC48_STM16+FEC(G.709).txt	OC-48/STM-16 ITU-T G.709 FEC	2.666 Gbit/s
SATA 1.5Gb TX250 Cyc.txt	SATA 250 Cycle	1.5 Gbit/s
SATA 1.5Gb TX5 Cyc.txt	SATA 5 Cycle	1.5 Gbit/s
XAUI-E Far.txt*4 XAUI-E Near.txt*5	XAUI Extender	*1

*1: Unspecified

*2: Mask file for HDMI transmitter

*3: Mask file for HDMI receiver

*4: Mask file for XAUI Extender Far

*5: Mask file for XAUI Extender Near

To measure mask margin

1. Touch [Setup].
2. Touch the Sampling Mode button to set the display [Eye] or [Coherent Eye].
3. Touch [Sampling] to set the display Run.
4. When the trace is displayed, touch [Auto Scale].
Check that the eye pattern is displayed in the center of the screen.
5. Touch [Measure].
6. Touch the Active Channel Selection button to set the channel.
7. Touch the Measure Item button.
8. Touch [Mask Test] or [Amplitude/Time&Mask].
9. When selecting [Amplitude/Time&Mask], touch the [Mask Test] tab.
10. Touch the [General] tab.
11. Touch the Align Method button to set to [Zero/One/ Crossing].
12. Touch the Margin Type button, and then select a mode of specifying threshold for Mask Margin measurement, from [Hit Count] and [Hit Ratio]*.
13. In the Hit Count or Hit Ratio box, set the threshold for Mask Margin measurement.
14. When performing the single measurement, touch the button on the right side of Mask Margin and set to [One Shot].
When performing the measurement continuously, touch the button on the right side of Mask Margin and set to [Continuous].
15. Touch [Update].
16. When selecting [One Shot], touch [Test] of Mask Margin to set Sampling to Hold and measure Mask Margin. On the other hand, when selecting [Continuous], set Sampling to Run to measure Mask Margin.

Whichever of [One Shot] and [Continuous] is selected, the mask margin is measured so that the number of samples in the mask area becomes less than the value set for Hit Count or Hit Ratio.

*: The relational expression of Hit Count and Hit Ratio is:

$$\text{HitCount} = \frac{\text{Hit Ratio} \times \text{Total Samples}}{\text{Bit On Screen}}$$

To set Mask Margin and execute mask test

1. Touch [Setup].
2. Touch the Sampling Mode button to set the display [Eye] or [Coherent Eye].
3. Touch [Sampling] to set the display Run.
4. When the trace is displayed, touch [Auto Scale].
Check that the eye pattern is displayed in the center of the screen.
5. Touch [Measure].
6. Touch the Active Channel Selection button to set the channel.
7. Touch [Mask Test].
8. Touch the [Enhancement] tab.
9. Touch the Mask Area Restriction button to set to [Off].
10. Touch the [General] tab.
11. Touch the Align Method button to set to [Zero/One/ Crossing].
12. Touch the right side button of Mask Margin to set to [One Shot].
13. Touch the mask margin text box.
14. Input the mask margin in the range of -100 to 100 .
15. The shape of the mask is changed, and the measurement result is displayed on the screen.

Note:

When executing the Mask Test, run Auto Scale to set Bit On Screen to 2.

The Mask Test measured value is assured when Bit On Screen is 2. If Bit On Screen is 3 or more, the optimum Mask position may not be detected because the vertical scale setting is not optimum.

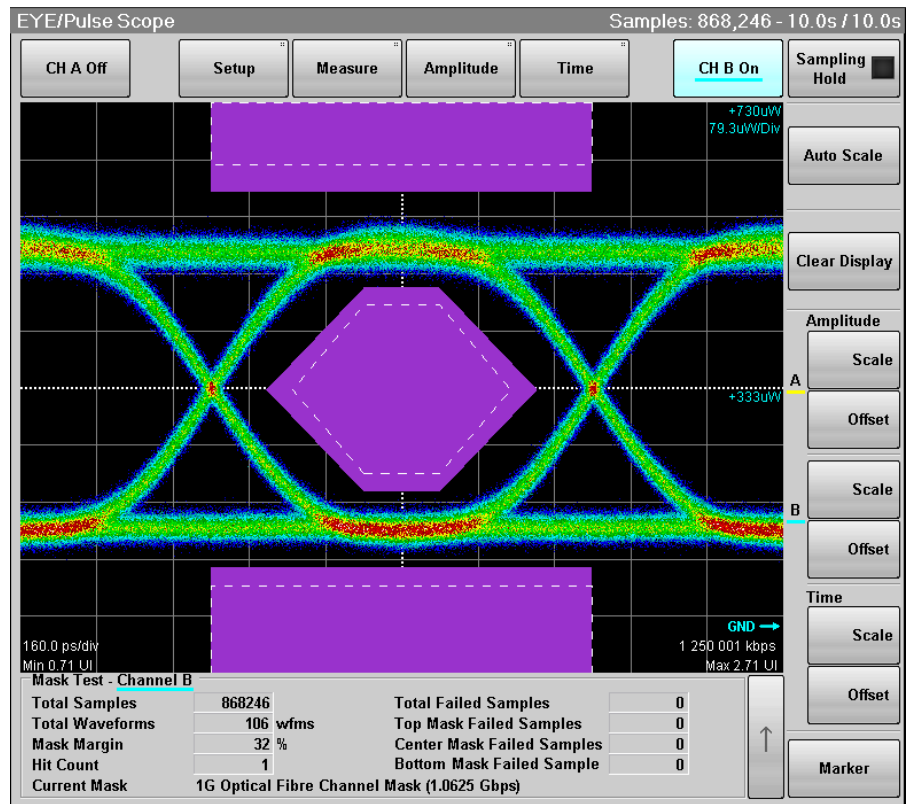


Figure 7.11.3-2 Mask Test Example

The following values are displayed in the measurement result:

- Total Samples: Total data count displayed on the screen
- Total Waveforms: Total waveform count displayed on the screen
- Mask Margin: Mask Margin measurement results or settings
- Hit Count or Hit Ratio: Threshold set for Mask Margin measurement
- Total Failed Samples: Total data count within three mask areas
- Top Mask Failed Samples: Data count in top mask area
- Center Mask Failed Samples: Data count in center mask area
- Bottom Mask Failed Samples: Data count in bottom mask area
- Current Mask: Present mask name

Adjusting mask position

To adjust mask position automatically


When Align Method is [Zero/One/Crossing], touch the Mask Alignment [Update].

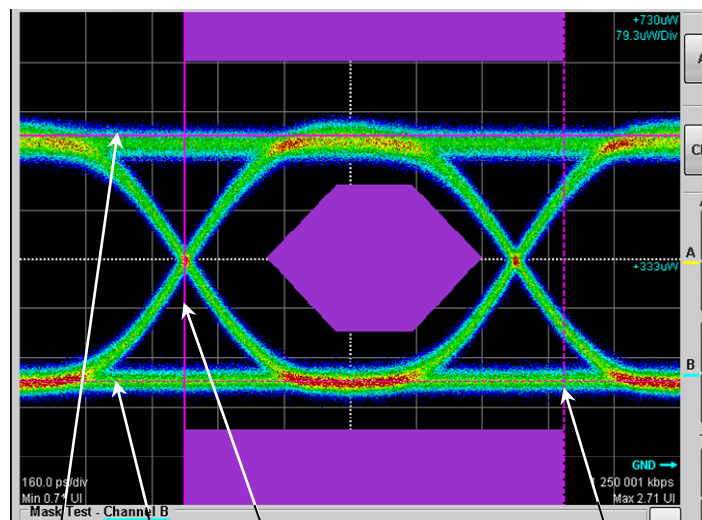
When touching the Mask Alignment [Update], calculate [One/Zero Crossing] of the currently described waveform and optimize the mask position automatically.

The mask position is adjusted automatically if the Scale and Offset on the screen are changed. However, the mask position cannot be changed.

To adjust mask position manually

When Align Method is [User Defined], the mask position, width and amplitude can be adjusted using the marker.

1. Touch the right side button of  and set [Display On] to display the marker.



Y1

Y2

X1

X2

2. Touch the X1 text box to set the mask position.
3. Touch the X text box to set the mask width.
4. Touch the Y1 text box to set the level 1.
5. Touch the Y text box to set the level 0.

Touching [Center] moves the marker without depending on the waveforms. In this case, the setting values of X1, ΔX , Y1, and ΔY are initialized.

Although the marker is not displayed at [Display Off], the marker position can be adjusted by changing the value in the text box.

To limit mask area

To examine in which part of the mask at the center the error occurs when the error occurs in the mask test, the mask area can be limited.

Setting width and angle can limit the mask area.

If the mask area is limited, the error that occurs in an upper and lower mask area is not measured.

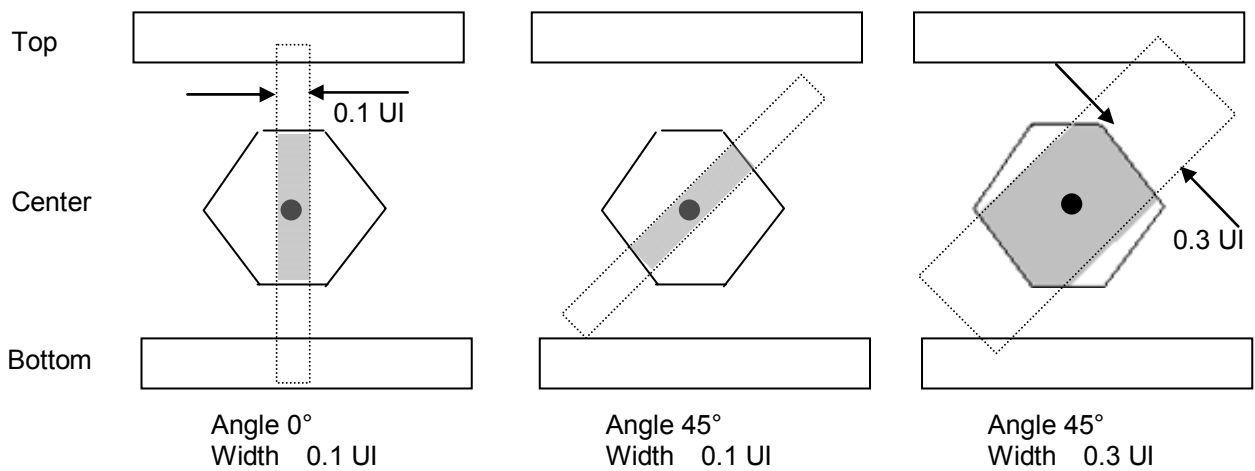


Figure 7.11.3-3 Example of Limiting Mask Area

1. Touch [Measure].
2. Touch the Active Channel Selection button to set the channel.
3. Touch [Mask Test].
4. Touch the [Enhancement] tab.
5. Touch the Mask Area Restriction button to set [On].
6. Touch the [Angle] text box to set the angle within the range of -90 to 90.
7. Touch the [Width] text box to set the width within the range of 0.01 to 1.00.

"Restriction enabled" is displayed in the measurement result display area.

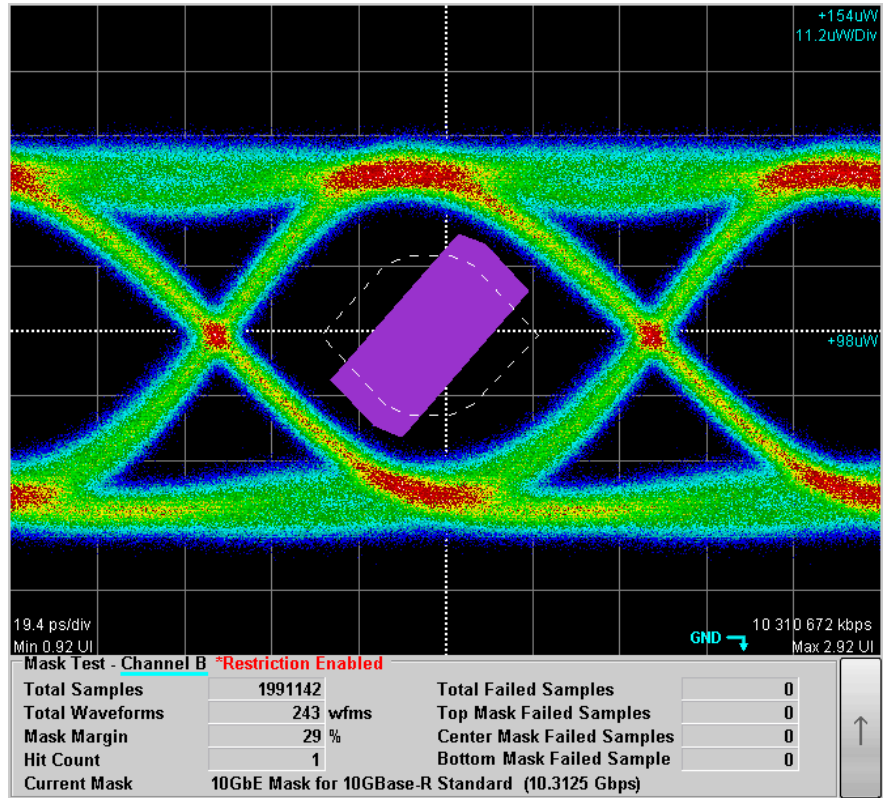


Figure 7.11.3-4 Example of Area Limited Mask Test

7.12 Using Marker

The marker is used to read the amplitude and time values of the waveform.

Also, the level and time differences between two points can be measured.

There are two markers each for the x- and y-axes. Display of each marker can be set to on or off separately.

1. Touch [Marker] to display the marker panel.

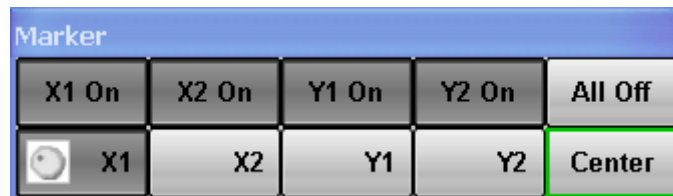
The marker panel can be moved in the EYE/Pulse Scope window.



2. To display the marker, touch the upper line buttons other than [All Off].

When the marker is displayed, the lower line buttons are invalid.

3. To move the marker, touch the lower line buttons other than [Center]. The selected marker button is changed to the in-use display, and then the icon is displayed.



4. Set the marker position using the rotary knob.

The marker position and time/level differences are displayed.

Marker Panel

X1 Off/On, X2 Off/On, Y1 Off/On, Y2 Off/On	Sets marker display
X1, X2, Y1, Y2	Selects marker to be moved
Center	Centers marker in the screen
All Off	Hide all markers

When the measurement result is displayed, touch [↑] at the left side of [Marker] to switch the marker display.

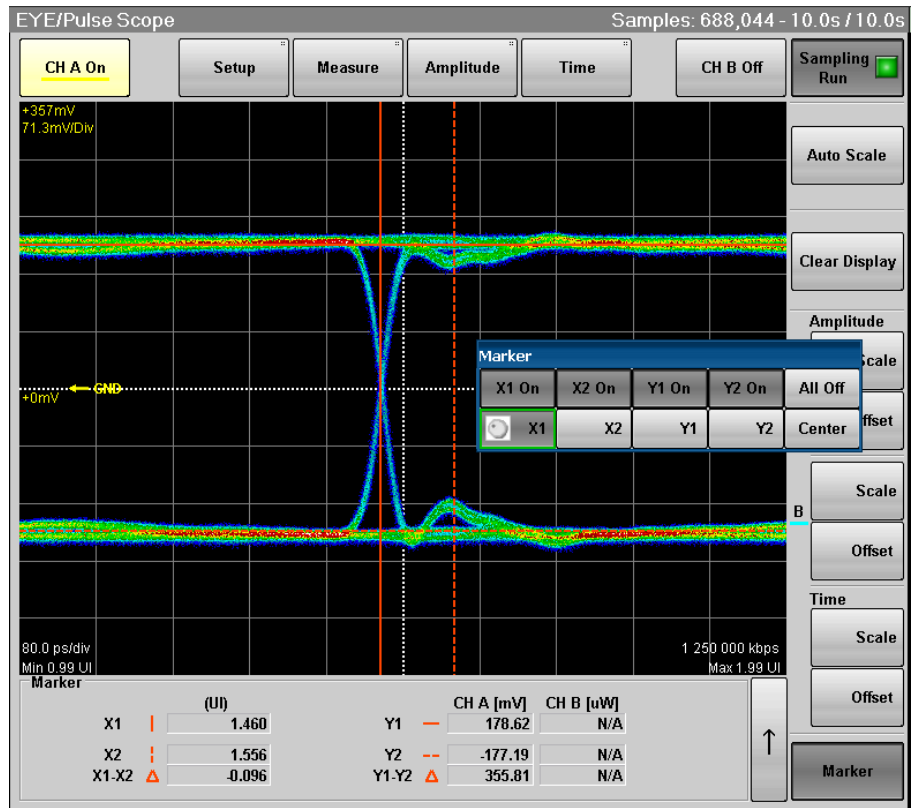


Figure 7.12.3-1 Marker Display

7.13 Waveform Math Calculation

The calculated math results for the two CH A and CH B waveforms can be displayed as a different waveform. The calculated math results can be measured at Section 7.11 “Measuring Waveform”.

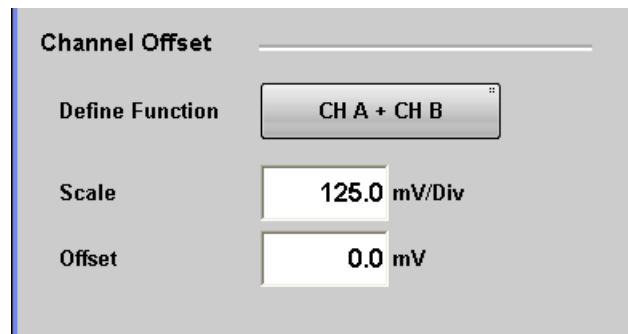
Note:

When calculating the EYE pattern waveform, set Sampling Mode to [Coherent Eye] and collect the data.

If Sampling Mode is set to [Eye] and data is collected, a computational error occurs.

Setting waveform calculation method and vertical scale

1. Touch [Amplitude] to display the Amplitude dialog.
2. Touch the Channel Math button to set the button display to [On].
3. Touch the Define Function button at Channel Offset.
4. Select the calculation method from the following:
[CH A+CH B]
[CH A-CH B]
[CH B-CH A]



5. Touch the Scale text box at Channel Offset.
6. Input the voltage per vertical scale.
7. Touch the Offset text box at Channel Offset.
8. Input the voltage for the center of the vertical scale.

For the adjustment method of the time axis, refer to 7.10.3 “Adjusting Horizontal-axis Screen”.

Even when the calculated waveform is displayed, [Auto Scale] can be displayed.

To close the waveform calculation display, touch the Channel Math button and set the button display to [Off].

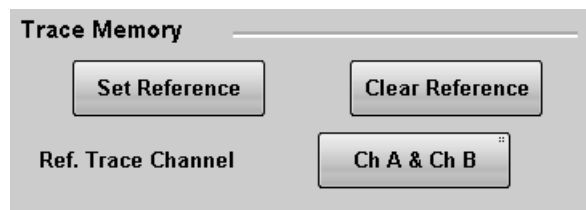
7.14 Using Trace Memory

The trace memory is a function to save the measurement waveform in the memory.

The waveform saved in the trace memory calls the reference trace.

To save the waveform in the trace memory

1. Touch [Setup] to display the Setup dialog.
2. Touch the [Utilities] tab.
3. Touch the Ref.Trace Channel button and select the channel to be saved from the following.
 - [Ch A & Ch B]
 - [Ch A]
 - [Ch B]
4. Touch [Set Reference].



5. The trace waveform is displayed in the screen.



Figure 7.14-1 Waveform Display of Trace Memory

To delete the trace memory waveform

1. Touch [Setup] to display the Setup dialog.
2. Touch the [Utilities] tab.
3. Touch [Clear Reference] to delete both reference traces in Channel A and B.

7.15 Displaying a Label

This section describes how to display an arbitrary string (label) in the EYE/Pulse Scope screen.

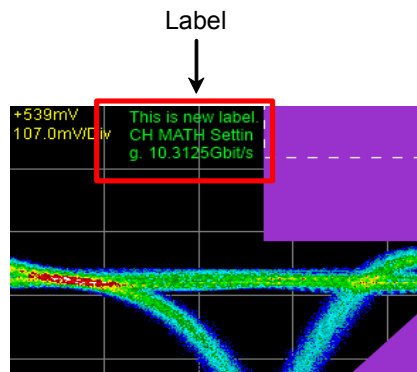


Figure 7.15-1 Label Display

Displaying a label

1. Touch [Setup], and the Setup dialog box appears.
2. Touch [Utilities] tab.
3. Touch [Add] for NEW Label, and the software keyboard appears.
4. On the software keyboard, enter a string of up to 1024 characters.
5. Touch [OK] on the software keyboard, and the label is displayed on the screen.

Note:

The location, width and color of the label cannot be changed.

Deleting the displayed label

1. Touch [Setup], and the Setup dialog box appears.
2. Touch [Utilities] tab.
3. Touch [Delete] for Delete Label, and the displayed label is deleted.

7.16 Saving Measurement Results

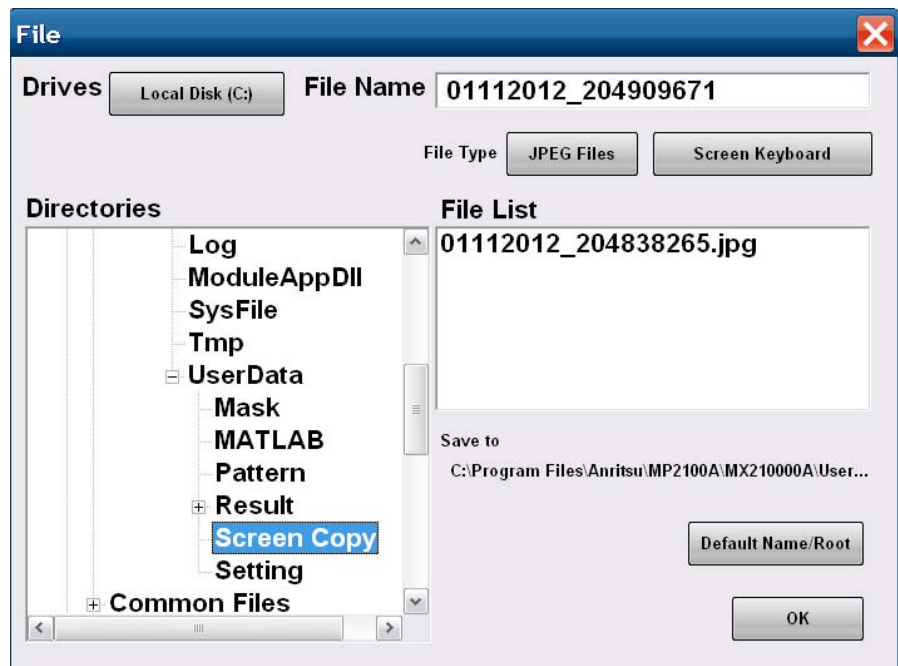
The sampling scope results can be saved in the following file types:

- Screen image
The image of the entire screen or only the measurement screen is saved to a PNG or JPEG file.
- Measurement result
The waveform is saved as a text file, binary file or CSV file.
- Measurement condition
The setting values in the Amplitude, Measurement, Setup, and Time dialogs are saved in the file.

To save screen image

When saving the entire screen

1. Touch [Screen Copy] at the system menu. The file selection screen is displayed.



2. Touch the Drives button and the Directories field to set the save destination folder. The path to the save folder is displayed at the Save to field.
3. The file format to be saved is displayed in the right button of the file type. Touching the button can set the file format.
4. To set the file name, touch [Screen Keyboard] and input the file name.
5. When overwriting an existing file, touch the file name displayed at File List.

6. Touch [OK] to save the screen image.

When overwriting a file, a confirmation dialog is displayed.

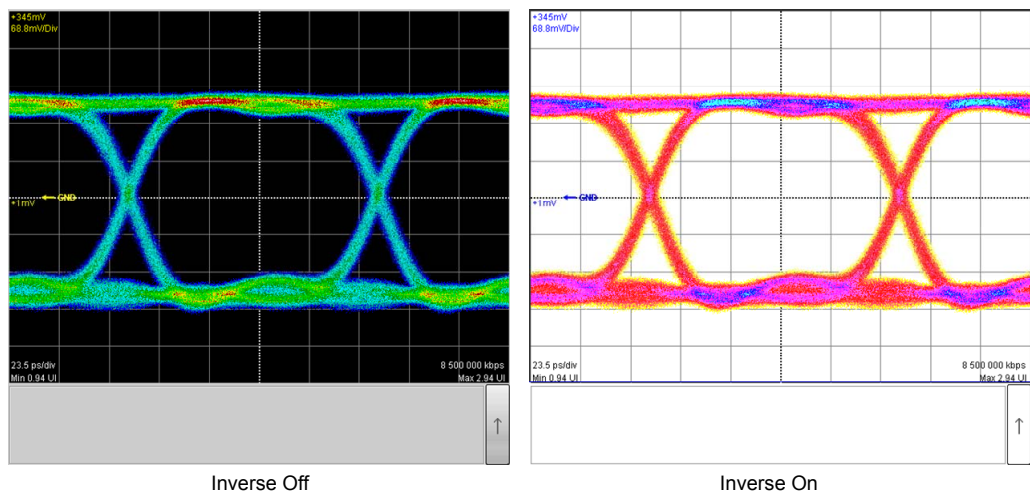
The path to the default folder is:

C:\Program Files\Anritsu\MP2100A\MX21000A\UserData\Screen Copy

The date and time are recorded in the default file name.

When saving the measurement screen:

1. Touch [Setup].
2. Touch [Utilities].
3. To save both waveform and measurement results as an image, switch the option for Waveform only to [Off].
To save only the waveform as an image, switch the option for Waveform only to [On].
4. To reverse the screen color, set Inverse background color to [On].



5. Touch [Capture]. The file selection screen same as the entire screen to be saved is displayed.
6. Set the file format, folder and file name and touch [OK].
7. The image png file is saved in the following path when the folder is set to the default.

C:\Program Files\Anritsu\MP2100A\MX21000A\UserData\Screen Copy

To save measurement condition or measurement result

1. Touch [Save] at the system menu.
2. Touch [EYE/Pulse Scope].
3. When saving the measurement condition, touch [Setting].
When saving the measurement result, touch [Result].
4. Input the file name.
5. Touch [OK] or press the rotary knob.

The measurement condition file is saved in the following folder.

The extension for saved files is WFS.

C:\Program Files\Anritsu\MP2100A\MX21000A\UserData\Setting

The measurement result file is saved in the following folder.

The extension of the measurement data file is CSV and TXT.

C:\Program Files\Anritsu\MP2100A\MX21000A\UserData\Result\CSV

C:\Program Files\Anritsu\MP2100A\MX21000A\UserData\Result\TXT

The measurement results file saves the number of samples per screen pixel.

