BERTWave™
MP2110A

All In One
4ch BERT+ Sampling Oscilloscope
Reduce cost. Increase productivity.


BERTWave MP2110A

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


BERTWave MP2110A
Multi-channel Optical Module, Device Manufacturing and Development

Data traffic volumes are exploding with the spread of fixed-rate video streaming and cloud services. As a result, there is a need for optical interfaces for transmission equipment supporting speeds of more than 10 Gbit/s as 100 GbE and even 200 GbE and 400 GbE networks are deployed. However, there are increasing requests for less-expensive optical interfaces due to major problems with how to increase line productivity and cut costs.

The BERTWave MP2110A is an all-in-one instrument with built-in BERT (Bit Error Rate Tester) and Sampling Oscilloscope (Eye pattern analysis) designed for manufacturing inspection of 100, 200, and 400G optical modules. It helps increase line productivity and cuts costs.

**Multi-channel Measurement**
- Captures 1 million samples in about 5 seconds
- 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 4ch 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
- Both NRZ and PAM4 signals are supported, and there is a built-in Clock Recovery Unit for Sampling Oscilloscope.

**Supported Applications: Evaluation of physical-layer performance for 25G/50G/100G/200G/400G optical transport modules, optical cables, and associated parts used by data centers, Core/Metro networks, 4G/5G mobile backhaul, and 5G mobile fronthaul**

Transmission Paths: Ethernet, eCPRI/RoE, CPRI, SDH/SONET, OTN, InfiniBand, Fibre Channel
Optical Transceiver Modules: SFP28, QSFP28, CFP2/4/8, SFP56, QSFP56, OSFP, QSFP-DD
Cables: Active Optical Cables (AOC), Direct Attach Cables (DAC)
Devices: TOSA, ROSA, High-Speed Optical Engine, PHY, Driver ICs
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.

Installing the BERT and sampling-oscilloscope options for up to 4ch in one unit makes it easy to implement simultaneous TRx measurements of optical modules, such as multichannel QSFP, and devices using an easily configured and controlled measurement system. This helps cut growing measurement times as the number of channels increases with development of multichannel optical modules and devices.

Configuring Efficient Measurement System: Integrated BERT and Sampling Oscilloscope

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.

Simply setting one channel of the MP2110A sets all channels simultaneously.

Operation is easy with simple settings and user interface. Remote commands are backwards-compatible with all BERTWave series, such as the MP2100B, facilitating instrument upgrades.

BER measurement results (left) and Eye Pattern analysis results (right) are displayed simultaneously.
Configuring Efficient Measurement System: 
Both Simultaneous All-Channel and Individual-Channel Measurement

As well as all-at-once simultaneous measurement of all channels using the sampling oscilloscope and BERT, individual channels can be measured separately. An evaluation system matching the application can be configured easily because both multichannel modules and multiple single-channel modules can be measured all at once.

Simultaneous All-Channel Measurement

Individual-Channel Measurement

All-at-once testing of 4-waveform module using simultaneous measurement of all channels

Parallel testing of four separate 1-waveform modules using separate measurement of each channel

Shorter test times increase throughput

Reduced cost per channel cuts capital investment

Supports Both Test Methods

4ch PAM4 TDECQ Measurement

4ch NRZ Mask Margin Measurement
Configuring Efficient Measurement System: Built-in Clock Recovery

Sampling oscilloscopes for signal waveform quality evaluation require a separate trigger clock signal synchronized with the data signal, but transmission equipment with built-in optical modules and 100G to 400G optical modules outputting PAM4 signals sometimes do not have a trigger signal. In this case, the trigger signal is generated from the data signal using clock recovery. This optional Clock Recovery Unit (CRU) can be installed in the BERTWave MP2110A Sampling Oscilloscope.

53G Clock Recovery (Option 055)
25.5 to 28.9, and 51 to 58 Gbaud
Single Mode

26G Clock Recovery (Option 054)
25.5 to 28.2 Gbaud
Single Mode/Multimode/Electrical

All optical modules measured with one unit

4ch multi-channel measurement also supported

Excellent Operability at Lower Cost
Since this clock recovery is built-in, it offers excellent operability at a lower price. The space-saving design and reduced need for complex cable connections as well as the easy-to-use settings help cut initial capital costs.

Wide Range of High-Performance Applications
The following clock recovery unit options are available:

- Option 055: Supports newest 53 Gbaud PAM4 signals (106 Gbit/s)
- Option 054: Supports 26 Gbaud multimode signals

These options can be combined freely to configure a flexible test system matching the site requirements at optimum cost. When all options are installed, various types of 100/200/400GbE optical modules can be evaluated without a trigger clock using one MP2110A unit.

In addition, combination with a 4ch oscilloscope supports all-at-once measurement using the recovered trigger signal to help cut evaluation times for multichannel optical modules.

High Performance
When using high-sensitivity modules, the impact of insertion loss on the data waveform is minimized by optimizing internal division ratios, demonstrating its usefulness when monitoring signal waveforms requiring high sensitivity. Additionally, there is no waveform degradation due to multimode splitting because Option 054 performs signal splitting for input to the CRU and oscilloscope using electrical signals after O/E conversion.

Without CRU
Without CRU

Almost no impact on Mask Margin*
Without CRU

With CRU

*: Waveform comparison at –2 dBm input
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
- High Sensitivity: –15 dBm (typ. SMF)
- Low Noise: 3.4 µW (typ. SMF)
- Low-Jitter: 200 fs rms (typ.)

