Anritsu envision:ensure

Quick Start Guide

MP1900A USB3.1 Test Solution

Signal Quality Analyzer-R

MP1900A Series

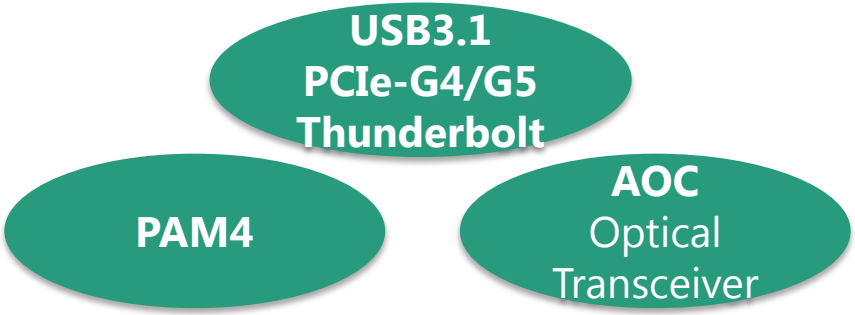
Contents

Outline

Digital devices are handling huge data volumes due to the spread of the IoT and cloud computing services, resulting in increased use of faster and serial interfaces between devices. The USB interface used for connecting these digital devices is switching to USB3.1 Gen2 supporting speeds of 10 Gbit/s for transmitting large data volumes faster and is also adopting the smaller Type-C connector.

The Anritsu Signal Quality Analyzer-R MP1900A series is a high speed BERT supporting USB3.1 receiver testing and compliance patterns to control DUT test modes.

MP1900A Strengths

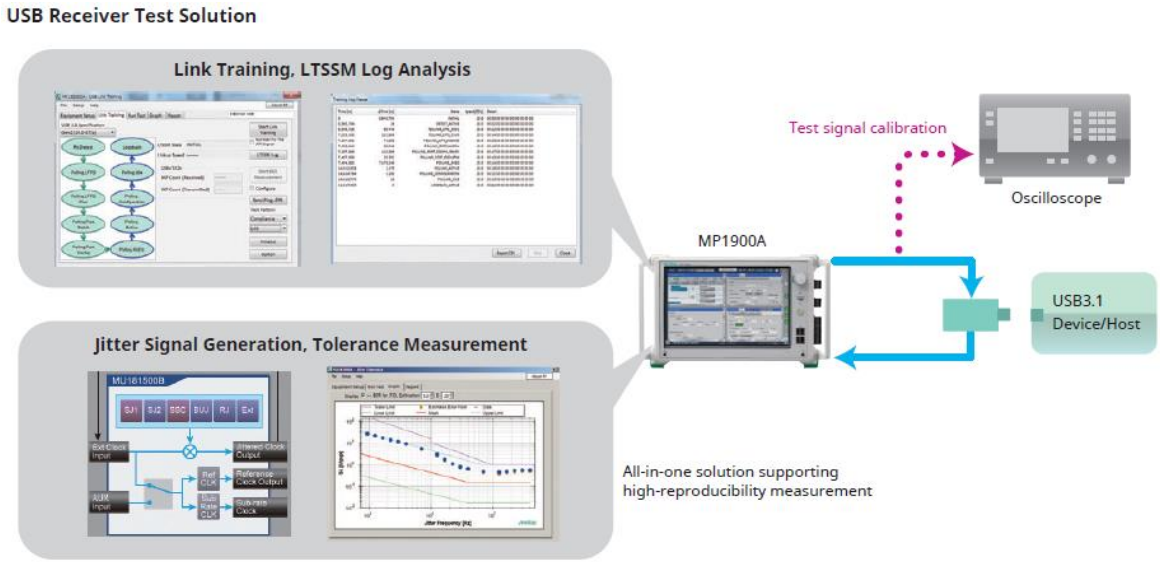


All-in-one support for both high-speed network interfaces and bus interfaces

SQA-R MP1900A

- **Signal Quality**
  - Low Jitter/Clean Eye
  - 10Tap Emphasis for Tx
  - High sensitivity
  - 12 dB variable CTLE for Rx
  - Jitter/Noise source
- **Scalability**
  - 32 Gbit/s NRZ up to 16 channels
  - 112 Gbit/s PAM4 (56 Gbaud) up to 4 channels
  - Same USB3.1, PCIe-G4/G5, Thunderbolt Test configuration
- **Analyzability**
  - Supports PCIe-G5 bit rate (32G NRZ)
  - USB/PCIe-G4 Link Training (Negotiation)
  - USB/PCIe-G4 LTSSM analysis
- **Usability**
  - All-in-One: Control PC, noise source, Emphasis, CTLE, CDR, etc.
  - New GUI/touch screen