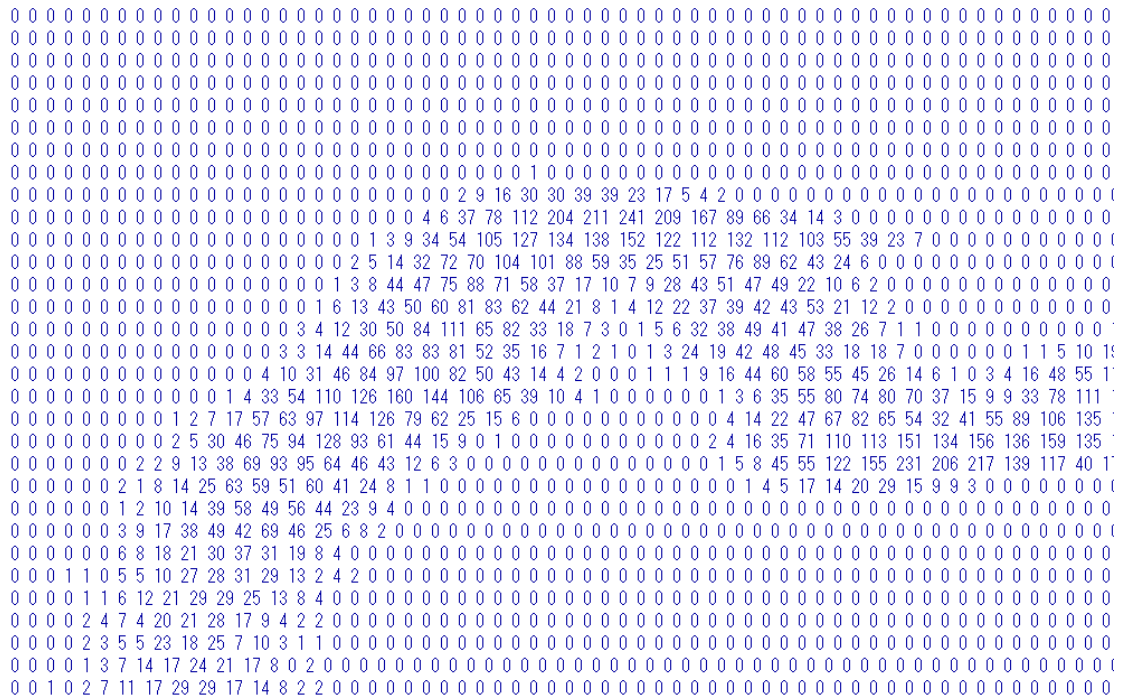


Figure 7.16-2 File Example of Screen Data

Amplitude/Time Measurement
[Results]
One Level CH A 192.12 191.80 0.10 191.66 192.12
One Level CH B N/A N/A N/A N/A N/A
Zero Level CH A -185.98 -185.63 0.10 -186.00 -185.43
Zero Level CH B N/A N/A N/A N/A N/A
Eye Amplitude CH A 378.10 377.44 0.19 377.16 378.12
Eye Amplitude CH B N/A N/A N/A N/A N/A
Eye Height CH A 330.00 329.46 0.19 329.13 330.03
Eye Height CH B N/A N/A N/A N/A N/A
Crossing CH A 49.55 50.18 0.24 49.53 50.28
Crossing CH B N/A N/A N/A N/A N/A
SNR CH A 23.58 23.60 0.04 23.52 23.67
SNR CH B N/A N/A N/A N/A N/A
Average Power (dBm) CH A N/A N/A N/A N/A N/A
Average Power (dBm) CH B N/A N/A N/A N/A N/A
Average Power (mW) CH A N/A N/A N/A N/A N/A
Average Power (mW) CH B N/A N/A N/A N/A N/A
Extinction Ratio CH A N/A N/A N/A N/A N/A
Extinction Ratio CH B N/A N/A N/A N/A N/A
Jitter P-P CH A 15.57 12.15 0.99 10.97 15.92
Jitter P-P CH B N/A N/A N/A N/A N/A
Jitter RMS CH A 2.57 1.93 0.13 1.85 2.58
Jitter RMS CH B N/A N/A N/A N/A N/A
Rise Time CH A 23.26 22.94 0.11 22.82 23.31
Rise Time CH B N/A N/A N/A N/A N/A
Fall Time CH A 22.21 22.02 0.07 21.93 22.29
Fall Time CH B N/A N/A N/A N/A N/A
Eye Width CH A 102.34 106.04 0.74 101.99 106.65
Eye Width CH B N/A N/A N/A N/A N/A
DCD CH A 1.80 1.73 0.39 0.75 2.71
DCD CH B N/A N/A N/A N/A N/A
OMA (mW) CH A N/A N/A N/A N/A N/A
OMA (mW) CH B N/A N/A N/A N/A N/A
OMA (dBm) CH A N/A N/A N/A N/A N/A
OMA (dBm) CH B N/A N/A N/A N/A N/A

Waveform
665x497
CH A
0 0 0 0 0 0 0 0 0 0 0.....(waveform data)
CH B
0 0 0 0 0 0 0 0 0 0 0.....(waveform data)

Figure 7.16-3 File Example of Amplitude/Time Measurement Data

```

Amplitude/Time and Mask Measurement - Channel A
[Setups]
Current Mask 1G Optical Fibre Channel Mask (1.0625 Gbps)
[Results]
One Level CH A 189.37 189.71 0.20 189.32 190.04
One Level CH B N/A N/A N/A N/A N/A
Zero Level CH A -185.00 -185.35 0.20 -185.73 -184.89
Zero Level CH B N/A N/A N/A N/A N/A
Eye Amplitude CH A 374.37 375.07 0.39 374.21 375.73
Eye Amplitude CH B N/A N/A N/A N/A N/A
Eye Height CH A 326.99 327.54 0.37 326.40 328.27
Eye Height CH B N/A N/A N/A N/A N/A
Crossing CH A 49.89 49.82 0.16 49.47 50.66
Crossing CH B N/A N/A N/A N/A N/A
SNR CH A 23.70 23.67 0.04 23.12 23.79
SNR CH B N/A N/A N/A N/A N/A
Average Power (dBm) CH A N/A N/A N/A N/A N/A
Average Power (dBm) CH B N/A N/A N/A N/A N/A
Average Power (mW) CH A N/A N/A N/A N/A N/A
Average Power (mW) CH B N/A N/A N/A N/A N/A
Extinction Ratio CH A N/A N/A N/A N/A N/A
Extinction Ratio CH B N/A N/A N/A N/A N/A
Jitter P-P CH A 11.32 11.62 0.90 7.78 14.86
Jitter P-P CH B N/A N/A N/A N/A N/A
Jitter RMS CH A 1.86 1.86 0.06 1.74 2.19
Jitter RMS CH B N/A N/A N/A N/A N/A
Rise Time CH A 35.24 31.12 5.85 22.66 35.68
Rise Time CH B N/A N/A N/A N/A N/A
Fall Time CH A 33.30 29.38 5.39 21.53 33.50
Fall Time CH B N/A N/A N/A N/A N/A
Eye Width CH A 106.78 106.48 0.40 104.43 107.24
Eye Width CH B N/A N/A N/A N/A N/A
DCD CH A 1.50 1.04 0.42 0.00 2.26
DCD CH B N/A N/A N/A N/A N/A
OMA (mW) CH A N/A N/A N/A N/A N/A
OMA (mW) CH B N/A N/A N/A N/A N/A
OMA (dBm) CH A N/A N/A N/A N/A N/A
OMA (dBm) CH B N/A N/A N/A N/A N/A
Total Samples 974729
Total Waveforms 119
Mask Margin 0
Hit Count 1
Total Failed Samples 0
Top Mask Failed Samples 0
Center Mask Failed Samples 0
Bottom Mask Failed Samples 0

Waveform
665x497
CH A
0 0 0 0 0 0 0 0 0 0.....(waveform data)
CH B
0 0 0 0 0 0 0 0 0 0.....(waveform data)

```

Figure 7.16-4 File Example of Histogram Measurement Data

```
Amplitude/Time and Histogram Measurement - Channel A
[Setups]
Axis Time
X1 Marker 0.50UI
X2 Marker 1.50UI
Y1 Marker 9mV
Y2 Marker -10mV
[Results]
One Level CH A 189.65 189.84 0.13 189.60 190.04
One Level CH B N/A N/A N/A N/A N/A
Zero Level CH A -185.34 -185.48 0.14 -185.73 -185.12
Zero Level CH B N/A N/A N/A N/A N/A
Eye Amplitude CH A 374.99 375.31 0.26 374.72 375.73
Eye Amplitude CH B N/A N/A N/A N/A N/A
Eye Height CH A 327.54 327.74 0.27 326.40 328.27
Eye Height CH B N/A N/A N/A N/A N/A
Crossing CH A 49.89 49.82 0.17 49.47 50.66
Crossing CH B N/A N/A N/A N/A N/A
SNR CH A 23.71 23.67 0.04 23.12 23.76
SNR CH B N/A N/A N/A N/A N/A
Average Power (dBm) CH A N/A N/A N/A N/A N/A
Average Power (dBm) CH B N/A N/A N/A N/A N/A
Average Power (mW) CH A N/A N/A N/A N/A N/A
Average Power (mW) CH B N/A N/A N/A N/A N/A
Extinction Ratio CH A N/A N/A N/A N/A N/A
Extinction Ratio CH B N/A N/A N/A N/A N/A
Jitter P-P CH A 11.68 11.71 0.84 7.78 14.86
Jitter P-P CH B N/A N/A N/A N/A N/A
Jitter RMS CH A 1.83 1.87 0.07 1.77 2.19
Jitter RMS CH B N/A N/A N/A N/A N/A
Rise Time CH A 35.16 27.11 5.94 22.66 35.68
Rise Time CH B N/A N/A N/A N/A N/A
Fall Time CH A 33.16 25.65 5.45 21.53 33.50
Fall Time CH B N/A N/A N/A N/A N/A
Eye Width CH A 106.25 106.41 0.46 104.43 107.01
Eye Width CH B N/A N/A N/A N/A N/A
DCD CH A 1.80 1.06 0.45 0.00 2.11
DCD CH B N/A N/A N/A N/A N/A
OMA (mW) CH A N/A N/A N/A N/A N/A
OMA (mW) CH B N/A N/A N/A N/A N/A
OMA (dBm) CH A N/A N/A N/A N/A N/A
OMA (dBm) CH B N/A N/A N/A N/A N/A
Mean 100.62
Std Dev 1.87
P-P 11.68
Hits 3835
Hit Point Detail
0.50UI 0 Hits
0.50UI 0 Hits
0.51UI 0 Hits
0.51UI 0 Hits
0.51UI 0 Hits
:
:
:
(Hit Point data)

Waveform
665x497
CH A
0 0 0 0 0 0 0 0 0 0 0.....(waveform data)
CH B
0 0 0 0 0 0 0 0 0 0 0.....(waveform data)
```

Figure 7.16-5 File Example of Mask Measurement Data

```
Histogram Measurement - Channel A
[Setups]
Axis Amplitude
X1 Marker 0.73UI
X2 Marker 0.75UI
Y1 Marker 287mV
Y2 Marker -276mV
[Results]
Mean 5.27
Std Dev 188.49
P-P 423.91
Hits 11979
Hit Point Detail
287mV 0 Hits
284mV 0 Hits
281mV 0 Hits
279mV 0 Hits
276mV 0 Hits
273mV 0 Hits
270mV 0 Hits
268mV 0 Hits
:
:
(Hit Point data)

Waveform
665x497
CH A
0 0 0 0 0 0 0 0 0 0 0.....(waveform data)
CH B
0 0 0 0 0 0 0 0 0 0 0.....(waveform data)
```

Figure 7.16-6 File Example of Histogram Measurement Data

```
Mask Measurement - Channel A
[Setups]
Current Mask 8G Optical Fibre Channel Mask (8.5 Gbps)
[Results]
Total Samples 991111
Total Waveforms 121
Mask Margin 0
Hit Count 1
Total Failed Samples 0
Top Mask Failed Samples 0
Center Mask Failed Samples 0
Bottom Mask Failed Samples 0

Waveform
665x497
CH A
0 0 0 0 0 0 0 0 0 0 0.....(waveform data)
CH B
0 0 0 0 0 0 0 0 0 0 0.....(waveform data)
```

Figure 7.16-7 File Example of Mask Measurement Data

Chapter 8 Operating Optical Interface

This chapter explains how to use the optical interface option.

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8.1 Optical Interface Types

The following optical interface types are available.

- O/E converter
- Optical transceiver (XFP)
- Optical transceiver (SFP+)

O/E Converter

The O/E converter configured by the wide bandwidth photo diode and amplifier can convert the optical signal to the electrical signal. The block diagram of the MP2102A-023 O/E converter is as follows.

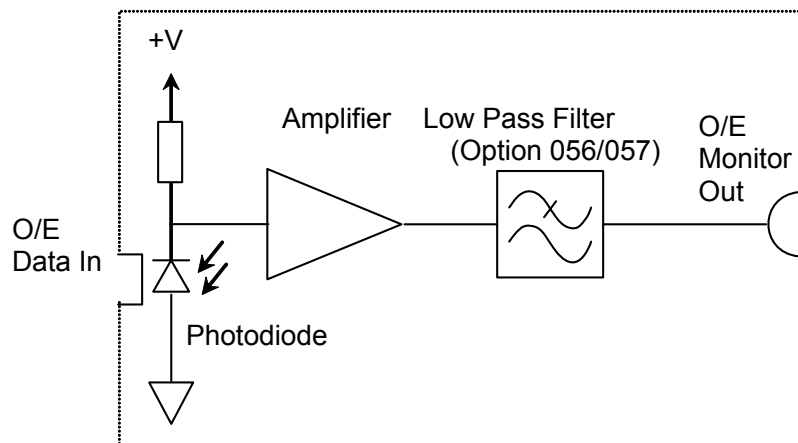


Figure 8.1-1 O/E Converter Block Diagram

The O/E Monitor Output connector is not available on the MP2100A-003 and MP2100A-007 front panel.

Here, the conversion efficiency means the ratio that the photodiode converts the optical signal to electrical signal. This efficiency varies depending on the wavelength. To measure the optical waveform amplitude correctly, it is necessary to calibrate the conversion efficiency. The value multiplied the photodiode conversion efficiency by amplifier gain is called the conversion gain.

 **CAUTION**

- The maximum optical power input to the O/E Data In is +2 dBm (1.58 mW). Inputting an optical power exceeding this level risks damaging the internal circuits. Connect the optical attenuator to the O/E Data In when measuring the optical signal exceeding +2 dBm.
 - The impedance of the O/E Monitor Out connectors is 50 Ω . Measurement may not be performed correctly if a coaxial cable with another impedance is used or if the impedance of the DUT is not 50 Ω .
-

Optical Transceiver (XFP/SFP+)

Optical transceivers combine the following two functions in one module:

- Tx for converting electrical signal into optical signal for transmission
- Rx for converting optical signal into electrical signal for reception

The format and pin layout of the optical transceiver for communication are standardized by the industry organization. So, just changing the optical transceiver makes the optical interface specifications easily.

The MP2100A+MP2100A-050/051 and MP2101A+MP2101A-050/051 can install the optical transceiver conformed with the XFP (10 Gigabit small form factor pluggable module) or SFP+ (Enhanced small form factor pluggable module), using the options. For the references of the optical transceiver, refer to Appendix F “Bibliography”.

The logic circuit is used in the Optical transceiver. This is the different from the O/E converter. The relationship between input signal and output signal is the nonlinearity because the waveform of the optical transceiver is shaped by the logic circuit.

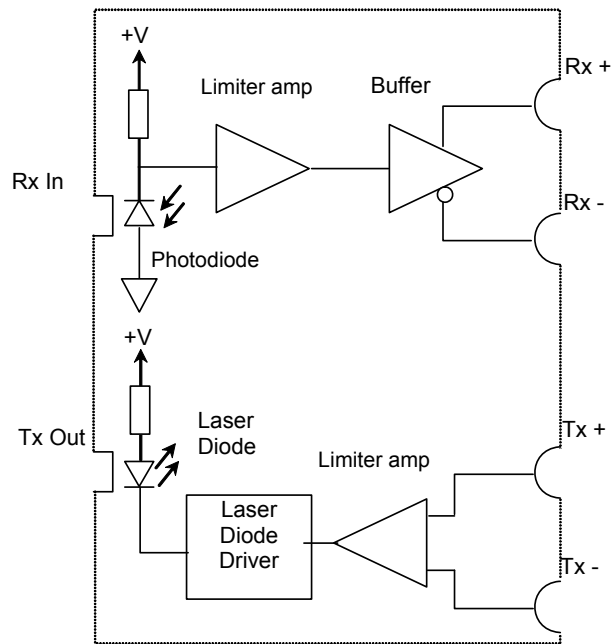


Figure 8.1-2 Optical Transceiver Block Diagram

 **CAUTION**

- Be sure that the optical power input to the Rx of the optical transceiver is the specified max .value or less. Inputting an optical power rather than this power risks damaging the internal circuits.
 - Use the appropriate optical fiber to the optical transceiver. Measurement may not be performed correctly if the optical fiber types (multi-mode fiber, single mode fiber) are not applicable.
 - The impedance of the Tx Data In and Rx Data Out connectors is 50 Ω . Measurement may not be performed correctly if a coaxial cable with another impedance is used or if the impedance of the connected devices is not 50 Ω .
-

8.2 Operating Optical Transceiver

8.2.1 Function List

The following items is set and displayed for the optical transceiver.

Table 8.2.1-1 Optical Transceiver Setting Items

Item	Description
Wavelength	Displays wavelength of light output from the optical transceiver. When the recommended optical transceiver is installed, one of the following wavelength is displayed. 850 nm, 1310 nm, 1550 nm
Output	Outputs light to the Tx connector of the Optical transceiver. Touch the Output button, and then the display is changed to ON or Off. The optical output indication is as follows: Green: On Black: Off
LOS	Indicates that the light is input to the RX connector of the Optical transceiver. Red: No input light (Loss of signal) Gray: Input light
Ready	Indicates the optical transceiver installed status. Green: Available Black: Optical transceiver not installed or not found
XFP Rx Reference CLK	When the optical transceiver is XFP, select the reference clock supplied to XFP.

To display the optical transceiver setting screen, touch [XFP/SFP+] at the top menu.

The screen as shown in Figure 8.2.1-1 is displayed.

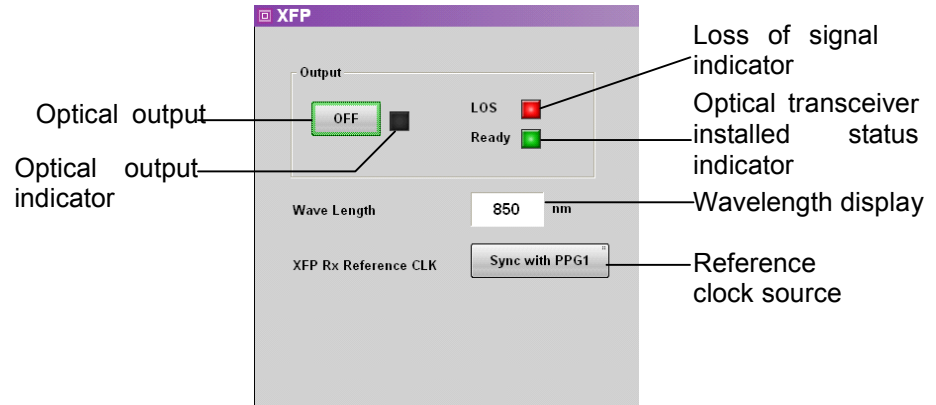


Figure 8.2.1-1 Optical Transceiver Setting Panel (XFP)

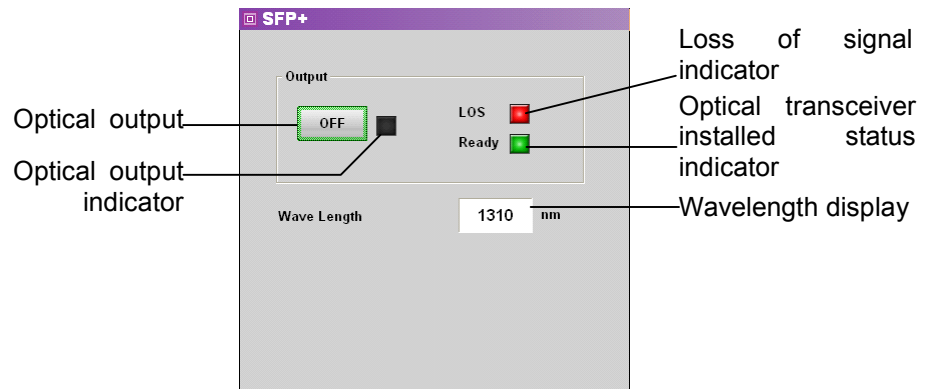


Figure 8.2.1-2 Optical Transceiver Setting Panel (SFP+)

The setting range of the optical transceiver is as follows.

Optical Output

Off

On

XFP Rx Ref CLK

Sync with PPG2

Sync with ED2

8.2.2 Optical Transceiver Types

The recommended optical transceiver is listed in Table 8.2.2-1.

For the specifications of the optical transceiver, refer to A.4 “Optical Transceiver Module Specifications”.

For how to install the optical transceiver, refer to Section 2.8 “Installing Optical Transceiver”.

Table 8.2.2-1 XFP

Model Name	Wavelength (nm)	Appropriate Optical Fiber	Bit Rate (kbit/s)
G0174A	850	MMF	9950000 to 11100000
G0194A	1310	SMF	9950000 to 11300000
G0195A	1550	SMF	9950000 to 10750000

Table 8.2.2-2 SFP+

Model Name	Wavelength (nm)	Appropriate Optical Fiber	Bit Rate (kbit/s)
G0238A	850	MMF	10312500
G0239A	1310	SMF	9953280 to 10312500

8.2.3 Connection between Panel Connector and Optical Transceiver

The Tx Data In connector on the front panel connects to the TX+ of the optical transceiver module.

The Rx Data Out connector on the front panel connects to the RX + of the optical transceiver module.

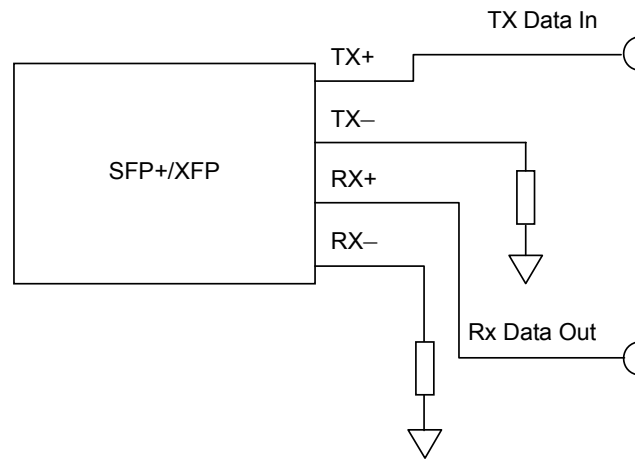


Figure 8.2.3-1 Connection Diagram between Panel Connector and Optical Transceiver

8.3 Operating O/E Converter

8.3.1 Function List

The following items are set and displayed when installing the O/E converter.

Table 8.3.1-1 O/E Converter Setting Items

Item	Description
Filter On/Off	When installing Option 086, the internal low pass filter is set to On/Off.
Filter Selection	When installing from Option 056 to Option 069, the internal low pass filter is set.
Wavelength	Select the wavelength of input light from the following: 850 nm, 1310 nm, 1550 nm, User The Responsivity, Conversion Gain, or System Conversion Gain varies depending on the wavelength.
Conversion Gain*	Indicates the conversion ratio of the O/E. The setting range is from 1 to 9999 (V/W).
System Conversion Gain*	Indicates the conversion ratio between the power input to the O/E Data In and the voltage displayed on the Result window. This is automatically set by Conversion Gain, internal loss of the BERTWave, and filter loss: System Conversion Gain = $\frac{\text{Conversion Gain}}{\text{Measurement internal loss} \times \text{Filter Loss}}$ When installing from Option 056 to Option 069, the loss is used for calculation. The loss varies with the filter types.
Responsivity*	Rate at which photodiode converts optical power to current The setting range is from 0.001 to 999.999.
Calibration	Automatically adjusts the Conversion Gain/Responsivity /System Conversion Gain values. For adjustment, refer to 8.3.3 “Adjustment required when changing the wavelength bands”.
Input Power	Sets optical signal power input to the device. The setting range is -2 to -10 dBm.
Extinction Ratio Correction	Sets whether to correct the Extinction Ratio measurement.
Extinction Ratio Correction Factor	Indicates the correction factor of Extinction Ratio The setting range is from -9.99 to 9.99%.
O/E Calibration	Starts module calibration.

*: Changes in the setting values of Conversion Gain, Responsivity and System Conversion Gain are not required when measuring an optical signal at a wavelength of 850 nm, 1310 nm or 1550 nm. For these wavelength bands, calibrated values have been set before shipment from the factory.

To measure an optical signal at the other wavelength than 850 nm, 1310 nm or 1550 nm, change the setting values of Conversion Gain, Responsivity and System Conversion Gain according to the changed wavelength. For how to change the setting values, refer to 8.3.3 “Adjustment required when changing the wavelength bands”.

To display the O/E converter setting screen, touch [O/E] at the top menu. The screen as shown in Figure 8.3.1-1 is displayed.

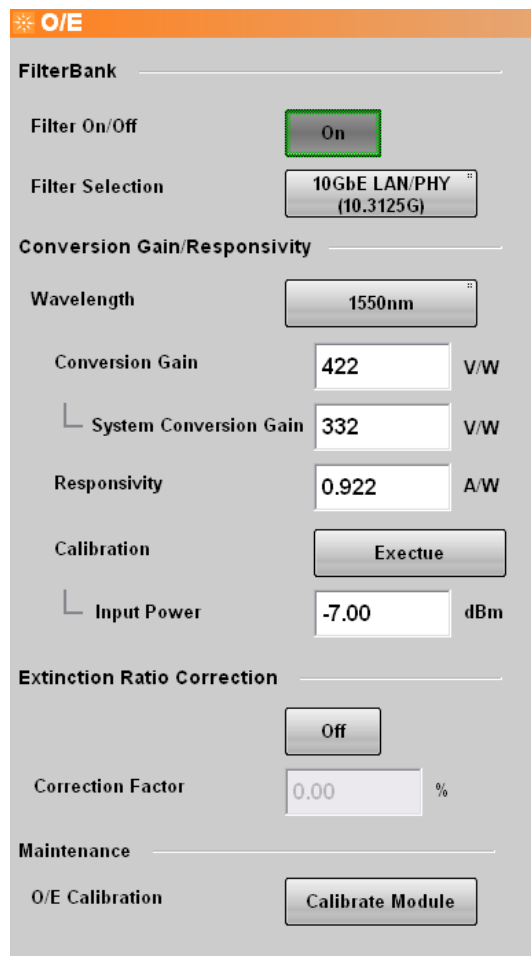
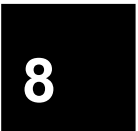


Figure 8.3.1-1 O/E Setting Panel



The setting range of the O/E converter is as follows.

Filter

O/E Calibration
ResponsivityOff
Sync with PPG1
Sync with ED1
1 to 9999 V/W
No Filter
1GFC*1
2GFC*2
4GFC*2
8GFC*2, *3
10GFC*3
10GFC FEC*3
10GbE FEC*3
10GbE LAN/PHY*2, *3
10GbE WAN*2, *3
CPRI*4
Infiniband×4*2, *3
OC-3/STM-1*5
OC-12/STM-4*6
OC-192/STM-64*2, *3
G975 FEC*2
OTU-1*7
OTU-2*3

Wavelength

1310 nm
1550 nm
850 nm

User

Conversion Gain

1 to 9999 V/W

System Conversion Gain

1 to 7404*8 V/W

Responsivity

0.001 to 999.999 A/W

Input Power

-2 to -10 dBm

Extinction Ratio Correction

On

Extinction Ratio Correction Factor

–9.99 to 9.99%

- *1: When installing Option 064, 065, 066, 067, 068 or 069 including the filter for 1.0625 Gbit/s as the product configuration.
- *2: When installing Option 057
- *3: When installing Option 056
- *4: When installing Option 064, 065, 066, 067, 068 or 069 including the filter for 614.4 Gbit/s as the product configuration.
- *5: When installing Option 064, 065, 066, 067, 068 or 069 including the filter for 155.52 Gbit/s as the product configuration.
- *6: When installing Option 064, 065, 066, 067, 068 or 069 including the filter for 622.08 Gbit/s as the product configuration.
- *7: When installing Option 064, 065, 066, 067, 068 or 069 including the filter for 2.666 Gbit/s as the product configuration.
- *8: Without Option
When installing Option, sometimes the upper limit is lower than 7404.

8.3.2 Calibration of O/E Module

When light is not input to the O/E module, the output voltage is adjusted.

The output voltage of the O/E module changes depending on the ambient temperature.

Calibrate the MP2100A before using the O/E module.

1. Close the O/E Data In cap.
2. Touch [Calibrate Module].
3. The window confirming that the light is not input is displayed. Touch [OK].
4. The window indicating that the calibration is finished at about five seconds is displayed. Touch [OK].

8.3.3 Adjustment required when changing the wavelength bands

To measure an optical signal at the other wavelength band than 850 nm, 1310 nm or 1550 nm, adjust the values of Conversion Gain, Responsivity and System Conversion Gain.

Warm up the O/E module at least one hour because the output voltage varies depending on the ambient temperature. Additionally, be sure to calibrate the sampling oscilloscope before performing adjustment.

<Adjusting Manually>

Adjustment method of Conversion Gain (System Conversion Gain)

1. Adjust the wavelength of the optical power meter to the optical signal.
2. Measure unmodulated optical signal power with the optical power meter.
3. Input the optical signal to the optical input connector of MP2100A-003 or MP2102A-023.
4. Measure the average of the optical signal power by using the Histogram function of the sampling oscilloscope.
5. Display the O/E setting panel.
6. Set Wavelength to User.
7. Adjust the Conversion Gain value so that the average of the optical signal power measured by the Histogram function of the sampling oscilloscope becomes equal to the value measured by the power meter. The System Conversion Gain value is automatically set by setting the Conversion Gain value.

Adjustment method of Responsivity

1. Adjust the wavelength of the optical power meter to the optical signal.
2. Measure unmodulated optical signal power with the optical power meter.
3. Input the optical signal to the optical input connector of MP2100A-003 or MP2102A-023.
4. Measure the Average Power (mW) or Average Power (dBm) of the optical signal by using the Amplitude/Time function of the sampling oscilloscope.
5. Display the O/E setting panel.
6. Set Wavelength to User.
7. Adjust the Responsivity value so that the Average Power value of the optical signal measured by the Amplitude/Time function of the sampling oscilloscope becomes equal to the value measured by the optical power meter.

<Adjusting Automatically by Auto Correction>

1. Adjust the wavelength of the optical power meter to that of the optical signal.
2. Measure unmodulated optical signal power with the optical power meter.
3. Input the optical signal to the optical input connector of MP2100A-003 or MP2100A-023.
4. Display the O/E setting panel.
5. Set Wavelength to User.
6. Set the Input Power to the value of the optical signal power measured by Step 2.
7. Press [Execute] to calibrate automatically.
8. When Auto Correction is completed, the values of Conversion Gain, Responsivity, and System Conversion Gain are adjusted so that they become equal to the values measured by the optical power meter.

Chapter 9 Performance Test

This chapter describes how to the performance of the BERTWave Series.

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9.1 Performance Test for Pulse Pattern Generator

The pulse pattern generator is required to test the following items.

- Operation frequency range
- Waveform
- Full rate clock output (with Option 052/152)

CAUTION

Connect a 50 Ω terminator to unused input/output connectors.

9.1.1 Apparatus Required for Performance Test

The following table shows the required equipment for performance test.

Before starting performance tests, warm up the MP2100A/MP2101A and the measuring instruments for at least 1 hour.

Table 9.1.1-1 Equipment for Performance Test

Product Name	Required Performance	Recommended Equipment
Sampling oscilloscope	Electrical interface Bandwidth: 20 GHz or more	MP2100A or MP2102A (Anritsu)
Frequency counter	Frequency range: 500 MHz to 20 GHz Accuracy: 0.1 ppm max.	MF2412C (Anritsu)

9.1.2 Operating Frequency Range

Procedure:

1. Connect the Sync Output connector to the input connector of the frequency counter.
2. Connect the PPG1 Data Out and PPG1 $\overline{\text{Data}}$ Out to the coaxial terminator.
3. Touch [PPG/ED1 Ch1].
4. Set Sync Output to [PPG1_1/8 Clk].
5. Set Reference Clock to [Internal].
6. Select [Variable] at Bit Rate and input 11320000 kbit/s.
When Option 090 is added, input 12500000 kbit/s.
7. Set [Offset] at Bit Rate to 0 ppm.
8. Set Data/XData to [On].
9. Read the setting value of the frequency counter.
10. Check that the read value multiplied by 8 is within the following range.

When the Option 090 is not installed: $11320000 \pm 113.2 \text{ kHz}$

When the Option 090 is installed: $12500000 \pm 125 \text{ kHz}$

11. Set Bit Rate to 8500000 kbit/s.
When Option 090 is added, input 8000000 kbit/s.
12. Read the value measured by the frequency counter.
13. Check that the read value multiplied by a factor of 8 is within the following limited values.

