



MP1900A 32 Gbaud PAM4 Solution

Signal Quality Analyzer-R
MP1900A Series

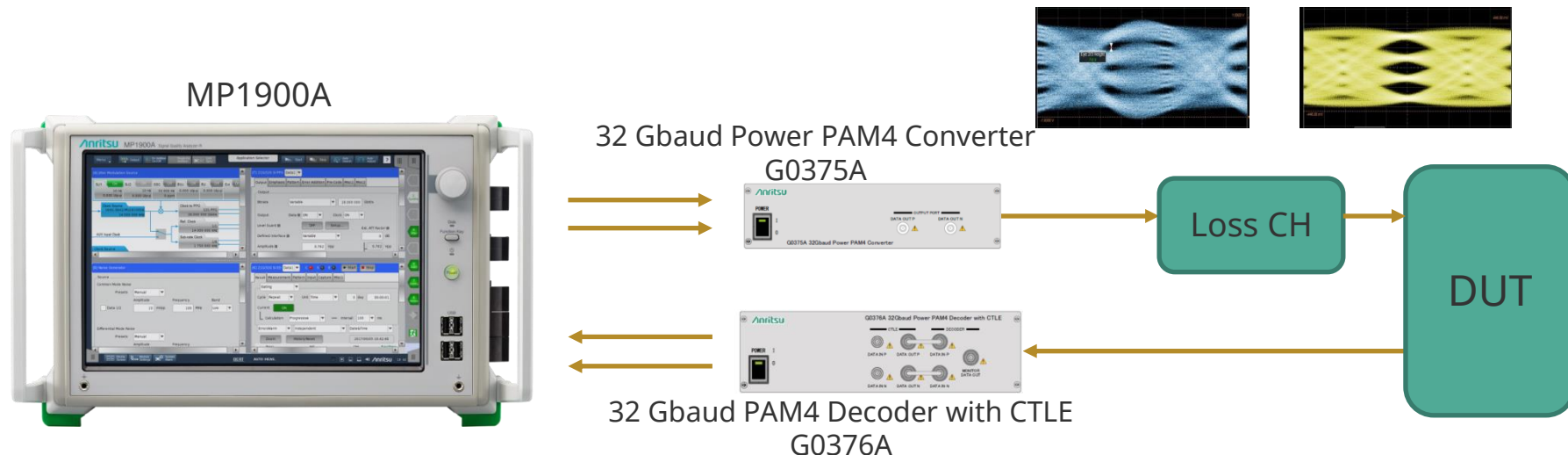
Outline

The Signal Quality Analyzer-R MP1900A series features a high-expandability design with real-time BER measurement using a PAM4 Convert/Decode function, plus sequential PAM4 BER measurements using an error detector for more efficient inspection of 400GbE transceivers and devices.

This Quick Start Guide explains use of the MP1900A series to generate PAM4 signals up to 32 Gbaud, real-time BER measurement using the 32 Gbaud PAM4 Decoder with CTLE G0376A, and sequential PAM4 BER measurement using the 21G/32Gbit/s SI ED MU195040A.

G0375A/G0376A Real-time BER Measurement

Outline of G0375A/G0376A 32 Gbaud PAM4 BER Solution



Supports PAM4 BER Measurements of PRBS31Q Pattern

- Small remote head for close-in approach to DUT
- Multi-channel
- Excellent expandability and PAM4/NRZ support
- [3.9 Vp-p \(differential\) PAM4 output](#)
- [10Tap Emphasis](#)
- [Clean Eye/Low Jitter](#)
- Tr/Tf 14 ps (typ.) (PAM4 output)
- [CTLE 14 GHz, 12 dB](#)
- [Clock recovery](#) (by MU195040A ED)
- [High input sensitivity of 40 mV\(EH\)](#)
- True PAM4 BER measurement

32 Gbaud PAM4 BER Measurement Item List

Model	Name	Option	Qty	Remark
G0375A	32Gbaud Power PAM4 Converter	-	1	
G0376A	32Gbaud PAM4 Decoder with CTLE	-	1	
MP1900A	Signal Quality Analyzer-R	-	1	
MU181000B	12.5GHz 4port Synthesizer	-	1	
MU181500B	Jitter Modulation Source	-	1	For Jitter injection
MU195020A	21G/32G bit/s SI PPG	001, 020, 021, 031	1	
MU195040A	21G/32G bit/s SI ED	001, 020, 022	1	
41KC-6	Fixed Attenuator 6 dB		4	
J1439A	Coaxial Cable (0.8m, K connector)		1	
J1728A	Electrical Length Specified Coaxial Cable (0.4m, K connector)	-	(2)	Cable for waveform monitoring
MX183000A PAM Control	PAM4 Control		1	Standard software
MX183000A- PL001	Jitter Tolerance Test		1	For Jitter Tolerance Test

Specifications Tx

G0375A 32Gbaud Power PAM4 Converter + MU195020A 21G/32G bit/s SI PPG

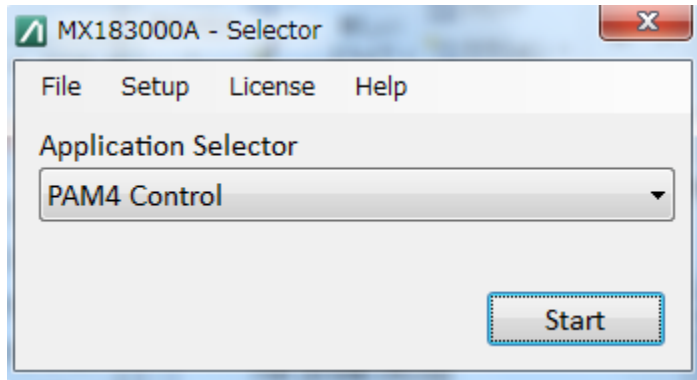
Item	Specification	Remarks
Number of Outputs	2 (Data, xData)	AC coupling
Baud Rate	10 to 32.1 Gbaud	
Output Amplitude	0.3 to 1.95 Vp-p (Single-end, typ.)	Data1 input 0.2 to 1.3 Vp-p and Data2 input 0.1 to 0.65 Vp-p
Random Jitter (rms)	200 fs (typ.)	
Tr/Tf (20% to 80%)	14 ps (typ.)	Using MU195020A SI-PPG
Eye Linearity (RLM)	0.6 to 1 adjustable from level ratio	
Number of Inputs	4 (Data1, xData1, Data2, xData2)	Uses Data3 and J1735A (two for differential) at 3 Eye independent level control
Maximum Input Amplitude	1.5 Vp-p (Data1, xData1) 0.75 Vp-p (Data2, xData2)	
In/Out Connector	K (female)	