The low-noise and high-sensitivity O/E plus low-jitter trigger support more accurate measurements of narrow Eye openings of PAM4 signals as well as attenuated signals passing through optical switches, etc., helping improve production-line yields.

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.
Selection of displays for up to 32 measurement items supports confirmation of multiple PAM measurement results at one screen. Additionally, all measurement results, including items not displayed on-screen, can be captured simultaneously using 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, Eye Height Ratio
- Crossing (%)
- SNR
- Jitter (P-P, RMS) (ps)
- Rise Time, Fall Time (ps)
- Eye Width (ps)
- DCD (%)
- RIN OMA
- TDEC*2
- TJ (J2, J4, J9, User Defined BER), Eye Opening*3
- RJ (d-d), RJ (rms)*3
- DJ (d-d)*3
- PJ (p-p), PJ Frequency*3
- DDJ (p-p), DDPWS*3
- DCD*3
- ISI (p-p)*3

**PAM4 (Option 095)**
- Average Power (dBm, μW)*1
- TDECQ (dB), Partial TDECQ, Ceq*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 (ps)
  - Eye Skews Upper/Middle/Lower (ps)
  - RIN OMA

*1: Optical signals only
*2: No IEEE 12.6 GHz hardware filter
*3: Option 096
Full Range of Measurement Functions (Sampling Oscilloscope)

NRZ Mask Margin Measurement
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

PAM4 TDECQ Measurement (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.

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

Histogram Measurement
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.
More Accurate Performance Confirmation: BERT Performance

**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.

<table>
<thead>
<tr>
<th>PPG/ED Supported Bit Rates</th>
<th>Application Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.3 Gbit/s to 28.2 Gbit/s</td>
<td>32G Fibre Channel, CPRI (Option 10), InfiniBand EDR, 100 GbE, 100 GbE FEC, OTU4</td>
</tr>
<tr>
<td>9.5 Gbit/s to 14.2 Gbit/s (Option 093)</td>
<td>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</td>
</tr>
</tbody>
</table>

**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.

**Fast and Stable Measurement Performance**
The MP2110A supports high-speed sampling at 250 ksamples/s. Measurement of 1 million samples can be completed in about 5 s, cutting pattern analysis time by about 65% compared to previous instruments.

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

Front Panel

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.

Back Panel

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

7 HDMI
   For connecting external monitor supporting HDMI specification.

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

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

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

11 Power Inlet
   For connecting accessory power cord.
**Status Lamp**
Lit when remote command received at normal operation. 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: Incorrect trigger clock input frequency setting

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

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

**Channel A/B/C/D Input (K or FC)**
This is the oscilloscope signal input. The connector type differs depending on the option. The electrical channel uses a K-connector. The optical channel SMF and MMF can be switched.

**Clock Recovery Unit Output (SMA) (Option 054)**
Connect the standard accessory U-link coaxial cable (SMA) to the Trigger Clk In connector for use.

**Clock Recovery Unit Input (K) (Option 054)**

**O/E Monitor Output (K) (Option 054, Optical channel installed)**
Connect the standard accessory U-link coaxial cable (K) to the CRU In connector for use. Always fit the standard accessory coaxial terminator when not connected.

* Fit the accessory Terminator when not connected. The signal cannot be monitored correctly without termination.
19 **Status Lamp**  
Lit when receiving remote commands at normal start operation. Color indicates clock recovery lock status.  
Green: Locked  
Red: Unlocked (no signal input)  
Orange: Unlocked (incorrect rate setting)

20 **Recovered Clock Output (SMA)**  
Clock Recovery Unit output. Connected to Trigger Clk In.

21 **Data Output (FC)**  
Branch data input signal output. Connected to oscilloscope SMF optical signal input (Ch A/B/C/D In).

22 **Data Input (FC)**  
SM Optical Data signal input

23 **Output Lamp**  
Lit green during signal output from PPG connector.

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

25 **Status Lamp**  
Lit green when receiving remote commands at normal start operation

26 **Clock Output Connector (SMA)**  
Outputs divided clock.

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

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

29 **PPG Output+/ED Input Connector (K)**  
Photograph shows configuration with Option 014 (4ch) installed; Option 011 adds 1ch and Option 012 adds 2ch.  
*: Fit the accessory Terminator when not connected.
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 4ch 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.

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.

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.
## BERTWave MP2110A Specifications

### Common

<table>
<thead>
<tr>
<th>Remote Interfaces</th>
<th>Ethernet, GPIB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peripheral Devices</td>
<td>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</td>
</tr>
<tr>
<td>* Screen output requires a display with a resolution of 1280 × 800 or higher</td>
<td></td>
</tr>
<tr>
<td>OS</td>
<td>Windows Embedded Standard 7</td>
</tr>
<tr>
<td>Internal Storage devices</td>
<td>SSD, 60 GB or more</td>
</tr>
<tr>
<td>Power Voltage</td>
<td>100 Vac to 240 Vac, (100 Vac/200 Vac System Auto-switching), 50 Hz/60 Hz</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>≤300 VA</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>+5°C to +40°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>−20°C to +60°C</td>
</tr>
<tr>
<td>Dimensions</td>
<td>422 (W) × 142.5 (H) × 389.4 (D) mm (excluding projections)</td>
</tr>
<tr>
<td>Mass</td>
<td>&lt;11 kg</td>
</tr>
<tr>
<td>CE</td>
<td>2014/30/EU, EN61326-1, EN61000-3-2</td>
</tr>
<tr>
<td>LVD</td>
<td>2014/35/EU, EN61010-1</td>
</tr>
<tr>
<td>RoHS</td>
<td>2011/65/EU, EN50581</td>
</tr>
</tbody>
</table>

