### 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**

Document No.: M-W3349AE-15.0

# Safety Symbols

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

#### Symbols used in manual



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



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



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)

30 November 2015 (15th Edition)

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

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- 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.
- 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.

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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.

thoroughly.

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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

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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.

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.



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.

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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.

Laser Safety

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

		-				
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]

Table 1	Laser Safety	<b>Classifications</b> I	Based on IEC 60825-1:2007
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\*: Indicates the possible optical output power when each and every reasonably foreseeable single-fault condition is included.

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

#### Table 2 Specifications of Laser Built into MP2100A/MP2101A

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

			– For Safety –		
			Table3 Labels on Product		
		Туре	Label	Affixed to:	Model Name
					MP2100A + MP2100A-050,
	1	Evolopation	▲ IEC 60825-1:2007	Figure 1 A	MP2100A + MP2100A-051,
	I	Explanation	CLASS 1 LASER PRODUCT	Figure I, A	MP2101A + MP2101A-050,
					MP2101A + MP2101A-051
					MP2100A + MP2100A-050,
	2	Certification	CERTIFICATION LABEL THIS PRODUCT CONFORMS TO ALL APPLICABLE STANDARDS UNDER 21 CFR 1040.10	Figure 1, B	MP2100A + MP2100A-051,
,	2				MP2101A + MP2101A-050,
					MP2101A + MP2101A-051
		3 Identification	IDENTIFICATION LABEL ANRITSU CORP. 5-1-1,0NNA,ATSUGI-SHI		MP2100A + MP2100A-050,
					MP2100A + MP2100A-051,
3	3		KANAGAWA 243-8555,JAPAN Manufactured At:tohoku Anritsu Co., Ltd Koriyama Plant,	Figure 1, C	MP2101A + MP2101A-050,
					MP2101A + MP2101A-051



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<ul> <li>Replacing Memory Back-up Battery</li> <li>This equipment uses a Poly-cardoon fluoride lithium battery to backup the memory. This battery must be replaced by service personnel when i has reached the end of its useful life; contact the Anritsu sales sectior or your nearest representative.</li> <li>Note: The battery used in this equipment has a maximum useful life of 4 years. It should be replaced before this period has elapsed.</li> <li>External Storage Media</li> <li>This equipment uses USB memory devices as external storage media for storing data and programs.</li> <li>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.</li> <li>Anritsu will not be held responsible for lost data.</li> <li>Pay careful attention to the following points.</li> <li>Never remove the USB memory device from the instrument while it is being accessed.</li> <li>The USB memory device may be damaged by static electric charges.</li> <li>Anritsu has thoroughly tested all external storage media such as USE memory, Hard disk drive and DVD drive. Users should note that external storage media may not have been tested by Anritsu, thus Anritsu canno guarantee the performance or suitability of such media.</li> </ul>	
4 years. It should be replaced before this period has elapsed.         External       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 USE memory, Hard disk drive and DVD drive. Users should note that external storage media may not have been tested by Anritsu, thus Anritsu canno	 the memory. This battery must be replaced by service personnel when i has reached the end of its useful life; contact the Anritsu sales section
<ul> <li>Storage Media for storing data and programs.</li> <li>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.</li> <li><u>Anritsu will not be held responsible for lost data.</u></li> <li>Pay careful attention to the following points.</li> <li>Never remove the USB memory device from the instrument while it is being accessed.</li> <li>The USB memory device may be damaged by static electric charges.</li> <li>Anritsu has thoroughly tested all external storage media such as USE memory, Hard disk drive and DVD drive. Users should note that external storage media may not have been tested by Anritsu, thus Anritsu cannot be and the programs and the programs.</li> </ul>	
<ul> <li>Iost. To prevent this chance occurrence, all important data and programs should be backed-up.</li> <li>Anritsu will not be held responsible for lost data.</li> <li>Pay careful attention to the following points.</li> <li>Never remove the USB memory device from the instrument while it is being accessed.</li> <li>The USB memory device may be damaged by static electric charges.</li> <li>Anritsu has thoroughly tested all external storage media such as USE memory, Hard disk drive and DVD drive. Users should note that external storage media may not have been tested by Anritsu, thus Anritsu cannot and the programmetic charge media may not have been tested by Anritsu, thus Anritsu cannot be be</li></ul>	
<ul> <li>Pay careful attention to the following points.</li> <li>Never remove the USB memory device from the instrument while it is being accessed.</li> <li>The USB memory device may be damaged by static electric charges.</li> <li>Anritsu has thoroughly tested all external storage media such as USE memory, Hard disk drive and DVD drive. Users should note that external storage media may not have been tested by Anritsu, thus Anritsu cannot a storage media may not have been tested by Anritsu.</li> </ul>	lost. To prevent this chance occurrence, all important data and
<ul> <li>Never remove the USB memory device from the instrument while it is being accessed.</li> <li>The USB memory device may be damaged by static electric charges.</li> <li>Anritsu has thoroughly tested all external storage media such as USE memory, Hard disk drive and DVD drive. Users should note that external storage media may not have been tested by Anritsu, thus Anritsu cannot a storage media may not have been tested by Anritsu.</li> </ul>	Anritsu will not be held responsible for lost data.
memory, Hard disk drive and DVD drive. Users should note that externa storage media may not have been tested by Anritsu, thus Anritsu cannot	<ul> <li>Never remove the USB memory device from the instrument while it is being accessed.</li> <li>The USB memory device may be damaged by static electric charges.</li> </ul>
	memory, Hard disk drive and DVD drive. Users should note that externa storage media may not have been tested by Anritsu, thus Anritsu cannot

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

place.

- 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

### **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

# CE

#### 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)	В
IEC 61000-4-3 (EMF)	А
IEC 61000-4-4 (Burst)	В
IEC 61000-4-5 (Surge)	В
IEC 61000-4-6 (CRF)	А
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:



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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### VIII.

# Chapter 1 Outline

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

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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	$\checkmark$	$\checkmark$	$\checkmark$
MP2101A	BERTWave PE	$\checkmark$	$\checkmark$	_
MP2102A	BERTWave SS	_	_	$\checkmark$

#### 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.

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
	Scope	One optical interface and one electrical interface of reception parts of SS
MP2100A-030/130	GPIB	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* <sup>2,*6</sup>	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

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#### Chapter 1 Outline

<b>Option Number</b>	Name	Description
MP2100A-066*2,*6	1 High Bit Rate/1 to 2 Low Bit Rate Filter Bank	
MP2100A-067* <sup>2,*6</sup>	1 to 2 High Bit Rate/3 to 4 Low Bit Rate Filter Bank	
MP2100A-068* <sup>2,*6</sup>	2 to 3 High Bit Rate/1 to 2 Low Bit Rate Filter Bank	
MP2100A-069* <sub>2,*6</sub>	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,
MP2100A-077/177*2,*8	LPF for 2.5G (H)	066-069
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.

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	

Table 1.1.2-2	MP2101A	<b>Option List</b>
---------------	---------	--------------------

\*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.

<b>Option Number</b>	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* <sup>2,*4</sup>	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
## 1.1 Introduction of BERTWave Series

<b>Option Number</b>	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
MP2102A-077/177*2,*6	LPF for 2.5G (H)	and 066 to 069
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	

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

- \*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.

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)	

Table 1.1.3-1 Optional Accessories

# **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.

Item	Specifications		
Transmission rate	9.95328 Gbit/s ±20 ppm (10GBASE-LR) 10.3125 Gbit/s ±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)		

Table 1.3-1 Transmitter Optical Output



Figure 1.3-2 Definition of Eye Mask Pattern

## Chapter 1 Outline

Item	Specifications	
Transmission rate	9.95328 Gbit/s ±100 ppm (10GBASE-LR) 10.3125 Gbit/s ±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)	

Table 1.3-2 Receiver Optical Interface

\*1: Bit error rate: 10<sup>-12</sup> 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.



MP2100A-003,005 BERTWave

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, Vp-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<sup>n</sup>-1, n is called the number of the PRBS. Using the BERTWave, n can be set to 7, 9, 15, 23, and 31.

······································				
n	2 <sup>n</sup> -1	Remarks		
7	127			
9	511			
15	32767			
23	8388607			
31	2147483647			

Table 1.4.1-1 PRBS Bit Length

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  $2\sqrt{2}$ . Vrms 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 Level–0 Level)/(\sigma_1 + \sigma_0)
\sigma_1: 1 Level Standard Deviation
\sigma_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.

Crossing = (crossing point level-0 Level)/(1 Level-0 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.

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

- $\sigma_1$ : 1 Level Standard Deviation
- $\sigma_0$ : 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

## Chapter 1 Outline

#### 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.

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
- $\sigma_1$ : Standard deviation of first crossing point
- $\sigma_2$ : 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.

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

$$DCD = (t_2 - t_1)/Bp \times 100$$
 (%)

Where,

$\mathbf{t}_1$ :	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

Bp: 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 Bite 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.

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

### Chapter 1 Outline



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 Appreviation			
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		
СН	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

# Chapter 1 Overview

Table 1.4.2-1 Abbreviation (Cont'd)			
Abbreviation	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		
ТХ	Transmitter		
UI	Unit Interval		
VECP	Vertical Eye Closure Penalty		
WAN	Wide Area Network		
XFP	10 Gigabit Small Form-factor Pluggable		

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	BERTWave		
	MP2101A	BERTWave PE	1	
	MP2102A	BERTWave SS		
Accessories		Power Cord	1	Packed in
	MX210000A	BERTWave Control Software (CD-ROM)	1	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

#### 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

# 

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.



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

Before Use



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

### Chapter 2 Before Use



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

Before Use

# 2.2.2 Rear Panel



Figure 2.2.2-1 Rear Panel

- \*1: Only MP2100A and MP2101A
- \*2: When installing Option 030 or Option 130

## Chapter 2 Before Use

# 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.



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.



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.



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.











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.

# 

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.

## Chapter 2 Before Use



# 

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.



# 

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.





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

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



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.



- 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.



- 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

## 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

## 

• 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.

## 

- 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.

Before Use

### 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

- Connect the power cord plug, referring to Section 2.3 "Power Connection".
   The BERTWave enters the standby state and the power switch lamp
- 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.

lights orange.

1 MIC/1000000 00 121 Weye Gandral Salteane	the second s	
	Welcome to MX210000A	
	Main application is started automatically in Main application	15 Seconds.
	्रम् Setup utility	
	[초] Exit	
	📼 Shut down	
	Shut down	

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 scr	een buttons execute the following processing:
[Main Applicatio	<ul> <li>on]: Displays the application screen where you can configure settings for the PPG, ED, sampling scope, and optical interface and view the measurement results.</li> <li>For details on how to use the screen, refer to the following chapters:</li> <li>Chapter 4, Screen Operation</li> <li>Chapter 5, Generating Pulse Signal</li> <li>Chapter 6, Measuring Bit Error</li> <li>Chapter 7, Observing Waveform</li> </ul>
	• Chapter 8, Operating Optical Interface
[Setup Utility]:	Displays the setup window where you can configure the
[Exit]:	remote interface, view the configuration and version of the software and update the software. Displays Windows Explorer where you can work with
	files saved by the Main Application.
	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."

2

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.

## 

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

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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.

lcon	Description
P	<ul> <li><u>Date &amp; Time</u></li> <li>Change the date, time and time zone as necessary.</li> <li>Internet Time is set to off at factory shipment. Operation may be affected if this setting is changed.</li> </ul>
	<ul> <li><u>Display</u></li> <li><u>Intel® GMA Driver for Mobile</u></li> <li>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.</li> <li>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.</li> </ul>
4	<ul> <li><u>Power Options</u></li> <li>The setting of the auto monitor off function (<b>Turn off monitor</b>) can be changed.</li> <li>The setting of the power off function for hard disks (<b>Turn off hard disks</b>) is set to <b>Never</b> by default. Do not change the setting.</li> <li>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.</li> </ul>
R	<ul> <li><u>Touch Panel</u></li> <li>This calibrates the touch panel detection point. For details refer to Section 10.6 "Touch Panel Position Calibration".</li> </ul>

			00
Intel <sup>®</sup> Graphics Media Accelerator Driver for mobile	J Notebook		Scheme Options
Display Devices	Color Quality 3	i2 Bit 💌	Rotation
Display Settings	Screen Resolution	280 x 768 💌	• Enable Rotation
Color Correction		i1 Hertz 💌	90 C 🔽 C 270
Hot Keys	Display Expansion Aspect Ratio Opt	ions	© 180
(intel)			Power Settings
Launch Zoom	3D Settings Video Overlay	]	Cancel Apply

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.

Intel° Graphics Media		
Accelerator Driver for mobile	🤳 Notebook	Scheme Options
Display Devices	Single Display • Notebook	C Monitor
Display Settings	- NOICDOOK	
Color Correction	Multiple Display	Primary Device
Hot Keys	Display Clone	
(intel)		Secondary Device
Launch Zoom	3D Settings	
Information	Video Overlay	OK Cancel Apply

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

#### 2.12 Using External Monitor

Intel®			0
Graphics Media Accelerator Driver for mobile	Intebook	J Monitor	Scheme Options
Display Devices	Refresh Rate	60 Hertz 💌	Rotation
Display Settings	Display Expansion	spect Ratio Options	90 🗢 📉 🗢 270
Color Correction			C 180
Hot Keys			
(intel)			
Launch Zoom	3D Settings		
Information	Video Overla	ок	Cancel Apply

- 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].

Confirm the Deskto 🔀
This desktop has been reconfigured. Do you want to keep these settings?
If you do not respond within 15 seconds, these changes will be canceled.
OK Cancel

17. Touch  $\left[\text{MX210000A}\right]$  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.

	ver scheme with the most appropriate Note that changing the settings below cheme.	
Power schemes		
Presentation		~
	Save As	<u>D</u> elete
Settings for Presentation	on power scheme	
Turn off <u>m</u> onitor:	After 5 mins	
Turn off hard disks:	Never	•
System s <u>t</u> andby:	Never	

- 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].



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.

Model Name Serial Number Option Infomation	MP2100A BERT 6200866938 003/005/051/055	
Function Remote Control	Infomation	Update License
	Help	Exit

2. Touch [Remote Control].

The window to set the remote interface is displayed.

#### 2.14.2 To set GPIB

 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.

Remote Control	
Active Interface	GPIB Address 1 I Remote HighSpeed Respose
	Ethernet(Windows) Local Area Connection IP Address 192 168 100 100 Subnet Mask 255 255 0 Gateway Clear
	Local Area Connection 2         IP Address       192       168       100       101         Subnet Mask       255       255       0       0         Gateway       Clear       Image: Clear       Image: Clear       Image: Clear       Image: Clear         Port Number       5001       5001       5001       5001       5001       5001
	Apply

- 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.
- 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

10101

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

	Active Interface Ethernet	GPIB Address 1 I Remote HighSpe	ed Resp	ose		
		Ethernet(Windows)	ion			
-		IP Address	192	168	100	100
	$\searrow$	Subnet Mask	255	255	255	0
		Gateway Clear				
		Local Area Connect	ion 2			
		IP Address	192	168	100	101
		Subnet Mask	255	255	255	0
		Gateway Clear				
		Port Number 500	1			
				Apply		Exit

- 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.
- 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
- 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).

Remote Control						
Active Interface	GPIB					
Ethernet	Address 5					
	Ethernet(Windows)					
	Local Area Connection	on(DHCF	<b>)</b>			
	IP Address	0	0	.0	0	
	Subnet Mask	0	.0	.0	.0	
	Gateway					

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].



