Product Brochure

Anritsu envision : ensure

BERTWave™

MP2110A

BERTWave

All In One

BERT+
Sampling Oscilloscope

4ch ~28.2 Gbit/s BERT

2ch Optical Sampling Oscilloscope

Excellent Eco Product

25 Gbit/s × 4 ch

Reduce cost. Increase productivity.

A single box solution - 28.2 Gbit/s × 4ch BERT + 40-GHz Sampling Oscilloscope for Multi-channel

Optical Module Evaluation and 100/200/400-Gbit/s Multi-channel Optical Module Evaluation
BERTWave MP2110A

MP2110A

Multi-channel Optical Module, Device Manufacturing and Development

Data traffic volumes are exploding as providers bring new unique services onlines. To solve this issue, the bit rates of optical modules and devices are being expanded greatly from 10 Gbit/s to much faster rates of 25 Gbit/s and 100 Gbit/s. However, a key issue for data-center systems is how to improve optical module and device manufacturing productivity while reducing costs.
With a built-in BERT (for Bit Error Rate measurements) and a sampling oscilloscope (for Eye pattern analysis) the All-in-one BERTWave MP2110A is optimized for manufacturing 100/200/400 GbE and 25 GbE optical modules. The BERTWave MP2110A will improve optical module production efficiency and reduce manufacturing costs.

All In One All-in-one max. 4ch 28.2 Gbit/s BERT + max. 2ch optical sampling oscilloscope

Low Cost Integrated BERT and sampling oscilloscope reduce instrument capital costs

PAM4 Analysis Easy, fast and high-sensitivity analysis of PAM4 signals including TDECQ with support for clock recovery

250 ksamples/s Captures 1 million samples in about 5 seconds

-15 dBm Sensitivity Measures optical signals attenuated by peripherals such as optical switches

Shorter Measurement Times

High-speed Sampling Oscilloscope
(250 ksamples/s)

Multi-channel Measurement
(4ch BERT and 2ch Optical Sampling Oscilloscope)

More Accurate Performance

Sampling Oscilloscope
- Bandwidth
  Optical: 35 GHz (SMF), 25 GHz (MMF)
  Electrical: 40 GHz
- High Sensitivity: –15 dBm (typ., SMF)
- Low-Jitter: 200 fs rms (typ.)

BERT
- Low-Jitter PPG: 600 fs rms (typ.)
- High-Sensitivity ED: 25 mV (typ.)

Built-in PC for Stable Operation

Efficient Measurement Systems

Easy configuration of flexible measurement system using All-in-one and discrete instruments

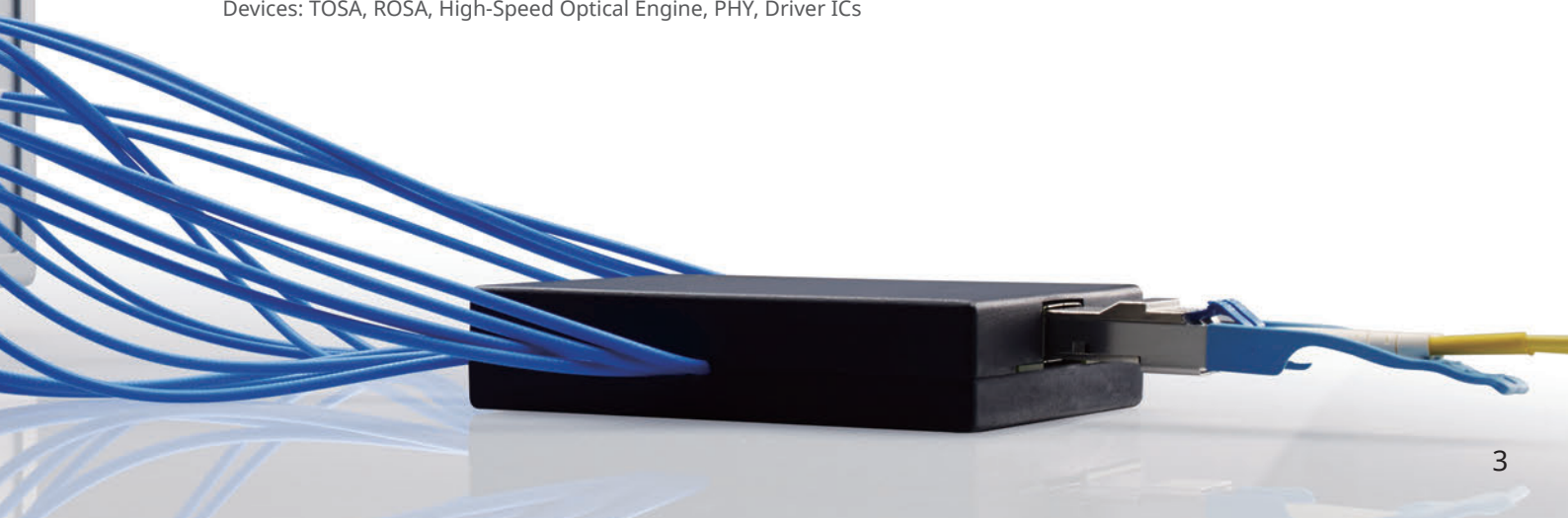
Slashes instrument capital costs by up to about 50% depending on selected configuration

Easy measurement system configuration using sample program

All-in-one support (sampling scilloscope) for both NRZ and PAM4 signals

Target Applications: Evaluating PHY layer performance of optical transceiver modules, cables and component devices

Transmission Paths: Ethernet, CPRI, SDH/SONET, OTN, InfiniBand, Fibre Channel
Modules/Cables: Optical Transceivers, Active Optical Cables (AOC), Direct Attach Cables (DAC)
Devices: TOSA, ROSA, High-Speed Optical Engine, PHY, Driver ICs



Configuration of Efficient Measurement Systems

Integrated BERT and Sampling Oscilloscope

Previous measurement systems were extremely complex due to the need for a separate BERT as the signal source and a sampling oscilloscope for Eye pattern analysis. Incorporating a BERT and sampling oscilloscope into the All-in-one BERTWave MP2110A greatly simplifies measurement system configuration.
Since a 4ch BERT and 2ch sampling oscilloscope are installed in one box, measurement systems are easier to configure and control, enabling simultaneous Tx/Rx measurements of optical modules and optical devices, such as multi-channel QSFP28. Increasing the number of channels slashes the measurement time for multi-channel optical modules and devices that would otherwise require longer measurement times.

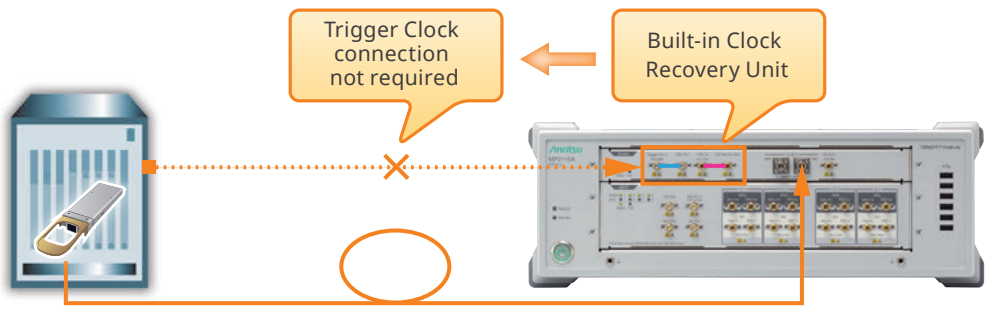
Poor Efficiency, Long Time

No Switching Necessary, Simple Measurement System

With synchronization of each channel, simply setting one channel of the MP2110A sets all channels simultaneously. And the MP2110A PPG can easily measure crosstalk interference required by multi-channel transmission equipment, such as Active Optical Cables (AOC) and Direct Attach Cables (DAC) systems because the test pattern can be changed for each channel. In addition, optical Eye pattern analysis is supported for up to 2ch.
Furthermore, the MP2110A retains the simple settings and easy-to-use user interface of all models in the BERTWave series; in addition compatibility with MP2100B remote commands assures trouble-free instrument upgrades.
Additionally, the stable operation resulting from the built-in PC guarantees performance irrespective of the operation environment.

Built-in Clock Recovery Unit (Option 054)

Usually, a sampling oscilloscope requires input of a trigger clock signal. This trigger clock can be recovered from the Data signal using this Clock Recovery Unit (CRU). The built-in CRU helps cut capital infrastructure costs by easy configuration of a measurement system with no complex cable connections.



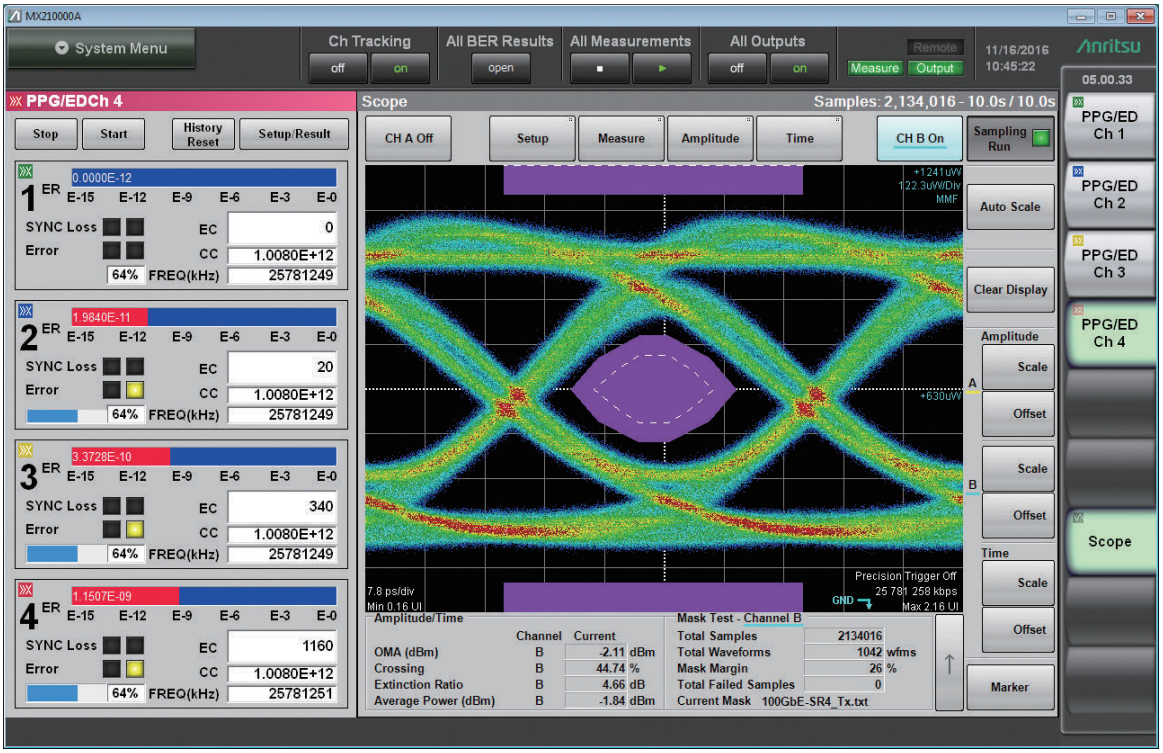
Transmission equipment, switches, etc., with optical modules

Supports clock recovery for 25.5 Gbaud to 28.2 Gbaud NRZ and PAM4 signals

Shorter Measurement Times

Multi-channel Measurement

With a BERT and sampling oscilloscope in one box, measurement results can be captured all at once along with simultaneous Eye pattern display. As a result, all the measurement results needed to evaluate multi-channel optical modules and devices can be seen at a glance, reducing measurement times by large margins.