Specifications Rx

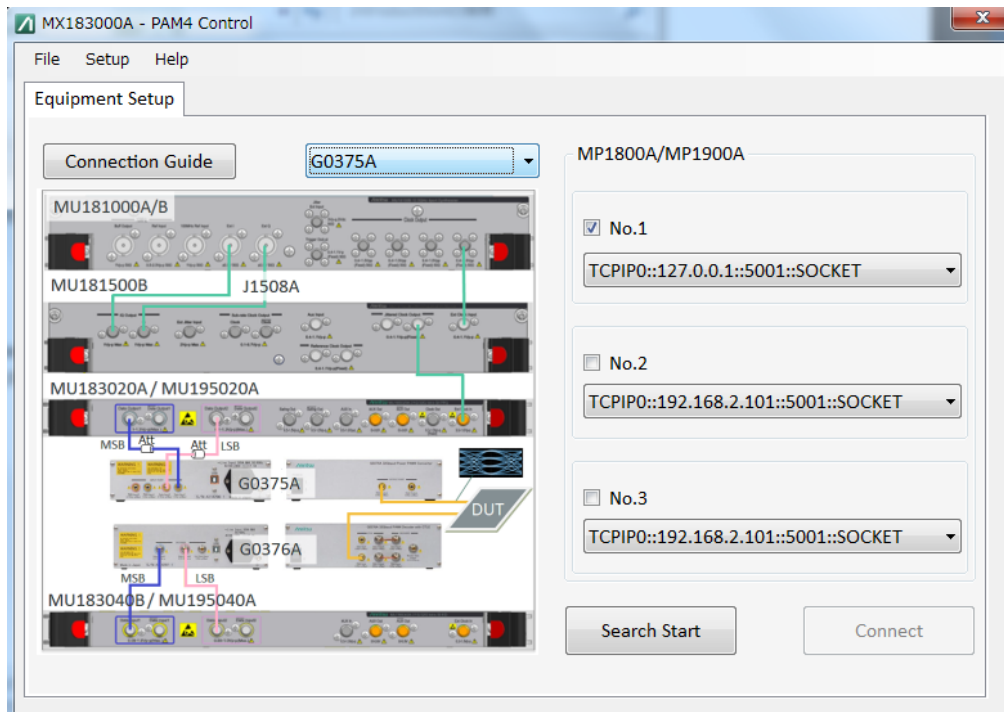
G0376A 32Gbaud PAM4 Decoder with CTLE + MU195040A 21G/32G bit/s SI ED

Item		Specification	Remarks
Decoder	Number of Inputs	2 (Data, xData) 1 (External clock)	K Connector (female)
	Baud Rate	10 to 32.1 Gbaud (DFF ON mode) 10 to 28.1 Gbaud (DFF OFF mode)	Uses MU19040A with external clock Uses CDR of MU195040A-022
	Data Input Amplitude	0.4 Vp-p (typ.) 0.5 Vp-p (max.)	Single-ended
	Data Input Sensitivity	40 mV (typ.)	28 Gbaud, Per Eye, Eye Height, Single-ended at E-6
	Clock Input Frequency	10 to 32.1 GHz (DFF ON mode)	Full-rate clock
	Clock Input Amplitude	0.3 to 1.0 Vp-p	External Clock Input
	Number of Outputs	3 (Data1, Data2, Monitor Data)	K Connector (female)
	Data Output level	0/-0.3 V (typ.)	
	Internal DFF	Selectable ON/OFF	Uses external Clock for D-FF ON mode
CTLE	Number of Inputs	2 (Data, xData)	K Connector (female)
	Input Amplitude	0.4 V (max.)	
	CTLE Gain	-12 to 0 dB adjustable	
	CTLE Peak Frequency	14 GHz (typ.)	
	Number of Outputs	2 (Data, xData)	K Connector (female)

Equipment setup(1/2)

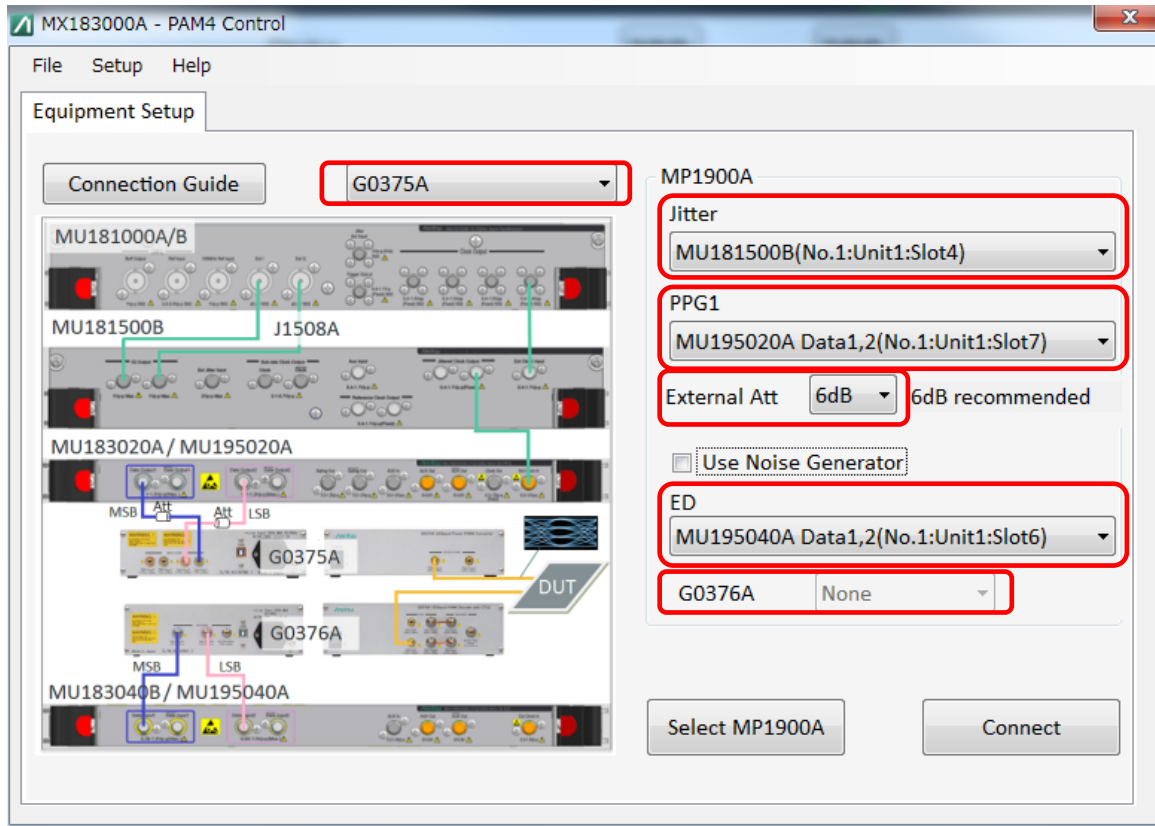


Select PAM4 Control from Application Selector of MX183000A software, and click Start.



Click Search Start. The software searches for equipment, and displays the equipment currently connected in the connected equipment display area.