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

Internet Protocol (TCP/IP) Prop ? 🔀						
General						
You can get IP settings assigned autor this capability. Otherwise, you need to the appropriate IP settings.						
Obtain an IP address automatical	y .					
<u>I</u> P address:	192.168.100.2					
S <u>u</u> bnet mask:	255 . 255 . 255 . 0					
<u>D</u> efault gateway:	· · ·					
<ul> <li>Obtain DNS server address auton</li> <li>O Use the following DNS server address</li> </ul>						
Preferred DNS server:						
<u>A</u> lternate DNS server:	· · ·					
	Ad <u>v</u> anced					
	OK Cancel					

- 7. Click [Use the following IP Address] or [Obtain an IP address automatically].
- 8. Click the [OK] button.
- 9. 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.



- Use a 50  $\Omega$ /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

## 

- 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.

## 

- 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

On the contrary, disconnect the coaxial cables between external devices and BERTWave before turning off the external devices. Before Use

#### Chapter 2 Before Use



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  $\Omega$ .
- 2. Set the input impedance of the oscilloscope to  $50 \Omega$ .
- 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	$\pm 2 \text{ V}$	1 Vp-p	—	_
MP2101A	1 Vp-p	1 Vp-p	_	_
MP2102A	_	_	$\pm 2 \text{ V}$	$\pm 2 \text{ V}$

### 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.



- 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.



Be sure to connect the ground structure (like frame ground) and the ground terminal with a ground wire.

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  $\Omega$  resistance in series with the DC terminal of the Bias-T to prevent risk of damage.

Chapter 2 Before Use

# 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:

- Connect the DUT input terminal to PPG1 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 Data Out.
- 2. Connect the DUT output terminator to ED1 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 +/-200mV 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 Data In using a coaxial cable.

If only one DUT output connect is conveniently available, connect to ED 1 Data In. Do not connect anything to Data In.



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.
- Connect the Rx Data Out to ED1 Data In using a coaxial cable. Do not connect anything to 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 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  $\overline{Data}$  Out.

Connect the DUT output terminal to ED1 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 Data In (B In).







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.

- Connect the DUT input terminal to PPG1 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 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.



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



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.
## 3.2 Measuring Waveform



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.



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.

## 3.2 Measuring Waveform



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 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 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.



- 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	
4.3	Setting System Menu	
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	

## 4.1 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)

## 4.1 Screen Configuration

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	<ul> <li>The following setting button can be displayed:</li> <li>Device internal signal connection</li> <li>Buzzer</li> <li>Unloading application</li> <li>File operation</li> <li>Saving screen image</li> <li>Setting and unsetting panel lock</li> <li>Confirming system alarm and deleting record</li> <li>Initializing device settings</li> <li>Minimizing screen display</li> </ul>	
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: System: System alarm occurs Remote: Remotely controlled Measure: Measuring bit error rate and obtaining waveform data of sampling scope Output: Signal output to the connector of the PPG and optical transceiver This displays when using the MP2100A/ MP2101A.	
Measurement screen display field	Displays the measurement screen selected at the top menu.	
Date/Time display	Displays date and time set in the BERTWave.	

 Table 4.1-1
 Setting Items on Application Window

4

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

Displayed Dutton	MP2100A		BERTWave Option Number			r
Displayed Button	001	003	005	007	050	051
PPG/ED Ch1	✓	✓	—	✓	—	—
PPG/ED Ch2	_	_	~	_	_	_
XFP	_	_	_	-	✓	_
SFP+	_	_	—	_	_	✓
O/E	_	$\checkmark$	_	$\checkmark$	_	_
EYE/Pulse Scope	~	$\checkmark$	_	~	_	_

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

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 o	n 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.

Displayed Button	Additional software		MP2100A	MP2101A	MP2102A
Jitter	MX210001A	Jitter Analysis Software	~	_	~
Transmission	MX210002A	Transmission Analysis Software	~	_	_

Table 4.1-5 Buttons Displayed on Top Menu (Additional 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

## 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

## Chapter 4 Screen Operation

## 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

4

Saving measurement conditions and measurement results

- 1. Touch [Save] to display the Save panel.
- 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.
- 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.

Close button

ОК

Software 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

 $\label{eq:c:Program Files Anritsu MP2100A MX21000A UserData Result TXT$ 

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

Close button

Reading measurement conditions from file

- 1. Touch [Open] to display the Open panel.
- 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.

# Module

- 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.

## Screen Operation

4

## Saving a screen to the image file

1. Touch [Screen Copy] .

The file selection screen is displayed.

File		X
Drives Loca	I Disk (C:) File Name	01112012_204909671
		File Type JPEG Files Screen Keyboard
Directories		File List
	Log ModuleAppDII SysFile Tmp UserData Mask	01112012_204838265.jpg
	MATLAB	Save to
	–Pattern ⊞ Result	C:\Program Files\Anritsu\MP2100A\MX210000A\User
	Screen Copy Setting	Default Name/Root
Comn Comn	non Files	ок

- 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.
- 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].
- 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
  - $\bullet$ System Alarm
- Touch [Buzzer On] to release the buzzer. The button display changes to [Buzzer Off].

Buzzer Off	Buzzer On
	Buzzor On displ

Buzzer Off display

Buzzer On display



Displaying alarm

- 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.

Alarm	Occurred Time
Power	//::
PG/ED Fatal Temperature	//
PG/ED PLL Unlock	08/19/2010 15:38:36
PG/ED Illegal Mode	//
YE/Pulse Scope Fatal Temperature	//
YE/Pulse Scope Temperature	//
	Auto Popup

## 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.





Minimizing the screen display

- 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

## 4.4 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  $[\blacktriangleright]$  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

System	Remote
Measure	Output

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].

Screen Operation

Chapter 4 Outline

## 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	Setting Restrictions	
5.3	Procedure for Generating Pulse Signal	
5.4	Setting Reference Clock	5-11
5.5	Setting Output Waveform	
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.

ltem	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	$\frac{\text{Sets the signal amplitude voltage output to the}}{\overline{\text{Data}}}$ 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 PPG

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.

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

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  $\overline{Data}$  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:

8 500 000 to 11 320 000 kbit/s

-100 to 100 ppm

-100 to 100 ppm

-100 to  $100 \ \rm ppm$ 

-100 to 100 ppm

-100 to 100 ppm

-100 to 100 ppm

-100 to 100 ppm

0.10 to 0.80 Vp-p

Offset

Offset

Offset

Offset

Variable-1/16

Offset

Variable-1/32

Offset

Variable-1/64

Offset

1GFC 2GFC 4GFC 8GFC

Variable-1/8

Variable-1/4

Variable-1/2

Amplitude

Bit Rate

Variable

## Chapter 5 Generating Pulse Signal

10GFC 10GFC-FEC 1GbE 2GbECPRI 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 1/11/21/41/81/161/321/64 Data/XData Off On Error Addition Off On Repeat 1E-2

5.1 List of Setting Items

1E-31E-41E-51E-61E-71E-81E-91E - 101E-11 1E-12Single 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  $10 \mathrm{~MHz}$ Internal Sync Output PPG1\_1/1 Clk\*3  $PPG1\_1/2\ Clk^{\star_4}$  $\rm PPG1\_1/4~Clk^{*5}$ 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  $\overline{Data}$  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\_1/2 Clk
- PPG2\_1/4 Clk
- PPG2\_1/8 Clk
- PPG2\_1/16 Clk
- PPG2\_1/64 ClkPD2\_Pattern Sync
- ED2\_1/4 Clk
- ED2\_1/8 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  $\pm 10$  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.

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)

Table 5.4-1 Reference CLK Settings

\*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.



Set Sync Output to PPG1\_1/1 Clk.

Figure 5.4-1 Eye Pattern Monitoring

5.4 Setting Reference Clock







Figure 5.4-3 Eye Pattern when Reference Clock is Synchronized

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



#### Chapter 5 Generating Pulse Signal

Figure 5.4-4 Setup for Simultaneous Monitoring of Two Channels

Procedures:

- 1. Touch the screen size change button, and set to [Expand].
- 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.
- 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

# A CAUTION

- The impedance of the Ext Clk In and External 10 MHz Input connectors is 50  $\Omega$ . 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 Data and Data connectors on the front panel.

The PPG\_Ch2 output terminal is the PPG2 Data and  $\overline{Data}$  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.



- The impedance of the Data Out and Data Out connectors is 50  $\Omega$ . 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  $\Omega$ .
- The amplitude of signal output to the Data Out and 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  $\overline{Data}$  and 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 [  $10\ \rm MHz$  ].
- 1. Touch the Bit Rate button.

The window is opened to select the specifications. The number of the displayed buttons varies with the options.



- 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.
- 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.

Specifications	Bit Rate	(kbit/s)
Specifications	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 $5\ 6600\ 000$	$4\ 000\ 000$ 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 $195$ $312$

Table 5.5-1 Bit Rate Specifications and Setting Range

To set amplitude

- 1. Touch the Amplitude text box and set the amplitude voltage.
- 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.



When inserting attenuator at both the Data Out connector and  $\overline{\text{Data}}$  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.

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

Table 5.5-2 Signal Specifications and Amplitude

#### Setting Patterns 5.6

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
$2^{2}-1$	$1 + X^{18} + X^{23}$	8388607	23	22
$2^{31-1}$	$1 + X^{28} + X^{31}$	214748647	31	30

5.6 Setting Patterns

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  $\pm$ 1bit 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.



Set the pattern using the following procedure.

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

Test Pattern	X
PRBS 2^7-1	PRBS 2^9-1
PRBS 2^ 15-1	PRBS 2^23-1
PRBS 2^31-1	Programmable Pattern

- 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.

#### 5.6 Setting Patterns

Programmable Pattern	×
Current Pattern File : Template_128bit_BIN.ppf	
10101010.dat	
11001100.dat	
11110000.dat	
CJTPAT.dat	
CRPAT-10GbE.dat	
CRPAT-FC.dat	
CSPAT.dat	
D21_5.dat	
HFPAT.dat	
JTPAT.dat	
K28_5.dat	
K28_7.dat	
LFPAT.dat	
MFPAT.dat	
RPAT.dat	
SPAT.dat	
Template_128bit_BIN.ppf	ок
Template_512bit_HEX.ppf	OK

- 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

## Chapter 5 Generating Pulse Signal

Product Name	File extension	Pattern	Supported/N ot supported
MU181020A		Data	$\checkmark$
MU181020B		Alternate	√ *
	PTN	Mixed(Data)	$\checkmark$
		Mixed (Alternate)	√ *
		Sequence	$\checkmark$
MP1758A		PRGM 1ch	$\checkmark$
	PTN	PRGM 2ch	$\checkmark$
		PRGM 4ch	$\checkmark$
		PRBS	_
MP1761A		ALT	$\checkmark$
MP1761B	PTN	Data	$\checkmark$
MP1761C		PRBS	—
		Zero-Subst	—
MP1775A MP1776A		PRGM 1ch	$\checkmark$
		PRGM 2ch	$\checkmark$
	PTN	PRGM 4ch	$\checkmark$
		PRBS	—
		Zero-Subst 1ch	—
		Zero-Subst 2ch	_
		Zero-Subst 4ch	
MP1632A MP1632C		PRGM	$\checkmark$
	PTN	Zero-Subst	
		PRBS	_
	PCP	PRGM	$\checkmark$

 Table 5.6-1
 File Compatibility with Previous Product

\*: 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].
- 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 <sup>-3</sup>	[1E-9]: 10 <sup>-9</sup>
$[1E-4]: 10^{-4}$	$[1E-10]$ : $10^{-10}$
$[1E-5]$ : $10^{-5}$	$[1E-11]$ : $10^{-11}$
$[1E-6]: 10^{-6}$	$[1E-12]$ : $10^{-12}$
[1E-7]: 10 <sup>-7</sup>	

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)							
Rale	155520	622080	1250000	2488320	4250000	10000000			
1E-4	64.3 μs	16.1 μs	$8  \mu s$	$4.02 \ \mu s$	$2.35~\mu s$	1 μs			
1E-6	6.43 ms	1.61 ms	$800 \ \mu s$	$402 \ \mu s$	$235~\mu s$	$100 \ \mu s$			
1E-8	643 ms	161 ms	80 ms	40.2  ms	23.5  ms	10 ms			
1E-10	64.3 s	$16.1 \mathrm{~s}$	8 s	$4.02 \mathrm{\ s}$	$2.35~\mathrm{s}$	1 s			
1E-12	$6430 \mathrm{\ s}$	$1608 \ {\rm s}$	$800 \mathrm{s}$	$402 \mathrm{~s}$	$235~{ m s}$	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

5.8 Setting Sync Output



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.

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

Table 5.8-1 Cycle of Sync Output	Table 5.8-1	8-1 Cycle of Sync Output
----------------------------------	-------------	--------------------------



- The impedance of the Sync Out connector is 50  $\Omega$ . 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  $\Omega$ .
- 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.

	Signal Type						
PPG Divide Rate	PPG1_ 1/1 CIK	PPG1_ 1/2 CIK	PPG1_ 1/4 CIK	PPG1_ 1/8 CIK	PPG1_ 1/16 Clk	PPG1_ 1/64 Clk	PPG1_ 1/Pattern Sync
1/1	-	_	—	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$
1/2	_	_	$\checkmark$	_	$\checkmark$	_	$\checkmark$
1/4	-	$\checkmark$	-	_	$\checkmark$	_	$\checkmark$
1/8	$\checkmark$	_	_	_	_	_	$\checkmark$
1/16	$\checkmark$	_	-	_	_	—	$\checkmark$
1/32	$\checkmark$	-	-	_	-	—	$\checkmark$
1/64	$\checkmark$	—	_	_	—	—	$\checkmark$

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

 $\checkmark$ : Can be set

 $\Rightarrow$  Cannot be set

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

	Signal Type		
ED Divide Rate	ED1_ 1/4 CIK	ED1_ 1/8 CIk	ED1_ 1/16 CIK
1/1	_	$\checkmark$	$\checkmark$
1/2	$\checkmark$		$\checkmark$

 $\checkmark$ : Can be set

 $\Rightarrow$  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.

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

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

# 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.

## 5.9 Setting Clock Output

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.

Table 5.9-2 Full Rate Clock Frequency Setting Methods

#### 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
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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.

ltem	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 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
-----------------------------

ltem	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".

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

**Measuring Bit Error** 

*6-3* 

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.