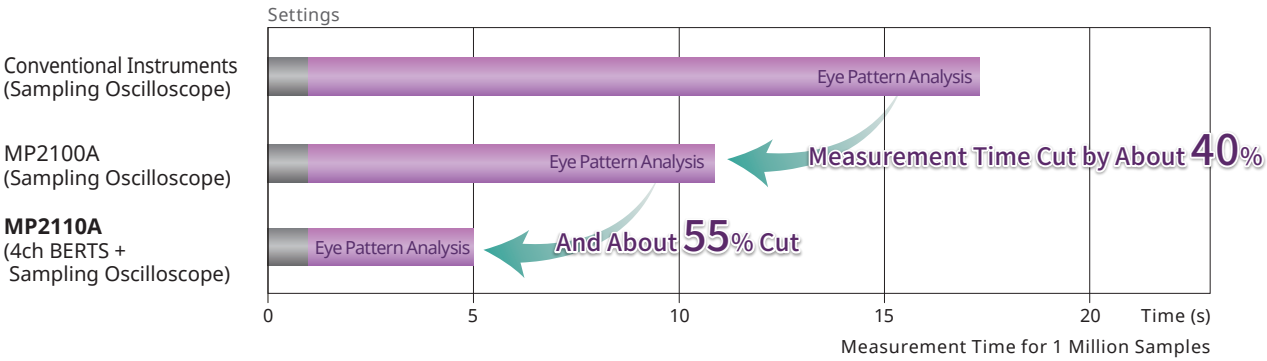


High-Speed Sampling and Fast Mask Margin Tests

The MP2110A supports high-speed sampling at 250 ksamples/s for up to 2ch simultaneously. The built-in as standard automatic Mask Margin test function can complete capture of 1 million samples of a 25 Gbaud signal in about 5 seconds, slashing Eye pattern analysis times by 65% compared to conventional instruments.

The All-in-one BERT and sampling oscilloscope makes it easy to configure and control the measurement system and supports simultaneous BER measurements and Eye pattern analysis. It reduces measurement times by 40% compared to systems using a combination of stand-alone instruments.
Moreover, the expanded 4ch BERTS can measure errors simultaneously for all channels of QSFP28 modules. Eliminating the need to switch channels also helps reduce measurement times.

Comparison of Eye Pattern Analysis Times at 1 M sample Measurement



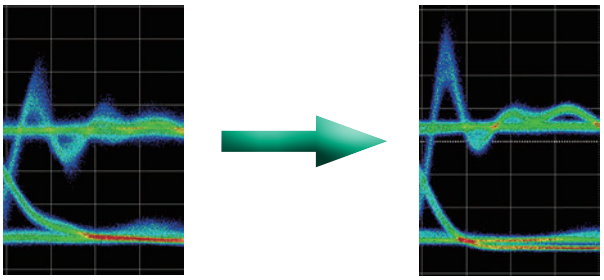
Assured Accurate Performance

Sampling Oscilloscope Functions

The MP2110A sampling oscilloscope has all the performance necessary for measuring optical modules such as 100 GbE, OTU4, etc., and optical devices used by optical modules.

- Bandwidth:
  Optical: 35 GHz (SMF), 25 GHz (MMF)
  Electrical: 40 GHz
- Sensitivity: –15 dBm (typ., SMF)
- O/E Noise: 3.4 µW (typ. SMF)
- Intrinsic Jitter: 200 fs rms (typ.)

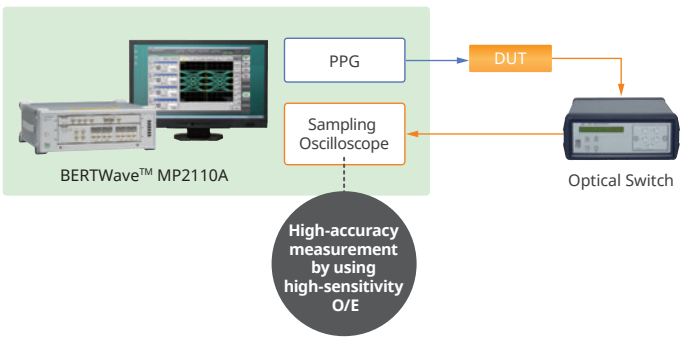
In comparison to conventional instruments, the wideband O/E draws accurate patterns of the characteristics of directly driven optical signals and optical modules for long-distance transmissions.

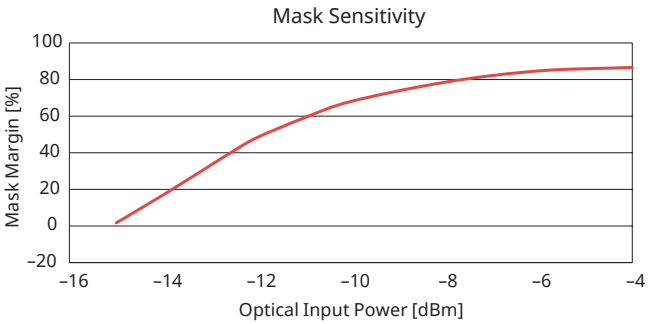


Conventional Instrument
(Filter Off)

MP2110A
(Filter Off)

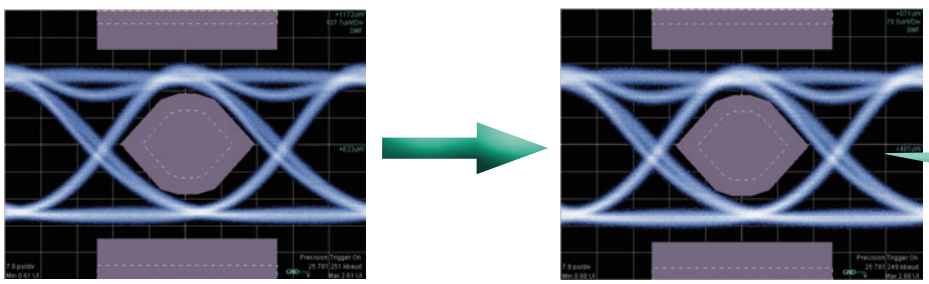
High sensitivity of –15 dBm (typ., SMF) assures DUT measurements even for measurement system with attenuation from optical switches, etc., and using PAM signals. And the sampling oscilloscope sampler has a low noise specification of 3.4 µW (typ., SMF). Additionally, the Precision Trigger option with low Intrinsic Jitter of 200 fs rms (typ.) can be added to the MP2110A. These functions assure accurate measurements to help improve production-line yields.





★ Estimated optical power when Mask Margin (Hit Count 0) reaches 0% (calculated from optical noise)

The MP2110A built-in CRU (Option 054) cuts loss from internal splitters, helping minimize the impact on monitored waveforms; useful for monitoring waveforms requiring high-sensitivity measurement.



Without CRU

With CRU

★: Waveform comparison at –2 dBm input

Various BERTWave MP2110A Measurement Functions

BERT

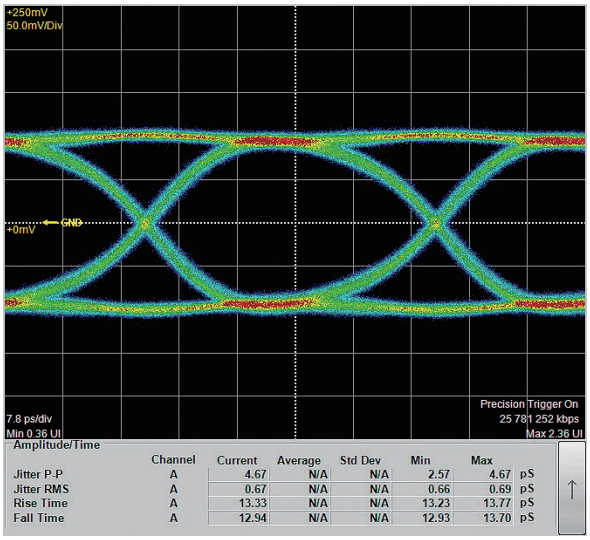
Wideband Operation Frequency

In the standard configuration, the MP2110A BERT operates at bit rates of 24.3 Gbit/s to 28.2 Gbit/s. This range can be extended optionally to support bit rates of 9.5 Gbit/s to 14.2 Gbit/s, enabling use for various applications including 10 GbE and 100 GbE.