Equipment setup(2/2)



- Select Jitter, PPG, and ED with unit number from each selection list.
- Select G0375A and G0376A COM port with USB
- *Select "None" when Jitter, PPG or ED isn't used for testing.
- Set External Att value to 6 dB when 6 dB attenuator is used between PPG and G0375A. (6 dB attenuator is recommended for evaluating SNDR or SNR_ISI.)

[Use Noise Generator] on MX183000A PAM4 Control

The screenshot shows the 'MX183000A - PAM4 Control' software window. The 'Equipment Setup' tab is active, displaying a connection diagram on the left and configuration options on the right. The diagram shows four main equipment units: MU181000A/B, MU181500B, MU183020A / MU195020A, and MU183040B / MU195040A. A 'G0375A' unit is connected to the MU183020A / MU195020A unit. A 'DUT' (Device Under Test) is connected to the MU183040B / MU195040A unit. The right-hand configuration panel is for the 'MP1900A' and includes the following settings:

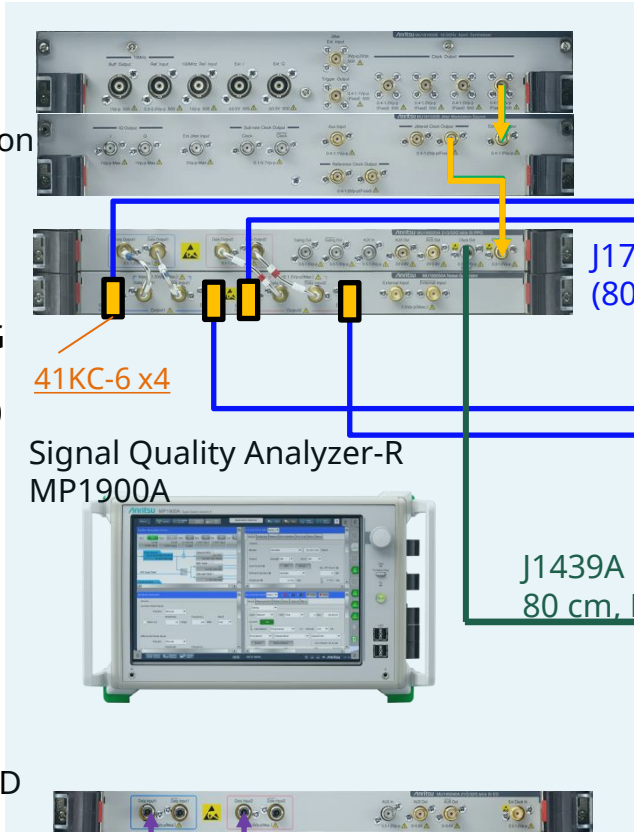
- Jitter: MU181500B(No.1:Unit1:Slot4)
- PPG1: MU195020A Data1,2(No.1:Unit1:Slot7)
- External Att: 6dB (6dB recommended)
- Use Noise Generator (highlighted with a red box)
- ED: MU195040A Data1,2(No.1:Unit1:Slot6)
- G0376A: None

Buttons at the bottom include 'Select MP1900A' and 'Connect'.

To use the Noise Generator MU195050A, put a check mark in the [Use Noise Generator] check box at the Equipment Setup tab.

Setup for PRBS31Q Error Free ([with MU195050A](#))

- Synthesizer MU181000B
- Jitter Modulation MU181500B
- Noise Generator MU195050A
- 32G 2ch SI PPG MU195020A (Opt-020, 021, 031)



41KC-6 x4

Signal Quality Analyzer-R
MP1900A

- 32G 2ch SI ED MU195040A (Opt-020, 022)

J1728A cable x2 (40 cm, skew <1 ps)

J1741A cable x4
(80 cm, skew <1 ps)

J1439A
80 cm, K cable

32Gbaud Power PAM4 Converter
G0375A

J1728A cable x2 (40 cm, skew <1 ps)
(*1) Cable x2 (skew <1 ps)