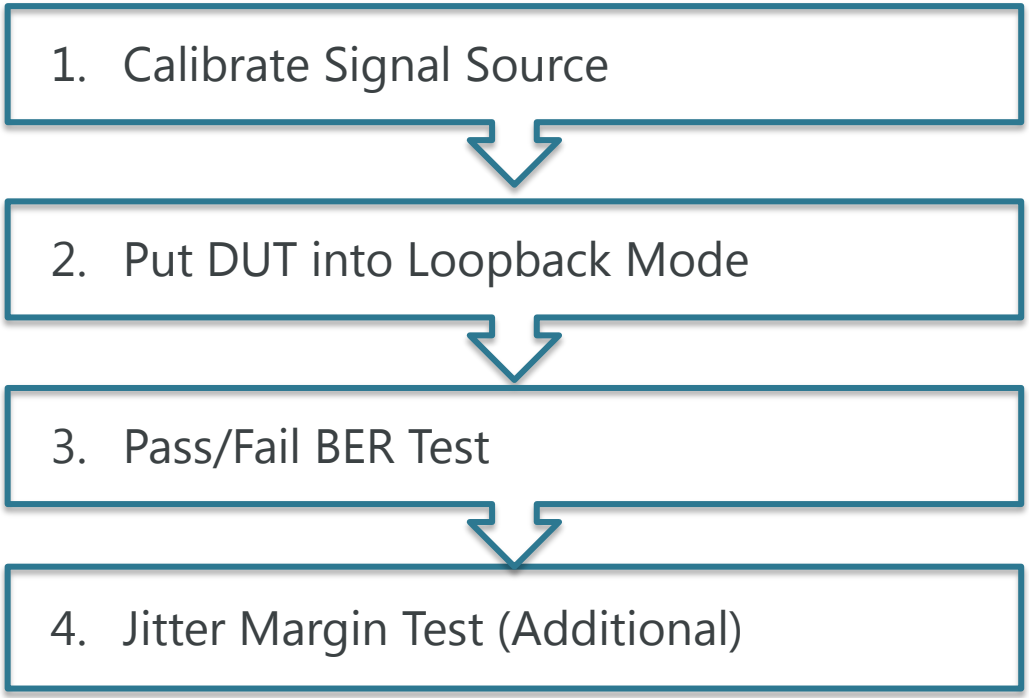
USB3.1 Solution Advantages



- Protocol aware and all-in-one USB3.1 Rx test solution
- Wideband BERT 2.4 to 32.1 Gbit/s supporting not only USB but also PCIe and Thunderbolt
- High-quality waveforms with low Intrinsic Jitter, high-reproducibility measurement using high-sensitivity ED
- Link Training and LTSSM Analysis functions for solving link issues
- Send and receive LFPS and LBPM signals
- Insert and identify Skip Ordered Set
- Jitter Addition (SJ, RJ, BUJ, SSC) and Tolerance measurements
- Fully automated Compliance and Jitter Tolerance tests

Contents

Flow of Rx Compliance Test



Rx Compliance Test Recommended Equipment List (1/2)

Model Number	Name	Qty.	Option	Remarks
MP1900A	Signal Quality Analyzer-R	1		
MU181000B	12.5 GHz Synthesizer	1		
MU181500B	Jitter Modulation Source	1		
MU195020A	21G/32G bit/s SI PPG	1	010, 011	
MU195040A	21G/32G bit/s SI ED	1	010, 011, 022	
MU195050A	Noise Generator	1		
J1510A	Pick Off Tee	2		When MU195050A not installed
J1551A	Coaxial skew matched cable 0.8 m, K-connector	2		
J1624A	Coaxial cable 0.3 m	4		Standard cable of MU181000B and MU181500B

Rx Compliance Test Recommended Equipment List (2/2)

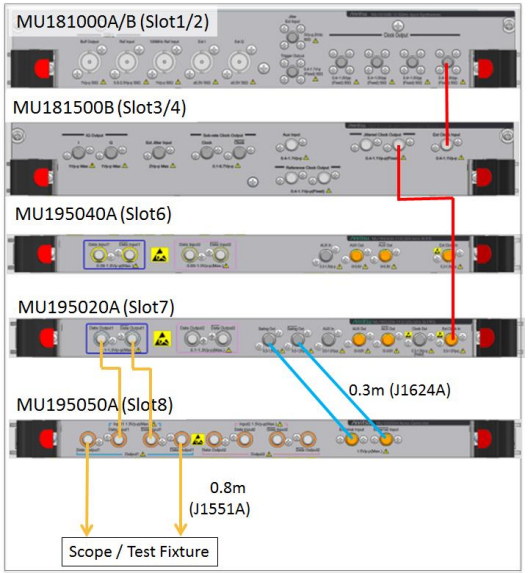
Model Number	Name	Option	Remarks
MX183000A-PL022	USB Link Training		
MX183000A-PL001	Jitter Tolerance		
-	Oscilloscope		At least 16 GHz bandwidth and sample rate of 80 GS/s
USB31CET*	USB3.1 USB (10 GT/s) Type-C Electrical Test Fixture Kit		Compliance Test Fixture For Type-C
USB31AET*	USB3.1 USB (10 GT/s) Type-A and Micro-B Electrical Test Fixture Kit		Compliance Test Fixture For Type-A and Micro-B

*Sold by USB-IF
http://www.usb.org/developers/estoreinfo/

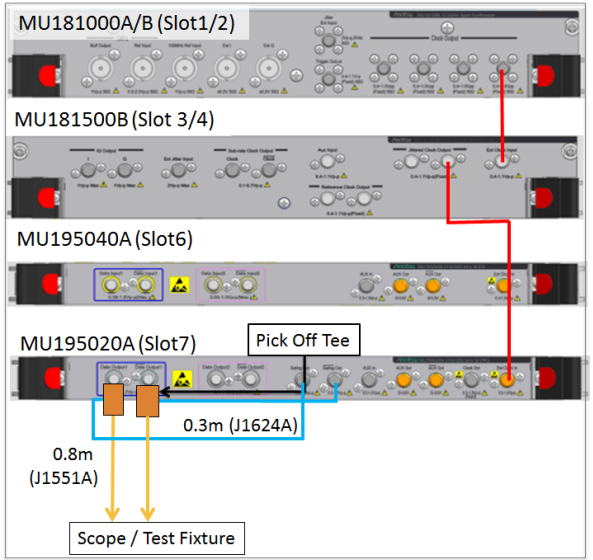
Compliance Test Overview: MP1900A Connections

- There are two ways to combine the test signal and LFPS.