PPG/ED Supported Bit Rates	Application Example
24.3 Gbit/s to 28.2 Gbit/s	32G Fibre Channel, CPRI (Option 10), InfiniBand EDR, 100 GbE, 100 GbE FEC, OTU4
9.5 Gbit/s to 14.2 Gbit/s (Option 093)	**Option** InfiniBand FDR/QDR, Fibre Channel (16G, 10G, 10G FEC), 10 GbE (WAN, LAN), 40 GbE (4 × 10 Gbit/s), CPRI (Option 8, 9), OC-192/STM-64, OC-192/STM-64 FEC (G.975), OTU1e, OTU2, OTU2e

Excellent PPG/ED Performance

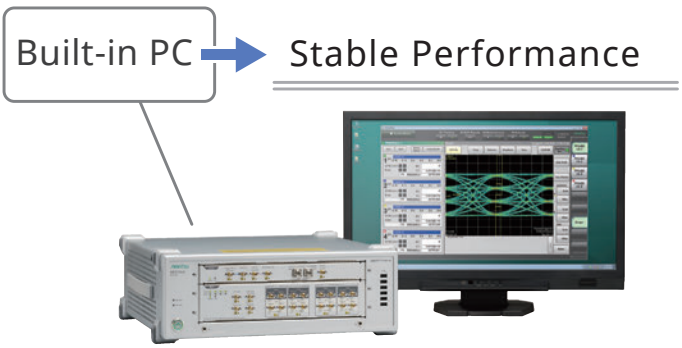
The MP2110A PPG has a low data Jitter of 600 fs rms (typ.) for accurate measurement of the characteristics of optical modules, optical devices, etc. Additionally, the 25 mV (typ.) ED supports BER measurement of low-amplitude signals resulting from transmission path losses, helping improve DUT yields.



Typical PPG Waveform
25.78125 Gbit/s Electrical Loopback Waveform
(at PRBS 31, 200 mV Amplitude, and Precision Trigger Option On)

Built-in PC for Stable Performance

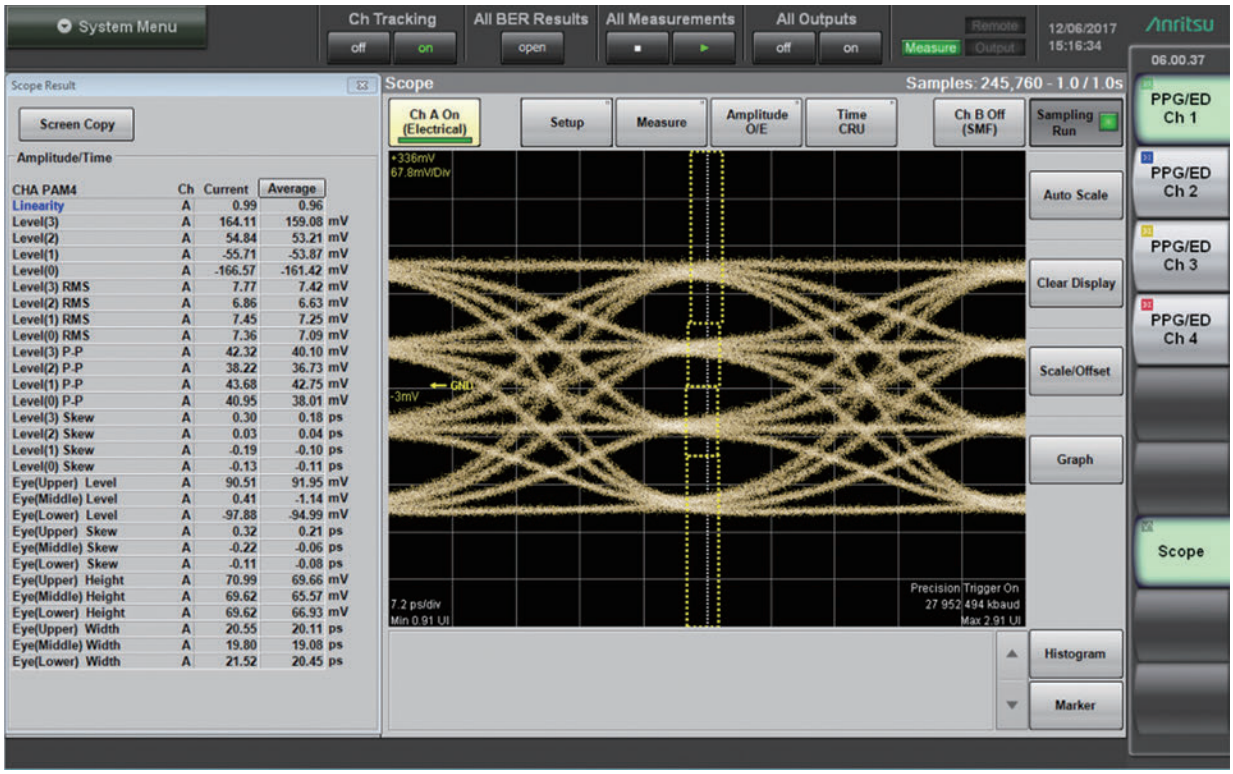
The MP2110A requires no external PC controller, because it has a built-in PC for measurement processing. Additionally, it supports high-speed processing irrespective of external PC controller specifications.



BERTWave MP2110A

Full Range of Measurement Functions (Sampling Oscilloscope)

Sampling oscilloscope supports both NRZ and PAM4 analysis.



Selected max. 32 measurement result items in following list displayed on GUI, and ALL following measurement items fetched by remote control.

NRZ

Average Power (dBm, µW)*1
Mask Margin (%)
Extinction Ratio (dB)*1
OMA (dBm, µW)*1
VECP (dB)*1
One Level, Zero Level
Eye Amplitude, Eye Height
Crossing (%)
SNR
Jitter (P-P, RMS) (ps)
Rise Time, Fall Time (ps)
Eye Width (ps)
DCD (%)

TJ (J2, J9, User Defined BER, Eye Opening)*2
RJ (d-d), RJ (rms)*2
DJ (d-d)*2
PJ (p-p), PJ Frequency*2
DDJ (p-p), DDPWS*2
DCD*2
ISI (p-p)*2

PAM4 (Option 095)

Average Power (dBm, µW)*1
TDECQ (dB)*1
Outer Extinction Ratio (dB)*1
Outer OMA (µW)*1
Linearity
Levels 0/1/2/3
Levels P-P, RMS 0/1/2/3
Level Skews 0/1/2/3 (ps)
Eye Levels Upper/Middle/Lower
Eye Heights Upper/Middle/Lower
Eye Widths Upper/Middle/Lower (ps)
Eye Skews Upper/Middle/Lower (ps)

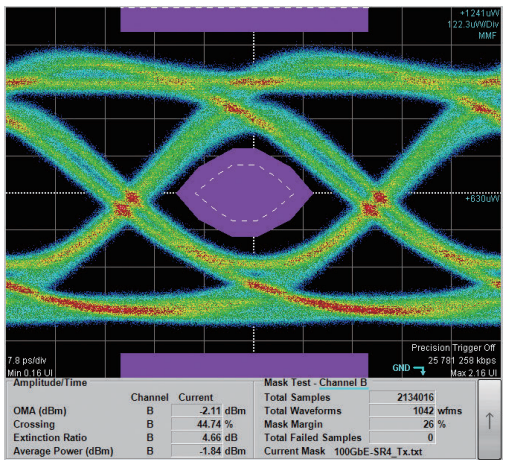
*1: Optical signals only
*2: Option 096

Full Range of Measurement Functions (Sampling Oscilloscope)

Mask Margin Measurement (NRZ)

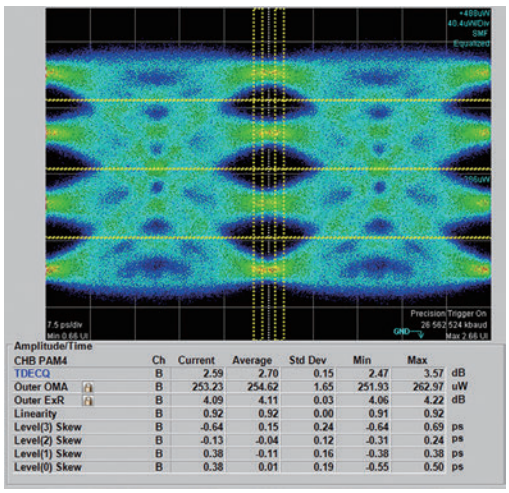
Testing is simple because Mask Margin tests are performed automatically. Furthermore, since the time required for Mask Margin tests is only about 1 second, line productivity is improved because standards-compliant measurements are performed at high speed in a shorter time.

- Automatic measurement within 1 second
- Real-time margin measurements
- Selectable Count and Rate at Mask Hit



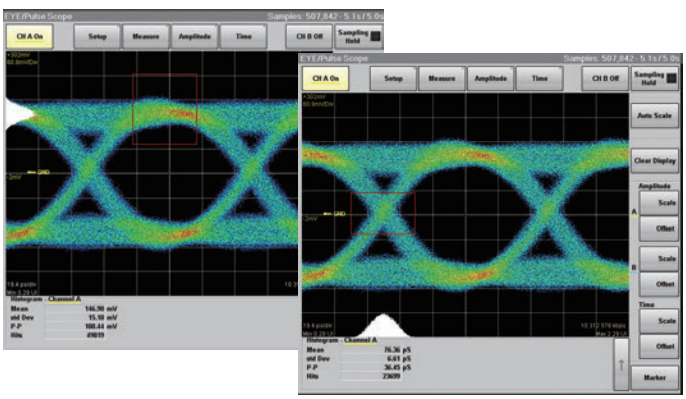
TDECQ Measurement (PAM4) (Option 095)

Easy capture of measurement results without complex settings. The low-noise (3.4 µW, typ.) high-sensitivity oscilloscope supports high-reproducibility measurement of even small Eye margin PAM4 signals. High-speed sampling shortens the time required for data collection for TDECQ analysis. Shorter measurement times help improve productivity even at PAM4 signal evaluation.



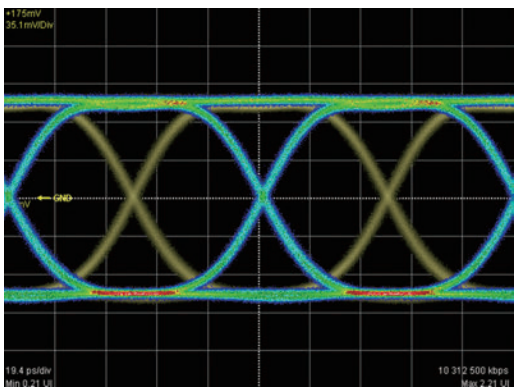
Histogram

Troubleshooting is made easier because waveform data component analysis can be performed using the mean, standard error, and scatter within the set data distribution.