Display W PPG/EDCh 1 PPG ED Main Screen size change Data Input Condition Threshold Electrical 0 mV Electrical 0 mV Fest Pattern Programmable Pattern PRBS 2^15.1 - " POS Data Length 32 767 bits ED Result "Total" Start Time::- ER Stop E EC History Reset CC C CR Unlock E FREO(kHz) SYNC Loss E	Channel		
ED tab Tracking ON Bit Rate / Test Pattern to PPG Bit Rate Variable (8.5-11.326) B500000 kbit/s - 1/1 Rate Data Input Condition Threshold Electrical Data Length 32 767 bits ED Result "Total" PRBS 2^15.1 - "-"" POS Data Length 32 767 bits ED Result "Total" EC ER Stop	Display —	W PPG/EDCh 1	
Tracking       ON       Bit Rate / Test Pattern to PPG       button         Bit Rate       Variable (8.5.11.326)       8500000       kbit/s - 1/1       Rate         Data Input Condition       Threshold       mV       Electrical       0       mV         Electrical       0       mV       External ATT       0       dB         Test Pattern       Programmable Pattern       PRBS 2^15.1       -	-12	PPG ED Main	
(8.5-11.32G) B500000 kbit's -1/1 Rate Data Input Condition Threshold Electrical 0 mV Electrical 0 mV Test Pattern Programmable Pattern PRBS 2^15.1 - "- POS Data Length 32 767 bits ED Result "Total" Start Time:	ED tab		
Threshold         External ATT       0       mV         External ATT       0       dB         Programmable Pattern         PRBS 2^15-1       "       POS         Data Length       32 767 bits         ED Result "Total"         Start Time      :::         ER       History         CC       CR Unlock       Image: Ima		(8.5-11.32G) 8500000 kbit/s - 1/1 Rate	
Electrical   Single-Ended Data   0   mV   External ATT   0   dB   Test Pattern   Programmable Pattern   PRBS 2^15.1   0   Data Length   32 767 bits   ED Result "Total"   Start Time   ER   Start Time   EC   History   Reset   CC   FREQ(kHz)   SYNC Loss			
Programmable Pattern         Programmable Pattern         PRBS 2^15-1       "       POS         Data Length       32 767 bits         ED Result "Total"         Start Time         Stop         EC       History         CC       CR Unlock       CR Unlock         FREQ(kHz)       SYNC Loss       Image: Colspan="2">Colspan="2"		Electrical	
PRBS 2^15.1 _ "" POS Data Length 32 767 bits ED Result "Total" Start Time *:: ER * Stop * EC * History Reset CC * CR Unlock *			
Data Length       32 767 bits         ED Result "Total"		Programmable Pattern	
ED Result "Total" Start Time:: ER Stop EC History Reset CC CR Unlock FREQ(kHz) SYNC Loss		PRBS 2^15-1 _ "" POS	
Start Time    ::       ER    :       EC        History     Reset       CC        FREQ(kHz)     SYNC Loss		Data Length 32 767 bits	
ER  Stop    EC  History Reset    CC  CR Unlock    FREQ(kHz)  SYNC Loss		ED Result "Total"	
EC CC FREQ(kHz) SYNC Loss		Start Time::	
CC CC CR Unlock		ER Stop	
FREQ(kHz) CR Unlock III		History	
		cc	
0% Error		FREQ(kHz) SYNC Loss	
		0% Error	

Figure 6.1-1 ED Setting Panel



Figure 6.1-2 ED Setting Panel (Details)

*6.1* 

**Function List** 



Figure 6.1-3 ED Panel Result Display 2





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-21E-3 1E-4 1E-51E-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  $1 \text{GbE}^{*1}$  $2GbE^{*1}$  $CPRI^{*1}$ CPRI-2\*1CPRI-4\*1 $\text{CPRI-5*}^1$  $CPRI-10*_{1}$ 

**Measuring Bit Error** 

#### Chapter 6 Measuring Bit Error

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  $0C-24^{*1}$ OC-48/STM-16\*1 **OTU-1\***<sup>1</sup> 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

## Chapter 6 Measuring Bit Error

Test	t Pattern
	NEG
	POS
	PRBS2^7-1
	PRBS2^9-1
	PRBS2^15-1
	PRBS2^23-1
	PRBS2^31-1
	Programmable Pattern Programmable Pattern
Tra	cking
114	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

# 6.2 Setting Restrictions

The setting items of the ED have the following restrictions.

#### Bit Rate

The bit rate rage 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.

• OC48/STM-16

- 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
- OBSAIRP3OBSAIRP3×2

• OC24

OTU-1CPRI

• CPRI-2

CPRI-4 CPRI-5

• CPRI-10

- OBSAIRP3×4
- OBSAIRP3×8

## Threshold

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

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#### 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  $\overline{Data}$  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
# <u> CAUTION</u>

The impedance of the electrical input connector is 50  $\Omega$ . 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  $\overline{\text{Data}}$  In connectors.

Do not impress a DC voltage of more than 1 V at the ED2 Data In and  $\overline{\text{Data}}$  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 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 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 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:

Calculated Threshold Voltage = Threshold Voltage  $\times$  10<sup>(attenuation/20)</sup>

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 it differences as it 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.

+B +C +D +E +F +0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +A 0A 0B 0C 0D 0E 0F 1A 1B 1C 1D 1E 1F 2F 2A 2C 2E 2B 2D 3A 3B 3C 3D 3E 3F 4C 4D 4E 4A 4B 4F 5A 5B 5C 5D 5E 5F 0000A0 6B 6C 6D 6F 6A 6E 0000B0 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.

**Measuring Bit Error** 

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  $9.77 \times 10^{-4}$ .

When the bit error rate (Sync Threshold) used to evaluate pattern synchronization is set to 10<sup>-3</sup>, 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 hysterics.

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.

## Chapter 6 Measuring Bit Error

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

#### Setting Conditions for Error Detection *6.4*

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

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

Curre o	Bit Error Rate				
Sync Threshold	Sync Processing Start Level	Sync Processing Stop Level			
1E-2	$2.5  imes 10^{-2}$	$1.56  imes 10^{-2}$			
1E–3	$2.5  imes 10^{-3}$	$1.56 \times 10^{-3}$			
1E-4	$2.5  imes 10^{-4}$	$1.56 \times 10^{-4}$			
1E–5	$2.5  imes 10^{-5}$	$1.56 \times 10^{-5}$			
1E–6	$2.5  imes 10^{-6}$	$1.56 \times 10^{-6}$			
1E-7	$2.5  imes 10^{-7}$	$1.56 \times 10^{-7}$			
1E8	$2.5  imes 10^{-8}$	$1.56 \times 10^{-8}$			

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.
- 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 Data In connector
   [Electrical Single-Ended Data]: Data In connector
   [Electrical Single-Ended XData]: Data In connector
- MP2100A-003+005, MP2100A-007+005, Ch2
   [Differential 50 Ohm ]: Data In and Data In connector
   [Electrical Single-Ended Data]: Data In connector
   [Electrical Single-Ended XData]: 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.



When attenuators are connected to both the Data In and 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:

 Touch the Gating Cycle button and select the measurement method as follows: [Repeat]
 [Single]

[Untimed]

- 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.
- 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  $\overline{Data}$  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  $\overline{Data}$  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

Pattern	Anritsu;MP2100A;01.00;TXT Pattern PRBS2^23-1					
Option (		0.47 E	ad 2010/0			
Start	2009/12/06 11:5	0:47 E	10 2010/0	07/06 16:05:55		
+-	Total	INS	OMI			
ER	2.0000E-08	8.0000E-02	2 1.2000E-	0		
EC	1.0000E+09					
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].
- 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.
- 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.

EYE/Pulse So	cope Setup	×	EYE/Pulse So	ope Setu	Р 🔰	<
General	Utilities		General	Utilities		
Sampling –			Screen Copy			
Sampling Mod	e	Eye	EYE/Pulse Sho	t [	Capture	
Number of San	nples	8191	Inverse backgr color	ound	On	
Accumulation	Туре	Limited	Waveforms on	ly	On	
Limit Type		Time	Label			
Time		10.0 sec	NEW Label		Add	
Samples		10 million	Delete Label		Delete	
Waveforms		100 wfms	Trace Memory			
Averaging		10 wfms	Set Refe	rence	Clear Reference	
Option			Ref. Trace Cha	innel	Ch A & Ch B	
CRU Input ED1 Electrical Single-Ended Data		Maintenance				
Clock Recovery Off		Temperatur Current: 3				
CRU Loop BW		Last Calib	oration: 34.3°C	C		
CRU Lock Continue Scan		Calibra	tion	Application Test		

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.			
	Crock 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 [>8.5G].			
	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.			

### Chapter 7 Observing Waveform

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

## 7.1 EYE/Pulse Scope Screen

r	
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".

## Chapter 7 Observing 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.

EYE/Pulse Scope Amplitude						
Channel Math Off						
Scale Offset	Scale Offset					
Channel A/B T	racking	Off				
-	А		В			
Scale	71.5 m	V/Div	102.9	uW/Div		
Offset	1 m	v	583	u₩		
Attenuation	0 dl	В	0	dB		
Channel A Attenuation Tracks ED1						
Channel Offse	t					
Define Functio	n Ch	IA+C	I B			
Scale	16	58.8 m <sup>1</sup>	//Div			
Offset		0.0 m <sup>3</sup>	V			

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

## 7.1 EYE/Pulse Scope Screen

Item	Description	
Channel Math	<ul> <li>[Off]: Displays waveforms for Channel A and B separately.</li> <li>[On]: Calculates waveforms for Channel A and B, and then that calculated result indicates a channel A</li> </ul>	
Scale Offset	is displayed as Channel A. 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.

acking     Off       aster     PPG1       ecalculate Option     Clock Rate       Clock Rate     1 062 500 KHz       Divide Ratio       X     8       Bit Rate     8 500 000 Kbps       Acquire Clock Rate     Channel A       O.0 pico s	Pulse Sc	ope Time		×	EYE/Pulse Se	cope Time		
racking Off Bits On Screen 50 B aster PPG1 Offset 0.00 U Pattern Length Tracking On Divide Ratio X 8 Bit Rate 8 500 000 Kbps Acquire Clock Rate Offset 0.00 U Pattern Length 32767 b Skew Channel A 0.0 pico s Channel B 0.0 pico s		Scale/Offset			Rate	Scale/Offset		
Bits On Screen 50 B Bits On Screen 50 B Offset 0.00 U Pattern Length Tracking 0n Master PPG1 Divide Ratio X 8 Bit Rate 8 500 000 Kbps Acquire Clock Rate On Channel A 0.0 pico s	ta Clock Ra	ite			Unit		UI	ĺ
Offset     0.00 U       Pattern Length     Pattern Length       Clock Rate     1062 500 KHz       Divide Ratio     Master       X     8       Bit Rate     8 500 000 Kbps       Acquire Clock Rate     Channel A       0.0 pico s	acking		Off		Bits On Scree	n	50	Bits
Clock Rate 1 062 500 KHz Divide Ratio X 8 Bit Rate 8 500 000 Khps Acquire Clock Rate Channel A 0.0 pico s	ister		PPG1		Offset		0.00	UI
Clock Rate 1 062 500 KHz Divide Ratio X 8 Bit Rate 8 500 000 Kbps Acquire Clock Rate Channel A 0.0 pico s Channel B 0.0 pico s	calculate C	ption C	ock Rate		Pattern Leng	th		52
Divide Ratio     Master     PPG1       X     8       Bit Rate     8 500 000 Kbps       Acquire Clock Rate     Channel A     0.0 pico s       Channel B     0.0 pico s	Clask Data	1.052.5	00 KH-		Tracking		On	
×     8       Bit Rate     8 500 000 Kbps       Acquire Clock Rate     Channel A       0.0 pico s       Channel B	CIUCK Rate	1 1 002 0			Master		PPG1	
Bit Rate 8 500 000 Kbps Acquire Clock Rate Channel A 0.0 pico s Channel B 0.0 pico s		×			Length		32767	bits
Acquire Clock Rate     Channel A     0.0 pico s       Channel B     0.0 pico s	Rit Date	8 500 0	00 Khnc		Skew			
	Dit Kate		00 1005		Channel A		0.0 pico	sec
ide Ratio Detect Off		Act	uire Clock Rate		Channel B		0.0 pico	sec
	vide Ratio D	)etect (	Off					

Figure 7.1.2-6 Time Dialog

## 7.1 EYE/Pulse Scope Screen

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 А В Offset А В Scale А В  $On^{*1}$ A/B Attenuation 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 CHAOffset Scale CH B Off On CH B Offset

7.2 Setting Item List

Sca		
Clear Di	splay	
Marker		
Off		
On		
	All Of	ff
	Cente	er
	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)\*<sup>3</sup> Average Power (mW)\*<sup>3</sup> Crossing DCD Extinction Ratio\*<sup>3</sup> Eye Amplitude Eye Height Eye Width Fall Time Jitter p-p

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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 Y2Mask Test Eye Mask Select 10GbE FEC 10GbE LAN 10GbE WAN  $10 \mathrm{GFC}$ 10GFC FEC 1GbE  $1 \mathrm{GFC}$ 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  $\Delta Y$ 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  $1 \mathrm{MHz}$  $2 \mathrm{~MHz}$  $4 \mathrm{~MHz}$ 8 MHz Off CRU Lock Continue Scan Label Delete Label Delete NEW Label Add Maintenance Calibration **Application Test** Number of Sampling  $509^{*5}$  $512^{*6}$  $1021^{*5}$  $1024^{*6}$  $1350^{*5}$  $2039^{*5}$  $2048^{*6}$  $4093^{*5}$  $4096^{*6}$  $8191^{*5}$  $8192^{*6}$ 

7.2 Setting Item List

 $16381^{*5}$  $16384^{*6}$ Sampling Mode Coherent Eye Eye Pulse Screen Copy Eye/Pulse Shot Capture Inverse background color OffOn Waveform Only OffOn 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



	Pattern Length Tracking			
	Off			
	Length			
	$2  ext{ to}$	0 16777216		
	$On^{\star_2}$			
	Master			
	PPO			
		G2*7		
	ED			
	ED	2*7		
	Skew			
	Channel A			
	Channel B Unit			
	Time			
	UI			
	01			
*1:	Only MP2100A-001 and MP2102	A-021 applicable		
*2:	Only MP2100A applicable			
*3:	Only MP2100A-003, MP2100A-0	07 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, 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.

Calibration 🔀		
Ų,	Turn off or disconnect all data and clock input signals. Click Ok to continue.	
	OK Cancel	

5. Touch [OK].

#### Chapter 7 Observing Waveform

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

Cali	ibration 🔀
į	Calibration Failed. Turn off the signal or disconnect all cable from the equipment.
	When the Calibration of CHA and CHB Fails
Calibr	ration
	Onlikentian Eniled Turn off the signal or discomposit only of OUA from the environment
Ų	Calibration Failed. Turn off the signal or disconnect cable of CHA from the equipment.

When the Calibration of CHA Fails

Calibration	
(į)	Calibration Failed. Turn off the signal or disconnect cable of CHB from the equipment.
	OK

When the Calibration of CHB 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), 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), 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 Mode] 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

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## 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, 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, <u>Data</u> 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 form the signal input to Data In (A In) or  $\overline{Data}$  In (B In).

When using the MP2102A with Option 055, the clock can be generated form 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.

Bit Rate = Clock Rate × Divide Rate



- 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.



- 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.

# 

 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].
- 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]: Data In(B In) as input connector [Optical]: O/E Data In as input connector

- 5. Touch [EYE/Pulse Scope].
- 6. Touch [Setup].
- 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].
- 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.
- 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].
- 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.
- 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].
- 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



## 7.7 Setting Data Collection Method

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.
- 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.
   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.

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.
- 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].
- 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

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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 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  $2.5^{\text{th}}$  scale up from the screen center and the 0 level is adjusted to the  $2.5^{\text{th}}$  scale down from the screen center.

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# 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.
- 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.
- 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

- 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].
- 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  $\overline{Data}$  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:

Electrical input:	$10^{\frac{n}{20}}$
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<sup>-</sup>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.

Measurement Method	Eye Mode	Pulse Mode	Coherent Mode
Measurement for amplitude and time	$\checkmark$	_	$\checkmark$
Histogram	$\checkmark$	$\checkmark$	$\checkmark$
Mask test	$\checkmark$	$\checkmark$	$\checkmark$

Table 7.11-1 Measurement Method per Displayed Mode

# 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.

EYE/Pulse Scope Measure	EYE/Pulse Scope Measure		
Active Channel Selection Channel A Measure Item Amplitude/Time	Active Channel Selection Channel A          Measure Item       Amplitude/Time&Mask		
Item Selection	Amp/Time Mask Test		
Add     Delete       1     (Ch. A) Jitter P.P     ↑       2     (Ch. A) Jitter RMS     ↓       3     (Ch. A) Crossing     ↓       4     (Ch. A) Eye Amplitude     ↓       Measure Area Display     Item     1	Add     Delete       1     (Ch. A) Jitter P.P       2     (Ch. A) Jitter RMS       3     (Ch. A) Crossing       4     (Ch. A) Eye Amplitude       Image: Measuring Area Marker     Item       3     Move		
Time	Time		
Rise/Fall Time 20/80%	Rise/Fall Time 20/80%		
Rise/Fall Time Correction Off	Rise/Fall Time Correction Off		
Correction Factor 0.0 ps	Correction Factor 0.0 ps		
EYE Boundary	EYE Boundary		
Offset from Crossing 0.50 UI	Offset from Crossing 0.50 UI		
Width 0.20 UI	Width 0.20 UI		

Figure 7.11.1-1 Setting Example of Amplitude/Time Measurement

Observing Waveform

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.
- Touch [Add] at Item Selection.
   The screen for selecting the measurement items is displayed.
- 6. Touch the measurement item.
- 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.