Using MU195050A (recommended configuration for simple cable connection using combiner circuit in MU195050A)

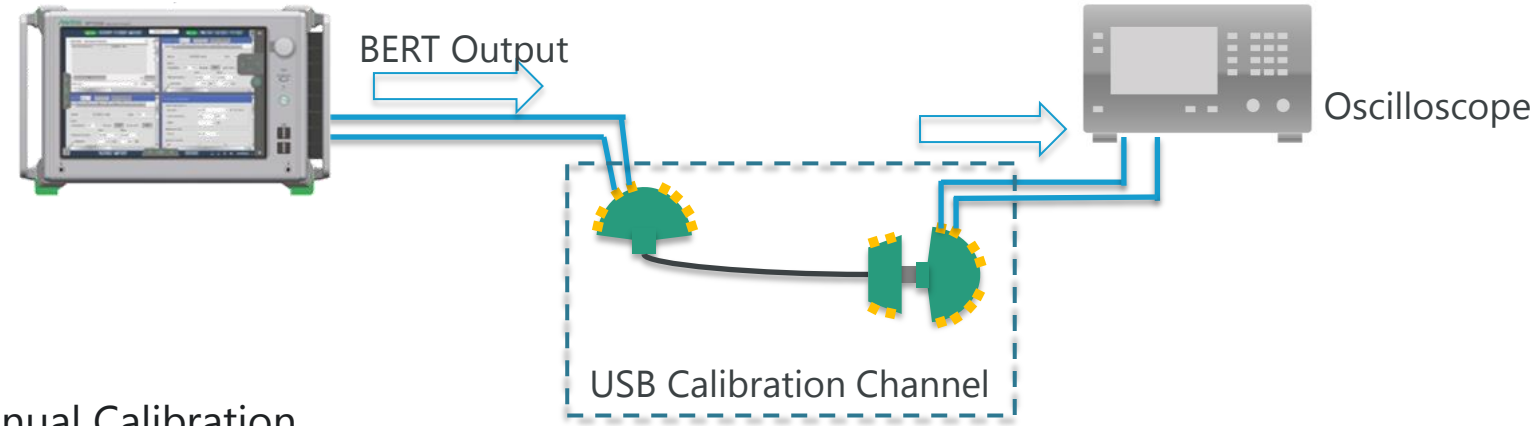


Using Pick Off Tee



Compliance Test Overview: Calibration for Rx Test

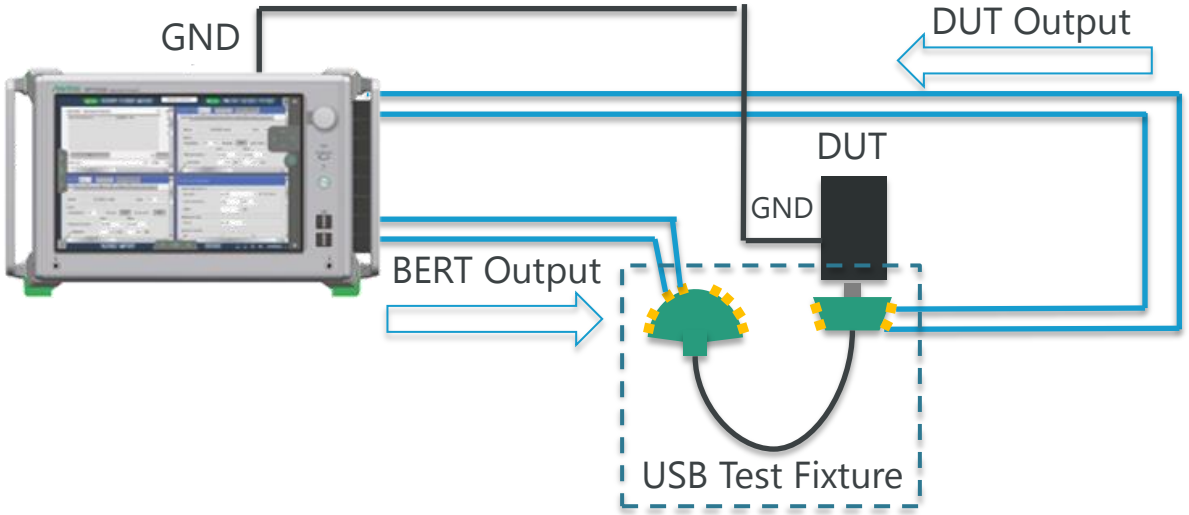
The main purpose of **Calibration** is to calibrate the Emphasis, Amplitude and Jitter settings to meet USB3.1 requirements.



- Manual Calibration
  - Calibrate the Amplitude, Emphasis, Jitter, Eye Height, and Eye Width of the BERT output as specified by the standard.
- Automated Calibration
  - Please contact our sales representative for automated calibration software.

Compliance Test Overview: Rx Test

The main purpose of the Compliance **Rx Test** is to verify that the Device Under Test (DUT) meets the USB3.1 Jitter Tolerance requirements.

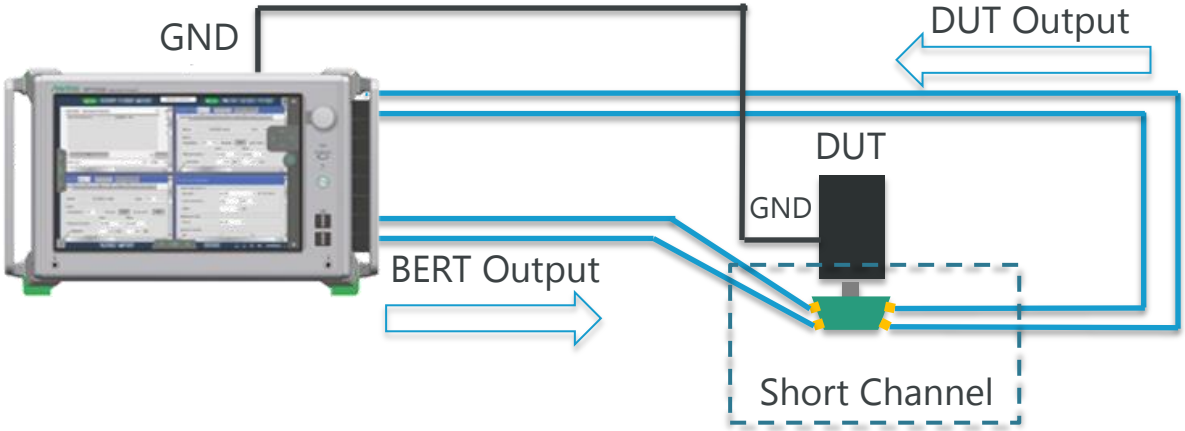


- MX183000A - PL022 USB Link Training and PL001 Jitter Tolerance
  - Put DUT into Loopback Mode
  - BER Measurement
  - Jitter Tolerance Test

Compliance Test Overview: Long/Short Channel Test

This Compliance Test requires that both the Long Channel and Short Channel tests*1 are passed by performing the same test with the two fixtures.