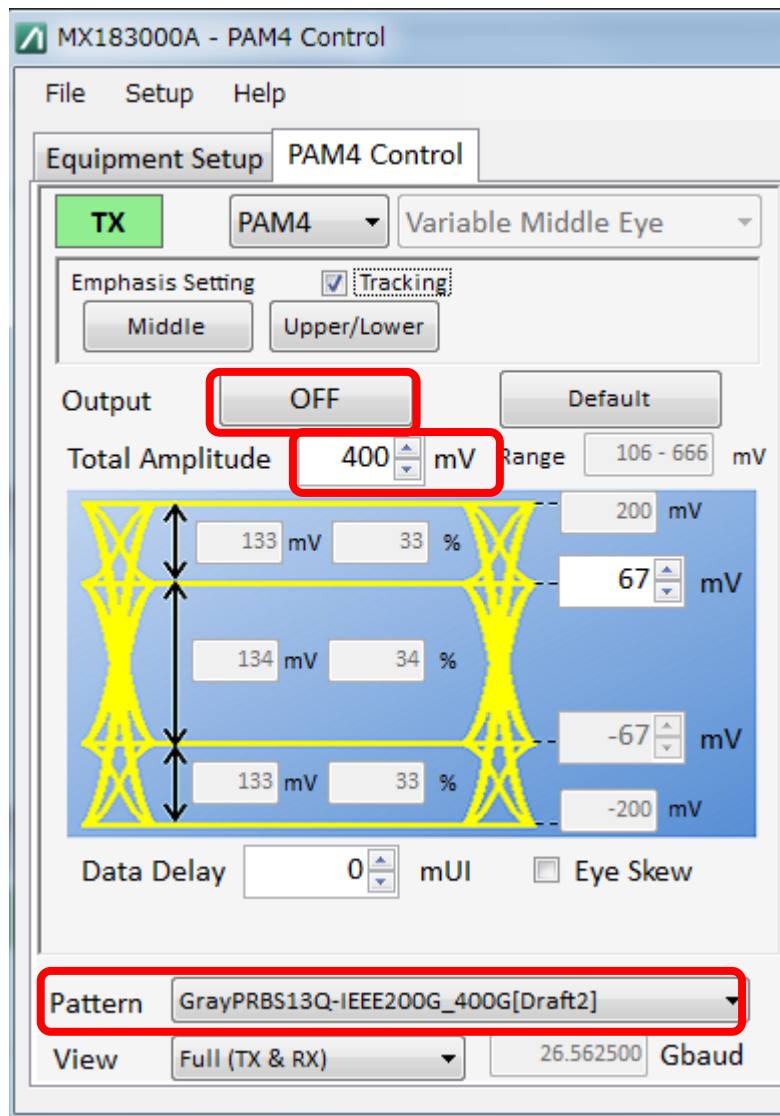
DUT

Decoder Input

32Gbaud PAM4 Decoder with CTLE
G0376A

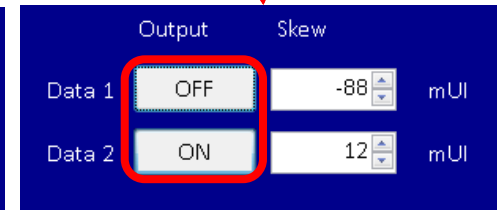
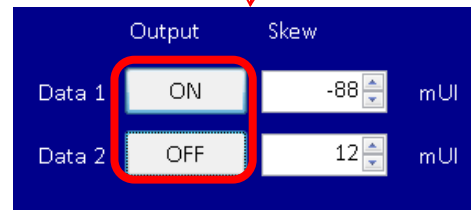
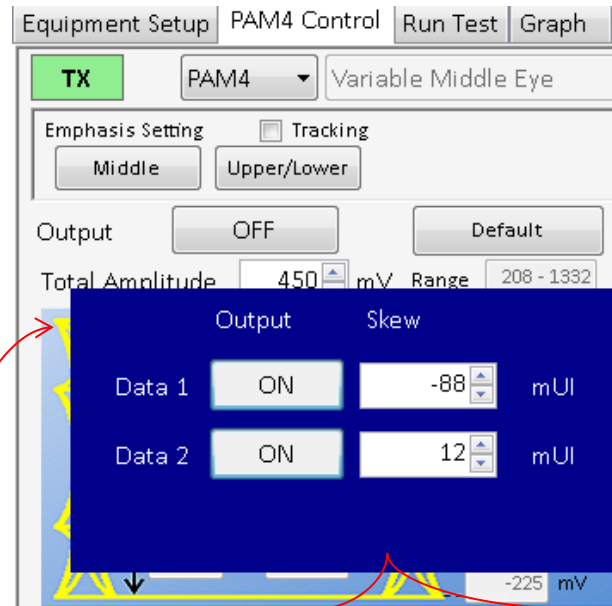
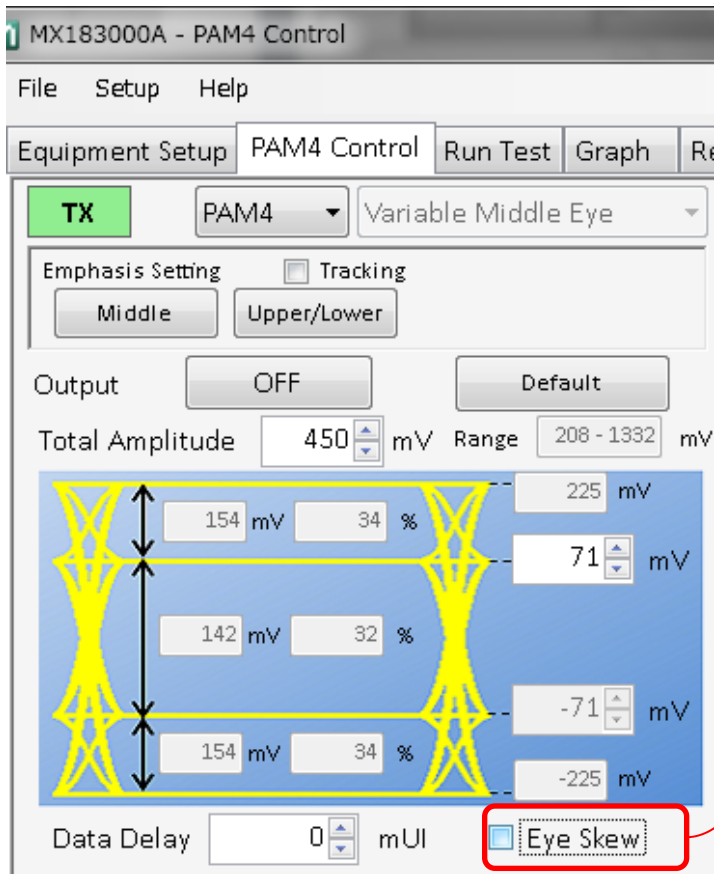
(*1) J1728A or lower loss cable

Total amplitude and pattern setting



Set Total Amplitude and Select a test pattern for the measurement.
Set Output to ON.

PAM4 Skew Adjustment between MSB and LSB

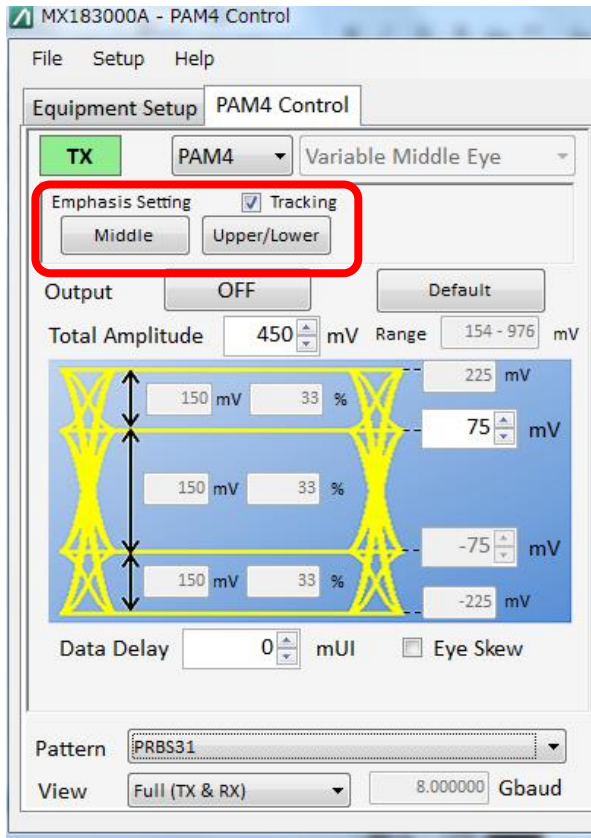


Adjust skew between Data1 and Data2 at [Eye Skew] while observing the G0375A output waveform with an oscilloscope to align the skew between MSB and LSB of PAM4.