- 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.

## 7.11 Measuring Waveform



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 *Corre	ected B	N/A		
Eye Amplitude	А	376.25	mV	
Rise Time	А	23.26	pS	
Fall Time	А	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.

- 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  $[\uparrow]$  or  $[\downarrow]$  to move the highlighted items.
- 4. Touch [Move], and then the button display is restored to the normal display.

## To delete items

- 1. Touch  $[\uparrow]$  or  $[\downarrow]$  at Item Selection to highlight the deleting items.
- 2. Touch [Delete] to delete the item form 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.

EYE/Pulse Scope Measure	EYE/Pulse Scope Measure
Active Channel Selection Channel A	Active Channel Selection Channel A
Measure Item Histogram	Measure Item Amplitude/Time&Histogram
	Amp/Time Histogram
Histogram	Histogram
Axis Time Amplitude	Axis Time Amplitude
Histogram Marker Center	Histogram Marker Center
Marker	Marker
X1 0.50 UI	X1 0.83 UI
X2 1.50 UI	X2 0.89 UI
Y1 100 mV	Y1 225 mV
Y2 -100 mV	Y2 147 mV

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.
- 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.

 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. 7



Figure 7.11.2-1 Histogram Measurement Example (Amplitude)



Figure 7.11.2-2 Histogram Measurement Example (Time)

## Chapter 7 Observing Waveform
### 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.

EYE/Pulse Sc	ope Measure	× EYE	/Pulse Sc	ope Measur	e 🗙
Active Channel S	election Channel A	Acti	ve Channel S	election	Channel A
Measure Item	Mask Test	Me	asure Item	Amplitu	ude/Time&Mask
		Amp	/Time	Mask Test	]
General	Enhancement	Gen	ieral	Enhancement	]
Mask Test		- M	ask Area Res	triction	On
Eye Mask Sele	ct 1GFC		Angle		0 degrees
Mask Margin	Test One Shot		Width	í í	0.10 UI
Target Failed	1 samples			,	
Mask Margin	0 %				
Align Method	User Defined				
Alignment Marker	Display Off Center				
X1	1.22 UI				
ΔX	1.00 UI				
Y1 —	338.31 mV				
ΔΥ	673.90 mV				

Figure 7.11.3-1 Setting Example of Mask Test

Observing Waveform

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".

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

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	*

Table 7.11.3-1 Mask List (Cont'd)

\*: This value varies depending on the selected file.

Table 7.11.3-2 Files That Can Be Selected When User Defined Is Selected	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	<b>*</b> 1
HDMI_TP2.txt*3		
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 Extender	*1
XAUI-E Near.txt <sup>*5</sup>		

\*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.
- 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:

 $HitCount = \frac{Hit Ratio \times Total Samples}{Bit On Screen}$ 

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.



- 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,  $\Delta$ X, Y1, and  $\Delta$ Y are initialized.

#### Chapter 7 Observing Waveform

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].
- 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.

+154u 11.2uW/E +98u\ 10 310 672 kbps Max 2.92 U 19.4 ps/div Min 0.92 UI Mask Test - Channel B \*Res GND on Enabled tri Total Samples 1991142 0 **Total Failed Samples Total Waveforms** 243 wfms **Top Mask Failed Samples** 0 1 0 0 Mask Margin 29 % **Center Mask Failed Samples** Hit Count 1 Bottom Mask Failed Sample Current Mask 10GbE Mask for 10GBase-R Standard (10.3125 Gbps)

"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.

Marker				
X1 Off	X2 Off	Y1 Off	Y2 Off	All Off
X1	X2	¥1	¥2	Center

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.

Marker				
X1 On	X2 On	Y1 On	Y2 On	All Off
🕥 X1	X2	¥1	¥2	Center

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,	Sets marker display
Y1 Off/On, Y2 Off/On	
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  $[\uparrow]$  at the left side of [Marker] to switch the marker display.



7.12 Using Marker

Figure 7.12.3-1 Marker Display

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## 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]

Channel Offset	
Define Function	CH A + CH B
Scale	125.0 mV/Div
Offset	0.0 mV

- 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.
- Touch the Ref.Trace Channel button and select the channel to be saved from the following.
   [Ch A & Ch B]
  - [Ch A & C [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.

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## 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.

ile Drives Local Disk (C:) F	ile Name 01112012_204909671
	File Type JPEG Files Screen Keyboard
Directories	File List
– Log – ModuleApp – SysFile – Tmp ⊜ UserData – Mask	oli 01112012_204838265.jpg
MATLAB	Save to
Pattern ⊕ Result	C:\Program Files\Anritsu\MP2100A\MX210000A\User.
Screen C Setting	Default Name/Root
Common Files	

- 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.

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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.

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 4 12 30 50 84 111 65 82 33 18 7 3 0 1 5 6 32 38 49 41 47 38 26 7 1 1 0 3 3 14 44 66 83 83 81 52 35 16 7 1 2 1 0 1 3 24 19 42 48 45 33 18 18 7 0 0 0 0 0 1 1 5 10 15 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 10 31 46 84 97 100 82 50 43 14 4 2 0 0 0 1 1 1 9 16 44 60 58 55 45 26 14 6 1 0 3 4 16 48 55 1 0 0 0 0 0 0 0 0 0 0 0 0 1 4 33 54 110 126 160 144 106 65 39 10 4 1 0 0 0 0 0 0 1 3 6 35 55 80 74 80 70 37 15 9 9 33 78 111 0 0 0 0 0 0 0 0 1 2 7 17 57 63 97 114 126 79 62 25 15 6 0 0 0 0 0 0 0 0 0 0 4 14 22 47 67 82 65 54 32 41 55 89 106 135 0 0 0 0 0 0 0 0 0 2 5 30 46 75 94 128 93 61 44 15 9 0 1 0 0 0 0 0 0 0 0 0 0 2 4 16 35 71 110 113 151 134 156 136 159 135 0 0 0 0 0 0 2 2 9 13 38 69 93 95 64 46 43 12 6 3 0 0 0 0 0 0 0 0 0 0 0 0 0 1 5 8 45 55 122 155 231 206 217 139 117 40 1 0 0 0 0 0 2 1 8 14 25 63 59 51 60 41 24 8 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 4 5 17 14 20 29 15 9 9 3 0 0 0 0 0 0 0 0 0 

Figure 7.16-2 File Example of Screen Data

#### Chapter 7 Observing Waveform

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

#### 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 Eve 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

 **Observing Waveform** 

Figure 7.16-4 File Example of Histogram Measurement Data

#### Chapter 7 Observing Waveform

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 CH B 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 .....(waveform 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 0 0 0 0 .....(waveform data)

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 .....(waveform data)

CH B

Figure 7.16-6 File Example of Histogram Measurement Data

#### Chapter 7 Observing Waveform

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 0 0 0.....(waveform data) CH B 0 0 0 0 0 0 0 0 0 0 0 0 0.....(waveform data)

#### Figure 7.16-7 File Example of Mask Measurement Data

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.

# 

- 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:

 $\bullet~$  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

# 

- 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  $\Omega$ . 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  $\Omega$ .

# 8.2 Operating Optical Transceiver

### 8.2.1 Function List

The following items is set and displayed for the optical transceiver.

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.

 Table 8.2.1-1
 Optical Transceiver Setting Items

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)





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".

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 8.2.2-1 XFP

Model Name	Wavelength (nm)	Appropriate Optical Fiber	Bit Rate (kbit/s)
G0238A	850	MMF	10312500
G0239A	1310	SMF	9953280 to 10312500

Table 8.2.2-2 SFP+

## 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.

ltem	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 $= \frac{\text{Conversion Gain}}{\text{Measuerement internal loss} \times \text{Filter Loss}}$
	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.

Table 8.3.1-1 O/E Converter Setting Items

 \*: 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.

※ O/E				
FilterBank				
Filter On/Off	On			
Filter Selection	10GbE LAN/PHY " (10.3125G)			
Conversion Gain/Responsivity				
Wavelength	1550nm			
Conversion Gain	422 V/W			
System Conversion Gain	332 V/W			
Responsivity	0.922 A/W			
Calibration	Exectue			
L Input Power	-7.00 dBm			
Extinction Ratio Correction				
	Off			
Correction Factor	).00 %			
Maintenance				
O/E Calibration	Calibrate Module			

Figure 8.3.1-1 O/E Setting Panel

**Operating Optical Interface** 

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 nm850 nm User **Conversion** Gain 1 to 9999 V/W System Conversion Gain 1 to  $7404^{\ast_8}\,\text{V/W}$ 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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**Performance Test** 

# 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)



Connect a 50  $\Omega$  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.

Product Name	Required Performance		Recommended Equipment
Sampling oscilloscope	Electrical interface Bandwidth: 20 GH	Iz or more	MP2100A or MP2102A (Anritsu)
Frequency counter		IHz to 20 GHz om max.	MF2412C (Anritsu)

Table 9.1.1-1 Equipment for Performance Test

# 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].
- Select [Variable] at Bit Rate and input 11320000 kbit/s.
   When Option 090 is added, input12500000 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±113.2 kHz When the Option 090 is installed: 12500000±125 kHz

- 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:	$8500000{\pm}85~\mathrm{kHz}$
With Option 090:	$8000000\pm80 \text{ kHz}$



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 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 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.

Product Name	Required Performance		Recommended Equipment
Pulse Pattern Generator	Bit rate: Amplitude:	4.25 to 11.32 Gbit/s 0.1 to 0.8 V	MP2100A, MP2101A (Anritsu)
E/O Converter	Bit rate: Extinction ratio: VECP 0.5 dB or 1	8.2  dB or more	MP2100A-050, MP2101A-050 (Anritsu)
Variable Optical Attenuator	For single mode Waveform: Insertion loss: Attenuation: Resolution:	1200 to 1600 nm 3 dB or less 0 to 30 dB	8163B+81570A (Keysight Technologies)
	For multi-mode f Waveform: Insertion loss: Attenuation: Resolution:	800 to 900 nm 3 dB or less 0 to 30 dB	8163B+81578A (Keysight Technologies)

Table 9.2.1-1 Equipment for Performance Test

## 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]  $\rightarrow$  [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]  $\rightarrow$  [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
- 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	on:	Electrical Single-Ended Data
Gating Cycle:	Single	
Gating Time:	$10 \mathrm{s}$	
Test Pattern:	PRBS $2^{\prime}$	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 Data Out and ED1 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 Data Out and E/O converter 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 Bate: 10ChE LAN/DHY

Bit Rate 10GbE L	AN/PHY
Data/XData Out:	On
Error Addition:	Off
Reference Clock:	Internal
Offset:	0 ppm
Sync Output:	PPG1_1/16 Clk
Test Pattern:	PRBS 2^31–1, Pos

6.	Set [ED] as follows.		
	Bit Rate:	10GbE L	AN/PHY
	Data Input condition	on:	Optical
	Gating Cycle:	Single	
	Gating Period:	10 s	
	Test Pattern:	PRBS 2^2	31–1, 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]  $\rightarrow$  [Start].

**Performance** Test

#### Chapter 9 Performance Test



11. 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:

- 1. Connect the PPG1 Data Out and Tx Data In connectors using a coaxial cable.
- 2. 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 Data Out and ED1 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.
- 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:	

4.	Set [ED] as follows:		
	Bit Rate:	Variable, 10000000 kbit/s	
	Data Input condition	on: 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 1E-11 and the error count is 1.
- 8. Set [ED] to [Electrical Single-Ended XData] at Data Input condition.
- 9. Connect the PPG1 Data Out connector and ED1 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 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 Data Out connector and the ED2 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.

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)

 Table 9.3.1-1
 Equipment for Performance Test

# 9.3.2 Amplitude Accuracy

#### Procedure:

FIU	Jeuure.			
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 Vp-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 Track	_		
	Scale – A:	50 mV/div		
	Offset – A: Attenuation – A:	0 mV 0 dB		
0		• •		
6.	Touch [Measure], and set as follows: Active Channel Selection: Channel A			
	Measure Item:			
	Histogram – Axis:	Histogram •		
	X1: 0	Ampiltude		
	X2: 2			
	Y1: -250 mV	Į		
	Y2: 250 mV			
7.	Set the Current Lin	mit 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 shield to minus.	conductor of the coaxial cable to plus and the		
10.	Touch [CH A] to set	t 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.

- 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.
- 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.

Product Name	Required Performance		Recommended Equipment
Light source	Wavelength:	850, 1310, 1550 nm	
	Output level ran	Output level range:	
		+3 dBm min.	
	Level accuracy:	$\pm 0.05 \text{ dB}$	
Optical power	Wavelength rang	ge:	
meter		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	For single-mode	fiber	8163B+81570A
attenuator	Wavelength:	1200 to 1600 nm	(Keysight
	Insertion loss:	3 dB max.	Technologies)
	Attenuation:	0 to 30 dB	
	Resolution: 0.1 dB max.		
	For multimode fiber		8163B+81578A
	Attenuation: 800 to 900 nm		(Keysight
	Insertion loss:	3 dB max.	Technologies)
	Attenuation:	0 to 30 dB	
	Resolution:	0.1 dB max.	
Pulse Pattern	Clock frequency:	100 MHz	MG3740A
Generator or	Amplitude:	0.5 Vp-p	(Anritsu)
Signal	-		
Generator			

Table 9.4.1-1 Equipment for O/E Converter Performance Test

## 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 Vp-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.
- 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.

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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



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.

<u> C</u>AUTION

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.



Adapter cleaner

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.



# **10.4 Displaying Software Version**

Confirm the software version using the following procedures.

- 1. Touch [Setup Utility] at the selector screen, and then the Setup Utility screen opens.
- Touch [Information], and then the Information screen is displayed. When the button display is Software, the version of the Windows application software is displayed.

When MX210001A Jitter Analysis Software or MX210002A Transmission Analysis Software is added, its software version is displayed as well.

Infomation					
Model Name Serial Number Option Infomation Version	Serial Number         6200866939           Option Infomation         003/005/051/055/057/090/030				
Model Name	Product Name	Version			
MX210000A	Installer	02.80.01			
	Main application	01.00.01			
	Setup Utility	02.02.01			
	Maintenance	02.02.01			
1					
			Exit		

3. Touch [Software], and then the button display is changed to Firmware/FPGA.

The software version saved in the hardware is displayed. The displayed Module Name varies depending on the model name and options.

## 10.4 Displaying Software Version

Model Name MP2101A BERTWave PE				
Serial Number	620000000			
Option Infomation	012/050/030			
Version	Firmware/FPGA			
Module Name	FileName	Version		
PPG/ED	PPGED.syst	01.00.00		
	PPGED_F.FPGA	01.00.00		
	PPGED_S.FPGA	01.00.00 00.01.00		
Rotary knob	Boot			
	FilterBank_Rotaryknob_A.syst	01.00.00		
	FilterBank_Rotaryknob_B.syst	01.00.00		

### 4. Touch [Exit], and then the software version display screen is closed.

# 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.

Model Name	File Name	Installed Version	New Version
PG/ED	PPGED.syst	02.02.01	02.02.01
	PPGED_F.FPGA	01.00.00	01.00.00
	PPGED_S.FPGA	02.02.01	02.02.01
Filter bank	FilterBank_Rotaryknob_A.syst	01.00.02	01.00.02
	FilterBank_Rotaryknob_B.syst	01.00.02	01.00.02
EYE/Pulse scope	EyePulseScope_C1.syst	T2.121.0	T2.121.0
	EyePulseScope.FPGA	V58.246.0	V58.246.0
Rotary knob	FilterBank_Rotaryknob_A.syst	01.00.02	01.00.02
	FilterBank_Rotaryknob_B.syst	01.00.02	01.00.02
He data Ellar			
Update File:			
			Load Exit

- 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.
- Touch [Touch Panel] twice.
   The property window of the touch panel is displayed.