*1 For more details, refer to Appendix A



- Rx Test
  - This test requires switching the connection at Long Channel fixture and Short Channel fixture.
- Tx Test
  - Use of the waveform analysis software SigTest channel emulation function does not require switching the Long Channel connection.

Contents

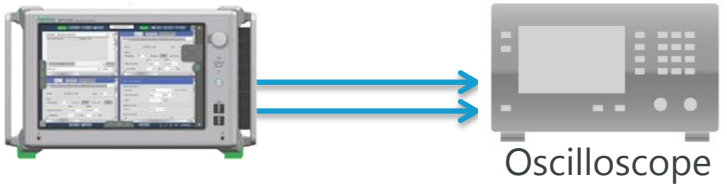
Calibration Procedure: Hardware Setup

Connector Type	Speed	items	Connection
Type-C	Gen1	Amplitude, Emphasis	Direct
		Jitter (RJ, SJ)	
	Gen2	Amplitude, Emphasis	Direct
		Jitter (RJ, SJ)	
		Eye Width, Eye Height	Fixture A-1
Type-A	Gen1	Amplitude, Emphasis	Direct
		Jitter (RJ, SJ)	Fixture A-3
		Eye Height	
	Gen2	Amplitude, Emphasis	Direct
		Jitter (RJ, SJ)	
		Eye Width, Eye Height	Fixture A-2
Micro-B	Gen1	Amplitude, Emphasis	Direct
		Jitter (RJ, SJ)	Fixture A-3
		Eye Height	
	Gen2	Amplitude, Emphasis	Direct
		Jitter (RJ, SJ)	
		CLB Select	Fixture A-2
		Eye Width, Eye Height	

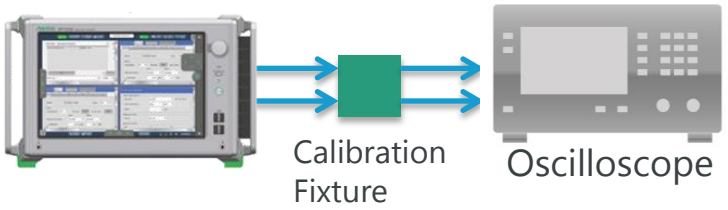
*For details, refer to Appendix A

*Test fixtures sold by USB-IF
http://www.usb.org/developers/estoreinfo/

Direct Connection



With Calibration Fixture



Calibration Procedure: Calibration Settings

Table 1 lists typical settings when calibrating the test signal using the MP1900A. Tables 2 and 3 also list the respective SJ settings for the receiver test.

Table 1 Calibration Results Summary

	Single-End Amplitude (V p-p)		Pre-Cursor1 (dB)	Post-Cursor1 (dB)	RJ (ps p-p)	SJ (UI p-p)	SSC
	Long Channel	Short Channel					
Gen1	0.500	0.630	-	–3.0	36	Table 2	Down 33 kHz 5000 ppm
Gen2	0.490	0.700	2.3	–0.9	14.0	Table 3	

Table 2 SJ Calibration Results for Gen1

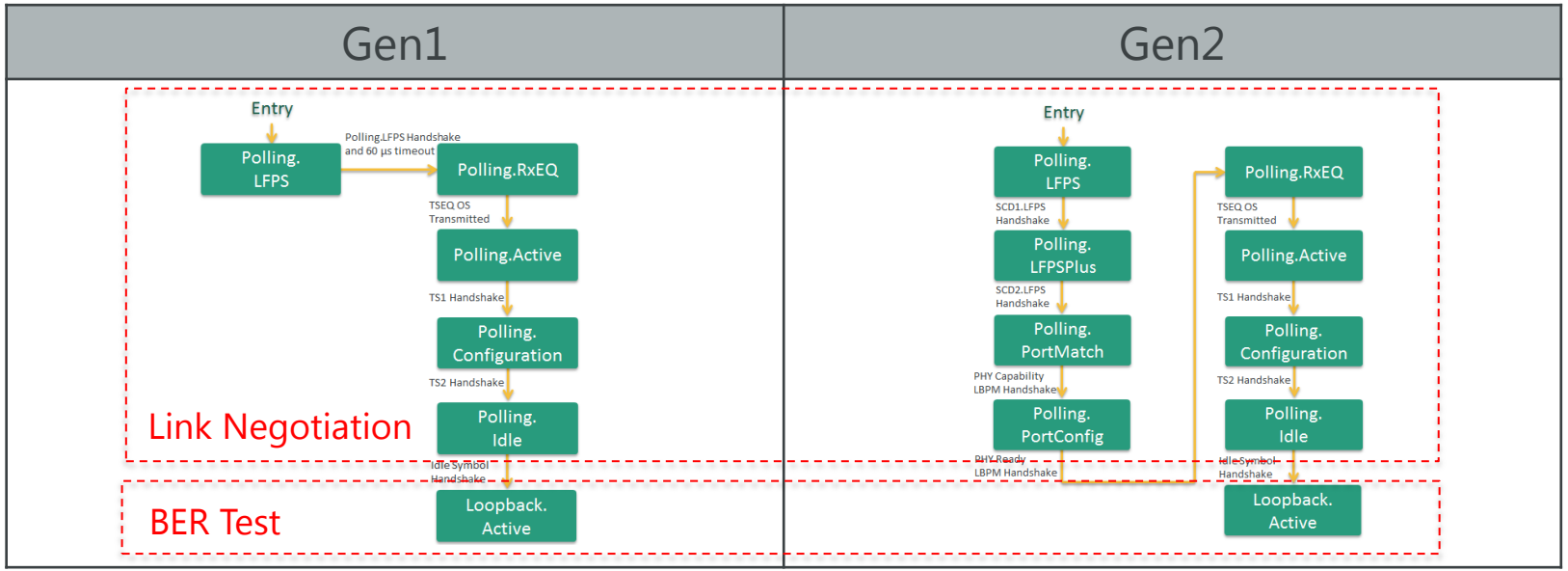
SJ Frequency	Setting (UI p-p)
50 MHz	0.200
30 MHz	0.200
20 MHz	0.200
10 MHz	0.200
4.9 MHz	0.200
2 MHz	0.200
1 MHz	0.500
500 kHz	2.000