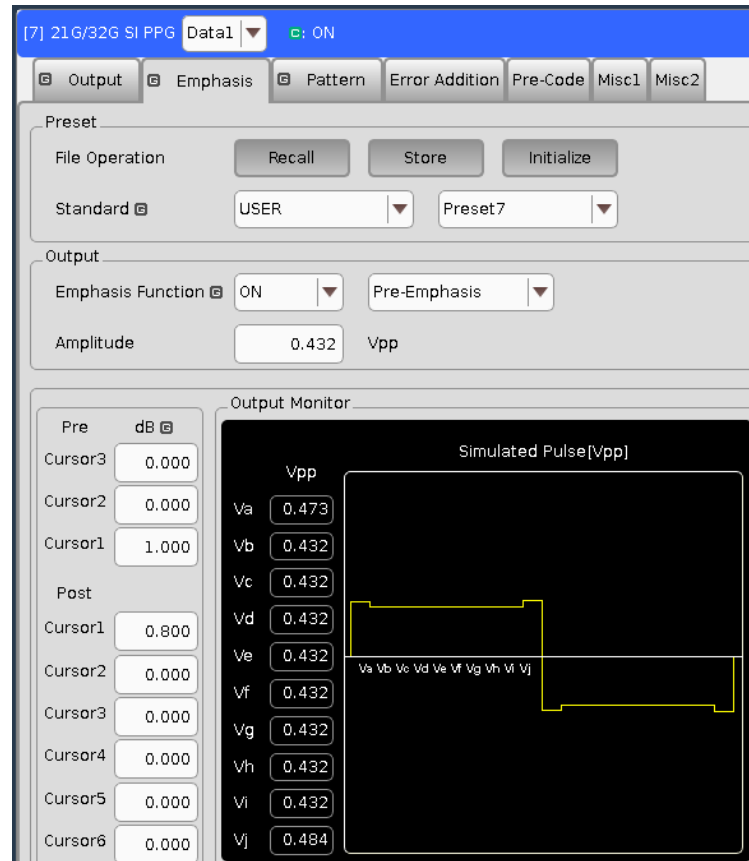
- Set Data 1 Output to ON and Data 2 Output to OFF and set a delay marker at the crosspoint position on the oscilloscope screen.
- Set Data 2 Output to ON and Data 1 Output to OFF. Adjust the Data 2 skew value so the crosspoint position aligns with the marker. Set the Data 1 Output to ON after finishing adjustment.
- Uncheck [Eye Skew] to close the skew setting window.

Emphasis Settings

Setting a checkmark in the [Tracking] checkbox of Emphasis Setting and clicking [Middle] performs Emphasis setting for Data1 (MSB). In addition, setting a checkmark in [Tracking] also sets the same value automatically at Data2 (LSB). Pressing [Return to MX183000A] after setting Emphasis returns to the MX183000A PAM4 Control screen.

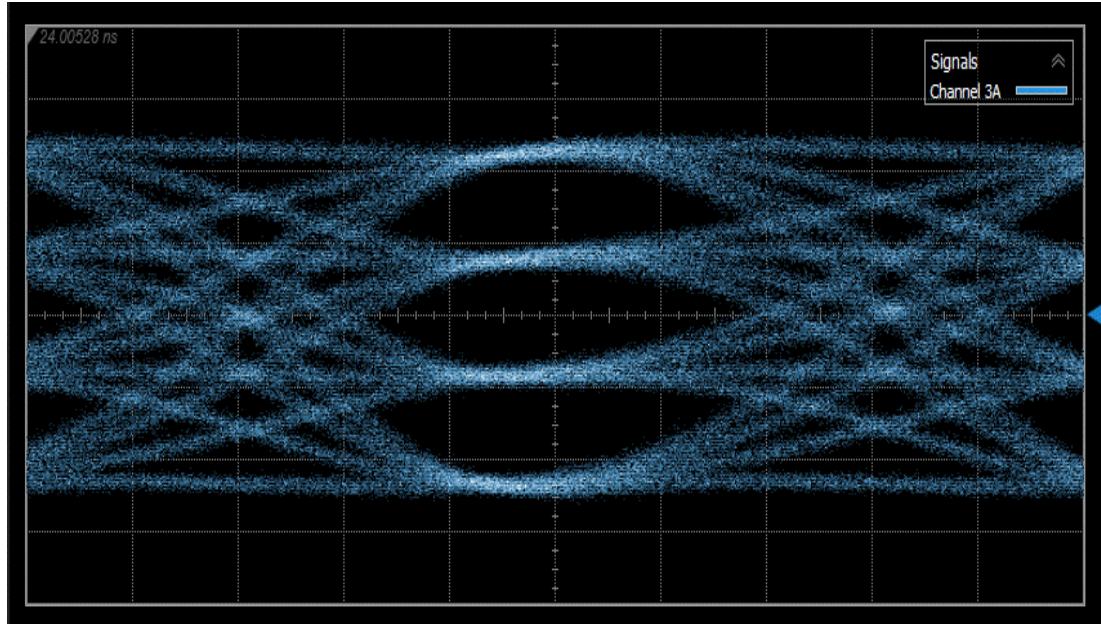


Data1 Emphasis Setting Screen



G0375A with MU195020A PPG PAM4 Typical Waveforms

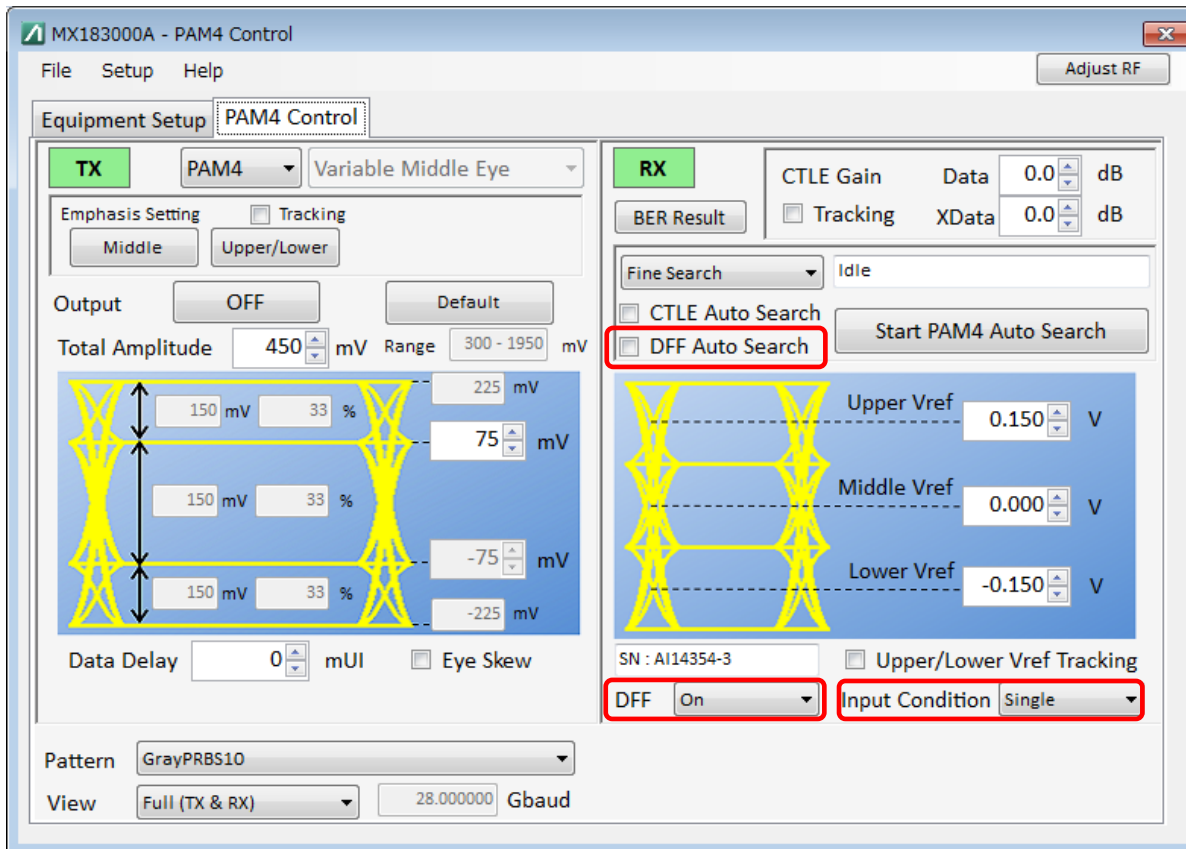
28 Gbaud, 0.9 Vp-p (Single-end)



Using oscilloscope with 70 GHz bandwidth and residual jitter of less than 200 fs rms.