Touch I	Panel Device I	properties					
Device Settings Advanced Calibration Others Version							
No	Device Device-0	Segment Segment Main	Controller 4/8 Wire				
<	nel device is normal.			Calibration			
		ОК	Cancel	Apply Help			

3. Touch [Calibration]. The screen to input the position is displayed.

#### Chapter 10 Maintenance



- 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

Table A.1-1 Configuration

Product Name	
—Main Frame—	
BERTWave	
—Standard Accessories—	
Power cord	1
Terminator	$2^{*_{3}}$
Open (Coaxial connect cover)	$5^{*1,*3}$
Coaxial adapter (K-P, K-J, SMA compatible)	$4^{ullet 2,oldsymbol{\star}3} \ 2^{ullet 1} \ 1^{ullet 2}$
BERTWave Control Software	1
(CD-ROM, including Operation Manual)	
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	
	<ul> <li>Main Frame—</li> <li>BERTWave</li> <li>Standard Accessories—</li> <li>Power cord</li> <li>Terminator</li> <li>Open (Coaxial connect cover)</li> <li>Coaxial adapter (K-P, K-J, SMA compatible)</li> <li>BERTWave Control Software</li> <li>(CD-ROM, including Operation Manual)</li> <li>—Options—</li> <li>Dual Electrical Receiver</li> <li>Optical/Single-ended Electrical Receiver</li> <li>Extended PPG/ED Channel</li> <li>1ch BERT and Optical/Single-ended Electrical Scope</li> <li>GPIB</li> <li>FC connector</li> <li>ST connector</li> <li>DIN47256 connector</li> <li>SC connector</li> <li>XFP slot</li> </ul>

\*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.

Appendix

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)

Table A.1-1 Configuration (Cont'd)

- \*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.

<sup>\*8:</sup> Clock recovery to analyze Ch B waveform is not available for Option 007.

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* <sup>5,*11</sup>	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

Table A.1-1 Configuration (Cont'd)

\*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.

ltem		Specifications				
Bit Rate	Standard Name Variable	Bit rate (kbit/s) 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 $\times 2$	5000000				
	Infiniband $\times 4$	10000000				

Table A.1-2	Pulse	Pattern	Generator
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\*1: Option 090 only

ltem		Specifications			
Bit Rate (Cont'd)	Standard Nam	e 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-6	4 9953280			
	G.975 FEC	10664228			
	OTU-2	10709225			
	CPRI	614400			
	$CPRI \times 2$	1228800			
	$CPRI \times 4$	2457600			
	$\text{CPRI} \times 5^{\star_1}$	3072000			
	$CPRI \times 10^{*1}$	6144000			
	$OBSAI^{*1}$	768000			
	$OBSAI \times 2^{*1}$	1536000			
	$OBSAI \times 4^{*1}$	3072000			
	$\text{OBSAI} \times 8^{\star_1}$	6144000			
Internal reference clock accuracy	±10 ppm* <sub>2,*4</sub>				
Bit rate offset	±100 ppm*3				
External 10 MHz input <sup>*3</sup>	Connector: Termination: Amplitude: Waveform:	BNC jack 50 Ω, AC coupling 0.7 to 2 Vp-p Square or sine wave			
External reference clock input	Connector: Termination: Amplitude: Waveform:	SMA jack 50 Ω, AC coupling 0.2 to 1.5 Vp-p Square or sine wave			

Table A.1-2	Pulse Pattern Generator (Cont'd)
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\*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

ltem	Specifications										
Sync output	Frequency:										
	Sync signal	Sync signal         Pulse Pattern Generator         Error Detector									
	source		_	-							
	Divide ratio	1/1	1/2	1/4	1/8	1/16	1/64	Pattern	1/4	1/8	1/16
	Bit rate							Sync.			
	Divide ratio							✓			
	Rate 1/64 Rate 1/32	✓ ✓						✓ ✓			
	Rate 1/32 Rate 1/16	• ✓						✓ ✓			
	Rate 1/8	$\checkmark$						√			
	Rate 1/4		√			~		✓			
	Rate 1/2			~		$\checkmark$		$\checkmark$	$\checkmark$		$\checkmark$
	Rate 1/1				$\checkmark$	$\checkmark$	~	$\checkmark$		$\checkmark$	$\checkmark$
Data output	Termination Low level (Vo High level (V	<sub>DL</sub> ): -			V						
Data output	MP2	( hann 2100A 2100A	0.4 Vp els: A-001,1 A-001+	-p*5 MP210 005, N				-007: 1 5, MP21	100A-	007+0	005: 2
Data output	Number of C MP2 MP2 Connector:	) hann 2100A 2100A 5	0.4 Vp els: A-001,1 A-001+ SMA j;	<sup>-</sup> p* <sup>5</sup> MP210 005, N ack	MP210	00A-00	)3+00	5, MP21	100A-	007+0	005: 2
Data output	Number of C MP2 MP2	( hann 2100A 2100A 5 (	0.4 Vp els: A-001,1 A-001+ SMA j: 0.1 to (	<sup>-</sup> p* <sup>5</sup> MP210 005, N ack 0.8 Vp	MP21( 	00A-00 0 mV r	)3+00 esolut	5, MP21 tion			005: 2
Data output	Number of C MP2 MP2 Connector:	( hann 2100A 2100A 5 (	0.4 Vp els: A-001,1 A-001+ SMA j;	<sup>-</sup> p* <sup>5</sup> MP210 005, N ack 0.8 Vp	MP21( 	00A-00 0 mV r	)3+00 esolut	5, MP21			005: 2
Data output	Number of C MP2 MP2 Connector:	( hann 2100A 2100A 5 ( (	0.4 Vp els: A-001,1 A-001+ SMA j: 0.1 to (	-p*5 MP210 005, N ack 0.8 Vp acy:	МР21( -р, 10	00A-00 0 mV r ±20 n	)3+00 esolut 1V ±20	5, MP21 tion			005: 2
Data output	Number of C MP2 MP2 Connector:	( hann 2100 2100 5 ( 1 2 100 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	0.4 Vp els: A-001,J A-001+ SMA j: 0.1 to 0 Accura	-p*5 MP210 005, N ack 0.8 Vp acy: ve disp	MP210 p, 10 play*6	00A-00 0 mV r ±20 n :	)3+00 esolut 1V ±20	5, MP21 tion 0% for s			005: 2
Data output	Number of C MP2 MP2 Connector: Amplitude:	( hann 2100A 2100A ( ( 1 1 1 2 1 2 1 1 1 1 1 1 1 1 1 1 1 1	0.4 Vp els: A-001,1 A-001+ SMA j: D.1 to 0 Accura Relativ	-p*5 MP210 005, N ack 0.8 Vp acy: ve disp	MP210 p, 10 play* <sup>6</sup> , 50 Ω	00A-00 0 mV r ±20 n :	)3+00 esolut 1V ±20	5, MP21 tion 0% for s			005: 2
Data output	Number of C MP2 MP2 Connector: Amplitude: Termination	( hann 2100A 2100A ( ( 2 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	0.4 Vp els: A-001,1 A-001+ SMA j: D.1 to 0 Accura Relativ	-p*5 MP210 005, N ack 0.8 Vp acy: ve disp apling 25	MP210 p, 10 play* <sup>6</sup> , 50 Ω	00A-00 0 mV r ±20 n :	)3+00 esolut 1V ±20	5, MP21 tion 0% for s			005: 2

Table A.1-2         Pulse Pattern Generator (Cor	ıt'd)
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\*5: Typical values

\*6: Multiplexing values by amplitude and external attenuation factor

\*7: Time changing between 20% to 80% amplitude

ltem		Specifications	
Full Rate Clock	Standard Accessory	J1341A Open (coaxial connector cover) 1	
Output (MP2100A-052/152)	Bit rate		
	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	
	Number of outputs		
	Amplitude: 30	00 to 750 mVp-p	
	Duty: 50% ±15%		
	Rise/Fall time (20 t	-	
	v	ps rms <sup>*5,*8,*9</sup>	
		ps rms* <sup>5,*8,*10</sup>	
	Connector: SMA jack		
		) Ω, AC coupling	
	0	$PG1^{*11}$ , ED1, $PPG2^{*12}$ , $*13$ , ED2 $^{*12}$	
	Alarm: P	LL Unlock detection	

Table A.1-2 Pulse Pattern Generator (Cont'd)

\*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.

ltem	Specifications				
External attenuation factor	0 to 30 dB, 1 dB resolutio	on			
Error insertion	Insertion method:	Single, Repeat			
	Error rate:	1E–n (n: 2 to 12)			
Test pattern	Logic invertible Programmable Pattern:	attern: -1, 2^9–1, 2^15–1, 2^23–1, 2^31–1 1305600 bit, editable by text editor and sample			

Table A.1-2 Pulse Pattern Generator (Cont'd)

ltem	Specification				
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			
	$1 \mathrm{GFC}^{*1}$	1062500			
	$2 \mathrm{GFC}^{*1}$	2125000			
	4GFC	4250000			
	8GFC	8500000			
	10GFC	10518750			
	10GFC FEC	11316800			
	$1 \text{GbE}^{*1}$	1250000			
	$2  ext{GbE}^{*1}$	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			

Table A.1-3 Error Detector

\*1: Option 090 only

ltem		Specification		
Bit rate (Cont'd)	Standard name	Bit rate (kbit/s)		
	OTU-1	2666057		
	OC-192/STM-64	9953280		
	G.975 FEC	10664228		
	OTU-2	10709225		
	$\text{CPRI} \times 2^{*1}$	1228800		
	$\text{CPRI} \times 4^{*1}$	2457600		
	$\text{CPRI} \times 5^{\star_1}$	3072000		
	$\mathrm{CPRI}\times 10^{\boldsymbol{\star}1}$	6144000		
	OBSAI*1	768000		
	$\text{OBSAI} \times 2^{*_1}$	1536000		
	$OBSAI \times 4^{*1}$	3072000		
	$\text{OBSAI} \times 8^{\star_1}$	6144000		
Offset tolerance	±100 ppm*2			
Internal reference clock accuracy	±10 ppm*3			
External 10 MHz	Connector:	BNC		
${ t input}^{ullet 4}$	Termination:	AC coupling, 50 $\Omega$		
	Amplitude:	0.7 to 2 Vp-p		
	Waveform:	Square or sine wave		
Test pattern	Pseudorandom Pattern len Logic invert	gth: 2^7-1, 2^9-1, 2^15-1, 2^23-1, 2^31-1		
	Programmable Pattern: Pattern length: 2 to 1305600 bits, editable by text editor and sample file available			

Table A.1-3 Error Detector (Cont'd)

\*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

	ltem	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 <sup>*5</sup>	Connector:K jackTermination:Single-end, differential*6Data format:NRZ, mark ratio 50%Amplitude:0.1 to 0.8 Vp-p*7,*80.25 to 0.8 Vp-p*7,*9Coupling method:DC coupling, termination voltage 0 VConsecutive identical digit immunity:72 bits or more*10		
	Optical input <sup>*11</sup>	Data format:NRZ, Mark rate 50%Sensitivity:-9 dBm*12,*13		
Thresho	ld value*14	-85 to 85 mV, 1 mV resolution* <sup>15</sup>		
Externa factor	l attenuation	0 to 30 dB, 1 dB resolution		

 Table A.1-3
 Error Detector (Cont'd)

\*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  $\overline{\text{Data}}$  In connector is not installed.

- \*6: MP2100A-001 ED1 and MP2100A-005 ED2 only
- \*7: The pattern without option 005: PRBS 2^31-1 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 2^31–1, Mark rate: 50%, 20 to 30°C Appendix A

\*13: The displayed threshold value is the value corrected by the external attenuation factor.

The calculation formula is as follows:

Maximum value =  $85 \times 10^{\circ}$  (factor /20)

Minimum value =  $-85 \times 10^{\circ}$  (factor/20)

Resolution =  $1.0 \times 10^{\circ}$  (factor/20)

\*14: Termination: Single, at 0 dB external attenuation factor

Item	Specification			
Measurement	Alarm Indicator: Pattern asynchronous (Sync loss),			
function	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* <sup>16</sup>			
	Measurement method			
	Measurement time: 1 seconds to 9 days 23 hours 59 minutes 59			
	seconds			
	Measurement frequency: single, repeat, untimed			
	Display update interval* <sup>17</sup> : 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			

Table A.1-3 Error Detector (Cont'd)

\*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.

Appendix A

ltem	Specifications		
Jitter resistance <sup>*19</sup>	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	
	UI 15.2 0.17 0.17 0.05 0.01E-3 2E-3 17.9E-3 0.4 Mo	4 8 27.2 80 MHz	

Table A.1-3 Error Detector (Cont'd)

\*19: When inputting 9.95328 Gbit/s, pattern is set to PRBS 2^31–1, and single-end and amplitude are set to 0.1 Vp-p.

ltem	Specifications			
ED High Sensitivity	Jitter specifications <sup>*20</sup>			
(MP2100A-091/191)	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		
		- *91		
	EYE mask specification	S <sup>*21</sup>		
	Received voltage			
	Y			
		1-X	1 Time (UI)	
	0 0			
	-Y			
	X: (UI)			
	10.3125 Gbps:	0.325		
	4.25 Gbps:	0.1625		
	2.125 Gbps:	0.1625		
	Y: (mV)			
	Bit Rate	CH1	CH2	
	10.3125 Gbps	50	25	
	4.25 Gbps	50	25	
	2.125 Gbps	50	25	

Table A.1-3 Error Detector (Cont'd)

- \*20: Specified under following conditions; design warranted at 20 to  $30^{\circ}$ 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  $\leq 10^{-12}$

e pattern
test
-

Table A.1-4 Sampling Scope

\*1: Processing can be performed for the NRZ waveform.