### 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 (VH): −0.2 V to 0.05 V  
Low Level (VL): −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 Option 093 installed)  
in 1 kbit/s steps |
## PPG

<table>
<thead>
<tr>
<th>Number of Channels</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP2110A-011: 1 (Data Out, Data Out)</td>
</tr>
<tr>
<td>MP2110A-012: 2 (Data Out, Data Out)</td>
</tr>
<tr>
<td>MP2110A-014: 4 (Data Out, Data Out)</td>
</tr>
<tr>
<td>Connector: K (f)</td>
</tr>
</tbody>
</table>

**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>
<thead>
<tr>
<th>Jitter (rms)</th>
<th>Typ.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1: At 25.78125 Gbit/s, 0.3 Vp-p Amplitude, at 25°C ±5°C test pattern PRBS 2\(^{31} – 1\)
*2: At 25.78125 Gbit/s, 0.3 Vp-p Amplitude, at 25°C ±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/Out Skew:** ±8 ps: Internal (at 25.78125 Gbit/s, 0.3 Vp-p Amplitude)

**Data Format:** NRZ

**Test Patterns:** 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

**Functions:** Output On/Off, Pattern Inversion, Error addition

## ED

**Input Number**

| MP2110A-011: 1 (Data, Data, Differential Input) |
| MP2110A-012: 2 (Data, Data Out, Differential Input) |
| MP2110A-014: 4 (Data, Data Out, Differential Input) |
| Connector: K (f) |
| Termination: 50Ω, AC coupled * The DC component is terminated to GND via a 50Ω |

**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°C to 30°C)
- 40 mVp-p max.

**Clock Recovery**

- Built-in

**Test Patterns**

- PRBS: 2\(^{7} – 1\), 2\(^{9} – 1\), 2\(^{15} – 1\), 2\(^{23} – 1\), 2\(^{31} – 1\), Inverted Pattern

**Measurements**

- 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 99999999, 1.0000E07 to 9.9999E17
- Regenerating Clock Detection: Input signal frequency (sampling method)
- History: Sync Loss, Bit Error (display reset supported)

**Gate Settings**

- 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)
BERTWave MP2110A Specifications

### Sampling Oscilloscope

**Sampling Mode**
- Eye, Pulse, Coherent Eye, Advanced Jitter (Option 096)
- 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)

**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, Eye Height Ratio, Crossing, SNR, Jitter (p-p, RMS), Rise Time, Fall Time, Eye Width, DCD, RIN OMA, TDEC*2

**Mask Test**
- Supported Masks: Selected by filter, user created
- Margin Type: Auto Align, user defined
- Mask Adjustment: Auto Align, user defined

**NRZ Jitter Analysis (Option 096)**
- TJ (J2, J4, J9, User Defined BER, Eye Opening), RJ (d-d), RJ (rms)*2, DJ (d-d), PJ (p-p)*3, PJ Frequency*3, DDJ (p-p)*3, DDPWS*3, DCD*3, ISI (p-p)*3
- Graph: TJ/RJ/PJ/DDJ Histogram, DDJ vs. Bit, Bathhtub, PJ vs. Frequency

**PAM4 Measurement (Option 095)**
- Average Power (dBm, μW)*1, TDECQ*1, Partial TDECQ*1, Ceq*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), RIN OMA

**TDECQ Measurement (Option 095)**
- TDECQ Equalizer
- No. of Taps: 3 to 13
- Tap Width: 1 UI (T-spaced)
- Threshold Adjustment (IEEE802.3cd)
- Target SER can be specified

*1: Optical signals only
*2: No IEEE 12.6 GHz hardware filter
*3: Enabled when Advanced Jitter Mode

### Sampling Oscilloscope (Horizontal System)

**Trigger Clock Input**
- Connector: SMA (f)
- Termination: 50Ω, AC coupled
- Frequency: 0.1 GHz to 15.0 GHz
- Division Ratio: 1 to 99 (but 1, 2, 4, 8, 16, 32, 40, 48, 64 only in Pulse Mode and Coherent Eye Mode)
- Trigger clock Sensitivity: 100 mVp-p (typ.), 200 mVp-p (max., typ. value using Option 024)
- Max. Amplitude: 1.2 Vp-p
- Absolute Max input: 2 Vp-p
- RMS Jitter

<table>
<thead>
<tr>
<th>Option</th>
<th>1ch, 2ch</th>
<th>4ch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trigger Clock Frequency (GHz)</td>
<td>0.1 to 1.25</td>
<td>2.4 to 15</td>
</tr>
<tr>
<td>Typ.</td>
<td>1.0 ps</td>
<td>400 fs</td>
</tr>
<tr>
<td>Max.</td>
<td>1.5 ps</td>
<td>1.35 ps</td>
</tr>
</tbody>
</table>

*: Option 024 Precision Trigger On

### Sampling Oscilloscope (Electrical Channel)

**Data Input**
- Connector: K (f)
- Termination: 50Ω, DC coupled
- Absolute Max. Rating: ± 2 V
- Dynamic Range: ±400 mV (Relative value of amplitude offset), Recommended input amplitude ±400 mVp-p

**Amplitude Setting**
- Scale: 1 mV/Div to 200 mV/Div, 1 mV steps
- Offset: -500 mV to +500 mV, 1 mV steps

| ± 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. |

<table>
<thead>
<tr>
<th>Amplitude Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>±3-dB Bandwidth</td>
</tr>
<tr>
<td>Flatness</td>
</tr>
<tr>
<td>RMS Noise</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
## Sampling Oscilloscope (Optical Channel)

### Connector

<table>
<thead>
<tr>
<th>Option</th>
<th>Wavelength</th>
<th>Fiber Coupling</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMF 1ch, 2ch</td>
<td>860 nm to 1650 nm</td>
<td>62.5 μm GI Multimode fiber, Single Mode fiber</td>
</tr>
<tr>
<td>4 ch</td>
<td>1260 nm to 1650 nm</td>
<td>Single Mode fiber</td>
</tr>
<tr>
<td>MMF 1ch, 2ch, 4ch</td>
<td>800 nm to 860 nm</td>
<td>62.5 μm GI Multimode fiber, Single Mode fiber</td>
</tr>
</tbody>
</table>

### Bandwidth (No Filter)

- **SMF:** 35 GHz (typ.)
- **MMF:** 25 GHz (typ.)