BER Measurement Procedure

1. Start MX183000A PAM4 Control
2. Adjust G0375A amplitude, Emphasis, skew, and pattern by referring to the previous slides. Pattern setting sets the same pattern for both Tx and Rx.
3. [For loopback performance check] connect the G0375A output directly to G0376A decoder input.
4. Ensure [DFF] is set to ON.



5. Ensure [Input Condition] is set to Differential when the input condition is differential.
6. Put a check mark in the [DFF Auto Search] check box.
7. Click [Start PAM4 Auto Search].
8. Click [BER Result] to display measurement results.

Typical Settings and BER Result

Recommended settings for error free condition at 26.5625 Gbaud and 28 Gbaud and loopback connection from G0375A to G0376A decoder input are listed below.

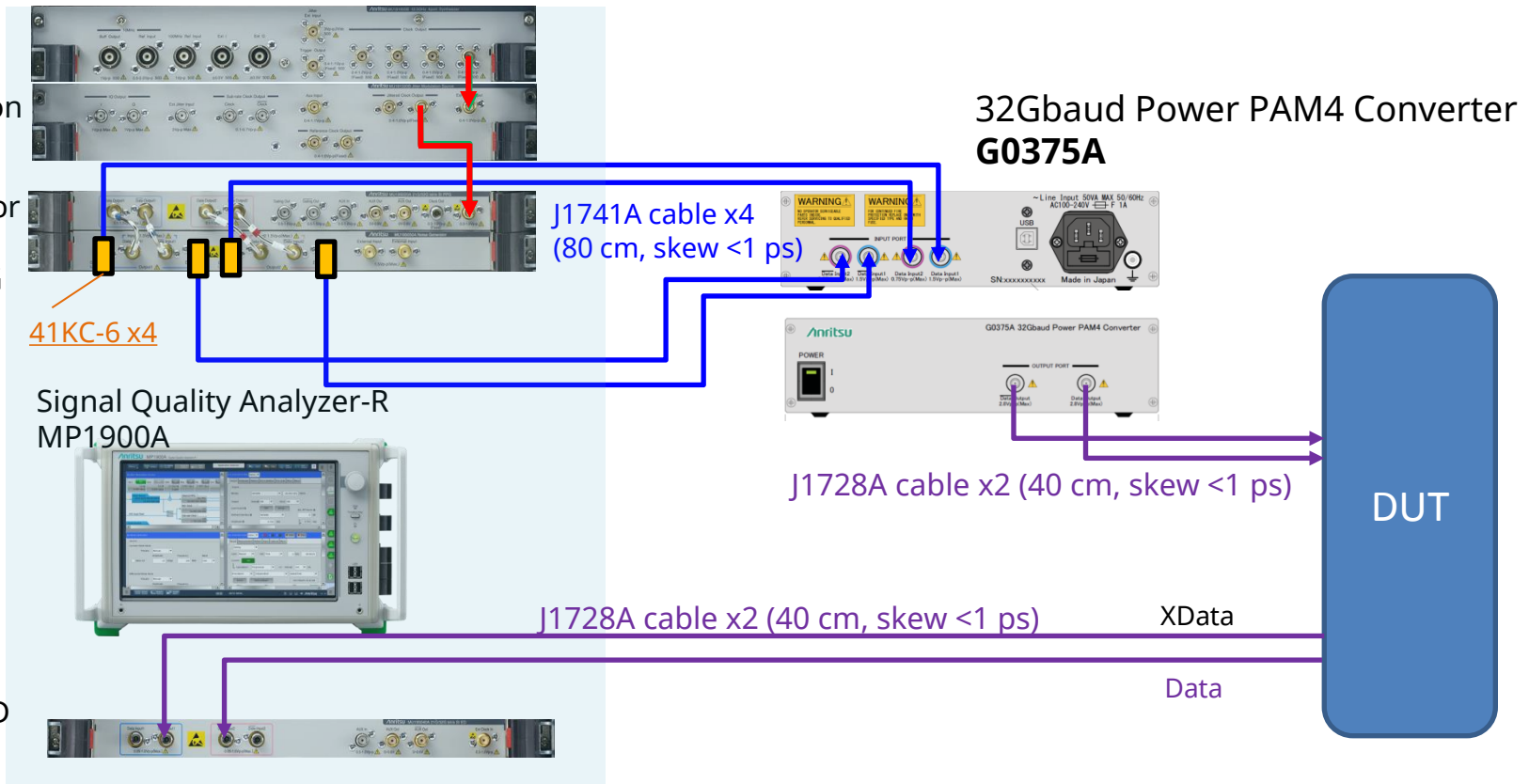
	MU195020A+G0375A Tx configuration	MU195020A+MU195050A +G0375A Tx configuration
G0375A output amplitude	400 mV (Single-end) 800 mV(Differential)	
Pattern	PRBS31Q	
Skew adjustment	100 mUI or less	
Emphasis Pre-cursor1	0.0 dB at 26.5625 G/ 0.8 dB at 28 G	1.0 dB at 26.5625 G/ 1.8 dB at 28 G
Emphasis Post cursor1	0.0 dB at 26.5625 G/ 0.2 dB at 28 G	0.8 dB at 26.5625 G/ 1.0 dB at 28 G
G0376A DFF On/Off	DFF On	
G0376A Input Condition	Differential	
Error Result	Error Free at 26.5625 G and 28 G	

MU195040A Error Detector PAM4 Sequential BER Measurement

Setup with G0375A and MU195040A ED for jitter tolerance test

Supports PAM4 Jitter tolerance test using MU195040A PAM4 sequential measurement

- Synthesizer MU181000B
- Jitter Modulation MU181500B
- Noise Generator MU195050A
- 32G 2ch SI PPG MU195020A (Opt-020, 021, 031)
- 32G 2ch SI ED MU195040A (Opt-020, 022)



Note:

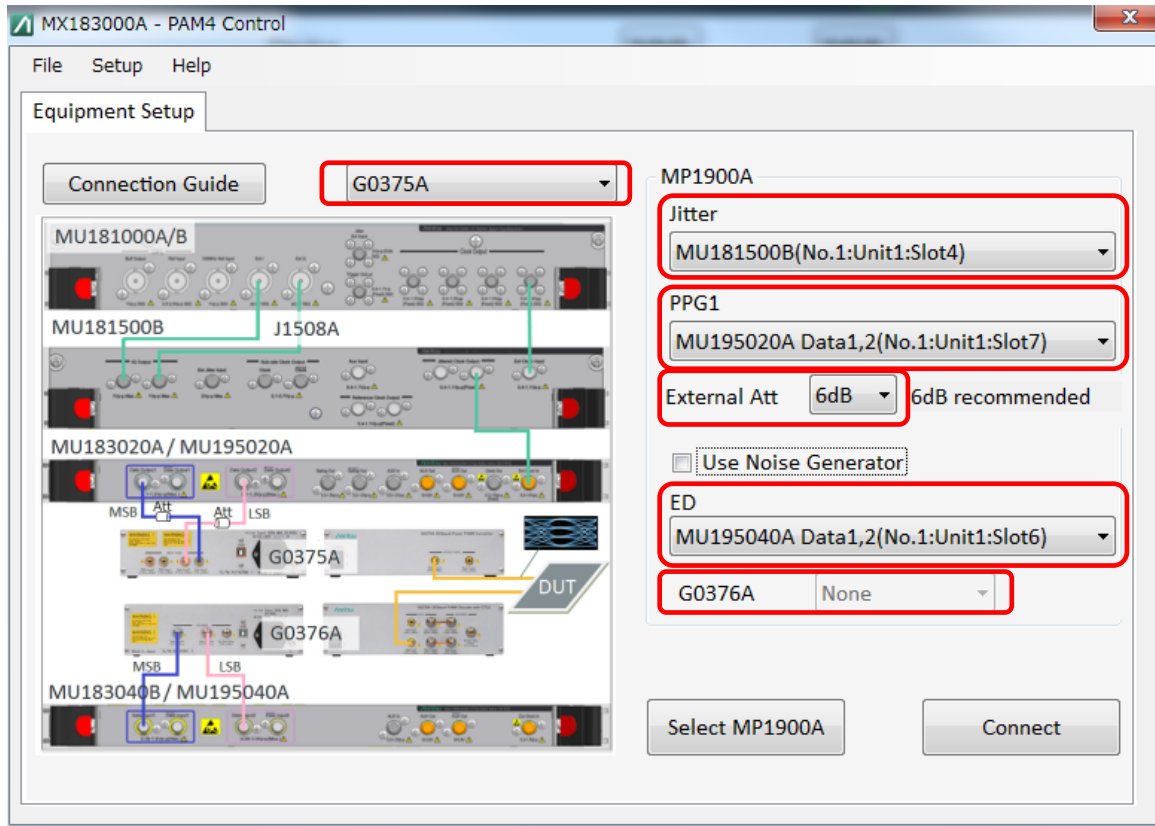
Connect xData output to xData1 input of ED for Clock Recovery.
Connect Data output to Data2 input of ED for sequential measurement.

Specifications Rx

MU195040A 21G/32G bit/s SI ED Data Input

Item	Specification	Remarks
Number of Inputs	2 (Data, xData)	K Connector (female)
Data Input Amplitude	0.3 to 1.0 Vp-p (\leq 28.1 Gbaud) 0.4 to 1.0 Vp-p ($>$ 28.1 Gbaud)	Single-ended
Data Input Sensitivity	120 mVp-p, 40 mVp-p/Eye (typ., 21Gbaud) 150 mVp-p, 50 mVp-p/Eye (typ., 28.1Gbaud)	Eye amplitude, PRBS15, Single-ended, CTLE Off
	24 mV/Eye (typ., 21Gbaud) 26 mV/Eye (typ., 28.1Gbaud)	Eye height, PRBS15, Single-ended, CTLE Off
Phase margin	Middle eye 8 ps (typ. 25 Gbaud) 5 ps (typ. 28 Gbaud) Upper and Lower 5 ps (typ. 25 Gbaud) 3 ps (typ. 28 Gbaud)	0.5 Vp-p input, Emphasis control(1Pre \leq 3 dB, 1Post \leq 1 dB) , PRBS15, Single-ended, CTLE Off
	Middle eye 20 ps (typ. 25 Gbaud) 15 ps (typ. 28 Gbaud) Upper and Lower 20 ps (typ. 25 Gbaud) 15 ps (typ. 28 Gbaud)	Eye width 0.5 Vp-p input, Emphasis control(1Pre \leq 3 dB, 1Post \leq 1 dB) , PRBS15, Single-ended, CTLE Off

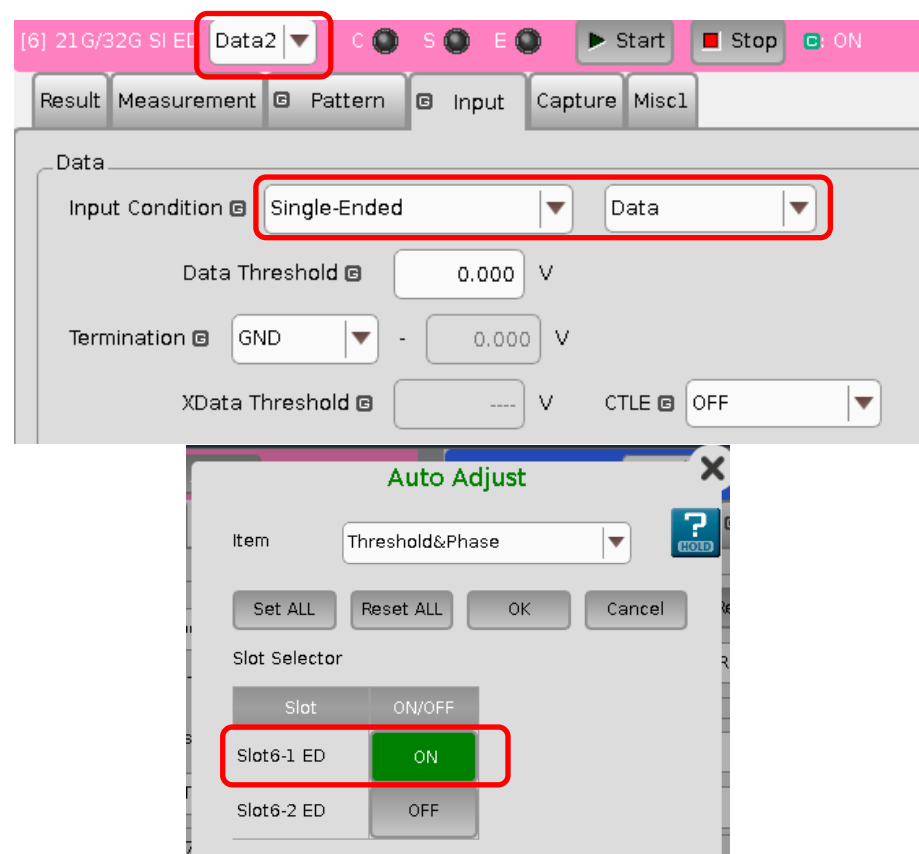
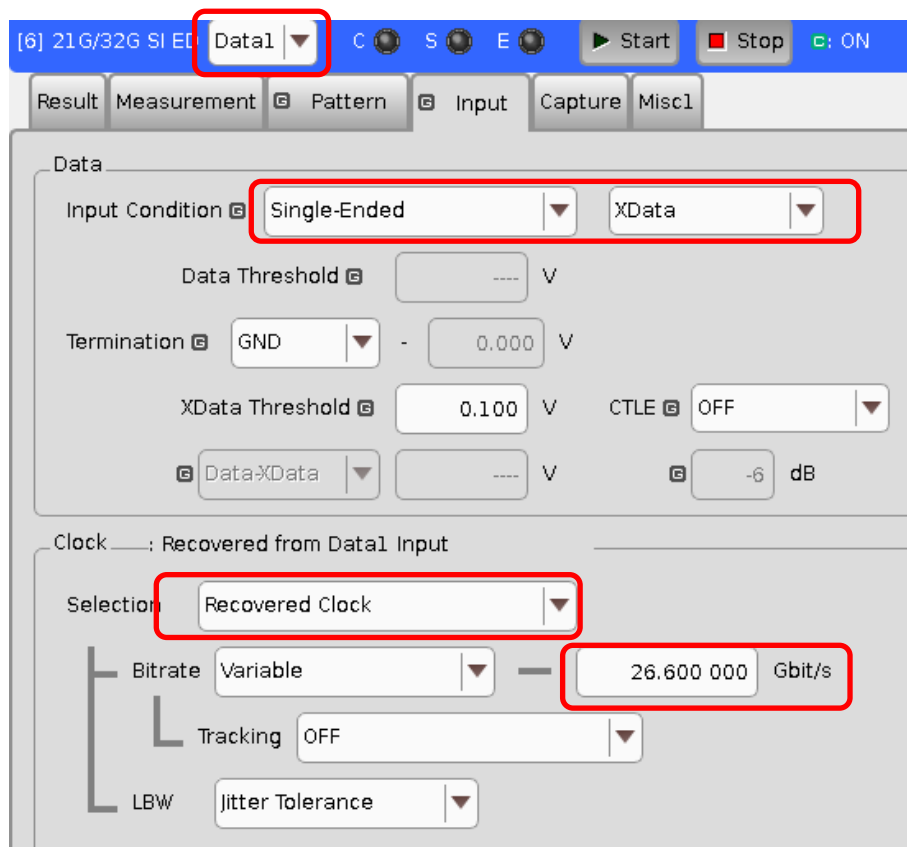
Equipment setup