Without Option 090: $8500000 \pm 85 \text{ kHz}$

With Option 090: $8000000 \pm 80 \text{ kHz}$

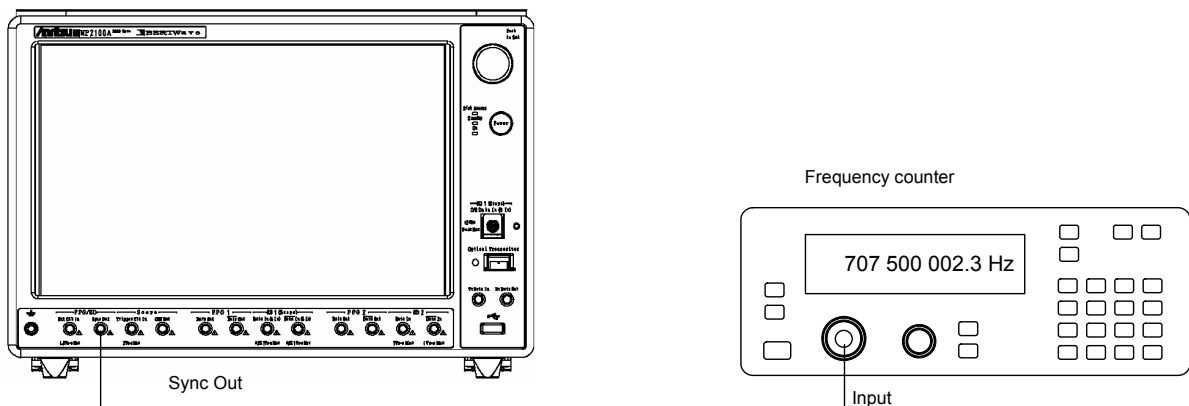


Figure 9.1.2-1 Operation Frequency Range Test Setup

9.1.3 Waveform

Procedure:

1. Connect the Sync Output connector and the trigger input connector of the sampling oscilloscope using a coaxial cable.
2. Connect the PPG1 Data Out connector and the input connector of the sampling oscilloscope using a coaxial cable.
3. Connect the coaxial terminator to the PPG1 $\overline{\text{Data}}$ Out connector.
4. Touch [PPG/ED Ch1].
5. Connect Sync Output to [PPG1_1/16 Clk].
6. Set Reference Clock to [Internal].
7. Select [Variable] at Bit Rate and input 11320000 kbit/s.
8. Set External Attenuation to 0 dB.
9. Set Test Pattern to [PRBS $2^{23}-1$].
10. Set Data/XData to [On].
11. Set Amplitude to 0.1 Vp-p.
12. Measure the amplitude using the sampling oscilloscope.
13. Set Amplitude to 0.8 Vp-p.
14. Measure the amplitude using the sampling oscilloscope.
15. Connect the PPG1 $\overline{\text{Data}}$ Out connector to the input connector of the sampling oscilloscope.
16. Connect the coaxial terminator to the PPG1 Data Out connector.
17. Repeat steps 11 to 14.

The following measurement added when selecting Ch2.

1. Connect the PPG2 Data Out connector and the input connector of the sampling oscilloscope using a coaxial cable.
2. Connect the PPG2 $\overline{\text{Data}}$ Out connector to the coaxial terminator.
3. Touch [PPG/ED Ch2].
4. Set Sync Output to [PPG2_1/16 Clk].
5. Repeat steps from 6 to 14 at Ch1.
6. Connect the PPG2 $\overline{\text{Data}}$ Out connector and the input connector of the sampling oscilloscope using a coaxial cable.
7. Connect the coaxial terminator to the PPG2 Data Out connector.
8. Repeat steps from 11 to 14 at Ch1.

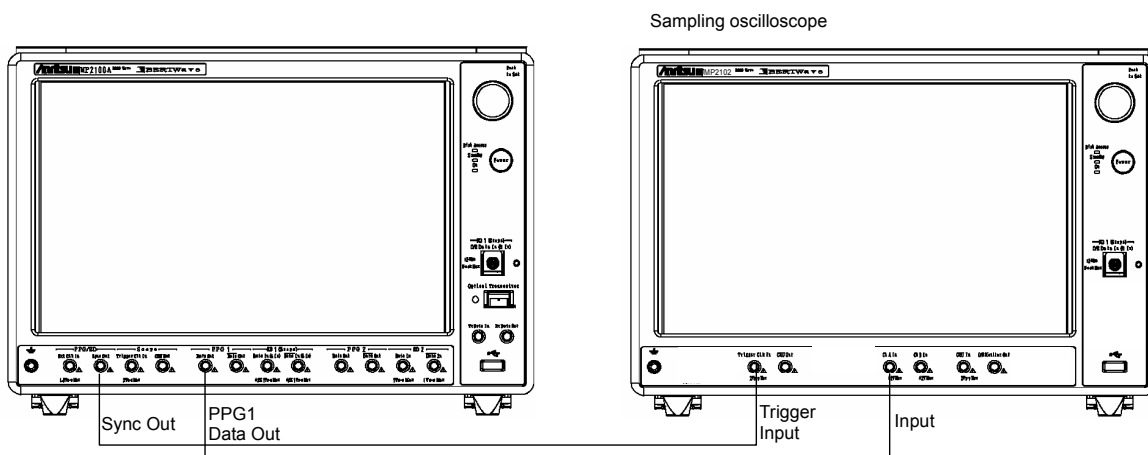


Figure 9.1.3-1 Waveform Test Connection Figure

9.1.4 Full Rate Clock Output

When Option 052/152 is installed, the signal output at Full Rate Clock Output can be tested.

Procedure:

1. Connect the PPG1 Data Output connector and sampling oscilloscope trigger input connector using a coaxial cable.
2. Connect Clock Output and the sampling oscilloscope input connector using a coaxial cable.
3. Connect a coaxial terminator to the PPG1 Data Out connector.
4. Touch [PPG/ED Ch1].
5. Set Test Pattern to [Programmable Pattern] and select [11110000.dat].
6. Set Sync Output to [PPG1_1/8Clk].
7. Set Reference Clock to [Internal].
8. Select [Variable] for Bit Rate and input 10000000 kbit/s.
9. Set Data/XData to [On].
10. Set Amplitude to 0.4 Vp-p.
11. Measure the Amplitude, Rise Time, Fall Time, Duty, and Jitter (RMS) at the sampling oscilloscope.

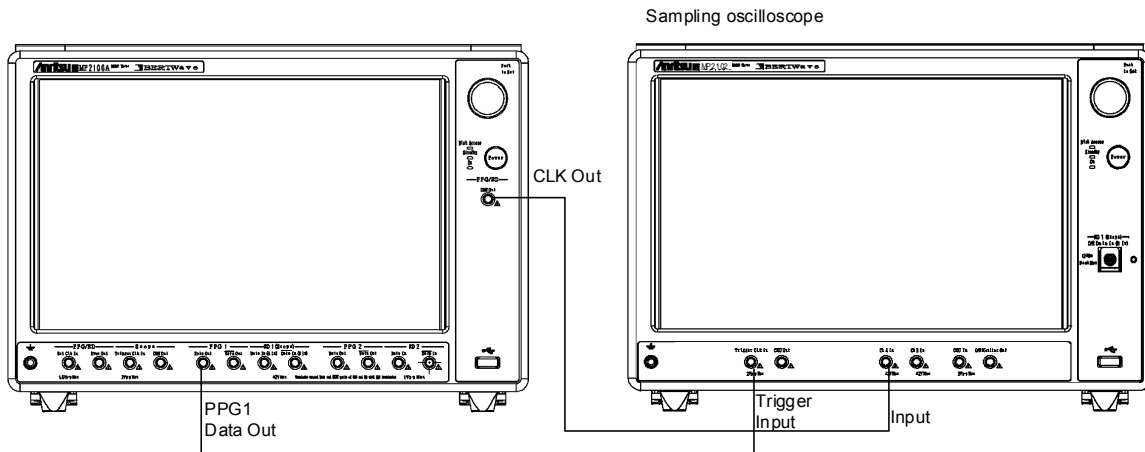


Figure 9.1.4-1 Full Rate Clock Output Test Connection Setup

9.2 Performance Test for Error Detector

The ED is required to test the following performance.

- Operating frequency
- Input level
- Pattern
- Error detection

Before testing the performance of the ED, confirm that the performance of the tested pulse pattern generator satisfies the specifications.

9.2.1 Apparatus Required for Performance Test

The following table lists the equipment for performance test.

Before starting performance tests, warm up the MP2100A/MP2101A and the measuring instruments for at least 1 hour.

Table 9.2.1-1 Equipment for Performance Test

Product Name	Required Performance	Recommended Equipment
Pulse Pattern Generator	Bit rate: 4.25 to 11.32 Gbit/s Amplitude: 0.1 to 0.8 V	MP2100A, MP2101A (Anritsu)
E/O Converter	Bit rate: 10.3125 GHz Extinction ratio: 8.2 dB or more VECP 0.5 dB or less	MP2100A-050, MP2101A-050 (Anritsu)
Variable Optical Attenuator	For single mode fiber Waveform: 1200 to 1600 nm Insertion loss: 3 dB or less Attenuation: 0 to 30 dB Resolution: 0.1 dB or less	8163B+81570A (Keysight Technologies)
	For multi-mode fiber Waveform: 800 to 900 nm Insertion loss: 3 dB or less Attenuation: 0 to 30 dB Resolution: 0.1 dB or less	8163B+81578A (Keysight Technologies)

9.2.2 Operating Frequency

Procedure:

1. Connect the PPG1 Data Out and the ED1 Data In using a coaxial cable.
2. Connect the PPG1 $\overline{\text{Data}}$ Out and ED1 $\overline{\text{Data}}$ In to the coaxial terminator.
3. Touch [PPG/ED Ch1] → [PPG].
Set the value as follows:
Amplitude: 0.1 V
Bit Rate: Variable, 11320000 kbit/s
Data/XData Out: On
Reference Clock: Internal
Offset: 100 ppm
Test Pattern: PRBS $2^{31}-1$, Pos
4. Touch [ED], and then set the value as follows:
Bit Rate: Variable, 11320000 kbit/s
Data Input condition: Electrical Single-Ended Data
Gating Cycle: Single
Gating Period: 10 s
Test Pattern: PRBS $2^{31}-1$, Pos
Threshold: 0 mV
5. Touch [Start] at All Measure.
6. Record the FREQ (kHz) of the ED Result and error count (EC) after measurement.
7. Set Offset to -100 set at step 3.
8. Touch [Start] at All Measure.
9. Record the FREQ (kHz) of the ED Result and error count (EC) after measurement.
10. Connect the PPG1 $\overline{\text{Data}}$ Out and ED1 $\overline{\text{Data}}$ In using a coaxial cable.
11. Connect the PPG1 Data Out and ED1 Data In to the coaxial terminator.
12. Touch [PPG/ED Ch1] → [PPG], and set the value as follows.
Offset: 100 ppm
13. Touch [ED], and set the value as follows.
Data Input condition: Electrical Single-Ended XData
14. Repeat steps 5 to 9.

When using MP2100A-005 and MP2101A-012:

1. Connect the PPG2 Data connector and ED2 Data connector using a coaxial cable.
2. Connect the PPG2 $\overline{\text{Data}}$ Out and ED2 $\overline{\text{Data}}$ In to the coaxial terminator.
3. Touch [PPG/ED Ch2], and then repeat steps 3 to 10.
4. Connect the PPG2 $\overline{\text{Data}}$ Out and the ED2 $\overline{\text{Data}}$ In using a coaxial cable.
5. Connect the coaxial terminator to the PPG2 Data Out connector.
6. Touch [PPG], and set the value as follows.
Offset: 100 ppm
7. Touch [ED], and set the value as follows.
Data Input condition: Electrical Single-Ended XData
8. Repeat steps 5 to 9.

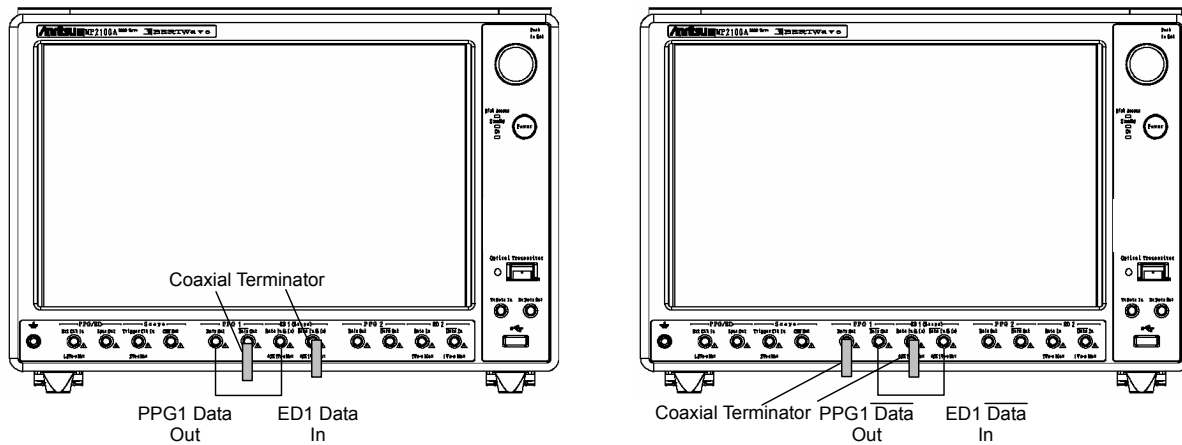


Figure 9.2.2-1 Operating Frequency Test Connection Setup

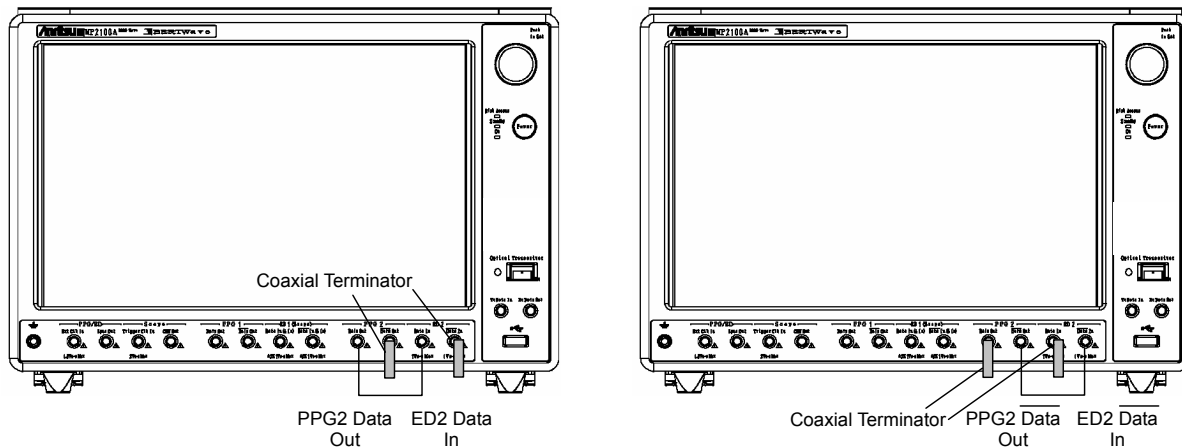


Figure 9.2.2-2 Operating Frequency Test Connection Setup (MP2100A-005, MP2101A-012)

9.2.3 Input Level

Procedure:

1. Connect the PPG1 Data Out and the ED1 Data In using a coaxial cable.
2. Connect the PPG1 $\overline{\text{Data}}$ Out and ED1 $\overline{\text{Data}}$ In to the coaxial terminator.
3. Touch [PPG], and then set the value as follows:
Amplitude: 0.1 V
Bit Rate: Variable, 11320000 kbit/s
Data/XData Out: On
Error Addition: Off
Reference Clock: Internal
Offset: 0 ppm
Test Pattern: PRBS $2^{31}-1$, Pos
4. Touch [ED], and set the value as follows.
Bit Rate: Variable, 11320000 kbit/s
Data Input condition: Electrical Single-Ended Data
Gating Cycle: Single
Gating Time: 10 s
Test Pattern: PRBS $2^{31}-1$, Pos
Threshold: 0 mV
5. Touch [Start] at Measure.
6. Record the FREQ (kHz) of the ED Result and error count (EC) after measurement.
7. Connect the PPG1 $\overline{\text{Data}}$ Out and ED1 $\overline{\text{Data}}$ In using a coaxial cable.
8. Connect the PPG1 Data Out and ED1 Data In connectors to the coaxial terminator.
9. Set the [ED] Data Input condition to [Electrical Single-Ended XData].
10. Touch [Start] at Measure.
11. Record the ED Result FREQ (kHz) and EC error count.
12. Set the amplitude of the pulse pattern generator to 0.8 Vp-p.
13. Repeat steps 5 to 11.
- *: When using the MP2100A-003 or MP2100A-007, omit steps 7 to 11.

When using MP2100A-005 and MP2101A-012:

1. Connect the PPG2 Data Out and ED2 Data In using a coaxial cable.
2. Connect the PPG2 $\overline{\text{Data}}$ Out and ED2 $\overline{\text{Data}}$ In to the coaxial terminator.
3. Touch [PPG/ED Ch2], and repeat the steps 3 to 13.

For the input level for test connection figure for the electrical interface, refer to Figure 9.2.2-1 and Figure 9.2.2-2.

Procedure (using MP2100A-003)

1. Connect the PPG1 Data Out and E/O converter Data connectors using a coaxial cable.
2. Connect the PPG1 $\overline{\text{Data}}$ Out and E/O converter $\overline{\text{Data}}$ connectors using a coaxial cable.
3. Connect the optical output connector of the E/O converter and the input connector of the variable optical attenuator using an optical fiber.
4. Connect the output connector of the variable optical attenuator and the optical power meter using an optical fiber.
5. Touch [PPG/ED Ch1], and then set [PPG] as follows.
 Amplitude: recommended values for E/O converter
 Bit Rate: 10GbE LAN/PHY
 Data/XData Out: On
 Error Addition: Off
 Reference Clock: Internal
 Offset: 0 ppm
 Sync Output: PPG1_1/16 Clk
 Test Pattern: PRBS 2³¹-1, Pos
6. Set [ED] as follows.
 Bit Rate: 10GbE LAN/PHY
 Data Input condition: Optical
 Gating Cycle: Single
 Gating Period: 10 s
 Test Pattern: PRBS 2³¹-1, Pos
 Threshold: 0 mV
7. Match [O/E] for Wavelength with the E/O converter wavelength.
8. Adjust the variable optical attenuator to set the optical input to -9 dBm.
9. Connect the output connector of the variable optical attenuator and the O/E Data In (B In) using an optical fiber.
10. Touch [PPG/ED Ch1] → [Start].

- After measurement, record the ED Result FREQ (kHz) and error count.

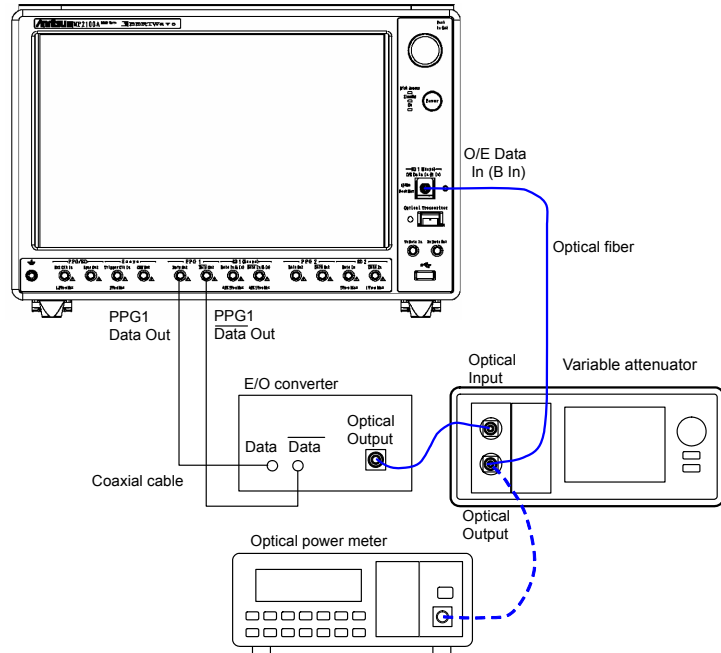
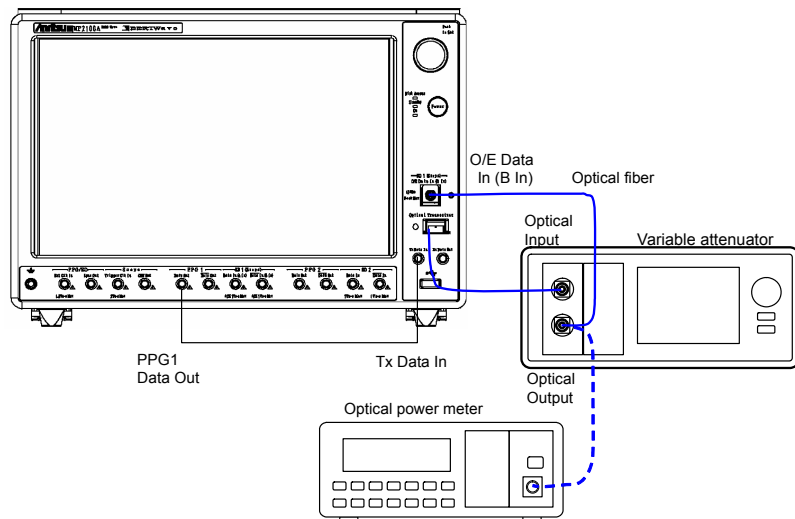


Figure 9.2.3-1 Input Level Test Connection Setup (MP2100A-003)

When using the MP2100A-050 or MP2100A-051 as the E/O converter, read steps 1 to 3 on the previous page as follows:

- Connect the PPG1 Data Out and Tx Data In connectors using a coaxial cable.
- Connect the Optical Transceiver Tx connector and the variable attenuator input connector using an optical fiber.



**Figure 9.2.3-2 Input Level Test Connection Setup (MP2100A-003)
(When Using Option 050/051)**

9.2.4 Pattern

Procedure

1. Connect the PPG1 Data Out and ED1 Data In using a coaxial cable.
2. Connect the PPG1 $\overline{\text{Data}}$ Out and ED1 $\overline{\text{Data}}$ In to the coaxial terminator.
3. Touch [PPG/ED Ch1] and set [PPG] as follows:

Amplitude:	0.5 V
Bit Rate:	Variable, 11320000 kbit/s
Data/XData Out:	On
Error Addition:	Off
Reference Clock:	Internal
Offset:	0 ppm
Test Pattern:	PRBS $2^{31}-1$, Pos
4. Set [ED] as follows:

Bit Rate:	Variable, 11320000 kbit/s
Data Input condition:	Electrical Single-Ended Data
Gating Cycle:	Single
Gating Period:	10 s
Test Pattern:	PRBS $2^{31}-1$, Pos
Threshold:	0 mV
5. Touch [Start] at Measure.
6. After measurement, confirm that the error count of the ED Result is 0.
7. Change Test Pattern for [PPG] and [ED] in succession to [PRBS 2^7-1], [PRBS 2^9-1], [PRBS $2^{15}-1$], and [PRBS $2^{23}-1$], and repeat steps 5 to 7 each time.
8. Connect the PPG1 $\overline{\text{Data}}$ Out and ED1 $\overline{\text{Data}}$ In using a coaxial cable.
9. Connect the PPG1 Data Out and ED1 Data In to the coaxial terminator.
10. Set [ED] at Data Input condition to [Electrical Single-Ended XData] at Data Input condition.
11. Repeat steps 3 to 8.
- *: When using the MP2100A-003 or MP2100A-007, omit steps 9 to 12.

When using MP2100A-005 and MP2101A-012:

1. Connect the PPG2 Data Out and ED2 Data In using a coaxial cable.
2. Connect the PPG2 $\overline{\text{Data}}$ Out and ED2 $\overline{\text{Data}}$ In to the coaxial terminator.
3. Touch [PPG/ED Ch2], and repeat the steps 3 to 12.

The pattern test setup is the same as shown in Figure 9.2.2-1 and Figure 9.2.2-2.

9.2.5 Error Detection

Procedure

1. Connect the PPG1 Data Out connector and the ED1 Data In using a coaxial cable.
 2. Connect the PPG1 $\overline{\text{Data}}$ Out and ED1 $\overline{\text{Data}}$ In to the coaxial terminator.
 3. Touch [PPG/ED Ch1], and the set [PPG] as follows:
Amplitude: 0.1 V
Bit Rate: Variable, 10000000 kbit/s
Data/XData Out: On
Error Addition: On, Single
Reference Clock: Internal
Offset: 0 ppm
Test Pattern: PRBS $2^{31}-1$, Pos
 4. Set [ED] as follows:
Bit Rate: Variable, 10000000 kbit/s
Data Input condition: Electrical Single-Ended Data
Gating Cycle: Single
Gating Period: 10 s
Test Pattern: PRBS $2^{31}-1$, Pos
Threshold: 0 mV
 5. Touch [Start] at Measure.
 6. Touch [PPG] at [Insert Error] once.
 7. After measurement, confirm that the bit error rate of the ED Result is $1\text{E}-11$ and the error count is 1.
 8. Set [ED] to [Electrical Single-Ended XData] at Data Input condition.
 9. Connect the PPG1 $\overline{\text{Data}}$ Out connector and ED1 $\overline{\text{Data}}$ In using a coaxial cable.
 10. Connect the PPG1 Data Out and ED1 Data In to the coaxial terminator.
 11. Repeat steps 5 to 7.
- * When using the MP2100A-003 or MP2100A-007, omit steps 8 to 11.

The error detection test connection is the same as Figure 9.2.2-1 and Figure 9.2.2-2.

When using MP2100A-005 and MP2101A-012:

1. Connect the PPG2 Data Out connector and the ED2 Data In using a coaxial cable.
2. Connect the coaxial terminator to the PPG2 $\overline{\text{Data}}$ Out connector.
3. Touch [PPG/ED Ch2], and set [PPG] to the previous step 3.
4. Repeat steps 4 to 8.
5. Connect the PPG2 $\overline{\text{Data}}$ Out connector and the ED2 $\overline{\text{Data}}$ In using a coaxial cable.
6. Connect the PPG2 Data Out and ED2 Data In to the coaxial terminator.
7. Repeat steps 5 to 7.

The error detection test connection is the same as Figure 9.2.2-1 and Figure 9.2.2-2.

9.3 Performance Test for Sampling Scope

A sampling scope is required to test the following performance.

- Amplitude accuracy

9.3.1 Apparatus Required for Performance Test

The following table lists the equipment required for the performance test.

Before starting performance tests, warm up the MP2100A /MP2102A and measuring instruments for at least 1 hour.

Table 9.3.1-1 Equipment for Performance Test

Product Name	Required Performance	Recommended Equipment
Pulse Pattern Generator	Clock frequency: 10 GHz Amplitude: 0.5 Vp-p	MP1800A, MU181000A MU181020A (Anritsu)
DC Power Source	Power voltage: ± 2.5 V Power current: ± 50 mA Setting accuracy: 1% or less With current limiting function	2400 (Keithley Instruments)

9.3.2 Amplitude Accuracy

Procedure:

1. Connect the Trigger Input and the clock output connector of the PPG using a coaxial cable.
2. Set the clock output the PPG as follows:
 - Amplitude: 0.5 V_{p-p}
 - Frequency: 10 GHz
3. Touch [Setup], and set as follows:
 - Sampling Mode: EYE
 - Accumulation Type: None
 - Clock Recovery: Off
 - Divide Ratio: 1
4. Touch [Time], and set as follows:
 - Unit: UI
 - Bit On Screen: 2
 - Offset: 0
 - Data Clock Rate – Tracking: Off
 - Clock Rate: 10 000 000 kHz
 - Divide Ratio: 1
5. Touch [Amplitude], and set as follows:
 - Channel Math: Off
 - Channel A/B Tracking: Off
 - Scale – A: 50 mV/div
 - Offset – A: 0 mV
 - Attenuation – A: 0 dB
6. Touch [Measure], and set as follows:
 - Active Channel Selection: Channel A
 - Measure Item: Histogram
 - Histogram – Axis: Amplitude
 - X1: 0
 - X2: 2
 - Y1: –250 mV
 - Y2: 250 mV
7. Set the Current Limit of DC Power Source to 20 mA.
8. Set the DC voltage to 0 V.
9. Connect the DC Power Source to Ch A In.
Connect the center conductor of the coaxial cable to plus and the shield to minus.
10. Touch [CH A] to set to On.
11. Touch [Sampling] to set to Run.

12. Record the average value (Mean) of the histogram measurement result.
13. Set the DC voltage to 200 mV.
14. Record the average value of the histogram measurement result.
15. Set the DC voltage to -200 mV.
16. Record the average value of the histogram measurement result.

When using the MP2100A-001 and MP2102A-021, test the amplitude accuracy for Ch B after measuring the amplitude control of Ch A.

1. Touch [Amplitude], and set as follows:
Channel Math: Off
Channel A/B Tracking: Off
Scale – B: 50 mV/div
Offset – B: 0 mV
Attenuation – B: 0 dB
2. Touch [Measure], and set as follows:
Active Channel Selection: Channel B
3. Set the DC voltage to 0 V.
4. Connect the DC Power Source to Ch B In.
Connect the center conductor of the coaxial cable to plus and the shield to minus.
5. Touch [CH B] to set to ON.
6. Touch [Sampling] to set to Run.
7. Record the average voltage (Mean) of the histogram measurement result.
8. Set the DC voltage to 200 mV.
9. Record the average value of the histogram measurement result.
10. Set the DC voltage to -200 mV.
11. Record the average voltage of the histogram measurement result.

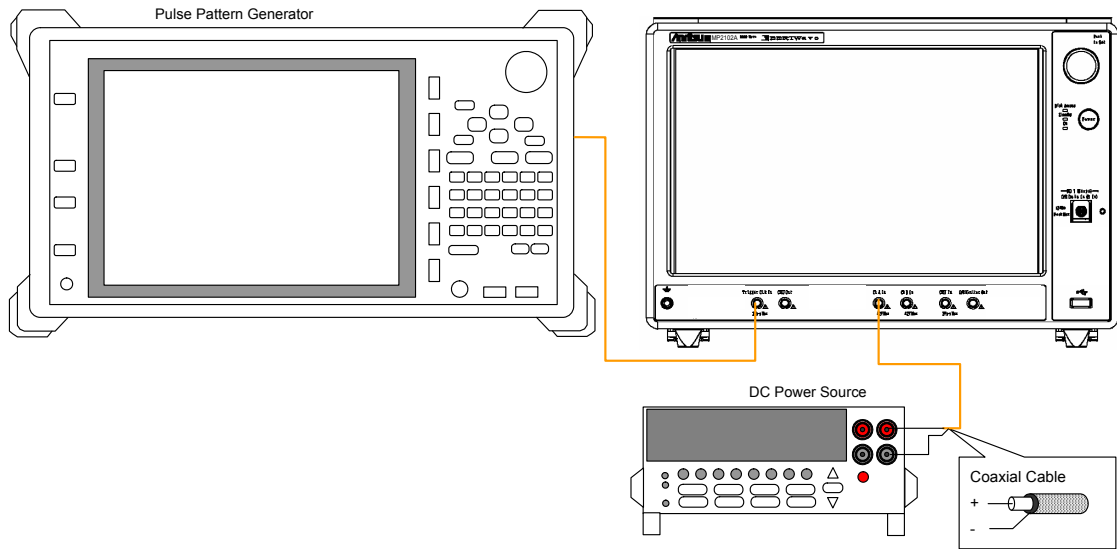


Figure 9.3.2-1 Amplitude Accuracy Test Connection Setup

9.4 Performance Test for Optical Interface (O/E Converter)

An O/E converter is required to test the following performance.