Table 3 SJ Calibration Results for Gen2

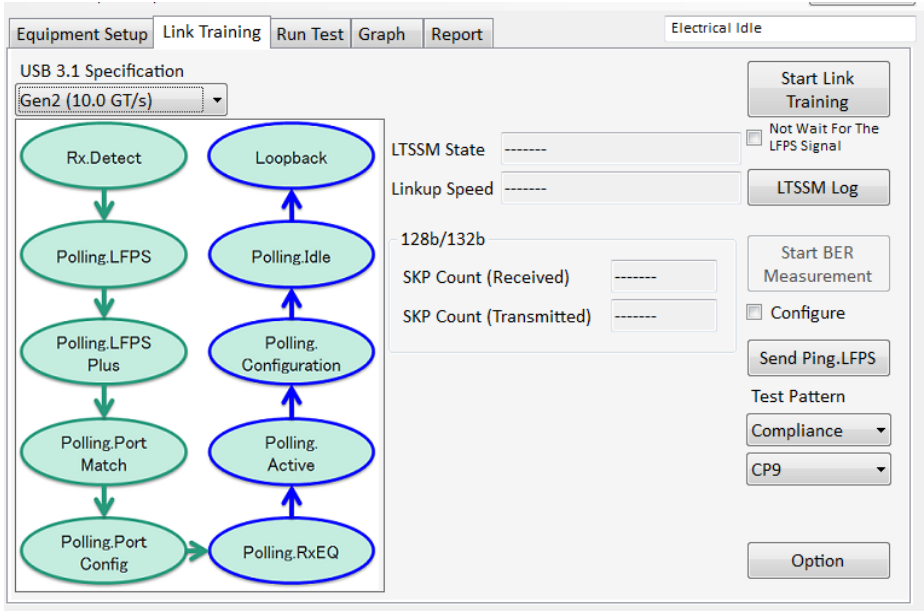
SJ Frequency	Setting (UI p-p)
100 MHz	0.170
50 MHz	0.170
30 MHz	0.170
15 MHz	0.170
7.5 MHz	0.170
4 MHz	0.370
2 MHz	0.870
1 MHz	2.030
500 kHz	4.760

Rx Link Training: Link Training and Status State Machine (LTSSM) (1/2)

– Different state machine sequence for each generation



Rx Link Training: Link Training and Status State Machine (LTSSM) (2/2)



MX183000A-PL022 USB Link Training Setting Screen
– Link Training by auto-negotiation

Rx Link Training: Host DUT Connection Diagram

Type-C Host DUT

Set jumpers on CC1 when SMAs connected to Tx1/Rx1.

Host DUT

GND

Host DUT Training via BIOS Mode

Jitter
ED
PPG
Noise

MP1900A
LFPS Bonding Method – Noise Module

Type C ↔ Type C 1-m cable

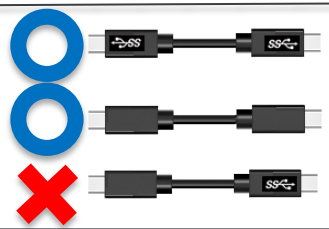
Host Fixture 1C

5.6" CLB

SMA Cables (Phase Matched)

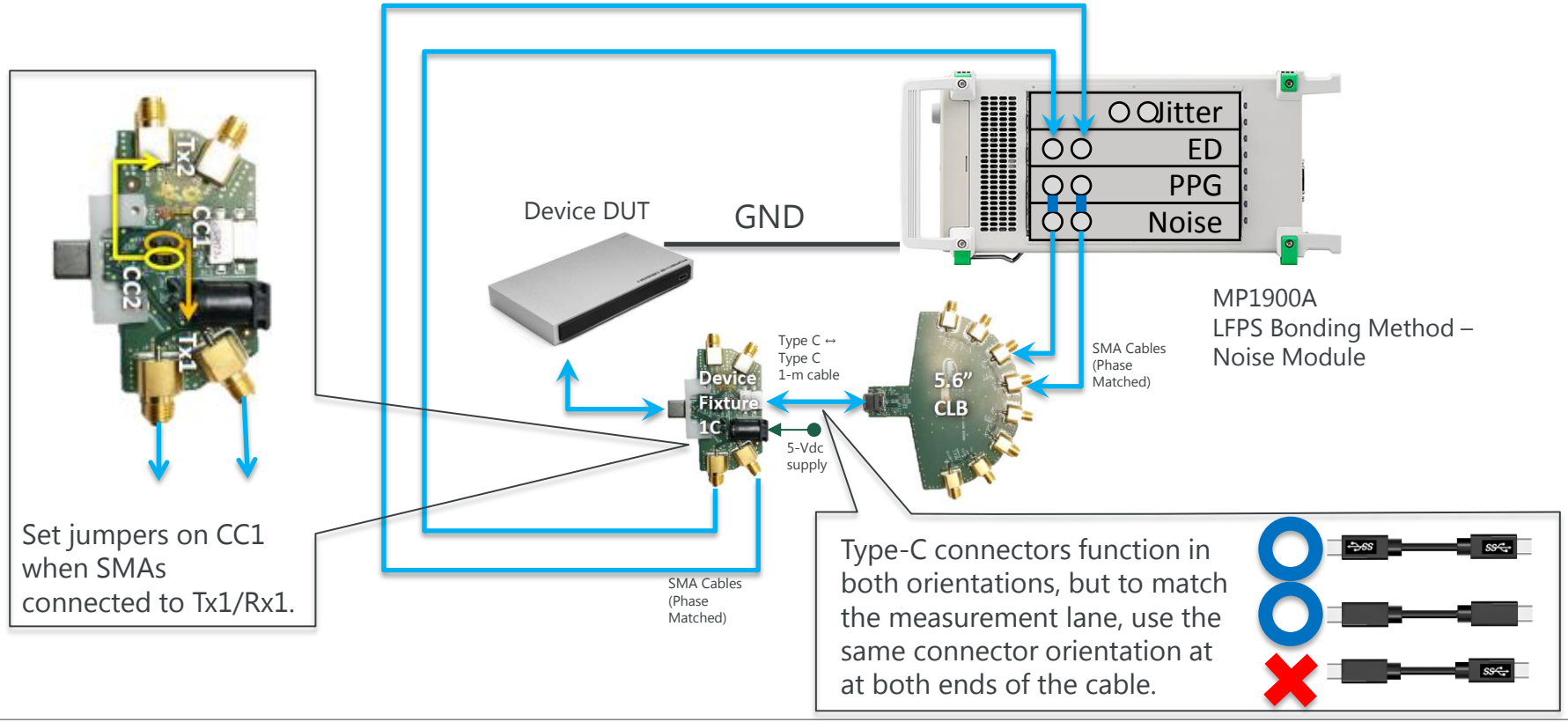
SMA Cables (Phase Matched)