Reference Trace Function

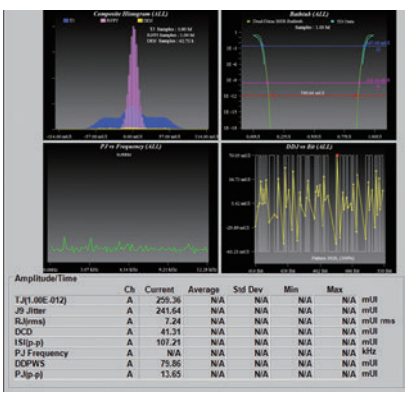
Saving measured waveform data for reference enables comparison of current data with previous data.

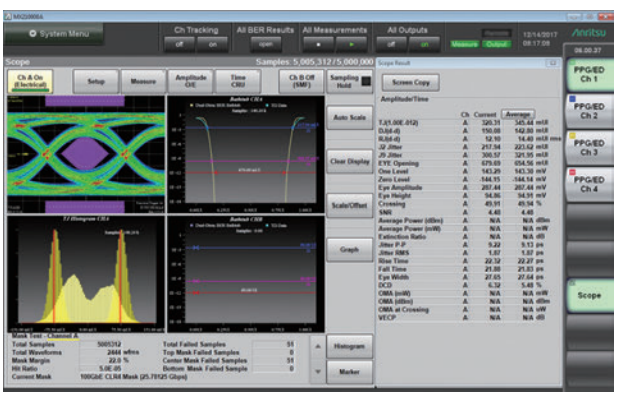


NRZ Jitter Analysis (Option 096)

This option supports separate analysis of Jitter components such as TJ, DJ, RJ, etc., with display in various graph formats.

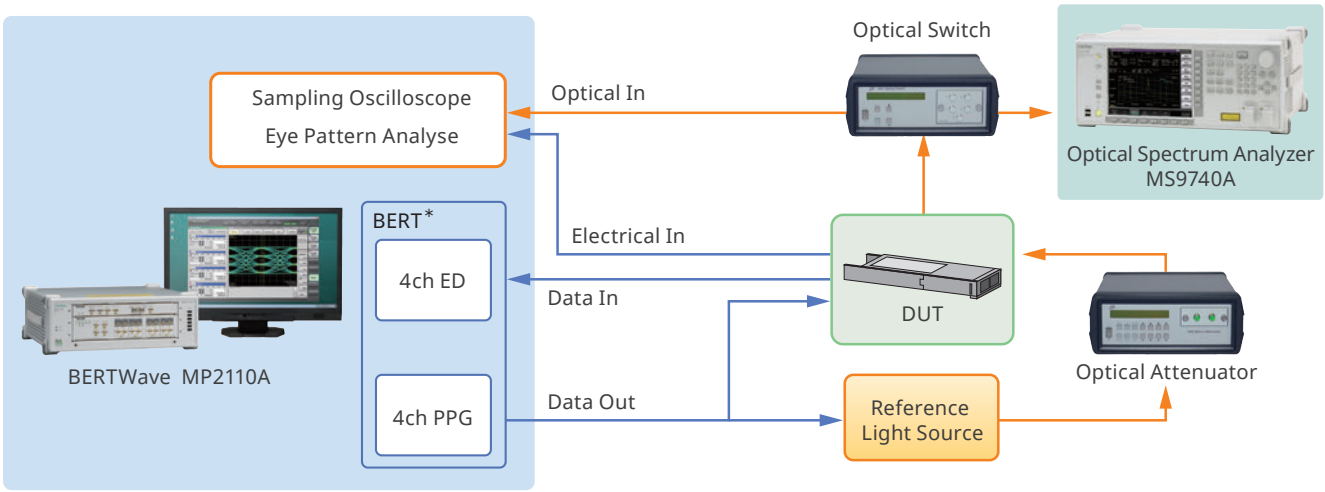
- Fast, easy J2/J9/etc. measurements for manufacturing inspections (Eye Mode)
- Detailed analyses for DJ (Advanced Jitter Mode)
- Simultaneous Jitter Analysis and Eye Mask tests help cut measurement times





Application Examples

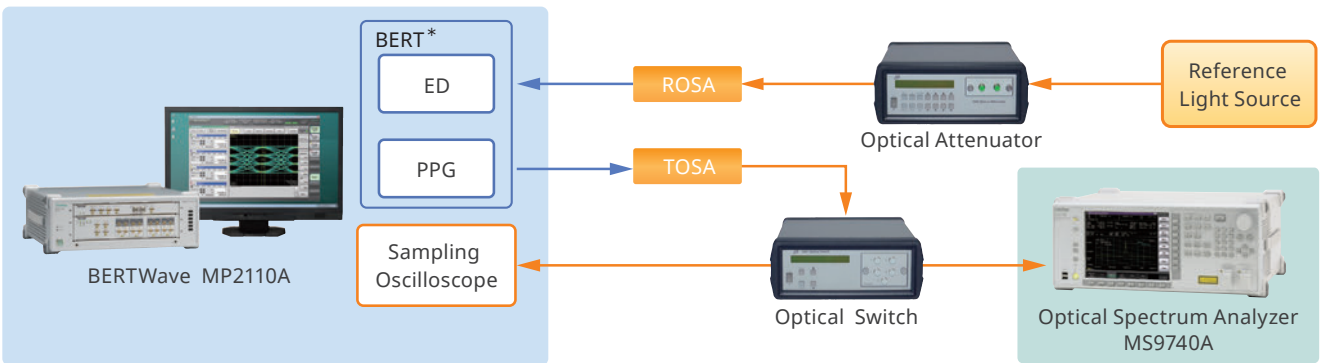
Multi-channel Optical Module Evaluation



Required Test Items

- Rx Electrical Signal Eye Pattern Analysis (NRZ: Mask Margin, Jitter, Tr/Tf, etc.)
- Tx Optical Signal Eye Pattern Analysis
  (Optical Power, NRZ: Mask Margin, Jitter, Tr/Tf, Extinction Ratio, PAM4: TDECQ, Outer OMA/Extinction Ratio, Linearity etc.)
- Rx Signal Rx Sensitivity Test (BER Measurement)

TOSA/ROSA Evaluation



Required Test Items

- Tx Optical Signal Eye Pattern Analysis
  (Optical Power, NRZ: Mask Margin, Jitter, Tr/Tf, Extinction Ratio, PAM4: TDECQ, Outer OMA/Extinction Ratio, Linearity etc.)
- Rx Signal Rx Sensitivity Test (BER Measurement)

*: Use MP1900A/MP1800A PPG/ED, etc., at PAM4 signal evaluation.

Optimized Measurement Costs

With All-in-one simultaneous BER measurements and Eye pattern analysis, the MP2110A slashes capital costs by eliminating the need to purchase a separate BERT and sampling oscilloscope. Additionally, easy expandability to up to a 4ch BERT and an optical 2ch sampling oscilloscope supports simultaneous BER measurement at the Rx side of optical modules as well as optical waveforms at the Tx side, slashing multi-channel optical module measurement times by up to 65%.

Tx/Rx Signal Mask Margin Test, Rx Signal Eye Pattern Analysis (Jitter, Tr/Tf, etc.),
Tx Signal Eye Pattern Analysis (Jitter, Tr/Tf, Extinction Ratio, etc.)

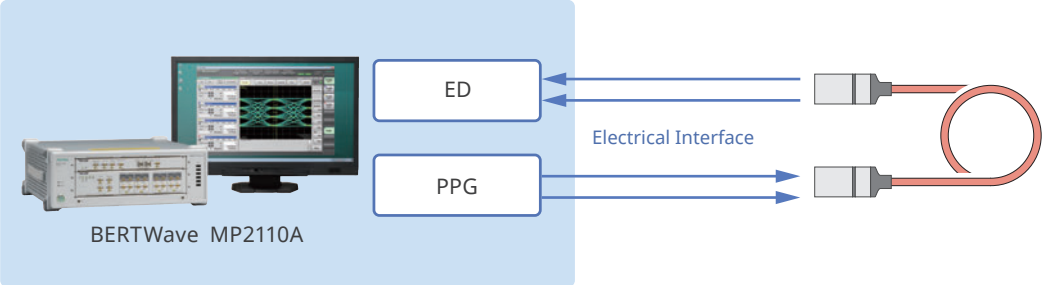
The MP2110A high sampling speed of up to 250 ksamples/s and built-in automatic Mask Margin test function cut Mask Margin test times.

Rx Signal Reception Sensitivity Test (BER Measurement)

The MP2110A BERT has a built-in PPG with a low data Jitter of just 600 fs rms (typ.) plus an ED with a high sensitivity of 25 mV (typ.).
This excellent ED performance improves line yields by supporting BER measurement of low-amplitude signals after passage through the transmission path.

BERTWave MP2110A Application Examples

Active Optical Cables (AOC)/Direct Attach Cables (DAC) Evaluation



Required Test Items

- 4ch Simultaneous BER Measurement (Crosstalk Test)
- Differential Electrical Signal Eye Pattern Analysis
- Differential Electrical Signal Jitter Analysis

4ch Simultaneous BER Measurement (Crosstalk Test)

Expanding the BERTWave series BERT to up to 4ch supports All-in-one simultaneous Tx/Rx measurements of high-speed, multi-channel AOC and DAC devices now becoming common as well as identification of crosstalk interference. Furthermore, Tx signal Eye pattern analysis is supported by installing the sampling oscilloscope option.

Excellent BERT Performance

The MP2110A BERT has a built-in PPG with a low data Jitter of just 600 fs rms (typ.) plus an ED with a high sensitivity of 25 mV (typ.).
The optical module/device can be sent a signal close to the DUT characteristics using this PPG feature, and BER measurement of low-amplitude signals after passing through the transmission path is also supported.

Differential Electrical Signal High Speed Eye Pattern/Automatic Mask Margin Tests

Eye pattern analysis of differential electrical signals is supported by installing MP2110A-021. Moreover, the MP2110A high sampling speed of up to 250 ksamples/s and built-in automatic Mask Margin measurement function cut Mask Margin test times.
Moreover, installing Option 096 supports jitter analysis of input signals.