- Optical power meter

9.4.1 Apparatus Required for Performance Test

The following table list the equipment required for the performance test.

Before starting performance tests, warm up the MP2100A /MP2102A and the measuring instruments for at least 1 hour.

Table 9.4.1-1 Equipment for O/E Converter Performance Test

Product Name	Required Performance	Recommended Equipment
Light source	Wavelength: 850, 1310, 1550 nm Output level range: +3 dBm min. Level accuracy: ± 0.05 dB	
Optical power meter	Wavelength range: 750 to 1700 nm Level range: -40 to +10 dBm (100 nW to 10 mW) Level accuracy: 5% Linearity: ± 0.05 dB min.	
Variable optical attenuator	For single-mode fiber Wavelength: 1200 to 1600 nm Insertion loss: 3 dB max. Attenuation: 0 to 30 dB Resolution: 0.1 dB max. For multimode fiber Attenuation: 800 to 900 nm Insertion loss: 3 dB max. Attenuation: 0 to 30 dB Resolution: 0.1 dB max.	8163B+81570A (Keysight Technologies) 8163B+81578A (Keysight Technologies)
Pulse Pattern Generator or Signal Generator	Clock frequency: 100 MHz Amplitude: 0.5 Vp-p	MG3740A (Anritsu)

9.4.2 Optical Power Meter

Procedure (MP2100A-003, MP2100A-007, MP2102A-023)

1. Connect the signal generator output and Trigger Clk In using a coaxial cable.
2. Set the signal generator as follows:
Frequency: 100 MHz
Amplitude: 0.5 V_{p-p} (at sine-wave -2.0 dBm)
3. Connect the output connector of the light source and the input connector of the variable optical attenuator using an optical fiber.
4. Connect the output connector of the variable optical attenuator and the optical power meter using an optical fiber.
5. Match the optical power meter wavelength with the light source wavelength.
6. Set the light source output to On.
7. Adjust the variable optical attenuation to set the optical power meter display to around -1 dBm (0.8 mW).
8. Record the optical power meter display P (dBm).
9. Disconnect the optical fiber from the optical power meter and connect it to the O/E Data In connector.
10. Touch [O/E].
11. Touch the Wavelength button to set the value equal to the wavelength of the light source.
12. Touch [EYE/Pulse Scope], and then set the value as follows:
CH_A: Off
CH_B: On
13. Set [Sampling] to Run.
14. Touch [Measure] and [Amplitude/ Time].
15. Add [Average Power (dBm)] in the Item Selection.
16. Record the displayed Average Power (dBm).
17. Change the light source wavelength and repeat steps 3 to 16.

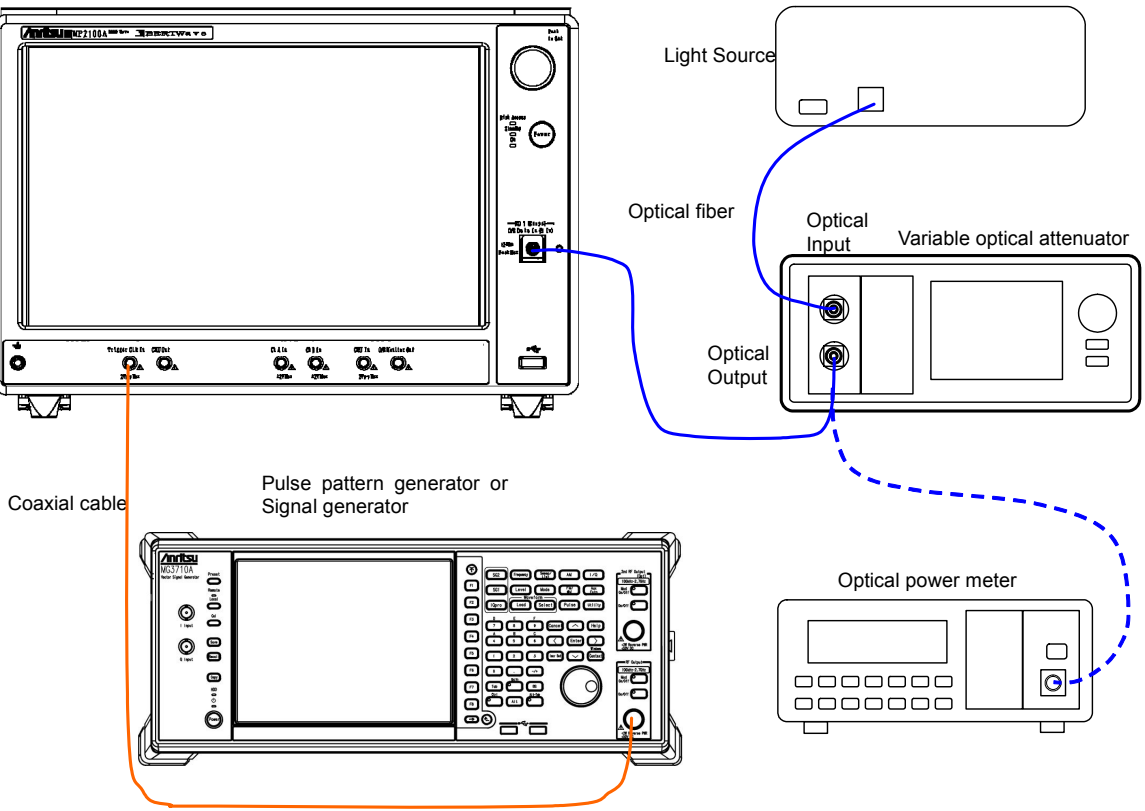


Figure 9.4.2-1 Optical Power Meter Test Connection Setup
(MP2100A-003, MP2100A-007, MP2102A-023)

Chapter 10 Maintenance

This chapter describes maintenance, storage and disposal procedures.

10.1	Daily Maintenance	10-2
10.2	Replacement of Optical Connector.....	10-3
10.3	Optical Connector/Optical Adapter Cleaning.....	10-5
10.4	Displaying Software Version.....	10-8
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10.1 Daily Maintenance

Before daily maintenance of the BERTWave, be sure to turn the power off and unplug it from the AC outlet.

Panel surface dirt

When surface dirt is noticeable, after the BERTWave has been used in a dusty environment, or when the BERTWave has not been used for an extended period of time, wipe its surface with a cloth moistened in detergent and wrung enough.

Screen surface dirt

During maintenance work, avoid using organic solvent, such as benzene and thinner; otherwise such chemicals may damage the surface of screen. Lightly wipe this surface with a dry, soft waste cloth or soft cloth slightly moistened in ethanol.

Loose screws

Use a Phillips screwdriver to tighten screws.

10.2 Replacement of Optical Connector

The standard optical connector is the FC type. The optical connector of the plug-in unit and pull-out type optical sensor can be removed and replaced with another connector (sold separately), and its interior can be cleaned. For information, Figure 10.2-1 shows the connector type.

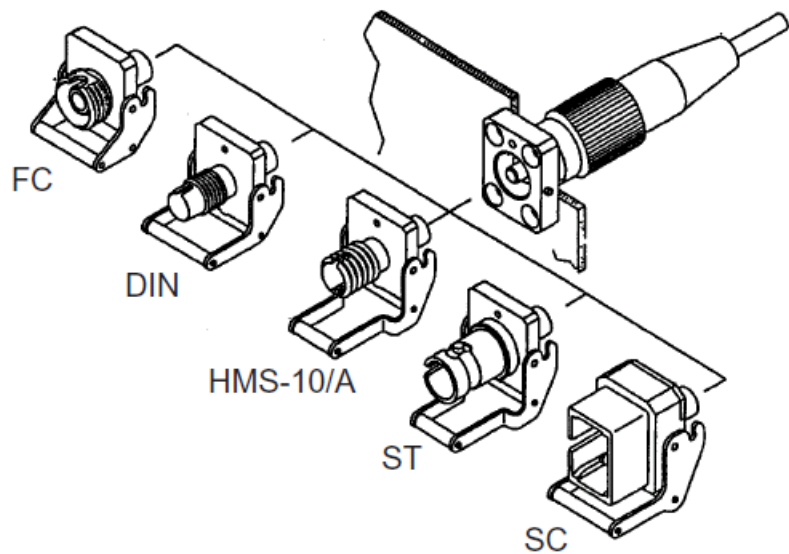


Figure 10.2-1 Connector Type

WARNING

Do not look into the connection surface of the optical fiber cable of the light source optical connector or the end face of the optical fiber cable connected to the light source as invisible laser light output may cause visual deficit and other problems.

CAUTION

Before replacing the optical fiber cable, be sure not to damage the connector and connection surface with connector.

To remove the optical connector:

1. Open the cover.
2. Pull up the connector lever toward you.
3. Check that the latch has been released, and then, gently pull the connector out straight toward you.

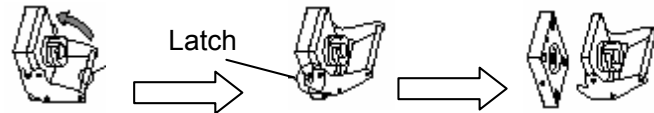


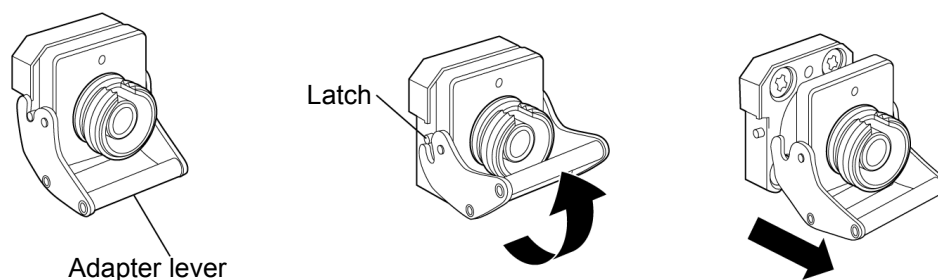
Figure 10.2-2 How to Remove the Optical Connector

10.3 Optical Connector/Optical Adapter Cleaning

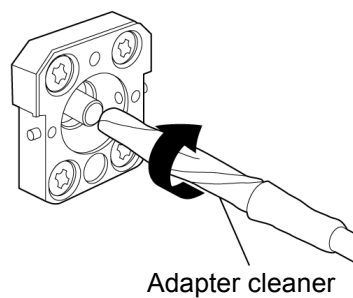
Cleaning the Ferrule End Surface

Use an approved adapter cleaner to clean the ferrule end surface in the optical connector. The ferrule in the optical connectors needs periodic cleaning. Although the following procedures use the FC connector and adapter as an example, use the same methods when cleaning other connector and adapter types.

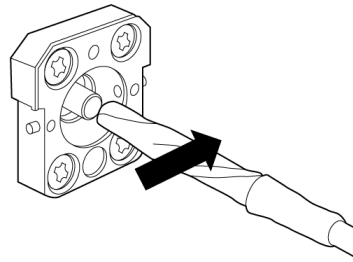
1. Remove the currently connected adapter by raising the adapter lever (you will hear a “click” when the latch disengages) and then gently pull the adapter straight towards you.



2. Moisten an adapter cleaner with isopropyl alcohol and then use it to clean the end surface and sides of the ferrule.



3. Press the tip of a new (dry) adapter cleaner into the ferrule end surface and then wipe in one direction 2 or 3 times to dry the surface.

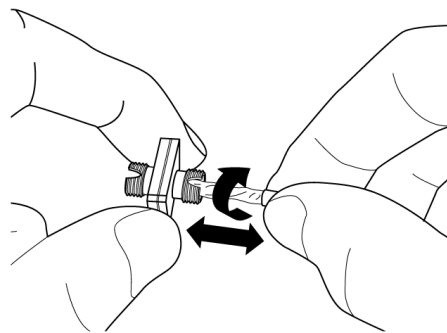


4. Clean the adapter interior with adapter cleaner. (Refer to “Cleaning the optical adapter” below.)
5. Attach the adapter in the reverse order. Be careful not to scratch the ferrule end surface.

Cleaning the Optical Adapter

Use an approved adapter cleaner to clean the optical fiber cable optical adapter. Although the following procedures use the FC connector and adapter as an example, use the same methods when cleaning other connector and adapter types.

Insert adapter cleaner into the split sleeve of the optical adapter. Rotate the adapter cleaner in one direction while moving it back and forth.



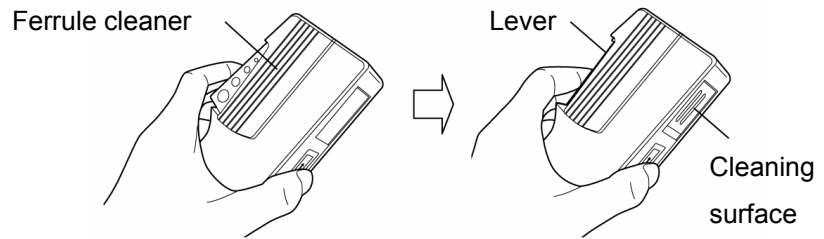
Note:

Check the ferrule diameter and use a cleaner only for the 1.25 mm or 2.5 mm adapter.

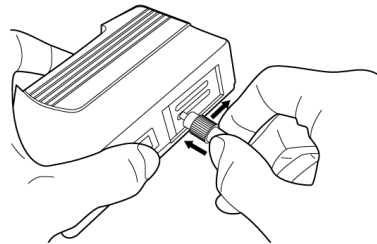
Cleaning the Optical Fiber Cable Ferrule End Surface

Use an approved ferrule cleaner to clean the optical fiber cable ferrule end surface. Although the following procedures use the FC connector and adapter as an example, use the same methods when cleaning other connector and adapter types.

1. Pull the ferrule cleaner lever to expose the cleaning surface.



2. Hold the lever in the opened position, press the optical connector ferrule end into the cleaning surface, and then rub in one direction as shown in the following figure.



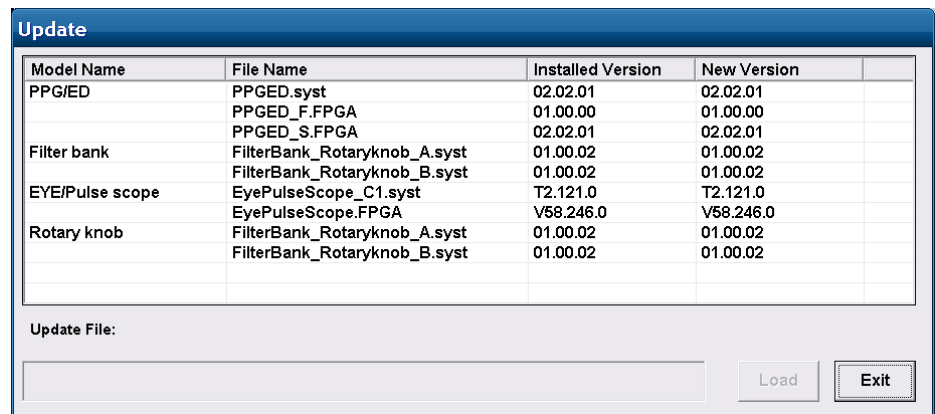
10.5 Updating Software

To update the software, install the new software in the BERTWave. For how to install the software, refer to the document attached to the software.

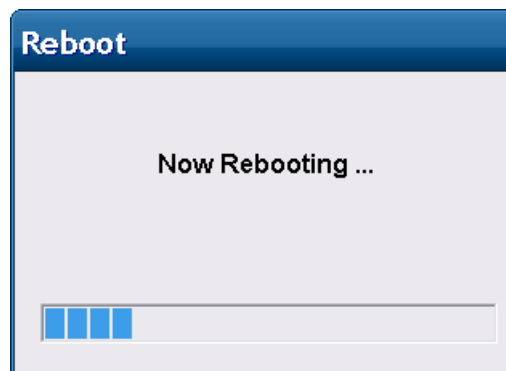
Start the BERTWave after installing the software, and then the version mismatch warning is displayed.

At this time, update the software referring the following procedures.

1. Touch [Setup Utility] at the selector screen, and then the Setup Utility screen opens.
2. Touch [Update], and then the Update screen is displayed.



3. Touch [Load], and then the software upgrading is started.
If the software to update does not exist, the [Load] button is invalid.
4. When the software update procedure is finished, the Reboot screen is displayed.

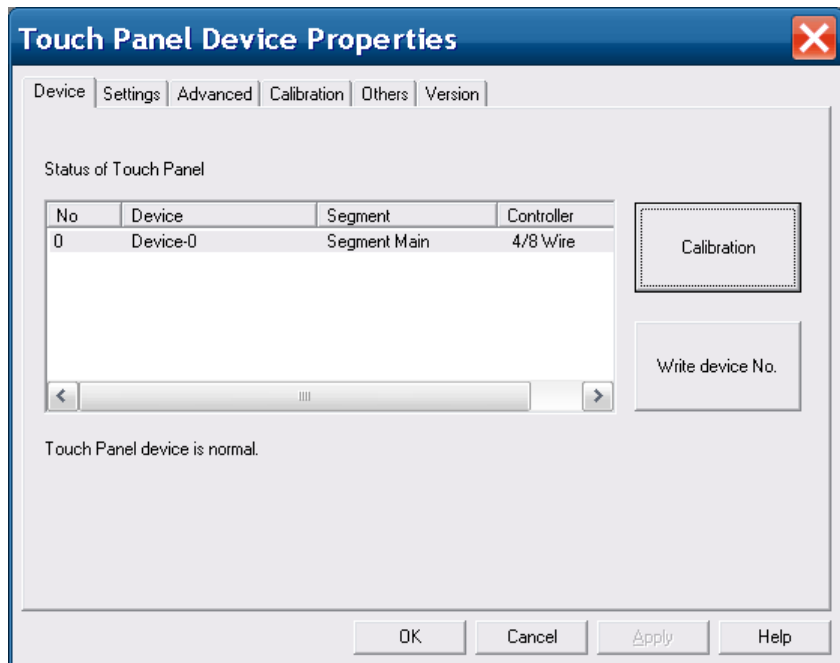


5. After closing the Reboot screen, touch [Exit].

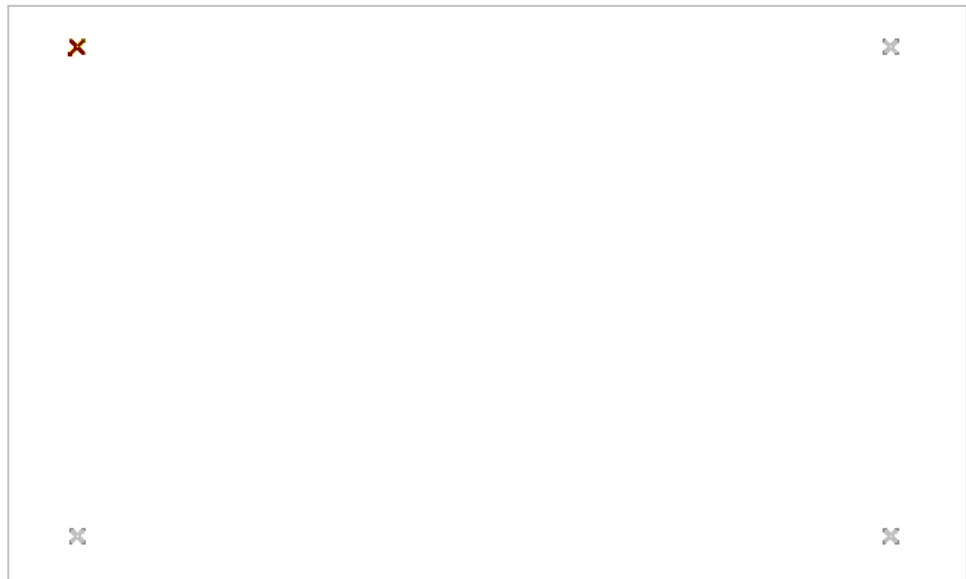
10.6 Touch Panel Position Calibration

Touch panel position may be misaligned depending on the changes of ambient environment (temperature/humidity). If the touch panel position is misaligned, calibrate the position using the following procedures. When calibrating the detecting position, use the sharp-nose stick but do not scratch the panel surface.

1. The Windows Control Panel is displayed.
2. Touch [Touch Panel] twice.
The property window of the touch panel is displayed.



3. Touch [Calibration].
The screen to input the position is displayed.



4. Touch the center of the brown cross using the sharp-noise stick. The next cross to be touch is displayed in brown.
5. Touch the four crosses, and then the property window of the touch panel is displayed.
6. Touch the [OK] button.

10.7 Cautions on Storage

Wipe off dust, fingerprint marks, stains, spots, etc. from the surface of the BERTWave before storing it.

Fit the attached coaxial connector cover to the coaxial connector on the front panel. Also, put the cap on the optical connector.

Put the power cord, CD-ROM and other accessories in the accessory box and store it with the main frame.

Avoid storing the BERTWave in these places:

- In direct sunlight for extended periods
- Outdoors
- In excessively dusty locations
- In liquids, such as water, oil, organic solvents, and medical fluids, or places where these liquids may adhere
- In salty air or where chemically active gases (sulfur dioxide, hydrogen sulfide, chlorine, ammonia, nitrogen oxide, or hydrogen chloride etc.) are present
- Where toppling over may occur
- In the presence of lubricating oil mists
- In places at an altitude of more than 2,000 m
- In the presence of frequent vibration and mechanical shock, such as in cars, ships, and airplanes
- Places with temperatures and relative humidity in the following ranges:
 - Temperature: lower than -20°C or higher than 60°C
 - Humidity: 90% or more

Recommended storage conditions

It is recommended that the BERTWave be stored in a place that meets the ambient conditions suggested above, plus the following conditions, if it is not to be used for a long period of time:

- Temperature: 5 to 45°C
- Humidity: 40 to 80%
- Little temperature and humidity fluctuations within one day

10.8 Transporting and Disposal

The following describes precautions for transporting and disposing of the BERTWave.

Repackaging

Repack the BERTWave in the packing material (box) in which it was delivered. If the packing material has been thrown away or damaged, repack the BERTWave in the following manner:

1. Prepare a corrugated cardboard, wooden, or aluminum box large enough to pack cushioning material in around the BERTWave.
2. Wrap the BERTWave in plastic or a similar material to avoid water droplets and dust.
3. Put the BERTWave in the box.
4. Then, pack the BERTWave in cushioning material so it does not move in the box.
5. Secure the outside of the box with packing cord, adhesive tape, bands, or other similar materials.

Transporting

Avoiding vibrations as much as possible and meet the recommended storage conditions during transport.

Disposal

Follow the instructions of your local waste disposal office when disposing of the BERTWave.

Before disposing of the BERTWave, dismantle or physically destroy any memory media it contains to ensure that any data saved in memory cannot be recovered by third parties.

Appendix A Specifications

A.1 MP2100A BERTWave Specifications

Table A.1-1 Configuration

Model Name	Product Name	
MP2100A	—Main Frame—	
	BERTWave	
MP2100A	—Standard Accessories—	
	Power cord	1
J1137	Terminator	2*3
J1341A	Open (Coaxial connect cover)	5*1,*3 4*2,*3
J1359A	Coaxial adapter (K-P, K-J, SMA compatible)	2*1
		1*2
MX210000A	BERTWave Control Software	1
	(CD-ROM, including Operation Manual)	
MP2100A-001*4 MP2100A-003*4 MP2100A-005 MP2100A-007/107*4 MP2100A-030/130 MP2100A-037*5,*6 MP2100A-038*5,*6 MP2100A-039*5,*6 MP2100A-040*5,*6 MP2100A-050*7 MP2100A-051*7	—Options—	
	Dual Electrical Receiver	
	Optical/Single-ended Electrical Receiver	
	Extended PPG/ED Channel	
	1ch BERT and Optical/Single-ended Electrical Scope	
	GPIB	
	FC connector	
	ST connector	
	DIN47256 connector	
	SC connector	
	XFP slot	
	SFP+ slot	

*1: When selecting Option 001

*2: When selecting Option 003 or Option 007

*3: Two added when installing Option 005.

*4: Select one of Option 001, 003 or 007.

*5: Can be installed when selecting Option 003 or Option 007

*6: Select one from Option 037 to 040.

*7: Either one of Option 050 or 051 can be installed.

Table A.1-1 Configuration (Cont'd)

Model Name	Product Name
	—Options—
MP2100A-052/152	Full Rate Clock Output
MP2100A-055*8	Clock Recovery for EYE/Pulse Scope
MP2100A-056*5,*9	Low Pass Filter Bank (8.5G/10G/10.7G)
MP2100A-057*5,*9	Low Pass Filter Bank (2G/4G/8.5G/10G)
MP2100A-061*5,*9	High Bit Rate Filter
MP2100A-062*5,*9	2 High Bit Rate Filter Bank
MP2100A-063*5,*9	3 to 4 High Bit Rate Filter Bank
MP2100A-064*5,*9	1 to 2 Low Bit Rate Filter Bank
MP2100A-065*5,*9	3 to 4 Low Bit Rate Filter Bank
MP2100A-066*5,*9	1 High Bit Rate/1 to 2 Low Bit Rate Filter Bank
MP2100A-067*5,*9	1 to 2 High Bit Rate/3 to 4 Low Bit Rate Filter Bank
MP2100A-068*5,*9	2 to 3 High Bit Rate/1 to 2 Low Bit Rate Filter Bank
MP2100A-069*5,*9	3 High Bit Rate/3 Low Bit Rate Filter Bank
MP2100A-070*5,*10	LPF for 156M (L)
MP2100A-071*5,*10	LPF for 622M (L)
MP2100A-072*5,*10	LPF for 1.0G (L)
MP2100A-073*5,*10	LPF for 1.2G (L)
MP2100A-076/176*5,*11	LPF for 2.1G (H)
MP2100A-077/177*5,*11	LPF for 2.5G (H)
MP2100A-078/178*5,*11	LPF for 2.6G (H)
MP2100A-079/179*5,*11	LPF for 3.1G (H)

*8: Clock recovery to analyze Ch B waveform is not available for Option 007.

*9: Either one of Option 056, 057 or 061 to 069 can be installed.

*10: Can be installed in Option 064 to 069.

*11: Can be installed in Option 061 to 063 or Option 066 to 069.

Table A.1-1 Configuration (Cont'd)

Model Name	Product Name
	—Options—
MP2100A-080/180*5,*11	LPF for 4.2G (H)
MP2100A-081/181*5,*11	LPF for 5.0G (H)
MP2100A-082/182*5,*11	LPF for 6.2G (H)
MP2100A-083/183*5,*11	LPF for 8.5G (H)
MP2100A-084/184*5,*11,*12	LPF for 9.9G to 10.3G (H)
MP2100A-085/185*5,*11	LPF for 10.5G to 11.3G (H)
MP2100A-086/186*5,*11,*12	LPF for Multi 10G (H)
MP2100A-090	Bit rate Extension for PPG/ED
MP2100A-091/191	ED High Sensitivity

*12: Either one of Option 084/184 or 086/186 can be installed.

Option No. 107, 130, 152, 176 through 186, and 191 are retrofit option.

Installing these options requires returning MP2100A to factory.