Type-C connectors function in both orientations, but to match the measurement lane, use the same connector orientation at both ends of the cable.



Rx Link Training: Device DUT Connection Diagram

Type-C Device DUT



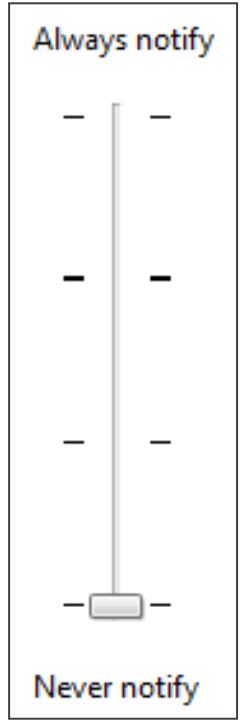
Rx Link Training: DUT Setup

One of the following procedures is required at the Host DUT before Link Training from the BERT.
This is not required for the Device DUT.

1. Use the open-source HSETT software at the USB I/F.
2. Start the Host DUT in the BIOS Mode.

Rx Link Training: 1 – Host DUT Setup Using HSETT (1/3)

- The HSETT[*1] software puts devices, hosts and hubs into the appropriate test modes. Download the HSETT software from the following link[*1] and use the following procedure to install it in the DUT.
- Before installing HSETT, disable User Account Control (UAC) in Windows.
- Choose Start → Control Panel → User Accounts and Family Safety → User Accounts → Change User Account Control settings.
- Set the Settings Bar to [Never notify]. Click [OK] and restart the computer.
- Start the downloaded HSETT and follow the instructions.

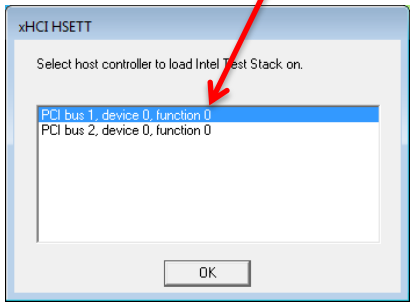


*1 Download link: http://www.usb.org/developers/tools/
- HSETT 32-bit version
- HSETT 64-bit version

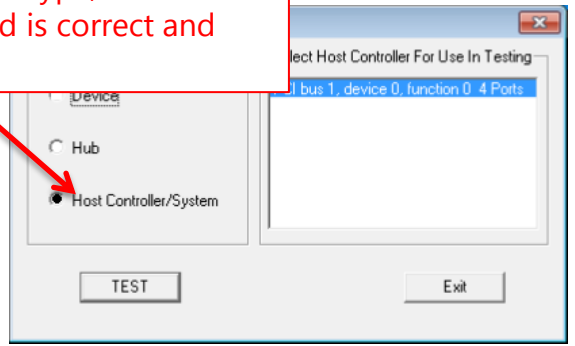
Rx Link Training: 1 – Host DUT Setup Using HSETT (2/3)

- Run HSETT on the Host DUT and follow the procedure below.

Choose the correct controller and click [OK].

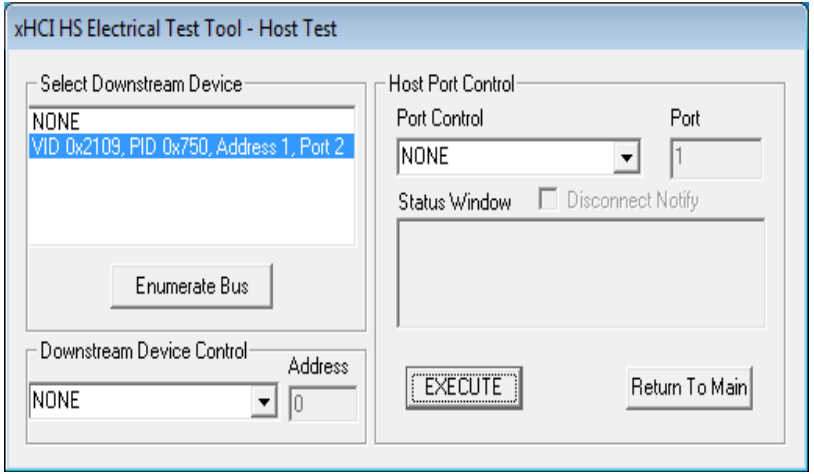


Select the appropriate test type; confirm the host controller being used is correct and click [Test].