Selection Guide by Application

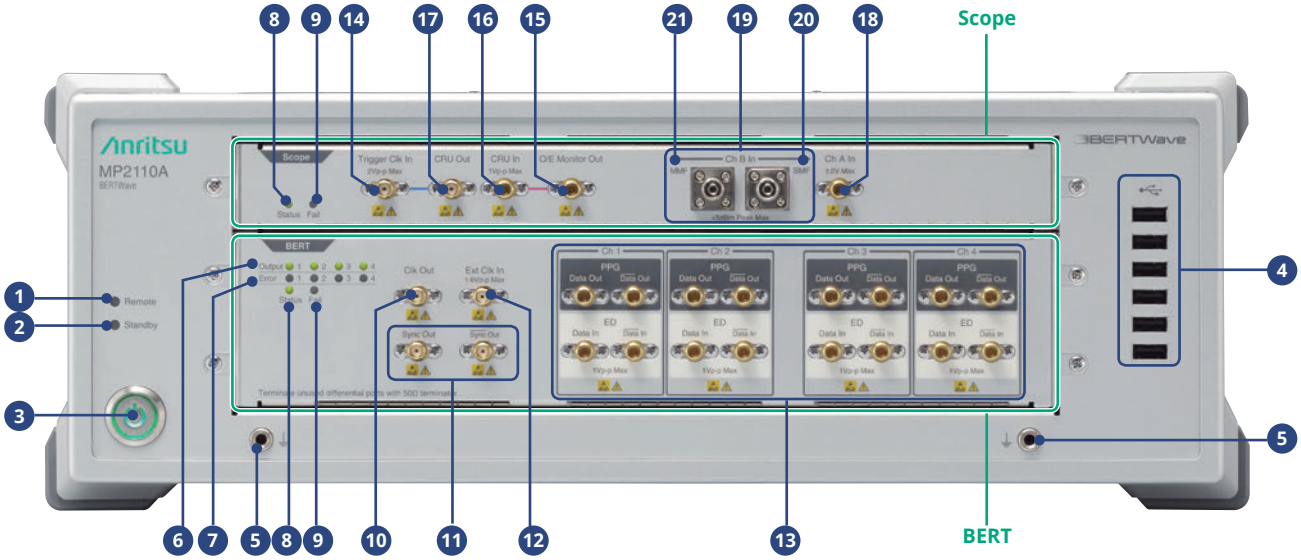
Application		Option							
		BERT	Sampling Oscilloscope						
		011/012/014	021	022/032*2	023/033*2	025/035*2	026/036*2	024	054*4
Optical Module	100GbE/200GbE/400GbE OTU4 CPRI Option 10 25/100G PON ONU	✓		✓	✓	✓	✓	✓	✓
Active Optical Cable (AOC) InfiniBand Fibre Channel	24.3 Gbaud to 28.2 Gbaud InfiniBand (EDR) Fibre Channel (32G)	✓	✓	✓	✓	✓	✓	✓	✓
	9.5 Gbaud to 14.2 Gbaud InfiniBand (FDR) Fibre Channel (10G, 14G)	✓*1	✓	✓*3	✓*3	✓*3	✓*3		
TOSA/ROSA	24.3 Gbaud to 28.2 Gbaud	✓			✓	✓	✓	✓	✓
	9.5 Gbaud to 14.2 Gbaud	✓*1			✓*3	✓*3	✓*3		
High-Speed Optical Engine	24.3 Gbaud to 28.2 Gbaud	✓		✓	✓	✓	✓	✓	✓
	9.5 Gbaud to 14.2 Gbaud	✓*1		✓*3	✓*3	✓*3	✓*3		
Direct Attach Cable (DAC)	9.5 Gbaud to 28.2 Gbaud	✓*1	✓					✓	✓

*1: MP2110A-093 required to support 9.5 Gbit/s to 14.2 Gbit/s
*2: Built-in standard Optical Channel Filter as follows.
- No Filter
- 100 GbE/4 (25.78125 Gbit/s)
- 100 GbE/4 FEC (27.7393 Gbit/s)
- OTU4 (27.952493 Gbit/s)
- 32GFC (28.05 Gbit/s)

Added filter with PAM4 (Option 095) installed as follows.
- 400 GbE/8 (26.5625 Gbaud 19.34 GHz)
- 400 GbE/8 SMF (26.5625 Gbaud TDECQ 13.3 GHz)
- 400 GbE/8 MMF (26.5625 Gbaud TDECQ 12.6 GHz)

*3: Supports No Filter only
*4: Supports 25.5 Gbaud to 28.2 Gbaud only

BERTWave MP2110A Key Arrangement



1 Remote Lamp
Lit green while MP2110A under remote control.

2 Standby Lamp
Lit orange while power supplied to MP2110A.

3 Power Switch
Lit green while MP2110A powered-on; flashes during shutdown.

4 USB Connector
USB 2.0 connector for connecting peripheral accessories, such as mouse, keyboard, etc.

5 Frame Ground
For connecting wrist strap and DUT.

6 Output Lamp
Lit green during signal output from PPG connector.

7 Error Lamp
Lit orange at following condition at ED.
- Unable to synchronize pattern (Sync Loss)
- Bit error detected

8 Status Lamp
Lit when remote command received at normal operation
Lit green at BERT
Lit green, red or orange at Sampling Oscilloscope (color indicates Trigger Clock input status)
Green: Trigger Clock detected normally
Red: No trigger Clock detected — check signal input at Trigger Clock Input connector
Orange: Trigger Clock input signal out of specified frequency range

9 Fail Lamp
Lit red when hardware fault detected.
This may light briefly at power-on, but there is no abnormality.

10 Clock Output Connector (SMA)
Outputs divided clock.

11 Sync Clock Output Connector (SMA)
Outputs PPG Sync clock.
Outputs PPG Sync clock (inverted)*.

12 External Clock Input Connector (SMA)
For input of external clock.

13 PPG Output*/ED Input Connector (K)
Panel when MP2110A-104 installed.
Can only use PPG1/ED1 when MP2110A-011 selected.
When MP2110A-012 selected, can select PPG1, PPG2/ED1 and ED2.

14 Trigger Clock Input Connector (SMA)
For trigger input.

15 O/E Monitor Out (K)*
O/E Monitor Output

16 CRU In (K)
Clock Recovery Unit Input

17 CRU Out (SMA)
Clock Recovery Unit Output

18 Ch A Input Connector (K)
For Channel A input.
Installing MP2110A-021/023/033 provides electrical connector and installing MP2110A-022/032 provides optical connector.
Not supported by MP2110A-025/026/035/036.

19 Ch B Input Connector (K)
Installing MP2110A-021 provides electrical connector and installing MP2110A-022/023/025/026/032/033/035/036 provides optical connector.

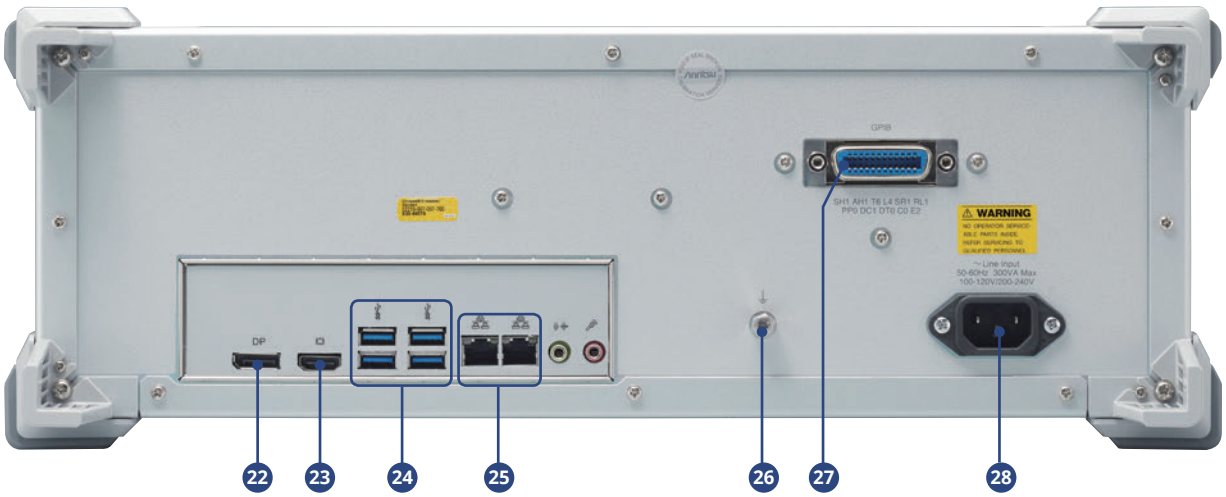
20 SMF
For input of 860 nm to 1650 nm optical signal.
Installing MP2110A-025/035 provides SMF connector only.

21 MMF
For input of 800 nm to 860 nm optical signal.
Installing MP2110A-026/036 provides MMF connector only.

*: Fit the accessory Terminator when not connected.

BERTWave MP2110A Key Arrangement

Back Panel



22 Display Port
For connecting external monitor supporting Display Port specification.

23 HDMI
For connecting external monitor supporting HDMI specification.

24 USB 3.0
For connecting accessories such as keyboard, mouse, external hard disk.

25 Ethernet
For connecting PC or network to control MP2110A remotely.

26 Frame Ground Terminal
For connecting wrist strap and DUT.

27 GPIB Connector
For connection to PC to remote control MP2110A.

28 Power Inlet
For connecting accessory power cord.

BERTWave MP2110A Specifications

Common

Remote Interfaces		Ethernet, GPIB
Peripheral Devices		HDMI, Display Port, USB3.0 (4 ports on rear panel), USB2.0 (6 ports on front panel), Ethernet (2 ports, 10/100/1000 Base-T), Line-Out, Mic
OS		Windows Embedded Standard 7
Internal Storage devices		SSD, 60 GB or more
Power Voltage		100 Vac to 120 Vac/200 Vac to 240 Vac, (100 Vac/200 Vac System Auto-switching), 50 Hz/60 Hz
Power Consumption		≤300 VA
Operating Temperature		+5° to +40°C
Storage Temperature		–20° to +60°C
Dimensions		422 (W) × 142.5 (H) × 389.4 (D) mm (excluding projections)
Mass		<11 kg
CE	EMC	EN61326-1, EN61000-3-2
	LVD	EN61010-1
	RoHS	EN50581

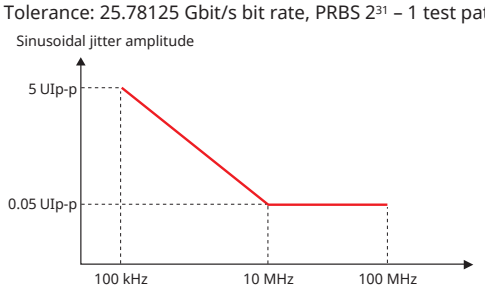
BERT (shared PPG/ED)