Table A.1-2 Pulse Pattern Generator

Item	Specifications	
Bit Rate	Standard Name	Bit rate (kbit/s)
	Variable	8500000 to 11320000
		8000000 to 12500000*1
	Variable 1/2	4250000 to 5660000
		4000000 to 6250000*1
	Variable 1/4	2125000 to 2830000
		2000000 to 3125000*1
	Variable 1/8	1062500 to 1415000
		1000000 to 1562500*1
	Variable 1/16	531250 to 707500
		500000 to 781250*1
	Variable 1/32	265625 to 353750
		250000 to 390625*1
	Variable 1/64	132813 to 176875
		125000 to 195312*1
	1GFC	1062500
	2GFC	2125000
	4GFC	4250000
	8GFC	8500000
	10GFC	10518750
	10GFC FEC	11316800
	1GbE	1250000
	2GbE	2500000
	10GbE WAN	9953280
	10GbE LAN/PHY	10312500
	10GbE OTU-1e	11049107
	10GbE OTU-2e	11095728
	Infiniband	2500000
	Infiniband × 2	5000000
	Infiniband × 4	10000000

*1: Option 090 only

Table A.1-2 Pulse Pattern Generator (Cont'd)

Item	Specifications	
Bit Rate (Cont'd)	Standard Name	Bit rate (kbit/s)
	OC-3/STM-1	155520
	OC-12/STM-4	622080
	OC-24	1244160
	OC-48/STM-16	2488320
	OTU-1	2666057
	OC-192/STM-64	9953280
	G.975 FEC	10664228
	OTU-2	10709225
	CPRI	614400
	CPRI × 2	1228800
	CPRI × 4	2457600
	CPRI × 5*1	3072000
	CPRI × 10*1	6144000
	OBSAI*1	768000
	OBSAI × 2*1	1536000
OBSAI × 4*1	3072000	
OBSAI × 8*1	6144000	
Internal reference clock accuracy	±10 ppm*2,*4	
Bit rate offset	±100 ppm*3	
External 10 MHz input*3	Connector: BNC jack Termination: 50 Ω, AC coupling Amplitude: 0.7 to 2 Vp-p Waveform: Square or sine wave	
External reference clock input	Connector: SMA jack Termination: 50 Ω, AC coupling Amplitude: 0.2 to 1.5 Vp-p Waveform: Square or sine wave	

*2: 1 hour after power-on

*3: When using internal clock

*4: MP2100A-001/003/007: Common for ED1
MP2100A-005: Common for PPG1, PPG2, ED1, and ED2

Table A.1-2 Pulse Pattern Generator (Cont'd)

Item	Specifications																																																																																																																									
Sync output	<p>Frequency:</p> <table border="1"> <thead> <tr> <th>Sync signal source</th> <th colspan="7">Pulse Pattern Generator</th> <th colspan="3">Error Detector</th> </tr> <tr> <th>Divide ratio</th> <th>1/1</th> <th>1/2</th> <th>1/4</th> <th>1/8</th> <th>1/16</th> <th>1/64</th> <th>Pattem Sync.</th> <th>1/4</th> <th>1/8</th> <th>1/16</th> </tr> </thead> <tbody> <tr> <td>Bit rate</td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> <tr> <td>Divide ratio</td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> <tr> <td>Rate 1/64</td> <td>✓</td><td></td><td></td><td></td><td></td><td></td><td>✓</td><td></td><td></td><td></td> </tr> <tr> <td>Rate 1/32</td> <td>✓</td><td></td><td></td><td></td><td></td><td></td><td>✓</td><td></td><td></td><td></td> </tr> <tr> <td>Rate 1/16</td> <td>✓</td><td></td><td></td><td></td><td></td><td></td><td>✓</td><td></td><td></td><td></td> </tr> <tr> <td>Rate 1/8</td> <td>✓</td><td></td><td></td><td></td><td></td><td></td><td>✓</td><td></td><td></td><td></td> </tr> <tr> <td>Rate 1/4</td> <td></td><td>✓</td><td></td><td></td><td></td><td>✓</td><td>✓</td><td></td><td></td><td></td> </tr> <tr> <td>Rate 1/2</td> <td></td><td></td><td>✓</td><td></td><td>✓</td><td></td><td>✓</td><td>✓</td><td></td><td>✓</td> </tr> <tr> <td>Rate 1/1</td> <td></td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td>✓</td><td>✓</td> </tr> </tbody> </table> <p>Connector: SMA jack</p> <p>Termination: 50 Ω</p> <p>Low level (V_{OL}): -0.5 to -0.3 V</p> <p>High level (V_{OH}): -0.1 to 0 V</p> <p>Amplitude: 0.4 V_{p-p}*5</p>	Sync signal source	Pulse Pattern Generator							Error Detector			Divide ratio	1/1	1/2	1/4	1/8	1/16	1/64	Pattem Sync.	1/4	1/8	1/16	Bit rate											Divide ratio											Rate 1/64	✓						✓				Rate 1/32	✓						✓				Rate 1/16	✓						✓				Rate 1/8	✓						✓				Rate 1/4		✓				✓	✓				Rate 1/2			✓		✓		✓	✓		✓	Rate 1/1				✓	✓	✓	✓		✓	✓
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Rate 1/1				✓	✓	✓	✓		✓	✓																																																																																																																
Data output	<p>Number of Channels:</p> <p>MP2100A-001,MP2100A-003, MP2100-007: 1</p> <p>MP2100A-001+005, MP2100A-003+005, MP2100A-007+005: 2</p> <p>Connector: SMA jack</p> <p>Amplitude: 0.1 to 0.8 V_{p-p}, 10 mV resolution</p> <p>Accuracy: ±20 mV ±20% for settings</p> <p>Relative display*6: available</p> <p>Termination: AC coupling, 50 Ω</p> <p>Rise/Fall time*5,*7: 25 ps</p> <p>Jitter: 3 ps rms*5</p> <p>Skew: ±15 ps max.</p>																																																																																																																									

*5: Typical values

*6: Multiplexing values by amplitude and external attenuation factor

*7: Time changing between 20% to 80% amplitude

Table A.1-2 Pulse Pattern Generator (Cont'd)

Item	Specifications																
Full Rate Clock Output (MP2100A-052/152)	<p>Standard Accessory J1341A Open (coaxial connector cover) 1</p> <p>Bit rate</p> <table border="1"> <thead> <tr> <th>Rate setting</th> <th>Output signal frequency</th> </tr> </thead> <tbody> <tr> <td>1/1</td> <td>1/1 PPG clock, 1/1 ED clock</td> </tr> <tr> <td>1/2</td> <td>1/2 PPG clock, 1/2 ED clock</td> </tr> <tr> <td>1/4</td> <td>1/4 PPG clock</td> </tr> <tr> <td>1/8</td> <td>1/8 PPG clock</td> </tr> <tr> <td>1/16</td> <td>No output</td> </tr> <tr> <td>1/32</td> <td>No output</td> </tr> <tr> <td>1/64</td> <td>No output</td> </tr> </tbody> </table> <p>Number of outputs: 1 (single end)</p> <p>Amplitude: 300 to 750 mVp-p</p> <p>Duty: 50% ±15%</p> <p>Rise/Fall time (20 to 80%): 30 ps^{*5*7}</p> <p>RMS jitter: 2 ps rms^{*5,*8,*9} 2 ps rms^{*5,*8,*10}</p> <p>Connector: SMA jack</p> <p>Impedance: 50 Ω, AC coupling</p> <p>Signal source: PPG1^{*11}, ED1, PPG2^{*12,*13}, ED2^{*12}</p> <p>Alarm: PLL Unlock detection</p>	Rate setting	Output signal frequency	1/1	1/1 PPG clock, 1/1 ED clock	1/2	1/2 PPG clock, 1/2 ED clock	1/4	1/4 PPG clock	1/8	1/8 PPG clock	1/16	No output	1/32	No output	1/64	No output
Rate setting	Output signal frequency																
1/1	1/1 PPG clock, 1/1 ED clock																
1/2	1/2 PPG clock, 1/2 ED clock																
1/4	1/4 PPG clock																
1/8	1/8 PPG clock																
1/16	No output																
1/32	No output																
1/64	No output																

*8: When Reference Clock is Internal, and when Sync Clock is 1/8

*9: Clock frequency: 10 GHz

*10: Clock frequency is 12.5 GHz, when installing Option 090.

*11: Excluding when Sync Output is set to PPG1 Pattern Sync.

*12: Option 005 only

*13: Excluding when Sync Output is set to PPG2 Pattern Sync.

Table A.1-2 Pulse Pattern Generator (Cont'd)

Item	Specifications
External attenuation factor	0 to 30 dB, 1 dB resolution
Error insertion	Insertion method: Single, Repeat Error rate: $1E-n$ (n: 2 to 12)
Test pattern	Pseudorandom (PRBS) pattern: Pattern length: 2^7-1 , 2^9-1 , $2^{15}-1$, $2^{23}-1$, $2^{31}-1$ Logic invertible Programmable Pattern: Pattern length: 2 to 1305600 bit, editable by text editor and sample file available

Table A.1-3 Error Detector

Item	Specification
Bit rate	Standard name Bit rate (kbit/s)
Variable	8500000 to 11320000
Variable 1/2	8000000 to 12500000*1
Variable 1/4	4250000 to 6150000
Variable 1/4*1	4000000 to 6250000*1
Variable 1/8*1	2000000 to 3125000
Variable 1/8*1	1000000 to 1562500
Variable 1/16*1	500000 to 781250
Variable 1/32*1	250000 to 390625
Variable 1/64*1	125000 to 195312
1GFC*1	1062500
2GFC*1	2125000
4GFC	4250000
8GFC	8500000
10GFC	10518750
10GFC FEC	11316800
1GbE*1	1250000
2GbE*1	2500000
10GbE WAN	9953280
10GbE LAN/PHY	10312500
10GbE OTU-1e	11049107
10GbE OTU-2e	11095728
Infiniband*1	2500000
Infiniband x 2	5000000
Infiniband x 4	10000000
OC-3/STM-1*1	155520
OC-12/STM-4*1	622080
OC-24*1	1244160
OC-48/STM-16*1	2488320

*1: Option 090 only

Table A.1-3 Error Detector (Cont'd)

Item	Specification																										
Bit rate (Cont'd)	<table border="0"> <tr> <td>Standard name</td> <td>Bit rate (kbit/s)</td> </tr> <tr> <td>OTU-1</td> <td>2666057</td> </tr> <tr> <td>OC-192/STM-64</td> <td>9953280</td> </tr> <tr> <td>G.975 FEC</td> <td>10664228</td> </tr> <tr> <td>OTU-2</td> <td>10709225</td> </tr> <tr> <td>CPRI × 2*1</td> <td>1228800</td> </tr> <tr> <td>CPRI × 4*1</td> <td>2457600</td> </tr> <tr> <td>CPRI × 5*1</td> <td>3072000</td> </tr> <tr> <td>CPRI × 10*1</td> <td>6144000</td> </tr> <tr> <td>OBSAI*1</td> <td>768000</td> </tr> <tr> <td>OBSAI × 2*1</td> <td>1536000</td> </tr> <tr> <td>OBSAI × 4*1</td> <td>3072000</td> </tr> <tr> <td>OBSAI × 8*1</td> <td>6144000</td> </tr> </table>	Standard name	Bit rate (kbit/s)	OTU-1	2666057	OC-192/STM-64	9953280	G.975 FEC	10664228	OTU-2	10709225	CPRI × 2*1	1228800	CPRI × 4*1	2457600	CPRI × 5*1	3072000	CPRI × 10*1	6144000	OBSAI*1	768000	OBSAI × 2*1	1536000	OBSAI × 4*1	3072000	OBSAI × 8*1	6144000
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OBSAI × 2*1	1536000																										
OBSAI × 4*1	3072000																										
OBSAI × 8*1	6144000																										
Offset tolerance	±100 ppm*2																										
Internal reference clock accuracy	±10 ppm*3																										
External 10 MHz input*4	Connector: BNC Termination: AC coupling, 50 Ω Amplitude: 0.7 to 2 Vp-p Waveform: Square or sine wave																										
Test pattern	Pseudorandom (PRBS) pattern: Pattern length: 2 ⁷ -1, 2 ⁹ -1, 2 ¹⁵ -1, 2 ²³ -1, 2 ³¹ -1 Logic invertible Programmable Pattern: Pattern length: 2 to 1305600 bits, editable by text editor and sample file available																										

*2: Data input signal bit rate deviation for set bit rate

*3: 1 hour after power-on

MP2100A-005: Common for ED1 and ED2

*4: MP2100A-001, 003, 007: common for PPG1 and ED1

MP2100A-005: Common for PPG1, PPG2, ED1, and ED2

Table A.1-3 Error Detector (Cont'd)

Item		Specifications
Data input	Number of Channel	MP2100A-001, MP2100A-003, MP2100A-007: 1 MP2100A-001+005, MP2100A-003+005, MP2100A-007+005: 2
	Electrical input*5	Connector: K jack Termination: Single-end, differential*6 Data format: NRZ, mark ratio 50% Amplitude: 0.1 to 0.8 Vp-p*7,*8 0.25 to 0.8 Vp-p*7,*9 Coupling method: DC coupling, termination voltage 0 V Consecutive identical digit immunity: 72 bits or more*10
	Optical input*11	Data format: NRZ, Mark rate 50% Sensitivity: -9 dBm*12,*13
Threshold value*14		-85 to 85 mV, 1 mV resolution*15
External attenuation factor		0 to 30 dB, 1 dB resolution

*5: The ED1 Data In connector is common for the sampling scope CH_A.
MP2100A-001: The ED1 Data In connector is common for the CH_B.
MP2100A-007: The ED1 Data In connector is not installed.

*6: MP2100A-001 ED1 and MP2100A-005 ED2 only

*7: The pattern without option 005: PRBS 2³¹-1 and mark rate: 1/2
Terminal: bit rate at single end: 10.3125 Gbit/s at 20 to 30°C

*8: Bit rate: 8.5 to 11.32 Gbit/s and divide ratio

*9: Bit rate: 8.0 to 8.5 Gbit/s, 11.32 to 12.5 Gbit/s, and their divide ratio

*10: Bit rate: 9.95328 Gbit/s, Pattern: Frame format equal to STM-64
Mark ratio: 1/2, Termination: single end, at 20 to 30°C

*11: MP2100A-003 O/E Data In only

The O/E Data In connector is common for the sampling scope CH_B.
Specifications other than items listed above are the same as the optical input specifications in Table A.1-4.

*12: Under following conditions:

Bit rate: 10.3125 Gbit/s,

Extinction rate: 8.2 dB min., VECP 0.5 dB max.

Pattern: PRBS 2³¹-1, Mark rate: 50%, 20 to 30°C

*13: The displayed threshold value is the value corrected by the external attenuation factor.

The calculation formula is as follows:

Maximum value = $85 \times 10^{(\text{factor}/20)}$

Minimum value = $-85 \times 10^{(\text{factor}/20)}$

Resolution = $1.0 \times 10^{(\text{factor}/20)}$

*14: Termination: Single, at 0 dB external attenuation factor

Table A.1-3 Error Detector (Cont'd)

Item	Specification
Measurement function	Alarm Indicator: Pattern asynchronous (Sync loss), Frequency asynchronous (CR Unlock)*15 Bit error detection Detection method: total error Bit error rate: 0.0001E-18 to 1.0000E-00 Bit error count: 0 to 9999999, 1.0000E07 to 9.9999E17 Regenerating clock detection Clock count: 0 to 9999999, 1.0000E07 to 9.9999E17 Frequency: Bit rate setting ±100 ppm, Accuracy: ±10 ppm*16 Measurement method Measurement time: 1 seconds to 9 days 23 hours 59 minutes 59 seconds Measurement frequency: single, repeat, untimed Display update interval*17: 0.1 seconds, set time at measurement time Auto sync control: On, Off Threshold value at bit error rate: INT, 1E-2, 1E-3, 1E-4, 1E-5, 1E-6, 1E-7, 1E-8 Sync control: Frame detection On*18, Off Frame length: 64 bits Frame position: 1 to (Pattern Length – Frame Length + 1) 1 bit resolution

*15: This can be detected when the Option 090 is added only in the case of Rate = 1/1 and 1/2.

*16: 1 hour after power-on

*17: This can be set when measurement cycle is single or repeat

*18: This can be set when test pattern is Programmable Pattern and data length is 128 bits or more.

Table A.1-3 Error Detector (Cont'd)

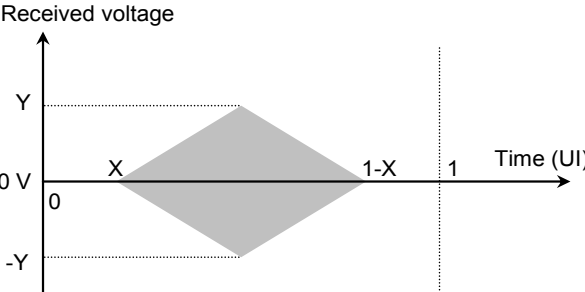
Item	Specifications
Jitter resistance* ¹⁹	Modulation frequency Jitter tolerance
	10 Hz to 2 kHz 15.2UI
	2 to 17.9 kHz 15.2 to 1.7UI
	17.9 to 400 kHz 1.7UI
	400 kHz to 4 MHz 1.7 to 0.17UI
	4 to 8 MHz 0.17UI
	8 to 27.2 MHz 0.17 to 0.05UI
	27.2 to 80 MHz 0.05UI

Jitter tolerance

Modulation frequency

*19: When inputting 9.95328 Gbit/s, pattern is set to PRBS 2³¹-1, and single-end and amplitude are set to 0.1 Vp-p.

Table A.1-3 Error Detector (Cont'd)

Item	Specifications																																										
ED High Sensitivity (MP2100A-091/191)	<p>Jitter specifications*20</p> <table border="0"> <tr> <td>Total Jitter:</td> <td>TJ [UI]</td> </tr> <tr> <td>10.3125 Gbps:</td> <td>0.65</td> </tr> <tr> <td>4.25 Gbps:</td> <td>0.325</td> </tr> <tr> <td>2.125 Gbps:</td> <td>0.325</td> </tr> <tr> <td>Deterministic Jitter:</td> <td>DJ (d-d)[UI]</td> </tr> <tr> <td>10.3125 Gbps:</td> <td>0.45</td> </tr> <tr> <td>4.25 Gbps:</td> <td>0.225</td> </tr> <tr> <td>2.125 Gbps:</td> <td>0.225</td> </tr> <tr> <td>Sinusoidal Jitter:</td> <td>SJ (d-d)[UI]</td> </tr> <tr> <td>10.3125 Gbps:</td> <td>0.22</td> </tr> <tr> <td>4.25 Gbps:</td> <td>0.11</td> </tr> <tr> <td>2.125 Gbps:</td> <td>0.11</td> </tr> </table> <p>EYE mask specifications*21</p>  <p>X: (UI)</p> <table border="0"> <tr> <td>10.3125 Gbps:</td> <td>0.325</td> </tr> <tr> <td>4.25 Gbps:</td> <td>0.1625</td> </tr> <tr> <td>2.125 Gbps:</td> <td>0.1625</td> </tr> </table> <p>Y: (mV)</p> <table border="1"> <thead> <tr> <th>Bit Rate</th> <th>CH1</th> <th>CH2</th> </tr> </thead> <tbody> <tr> <td>10.3125 Gbps</td> <td>50</td> <td>25</td> </tr> <tr> <td>4.25 Gbps</td> <td>50</td> <td>25</td> </tr> <tr> <td>2.125 Gbps</td> <td>50</td> <td>25</td> </tr> </tbody> </table>	Total Jitter:	TJ [UI]	10.3125 Gbps:	0.65	4.25 Gbps:	0.325	2.125 Gbps:	0.325	Deterministic Jitter:	DJ (d-d)[UI]	10.3125 Gbps:	0.45	4.25 Gbps:	0.225	2.125 Gbps:	0.225	Sinusoidal Jitter:	SJ (d-d)[UI]	10.3125 Gbps:	0.22	4.25 Gbps:	0.11	2.125 Gbps:	0.11	10.3125 Gbps:	0.325	4.25 Gbps:	0.1625	2.125 Gbps:	0.1625	Bit Rate	CH1	CH2	10.3125 Gbps	50	25	4.25 Gbps	50	25	2.125 Gbps	50	25
Total Jitter:	TJ [UI]																																										
10.3125 Gbps:	0.65																																										
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Deterministic Jitter:	DJ (d-d)[UI]																																										
10.3125 Gbps:	0.45																																										
4.25 Gbps:	0.225																																										
2.125 Gbps:	0.225																																										
Sinusoidal Jitter:	SJ (d-d)[UI]																																										
10.3125 Gbps:	0.22																																										
4.25 Gbps:	0.11																																										
2.125 Gbps:	0.11																																										
10.3125 Gbps:	0.325																																										
4.25 Gbps:	0.1625																																										
2.125 Gbps:	0.1625																																										
Bit Rate	CH1	CH2																																									
10.3125 Gbps	50	25																																									
4.25 Gbps	50	25																																									
2.125 Gbps	50	25																																									

*20: Specified under following conditions; design warranted at 20 to 30°C
 Single-end input; JTPAT pattern; jitter amplitude when BER at 10⁻¹²; TJ value including DJ; DJ value including SJ; 4-MHz SJ modulation frequency

*21: Specified under following conditions
 Single-end input, Y-axis voltage at BER ≤10⁻¹²

Table A.1-4 Sampling Scope

Item	Specifications
Function	Waveform display: Eye pattern, Pulse pattern Statistical Processing*1: Histogram, Mask test For supported mask: 1GFC 2GFC 4GFC 8GFC 8GFC_Elect_Tx 8GFC_Elect_Rx 10GFC 10GFC FEC 1GbE 2GbE 10GbE_WAN 10GbE LAN/PHY 10GbE FEC OC48/STM16 OTU-1 OC192/STM64 OC192/STM64 FEC (G.975) OTU-2 1310 nm OTU-2 1550 nm OTU-2 1550 nm Expanded OTU-2 Amplified User defined Mask file Text file with extension (msk, pcm)

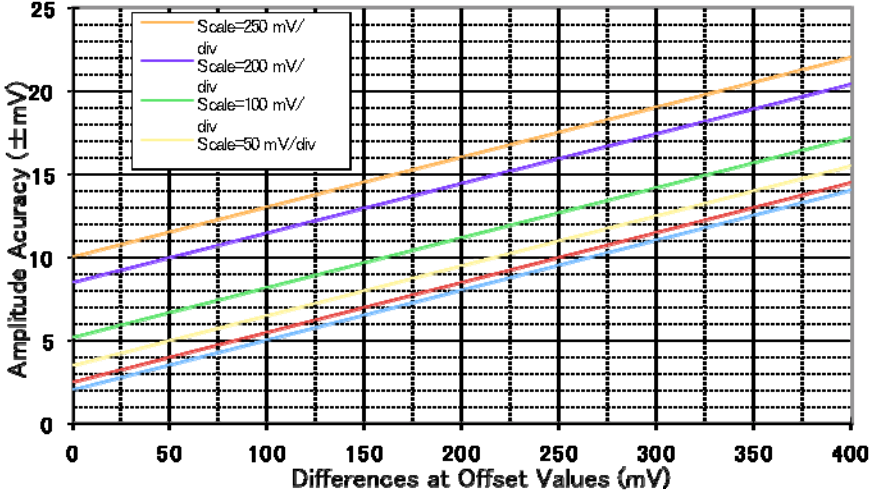
*1: Processing can be performed for the NRZ waveform.

Table A.1-4 Sampling Scope (Cont'd)

Item	Specifications
Horizontal system	<p>Clock Trigger Input</p> <p>Connector: SMA jack</p> <p>Termination: 50 Ω</p> <p>Frequency: 0.1 to 12.5 GHz</p> <p>Sensitivity: 100 mVp-p*2</p> <p>Absolute maximum input: 2 Vp-p*3</p> <p>Jitter, RMS: 5 to 12.5 GHz: 1.35 ps max., 0.85 ps*2 1 to 5 GHz: 1 ps*2 0.1 to 1 GHz: 2 ps*2</p> <p>Scale</p> <p>Eye pattern display: 1 UI or more at full scale</p> <p>Pulse pattern display: 1 bit or more at full scale</p>
Vertical system	<p>Electrical input</p> <p>Input connector: K</p> <p>Termination: 50 Ω</p> <p>CH_A input: common for ED_1 Data In input</p> <p>CH_B input: common for ED_1 $\overline{\text{Data}}$ In input*4</p> <p>Absolute maximum input ±2 V*3</p> <p>Input range</p> <p>Offset: ±500 mV max.</p> <p>Dynamic range: ±400 mV max.</p> <p>Bandwidth (−3 dB): DC to 20 GHz min. DC to 25 GHz*2</p> <p>Flatness: ±1 dB*2</p> <p>RMS noise: 3.5 mV max. 2 mV*2</p>

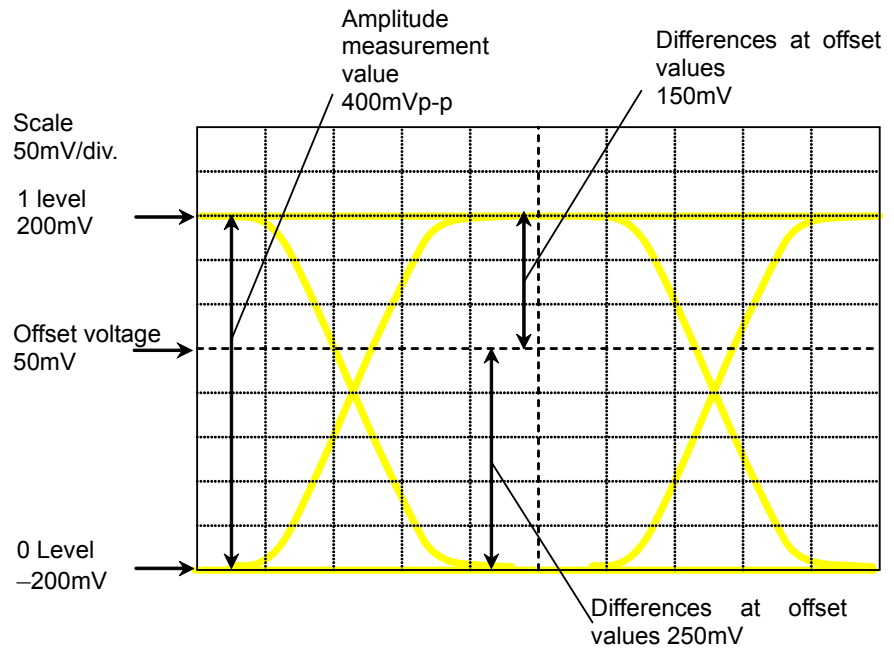
*2: Typical values
 *3: Design guaranteed
 *4: MP2100A-001 only

Table A.1-4 Sampling Scope (Cont'd)

Item	Specifications																																																		
Vertical system	<p>Amplitude accuracy*⁵</p> <p>±amplitude accuracy ±2% for reading value*⁶</p> <p>The following figure shows the amplitude accuracy after calibration.</p>  <table border="1"> <caption>Approximate data points from the graph</caption> <thead> <tr> <th>Differences at Offset Values (mV)</th> <th>Scale=250 mV/div (±mV)</th> <th>Scale=200 mV/div (±mV)</th> <th>Scale=100 mV/div (±mV)</th> <th>Scale=50 mV/div (±mV)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>10</td> <td>8</td> <td>5</td> <td>3</td> </tr> <tr> <td>50</td> <td>12</td> <td>10</td> <td>7</td> <td>4</td> </tr> <tr> <td>100</td> <td>14</td> <td>12</td> <td>9</td> <td>5</td> </tr> <tr> <td>150</td> <td>16</td> <td>14</td> <td>11</td> <td>6</td> </tr> <tr> <td>200</td> <td>18</td> <td>16</td> <td>13</td> <td>7</td> </tr> <tr> <td>250</td> <td>20</td> <td>18</td> <td>15</td> <td>8</td> </tr> <tr> <td>300</td> <td>22</td> <td>20</td> <td>17</td> <td>9</td> </tr> <tr> <td>350</td> <td>24</td> <td>22</td> <td>19</td> <td>10</td> </tr> <tr> <td>400</td> <td>26</td> <td>24</td> <td>21</td> <td>11</td> </tr> </tbody> </table>	Differences at Offset Values (mV)	Scale=250 mV/div (±mV)	Scale=200 mV/div (±mV)	Scale=100 mV/div (±mV)	Scale=50 mV/div (±mV)	0	10	8	5	3	50	12	10	7	4	100	14	12	9	5	150	16	14	11	6	200	18	16	13	7	250	20	18	15	8	300	22	20	17	9	350	24	22	19	10	400	26	24	21	11
Differences at Offset Values (mV)	Scale=250 mV/div (±mV)	Scale=200 mV/div (±mV)	Scale=100 mV/div (±mV)	Scale=50 mV/div (±mV)																																															
0	10	8	5	3																																															
50	12	10	7	4																																															
100	14	12	9	5																																															
150	16	14	11	6																																															
200	18	16	13	7																																															
250	20	18	15	8																																															
300	22	20	17	9																																															
350	24	22	19	10																																															
400	26	24	21	11																																															

*⁵: After internal calibration

*⁶: Calculation example: At 400 mV amplitude reading value and 50 mV offset voltage



In this example, the difference between 1 level voltage (200 mV) and offset voltage (50 mV) is 150 mV. At a scale of 50 mV/div for a voltage difference of 150 mV, the amplitude accuracy is 8 mV. At 1 level accuracy, the difference is calculated as follows:

$$200 \times 2\% + 8 = 12 \quad \pm 12 \text{ mV}$$

The difference between 0 level voltage (-200 mV) and offset voltage (50 mV) is 250 mV.

At the 50 mV/div scale for a voltage difference of 250 mV, the amplitude accuracy is 11 mV. At 0 level accuracy, the difference is calculated as follows:

$$200 \times 2\% + 11 = 15 \quad \pm 15 \text{ mV}$$

Table A.1-4 Sampling Scope (Cont'd)

Item	Specifications			
Vertical system	Optical input*7			
	Connector	FC*8, SC*9		
	Suitable fiber	multi-mode fiber (62.5 μm)*10		
	Wavelength range	750 to 1650 nm		
	Bandwidth*11	DC to 9.0 GHz		
	Conversion efficiency	850 nm: 0.25 A/W*2		
		1310 nm: 0.475 A/W*2		
		1550 nm: 0.45 A/W*2		
	Conversion gain	850 nm: 112.5 V/W*2		
		1310 nm: 210 V/W*2		
		1550 nm: 200 V/W*2		
	Optical noise*2	MP2100A-003 (Unit: μWrms)		
		Wavelength	850 nm	1310, 1550 nm
	When using a filter of Option 070 to 073	4.2	2.4	
	When using a filter of Option 076 to 080	3.6	2.0	
	When using a filter of Option 081 to 083	5.2	3.0	
	When using a filter of Option 084 or 085	6.5	3.7	
	When using a filter of Option 086	3.4	2.0	
	MP2100A-007 (Unit: μWrms)			
		Wavelength	850 nm	1310, 1550 nm
When using a filter of Option 070 to 073	3.1	1.8		
When using a filter of Option 076 to 080	2.7	1.5		
When using a filter of Option 081 to 083	3.9	2.2		
When using a filter of Option 084 or 085	4.8	2.8		
When using a filter of Option 086	2.5	1.4		

*7: MP2100A-003 or MP2100A-007 CH_B only

*8: Option 037

*9: Option 040

*10: Single mode fiber acceptable

*11: No internal filter, Frequency that electrical output level goes -3 dB down, typical value

Table A.1-4 Sampling Scope (Cont'd)

Item	Specifications
Clock Recovery (MP2100A-055)	Standard accessory J1341A Open (Coaxial connector cover) 1 Data input Connector: common for Ch A and Ch B*14 Clock output Connector: SMA jack Termination: AC coupling, 50 Ω Amplitude: 0.1 to 2.7 GHz: 270 to 540 mVp-p 8.5 to 12.5 GHz: 500 to 1500 mVp-p Frequency: 8.5 to 12.5 GHz, 0.1 to 2.7 GHz Jitter (RMS): 8.5 to 12.5 GHz: 20 mUI or less*15, 10 mUI*2, *15 0.1 to 2.7 GHz: 5 mUI or less Loop bandwidth: 8.5 to 12.5 GHz Band: 1, 2, 4, 8 MHz*2 0.1 to 2.7 GHz Band 2488.32 MHz: 200 kHz*2 622 MHz: 50 kHz*2 156 MHz: 20 kHz*2
Filter bank (8.5G/10G/10.5G) (MP2100A-056)	3 dB cutoff frequency 8.5 Gbit/s: 6.38 GHz*2 Low-pass filter 10 Gbit/s: 7.6 GHz*2 Low-pass filter 10GbE WAN (10 GBase-W) & OC-192/STM-64, 10GE LAN(10 GBase-R) , 8GFC 10.5 Gbit/s: 8.2 GHz*2 Low-pass filter 10GFC, OC-192/STM-64 FEC (G.975), OTU-2, 10GFC FEC,10GbE FEC

*14: When using MP2100A-007, Ch B cannot be used as the data input for Clock Recovery

*15: Loop bandwidth: 4 MHz

Table A.1-4 Sampling Scope (Cont'd)

Item	Specifications
Filter bank (2G/4G/8.5G/10G) (MP2100A-057)	3 dB cutoff frequency 2 Gbit/s: 1.6 GHz*2 Low-pass filter 2GFC 4 Gbit/s: 3.2 GHz*2 Low-pass filter 4GFC 8.5 Gbit/s: 6.38 GHz*2 Low-pass filter 10 Gbit/s: 7.6 GHz*2 Low-pass filter 10GbE WAN (10GBase-W) & OC-192/STM-64, 10GE LAN(10 GBase-R), 8GFC
High Bit Rate Filter (MP2100A-061)	Filter configuration One of MP2100A-076 to 086 can be installed.
2 High Bit Rate Filter Bank (MP2100A-062)	Filter configuration Two of MP2100A-076 to 086 can be installed.
3 to 4 High Bit Rate Filter Bank (MP2100A-063)	Filter configuration Three or four of MP2100A-076 to 086 can be installed.