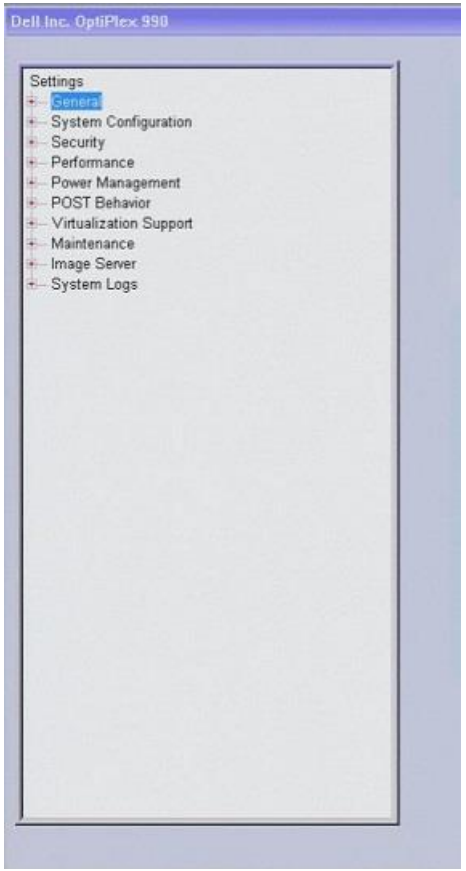
Rx Link Training: 1 – Host DUT Setup Using HSETT (3/3)

- Pressing the [Test] button as described on the previous slide displays the xHCI HS Electrical Test Tool – Host Test screen shown on the right.
- The settings are correct when transitioning to the Loopback Mode is supported by performing Link Training in this condition.

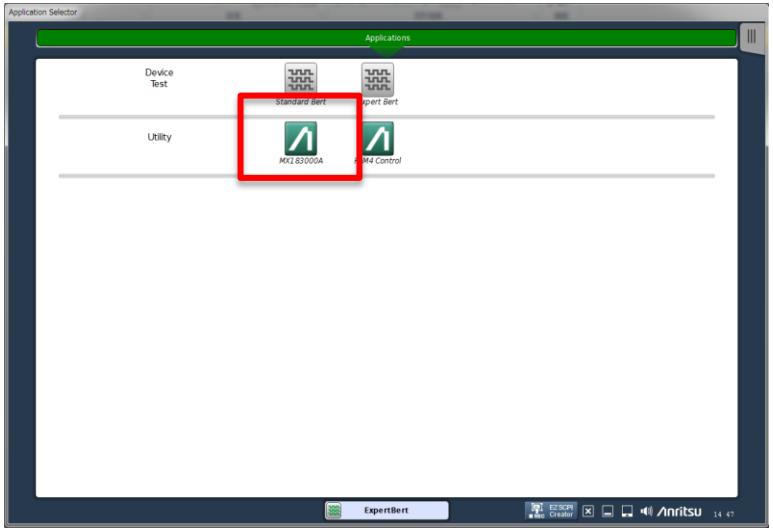


Rx Link Training: 2 – Host DUT Setup Using BIOS Mode

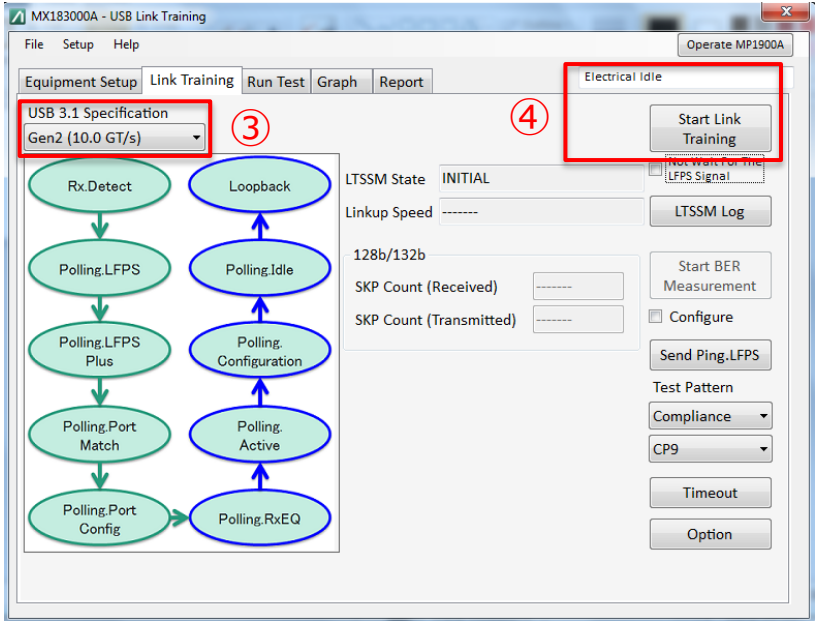
- In addition to the method using HSETT, it is also possible to transition to the Loopback Mode by booting the Host DUT in the BIOS Mode.



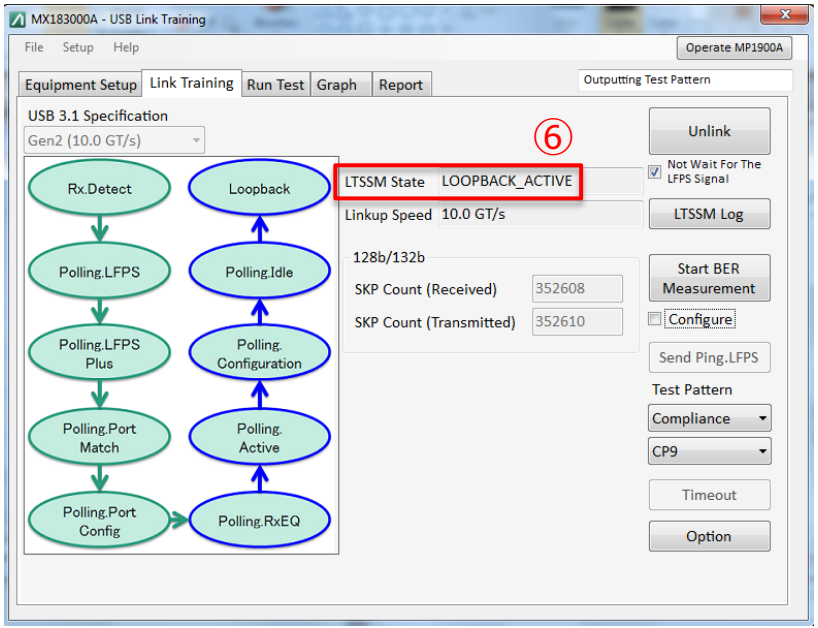
Rx Link Training: Software Control (1/3)

MP1900A USB Link Training	Setup and Execution
	1. Open the MP1900A application selector. 2. Click MX183000A.