Item	Specifications	
Horizontal system	Clock Trigger Input	
	Connector: SMA jack	
	Termination: $50 \Omega$	
	Frequency: 0.1 to 12.5 GHz	
	Sensitivity: 100 mVp-p*2	
	Absolute maximum input: 2 Vp-p*3	
	Jitter, RMS: 5 to 12.5 GHz: 1.35 ps max., 0.85 ps*2	
	1 to 5 GHz: 1 ps <sup>*2</sup>	
	0.1 to 1 GHz: 2 $ps^{*2}$	
	Scale	
	Eye pattern display: 1 UI or more at full scale	
	Pulse pattern display: 1 bit or more at full scale	
Vertical system	Electrical input	
	Input connector: K	
	Termination: $50 \Omega$	
	CH_A input: common for ED_1 Data In input	
	CH_B input: common for ED_1 $\overline{\text{Data}}$ In input <sup>*4</sup>	
	Absolute maximum input $\pm 2 \text{ V}^{*3}$	
	Input range	
	Offset: ±500 mV max.	
	Dynamic range: ±400 mV max.	
	Bandwidth (–3 dB): DC to 20 GHz min.	
	DC to $25 \text{ GHz}^{*2}$	
	Flatness: ±1 dB*2	
	RMS noise: 3.5 mV max.	
	$2 \text{ mV*}^2$	

Table A.1-4 Sampling Scope (Cont'd)

\*2: Typical values

- \*3: Design guaranteed
- \*4: MP2100A-001 only

ltem	Specifications
<b>Item</b> Vertical system	Specifications Amplitude accuracy*5 ±amplitude accuracy ±2% for reading value*6 The following figure shows the amplitude accuracy after calibration. 25 5 cale=200 mV/ 5 cale=200 mV/ 5 cale=200 mV/ 5 cale=200 mV/ 9 scale=200 mV/ 10 5 cale=200 mV/ 10 10 10 10 10 10 10 10 10 10
	0 50 100 150 200 250 300 350 400 Differences at Offset Values (mV)

Table A.1-4 Sampling Scope (Cont'd)

- \*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:

 $200 \times 2\% + 8 = 12$  ±12 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:

 $200 \times 2\% + 11 = 15 \pm 15 \text{ mV}$ 

ltem	Specifications			
Vertical system	Optical input*7			
	Connector	FC*8, SC*9		
	Suitable fiber	Suitable fiber multi-mode fiber $(62.5 \ \mu m)^{*10}$		
	Wavelength range	750 to 1650 nm		
	Bandwidth*11	DC to 9.0 GHz		
	Conversion efficiency	850 nm: 0.25 A/V	$V^{*2}$	
		1310 nm: 0.475 A/		
		1550 nm: 0.45 A/V		
	Conversion gain	850 nm: 112.5 V/		
		1310 nm: 210 V/W 1550 nm: 200 V/W		
	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 C	ption 086	3.4	2.0
	MP2100A-007 (Unit: µWrms)			
	Wavelength		850 nm	1310, 1550 nm
	When using a filter of C	ption 070 to 073	3.1	1.8
	When using a filter of C	ption 076 to 080	2.7	1.5
	When using a filter of C	ption 081 to 083	3.9	2.2
	When using a filter of C	ption 084 or 085	4.8	2.8
	When using a filter of C	ption 086	2.5	1.4

Table A.1-4 Sampling Scope (Cont'd)

- \*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

Item	Specifications	i		
Vertical system (Cont'd)	Optical input (Cont'd) Sensitivity <sup>*2,*12</sup>			
	Option	MP2100A-003	MP2100A-007	
	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* <sup>13</sup> : Average power –1 dBm (794 µW)			
	Peak power +2 dBm (1.58 mW)			
	Absolute maximum power: Peak pow	wer +5 dBm (3.	16 mW)	
	Optical power measurement: Range –	18 to 0 dBm		
	Accuracy:	$\pm 0.35 \text{ dB*}{}_2 - 12$	2 dBm or more	
		$\pm 0.6 \text{ dB}^{*2} \text{ less}$	than –12 dBm	
	Optical return loss $-30 \text{ dB}^{*2}$			
Digital system	Sampling speed: 100 ksa/second*2			

Table A.1-4	Sampling Scope (Cont'd)
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\*12: Mask test available range

\*13: Level deteriorating linearity

ltem		Specifications			
Clock Recovery (MP2100A-055)	Standard access J1341A Open	sory (Coaxial connector cover) 1			
	Data input				
	Connector:	common for Ch A and Ch $B^{*14}$			
	Clock output				
	Connector:	SMA jack			
	Termination:	AC coupling, 50 S	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 <sup>*15</sup> , 10 mUI <sup>*2, *15</sup>		
		0.1 to 2.7 GHz:	5 mUI or less		
	Loop bandwidth: 8.5 to 12.5 GHz Band:				
		1, 2, 4, 8 MHz* <sup>2</sup>			
		0.1 to 2.7 GHz Band			
		2488.32 MHz:	$200 \text{ kHz}^{\star_2}$		
		622 MHz:	$50 \text{ kHz}^{*2}$		
		156 MHz:	20 kHz*2		
Filter bank (8.5G/10G/10.5G)	3 dB cutoff frequ 8.5 Gbit/s: 6.3	quency 3.38 GHz*2 Low-pass filter			
(MP2100A-056)	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:	10.5 Gbit/s: 8.2 GHz* <sup>2</sup>			
	Low-pass filter 10GFC, OC-192/STM-64 FEC (G.975),				
	OTU	J-2, 10GFC FEC,10	OGbE FEC		

Table A.1-4 Sampling Scope (Cont'd)

\*14: When using MP2100A-007, Ch B cannot be used as the data input for Clock Recovery

\*15: Loop bandwidth: 4 MHz

ltem	Specifications		
Filter bank	3 dB cutoff frequency		
(2G/4G/8.5G/10G)	2 Gbit/s: 1.6 GHz* <sup>2</sup> Low-pass filter 2GFC		
(MP2100A-057)	4 Gbit/s: 3.2 GHz* <sup>2</sup> Low-pass filter 4GFC		
	8.5 Gbit/s: 6.38 GHz* <sup>2</sup> Low-pass filter		
	10 Gbit/s: 7.6 GHz* <sup>2</sup>		
	Low-pass filter 10GbE WAN (10GBase-W) &		
	OC-192/STM-64,10GE LAN(10 GBase-R), 8GFC		
High Bit Rate Filter	Filter configuration		
(MP2100A-061)	One of MP2100A-076 to 086 can be installed.		
2 High Bit Rate Filter	Filter configuration		
Bank (MP2100A-062)	Two of MP2100A-076 to 086 can be installed.		
3 to 4 High Bit Rate	Filter configuration		
Filter Bank (MP2100A-063)	Three or four of MP2100A-076 to 086 can be installed.		

Table A.1-4 Sampling Scope (Cont'd)

ltem	Specifications
	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* <sup>2</sup> Low-pass filter for OC-3/STM-1
LPF for 622M (L) (MP2100A-071)	3 dB cutoff frequency 622 Mbit/s: 470 MHz* <sup>2</sup> 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* <sup>2</sup> Low-pass filter for 1GFC
LPF) for 1.2G (L) (MP2100A-073)	3 dB cutoff frequency 1.2 Gbit/s: 940 MHz* <sup>2</sup> 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* <sup>2</sup> Low-pass filter for 2GFC
LPF for 2.5G (H) (MP2100A-077/177)	3 dB cutoff frequency 2.5 Gbit/s: 1.87 GHz* <sup>2</sup> Low-pass filter for CPRI × 4, OC-48/STM-16, 2GbE, Infiniband

Table A.1-4	Sampling S	cope (Cont'd)
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Item	Specifications	
LPF for 2.6G (H)	3 dB cutoff frequency	
(MP2100A-078/178)	2.6 Gbit/s: 2.0 GHz* <sup>2</sup> 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* <sup>2</sup> Low-pass filter for CPRI × 5, 10GBASE-LX4, 10GFC-LX4	
LPF for 4.2G (H)	3 dB cutoff frequency	
(MP2100A-080/180)	4.2 Gbit/s: 3.2 GHz* <sup>2</sup> Low-pass filter for 4GFC	
LPF for 5.0G (H)	3 dB cutoff frequency	
(MP2100A-081/181)	5.0 Gbit/s: 3.75 GHz* <sup>2</sup> Low-pass filter for Infiniband × 2, CPRI × 8	
LPF for 6.2G (H)	3 dB cutoff frequency	
(MP2100A-082/182)	6.2 Gbit/s: 4.61 GHz* <sup>2</sup> Low-pass filter for CPRI × 10, XAUI Optical × 2	
LPF for 8.5G (H)	3 dB cutoff frequency	
(MP2100A-083/183)	8.5 Gbit/s: 6.3GHz*2 Low-pass filter	
LPF for 9.9G to (H)	3 dB cutoff frequency	
10.3G	9.9 to 10.3 Gbit/s: 7.6 GHz* <sup>2</sup> Low-pass filter for	
(MP2100A-084/184)	8GFC, 10GbE WAN, 10GbE LAN/PHY, OC-192/STM-64, Infiniband × 4	
LPF for 10.5G (H) to	3 dB cutoff frequency	
11.3G	10.5 to 11.3Gbit/s: 8.2 GHz*2 Low-pass filter for	
(MP2100A-085/185)	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* <sup>2</sup> 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.1-4 Sampling Scope (Cont'd)

ltem	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: $50 \Omega^{*1}$		
	Input amplitude: 0.2 to 0.4 Vp-p		
	Waveform: NRZ		
	Received data output		
	Connector: SMA jack		
	Termination: AC coupling		
	Impedance: $50 \Omega^{*1}$		
	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		

 Table A.1-5
 Slot for Optical Transceiver

\*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

Item	Specifications		
SFP+Slot (MP2100A-051)	Standard accessory J1341A Open (Coaxial connector cover) 2		
	Transmission data input		
	Connector: SMA jack		
	Termination: AC coupling		
	Terminator voltage: 0 V		
	Impedance: $50 \Omega^{*1}$		
	Input amplitude: 0.6 to 0.8 Vp-p (at G0238A)		
	0.25 to 0.35 Vp-p (at G0239A)		
	Waveform: NRZ		
	Received data output		
	Connector: SMA jack		
	Termination: AC coupling		
	Terminator voltage: 0 V		
	Impedance: $50 \Omega^{*1}$		
	Output amplitude: 0.10 to 1.0 Vp-p*3		
	Waveform: NRZ		
	Functions		
	Status indicator for module availability		
	Module information display: wavelength, LOS, optical output		
	Optical output control: On, Off		

 Table A.1-5
 Slot for Optical Transceiver (Cont'd)

\*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

-			
ltem	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 $\times 2$ (10/100/1000BASE-T)		
	$GPIB \times 1^{*1}$		
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	Operating temperature: +5 to +40°C		
performance	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)		

Table A.1-6	General Performance
	Ocherari enomiance

\*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

Model Name	Product name	
	—Main Frame—	
MP2101A	BERTWave PE	
	—Standard Accessories—	
	Power cord	1
J1137	Terminator	$2^{*1}$
		$4^{*2}$
J1341A	Open (Coaxial connector cover)	$4^{*1}$
		$6^{*2}$
MX210000A	BERTWave Control Software	1
	(CD-ROM, including Operation Manual)	
	Options	
MP2101A-011*3	1CH PPG/ED	
MP2101A-012*3	2CH PPG/ED	
MP2101A-030/130	GPIB	
MP2101A-050*4	XFP slot	
MP2101A-051*4	SFP+ slot	
MP2101A-052/152	Full Rate Clock Output	
MP2101A-090	Bit rate Extension for PPG/ED	
MP2101A-091/191	ED High Sensitivity	

Table A.2-1 Configuration

\*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.

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	
	$2\mathrm{GbE}$	2500000	
	10GbE WAN	9953280	
	10GbE LAN/PHY	10312500	
	10GbE OTU-1e	11049107	
	10GbE OTU-2e	11095728	
	Infiniband	2500000	
	Infiniband $\times 2$	5000000	
	Infiniband × 4	10000000	
	minimulu ^ Ŧ	1000000	

Table A.2-2 Pulse Pattern Generator
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\*1: Option 090 only

Item	Specifications		
Bit Rate	Standard Nam	e 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-6	9953280	
	$G.975 \; FEC$	10664228	
	OTU-2	10709225	
	CPRI	614400	
	$CPRI \times 2$	1228800	
	$CPRI \times 4$	2457600	
	$CPRI \times 5^{*1}$	3072000	
	$CPRI \times 10^{*1}$	6144000	
	OBSAI*1	768000	
	$OBSAI \times 2^{*1}$	1536000	
	$\text{OBSAI} \times 3^{\boldsymbol{*}1}$	3072000	
Internal reference clock accuracy	±10 ppm* <sup>2,*4</sup>		
Bit rate offset	±100 ppm*3		
External 10 MHz	Connector:	BNC jack	
input*3	Termination:	$50 \Omega$ , AC coupling	
	Amplitude:	0.7 to 2 Vp-p, AC coupling	
	Waveform:	Square or sine wave	
External reference	Connector:	SMA jack	
clock input	Termination:	$50 \Omega$ , AC coupling	
	Amplitude:	0.2 to 1.5 Vp-p	
	Waveform:	Square or sine wave	

Table A.2-2	Pulse Pattern Generator (Cont'd)	
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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 Appendix

ltem	Specifications
Sync output	Frequency:
	Sync signal         Pulse Pattern Generator         Error Detector           source
	Divide ratio         1/1         1/2         1/4         1/8         1/16         1/64         Pattern         1/4         1/8         1/16           Bit rate         Divide ratio         1
	Rate 1/64         ✓           Rate 1/32         ✓
	Rate $1/16$ $\checkmark$
	Rate 1/8         ✓         ✓           Rate 1/4         ✓         ✓         ✓
	Rate 1/2 $\checkmark$ $\checkmark$ $\checkmark$ $\checkmark$ $\checkmark$ Rate 1/1 $\checkmark$ $\checkmark$ $\checkmark$ $\checkmark$ $\checkmark$
	Connector:SMA jackImpedance: $50 \Omega$ Low level (VoL): $-0.5$ to $-0.3$ VHigh level (VoH) $-0.1$ to 0 VAmplitude: $0.4$ Vp-p*5
Data output	Number of Channel:MP2101A-011: 1, MP2101A-012: 2Connector:SMA jack
	Amplitude:       0.1 to 0.8 Vp-p, 10 mV resolution         Accuracy:       ±20 mV ±20% for settings         Delation       the tag
	Relative display*6:availableTermination:AC coupling, 50 Ω
	Rise/Fall time: 25 ps* <sup>5,*7</sup>
	Jitter: 3 ps rms* <sup>5</sup>
	Skew ±15 ps or less

Table A.2-2	Pulse Pattern	Generator (	(Cont'd)
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\*5: Typical values

- \*6: Multiplexing values by amplitude and external attenuation factor
- \*7: Time changing between 20 to 80 % amplitude

ltem	Specifications			
Full Rate Clock	-	J1341A Open (coaxial connector cover) 1		
Output (MP2101A-052/152)	Bit rate			
(MP2101A <sup>-</sup> 052/152)	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		
	Number of outputs:	1 (single end)		
	Amplitude: 30	0 to 750 mVp-p		
	Duty: 50	$\% \pm 15\%$		
	Rising and falling ti	me (20 to 80%): 30 ps* <sup>5,*7</sup>		
	RMS jitter: 2	os rms*5,*8,*9		
	2	os rms*5,*8,*10		
	Connector: SN	MA jack		
	Impedance: 50	Ω, AC coupling		
	Signal source: PI	$PG1^{*11}$ , ED1, PPG2 $^{*12}$ , *13, ED2 $^{*12}$		
	Alarm: PI	L Unlock detection		

Table A.2-2 Pulse Pattern Generator (Cont'd)

\*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.