Table A.1-4 Sampling Scope (Cont'd)

Item	Specifications
1 to 2 Low Bit Rate Filter Bank (MP2100A-064)	Filter configuration One or two of MP2100A-070 to 073 can be installed.
3 to 4 Low Bit Rate Filter Bank (MP2100A-065)	Filter configuration Three or four of MP2100A-070 to 073 can be installed.
1 High Bit Rate/1 to 2 Low Bit Rate Filter Bank (MP2100A-066)	Filter configuration One of MP2100A-076 to 086 and one or two of MP2100A-070 to 073 can be installed.
1 to 2 High Bit Rate/3 to 4 Low Bit Rate Filter Bank (MP2100A-067)	Filter configuration One or two of MP2100A-076 to 086 and three or four of MP2100A-070 to 073 can be installed.
2 to 3 High Bit Rate/1 to 2 Low Bit Rate Filter Bank (MP2100A-068)	Filter configuration Two or three of MP2100A-076 to 086 and one or two of MP2100A-070 to 073 can be installed.
3 High Bit Rate/3 Low Bit Rate Filter Bank (MP2100A-069)	Filter configuration Three of MP2100A-076 to 086 and three of MP2100A-070 to 073 can be installed.
LPF for 156M (L) (MP2100A-070)	3 dB cutoff frequency 155 Mbit/s: 116 MHz* ² Low-pass filter for OC-3/STM-1
LPF for 622M (L) (MP2100A-071)	3 dB cutoff frequency 622 Mbit/s: 470 MHz* ² Low-pass filter for OC-12/STM-4, CPRI
LPF for 1.0G (L) (MP2100A-072)	3 dB cutoff frequency 1062.5 Mbit/s: 800 MHz* ² Low-pass filter for 1GFC
LPF) for 1.2G (L) (MP2100A-073)	3 dB cutoff frequency 1.2 Gbit/s: 940 MHz* ² Low-pass filter for 1GbE, OC-24, CPRI × 2
LPF for 2.1G (H) (MP2100A-076/176)	3 dB cutoff frequency 2.1 Gbit/s: 1.6 GHz* ² Low-pass filter for 2GFC
LPF for 2.5G (H) (MP2100A-077/177)	3 dB cutoff frequency 2.5 Gbit/s: 1.87 GHz* ² Low-pass filter for CPRI × 4, OC-48/STM-16, 2GbE, Infiniband

Table A.1-4 Sampling Scope (Cont'd)

Item	Specifications
LPF for 2.6G (H) (MP2100A-078/178)	3 dB cutoff frequency 2.6 Gbit/s: 2.0 GHz* ² Low-pass filter for OTU-1
LPF for 3.1G (H) (MP2100A-079/179)	3 dB cutoff frequency 3.1 Gbit/s: 2.37 GHz* ² Low-pass filter for CPRI × 5, 10GBASE-LX4, 10GFC-LX4
LPF for 4.2G (H) (MP2100A-080/180)	3 dB cutoff frequency 4.2 Gbit/s: 3.2 GHz* ² Low-pass filter for 4GFC
LPF for 5.0G (H) (MP2100A-081/181)	3 dB cutoff frequency 5.0 Gbit/s: 3.75 GHz* ² Low-pass filter for Infiniband × 2, CPRI × 8
LPF for 6.2G (H) (MP2100A-082/182)	3 dB cutoff frequency 6.2 Gbit/s: 4.61 GHz* ² Low-pass filter for CPRI × 10, XAUI Optical × 2
LPF for 8.5G (H) (MP2100A-083/183)	3 dB cutoff frequency 8.5 Gbit/s: 6.3GHz* ² Low-pass filter
LPF for 9.9G to (H) 10.3G (MP2100A-084/184)	3 dB cutoff frequency 9.9 to 10.3 Gbit/s: 7.6 GHz* ² Low-pass filter for 8GFC, 10GbE WAN, 10GbE LAN/PHY, OC-192/STM-64, Infiniband × 4
LPF for 10.5G (H) to 11.3G (MP2100A-085/185)	3 dB cutoff frequency 10.5 to 11.3Gbit/s: 8.2 GHz* ² Low-pass filter for 10GFC, G.975 FEC, OTU-2, 10GbE FEC, 10GFC FEC
LPF for Multi 10G (H) (MP2100A-086/186)	3 dB cutoff frequency 9.9 to 10.7Gbit/s: 7.5 GHz* ² Low-pass filter for 8GFC, 10GbE WAN, 10GbE LAN/PHY, OC-192/STM-64, Infiniband x 4, 10GFC, G.975 FEC, OTU-2

Table A.1-5 Slot for Optical Transceiver

Item	Specifications
XFP Slot (MP2100A-050)	Standard accessory J1341A Open (Coaxial connector cover) 2 Transmission data input Connector: SMA jack Termination: AC coupling, Single end Impedance: 50 Ω* ¹ Input amplitude: 0.2 to 0.4 Vp-p Waveform: NRZ Received data output Connector: SMA jack Termination: AC coupling Impedance: 50 Ω* ¹ Output amplitude: 0.10 to 1.0 Vp-p* ² Waveform: NRZ Functions Status indicator for module availability Module information display: wavelength* ³ , LOS, optical output Optical output control: On, Off

*1: Nominal value

*2: When the input optical power is in the range of recommended XFP module input optical power

*3: When installing G0174A, G0194, or G0195A

Table A.1-5 Slot for Optical Transceiver (Cont'd)

Item	Specifications
SFP+Slot (MP2100A-051)	<p>Standard accessory J1341A Open (Coaxial connector cover) 2</p> <p>Transmission data input</p> <p>Connector: SMA jack</p> <p>Termination: AC coupling</p> <p>Terminator voltage: 0 V</p> <p>Impedance: 50 Ω*1</p> <p>Input amplitude: 0.6 to 0.8 Vp-p (at G0238A) 0.25 to 0.35 Vp-p (at G0239A)</p> <p>Waveform: NRZ</p> <p>Received data output</p> <p>Connector: SMA jack</p> <p>Termination: AC coupling</p> <p>Terminator voltage: 0 V</p> <p>Impedance: 50 Ω*1</p> <p>Output amplitude: 0.10 to 1.0 Vp-p*3</p> <p>Waveform: NRZ</p> <p>Functions</p> <p>Status indicator for module availability</p> <p>Module information display: wavelength, LOS, optical output</p> <p>Optical output control: On, Off</p>

*4: When the input optical power is in the range of the recommended SFP+ module input optical power

*5: When G0238A or G0239A is installed

Table A.1-6 General Performance

Item	Specifications
Panel	Input functions: Rotary encoder, touch panel, power switch
Display	12.1 inch LCD: WXGA (1280 × 768, or 1280 × 800) LED: Disk access, standby, power
Function	Measurement buzzer, panel lock
Peripheral Devices connection	VGA output (SVGA), USB 2.0 × 5
Remote interface	Ethernet × 2 (10/100/1000BASE-T) GPIB × 1*1
OS	Windows XP Embedded Standard 2009 Service Pack 3*2
Internal storage devices	Flash Memory Drive, 8 GB or more
Power source	Power voltage: AC 100 to 120 V, 200 to 240 V (Auto switch: 100/200 V) *3 Frequency: 50 Hz to 60 Hz Power consumption: 300 VA or less
Environment performance	Operating temperature: +5 to +40°C Storage temperature: -20 to +60°C EMC: EN61326-1, EN61000-3-2 LVD: EN61010-1
Size and mass	Dimensions: 221.5 (H) × 341 (W) × 180 (D) mm (excluding protrusions) Weight: 7 kg max. (MP2100A-003, others excluding options)

*1: Option 030/130 required

*2: Operation not warranted when software installed after factory shipment

*3: Operating voltage: within the range of +10% to -15% from the rated voltage

A.2 MP2101A BERTWave PE Specifications

Table A.2-1 Configuration

Model Name	Product name	
MP2101A	—Main Frame—	
	BERTWave PE	
J1137	—Standard Accessories—	
	Power cord	1
J1341A	Terminator	2*1
	Open (Coaxial connector cover)	4*2
MX210000A		4*1
		6*2
MP2101A-011*3	BERTWave Control Software	1
	(CD-ROM, including Operation Manual)	
MP2101A-012*3	—Options—	
	1CH PPG/ED	
MP2101A-030/130	2CH PPG/ED	
	GPIB	
MP2101A-050*4	XFP slot	
	SFP+ slot	
MP2101A-051*4	Full Rate Clock Output	
	Bit rate Extension for PPG/ED	
MP2101A-090	ED High Sensitivity	

*1: When selecting Option 011

*2: When selecting Option 012

*3: Select either Option 011 or 012.

*4: Either one of Option 050 or 051 can be installed.

Option No. 130, 152, and 191 are retrofit option. Installing these options requires returning MP2101A to factory.

Table A.2-2 Pulse Pattern Generator

Item	Specifications	
Bit Rate	Standard Name Bit rate (kbit/s)	
	Variable 8500000 to 11320000	
		8000000 to 12500000*1
	Variable 1/2	4250000 to 5660000
		4000000 to 6250000*1
	Variable 1/4	2125000 to 2830000
		2000000 to 3125000*1
	Variable 1/8	1062500 to 1415000
		1000000 to 1562500*1
	Variable 1/16	531250 to 707500
		500000 to 781250*1
	Variable 1/32	265625 to 353750
		250000 to 390625*1
	Variable 1/64	132813 to 176875
		125000 to 195312*1
	1GFC	1062500
	2GFC	2125000
	8GFC	8500000
	10GFC	10518750
	10GFC FEC	11316800
	1GbE	1250000
	2GbE	2500000
	10GbE WAN	9953280
	10GbE LAN/PHY	10312500
	10GbE OTU-1e	11049107
	10GbE OTU-2e	11095728
Infiniband	2500000	
Infiniband × 2	5000000	
Infiniband × 4	10000000	

*1: Option 090 only

Table A.2-2 Pulse Pattern Generator (Cont'd)

Item	Specifications																																
Bit Rate	<table border="0"> <tr> <td>Standard Name</td> <td>Bit rate (kbit/s)</td> </tr> <tr> <td>OC-3/STM-1</td> <td>155520</td> </tr> <tr> <td>OC-12/STM-4</td> <td>622080</td> </tr> <tr> <td>OC-48/STM-16</td> <td>2488320</td> </tr> <tr> <td>OTU-1</td> <td>2666057</td> </tr> <tr> <td>OC-192/STM-64</td> <td>9953280</td> </tr> <tr> <td>G.975 FEC</td> <td>10664228</td> </tr> <tr> <td>OTU-2</td> <td>10709225</td> </tr> <tr> <td>CPRI</td> <td>614400</td> </tr> <tr> <td>CPRI × 2</td> <td>1228800</td> </tr> <tr> <td>CPRI × 4</td> <td>2457600</td> </tr> <tr> <td>CPRI × 5*1</td> <td>3072000</td> </tr> <tr> <td>CPRI × 10*1</td> <td>6144000</td> </tr> <tr> <td>OBSAI*1</td> <td>768000</td> </tr> <tr> <td>OBSAI × 2*1</td> <td>1536000</td> </tr> <tr> <td>OBSAI × 3*1</td> <td>3072000</td> </tr> </table>	Standard Name	Bit rate (kbit/s)	OC-3/STM-1	155520	OC-12/STM-4	622080	OC-48/STM-16	2488320	OTU-1	2666057	OC-192/STM-64	9953280	G.975 FEC	10664228	OTU-2	10709225	CPRI	614400	CPRI × 2	1228800	CPRI × 4	2457600	CPRI × 5*1	3072000	CPRI × 10*1	6144000	OBSAI*1	768000	OBSAI × 2*1	1536000	OBSAI × 3*1	3072000
Standard Name	Bit rate (kbit/s)																																
OC-3/STM-1	155520																																
OC-12/STM-4	622080																																
OC-48/STM-16	2488320																																
OTU-1	2666057																																
OC-192/STM-64	9953280																																
G.975 FEC	10664228																																
OTU-2	10709225																																
CPRI	614400																																
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CPRI × 4	2457600																																
CPRI × 5*1	3072000																																
CPRI × 10*1	6144000																																
OBSAI*1	768000																																
OBSAI × 2*1	1536000																																
OBSAI × 3*1	3072000																																
Internal reference clock accuracy	±10 ppm*2,*4																																
Bit rate offset	±100 ppm*3																																
External 10 MHz input*3	<table border="0"> <tr> <td>Connector:</td> <td>BNC jack</td> </tr> <tr> <td>Termination:</td> <td>50 Ω, AC coupling</td> </tr> <tr> <td>Amplitude:</td> <td>0.7 to 2 Vp-p, AC coupling</td> </tr> <tr> <td>Waveform:</td> <td>Square or sine wave</td> </tr> </table>	Connector:	BNC jack	Termination:	50 Ω, AC coupling	Amplitude:	0.7 to 2 Vp-p, AC coupling	Waveform:	Square or sine wave																								
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Amplitude:	0.7 to 2 Vp-p, AC coupling																																
Waveform:	Square or sine wave																																
External reference clock input	<table border="0"> <tr> <td>Connector:</td> <td>SMA jack</td> </tr> <tr> <td>Termination:</td> <td>50 Ω, AC coupling</td> </tr> <tr> <td>Amplitude:</td> <td>0.2 to 1.5 Vp-p</td> </tr> <tr> <td>Waveform:</td> <td>Square or sine wave</td> </tr> </table>	Connector:	SMA jack	Termination:	50 Ω, AC coupling	Amplitude:	0.2 to 1.5 Vp-p	Waveform:	Square or sine wave																								
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*2: 1 hour after power-on

*3: When using internal clock

*4: MP2101A-011: Common for ED1

MP2101A-012: common for PPG1, PPG2, ED1, or ED2

Table A.2-2 Pulse Pattern Generator (Cont'd)

Item	Specifications																																																																																																																									
Sync output	<p>Frequency:</p> <table border="1"> <thead> <tr> <th>Sync signal source</th> <th colspan="7">Pulse Pattern Generator</th> <th colspan="3">Error Detector</th> </tr> <tr> <td>Divide ratio</td> <td>1/1</td> <td>1/2</td> <td>1/4</td> <td>1/8</td> <td>1/16</td> <td>1/64</td> <td>Pattern Sync.</td> <td>1/4</td> <td>1/8</td> <td>1/16</td> </tr> <tr> <td>Bit rate</td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> <tr> <td>Divide ratio</td> <td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td> </tr> </thead> <tbody> <tr> <td>Rate 1/64</td> <td>✓</td><td></td><td></td><td></td><td></td><td></td><td>✓</td><td></td><td></td><td></td> </tr> <tr> <td>Rate 1/32</td> <td>✓</td><td></td><td></td><td></td><td></td><td></td><td>✓</td><td></td><td></td><td></td> </tr> <tr> <td>Rate 1/16</td> <td>✓</td><td></td><td></td><td></td><td></td><td></td><td>✓</td><td></td><td></td><td></td> </tr> <tr> <td>Rate 1/8</td> <td>✓</td><td></td><td></td><td></td><td></td><td></td><td>✓</td><td></td><td></td><td></td> </tr> <tr> <td>Rate 1/4</td> <td></td><td>✓</td><td></td><td></td><td></td><td>✓</td><td>✓</td><td></td><td></td><td></td> </tr> <tr> <td>Rate 1/2</td> <td></td><td></td><td>✓</td><td></td><td>✓</td><td></td><td>✓</td><td>✓</td><td></td><td>✓</td> </tr> <tr> <td>Rate 1/1</td> <td></td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td>✓</td><td>✓</td> </tr> </tbody> </table> <p>Connector: SMA jack</p> <p>Impedance: 50 Ω</p> <p>Low level (V_{OL}): -0.5 to -0.3 V</p> <p>High level (V_{OH}): -0.1 to 0 V</p> <p>Amplitude: 0.4 V_{p-p}*5</p>	Sync signal source	Pulse Pattern Generator							Error Detector			Divide ratio	1/1	1/2	1/4	1/8	1/16	1/64	Pattern Sync.	1/4	1/8	1/16	Bit rate											Divide ratio											Rate 1/64	✓						✓				Rate 1/32	✓						✓				Rate 1/16	✓						✓				Rate 1/8	✓						✓				Rate 1/4		✓				✓	✓				Rate 1/2			✓		✓		✓	✓		✓	Rate 1/1				✓	✓	✓	✓		✓	✓
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Rate 1/1				✓	✓	✓	✓		✓	✓																																																																																																																
Data output	<p>Number of Channel: MP2101A-011: 1, MP2101A-012: 2</p> <p>Connector: SMA jack</p> <p>Amplitude: 0.1 to 0.8 V_{p-p}, 10 mV resolution</p> <p>Accuracy: ±20 mV ±20% for settings</p> <p>Relative display*6: available</p> <p>Termination: AC coupling, 50 Ω</p> <p>Rise/Fall time: 25 ps*5,*7</p> <p>Jitter: 3 ps rms*5</p> <p>Skew ±15 ps or less</p>																																																																																																																									

*5: Typical values

*6: Multiplexing values by amplitude and external attenuation factor

*7: Time changing between 20 to 80 % amplitude

Table A.2-2 Pulse Pattern Generator (Cont'd)

Item	Specifications																
Full Rate Clock Output (MP2101A-052/152)	<p>Standard Accessory J1341A Open (coaxial connector cover) 1</p> <p>Bit rate</p> <table border="1"> <thead> <tr> <th>Rate setting</th> <th>Output signal frequency</th> </tr> </thead> <tbody> <tr> <td>1/1</td> <td>1/1 PPG clock, 1/1 ED clock</td> </tr> <tr> <td>1/2</td> <td>1/2 PPG clock, 1/2 ED clock</td> </tr> <tr> <td>1/4</td> <td>1/4 PPG clock</td> </tr> <tr> <td>1/8</td> <td>1/8 PPG clock</td> </tr> <tr> <td>1/16</td> <td>No output</td> </tr> <tr> <td>1/32</td> <td>No output</td> </tr> <tr> <td>1/64</td> <td>No output</td> </tr> </tbody> </table> <p>Number of outputs: 1 (single end)</p> <p>Amplitude: 300 to 750 mVp-p</p> <p>Duty: 50% ±15%</p> <p>Rising and falling time (20 to 80%): 30 ps^{*5,*7}</p> <p>RMS jitter: 2 ps rms^{*5,*8,*9} 2 ps rms^{*5,*8,*10}</p> <p>Connector: SMA jack</p> <p>Impedance: 50 Ω, AC coupling</p> <p>Signal source: PPG1^{*11},ED1,PPG2^{*12,*13},ED2^{*12}</p> <p>Alarm: PLL Unlock detection</p>	Rate setting	Output signal frequency	1/1	1/1 PPG clock, 1/1 ED clock	1/2	1/2 PPG clock, 1/2 ED clock	1/4	1/4 PPG clock	1/8	1/8 PPG clock	1/16	No output	1/32	No output	1/64	No output
Rate setting	Output signal frequency																
1/1	1/1 PPG clock, 1/1 ED clock																
1/2	1/2 PPG clock, 1/2 ED clock																
1/4	1/4 PPG clock																
1/8	1/8 PPG clock																
1/16	No output																
1/32	No output																
1/64	No output																

*8: When Reference Clock is Internal, and when Sync Clock is 1/8

*9: Clock frequency: 10 GHz

*10: Clock frequency is 12.5 GHz, when installing Option 090.

*11: Excluding when Sync Output is set to PPG1 Pattern Sync.

*12: Option 012 only

*13: Excluding when Sync Output is set to PPG2 Pattern Sync.

Table A.2-2 Pulse Pattern Generator (Cont'd)

Item	Specifications
External attenuation factor	0 to 30 dB, 1 dB resolution
Error insertion	Insertion method: Single, Repeat Error rate: $1E-n$ (n: 2 to 12)
Test pattern	Pseudorandom (PRBS) pattern: Pattern length: 2^7-1 , 2^9-1 , $2^{15}-1$, $2^{23}-1$, $2^{31}-1$ Logic invertible Programmable Pattern: Pattern length: 2 to 1305600 bit, editable by text editor and sample file available

Table A.2-3 Error Detector

Item	Specifications	
Bit rate	Standard name	Bit rate (kbit/s)
	Variable	8500000 to 11320000
		8000000 to 12500000*1
	Variable 1/2	4250000 to 6150000
		4000000 to 6250000*1
	Variable 1/4*1	2000000 to 3125000
	Variable 1/8*1	1000000 to 1562500
	Variable 1/16*1	500000 to 781250
	Variable 1/32*1	250000 to 390625
	Variable 1/64*1	125000 to 195312
	1GFC*1	1062500
	2GFC*1	2125000
	4GFC	4250000
	8GFC	8500000
	10GFC	10518750
	10GFC FEC	11316800
	1GbE*1	1250000
	2GbE*1	2500000
	10GbE WAN	9953280
	10GbE LAN/PHY	10312500
	10GbE OTU-1e	11049107
	10GbE OTU-2e	11095728
	Infiniband*1	2500000
	Infiniband × 2	5000000
Infiniband × 4	10000000	
OC-3/STM-1*1	155520	
OC-12/STM-4*1	622080	
OC-24*1	1244160	
OC-48/STM-16*1	2488320	

*1: Option 090 only

Table A.2-3 Error Detector (Cont'd)

Item	Specifications																										
Bit rate (Cont'd)	<table border="1"> <thead> <tr> <th>Specification Name</th> <th>Bit Rate (kbit/s)</th> </tr> </thead> <tbody> <tr> <td>OTU-1</td> <td>2666057</td> </tr> <tr> <td>OC-192/STM-64</td> <td>9953280</td> </tr> <tr> <td>G.975 FEC</td> <td>10664228</td> </tr> <tr> <td>OTU-2</td> <td>10709225</td> </tr> <tr> <td>CPRI*¹</td> <td>614400</td> </tr> <tr> <td>CPRI × 2*¹</td> <td>1228800</td> </tr> <tr> <td>CPRI × 4*¹</td> <td>2457600</td> </tr> <tr> <td>CPRI × 5*¹</td> <td>3072000</td> </tr> <tr> <td>CPRI v 10*¹</td> <td>6144000</td> </tr> <tr> <td>OBSAI*¹</td> <td>768000</td> </tr> <tr> <td>OBSAI × 2*¹</td> <td>1536000</td> </tr> <tr> <td>OBSAI × 3*¹</td> <td>3072000</td> </tr> </tbody> </table>	Specification Name	Bit Rate (kbit/s)	OTU-1	2666057	OC-192/STM-64	9953280	G.975 FEC	10664228	OTU-2	10709225	CPRI* ¹	614400	CPRI × 2* ¹	1228800	CPRI × 4* ¹	2457600	CPRI × 5* ¹	3072000	CPRI v 10* ¹	6144000	OBSAI* ¹	768000	OBSAI × 2* ¹	1536000	OBSAI × 3* ¹	3072000
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Offset tolerance	±100 ppm* ²																										
Internal reference clock accuracy	±10 ppm* ³																										
External 10 MHz input* ⁴	<table border="1"> <tbody> <tr> <td>Connector:</td> <td>BNC</td> </tr> <tr> <td>Termination:</td> <td>AC coupling, 50 Ω</td> </tr> <tr> <td>Amplitude:</td> <td>0.7 to 2 Vp-p</td> </tr> <tr> <td>Waveform:</td> <td>Square waveform or sine wave</td> </tr> </tbody> </table>	Connector:	BNC	Termination:	AC coupling, 50 Ω	Amplitude:	0.7 to 2 Vp-p	Waveform:	Square waveform or sine wave																		
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Termination:	AC coupling, 50 Ω																										
Amplitude:	0.7 to 2 Vp-p																										
Waveform:	Square waveform or sine wave																										

*2: Data input signal bit rate deviation for set bit rate

*3: 1 hour after power-on

MP2101A-012: common for ED1 and ED2

*4: MP2101A-011: common for PPG1 and ED1

MP2101A-012: common for PPG1, PPG2, ED1, and ED2

Table A.2-3 Error Detector (Cont'd)

Item		Specifications
Test pattern		Pseudorandom (PRBS) pattern: Pattern length: 2^7-1 , 2^9-1 , $2^{15}-1$, $2^{23}-1$, $2^{31}-1$ Logic invertible Programmable pattern: Pattern length: 2 to 1305600 bit, editable by text editor and sample file available
Data input	Number of Channel	MP2101A-011: 1 MP2101A-012: 2
	Electrical input	Connector: SMA jack Termination: Single-end, differential Data format: NRZ, Mark ratio 50% Amplitude 0.1 to 0.8 V _{p-p} *5,*6 0.25 to 0.8 V _{p-p} *5,*7 Coupling method: DC coupling, termination voltage 0 V Consecutive identical digit immunity: 72 bit or more*8
Threshold value*9		-85 mV to 85 mV, 1 mV resolution*10 Data/ $\overline{\text{Data}}$ change in synchronization
External attenuation factor		0 to 30 dB , 1 dB resolution

*5: Pattern: PRBS $2^{31}-1$, Mark ratio: 1/2, Termination: single end, Bit rate: 10.3125 Gbit/s, at 20 to 30°C

*6: Bit rate: 5 to 11.32 Gbit/s and its divide ratio

*7: Bit rate: 8.0 to 8.5 Gbit/s, 11.32 to 12.5Gbit/s and their divide ratio

*8: Bit rate: 9.95328 Gbit/s, Pattern: Frame format equal to STM-64 Mark ratio: 1/2, Termination: single end at 20 to 30°C

*9: The displayed threshold value is the value corrected by the external attenuation factor.

The calculation formula is as follows:

Maximum value = $85 \times 10^{\text{(factor / 20)}}$

Minimum value = $-85 \times 10^{\text{(factor / 20)}}$

Resolution = $1.0 \times 10^{\text{(factor / 20)}}$

*10: Termination: single end, when external attenuation is 0 dB.

Table A.2-3 Error Detector (Cont'd)

Item	Specifications
Measurement functions	<p>Alarm Indicator: Pattern asynchronous (Sync loss), Frequency asynchronous (CR Unlock)*11</p> <p>Bit error detection</p> <p>Detection method: total error</p> <p>Bit error rate: 0.0001E-18 to 1.0000E-00</p> <p>Bit error count: 0 to 9999999, 1.0000E07 to 9.9999E17</p> <p>Regenerating clock detection</p> <p>Clock count: 0 to 9999999, 1.0000E07 to 9.9999E17</p> <p>Frequency: Bit rate setting ±100 ppm, Accuracy: ±10 ppm*12</p> <p>Measurement method</p> <p>Measurement time: 1 seconds to 9 days 23 hours 59 minutes 59 seconds</p> <p>Measurement frequency: single, repeat, untimed</p> <p>Display update interval*13: 0.1 seconds, set time at measurement time</p> <p>Auto sync control: On, Off</p> <p>Threshold value at bit error rate: INT, 1E-2, 1E-3, 1E-4, 1E-5, 1E-6, 1E-7, 1E-8</p> <p>Sync control: frame detection On*14, Off</p> <p>Frame length: 64 bits</p> <p>Frame position: 1 to (Pattern Length - Frame Length + 1)</p> <p>1 bit resolution</p>

*11: This can be detected when the Option 090 is added only in the case of Rate = 1/1 and 1/2.

*12: 1 hour after power-on

*13: This can be set when measurement cycle is single or repeat.

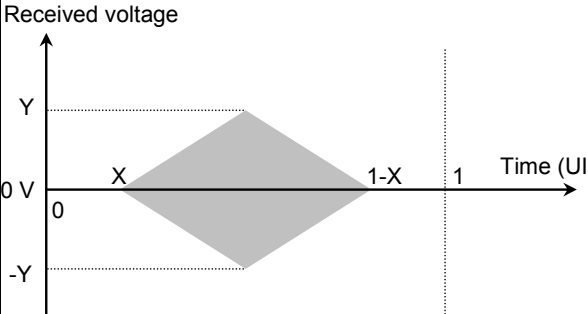
*14: This can be set when test pattern is Programmable Pattern and data length is 128 bits or more.