### Filters

#### Input Option Wavelength Fiber Coupling

- **SMF 1 ch, 2 ch:** 860 nm to 1650 nm (62.5 μm GI Multimode fiber, Single Mode fiber)
- **MMF 1 ch, 2 ch, 4 ch:** 800 nm to 860 nm (62.5 μm GI Multimode fiber, Single Mode fiber)

#### Output Options

- **NRZ:**
  - 100 GbE/4 (25.78125 Gbit/s)
  - 100 GbE/4 FEC (27.7393 Gbit/s)
- **PAM4:**
  - (Option 095)*
  - 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)
- **50 GbE/100 GbE/200 GbE/400 GbE:**
  - 50 GbE/100 GbE/200 GbE/400 GbE (25.78 Gbit/s)
  - SMF 1310 nm OTU4 (27.952493 Gbit/s)
  - 32GFC (28.05 Gbit/s)
  - 64GFC:
  - 28.9000 Gbaud MM TDECQ (12.4 GHz)
  - 28.9000 Gbaud SM TDECQ (14.45 GHz)
- **53.1250 Gbaud:**
  - 26.5625 Gbaud MM TDECQ (11.2 GHz)
  - 26.5625 Gbaud SM TDECQ (13.3 GHz)
  - 26.5625 Gbaud (19.3 GHz)
  - 53.1250 Gbaud (38.7 GHz)
  - 64GFC:
  - 28.9000 Gbaud MM TDECQ (12.4 GHz)
  - 28.9000 Gbaud SM TDECQ (14.45 GHz)

#### Filters

- **NRZ PAM4 (Option 095)*:**
  - 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)
- **50 GbE/100 GbE/200 GbE/400 GbE:**
  - 26.5625 Gbaud MM TDECQ (11.2 GHz)
  - 26.5625 Gbaud SM TDECQ (13.3 GHz)
  - 26.5625 Gbaud (19.3 GHz)
  - 53.1250 Gbaud (38.7 GHz)
  - 64GFC:
  - 28.9000 Gbaud MM TDECQ (12.4 GHz)
  - 28.9000 Gbaud SM TDECQ (14.45 GHz)

* Supports operation when Coherent Eye Mode and Test Pattern setting is not Variable. Uses filter response correction by digital signal processing (software) to secure reference filter band.

### Optical Noise

#### Input Option Wavelength OTU4 Filter

- **SMF:**
  - 1310 nm
  - 03x (excluding 030) Typ. 3.4 µWrms, Max. 4.3 µWrms (Typ. 4.8 µWrms, Max. 6.1 µWrms)
  - 04x (excluding 040) Typ. 4.1 µWrms, Max. 5.2 µWrms (Typ. 5.8 µWrms, Max. 7.4 µWrms)
  - 030 Typ. 4.8 µWrms, Max. 6.1 µWrms (Typ. 6.8 µWrms, Max. 8.6 µWrms)
  - 040 Typ. 5.8 µWrms, Max. 7.3 µWrms (Typ. 8.2 µWrms, Max. 10.4 µWrms)
- **MMF:**
  - 850 nm
  - 03x Typ. 6.7 µWrms, Max. 8.4 µWrms (Typ. 9.5 µWrms, Max. 11.9 µWrms)
  - 04x Typ. 7.0 µWrms, Max. 8.9 µWrms (Typ. 9.9 µWrms, Max. 12.6 µWrms)
- **No Filter:**
  - 03x Typ. 7.6 µWrms, Max. 10.6 µWrms (Typ. 10.8 µWrms, Max. 15.0 µWrms)
  - 04x Typ. 7.8 µWrms, Max. 10.6 µWrms (Typ. 11.0 µWrms, Max. 15.0 µWrms)

* Numeric values in parenthesis are values for channel B when the Option 054 Clock Recovery Unit is installed.

### Mask Sensitivity

#### Input Option Wavelength OTU4 Filter

- **SMF (1310 nm OTU4 Filter):**
  - 03x (excluding 030) –15 dBm (–13.5 dBm)
  - 04x (excluding 040) –14 dBm (–12.5 dBm)
  - 030 –13.5 dBm (–12 dBm)
  - 040 –12 dBm (–10.5 dBm)
- **MMF (850 nm OTU4 Filter):**
  - 03x –12 dBm (–10.5 dBm)
  - 04x –11.0 dBm (–9.5 dBm)

* Numeric values in parenthesis are values for channel B when the Option 054 Clock Recovery Unit is installed.