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	
# A.2 MP2101A BERTWave PE Specifications

ltem	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	
	$1 \mathrm{GFC}^{*1}$	1062500	
	$2 \mathrm{GFC}^{*_1}$	2125000	
	4GFC	4250000	
	8GFC	8500000	
	10GFC	10518750	
	10GFC FEC	11316800	
	$1 \text{GbE}^{*1}$	1250000	
	$2\text{GbE*}^1$	2500000	
	10GbE WAN	9953280	
	10GbE LAN/PHY	10312500	
	10GbE OTU-1e	11049107	
	10GbE OTU-2e	11095728	
	Infiniband <sup>*1</sup>	2500000	
	Infiniband $\times 2$	5000000	
	Infiniband $\times 4$	10000000	
	OC-3/STM-1*1	155520	
	$OC-12/STM-4^{*1}$	622080	
	$OC-24^{*1}$	1244160	
	OC-48/STM-16*1	2488320	

Table A.2-3 Error Detector

\*1: Option 090 only

ltem	Specifications		
Bit rate (Cont'd)	Specification N	Name Bit Rate (kbit/s)	
	OTU-1	2666057	
	OC-192/STM-64	9953280	
	$G.975 \ FEC$	10664228	
	OTU-2	10709225	
	$CPRI^{*1}$	614400	
	$\text{CPRI} \times 2^{*1}$	1228800	
	$CPRI \times 4^{*1}$	2457600	
	$CPRI \times 5^{*1}$	3072000	
	CPRI v $10^{*1}$	6144000	
	$OBSAI^{*1}$	768000	
	$\text{OBSAI} \times 2^{\star_1}$	1536000	
	$OBSAI \times 3^{*1}$	3072000	
Offset tolerance	±100 ppm*2		
Internal reference clock accuracy	±10 ppm*3		
External 10 MHz	Connector:	BNC	
input*4	Termination:	AC coupling, 50 $\Omega$	
	Amplitude:	0.7 to 2 Vp-p	
	Waveform:	Square waveform or sine wave	

Table A.2-3	Error Detector (Cont'd)
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\*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

	Item		Specifications	
Test pattern		Pseudorandom (PRE	Pseudorandom (PRBS) pattern:	
		Pattern length:	2^7-1, 2^9-1, 2^15-1, 2^23-1, 2^31-1	
			Logic invertible	
		Programmable patte	ern:	
		Pattern length:	2 to 1305600 bit, editable by text editor	
			and sample file available	
Data input	Number of	MP2101A-011: 1		
	Channel	MP2101A-012: 2		
	Electrical	Connector: SM	IA jack	
	input	Termination: Sin	ngle-end, differential	
		Data format: NR	Z, Mark ratio 50%	
		Amplitude 0.1 to 0.8	Vp-p*5,*6	
		0.25 to 0.	8 Vp-p*5,*7	
		Coupling method:	DC coupling, termination voltage 0 V	
		Consecutive identica		
Threshold va	lue*9	-85 mV to 85 mV, 1 mV resolution*10		
		Data/Data change	in synchronization	
External atte	enuation factor	0 to 30 dB , 1 dB resolution		
	*5:	Pattern: PRBS 2^31– rate: 10.3125 Gbit/s, a	-1, Mark ratio: 1/2, Termination: single end, Bit at 20 to 30°C	
	*6:	Bit rate: 5 to 11.32 G	bit/s and its divide ratio	
	*7:	Bit rate: 8.0 to 8.5 Gb	it/s, 11.32 to 12.5Gbit/s and their divide ratio	
	*8:		t/s, Pattern: Frame format equal to STM-64	
			ination: single end at 20 to 30°C	
	*9:	The displayed thresh attenuation factor.	old value is the value corrected by the external	
		The calculation form	ula is as follows:	
		Maximum value = 85		
		Minimum value = $-83$		
		Resolution = $1.0 \times 10$	(lactor /20)	

Table A.2-3 Error Detector (Cont'd)

\*10: Termination: single end, when external attenuation is 0 dB.

ltem	Specifications		
Measurement	Alarm Indicator: Pattern asynchronous (Sync loss), Frequency		
functions	asynchronous (CR Unlock)*11		
	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 9.99999E17		
	Frequency: Bit rate setting ±100 ppm, Accuracy: ±10 ppm* <sup>12</sup>		
	Measurement method		
	Measurement time: 1 seconds to 9 days 23 hours 59 minutes 59		
	seconds		
	Measurement frequency: single, repeat, untimed		
	Display update interval* <sup>13</sup> : 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*14, Off		
	Frame length: 64 bits		
	Frame position: 1 to (Pattern Length - Frame Length + 1)		
	1 bit resolution		

Table A.2-3	Error Detector	(Cont'd)
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\*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.

# A.2 MP2101A BERTWave PE Specifications

Item	Sp	pecifications
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
	UI 15.2 15.2 1.7 0.17 0.05 0.01E-3 2E-3 17.9E-3 0.4 Mc	4 8 27.2 80 MHz bodulation frequency

Table A.2-3 Error Detection (Cont'd)



ltem		Specifications
ED High Sensitivity	Jitter specifications <sup>*16</sup>	
(MP2101A-091/191)	Total Jitter: 10.3125 Gbps: 4.25 Gbps: 2.125 Gbps: Deterministic Jitter: 10.3125 Gbps: 4.25 Gbps: 2.125 Gbps: 2.125 Gbps: Sinusoidal Jitter: 10.3125 Gbps:	TJ [UI] 0.65 0.325 0.325 DJ (d-d) [UI] 0.45 0.225 0.225 SJ (d-d)[UI] 0.22
	4.25 Gbps:	0.11
	2.125 Gbps:	0.11
	EYE mask specifications Received voltage Y 0 V 0 -Y	1-X 1 Time (UI)
	X: (UI)	
	10.3125 Gbps: 4.25 Gbps: 2.125 Gbps: Y: (mV)	$0.325 \\ 0.1625 \\ 0.1625$
	Bit rate	CH1 CH2
	10.3125 Gbps	25 25
	4.25 Gbps	25 $25$ $25$
	2.125 Gbps	25 $25$ $25$ $25$
	2.120 Cups	

Table A.2-3 Error Detector (Cont'd)

- \*16: Specified under following conditions; design warranted at 20 to 30°C Single-end input; JTPAT pattern; jitter amplitude when BER at 10<sup>-12</sup>; 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  ${\leq}10^{{-}12}$ 

#### A.2 MP2101A BERTWave PE Specifications

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: $50 \Omega^{*1}$	
	Input amplitude: 0.2 to 0.4 Vp-p	
	Waveform: NRZ	
	Received data output	
	Connector: SMA jack	
	Termination: AC coupling	
	Impedance: $50 \Omega^{*1}$	
	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	

 Table A.2-4
 Slot for Optical Transceiver

\*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

Item	Specifications	
SFP+ Slot (MP2101A-051)	Standard accessory J1341A Open (Coaxial connector cover) 2	
	Transmission data input	
	Connector: SMA jack	
	Termination: AC coupling	
	Termination voltage 0 V	
	Impedance: $50 \Omega^{*1}$	
	Input amplitude: 0.6 to 0.8 Vp-p (at G0238A)	
	0.25 to 0.35 Vp-p (at G0239A)	
	Waveform: NRZ	
	Received data output	
	Connector: SMA jack	
	Termination: AC coupling	
	Impedance: $50 \Omega^{*1}$	
	Termination voltage 0 V	
	Output amplitude: 0.18 to 1.0 Vp-p*4	
	Waveform: NRZ	
	Functions	
	Status indicator for module availability	
	Module information display: wavelength*5, LOS, optical output	
	Optical output control: On, Off	

Table A.2-4 Slot for Optical Transceiver (Cont'd)

\*4: When input optical power is within the range of the recommended SFP+ module optical power

\*5: When G0238A, or G0239A is installed

### A.2 MP2101A BERTWave PE Specifications

ltem	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	Ethernet $\times 2$ (10/100/1000BASE-T)	
interface	$GPIB \times 1^{*1}$	
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	Operating temperature: +5 to +40°C	
performance	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)	

Table A.2-5 General Performance

\*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	
	–Main Frame–	
MP2102A	BERTWave SS	
	-Standard Accessories-	
	Power cord	1
J1137	Terminator	$1^{*2}$
J1341A	Open (Coaxial connector cover)	$2^{*2}$
		3*1
J1359A	Coaxial adapter (K-P, K-J, SMA)	2*1
MX210000A	BERTWave Control Software (CD-ROM, including Operation Manual)	1*2 1
	-Options-	
MP2102A-021*3	Dual Electrical Receiver	
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.

### A.3 MP2102A BERTWave SS Specifications

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)

Table A.3-1 Configuration

\*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.

ltem	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
	$2\mathrm{GbE}$
	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)

Table A.3-2 Sampling Scope

\*1: Processing is performed for the NRZ waveform.

#### MP2102A BERTWave SS Specifications A.3

ltem	Specifications
Horizontal system	Clock trigger input
	Connector: SMA jack
	Termination: $50 \Omega$
	Frequency 0.1 to 12.5 GHz
	Sensitivity 100 mVp-p*2
	Absolute maximum rating: 2 Vp-p*3
	Jitter, RMS 5 to 12.5 GHz: 1.35 ps or less,
	$0.85 \text{ ps}^{*2}$
	1 to 5 GHz: 1 ps <sup><math>*2</math></sup>
	0.1  to  1  GHz: 2 ps*2
	Scale
	Eye pattern display: full scale 1UI or more
	Pulse pattern display: full scale 1 bit or more
Vertical system	Electrical input
	Input connector: K
	Termination: $50 \Omega$
	CH_A
	$CH_B^{*4}$
	Absolute maximum input $\pm 2 V^{*3}$
	Input range
	Offset: $\pm 500 \text{ mV} \text{ or more}$
	Dynamic range: ±400 mV or more
	Bandwidth (–3 dB): DC to 20 GHz or more,
	$\mathrm{DC}$ to 25 $\mathrm{GHz^{*2}}$
	Flatness: $\pm 1 dB^{*2}$
	RMS noise: 3.5 mV or less
	$2 \text{ mV*}^2$

Table A.3-2 Sampling Scope (Cont'd)

\*2: Typical value

- \*3: Design guaranteed
- \*4: MP2102A-021 only

Item	Specifications
Vertical system	Amplitude accuracy <sup>*5</sup>
	$\pm$ amplitude accuracy $\pm$ 2% for reading value* <sup>6</sup>
	The following figure indicates the amplitude accuracy after calibration.
	25 Cale=200 mV/ Scale=200 mV/ Scale=30 mV/div Scale=50 mV/div Scale=5

Table A.3-2 Sampling Scope (Cont'd)

- \*5: After internal calibration
- \*6: Calculation example: when the amplitude reading is 400 mV and the offset voltage is 50 mV



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:  $200 \times 2\% + 8 = 12$   $\pm 12$  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:

 $200 \times 2\% + 11 = 15 \pm 15 \text{ mV}$ 

ltem		Specification	S	
Vertical system	Optical input*7			
	Connector	FC*8, SC*9		
	Suitable fiber	multi-mode fiber	(62.5 μm)* <sub>10</sub>	
	Wavelength range	750 to 1650 nm		
	Bandwidth*11	DC to 9.0 GHz		
	Conversion efficiency	850 nm:0.25 A/ 1310 nm:0.475 A		
	Conversion gain	1550 nm: 0.45 A/V 850 nm: 112.5 V 1310 nm: 210 V/W 1550 nm: 200 V/W	/₩*2 √*2	
	Optical noise*2			
	With MP2102A-055 (U	Jnit: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 C	Option 081 to 083	5.2	3.0
	When using a filter of C	Option 084 or 085	6.5	3.7
	When using a filter of C	Option 086	3.4	2.0
	Without MP2102A-05	5 (Unit:µWrms)		
	Wavelength		850 nm	1310, 1550 nm
	When using a filter of C	Option 070 to 073	3.1	1.8
	When using a filter of C	Option 076 to 080	2.7	1.5
	When using a filter of C	Option 081 to 083	3.9	2.2
	When using a filter of C	Option 084 or 085	4.8	2.8
	When using a filter of C	Option 086	2.5	1.4

 Table A.3-2
 Sampling Scope (Cont'd)

\*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  $-3~\mathrm{dB}$  down, typical value

ltem	Specificati	ons	
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* <sup>13</sup> : Aver	age power –1 dBr	m (794 μW)
	Peak	power +2 dBm (	1.58 mW)
	Absolute maximum power: Peak	power +5 dBm (	3.16 mW)
	Optical power measurement Rang	ge: -18 to 0 dBn	1
	Accuracy ±0.3	5 dB*2: –12 dBm	or more
	±0.6	dB*2: less than –	12 dBm
	Optical return loss $-30 \text{ dB}^{*2}$		
Digital system	Sampling speed: 100 ksa/second typ.*2		

Table A.3-2 Sampling Scope (Cont'd)	Table A.3-2	Sampling So	cope (Cont'd)
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\*12: Mask test available range

\*13: Level deteriorating linearity

Item	Specifications	
Clock Recovery (MP2102A-055)	Standard accesso J1341A Open (	ory (Coaxial connector cover) 2
	Data input	
	Connector:	SMA jack
	Termination:	AC coupling, 50 $\Omega$
	Sensitivity:	100 mVp-p*2
	Clock output	
	Connector:	SMA jack
	Termination:	AC coupling, 50 $\Omega$
	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 $12.5~\mathrm{GHz},0.1$ to $2.7~\mathrm{GHz}$
	Jitter (RMS):	8.5 to 12.5 GHz: 20 mUI or less <sup>*14</sup> , 10 mUI <sup>*2, *14</sup>
		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* <sup>2</sup>
		156 MHz: 20 kHz*2

 Table A.3-2
 Sampling Scope (Cont'd)

# A.3 MP2102A BERTWave SS Specifications

ltem	Specifications	
Filter bank (8.5G/10G/10.5G) (MP2102A-056)	3 dB cutoff frequency 8.5 Gbit/s: 6.38 GHz* <sup>2</sup> Low-pass filter 8GFC 10 Gbit/s: 7.6 GHz* <sup>2</sup> Low-pass filter 8GFC	
	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* <sup>2</sup> Low-pass filter 2GFC 4 Gbit/s: 3.2 GHz* <sup>2</sup> Low-pass filter 4GFC 8.5 Gbit/s: 6.38 GHz* <sup>2</sup> Low-pass filter 8GFC 10 Gbit/s: 7.6 GHz* <sup>2</sup> 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.	

Table A.3-2 Sampling Scope (Cont'd)

\*14: Loop bandwidth: 4 MHz

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	Filter configuration:
Bit Rate Filter Bank	Three of MP2102A-076 to 086 and three of MP2102A-070 to 073 can be
(MP2102A-069)	installed.
LPF for 156M (L)	3 dB cutoff frequency
(MP2102A-070)	155 Mbit/s: 116 MHz*2 Low-pass filter for OC-3/STM-1
LPF for 622M (L)	3 dB cutoff frequency
(MP2102A-071)	622 Mbit/s: 470 MHz*2 Low-pass filter for OC-12/STM-4, CPRI
LPF for 1.0G (L)	3 dB cutoff frequency
(MP2102A-072)	1062.5 Mbit/s: 800MHz*2 Low-pass filter for 1GFC
LPF for 1.2G (L)	3 dB cutoff frequency
(MP2102A-073)	1.2 Gbit/s: 940 MHz* <sup>2</sup> Low-pass filter for 1GbE, OC-24, CPRI × 2
LPF for 2.1G (H)	3 dB cutoff frequency
(MP2102A-076/176)	2.1Gbit/s: 1.6 GHz* <sup>2</sup> Low-pass filter for 2GFC
LPF for 2.5G (H) (MP2102A-077/177)	3 dB cutoff frequency 2.5 Gbit/s: 1.87 GHz* <sup>2</sup> Low-pass filter for CPRI × 4, OC-48/STM-16, 2GbE, Infiniband
LPF for 2.6G (H)	3 dB cutoff frequency
(MP2102A-078/178)	2.6 Gbit/s: 2.0 GHz* <sup>2</sup> Low-pass filter for OTU-1

Table A.3-2	Sampling Scope (Cont'd)	
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# A.3 MP2102A BERTWave SS Specifications

ltem	Specifications
LPF for 3.1G (H)	3 dB cutoff frequency
(MP2102A-079/179)	3.1 Gbit/s: 2.37 GHz*2 Low-pass filter for CPRI $\times$ 5, 10GBASE-LX4, 10GFC-LX4
LPF for $4.2G$ (H)	3 dB cutoff frequency
(MP2102A-080/180)	4.2 Gbit/s: 3.2 GHz* <sup>2</sup> Low-pass filter for 4GFC
LPF for 5.0G (H)	3 dB cutoff frequency
(MP2102A-081/181)	5.0 Gbit/s: 3.75 GHz* <sup>2</sup> Low-pass filter for Infiniband $\times$ 2, CPRI $\times$ 8
LPF for 6.2G (H)	3 dB cutoff frequency
(MP2102A-082/182)	6.2 Gbit/s: 4.61 GHz*2 Low-pass filter for CPRI $\times$ 10, XAUI Optical $\times$ 2
LPF for 8.5G (H)	3 dB cutoff frequency
(MP2102A-083/183)	8.5 Gbit/s: 6.3 GHz* <sup>2</sup> Low-pass filter
LPF for 9.9G to 10.3G	3 dB cutoff frequency
(H)	9.9 to 10.3 Gbit/s: 7.6 GHz* <sup>2</sup> Low-pass filter for
(MP2102A-084/184)	8GFC, 10GbE WAN, 10GbE LAN/PHY, OC-192/STM-64, Infiniband × 4
LPF for 10.5G to	3 dB cutoff frequency
11.3G (H)	10.5 to 11.3 Gbit/s: 8.2 GHz*2 Low-pass filter for
(MP2102A-085/185)	10GFC, G.975 FEC, OTU-2, 10GbE FEC, 10GFC FEC
LPF for Multi 10G (H)	3 dB cutoff frequency
(MP2102A-086/186)	9.9 to 10.7Gbit/s: 7.5 GHz* <sup>2</sup> Low-pass filter for
	8GFC, 10GbE WAN, 10GbE LAN/PHY, OC-192/STM-64, Infiniband × 4,
	10GFC, G.975 FEC, OTU-2