- Select Jitter and PPG with unit number from each selection list.
- *Select "None" when Jitter isn't used for testing.
- Select G0375A.
- Select "None" from ED and G0376A selection lists.
- Set External Att value to 6 dB when 6 dB attenuator is used between PPG and G0375A.

Measurement Procedure (1/2)

1. Set G0375A amplitude, Emphasis, skew, and pattern by referring to previous explanation.
2. Click "Operate MP1900A" button for MU195040A BER measurement.
3. Ensure that the ED combination setting is Independent.
4. Select Recovered Clock at [Selection] of [Clock] at the Data1 [Input] tab and select Single-Ended and XData at [Input Condition] of [Data] at the Data1 [Input] tab. Ensure that the [Bitrate] setting is same as the PPG setting.
5. Select Single-Ended and Data at [Input Condition] of [Data] at the Data2 [Input] tab.
6. Start Auto Adjust ONLY for Data1 input to recover the clock.



Measurement Procedure (2/2)

7. Click [AUTO MEAS] and click [PAM4 BER] listed in the auto measurement side menu bar on the screen right.
8. Select the ED test pattern at [Pattern]. Use the same pattern as the PPG.
9. Select PAM Fine at [Auto Search] and Data2 at [Module].
10. Click [Start] to start the PAM4 sequential BER measurement.

Serial

Measurement Condition

Time Repeat 00:00:01

Pattern PRBS15

Auto Search PAM Fine

Module Unit1-Slot6-Data2

Change the PPG Combination setting to..

Operation: Combination

Combination: 2ch

Result

	Threshold	Phase	Error Rate	Error Count	Alarm
	Data	XData			
Upper	<input type="checkbox"/> ON	<input type="text"/> V	<input type="text"/> mUI	<input type="text"/>	<input type="text"/>
Middle	<input type="checkbox"/> ON	<input type="text"/> V	<input type="text"/> mUI	<input type="text"/>	<input type="text"/>
Lower	<input type="checkbox"/> ON	<input type="text"/> V	<input type="text"/> mUI	<input type="text"/>	<input type="text"/>

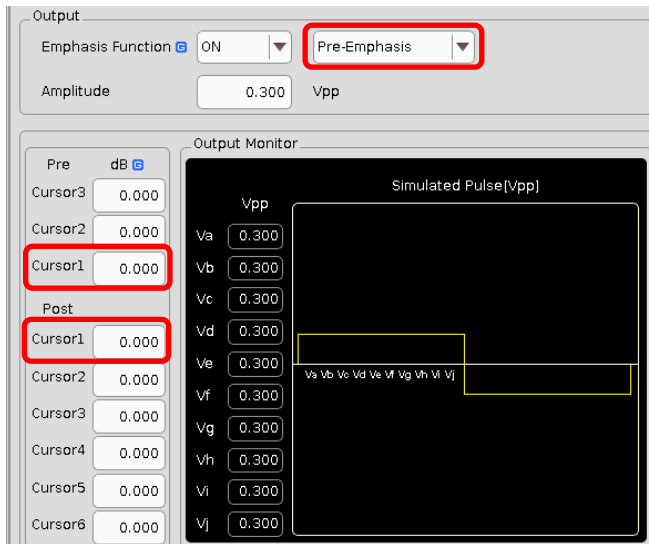
Contour

Bathtub

Margin

PAM4 BER

[Optional] Optimizing BER by Adjusting Emphasis Setting



1. Go to the [Emphasis] tab on the PPG setting screen
2. Select Pre-Emphasis and adjust Pre-Cursor1 for both Data1 and Data2 outputs so the error rate is lower. The settings for Data1 and Data2 are the same in most cases.
3. Adjust Post-Cursor1 for both Data1 and Data2 as well.

Typical Settings and BER Result

Recommended settings for error free condition at 26.5625 Gbaud and loopback connection from G0375A to MU195040A ED input are listed below.

	Settings and BER result
G0375A output amplitude	600 mV (Single-end)
Pattern	PRBS13Q, PRBS15
Skew adjustment	100 mUI or less
Emphasis Pre-cursor1	1.0 dB at 26.5625 G/ 1.8 dB at 28 G
Emphasis Post cursor1	0.8 dB at 26.5625 G/ 1.0 dB at 28 G
MU195040A Data1 Input	Input condition: Single-end, xData Clock input: Recovered Clock Auto Adjust: On for Data1
MU195040A Data2 Input	Input condition: Single-end, Data
PAM4 BER AUTO MEAS	Condition: Unit xx-Slotxx-Data2
Error Result	Error Free at 26.5625 G and 28 G