### 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)

<table>
<thead>
<tr>
<th>Input</th>
<th>Option</th>
<th>Typical Maximum Input Power (Before Distortion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMF</td>
<td>1 ch, 2 ch</td>
<td>–2 dBm (at 1310 nm, ExR 8 dB signal input)</td>
</tr>
<tr>
<td></td>
<td>4 ch</td>
<td>+2 dBm (at 1310 nm, ExR 4 dB signal input)</td>
</tr>
<tr>
<td>MMF</td>
<td>1ch, 2ch, 4ch</td>
<td>+2 dBm (at 850 nm, ExR 3 dB signal input)</td>
</tr>
</tbody>
</table>

### Absolute Max. Rating (Damage-free Range)

<table>
<thead>
<tr>
<th>Input</th>
<th>Option</th>
<th>Average Value</th>
<th>Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMF</td>
<td>1 ch</td>
<td>+5 dB</td>
<td>+7 dB</td>
</tr>
<tr>
<td></td>
<td>±8 dB</td>
<td>±10 dB</td>
<td></td>
</tr>
<tr>
<td>MMF</td>
<td>1 ch</td>
<td>+5 dB</td>
<td>+7 dB</td>
</tr>
<tr>
<td></td>
<td>±8 dB</td>
<td>±10 dB</td>
<td></td>
</tr>
</tbody>
</table>

### Optical Return Loss

- **SMF:** –27 dB (typ., at 1310 nm SMF connection)
- **MMF:** –20 dB (typ., at 850 nm MMF connection)

### Optical Power Meter Accuracy (typ.)

<table>
<thead>
<tr>
<th>Input Level</th>
<th>Accuracy (typ.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>–18 to –12 dB</td>
<td>±0.6 dB</td>
</tr>
<tr>
<td>–12 to 0 dB</td>
<td>±0.35 dB</td>
</tr>
<tr>
<td>0 to +2 dB</td>
<td>±0.55 dB</td>
</tr>
</tbody>
</table>

* This specified value does not apply to SMF input at the 1ch and 2ch configurations.
### 26G Clock Recovery (SMF/MMF/Electrical) (Option 054)

<table>
<thead>
<tr>
<th><strong>Ch B O/E Monitor Out</strong> (with built-in optical channel oscilloscope)</th>
<th><strong>Data Input</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Connector: K (f)</td>
<td>Connector: K (f), 50Ω, AC coupled</td>
</tr>
<tr>
<td>Conversion Gain: 60 V/W (SMF input, typ.), 33 V/W (MMF input, typ.)</td>
<td>Data Format: NRZ, PAM4</td>
</tr>
<tr>
<td>Insertion Loss: 1.5 dBo (typ.)</td>
<td>Bit Rate: 25.5 Gb/s to 28.2 Gb/s</td>
</tr>
<tr>
<td></td>
<td>Input Sensitivity: 10 mVp-p (typ.), 33 V/W (MMF input, typ.)</td>
</tr>
<tr>
<td></td>
<td>Max. Amplitude: 800 mVp-p</td>
</tr>
<tr>
<td></td>
<td>Absolute Maximum Input: 1 Vp-p</td>
</tr>
<tr>
<td></td>
<td>Contiguous Zeros Tolerance: ≥500 bits at PRBS 2^n – 1 Zero Substitution Pattern</td>
</tr>
<tr>
<td></td>
<td>Auto Relock</td>
</tr>
</tbody>
</table>

#### Data Input

- **Connector:** K (f), 50Ω, AC coupled
- **Data Format:** NRZ, PAM4
- **Bit Rate:** 25.5 Gb/s to 28.2 Gb/s
- **Input Sensitivity:** 10 mVp-p (typ.), 33 V/W (MMF input, typ.)
- **Max. Amplitude:** 800 mVp-p
- **Absolute Maximum Input:** 1 Vp-p
- **Contiguous Zeros Tolerance:** ≥500 bits at PRBS 2^n – 1 Zero Substitution Pattern
- **Auto Relock**

#### Recovered Clock Output

- **Connector:** SMA (f), 50Ω, AC coupled
- **Recovery Mode**
  - **Amplitude:** 480 mVp-p (typ.)
  - **Division Ratio:** 1/2
  - **Jitter:** 250 fs rms (typ.), 400 fs rms (max.)
  - **Loop Bandwidth:** Select from 4 MHz, 10 MHz, bit rate/1667, Attenuation: –20 dB/dec
  - **Through Mode**
    - **Amplitude:** 500 mVp-p (typ.)
    - **Operation Frequency:** 0.1 GHz to 1.7625 GHz (1/16 Clock)
    - **Jitter:** 200 fs rms (typ.), 400 fs rms (max.)

#### Optical Data Input

- **FC Connector** (changeable)
- **Wavelength, Fiber Coupling:** 1260 nm to 1620 nm, Single Mode fiber
- **Bit Rate:** 25.5 Gb/s to 28.9 Gb/s, 51 Gb/s to 58 Gb/s
- **Input Sensitivity:** Outer OMA 100 µW (typ., Open Eye (PRBS13Q, TDECQ 2.0 dB), 26.5625/53.125 Gb/s)
  - Outer OMA 630 µW (typ., Stressed Eye (SSPRQ, TDECQ 3.4 dB), 53.125 Gb/s)
- **Absolute Max. Rating:** +9.0 dBm (Average), +12.0 dBm (Peak)
- **Contiguous Zeros Tolerance:** ≥500 bits at PRBS 2^n – 1 Zero Substitution Pattern
- **Optical Return Loss:** –30 dB (typ., 1310 nm)
- **Auto Relock**

#### Optical Data Output

- **FC Connector** (changeable)
- **Insertion Loss:** 1.5 dB (typ.), 2.3 dB (max., 1310 nm)

#### Recovered Clock Output

- **Connector:** SMA (f), 50Ω, AC coupled
- **Recovery Mode**
  - **Amplitude:** 440 mVp-p (typ.), 340 mVp-p (min.)
  - **Division Ratio:** 1/4 (at 25.5 Gb/s to 28.9 Gb/s input), 1/8 (at 51 Gb/s to 58 Gb/s input)
  - **Jitter:** 200 fs rms (typ.), 400 fs rms (typ.)
  - **Loop Bandwidth:** Select from 4 MHz, 10 MHz, bit rate/1667, Attenuation: –20 dB/dec
  - **Through Mode**
    - **Amplitude:** 220 mVp-p (typ.), 200 mVp-p (min.)
    - **Operation Frequency:** 0.1 GHz to 1.81 GHz, 3.19 GHz to 3.625 GHz (1/16 Clock)
    - **Jitter:** 200 fs rms (typ.), 400 fs rms (max.)