Table A.2-3 Error Detection (Cont'd)

Item	Specifications
Jitter resistance* ¹⁵	Modulation frequency Jitter tolerance
	10 Hz to 2 kHz 15.2UI
	2 to 17.9 kHz 15.2 to 1.7UI
	17.9 to 400 kHz 1.7UI
	400 kHz to 4 MHz 1.7 to 0.17UI
	4 to 8 MHz 0.17UI
	8 to 27.2 MHz 0.17 to 0.05UI
	27.2 to 80 MHz 0.05UI

*15: When inputting 9.95328 Gbit/s, pattern is set to PRBS 2³¹-1 and single-end and amplitude are set to 0.1 Vp-p

Table A.2-3 Error Detector (Cont'd)

Item	Specifications																																										
ED High Sensitivity (MP2101A-091/191)	<p>Jitter specifications*¹⁶</p> <table border="0"> <tr> <td>Total Jitter:</td> <td>TJ [UI]</td> </tr> <tr> <td>10.3125 Gbps:</td> <td>0.65</td> </tr> <tr> <td>4.25 Gbps:</td> <td>0.325</td> </tr> <tr> <td>2.125 Gbps:</td> <td>0.325</td> </tr> <tr> <td>Deterministic Jitter:</td> <td>DJ (d-d) [UI]</td> </tr> <tr> <td>10.3125 Gbps:</td> <td>0.45</td> </tr> <tr> <td>4.25 Gbps:</td> <td>0.225</td> </tr> <tr> <td>2.125 Gbps:</td> <td>0.225</td> </tr> <tr> <td>Sinusoidal Jitter:</td> <td>SJ (d-d)[UI]</td> </tr> <tr> <td>10.3125 Gbps:</td> <td>0.22</td> </tr> <tr> <td>4.25 Gbps:</td> <td>0.11</td> </tr> <tr> <td>2.125 Gbps:</td> <td>0.11</td> </tr> </table> <p>EYE mask specifications*¹⁷</p>  <p>X: (UI)</p> <table border="0"> <tr> <td>10.3125 Gbps:</td> <td>0.325</td> </tr> <tr> <td>4.25 Gbps:</td> <td>0.1625</td> </tr> <tr> <td>2.125 Gbps:</td> <td>0.1625</td> </tr> </table> <p>Y: (mV)</p> <table border="1"> <thead> <tr> <th>Bit rate</th> <th>CH1</th> <th>CH2</th> </tr> </thead> <tbody> <tr> <td>10.3125 Gbps</td> <td>25</td> <td>25</td> </tr> <tr> <td>4.25 Gbps</td> <td>25</td> <td>25</td> </tr> <tr> <td>2.125 Gbps</td> <td>25</td> <td>25</td> </tr> </tbody> </table>	Total Jitter:	TJ [UI]	10.3125 Gbps:	0.65	4.25 Gbps:	0.325	2.125 Gbps:	0.325	Deterministic Jitter:	DJ (d-d) [UI]	10.3125 Gbps:	0.45	4.25 Gbps:	0.225	2.125 Gbps:	0.225	Sinusoidal Jitter:	SJ (d-d)[UI]	10.3125 Gbps:	0.22	4.25 Gbps:	0.11	2.125 Gbps:	0.11	10.3125 Gbps:	0.325	4.25 Gbps:	0.1625	2.125 Gbps:	0.1625	Bit rate	CH1	CH2	10.3125 Gbps	25	25	4.25 Gbps	25	25	2.125 Gbps	25	25
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4.25 Gbps	25	25																																									
2.125 Gbps	25	25																																									

*16: Specified under following conditions; design warranted at 20 to 30°C
 Single-end input; JTPAT pattern; jitter amplitude when BER at 10⁻¹²; TJ value including DJ; DJ value including SJ; 4-MHz SJ modulation frequency

*17: Specified under following conditions
 Single-end input, Y-axis voltage at BER ≤10⁻¹²

Table A.2-4 Slot for Optical Transceiver

Item	Specifications
XFP Slot (MP2101A-050)	Standard accessory J1341A Open(Coaxial connector cover) 2 Transmission data input Connector: SMA jack Termination: AC coupling, single end Impedance: 50 Ω* ¹ Input amplitude: 0.2 to 0.4 Vp-p Waveform: NRZ Received data output Connector: SMA jack Termination: AC coupling Impedance: 50 Ω* ¹ Output amplitude: 0.1 to 1.0 Vp-p* ² Waveform: NRZ Functions Status indicator for module availability Module information display: wavelength* ³ , LOS, optical output Optical output control: On, Off

*1: Nominal value

*2: When the input optical power is in the range of the recommended XFP module optical power

*3: When G0174A, G0194, or G0195A is installed

Table A.2-4 Slot for Optical Transceiver (Cont'd)

Item	Specifications
SFP+ Slot (MP2101A-051)	<p>Standard accessory</p> <p>J1341A Open (Coaxial connector cover) 2</p> <p>Transmission data input</p> <p>Connector: SMA jack</p> <p>Termination: AC coupling</p> <p>Termination voltage 0 V</p> <p>Impedance: 50 Ω*1</p> <p>Input amplitude: 0.6 to 0.8 Vp-p (at G0238A) 0.25 to 0.35 Vp-p (at G0239A)</p> <p>Waveform: NRZ</p> <p>Received data output</p> <p>Connector: SMA jack</p> <p>Termination: AC coupling</p> <p>Impedance: 50 Ω*1</p> <p>Termination voltage 0 V</p> <p>Output amplitude: 0.18 to 1.0 Vp-p*4</p> <p>Waveform: NRZ</p> <p>Functions</p> <p>Status indicator for module availability</p> <p>Module information display: wavelength*5, LOS, optical output</p> <p>Optical output control: On, Off</p>

*4: When input optical power is within the range of the recommended SFP+ module optical power

*5: When G0238A, or G0239A is installed

Table A.2-5 General Performance

Item	Specifications
Panel	Input functions: rotary encoder, touch panel, power switch measurement buzzer, panel lock
Display	12.1 inch LCD: WXGA (1280 × 768, or 1280 × 800) LED: disk access, standby, power
Functions	Measurement buzzer, panel lock
Peripheral devices connection	VGA Output (SVGA), USB 2.0 × 5
Remote interface	Ethernet × 2 (10/100/1000BASE-T) GPIB × 1*1
OS	Windows XP Embedded Standard 2009 Service Pack 3*2
Internal storage devices	Flash Memory Drive, 8 GB or more
Power source	Voltage: AC 100 to 120 V, 200 to 240 V (Auto switch: 100/200 V)*3 Frequency: 50 Hz to 60 Hz Power consumption: 300 VA or less
Environment performance	Operating temperature: +5 to +40°C Storage temperature: -20 to +60°C EMC: EN61326-1, EN61000-3-2 LVD: EN61010-1
Size and mass	Dimension 221.5 (H) × 341 (W) × 180 (D) mm (excluding protrusions) Weight 7 kg or less (excluding options)

*1: Option 030/130 required

*2: Operation not warranted when software installed after factory shipment

*3: Operating voltage: within the range of +10% to -15% from the rated voltage

A.3 MP2102A BERTWave SS Specifications

Table A.3-1 Configuration

Model Name	Product Name	
MP2102A	–Main Frame–	
	BERTWave SS	
J1137	–Standard Accessories–	
	Power cord	1
J1341A	Terminator	1*2
J1359A	Open (Coaxial connector cover)	2*2
	Coaxial adapter (K-P, K-J, SMA)	3*1
MX210000A		2*1
	BERTWave Control Software (CD-ROM, including Operation Manual)	1*2
MP2102A-021*3	–Options–	
	Dual Electrical Receiver	1
MP2102A-023*3	Optical/Electrical Single-ended Receiver	
MP2102A-030/130	GPIB	
MP2102A-037*4,*5	FC connector	
MP2102A-038*4,*5	ST connector	
MP2102A-039*4,*5	DIN 47256 connector	
MP2102A-040*4,*5	SC connector	
MP2102A-055	Clock Recovery	
MP2102A-056*4,*6	Low Pass Filter Bank (8.5G/10G/10.7G)	
MP2102A-057*4,*6	Low Pass Filter Bank (2G/4G/8.5G/10G)	

*1: When selecting Option 021

*2: When selecting Option 023

*3: When selecting either one of Option 021 or 023

*4: Can be installed when selecting Option 023

*5: Select one from Option 037 to 040.

*6: Either one of Option 056, 057 or 061 to 069 can be installed.

Table A.3-1 Configuration

Model Name	Product Name
	–Options–
MP2102A-061*4,*6	High Bit Rate Filter
MP2102A-062*4,*6	2 High Bit Rate Filter Bank
MP2102A-063*4,*6	3 to 4 High Bit Rate Filter Bank
MP2102A-064*4,*6	1 to 2 Low Bit Rate Filter Bank
MP2102A-065*4,*6	3 to 4 Low Bit Rate Filter Bank
MP2102A-066*4,*6	1 High Bit Rate/1 to 2 Low Bit Rate Filter Bank
MP2102A-067*4,*6	1 to 2 High Bit Rate/3 to 4 Low Bit Rate Filter Bank
MP2102A-068*4,*6	2 to 3 High Bit Rate/1 to 2 Low Bit Rate Filter Bank
MP2102A-069*4,*6	3 High Bit Rate/3 Low Bit Rate Filter Bank
MP2102A-070*4,*7	LPF for 156M (L)
MP2102A-071*4,*7	LPF for 622M (L)
MP2102A-072*4,*7	LPF for 1.0G (L)
MP2102A-073*4,*7	LPF for 1.2G (L)
MP2102A-076/176*4,*8	LPF for 2.1G (H)
MP2102A-077/177*4,*8	LPF for 2.5G (H)
MP2102A-078/178*4,*8	LPF for 2.6G (H)
MP2102A-079/179*4,*8	LPF for 3.1G (H)
MP2102A-080/180*4,*8	LPF for 4.2G (H)
MP2102A-081/181*4,*8	LPF for 5.0G (H)
MP2102A-082/182*4,*8	LPF for 6.2G (H)
MP2102A-083/183*4,*8	LPF for 8.5G (H)
MP2102A-084/184*4,*8,*9	LPF for 9.9G to 10.3G (H)
MP2102A-085/185*4,*8	LPF for 10.5G to 11.3G (H)
MP2102A-086/186*4,*8,*9	LPF for Multi 10G (H)

*7: Can be installed in Option 064 to 069.

*8: Can be installed in Option 061 to 063 or Option 066 to 069.

*9: Either one of Option 084/184 or 086/186 can be installed.

Option No. 130, and 176 through 186 are retrofit option. Installing these options requires returning MP2102A to factory.

Table A.3-2 Sampling Scope

Item	Specifications
Functions	Waveform display: eye pattern, pulse pattern Statistics processing*1: histogram, mask test Applicable mask 1GFC 2GFC 4GFC 8GFC 8GFC_Elect_Tx 8GFC_Elect_Rx 10GFC 10GFC FEC 1GbE 2GbE 10GbE_WAN 10GbE LAN/PHY 10GbE FEC OC48/STM16 OTU-1 OC192/STM64 OC192/STM64 FEC (G.975) OTU-2 1310 nm OTU-2 1550 nm OTU-2 1550 nm Expanded OTU-2 Amplified User Defined Mask file Text file with extension (msk,pcm)

*1: Processing is performed for the NRZ waveform.

Table A.3-2 Sampling Scope (Cont'd)

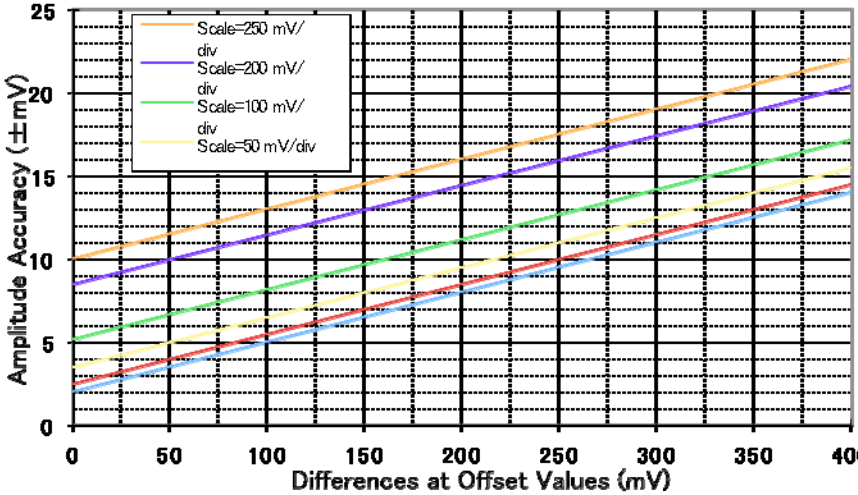
Item	Specifications
Horizontal system	<p>Clock trigger input</p> <p>Connector: SMA jack</p> <p>Termination: 50 Ω</p> <p>Frequency 0.1 to 12.5 GHz</p> <p>Sensitivity 100 mVp-p*2</p> <p>Absolute maximum rating: 2 Vp-p*3</p> <p>Jitter, RMS 5 to 12.5 GHz: 1.35 ps or less, 0.85 ps*2</p> <p>1 to 5 GHz: 1 ps*2</p> <p>0.1 to 1 GHz: 2 ps*2</p> <p>Scale</p> <p>Eye pattern display: full scale 1UI or more</p> <p>Pulse pattern display: full scale 1 bit or more</p>
Vertical system	<p>Electrical input</p> <p>Input connector: K</p> <p>Termination: 50 Ω</p> <p>CH_A</p> <p>CH_B*4</p> <p>Absolute maximum input ±2 V*3</p> <p>Input range</p> <p>Offset: ±500 mV or more</p> <p>Dynamic range: ±400 mV or more</p> <p>Bandwidth (−3 dB): DC to 20 GHz or more, DC to 25 GHz*2</p> <p>Flatness: ±1 dB*2</p> <p>RMS noise: 3.5 mV or less 2 mV*2</p>

*2: Typical value

*3: Design guaranteed

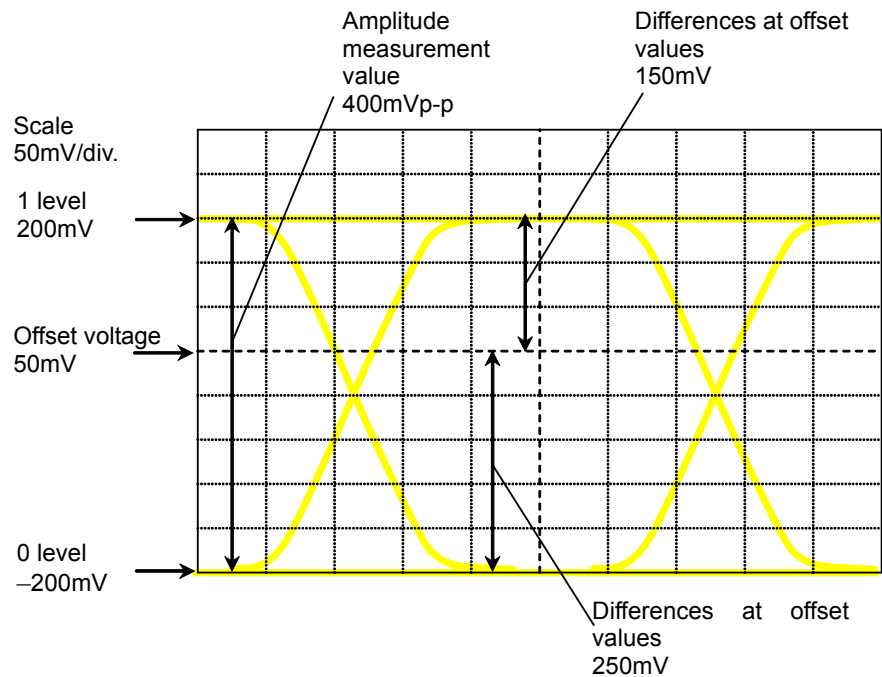
*4: MP2102A-021 only

Table A.3-2 Sampling Scope (Cont'd)

Item	Specifications
Vertical system	<p>Amplitude accuracy*5</p> <p>\pmamplitude accuracy $\pm 2\%$ for reading value*6</p> <p>The following figure indicates the amplitude accuracy after calibration.</p> 

*5: After internal calibration

*6: Calculation example: when the amplitude reading is 400 mV and the offset voltage is 50 mV



A.3 MP2102A BERTWave SS Specifications

In this example, the difference between 1 level voltage (200 mV) and offset voltage (50 mV) is 150 mV. At the scale 50 mV/div graph for the voltage difference 150 mV, the amplitude accuracy is 8 mV.

At 1 level accuracy, the difference is calculated as follows:

$$200 \times 2\% + 8 = 12 \quad \pm 12 \text{ mV}$$

The difference between 0 level voltage (-200 mV) and offset voltage (50 mV) is 250 mV.

At the scale 50 mV/div graph for the voltage difference 250 mV, the amplitude accuracy is 11 mV. At 10 level accuracy, the difference is calculated as follows:

$$200 \times 2\% + 11 = 15 \quad \pm 15 \text{ mV}$$

Table A.3-2 Sampling Scope (Cont'd)

Item	Specifications	
Vertical system	Optical input*7	
	Connector	FC*8, SC*9
	Suitable fiber	multi-mode fiber (62.5 μm)*10
	Wavelength range	750 to 1650 nm
	Bandwidth*11	DC to 9.0 GHz
	Conversion efficiency	850 nm: 0.25 A/W*2
		1310 nm: 0.475 A/W*2
		1550 nm: 0.45 A/W*2
	Conversion gain	850 nm: 112.5 V/W*2
		1310 nm: 210 V/W*2
		1550 nm: 200 V/W*2
	Optical noise*2	
	With MP2102A-055 (Unit:μWrms)	
	Wavelength	850 nm 1310, 1550 nm
	When using a filter of Option 070 to 073	4.2 2.4
	When using a filter of Option 076 to 080	3.6 2.0
	When using a filter of Option 081 to 083	5.2 3.0
	When using a filter of Option 084 or 085	6.5 3.7
	When using a filter of Option 086	3.4 2.0
	Without MP2102A-055 (Unit:μWrms)	
	Wavelength	850 nm 1310, 1550 nm
	When using a filter of Option 070 to 073	3.1 1.8
	When using a filter of Option 076 to 080	2.7 1.5
	When using a filter of Option 081 to 083	3.9 2.2
	When using a filter of Option 084 or 085	4.8 2.8
	When using a filter of Option 086	2.5 1.4

*7: MP2102A-023 for CH_B only

*8: Option 037

*9: Option 040

*10: Single mode fiber acceptable

*11: No internal filter, frequency that electrical output level goes –3 dB down, typical value

Table A.3-2 Sampling Scope (Cont'd)

Item	Specifications		
Vertical system (Cont'd)	Optical input (Cont'd) Sensitivity*2,*12		
	Option	With MP2102A-055	Without MP2102A-055
	When using a filter other than Option 086	-9 dBm	-12 dBm
	When using a filter of Option 086	-11 dBm	-14 dBm
	No filter option	-12 dBm	-15 dBm
	Maximum input power*13: Absolute maximum power: Optical power measurement Optical return loss	Average power -1 dBm (794 μW) Peak power +2 dBm (1.58 mW) Peak power +5 dBm (3.16 mW) Range: -18 to 0 dBm Accuracy ±0.35 dB*2: -12 dBm or more ±0.6 dB*2: less than -12 dBm -30 dB*2	
Digital system	Sampling speed: 100 ksa/second typ.*2		

*12: Mask test available range

*13: Level deteriorating linearity

Table A.3-2 Sampling Scope (Cont'd)

Item	Specifications
Clock Recovery (MP2102A-055)	Standard accessory J1341A Open (Coaxial connector cover) 2 Data input Connector: SMA jack Termination: AC coupling, 50 Ω Sensitivity: 100 mVp-p*2 Clock output Connector: SMA jack Termination: AC coupling, 50 Ω Amplitude: 0.1 to 2.7 GHz: 270 to 540 mVp-p 8.5 to 12.5 GHz: 500 to 1500 mVp-p Frequency: 8.5 to 12.5 GHz, 0.1 to 2.7 GHz Jitter (RMS): 8.5 to 12.5 GHz: 20 mUI or less*14, 10 mUI*2, *14 0.1 to 2.7 GHz: 5 mUI or less Loop bandwidth: 8.5 to 12.5 GHz Band: 1, 2, 4, 8 MHz*2 0.1 to 2.7 GHz Band: 2488.32 MHz: 200 kHz*2 622 MHz: 50 kHz*2 156 MHz: 20 kHz*2

Table A.3-2 Sampling Scope (Cont'd)

Item	Specifications
Filter bank (8.5G/10G/10.5G) (MP2102A-056)	3 dB cutoff frequency 8.5 Gbit/s: 6.38 GHz*2 Low-pass filter 8GFC 10 Gbit/s: 7.6 GHz*2 Low-pass filter 10GbE WAN (10 GBase-W) & OC-192/STM-64, 10GE LAN(10 GBase-R) 10.7 Gbit/s: 8.2 GHz*2 Low-pass filter 10GFC, OC-192/STM-64 FEC (G.975), OTU-2, 10GFC EFC, 10GbE FEC
Filter bank (2G/4G/8.5G/10G) (MP2102A-057)	3 dB cutoff frequency 2 Gbit/s: 1.6 GHz*2 Low-pass filter 2GFC 4 Gbit/s: 3.2 GHz*2 Low-pass filter 4GFC 8.5 Gbit/s: 6.38 GHz*2 Low-pass filter 8GFC 10 Gbit/s: 7.6 GHz*2 Low-pass filter 10GbE WAN (10GBase-W) & OC-192/STM-64,10GE LAN(10 GBase-R)
High Bit Rate Filter (MP2102A-061)	Filter configuration: One of MP2102A-076 to 086 can be installed.
2 High Bit Rate Filter Bank (MP2102A-062)	Filter configuration: Two of MP2102A-076 to 086 can be installed.
3 to 4 High Bit Rate Filter Bank (MP2102A-063)	Filter configuration: Three or four of MP2102A-076 to 086 can be installed.
1 to 2 Low Bit Rate Filter Bank (MP2102A-064)	Filter configuration: One or two of MP2102A-070 to 073 can be installed.

*14: Loop bandwidth: 4 MHz

Table A.3-2 Sampling Scope (Cont'd)

Item	Specifications
3 to 4 Low Bit Rate Filter Bank (MP2102A-065)	Filter configuration: Three or four of MP2102A-070 to 073 can be installed.
1 High Bit Rate/1 to 2 Low Bit Rate Filter Bank (MP2102A-066)	Filter configuration: One of MP2100A-076 to 086 and one or two of MP2100A-070 to 073 can be installed.
1 to 2 High Bit Rate/3 to 4 Low Bit Rate Filter Bank (MP2102A-067)	Filter configuration: One or two of MP2102A-076 to 086 and three or four of MP2102A-070 to 073 can be installed.
2 to 3 High Bit Rate/1 to 2 Low Bit Rate Filter Bank (MP2102A-068)	Filter configuration: Two or three of MP2102A-076 to 086 and one or two of MP2102A-070 to 073 can be installed.
3 High Bit Rate/3 Low Bit Rate Filter Bank (MP2102A-069)	Filter configuration: Three of MP2102A-076 to 086 and three of MP2102A-070 to 073 can be installed.
LPF for 156M (L) (MP2102A-070)	3 dB cutoff frequency 155 Mbit/s: 116 MHz* ² Low-pass filter for OC-3/STM-1
LPF for 622M (L) (MP2102A-071)	3 dB cutoff frequency 622 Mbit/s: 470 MHz* ² Low-pass filter for OC-12/STM-4, CPRI
LPF for 1.0G (L) (MP2102A-072)	3 dB cutoff frequency 1062.5 Mbit/s: 800MHz* ² Low-pass filter for 1GFC
LPF for 1.2G (L) (MP2102A-073)	3 dB cutoff frequency 1.2 Gbit/s: 940 MHz* ² Low-pass filter for 1GbE, OC-24, CPRI × 2
LPF for 2.1G (H) (MP2102A-076/176)	3 dB cutoff frequency 2.1Gbit/s: 1.6 GHz* ² Low-pass filter for 2GFC
LPF for 2.5G (H) (MP2102A-077/177)	3 dB cutoff frequency 2.5 Gbit/s: 1.87 GHz* ² Low-pass filter for CPRI × 4, OC-48/STM-16, 2GbE, Infiniband
LPF for 2.6G (H) (MP2102A-078/178)	3 dB cutoff frequency 2.6 Gbit/s: 2.0 GHz* ² Low-pass filter for OTU-1

Table A.3-2 Sampling Scope (Cont'd)

Item	Specifications
LPF for 3.1G (H) (MP2102A-079/179)	3 dB cutoff frequency 3.1 Gbit/s: 2.37 GHz*2 Low-pass filter for CPRI × 5, 10GBASE-LX4, 10GFC-LX4
LPF for 4.2G (H) (MP2102A-080/180)	3 dB cutoff frequency 4.2 Gbit/s: 3.2 GHz*2 Low-pass filter for 4GFC
LPF for 5.0G (H) (MP2102A-081/181)	3 dB cutoff frequency 5.0 Gbit/s: 3.75 GHz*2 Low-pass filter for Infiniband × 2, CPRI × 8
LPF for 6.2G (H) (MP2102A-082/182)	3 dB cutoff frequency 6.2 Gbit/s: 4.61 GHz*2 Low-pass filter for CPRI × 10, XAUI Optical × 2
LPF for 8.5G (H) (MP2102A-083/183)	3 dB cutoff frequency 8.5 Gbit/s: 6.3 GHz*2 Low-pass filter
LPF for 9.9G to 10.3G (H) (MP2102A-084/184)	3 dB cutoff frequency 9.9 to 10.3 Gbit/s: 7.6 GHz*2 Low-pass filter for 8GFC, 10GbE WAN, 10GbE LAN/PHY, OC-192/STM-64, Infiniband × 4
LPF for 10.5G to 11.3G (H) (MP2102A-085/185)	3 dB cutoff frequency 10.5 to 11.3 Gbit/s: 8.2 GHz*2 Low-pass filter for 10GFC, G.975 FEC, OTU-2, 10GbE FEC, 10GFC FEC
LPF for Multi 10G (H) (MP2102A-086/186)	3 dB cutoff frequency 9.9 to 10.7Gbit/s: 7.5 GHz*2 Low-pass filter for 8GFC, 10GbE WAN, 10GbE LAN/PHY, OC-192/STM-64, Infiniband × 4, 10GFC, G.975 FEC, OTU-2

Table A.3-3 General Performance

Item	Specifications
Panel	Input functions: rotary encoder, touch panel, power switch measurement buzzer, panel lock
Display	12.1 inch LCD: WXGA (1280 × 768, 1280 × 800) LED: disk access, standby, power
Functions	Measurement buzzer, panel lock
Peripheral devices connection	VGA OUTPUT (SVGA), USB 2.0 × 5
Remote interface	Ethernet × 2 (10/100/1000BASE-T) GPIB × 1*1
OS	Windows XP Embedded Standard 2009 Service Pack 3*2
Internal storage devices	Flash Memory Drive, 8 GB or more
Power source	Voltage: AC 100 to 120 V, 200 to 240 V (Auto switch: 100/200 V)*3 Frequency: 50 Hz to 60 Hz Power consumption: 300 VA or less
Environment performance	Operating temperature: +5 to +40°C Storage temperature: -20 to +60°C EMC: EN61326-1, EN61000-3-2 LVD: EN61010-1
Size and mass	Dimension 221.5 (H) × 341 (W) × 180 (D) mm (excluding protrusions) Weight 7 kg or less (excluding options)

*1: Option 030/130 required

*2: Operation not warranted when software installed after factory shipment

*3: Operating voltage: within the range of +10% to -15% from the rated voltage

A.4 Optical Transceiver Module Specifications

Table A.4-1 850 nm XFP

Item		Specifications
Model/Product Name		G0174A 850 nm XFP Module
Bit rate		9.95 to 11.10 Gbit/s
Transmitter* ¹	Output	-4.0 to -1.08 dBm
	Laser safety class	IEC60825-1: Class 1 21 CFR 1040.10 Laser safety notice 50
	Center wavelength	840 to 860 nm
	RMS Spectrum width	0.45 nm or less
	Extinction Ratio	3.0 dB or more* ²
	Suitable optical fiber	GI (50/125 μm), GI (62.5/125 μm)
	Connector	LC/PC
	Eye mask pattern	{X1, X2, X3, Y1, Y2, Y3} {0.25, 0.40, 0.45, 0.25, 0.28, 0.40}* ²

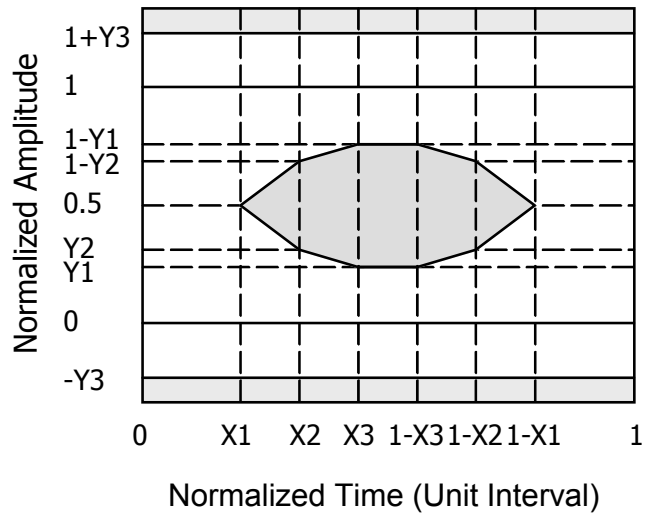


Table A.4-1 850 nm XFP (Cont'd)

Item		Specifications
Receiver* ¹	Wavelength range	840 to 860 nm
	Sensitivity	-9.9 dBm or less* ³
	Maximum input	-1.0 dBm* ³
	Suitable optical fiber	GI (50/125 μm), GI (62.5/125 μm)
	Connector	LC/PC

*1: NRZ signal: PRBS²²³-1, mark ratio: 1/2, bit rate: 10.3125 Gbit/s

*2: Uses 10.3125 Gbit/s filter

*3: Average power: BER ≤10⁻¹², 20 to 30°C

Table A.4-2 1310 nm XFP

Item		Specifications
Model/Product Name		G0194A 1310 nm XFP Module
Bit rate		9.95328, 10.3125, 10.51875, 10.66423, 10.70923, 11.09 Gbit/s
Transmitter* ¹	Output	-6.0 to -1.0 dBm
	Laser safety class	IEC60825-1: Class 1 21 CFR 1040.10 Laser safety notice 50
	Center wavelength	1290 to 1330 nm
	SMSR	30.0 dB or more
	Extinction Ratio	6.0 dB or more* ²
	Suitable optical fiber	Single mode fiber (ITU-T G.652)
	Connector	LC/PC
	Eye mask pattern	{X1, X2, X3, Y1, Y2, Y3} {0.25, 0.40, 0.45, 0.25, 0.28, 0.40,}* ²

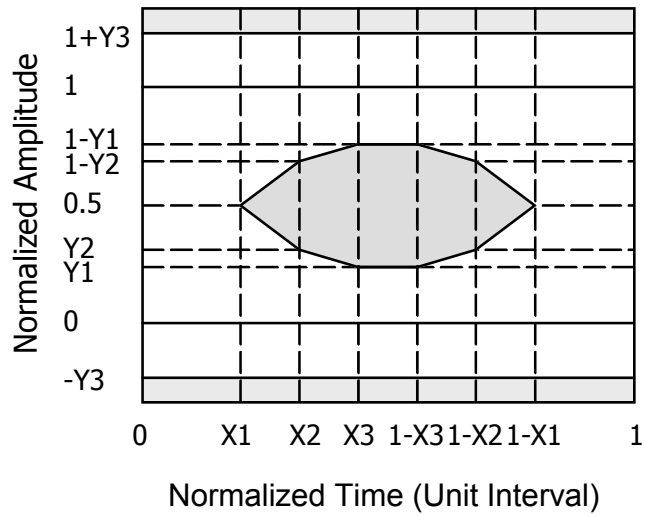


Table A.4-2 1310 nm XFP

Item		Specifications
Receiver* ¹	Wavelength range	1290 to 1330 nm
	Sensitivity	-11 dBm or less* ³
	Maximum input	+0.5 dBm* ³
	Suitable optical fiber	Single mode fiber (ITU-T G.652)
	Connector	LC/PC

*1: NRZ signal: PRBS²²³-1, mark ratio: 1/2, bit rate: 9.95328 Gbit/s

*2: Uses 9.95328 Gbit/s filter

*3: Average power: BER $\leq 10^{-12}$, 20 to 30°C

Table A.4-3 1550 nm XFP

Item		Specifications
Model/Product Name		G0195A 1550 nm XFP Module
Bit rate		9.95328, 10.3125, 10.51875, 10.66423, 10.70923, 11.09 Gbit/s
Transmitter* ¹	Output	-1.0 to +2.0 dBm
	Laser safety class	IEC60825-1: Class 1 21 CFR 1040.10 Laser safety notice 50
	Center wavelength	1530 to 1565 nm
	SMSR	30.0 dB or more
	Extinction Ratio	8.2 dB or more* ²
	Suitable optical fiber	Single mode fiber (ITU-T G.652)
	Connector	LC/PC
	Eye mask pattern	{X1, X2, X3, Y1, Y2, Y3} {0.25, 0.40, 0.45, 0.25, 0.28, 0.40}* ²