Internal Clock	Frequency: 10 MHz Frequency Accuracy: ±10 ppm (1 hour after power-on, design guaranteed) Bit Rate Offset:±100 ppm (common to all channels)
External Clock Input	Connector: SMA (f) Termination: 50Ω, AC coupled Amplitude: 0.2 Vp-p to 1.6 Vp-p Waveform: Square Wave or Sine Wave Division: 1/16 (at operating bit rate of 9.5 Gbit/s to 14.2 Gbit/s) 1/40 (at operating bit rate of 24.3 Gbit/s to 28.2 Gbit/s)
Clock Output	Connector: SMA (f) Termination: 50Ω, AC coupled Clock Source: Ch1/2 or Ch3/4 Division Ratio: 1/2 (at 9.5 Gbit/s to 14.2 Gbit/s operation bit rate) 1/4 (at 24.3 Gbit/s to 28.2 Gbit/s operation bit rate) Amplitude: 0.3 Vp-p to 0.5 Vp-p Duty: 50 ±10%
Sync Output	Connector: SMA (f) Division Ratio: Pattern Sync, 1/8, 1/16, 1/40 Output Level High Level (V_{OH}): –0.2 V to 0.05 V Low Level (V_{OL}): –1.2 V to –0.7 V
Operation Bit Rates	24.3 Gbit/s to 28.2 Gbit/s 9.5 Gbit/s to 14.2 Gbit/s (with MP2110A-093 installed) (in 1 kbit/s steps)

PPG

<table>
<tr><td>Data Output</td><td>
Data Output items are measured by the MP2110A sampling scope (with MP2110A-024).
The clock output is used for the external trigger (Trigger) of the sampling scope.
Number of Channels
MP2110A-011: 1 (Data Out, $\overline{\text{Data}}$ Out)
MP2110A-012: 2 (Data Out, $\overline{\text{Data}}$ Out)
MP2110A-014: 4 (Data Out, $\overline{\text{Data}}$ Out)
Connector: K (f)
Amplitude
Setting Range: 0.1 Vp-p to 0.8 Vp-p, 10 mV steps (single-end)
0.2 Vp-p to 1.6 Vp-p, 20 mV steps (differential output)
Accuracy: ±0.02 V ±20% for settings (at 25.78125 Gbit/s)
Data Crossing: 50% ±10% (at 25.78125 Gbit/s, 0.3 Vp-p Amplitude)
Tr/Tf (20 to 80%): 15 ps (typ.), 17 ps (max.) (at 25.78125 Gbit/s, 0.3 Vp-p Amplitude)
Jitter
<table>
<tr><th></th><th>Typ.</th><th>Max.</th></tr>
<tr><td>Jitter (rms)*1</td><td>600 fs*3
900 fs*4</td><td>900 fs*3
1200 fs*4</td></tr>
<tr><td>Intrinsic RJ (rms)*2</td><td>400 fs*3
800 fs*4</td><td>600 fs*3
1000 fs*4</td></tr>
</table>
*1: At 25.78125 Gbit/s, 0.3 Vp-p Amplitude, at 25° ±5°C test pattern PRBS $2^{31} - 1$
*2: At 25.78125 Gbit/s, 0.3 Vp-p Amplitude, at 25° ±5°C, 1/16 Clock Pattern
*3: With MP2110A-014 installed and when measurement channel and same channel clock source selected
Example: Ch1/2 selected as clock source and measuring Ch1
*4: With MP2110A-014 installed and when measurement channel and different channel clock source selected
Example: When Ch3/4 selected as clock source and measuring Ch1
Data Out/$\overline{\text{Data}}$ Out Skew: ±8 ps: Internal (at 25.78125 Gbit/s, 0.3 Vp-p Amplitude)
</td></tr>
<tr><td>Data Format</td><td>NRZ</td></tr>
<tr><td>Test Patterns</td><td>PRBS: $2^7 - 1$, $2^9 - 1$, $2^{15} - 1$, $2^{23} - 1$, $2^{31} - 1$
Auxiliary Pattern: 1/2 Clock Pattern, 1/16 Clock Pattern</td></tr>
<tr><td>Functions</td><td>Output On/Off, Pattern Inversion, Error addition</td></tr>
</table>

ED

<table>
<tr><td>Data Input</td><td>
Input Number
MP2110A-011: 1 (Data, $\overline{\text{Data}}$, Differential Input)
MP2110A-012: 2 (Data, $\overline{\text{Data}}$ Out, Differential Input)
MP2110A-014: 4 (Data, $\overline{\text{Data}}$ Out, Differential Input)
Connector: K (f)
Termination: DC coupling, termination voltage 0 V
Data Format: NRZ, Mark Ratio 50%, single-end or differential input
Amplitude: 0.05 Vp-p to 0.8 Vp-p
Threshold: –0.085 V to +0.085 V, 1 mV steps (single-end input, with external ATT factor of 0 dB)
Sensitivity: 25 mVp-p typ. (20° to 30°C)
40 mVp-p max.
(25.78125 Gbit/s bit rate, PRBS $2^{31} - 1$ test pattern, single-end, Mark Ratio 1/2, loopback connection)
Jitter Tolerance: 25.78125 Gbit/s bit rate, PRBS $2^{31} - 1$ test pattern, single-end, 50 mV amplitude


</td></tr>
<tr><td>Clock Recovery</td><td>Built-in</td></tr>
<tr><td>Test Patterns</td><td>PRBS: $2^7 - 1$, $2^9 - 1$, $2^{15} - 1$, $2^{23} - 1$, $2^{31} - 1$, Inverted Pattern</td></tr>
<tr><td>Measurements</td><td>
Alarm Detection: Sync Loss (test pattern and asynchronous)
Bit Error Rate Detection
Error Rate: 0.0001E–18 to 1.0000E–03
Error Count: 0 to 9999999, 1.0000E07 to 9.9999E17
Regenerating Clock Detection: Input signal frequency (sampling method)
History: Sync Loss, Bit Error (display reset supported)
</td></tr>
<tr><td>Gate Settings</td><td>
Measurement time: 1 second to 9 days 23 hours 59 minutes 59 seconds
Gating cycle: Single/Repeat/Untimed
Display update interval: Can display results during measurement (Current)
</td></tr>
</table>

Sampling Oscilloscope

Sampling Mode	Eye, Pulse, Coherent Eye, Advanced Jitter (With Option 096 installed) Sampling Speed 250 ksamples/s (nominal, Sampling Mode Eye, Number of Samples 1350, 25.78125 Gbaud bit rate, 6.4453125 GHz clock rate, 2UI bit count)
Measure Type	Amplitude/Time, Histogram, Mask Test
NRZ Measurement	Average Power (dBm, μW)*1, Extinction Ratio*1, OMA (dBm, μW)*1, OMA at Crossing*1, VECP*1, One Level, Zero Level, Eye Amplitude, Eye Height, Crossing, SNR, Jitter (p-p, RMS), Rise Time, Fall Time, Eye Width, DCD Rise/Fall Time Detection Level: 10 to 90%, 20 to 80%
NRZ Jitter Analysis (Option 096)	TJ (J2, J9, User Defined BER, Eye Opening), RJ (d-d), RJ (rms)*2, DJ (d-d), PJ (p-p)*2, PJ Frequency*2, DDJ (p-p)*2, DDPWS*2, DCD*2, ISI (p-p)*2 Graph: TJ/RJ/PJ/DDJ Histogram, DDJ vs. Bit, Bathtub, PJ vs. Frequency
PAM4 Measurement (Option 095)	Average Power (dBm, μW)*1, TDECQ*1, Outer ExR*1, Outer OMA*1, Linearity, Levels 0/1/2/3, Levels RMS (0/1/2/3), Levels P-P (0/1/2/3), Level Skews (0/1/2/3), Eye Levels (Upper/Middle/Lower), Eye Heights (Upper/Middle/Lower), Eye Widths (Upper/Middle/Lower), Eye Skews (Upper/Middle/Lower)
Mask Test	Supported Masks: Selected by filter, user created Mask Adjustment: Auto Align, user defined Margin Type: Hit Count, Hit Ratio
Skew	Time equivalent to ± (number of displayed bits)/2 UI (0.1 ps steps)

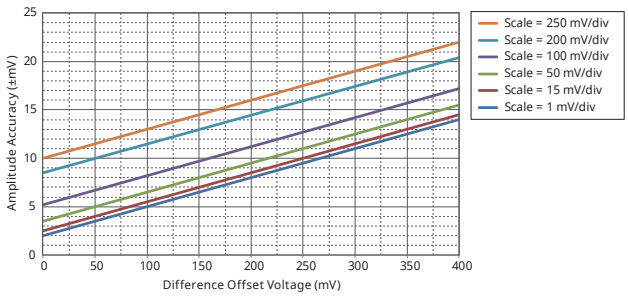
∗1: Optical signals only
∗2: Enabled when Advanced Jitter Mode

Sampling Oscilloscope (Horizontal System)

Clock Trigger Input	Connector: SMA (f), 50 A, AC coupled Frequency: 0.1 GHz to 15.0 GHz Trigger clock Sensitivity: Specified as trigger clock frequency input up to 1 GHz Typ. 100 mVp-p / 200 mVp-p (at 25°C, MP2110A-024 Precision Trigger On) Max. 200 mVp-p Max. Amplitude: 1.2 Vp-p Absolute Max input: 2 Vp-p
RMS Jitter	f: Trigger Clock Frequency

Trigger Clock Frequency (GHz)	0.1 ≤ f < 1.25	1.25 ≤ f ≤ 15
Typ.	1.0 ps	400 fs 200 fs (at 25°C, MP2110A-024 Precision Trigger On)
Max.	1.5 ps	1.35 ps 280 fs (at 25°C, MP2110A-024 Precision Trigger On)

Sampling Oscilloscope (Electrical Channel)

Data Input	Connector: K (f) Termination: 50Ω Absolute Max. Rating: ±2 V Dynamic Range: ±400 mV (Relative value of amplitude offset)
Amplitude Setting	Scale: 1 mV/Div to 200 mV/Div, 1 mV steps Offset: –500 mV to +500 mV, 1 mV steps
Amplitude Accuracy (after calibration)	± amplitude accuracy ±2% for read value (Calculation example: At 400 mV amplitude read value and 50 mV offset voltage) The following figure shows the amplitude accuracy after calibration. 
3-dB Bandwidth	40 GHz (typ.)
Flatness	±1 dB (10 MHz to 30 GHz, typ.)
RMS Noise	1.5 mV (typ.) 2.5 mV (max.)