---

*1: 25°C ±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

### 26G/53G Clock Recovery (SMF) (Option 055)

#### Optical Data Input

- **FC Connector** (changeable)
- **Wavelength, Fiber Coupling:** 1260 nm to 1620 nm, Single Mode fiber
- **Bit Rate:** 25.5 Gb/s to 28.9 Gb/s, 51 Gb/s to 58 Gb/s
- **Input Sensitivity:**
  - Outer OMA 100 µW (typ., Open Eye (PRBS13Q, TDECQ 2.0 dB), 26.5625/53.125 Gb/s)
  - Outer OMA 630 µW (typ., Stressed Eye (SSPRQ, TDECQ 3.4 dB), 53.125 Gb/s)
- **Absolute Max. Rating:** +9.0 dBm (Average), +12.0 dBm (Peak)
- **Contiguous Zeros Tolerance:** ≥500 bits at PRBS 2^n – 1 Zero Substitution Pattern
- **Optical Return Loss:** –30 dB (typ., 1310 nm)
- **Auto Relock**

#### Optical Data Output

- **FC Connector** (changeable)
- **Insertion Loss:** 1.5 dB (typ.), 2.3 dB (max., 1310 nm)

#### Recovered Clock Output

- **Connector:** SMA (f), 50Ω, AC coupled
- **Recovery Mode**
  - **Amplitude:** 440 mVp-p (typ.), 340 mVp-p (min.)
  - **Division Ratio:** 1/2
  - **Jitter:** 250 fs rms (typ.), 400 fs rms (max.)
  - **Loop Bandwidth:** Select from 4 MHz, 10 MHz, bit rate/1667, Attenuation: –20 dB/dec
  - **Through Mode**
    - **Amplitude:** 220 mVp-p (typ.), 200 mVp-p (min.)
    - **Operation Frequency:** 0.1 GHz to 1.81 GHz, 3.19 GHz to 3.625 GHz (1/16 Clock)
    - **Jitter:** 200 fs rms (typ.), 400 fs rms (max.)

---

*1: 25°C ±5°C
*2: 4 MHz Loop Bandwidth
*3: at 26.5625/53.125 Gb/s Clock Pattern, Outer OMA 0 dBm
## MP2110A Option Selection Guide

<table>
<thead>
<tr>
<th>Selection Conditions and Function</th>
<th>Selection/Option Addition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscilloscope</td>
<td></td>
</tr>
<tr>
<td>Select any one or both.</td>
<td></td>
</tr>
<tr>
<td>Select any one.</td>
<td>Electrical 2ch</td>
</tr>
<tr>
<td></td>
<td>Electrical 1ch + Optical 1ch</td>
</tr>
<tr>
<td></td>
<td>Optical 1ch</td>
</tr>
<tr>
<td></td>
<td>Optical 2ch</td>
</tr>
<tr>
<td></td>
<td>Optical 4ch</td>
</tr>
<tr>
<td></td>
<td>SMF or MMF</td>
</tr>
<tr>
<td></td>
<td>SMF or MMF</td>
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<td>MMF</td>
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<td>SMF</td>
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<td>MMF</td>
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<tr>
<td></td>
<td>SMF</td>
</tr>
<tr>
<td></td>
<td>MMF</td>
</tr>
<tr>
<td>Select additions.</td>
<td>26G Clock Recovery (SMF/MMF/Electrical)</td>
</tr>
<tr>
<td></td>
<td>PAM4 Analysis Software</td>
</tr>
<tr>
<td></td>
<td>NRZ Jitter Analysis Software</td>
</tr>
<tr>
<td></td>
<td>Precision Trigger</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Select any one.</td>
<td>26G/53G Clock Recovery (SMF)</td>
</tr>
<tr>
<td>BERT</td>
<td></td>
</tr>
<tr>
<td>Select any one.</td>
<td>Optical 1ch</td>
</tr>
<tr>
<td></td>
<td>Optical 2ch</td>
</tr>
<tr>
<td></td>
<td>Optical 4ch</td>
</tr>
<tr>
<td>Select additions.</td>
<td>Bit Rate Extension (Adds 10G band)</td>
</tr>
</tbody>
</table>

*1: Only the optical channel reference receiver (Bessel filter approximation characteristics) are different for Option 04x and Option 03x.

*2: Either 1ch or 2ch can be selected for Option 024 Precision Trigger. Cannot be added for 4ch oscilloscope (Option 030/039/040/049).