Table A.3-2 Sampling Scope (Cont'd)

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 $2.0 \times 5$		
Remote	Ethernet × 2 (10/100/1000BASE-T)		
interface	$GPIB \times 1^{*1}$		
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	Operating temperature: +5 to +40°C		
performance	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)		

Table A 3-3	General	Performance
	General	I enormance

\*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

ltem	Specifications
Jame	G0174A 850 nm XFP Module
	9.95 to 11.10 Gbit/s
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	$3.0 \text{ dB or more}^{*2}$
Suitable optical fiber	GI (50/125 μm), GI (62.5/125 μm)
Connector	LC/PC
Eye mask pattern	{X1, X2, X3, Y1, Y2, Y3}
	$\{0.25, 0.40, 0.45, 0.25, 0.28, 0.40\}^{*2}$
	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$
	Jame         Output         Laser safety class         Center wavelength         RMS Spectrum width         Extinction Ratio         Suitable optical fiber         Connector

Table A.4-1 850 nm XFP

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

Table A.4-1 850 nm XFP (Cont'd)

\*1: NRZ signal: PRBS2^23–1, mark ratio: 1/2, bit rate: 10.3125 Gbit/s

\*2: Uses 10.3125 Gbit/s filter

\*3: Average power: BER  $\leq 10^{-12}$ , 20 to 30°C

# A.4 Optical Transceiver Module Specifications

ltem		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}
		$\{0.25, 0.40, 0.45, 0.25, 0.28, 0.40,\}^{*2}$
		1+Y3 1 1-Y1 1-Y2 0.5 Y2 Y1 0 -Y3 0 X1 X2 X3 1-X31-X21-X1 1
		Normalized Time (Unit Interval)

Table A.4-2 1310 nm XFP

Item		Specifications
Receiver <sup>*1</sup>	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

Table A.4-2 1310 nm XFP

\*1: NRZ signal: PRBS2^23–1, 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

# A.4 Optical Transceiver Module Specifications

	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	$8.2 \text{ dB or more}^{*2}$
	Suitable optical fiber	Single mode fiber (ITU-T G.652)
	Connector	LC/PC
	Eye mask pattern	{X1, X2, X3, Y1, Y2, Y3}
		$\{0.25, 0.40, 0.45, 0.25, 0.28, 0.40\}^{*2}$
		1+Y3 1 1-Y1 1-Y2 0.5 Y2 Y1 0 -Y3 0 X1 X2 X3 1-X31-X21-X1 1
		Normalized Time (Unit Interval)

Table A.4-3 1550 nm XFP

	Item	Specifications
Receiver <sup>*1</sup>	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

Table A.4-3 1550 nm XFP (Cont'd)

\*1: NRZ signal: PRBS2^23–1, mark ratio: 1/2, bit rate: 9.95328 Gbit/s

\*2: Uses 9.95328 Gbit/s filter

\*3: Average power: BER  $\leq 10^{-12}$ 

\*4: 20 to 30°C

# A.4 Optical Transceiver Module Specifications

Item	Specifications
Name	G0238A 850 nm SFP+ Module
	10.3125 Gbit/s
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}
	$\{0.25, 0.40, 0.45, 0.25, 0.28, 0.40\}^{*2}$
	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$
	Name         Output         Laser safety class         Center wavelength         RMS Spectrum width         Extinction Ratio         Suitable optical fiber         Connector

Table A.4-4 850 nm SFP+

	Item	Specifications
Receiver <sup>*1</sup>	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	$-12.0 \text{ dBm or less}, -20.0 \text{ dBm}^{*5}$

Table A.4-4 850 nm SFP+

\*1: NRZ signal: PRBS2^23–1, mark rate: 1/2, bit rate: 10.3125 Gbit/s,

\*2: Uses 10.3125 Gbit/s filter

\*3: Optical Modulation Amplitude, BER  $\leq 10^{-12}$ , at 20 to 30°C

- \*4: Average power,  $BER \leq \!\! 10^{-12}$ , at 20 to  $30^{\circ}C$
- \*5: Typical values

# A.4 Optical Transceiver Module Specifications

ame	
ame	G0239A 1310 nm SFP+ Module
	9.95328 to 10.3125 Gbit/s
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}
	$\{0.25, 0.40, 0.45, 0.25, 0.28, 0.40\}^{*2}$
	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$
	Laser safety class Center wavelength SMSR Extinction Ratio Suitable optical fiber Connector

Table A.4-5 1310 nm SFP+

	ltem	Specifications
Receiver <sup>*1</sup>	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

Table A.4-5 1310 nm SFP+ (Cont'd)

\*1: NRZ signal: PRBS2^23–1, mark rate: 1/2, bit rate: 10.3125 Gbit/s,

\*2: Uses 10.3125 Gbit/s filter

- \*3: Optical Modulation Amplitude, BER  $\leq 10^{-12}$ , at 20 to 30°C
- \*4: Average power, BER  $\leq 10^{-12}$ , at 20 to 30°C

Item	Initial Value	Remarks
Amplitude	0.40	Vp-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-1 Initial Values of PPG

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-2 Initial Values of ED

	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	$mV^{*1}$
		0	$\mu W^{*2}$
	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	

### Table B-3 Initial Values of Sampling Scope (EYE/Pulse Scope)

\*1: Electrical interface

\*2: Optical interface

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
		$\mu W *_2$
Y2	-500	mV *1
		μW *2

Table B-3 Initial Values of Sampling Scope (EYE/Pulse Scope) (Cont'd)
#### Appendix B Initial Values

ltem		Initial Value	Remarks
Measure (Co	ont'd)		
Measurement Item		Off	
Ma	ask Test		
	Align Marker	Display Off	
	X1	0.50	
	$\Delta X$	1.00	
	Y1	338.31	
	ΔΥ	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	

Initial Values of Sampling Scope (EYE/Pulse Scope) (Cont'd) Table B-3

#### Appendix B Initial Values

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	
<b>Recalculate Option</b>	Clock Rate	
Skew		
А	0.0	
В	0.0	
Tracking (Data Clock Rate)	Off	
Tracking (Pattern Length)	Off	
Unit	UI	

Table B-3 Initial Values of Sampling Scope (EYE/Pulse Scope) (Cont'd)

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
Subnet Mask	$255\ 255\ 255\ 0$	Connection
Gateway		
IP Address	192 168 100 102	Local Area
Subnet Mask	$255\ 255\ 255\ 0$	Connection 2
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	Shift + Tab
Counterclockwise rotation	
Rotary Knob	Tab
Clockwise rotation	
Pressing Rotary Knob	Enter

Panel Key	Keyboard	
0	0	
1	1	
2	2	
}	3	
4	4	
5	5	
6	6	
7	7	
8	8	
9	9	
÷	+	
_	_	
(Period)	. (Period)	
	1	
>	$\rightarrow$	
▼	$\downarrow$	
<	←	
ЭК	Enter	
Cancel	ESC	
<<,BKSP	Back Space	

Panel operations using the keyboard at the Setup Utility are not supported.

#### Appendix C Keyboard and Mouse Operations

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	

Table C-3 Corresponding to Mouse Operation

### **D.1 Pattern File Specifications**

The specifications for data files read as PPG or ED are as follows:

ltem	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

Table D.1-1	Specifications for Data Pattern Fil	е
-------------	-------------------------------------	---

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

Template_512bit_HEX.ppf - Notepad	
<u>File E</u> dit F <u>o</u> rmat <u>Vi</u> ew <u>H</u> elp	
512,HEX, АААААААААААААААААААААААААААААААААААА	
1	<b>V</b>
	Ln 1, Col 1 //

Figure D.1-1 Example of Pattern File Described by Hexadecimal Number

Template_128bit_BIN.ppf - Notepad	
File Edit Format View Help	
128,BIN, 1010101011001100111100001111000010101010	×
Ln 1, Col 1	

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
-------------	--------------------------

ltem	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.

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;						
Тор	X 0 1 -1 -1 -1 -1 -1 -1	Y 99 1.3 1.3 99 -1 -1 -1 -1 -1 -1 -1	X_min 0 1 1 -1 -1 -1 -1 -1 -1	Y_min 99 1.6 1.6 99 -1 -1 -1 -1 -1 -1	X_max 0 1 1 -1 -1 -1 -1 -1 -1	Y_max 99 1 1 999 -1 -1 -1 -1 -1
Middle	-1 X 0.215 0.4 0.6 0.785 0.6 0.4 -1 -1 -1 -1	-1 Y 0.5 0.8 0.8 0.5 0.2 0.2 -1 -1 -1 -1	-1 X_min 0.5 0.5 0.5 0.5 0.5 0.5 -1 -1 -1 -1	-1 Y_min 0.5 0.5 0.5 0.5 0.5 0.5 -1 -1 -1 -1	-1 X_max 0 0.4 0.6 1 0.6 0.4 -1 -1 -1 -1	-1 Y_max 0.5 1 1 0.5 0 0 -1 -1 -1 -1
Bottom	-1 X 0 1 -1 -1 -1 -1 -1 -1 -1	Y -99 -0.2 -99 -1 -1 -1 -1 -1 -1	-1 X_min 0 1 1 -1 -1 -1 -1 -1 -1 -1	-1 Y_min -99 -0.4 -0.4 -99 -1 -1 -1 -1 -1 -1	-1 X_max 0 1 1 -1 -1 -1 -1 -1 -1 -1	-1 Y_max -99 0 -99 -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		<u>°C</u>
Relative humidity	%	
Instruments used: Model name		Serial number
Model name		Serial number
Model name		Serial number
Model name		Serial number
<u>Remarks</u>		

### E.1 Pulse Pattern Generator

Frequency Range: 8500000 to 11320000 kbit/s ±100 ppm

8000000 to 12500000 kbit/s ±100 ppm (Option 090)

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

Table E.1-1 Operating Frequency Range

Level Accuracy:  $\pm 20\% \pm 20 \text{ mV}$ 

Table E.1-2	Level	Accuracy
-------------	-------	----------

Connector	Amplitude Setting Value	Minimum Value	Measured Value	Maximum Value	Measurement Uncertainty	Pass/Fail
PPG1	0.1 Vp-p	0.06 Vp-p	Vp-p	0.14 Vp-p		Pass/Fail
Data Out	0.8 Vp-p	0.62 Vp-p	Vp-p	0.98 Vp-p		Pass/Fail
PPG1	0.1 Vp-p	0.06 Vp-p	Vp-p	0.14 Vp-p		Pass/Fail
Data Out	0.8 Vp-p	0.62 Vp-p	Vp-p	0.98 Vp-p		Pass/Fail
PPG2	0.1 Vp-p	0.06 Vp-p	Vp-p	0.14 Vp-p		Pass/Fail
Data Out	0.8 Vp-p	0.62 Vp-p	Vp-p	0.98 Vp-p		Pass/Fail
PPG2	0.1 Vp-p	0.06 Vp-p	Vp-p	0.14 Vp-p		Pass/Fail
Data Out	0.8 Vp-p	0.62 Vp-p	Vp-p	0.98 Vp-p		Pass/Fail

#### Appendix E Performance Test Result Form

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

#### Table E.1-3 Full Rate Clock Output (MP2100A-052/152, MP2101A-052/152)

### 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.

Connector	Bit Rate Setting Value	Offset Setting Value	Measured Frequency	Error Count	Pass/Fail
ED1 Data La	11320000 kbit/s	+100 ppm	kHz		Pass/Fail
ED1 Data In	11320000 kbit/s	-100 ppm	kHz		Pass/Fail
	11320000 kbit/s	+100 ppm	kHz		Pass/Fail
ED1 Data In	11320000 kbit/s	-100 ppm	kHz		Pass/Fail
ED2 Data In	11320000 kbit/s	+100 ppm	kHz		Pass/Fail
ED2 Data In	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

Table E.2-1 Operating Frequency Range

#### Appendix E Performance Test Result Form

Connector	Bit Rate Setting Value	Offset Setting Value	Measured Frequency	Error Count	Pass/Fail
	12500000 kbit/s	+100 ppm	kHz		Pass/Fail
ED1 Data In	12500000 kbit/s	-100 ppm	kHz		Pass/Fail
ED1 Data In	12500000 kbit/s	+100 ppm	kHz		Pass/Fail
	12500000 kbit/s	-100 ppm	kHz		Pass/Fail
FD2 Data In	12500000 kbit/s	+100 ppm	kHz		Pass/Fail
ED2 Data In	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

#### Table E.2-2 Operating Frequency Range (Option 090)

#### Appendix E Performance Test Result Form

	Table E.	2-3 Range of In	put Level	
Connector	Input Level	Measured Frequency	Error Count	Pass/Fail
ED1	0.1 Vp-p	kHz		Pass/Fail
Data In	0.8 Vp-p	kHz		Pass/Fail
ED1	0.1 Vp-p	kHz		Pass/Fail
Data In	0.8 Vp-p	kHz		Pass/Fail
ED2	0.1 Vp-p	kHz		Pass/Fail
Data In	0.8 Vp-p	kHz		Pass/Fail
ED2	0.1 Vp-p	kHz		Pass/Fail
Data In	0.8 Vp-p	kHz		Pass/Fail
O/E Data In	−9 dBm	kHz		Pass/Fail

Input Level Range: 0.1 to 0.8 Vp-p

Pattern Specifications

Test Pattern: 2^7-1, 2^9-1, 2^15-1, 2^23-1, 2^31-1

Input Level: 0.1 Vp-p, Bit rate: 11320000 kbit/s

(no bit error occurs when inputting single end)

Connector	Pattern	Error Count	Pass/Fail
	2^7-1		Pass/Fail
	2^9-1		Pass/Fail
ED1 Data In	2^15-1		Pass/Fail
	2^23-1		Pass/Fail
	2^31-1		Pass/Fail
	2^7-1		Pass/Fail
	2^9-1		Pass/Fail
ED1 Data In	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
	2^7-1		Pass/Fail
	2^9-1		Pass/Fail
ED2 Data In	2^15-1		Pass/Fail
	2^23-1		Pass/Fail
	2^31-1		Pass/Fail
	2^7-1		Pass/Fail
	2^9-1		Pass/Fail
$\frac{\text{ED2}}{\text{Data}}$ In	2^15-1		Pass/Fail
	2^23-1		Pass/Fail
	2^31-1		Pass/Fail

#### Appendix E Performance Test Result Form

Error Detector (ED) Input Level: 0.1 Vp-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).

Connector	Bit Error Rate	Error Count	Pass/Fail
ED1 Data In			Pass/Fail
ED1 Data In			Pass/Fail
ED2 Data In			Pass/Fail
ED2 Data In			Pass/Fail

Table E.2-5 Error Detector

# E.3 Sampling Scope

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
Ch A	-200 mV	–213.5 mV	mV	-186.5 mV		Pass/Fail
Ch D	+200 mV	+186.5 mV	mV	+213.5 mV		Pass/Fail
Ch B	-200 mV	–213.5 mV	mV	–186.5 mV		Pass/Fail

Amplitude Accuracy

Table E 3-1 Lovel A

# E.4 Optical Interface

Optical Power Meter: ±0.35 dB or less (-12 dBm or more)

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

Table E.4-1 Accuracy of Optical Power Meter (MP2100A-003, MP2102A-023)

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