Sampling Oscilloscope (Optical Channel)

Connector	FC Connector (changeable)
Fiber Coupling	62.5 µm GI MMF, SMF
Wavelength	SMF: 860 nm to 1650 nm MMF: 800 nm to 860 nm
Bandwidth (No Filter)	SMF: 35 GHz (typ.) MMF: 25 GHz (typ.)
Filters	NRZ: 100 GbE/4 (25.78125 Gbit/s); 100 GbE/4 FEC (27.7393 Gbit/s); OTU4 (27.952493 Gbit/s); 32GFC (28.05 Gbit/s) PAM4 (Option 095): 400 GbE/8 (26.5625 Gbaud 19.34 GHz) *1; 400 GbE/8 SMF (26.5625 Gbaud TDECQ 13.3 GHz)*1; 400 GbE/8 MMF (26.5625 Gbaud TDECQ 12.6 GHz)*1, *2 *1: Supports operation when Coherent Eye Mode and Test Pattern setting is not Variable *2: IEEE802.3cd Draft 2.0
Optical Noise	@1310 nm, OTU4 Filter: 3.4 µWrms (typ.), 4.3 µWrms (max.) / 4.8 µWrms (typ.), 6.1 µWrms (max.) @1310 nm, No Filter: 5.4 µWrms (typ.), 7.5 µWrms (max.) / 7.6 µWrms (typ.), 10.6 µWrms (max.) @850 nm, OTU4 Filter: 6.7 µWrms (typ.), 8.4 µWrms (max.) / 9.5 µWrms (typ.), 11.9 µWrms (max.) @850 nm, No Filter: 8.1 µWrms (typ.), 10.5 µWrms (max.) / 11.4 µWrms (typ.), 14.9 µWrms (max.)
Mask Margin (Estimated optical power when Mask Margin (Hit Count 0) reaches 0% (calculated from optical noise))	SMF (typ., 1310 nm, OTU4 Filter): –15.0 dBm / –12.0 dBm MMF (typ., 850 nm, OTU4 Filter): –12.0 dBm / –9.0 dBm
Amplitude Setting	Scale: 1 µW/Div to 200 µW/Div, 1 µW steps Offset: –500 µW/Div to 500 µW/Div, 1 µW steps
Max. Input Power (Non-Saturated Range)	SMF: –2 dBm (typ., at monitoring 1310 nm, 8 dB extinction ratio signal) MMF: 0 dBm (typ., at monitoring 850 nm, 3 dB extinction ratio signal)
Absolute Max. Rating (Damage-free Range)	Average Value: +5 dBm (SMF) / +7 dBm (MMF) Peak: +8 dBm (SMF) / +10 dBm (MMF)
Optical Return Loss	SMF: –27 dB (typ., at 1310 nm SMF connection) MMF: –20 dB (typ., at 850 nm MMF connection)
Optical Parameters	Range: –18 to 0 dBm Accuracy p: Input Level Input Level (dBm): –18 ≤ p < –12 / –12 ≤ p ≤ 0 Accuracy (typ.): ±0.6 dB / ±0.35 dB
O/E Monitor Out (Only with Option 054 installed)	Connector: K (f) Conversion Gain: 60 V/W (SMF input, typ.), 33 V/W (MMF input, typ.)

Clock Recovery (Electrical/Optical) (Option 054)

CRU Input	Connector: K (f), 50Ω, AC coupled Data Format: NRZ, PAM4 Bit Rate: 25.5 Gbaud to 28.2 Gbaud Input Sensitivity: 10 mVp-p (typ.)*1, *2, 20 mVp-p (max.)*2 Max. Amplitude: 800 mVp-p Absolute Maximum Input: 1 Vp-p Withstand Contiguous 0 s: 500 bits min. at PRBS 2^{15} – 1 Zero Substitution Pattern
CRU Output	Connector: SMA (f), 50Ω, AC coupled In Recovery Mode Amplitude: 480 mVp-p (typ.) Clock frequency: 12.75 GHz to 14.1 GHz (half-rate Clock) Additive Jitter: 250 fs rms (typ.)*1, *3, 400 fs rms (max.)*3 Loop Bandwidth: 4 MHz, 10 MHz, bit rate/1667 selected, –20 dB/dec attenuation In Through Mode Amplitude: 500 mVp-p (typ.) Operation Frequency: 0.1 GHz to 1.7625 GHz (1.7625 GHz requires 28.2 GHz 1/16 Clock) Additive Jitter: 200 fs rms (typ.)*1, *4, 400 fs rms (max.)*4

*1: 25 ±5°C
*2: NRZ, at 25.78125 Gbit/s, PRBS 2^{31} – 1, 10-MHz Loop Bandwidth, using MP2110A PPG
*3: NRZ, at 25.78125/26.5625/28.05 Gbit/s, 400 ±100 mVp-p, 1/4 Clock Pattern, 10-MHz Loop Bandwidth, using MP2110A PPG
*4: NRZ, at 25.78125/26.5625/28.05 Gbit/s, 400 mVp-p, 1/16 Clock Pattern, using MP2110A PPG

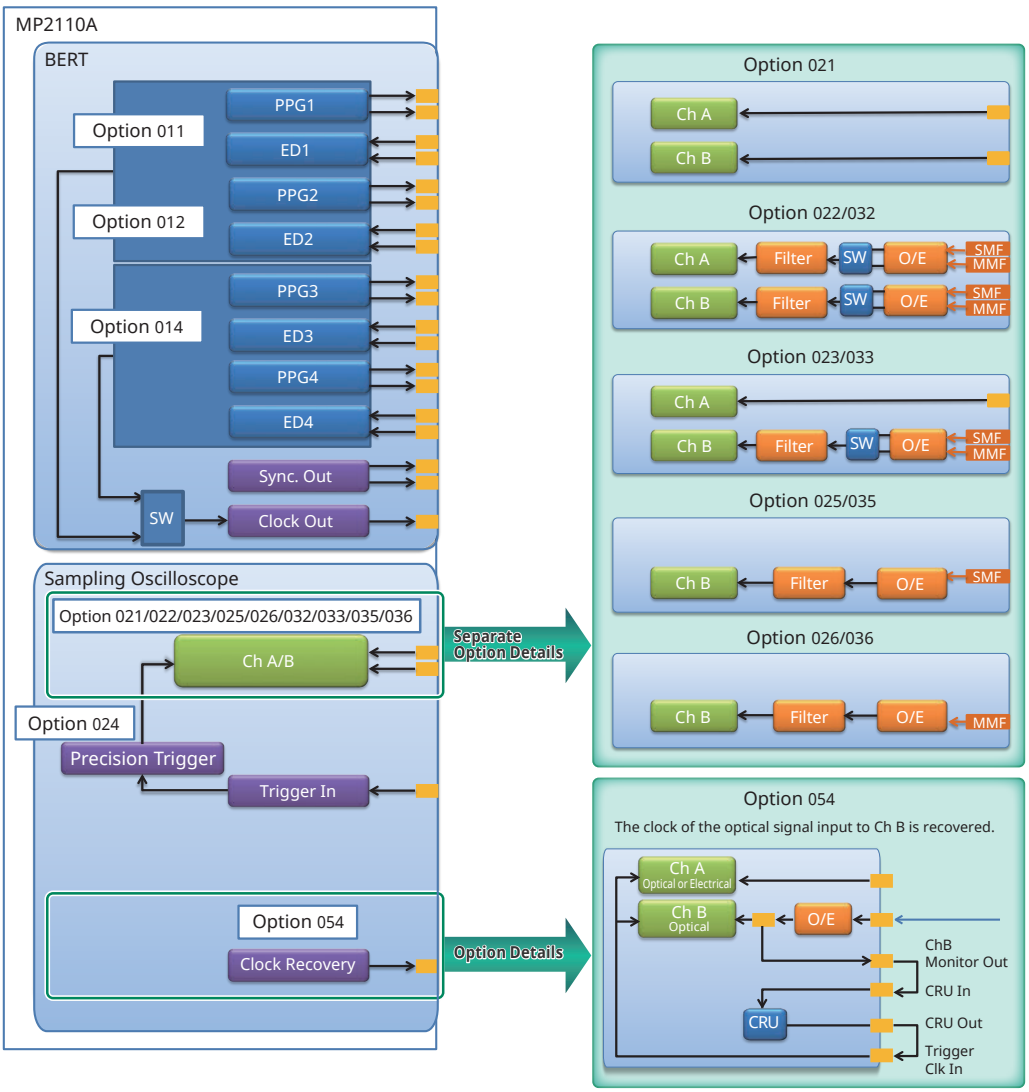
Selection Guide

Either a BERT or a sampling oscilloscope, or both a BERT and a sampling oscilloscope can be selected for the MP2110A.
Select by referring to the following table and block diagram.

Function			Selection/Option Addition
BERT	Select any one	1ch	MP2110A-011
		2ch	MP2110A-012
		4ch	MP2110A-014
	Select as addition	PPG/ED Bit Rate Extension Adds bit rates of 9.5 Gbit/s to 14.2 Gbit/s to standard range of 24.3 Gbit/s to 28.2 Gbit/s.	MP2110A-093
Sampling Oscilloscope	Select any one	Differential Electrical	MP2110A-021
		Optical 2ch*1	MP2110A-022 or MP2110A-032*2
		E/O*1	MP2110A-023 or MP2110A-033*2
		1ch SMF Optical*1	MP2110A-025 or MP2110A-035*2
		1ch MMF Optical*1	MP2110A-026 or MP2110A-036*2
	Select as addition	Precision Trigger Supports high-accuracy jitter measurement	MP2110A-024
		Clock Recovery (Electrical/Optical) Recovers Clock from input data signal	MP2110A-054
		PAM4 Analysis Software Supports PAM4 signal analysis	MP2110A-095
		Jitter Analysis Software Supports NRZ signal Jitter analysis	MP2110A-096

∗1: The Single Mode (SMF) supports optical signals of 860 nm to 1650 nm; the Multi Mode (MMF) supports optical signals of 800 nm to 890 nm.
∗2: Option 02x and Option 03x have different optical channel reference receiver characteristics (Bessel filter approximation characteristics).
Option 03x is adjusted for a smooth roll-off characteristic at the low-frequency side.