### Block Diagram

- **Option 03x/04x Oscilloscope**
  - Ch A: Electrical Ch
  - Ch B: Optical Ch
  - Filter
  - SMF O/E
  - MMF O/E
  - Option 054 CRU
  - CRU
  - Ch B O/E Monitor Out
  - CRU In
  - Recovered Clock Out
  - Trigger Clock In

- **Option 055 CRU**
  - CRU
  - Recovered Clock Out
  - SMF Data Out
  - SMF Data In

- **BERT**
  - Option 011
  - PPG 1
  - ED 1
  - Data/xData Out
  - Data/xData In
  - Option 012
  - PPG 1
  - ED 1
  - Data/xData Out
  - Data/xData In
  - Option 014
  - PPG 1
  - ED 1
  - Data/xData Out
  - Data/xData In
  - Option 014
  - Internal Clock
  - Sync/xSync Out
  - Clock Out
  - External Clock In

* Optical channel: The clock in the optical signal input to Ch B is recovered.

  Electrical channel: There is no Monitor Out connector when Ch B is an electrical channel. Split the signal using the Pick-off tee and input to CRU In.
## BERTWave MP2110A Ordering Information

When making a contract, determine the configuration by referencing the selection guide (p.21) 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.

<table>
<thead>
<tr>
<th>Model/Order No.</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
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<td>MP2110A-011</td>
<td>1ch BERT Retrofit</td>
<td>Options</td>
</tr>
<tr>
<td>MP2110A-012</td>
<td>2ch BERT Retrofit</td>
<td></td>
</tr>
<tr>
<td>MP2110A-014</td>
<td>4ch BERT Retrofit</td>
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<tr>
<td>MP2110A-032</td>
<td>Dual Optical Scope Retrofit</td>
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<tr>
<td>MP2110A-033</td>
<td>Optical and Single-ended Optical Scope Baseband Flat Retrofit</td>
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<tr>
<td>MP2110A-035</td>
<td>Optical Scope for Singlemode Baseband Flat Retrofit</td>
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<tr>
<td>MP2110A-036</td>
<td>Optical Scope for Multi-mode Baseband Flat Retrofit</td>
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<tr>
<td>MP2110A-039</td>
<td>Quad Optical Scope for Multi-mode Baseband Flat Retrofit</td>
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<tr>
<td>MP2110A-040</td>
<td>Quad Optical Scope for Singlemode Flat Retrofit</td>
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<tr>
<td>MP2110A-041</td>
<td>Quad Optical Scope for Singlemode Flat Retrofit</td>
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<tr>
<td>MP2110A-043</td>
<td>Optical and Single-ended Optical Scope Retrofit</td>
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<td>MP2110A-045</td>
<td>Optical Scope for Singlemode Retrofit</td>
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<td>MP2110A-046</td>
<td>Optical Scope for Multi-mode Retrofit</td>
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<tr>
<td>MP2110A-049</td>
<td>Quad Optical Scope for Multimode Flat Retrofit</td>
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<tr>
<td>MP2110A-054</td>
<td>Clock Recovery (Electrical/Optical) Retrofit</td>
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<td>MP2110A-055</td>
<td>2G/53Gbaud Clock Recovery (SM Optical) Retrofit</td>
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<tr>
<td>MP2110A-093</td>
<td>PPG/ED Bit Rate Extension Retrofit</td>
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</tr>
<tr>
<td>MP2110A-095</td>
<td>PAM4 Analysis Software Retrofit</td>
<td></td>
</tr>
<tr>
<td>MP2110A-096</td>
<td>Jitter Analysis Software Retrofit</td>
<td></td>
</tr>
</tbody>
</table>

### Options

- **MP2110A-395**: Replaceable Optical Connector (FC-PC) Retrofit
- **MP2110A-195**: PPG/ED Bit Rate Extension Retrofit
- **J0617B**: Replaceable Optical Connector (FC-PC) Retrofit
- **J3097A**: FC ADAPTER CAP Retrofit
- **J1341A**: Open (Coaxial connector cover) Retrofit

### Maintenance Service

- **MP2110A-054**: Terminator Retrofit (4)
- **J0617B**: Replaceable Optical Connector (FC-PC) Retrofit
- **J3097A**: FC ADAPTER CAP Retrofit
- **J1341A**: Open (Coaxial connector cover) Retrofit

### Optional Accessories

- **J1341A**: Open (Coaxial connector cover)
- **J1342A**: Coaxial Cable (0.8 m, SMA connector)
- **J1343A**: Optical Cable (0.8 m, SMA connector)
- **J1344A**: Optical Cable (1 m, SMA connector)
- **J1349A**: Coaxial Cable (0.8 m, K connector)
- **J1351A**: Optical and Single-ended Optical Scope Retrofit
- **J1632A**: U Link Coaxial Cable (4)
- **J1764A**: U Link Coaxial Cable (SM-A)