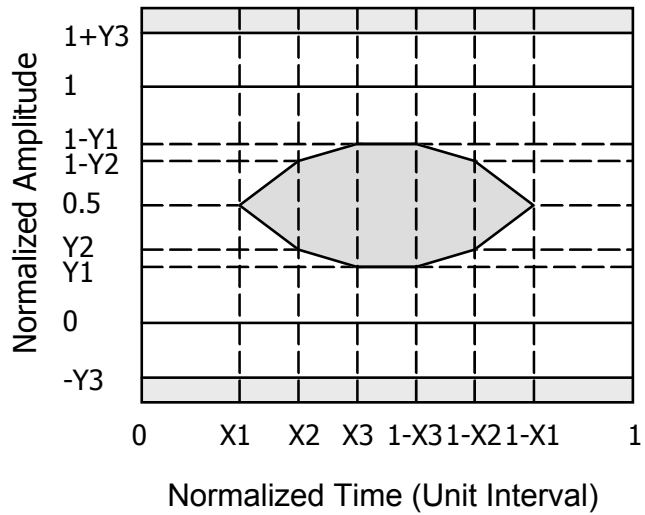


Table A.4-3 1550 nm XFP (Cont'd)

Item		Specifications
Receiver* ¹	Wavelength range	1530 to 1565 nm
	Sensitivity	-14 dBm or less* ³ ,* ⁴
	Maximum input	-1.0 dBm* ³
	Suitable optical fiber	Single mode fiber (ITU-T G.652)
	Connector	LC/PC

*1: NRZ signal: PRBS²²³⁻¹, mark ratio: 1/2, bit rate: 9.95328 Gbit/s

*2: Uses 9.95328 Gbit/s filter

*3: Average power: BER ≤ 10⁻¹²

*4: 20 to 30°C

Table A.4-4 850 nm SFP+

Item		Specifications
Model/Product Name		G0238A 850 nm SFP+ Module
Bit rate		10.3125 Gbit/s
Transmitter* ¹	Output	-5.0 to -1.0 dBm
	Laser safety class	IEC60825-1: Class 1 21 CFR 1040.10 Laser safety notice 50
	Center wavelength	840 to 860 nm
	RMS Spectrum width	0.45 nm or less
	Extinction Ratio	3.0 dB or more* ²
	Suitable optical fiber	GI (50/125 μm), GI (62.5/125 μm)
	Connector	LC/PC
	Eye mask pattern	{X1, X2, X3, Y1, Y2, Y3} {0.25, 0.40, 0.45, 0.25, 0.28, 0.40}* ²

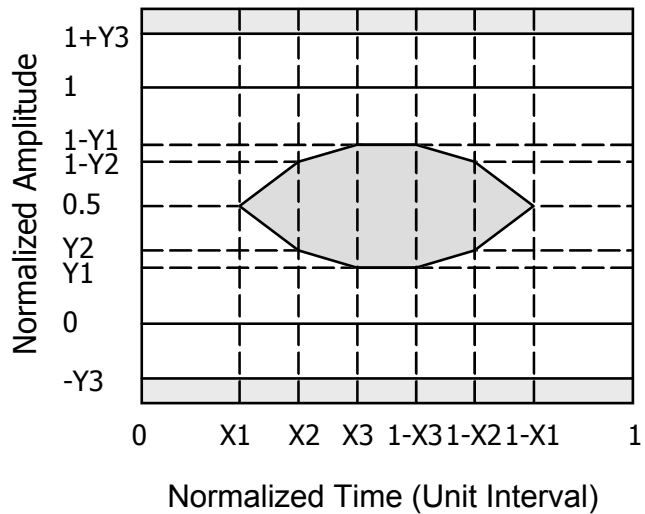


Table A.4-4 850 nm SFP+

Item		Specifications
Receiver* ¹	Wavelength range	840 to 860 nm
	Sensitivity	-11.1 dBm or less* ³
	Maximum input	0.5 dBm* ⁴
	Suitable optical fiber	GI (50/125 μm), GI (62.5/125 μm)
	Connector	LC/PC
	LOS detection level	-12.0 dBm or less, -20.0 dBm* ⁵

*1: NRZ signal: PRBS²³-1, mark rate: 1/2, bit rate: 10.3125 Gbit/s,

*2: Uses 10.3125 Gbit/s filter

*3: Optical Modulation Amplitude, BER ≤10⁻¹², at 20 to 30°C

*4: Average power, BER ≤10⁻¹², at 20 to 30°C

*5: Typical values

Table A.4-5 1310 nm SFP+

Item		Specifications
Model/Product Name		G0239A 1310 nm SFP+ Module
Bit rate		9.95328 to 10.3125 Gbit/s
Transmitter* ¹	Output	-8.2 to 0.5 dBm
	Laser safety class	IEC60825-1: Class 1 21 CFR 1040.10 Laser safety notice 50
	Center wavelength	1260 to 1355 nm
	SMSR	30.0 dB or more
	Extinction Ratio	3.5 dB or more* ²
	Suitable optical fiber	Single mode fiber (ITU-T G.652)
	Connector	LC/PC
	Eye mask pattern	{X1, X2, X3, Y1, Y2, Y3} {0.25, 0.40, 0.45, 0.25, 0.28, 0.40}* ²

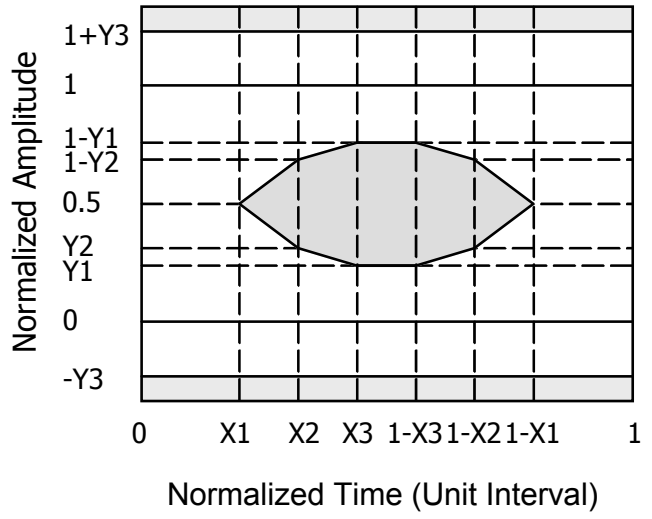


Table A.4-5 1310 nm SFP+ (Cont'd)

	Item	Specifications
Receiver* ¹	Wavelength range	1260 to 1355 nm
	Sensitivity	-12.6 dBm or less* ³
	Maximum input	0.5 dBm* ⁴
	Suitable optical fiber	Single mode fiber (ITU-T G.652)
	Connector	LC/PC
	LOS detection level	-30.0 dBm or more

*1: NRZ signal: PRBS²²³⁻¹, mark rate: 1/2, bit rate: 10.3125 Gbit/s,

*2: Uses 10.3125 Gbit/s filter

*3: Optical Modulation Amplitude, BER ≤10⁻¹², at 20 to 30°C

*4: Average power, BER ≤10⁻¹², at 20 to 30°C

Appendix B Initial Values

Table B-1 Initial Values of PPG

Item	Initial Value	Remarks
Amplitude	0.40	V _{p-p}
Bit Rate Standard	Variable	
Bit Rate	8500000	kbit/s
Bit Rate Offset	0	ppm
Data/Xdata	Off	
Error Addition	Off	
Error Addition Rate	Repeat	
Error Rate	1E-2	
External ATT	0	dB
External CLK	10 MHz	
Logic	Pos	
Reference CLK	Internal	
Sync Output	PPG1_1/8Clk	
Test Pattern	PRBS 2 ⁹ -1	
Programmable Pattern	“-----“	

Table B-2 Initial Values of ED

Item	Initial Value	Remarks
Auto SYNC	On	
Auto SYNC Threshold	INT	
Bit Rate Standard	Variable	
Bit Rate	8500000	kbit/s
Data Input Condition	Electrical Single-Ended-Data	
Data Input Condition Threshold	0	mV
ED Result	“Total”	
	Start Time	
	Stop	
External ATT	0	dB
Frame Position	1	
Gating Cycle	Repeat	
Gating Current	On	
Gating Period	0 Day 0 H 0 M 1 S	
Logic	Pos	
SYNC Control	Off	
Sync Output	PPG1_1/8Clk	
Test Pattern	PRBS 2 ⁹ -1	
Tracking	On	
Programmable Pattern	“-----“	

Table B-3 Initial Values of Sampling Scope (EYE/Pulse Scope)

Item	Initial Value	Remarks
Amplitude		
Attenuation A	0	dB
Attenuation B	0	dB
Channel A Attenuation Tracks ED1	Off	
Channel A/B Tracking	Off	
Channel Math	Off	
Define Function	CHA+CHB	
Scale	2500	mV/div.
Offset	0	mV
Offset A	0	mV
Offset B	0	mV* ¹ μ W* ²
Scale A	100	mV/div.
Scale B	250	mV/div.
CH A	On	
CH B	On	
Marker Disp	Off	
X1	Off	
X2	Off	
Y1	Off	
Y2	Off	

*1: Electrical interface

*2: Optical interface

Table B-3 Initial Values of Sampling Scope (EYE/Pulse Scope) (Cont'd)

Item	Initial Value	Remarks
Measure		
Active Channel Selection	Channel A	
Measurement Item	Off	
Amplitude/Time		
Correction Factor	0	ps
Item	1	
Item Selection	(Ch.A) Jitter p-p (Ch.A) Jitter RMS (Ch.A) Crossing (Ch.A) Eye Amplitude	
Measure Area Marker	Off	
Offset form Crossing	0.50	UI
Rise/Fall Time	20/80%	
Rise/Fall Time Correction	Off	
Width	0.20	UI
Histogram		
Axis	Amplitude	
X1	0.50	UI
X2	1.50	UI
Y1	500	mV *1 μW *2
Y2	-500	mV *1 μW *2

Table B-3 Initial Values of Sampling Scope (EYE/Pulse Scope) (Cont'd)

Item	Initial Value	Remarks
Measure (Cont'd)		
Measurement Item	Off	
Mask Test		
Align Marker	Display Off	
X1	0.50	
ΔX	1.00	
Y1	338.31	
ΔY	673.90	
Align Method	Zero/One/Crossing	
Eye Mask Select	1GFC	
Mask Area Restriction	Off	
Angle	0	
Width	0.10	UI
Mask Margin	One Shot	
Mask Margin	0	%
Margin Type	Hit Count	
Hit Count	1	
Hit Ratio	5E-05	

Table B-3 Initial Values of Sampling Scope (EYE/Pulse Scope) (Cont'd)

Item	Initial Value	Remarks
Setup		
Accumulation Type	Persistency	
Averaging	10	
CRU Band	Off	
CRU Loop BW	1 MHz	
Inverse Background color	Off	
Limit Type	Time	
Number of sample	8191	
Ref. Trace Memory	ChA & ChB	
Samples	10	million
Sampling Mode	Eye	
Time	10.0	sec
Waveforms	100	
Time		
Bits on Screen	2	
Clock Rate	8500000	kHz
Bit Rate	8500000	kbit/s
Divide Ratio	8	
Length	511	
Master (Data Clock Rate)	PPG1	
Master (Pattern Length)	PPG1	
Offset	0	
Recalculate Option	Clock Rate	
Skew		
A	0.0	
B	0.0	
Tracking (Data Clock Rate)	Off	
Tracking (Pattern Length)	Off	
Unit	UI	

Table B-4 Initial Values of Optical Transceiver (XFP/SFP+)

Item	Initial Value	Remarks
Output	Off	
XFP RX Ref CLK*	Sync with PPG1	

*: Option 050 installed only

Table B-5 Initial Values of O/E Converter

Item	Initial Value	Remarks
Filter On/Off	On	
Conversion Gain		*1
Extinction Ratio Correction	Off	
Extinction Ratio Correction Factor	0.00%	
Filter		*2
Responsivity		*1
System Conversion Gain		*1
Wavelength	1550	
Input Power	-7.00 dBm	

*1: The initial value of this item is adjusted to go with the wavelength of 1550 nm at factory.

*2: This indicates the lowest bit rate filter in the filters installed.

Table B-6 Initial Values of Setup Utility

Item	Initial Value	Remarks
Remote Control		
Active Interface	Ethernet	
Protect	OFF	
GPIB *		
Address	1	
Remote High Speed Response	Checked	
Ethernet		
IP Address	192 168 100 101	Local Area Connection
Subnet Mask	255 255 255 0	
Gateway		
IP Address	192 168 100 102	Local Area Connection 2
Subnet Mask	255 255 255 0	
Gateway		
Port Number	5001	
Information	Software	

*: When Option 030/130 installed

Appendix C Keyboard and Mouse Operations

The operation of the rotary knob, arrow keys displayed on the screen, numeric input panel, and buttons in dialog boxes and the corresponding keyboard and mouse operations are explained below.

Table C-1 Correspondence between Rotary Knob Operation and Keyboard

Rotary Knob Operation	Keyboard
Rotary Knob Counterclockwise rotation	Shift + Tab
Rotary Knob Clockwise rotation	Tab
Pressing Rotary Knob	Enter

Table C-2 Correspondence between Panel Keys and Keyboard

Panel Key	Keyboard
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
+	+
-	-
.(Period)	.(Period)
▲	↑
>	→
▼	↓
<	←
OK	Enter
Cancel	ESC
<<,BKSP	Back Space

Panel operations using the keyboard at the Setup Utility are not supported.

Table C-3 Corresponding to Mouse Operation

Mouse Operation	Corresponding Operation
Left button click	Save same as touching touch panel
Right button click	No operation
Wheel	Same as turning rotary knob ↑Forwards: Clockwise ↓Backwards: Counterclockwise

Appendix D Pattern Files

D.1 Pattern File Specifications

The specifications for data files read as PPG or ED are as follows:

Table D.1-1 Specifications for Data Pattern File

Item	Specifications
Save destination folder	C:\Program Files\Anritsu\MP2100A \MX210000A\UserData\Pattern
File extension	ppf
Data length (bits)	2 to 1305600
Description method	Hexadecimal or binary

Data description specifications

- Data pattern as text file
- Comma-separated (,) data length, description method and data
- Decimal data length description
- HEX descriptor for hexadecimal and BIN for binary
- HEX not case sensitive
- 2-byte characters not supported
- Ignores spaces, line breaks and tabs
- Errors occur under following conditions:
 - One or less commas (,) included in file
 - Data longer than 10000000 bits
 - 2-byte characters included in file
- Ignores data after third comma when 3 or more commas (,) included in file
- Displays warning when reading 1305601 or more bits of data
In this case, pattern only uses data from header to bit 1305600.
- Pads missing part with 0s when described data bit count smaller than data length
- Uses data up to data length for pattern when described data bit count larger than data length
- Sets data to all 0s when data description omitted

Hexadecimal description specifications

- Hexadecimal description only as integer values with no decimals
- Data length in multiples of 4
- Supports mixture of upper- and lower-case characters A to F (case insensitive)
- File read error when data includes characters other than A, B, C, D, E, F, a, b, c, d, e, and f

Binary description specifications

- Binary description only as integer values with no decimals
- File read error if data includes characters other than 0 and 1

Example of pattern file

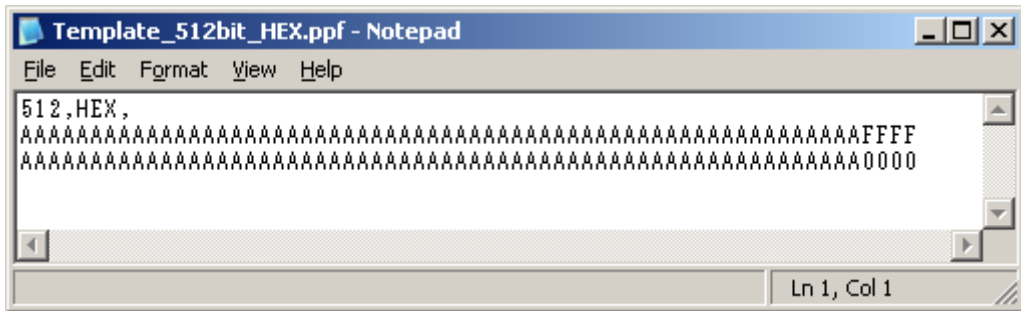


Figure D.1-1 Example of Pattern File Described by Hexadecimal Number

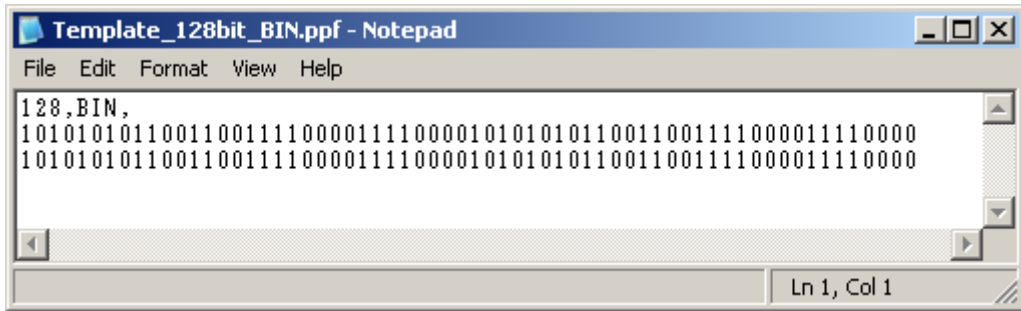


Figure D.1-2 Example of Pattern File Described by Binary Number

D.2 Mask file Specifications

The mask file specifications reading with Sampling Scope is as follows.

Table D.2-1 Mask File Specifications

Item	Specification
Save folder	C:\Program Files\Anritsu\MP2100A \MX210000A\UserData\Mask
File extension	txt

The mask file is the test format file.

The mask margin 0, -100 and 100% of the top mask of the coordinate value are described to the file.

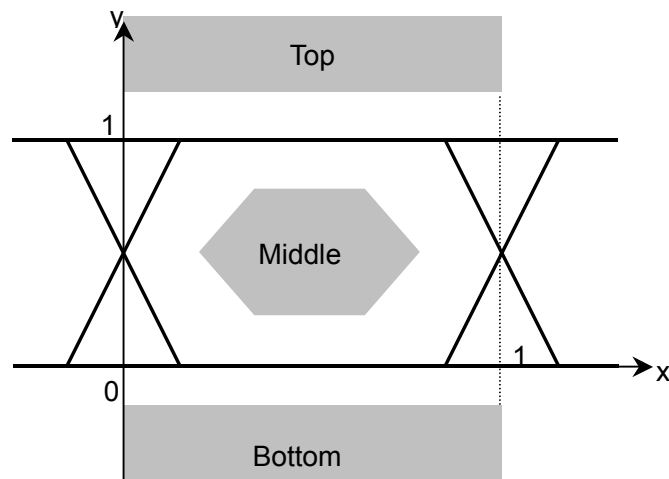


Figure D.2-1 Coordinate System of Mask

The following items are described in the mask file.

Table D.2-2 Details of Mask File

Item	Parameter to be set	Description
Version	Masks Version#1	Make sure that the version is written.
Mask name	Mask name	Mask name displayed on the measurement screen.
Mask type	Relative Mask Fixed Mask	Relative: Sets coordinate of amplitude direction by rate. The Mask coordinate varies with the amplitude of input signal. Fixed: Sets coordinate of amplitude direction at the fixed value. The Mask coordinate does not vary with the amplitude of input signal.
Coordinates in the top	TOP X Y X_min Y_min X_max Y_max	Specifies each X and Y coordinate in the area of Top/Middle/Bottom.
Coordinates in the middle	MIDDLE X Y X_min Y_min X_max Y_max	As for X_min and Y_min, set the coordinate at -100% of Mask Margin.
Coordinates in the bottom	BOTTOM X Y Y_min X_max Y_max	As for X_max, and Y_max, set the coordinate at 100% of Mask Margin. The coordinate can be set up to 10 points. If it is not used, set "-1".

Example of mask file

```

>>>>>>>>> START >>>>>>>>>
Masks Version#1
<1GFC ; 1G Optical Fibre Channel Mask (1.0625 Gbps)> Relative Mask;

Top    X      Y      X_min  Y_min  X_max  Y_max
      0      99      0      99      0      99
      0      1.3    0      1.6    0      1
      1      1.3    1      1.6    1      1
      1      99      1      99      1      999
      -1     -1     -1     -1     -1     -1
      -1     -1     -1     -1     -1     -1
      -1     -1     -1     -1     -1     -1
      -1     -1     -1     -1     -1     -1
      -1     -1     -1     -1     -1     -1
      -1     -1     -1     -1     -1     -1
Middle X      Y      X_min  Y_min  X_max  Y_max
      0.215  0.5    0.5    0.5    0      0.5
      0.4    0.8    0.5    0.5    0.4    1
      0.6    0.8    0.5    0.5    0.6    1
      0.785  0.5    0.5    0.5    1      0.5
      0.6    0.2    0.5    0.5    0.6    0
      0.4    0.2    0.5    0.5    0.4    0
      -1     -1     -1     -1     -1     -1
      -1     -1     -1     -1     -1     -1
      -1     -1     -1     -1     -1     -1
      -1     -1     -1     -1     -1     -1
Bottom X      Y      X_min  Y_min  X_max  Y_max
      0     -99      0     -99      0     -99
      0     -0.2    0     -0.4    0      0
      1     -0.2    1     -0.4    1      0
      1     -99      1     -99      1     -99
      -1     -1     -1     -1     -1     -1
      -1     -1     -1     -1     -1     -1
      -1     -1     -1     -1     -1     -1
      -1     -1     -1     -1     -1     -1
      -1     -1     -1     -1     -1     -1
      -1     -1     -1     -1     -1     -1
>>>>>>>>> END >>>>>>>>>

```

Figure D.2-2 Coordinate System of Mask

Appendix E Performance Test Result Form

Document number: _____

Test Location: _____

Date: _____

Test person in charge: _____

Product name: _____

Serial number: _____

Software version: _____

Option: _____

Power voltage: _____ V

Power frequency: _____ Hz

Ambient temperature _____ °C

Relative humidity _____ %

Instruments used: Model name _____ Serial number _____

Model name _____ Serial number _____

Model name _____ Serial number _____

Model name _____ Serial number _____

Remarks _____

E.1 Pulse Pattern Generator

Frequency Range: 8500000 to 11320000 kbit/s ± 100 ppm
 8000000 to 12500000 kbit/s ± 100 ppm (Option 090)

Table E.1-1 Operating Frequency Range

Bit Rate Setting Value	Minimum Value	Measured Value	Maximum Value	Measurement Uncertainty	Pass/Fail
12500000 kbit/s	12498750 kHz	kHz	12501250 kHz		Pass/Fail
11320000 kbit/s	11318868 kHz	kHz	11321132 kHz		Pass/Fail
8500000 kbit/s	8499150 kHz	kHz	8500850 kHz		Pass/Fail
8000000 kbit/s	7999200 kHz	kHz	8000800 kHz		Pass/Fail

Level Accuracy: $\pm 20\%$ ± 20 mV

Table E.1-2 Level Accuracy

Connector	Amplitude Setting Value	Minimum Value	Measured Value	Maximum Value	Measurement Uncertainty	Pass/Fail
PPG1 Data Out	0.1 V _{p-p}	0.06 V _{p-p}	V _{p-p}	0.14 V _{p-p}		Pass/Fail
	0.8 V _{p-p}	0.62 V _{p-p}	V _{p-p}	0.98 V _{p-p}		Pass/Fail
PPG1 Data Out	0.1 V _{p-p}	0.06 V _{p-p}	V _{p-p}	0.14 V _{p-p}		Pass/Fail
	0.8 V _{p-p}	0.62 V _{p-p}	V _{p-p}	0.98 V _{p-p}		Pass/Fail
PPG2 Data Out	0.1 V _{p-p}	0.06 V _{p-p}	V _{p-p}	0.14 V _{p-p}		Pass/Fail
	0.8 V _{p-p}	0.62 V _{p-p}	V _{p-p}	0.98 V _{p-p}		Pass/Fail
PPG2 Data Out	0.1 V _{p-p}	0.06 V _{p-p}	V _{p-p}	0.14 V _{p-p}		Pass/Fail
	0.8 V _{p-p}	0.62 V _{p-p}	V _{p-p}	0.98 V _{p-p}		Pass/Fail

Table E.1-3 Full Rate Clock Output (MP2100A-052/152, MP2101A-052/152)

Item	Minimum Value	Measured Value	Maximum Value	Measurement Uncertainty	Pass/Fail
Amplitude	300 mVp-p	mV	750 mVp-p		Pass/Fail
Rise Time	0 ps	ps	30 ps		Pass/Fail
Fall Time	0 ps	ps	30 ps		Pass/Fail
Duty	35 %	%	65 %		Pass/Fail
Jitter (rms)	0 ps				Pass/Fail

E.2 Error Detector

Frequency Range

Variable: 8500000 to 11320000 kbit/s ± 100 ppm

8000000 to 12500000 kbit/s ± 100 ppm (Option 090)

When connecting the PPG output connector, no bit error occurs during the 10-seconds measurement.

Table E.2-1 Operating Frequency Range

Connector	Bit Rate Setting Value	Offset Setting Value	Measured Frequency	Error Count	Pass/Fail
ED1 Data In	11320000 kbit/s	+100 ppm	kHz		Pass/Fail
	11320000 kbit/s	-100 ppm	kHz		Pass/Fail
ED1 $\overline{\text{Data}}$ In	11320000 kbit/s	+100 ppm	kHz		Pass/Fail
	11320000 kbit/s	-100 ppm	kHz		Pass/Fail
ED2 Data In	11320000 kbit/s	+100 ppm	kHz		Pass/Fail
	11320000 kbit/s	-100 ppm	kHz		Pass/Fail
ED2 $\overline{\text{Data}}$ In	11320000 kbit/s	+100 ppm	kHz		Pass/Fail
	11320000 kbit/s	-100 ppm	kHz		Pass/Fail

Table E.2-2 Operating Frequency Range (Option 090)

Connector	Bit Rate Setting Value	Offset Setting Value	Measured Frequency	Error Count	Pass/Fail
ED1 Data In	12500000 kbit/s	+100 ppm	kHz		Pass/Fail
	12500000 kbit/s	-100 ppm	kHz		Pass/Fail
ED1 $\overline{\text{Data}}$ In	12500000 kbit/s	+100 ppm	kHz		Pass/Fail
	12500000 kbit/s	-100 ppm	kHz		Pass/Fail
ED2 Data In	12500000 kbit/s	+100 ppm	kHz		Pass/Fail
	12500000 kbit/s	-100 ppm	kHz		Pass/Fail
ED2 $\overline{\text{Data}}$ In	12500000 kbit/s	+100 ppm	kHz		Pass/Fail
	12500000 kbit/s	-100 ppm	kHz		Pass/Fail

Input Level Range: 0.1 to 0.8 Vp-p

Table E.2-3 Range of Input Level

Connector	Input Level	Measured Frequency	Error Count	Pass/Fail
ED1 Data In	0.1 Vp-p	kHz		Pass/Fail
	0.8 Vp-p	kHz		Pass/Fail
ED1 Data In	0.1 Vp-p	kHz		Pass/Fail
	0.8 Vp-p	kHz		Pass/Fail
ED2 Data In	0.1 Vp-p	kHz		Pass/Fail
	0.8 Vp-p	kHz		Pass/Fail
ED2 Data In	0.1 Vp-p	kHz		Pass/Fail
	0.8 Vp-p	kHz		Pass/Fail
O/E Data In	-9 dBm	kHz		Pass/Fail

Pattern Specifications

Test Pattern: 2^7-1 , 2^9-1 , $2^{15}-1$, $2^{23}-1$, $2^{31}-1$

Input Level: 0.1 V_{p-p}, Bit rate: 11320000 kbit/s

(no bit error occurs when inputting single end)

Table E.2-4 Pattern

Connector	Pattern	Error Count	Pass/Fail
ED1 Data In	2^7-1		Pass/Fail
	2^9-1		Pass/Fail
	$2^{15}-1$		Pass/Fail
	$2^{23}-1$		Pass/Fail
	$2^{31}-1$		Pass/Fail
ED1 Data In	2^7-1		Pass/Fail
	2^9-1		Pass/Fail
	$2^{15}-1$		Pass/Fail
	$2^{23}-1$		Pass/Fail
	$2^{31}-1$		Pass/Fail

Table E.2-4 Pattern (Cont'd)

Connector	Pattern	Error Count	Pass/Fail
ED2 Data In	2^7-1		Pass/Fail
	2^9-1		Pass/Fail
	$2^{15}-1$		Pass/Fail
	$2^{23}-1$		Pass/Fail
	$2^{31}-1$		Pass/Fail
ED2 Data In	2^7-1		Pass/Fail
	2^9-1		Pass/Fail
	$2^{15}-1$		Pass/Fail
	$2^{23}-1$		Pass/Fail
	$2^{31}-1$		Pass/Fail

Error Detector (ED)

Input Level: 0.1 V_{p-p}

Bit Rate: 10000000 kbit/s

(single error detects when inputting the single end)

The calculation value of the bit error rate corresponds to the error count (EC) and clock count (CC).

Table E.2-5 Error Detector

Connector	Bit Error Rate	Error Count	Pass/Fail
ED1 Data In			Pass/Fail
ED1 $\overline{\text{Data}}$ In			Pass/Fail
ED2 Data In			Pass/Fail
ED2 $\overline{\text{Data}}$ In			Pass/Fail

E.3 Sampling Scope

Amplitude Accuracy

Table E.3-1 Level Accuracy

Connector	Setting Voltage	Minimum Value	Measured Value	Maximum Value	Measurement Uncertainty	Pass/Fail
Ch A	+200 mV	+186.5 mV	mV	+213.5 mV		Pass/Fail
	-200 mV	-213.5 mV	mV	-186.5 mV		Pass/Fail
Ch B	+200 mV	+186.5 mV	mV	+213.5 mV		Pass/Fail
	-200 mV	-213.5 mV	mV	-186.5 mV		Pass/Fail

E.4 Optical Interface

Optical Power Meter: ± 0.35 dB or less (-12 dBm or more)

Table E.4-1 Accuracy of Optical Power Meter (MP2100A-003, MP2102A-023)

Wavelength	Reading of Optical Power Meter	Average Power(dBm) Measurement Value	Minimum Value	Level Difference	Maximum Value	Pass/Fail
850 nm	dBm	dBm	-0.35 dB	dB	$+0.35$ dB	Pass/Fail
1310 nm	dBm	dBm	-0.35 dB	dB	$+0.35$ dB	Pass/Fail
1550 nm	dBm	dBm	-0.35 dB	dB	$+0.35$ dB	Pass/Fail

Appendix F Bibliography

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http://dl.cdn-anritsu.com/en-au/test-measurement/files/Manuals/Quick-Reference-Guide/MP2100A_ET2100.pdf

References are to page numbers.

Symbol and Numbers

0

0 Level1-14

1

1 Level1-14
1/16 Clk5-14
10MHz5-14
1310 nm SFP+A-65
1310 nm XFPA-59
1550 nm XFPA-61

8

850 nm SFP+A-63
850 nm XFPA-57

A

Abbreviation1-25
About Eco label.....xv
Accumulation Type.....7-33
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