Block Diagram



BERTWave MP2110A Ordering Information

When making a contract, determine the configuration by referencing the selection guide and specify the type, model, name, and quantity.
The names listed in the chart below are Order Names. The actual name of the item may differ from the Order Name.

Model/Order No.	Name	
	–Main Frame–	
MP2110A	BERTWave	
	–Standard Accessories–	
	Power Cord	
J1627A	GND Connection Cable:	1
	MX210000A BERTWave Control Software CD-ROM:	1
	–Options–	
MP2110A-011	1ch BERT	
MP2110A-012	2ch BERT	
MP2110A-014	4ch BERT	
MP2110A-021	Dual Electrical Scope	
MP2110A-022	Dual Optical Scope	
MP2110A-023	Optical and Single-ended Electrical Scope	
MP2110A-024	Precision Trigger	
MP2110A-025	Optical Scope for Singlemode	
MP2110A-026	Optical Scope for Multimode	
MP2110A-032	Dual Optical Scope Baseband Flat	
MP2110A-033	Optical and Single-ended Electrical Scope Baseband Flat	
MP2110A-035	Optical Scope for Singlemode Baseband Flat	
MP2110A-036	Optical Scope for Multimode Baseband Flat	
MP2110A-054	Clock Recovery (Electrical/Optical)	
MP2110A-093	PPG/ED Bit Rate Extension	
MP2110A-095	PAM4 Analysis Software	
MP2110A-096	Jitter Analysis Software	
	–Retrofit Options–	
MP2110A-111	1ch BERT Retrofit	
MP2110A-112	2ch BERT Retrofit	
MP2110A-114	4ch BERT Retrofit	
MP2110A-121	Dual Electrical Scope Retrofit	
MP2110A-122	Dual Optical Scope Retrofit	
MP2110A-123	Optical and Single-ended Electrical Scope Retrofit	
MP2110A-124	Precision Trigger Retrofit	
MP2110A-125	Optical Scope for Singlemode Retrofit	
MP2110A-126	Optical Scope for Multimode Retrofit	
MP2110A-132	Dual Optical Scope Baseband Flat Retrofit	
MP2110A-133	Optical and Single-ended Electrical Scope Baseband Flat Retrofit	
MP2110A-135	Optical Scope for Singlemode Baseband Flat Retrofit	
MP2110A-136	Optical Scope for Multimode Baseband Flat Retrofit	
MP2110A-154	Clock Recovery (Electrical/Optical) Retrofit	
MP2110A-193	PPG/ED Bit Rate Extension Retrofit	
MP2110A-395	PAM4 Analysis Software Retrofit	
MP2110A-396	Jitter Analysis Software Retrofit	
	–Standard Accessories MP2110A-011–	
J1632A	Terminator:	3
J1341A	Open:	5
	–Standard Accessories MP2110A-012–	
J1632A	Terminator:	5
J1341A	Open:	7
	–Standard Accessories MP2110A-014–	
J1632A	Terminator:	9
J1341A	Open:	11
	–Standard Accessories MP2110A-021–	
J1341A	Open:	3
	–Standard Accessories MP2110A-022/032–	
J0617B	Replaceable Optical Connector (FC-PC):	4
Z0397A	FC ADAPTER CAP:	4
J1341A	Open:	1
	–Standard Accessories MP2110A-023/033–	
J0617B	Replaceable Optical Connector (FC-PC):	2
Z0397A	FC ADAPTER CAP:	2
J1341A	Open:	2
	–Standard Accessories MP2110A-025/035–	
J0617B	Replaceable Optical Connector (FC-PC):	1
Z0397A	FC ADAPTER CAP:	1
J1341A	Open:	1

Model/Order No.	Name	
	–Standard Accessories MP2110A-026/036–	
J0617B	Replaceable Optical Connector (FC-PC):	1
Z0397A	FC ADAPTER CAP:	1
J1341A	Open:	1
	–Standard Accessories MP2110A-054–	
J1632A	Terminator:	1
J1341A	Open:	2
J1763A	U Link Coaxial Cable (K):	1
J1764A	U Link Coaxial Cable (SMA):	1
	–Optional Accessories–	
B0734A	Carrying Case	
B0735A	Rack Mount Kit	
G0342A	ESD DISCHARGER	
G0364A	100G LR4 1310 nm QSFP28	
G0366A	100G SR4 850 nm QSFP28	
J0617B	Replaceable Optical Connector (FC-PC)	
J0618D	Replaceable Optical Connector (ST)	
J0618E	Replaceable Optical Connector (DIN)	
J0619B	Replaceable Optical Connector (SC)	
J0635A	FC · PC-FC · PC-1M-SM	
J0660A	SC · PC-SC · PC-1M-SM	
J0839A	SC · PC-SC · PC-1M-GI	
J0893A	FC · PC-FC · PC-1M-GI	
J1632A	Terminator	
J1139A	FC · PC-LC · PC-1M-SM	
J1341A	Open (Coaxial connector cover)	
J1342A	Coaxial Cable 0.8 m	
J1343A	Coaxial Cable 1 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	
J1359A	Coaxial Adaptor (K-P · K-J, SMA compatible)	
J1439A	Coaxial Cable (0.8 m, K connector)	
J1763A	U Link Coaxial Cable (K)	
J1764A	U Link Coaxial Cable (SMA)	
J1510A	Pick OFF Tee	
J1519A	Optical Fiber Cord (MM, 12FIBER, MPO,3M)	
J1551A	Coaxial Skew Match Cable (0.8 m, K connector)	
J1681A	MPO Loopback Cable	
J1682A	MPO to FC convert cable	
W3831AE	MP2110A BERTWave Operation Manual	
W3773AE	BERTWave Series Remote Control Operation Manual	
Z0306A	List Wrap	
Z0397A	FC ADAPTER CAP	
Z0541A	USB Mouse	
Z0914A	Ferrule Cleaner	
Z0915A	Replacement Reel for Ferrule Cleaner	
Z1944A	LCD Monitor	
Z1952A	HDMI to VGA Adapter	

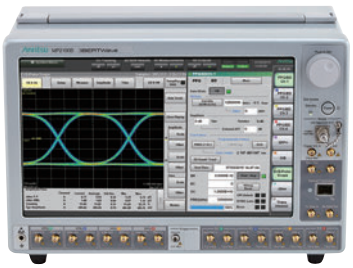
BERTWave MP2110A Related Products

BERTWave MP2100B

For R&D and Manufacturing of 10G and 40G Multi-channel Optical Modules

- All-in-one BER and Eye-pattern analysis
- Built-in 1ch to 4 ch 12.5 Gbit/s BERT
- High-speed mask tests
- Jitter 1 ps high-quality PPG and 10 mVp-p high-sensitivity ED

The all-in-one MP2100B has a built-in BER tester and sampling oscilloscope for running simultaneous BER tests and eye pattern analyses required for developing and manufacturing modules. The number of BERT channels can be expanded to four, all supporting simultaneous BER measurements. Additionally, the high sampling speed reduces the eye pattern measurement time. Multi-channel optical modules, such as QSFP+, can be measured more efficiently using the MP2100B.



Optical Spectrum Analyzer MS9740A

Faster measurement speed shortens measurement time and improves production efficiency

- 600 nm to 1750 nm
- Faster measurement speed of <0.2 s/5 nm reduces total analysis time for active optical devices
- Built-in applications for evaluating active optical devices
- Excellent cost performance
- >58 dB dynamic range (0.4 nm from peak wavelength)
- 30 pm minimum resolution
- Low power consumption (75 VA), light weight (15 kg max.)

The MS9740A reduces production costs by shortening active optical device evaluation times and supporting efficient analysis applications.

Optical Attenuator G035xF/S

This bench-top optical attenuator has an optical attenuation of 60 dB. Support for remote control over GPIB makes it easy to configure a remote measurement setup in combination with the the BERTWave series.
Choose the model with the correct fiber connectors for the application.

Model/Order No.	Name
G0350F*	Programmable Optical Attenuator (SM9, FC/UPC)
G0350S*	Programmable Optical Attenuator (SM9, SC/UPC)
G0351F*	Programmable Optical Attenuator (SM9, FC/UPC, Power Monitor)
G0351S*	Programmable Optical Attenuator (SM9, SC/UPC, Power Monitor)
G0352F*	Programmable Optical Attenuator (GI50, FC/UPC)
G0352S*	Programmable Optical Attenuator (GI50, SC/UPC)
G0353F*	Programmable Optical Attenuator (GI50, FC/UPC, Power Monitor)
G0353S*	Programmable Optical Attenuator (GI50, SC/UPC, Power Monitor)
G0354F*	Programmable Optical Attenuator (GI62.5, FC/UPC)
G0354S*	Programmable Optical Attenuator (GI62.5, SC/UPC)
G0355F*	Programmable Optical Attenuator (GI62.5, FC/UPC, Power Monitor)
G0355S*	Programmable Optical Attenuator (GI62.5, SC/UPC, Power Monitor)

*: KC Mark not support

Optical Switch G034xF/S

This bench-top optical switch supports 1×4, 2×4, and 1×16 switching. Support for remote control over GPIB makes it easy to configure a remote measurement setup in combination with the the BERTWave series.
Choose the model with the correct fiber connectors for the application.

Model/Order No.	Name
G0344F*	Optical Switch (1×4, SM9, FC/UPC)
G0344S*	Optical Switch (1×4, SM9, SC/UPC)
G0345F*	Optical Switch (1×16, SM9, FC/UPC)
G0345S*	Optical Switch (1×16, SM9, SC/UPC)
G0346F*	Optical Switch (1×4, GI50, FC/UPC)
G0346S*	Optical Switch (1×4, GI50, SC/UPC)
G0347F*	Optical Switch (1×4, GI62.5, FC/UPC)
G0347S*	Optical Switch (1×4, GI62.5, SC/UPC)
G0348F*	Optical Switch (2×4, GI50, FC/UPC)
G0348S*	Optical Switch (2×4, GI50, SC/UPC)
G0349F*	Optical Switch (2×4, GI62.5, FC/UPC)
G0349S*	Optical Switch (2×4, GI62.5, SC/UPC)

*: KC Mark not support

Note:

Note:

Note:

Anritsu envision : ensure

Specifications are subject to change without notice.

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