### Standard Accessories

- **MP2110A-033/043**: 3 Years Extended Warranty Service
- **MP2110A-035/045**: 3 Years Extended Warranty Service
- **J1341A**: Open (Coaxial connector cover)
- **J1342A**: Coaxial Cable (0.8 m, SMA connector)
- **J1343A**: Optical Cable (0.8 m, SMA connector)
- **J1344A**: Optical Cable (1 m, SMA connector)
- **J1345A**: Optical Cable (5 m, SMA connector)
- **J0617B**: Replaceable Optical Connector (FC-PC)
- **J0618D**: Replaceable Optical Connector (ST)
- **J0618E**: Optical Cable (5 m, SMA connector)
- **J0618F**: Optical Cable (10 m, SMA connector)
- **J0619B**: Replaceable Optical Connector (SC)
- **J0635A**: Coaxial Cable (15 m, SMA connector)
- **J1349A**: Coaxial Cable (0.8 m, K connector)
- **J1349B**: Optical Cable (0.8 m, K connector)
- **J1349C**: Optical Cable (1 m, SMA connector)
- **J0635A**: Coaxial Cable (5 m, SMA connector)
- **J0636A**: Coaxial Cable (10 m, SMA connector)
- **J0636F**: Coaxial Adaptor (K-P · K-J, SMA compatible)
- **J0641A**: Replaceable Optical Connector (SC)
- **J0641B**: Optical Cable (5 m, SMA connector)
- **J0651A**: Optical and Single-ended Optical Scope Retrofit
- **J1681A**: MPO Loopback Cable
- **J1682A**: MPO to FC convert cable
- **J0634A**: 100G LR4 1310 nm QSFP28
- **J0636A**: 100G SRA 850 nm QSFP28
- **Z0914A**: Ferrule Cleaner
- **Z0915A**: Replacement Reel for Ferrule Cleaner
- **G0342A**: VAGG K connector
- **G0364A**: VAGG Connector
- **J1139A**: Coaxial Cable (5 m, SMA connector)
- **J1344A**: LC/PC-LC/PC-1M-SM
- **J1345A**: SC/LC-LC-LC-LC-1M-50 (62.5/125)
- **J1346A**: SC/LC-LC-LC-LC-1M-50 (62.5/125)
- **J1347A**: SC/LC-LC-LC-LC-1M-50 (62.5/125)
- **J1348A**: SC/LC-LC-LC-LC-1M-50 (62.5/125)
- **J1349A**: SC/LC-LC-LC-LC-1M-50 (62.5/125)
- **J1351A**: Optical Fiber Connector (MM, 12Fiber, MPO, 3 m)
- **J1681A**: MPO Loopback Cable
- **J1682A**: MPO to FC convert cable
- **J0634A**: 100G LR4 1310 nm QSFP28
- **J0636A**: 100G SRA 850 nm QSFP28
- **Z0914A**: Ferrule Cleaner
- **Z0915A**: Replacement Reel for Ferrule Cleaner
- **G0342A**: VAGG K connector
- **G0364A**: VAGG Connector
- **Z0914A**: Ferrule Cleaner
- **Z0915A**: Replacement Reel for Ferrule Cleaner
- **Z0397A**: Replaceable Optical Connector (FC-PC)
- **J3097A**: FC ADAPTER CAP Retrofit
- **J1341A**: Open (Coaxial connector cover) Retrofit

*1: BERT retrofit supported when BERT not installed or to increase number of channels
*2: Oscilloscope retrofit supported when oscilloscope not installed or when changing Option 03x and 04x, same channel configuration.
*3: About PAM4 Analysis Software Retrofit is sometimes, depending on the serial number, the customer can perform the retrofit, but sometimes return to the factory may be necessary. Contact your sales representative for more details.

In addition, refer to page 21 (MP2110A Option Selection Guide) for any restrictions on option configurations.
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 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.

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

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.

<table>
<thead>
<tr>
<th>Model/Order No.</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>G0344F*</td>
<td>Optical Switch (1×4, SM9, FC/UPC)</td>
</tr>
<tr>
<td>G0344S*</td>
<td>Optical Switch (1×4, SM9, SC/UPC)</td>
</tr>
<tr>
<td>G0345F*</td>
<td>Optical Switch (1×4, GI50, FC/UPC)</td>
</tr>
<tr>
<td>G0345S*</td>
<td>Optical Switch (1×4, GI50, SC/UPC)</td>
</tr>
<tr>
<td>G0346F*</td>
<td>Optical Switch (1×4, GI62.5, FC/UPC)</td>
</tr>
<tr>
<td>G0346S*</td>
<td>Optical Switch (1×4, GI62.5, SC/UPC)</td>
</tr>
<tr>
<td>G0347F*</td>
<td>Optical Switch (1×4, GI62.5, FC/UPC, Power Monitor)</td>
</tr>
<tr>
<td>G0347S*</td>
<td>Optical Switch (1×4, GI62.5, SC/UPC, Power Monitor)</td>
</tr>
<tr>
<td>G0348F*</td>
<td>Optical Switch (2×4, GI50, FC/UPC)</td>
</tr>
<tr>
<td>G0348S*</td>
<td>Optical Switch (2×4, GI50, SC/UPC)</td>
</tr>
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<td>G0349F*</td>
<td>Optical Switch (2×4, GI62.5, FC/UPC)</td>
</tr>
<tr>
<td>G0349S*</td>
<td>Optical Switch (2×4, GI62.5, SC/UPC)</td>
</tr>
</tbody>
</table>

*: KC Mark not support

Optical Spectrum Analyzer MS9740B

600 nm to 1750 nm

Faster measurement speed shortens measurement time and improves production efficiency
• 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
• Built-in Fast mode cuts measurement time by 50% for better production efficiency to predecessor MS9740A using 200 Hz or 1 kHz bandwidth
• 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 MS9740B reduces production costs by shortening active optical device evaluation times and supporting efficient analysis applications.

Programmable Optical Attenuator (SM9, FC/UPC)
Programmable Optical Attenuator (SM9, SC/UPC)
Programmable Optical Attenuator (SM9, FC/UPC, Power Monitor)
Programmable Optical Attenuator (SM9, SC/UPC, Power Monitor)
Programmable Optical Attenuator (GI50, FC/UPC)
Programmable Optical Attenuator (GI50, SC/UPC)
Programmable Optical Attenuator (GI50, FC/UPC, Power Monitor)
Programmable Optical Attenuator (GI50, SC/UPC, Power Monitor)
Programmable Optical Attenuator (GI62.5, FC/UPC)
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Programmable Optical Attenuator (GI62.5, SC/UPC, Power Monitor)

*: KC Mark not support