Rx Link Training: SW Control (2/3)

MP1900A USB Link Training	Setup and Execution
	3. Go to the [Link Training] tab via the MX183000A USB Link Training application and select the target link speed at [USB 3.1 Specification]. 4. With the DUT disconnected from the fixture, click the [Start Link Training] button to display Waiting for DUT connection. 5. Start LTSSM by connecting the DUT to the fixture.

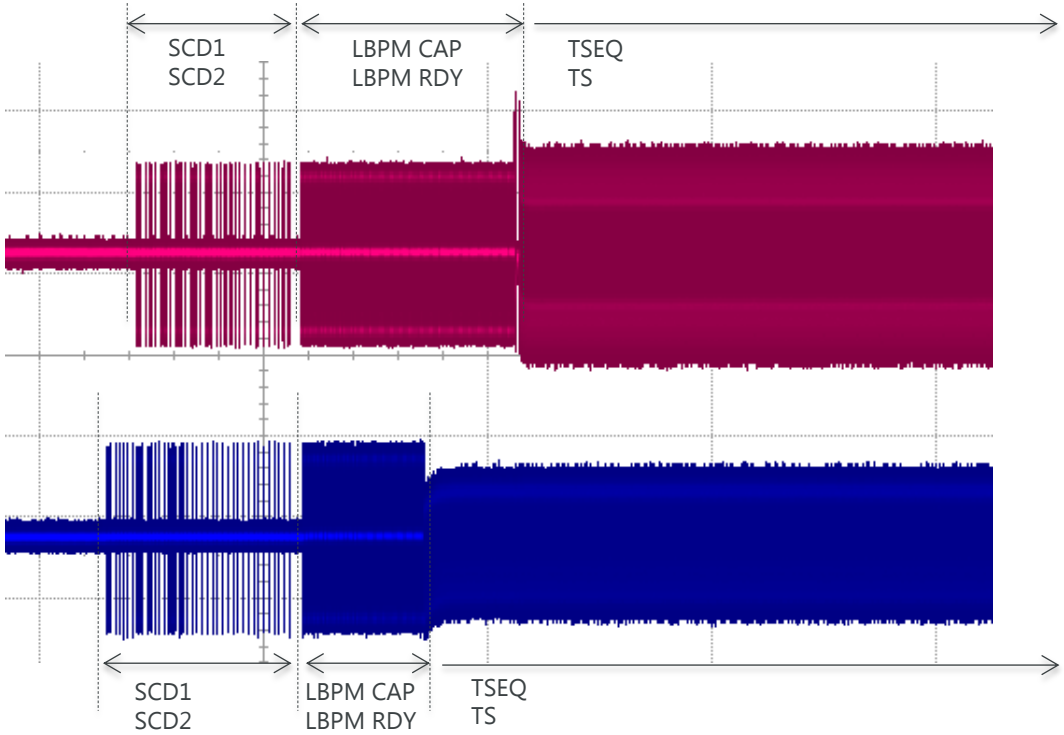
Rx Link Training: Software Control (3/3)

MP1900A USB Link Training	Setup and Execution
	6. Confirm that [LTSSM State] displays Loopback_Active.

Rx Link Training: Waveforms at Gen2 Training

BERT Output

DUT Output



- Refer to Appendix-D for details about the LTSSM State Transition.
- Handshaking using the LFPS signal is required to establish a link between USB devices.
- The device sends the LFPS signal at power-on. The host sends the LFPS signal on detecting the connector connection.
- The MP1900A starts Link Training using the LFPS signal output from the DUT as the trigger.

Rx Link Training: Waveforms at Gen1 Training

– Gen1 Training on Gen2 DUT

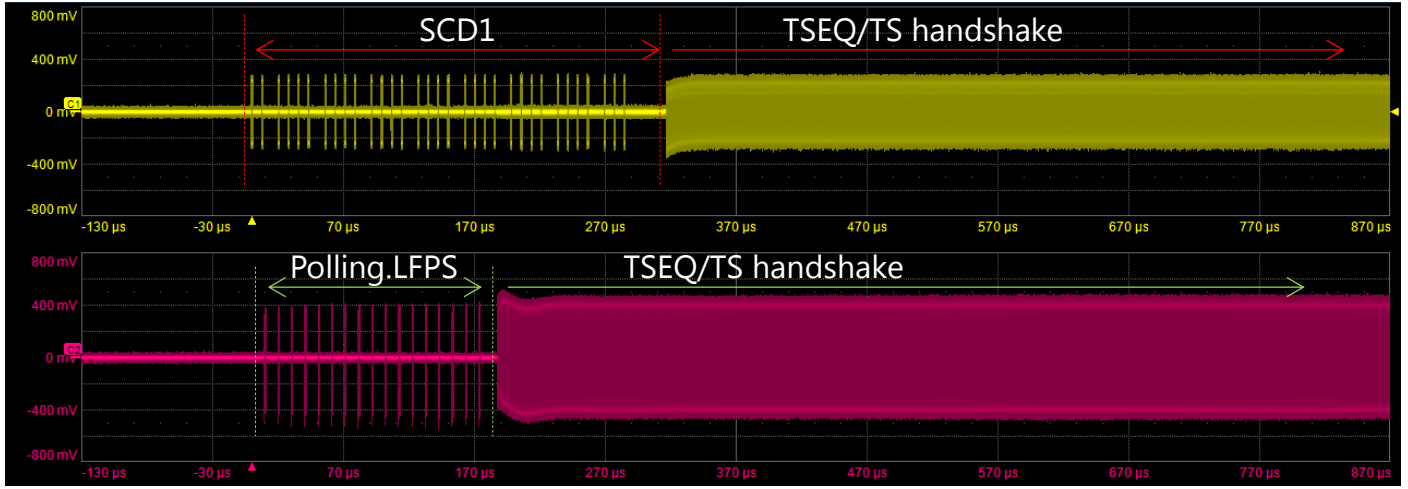
- Based on the USB3.1 specifications, the DUT must continue operation and switch to the SuperSpeed Mode.

DUT Output

(Supporting Gen2)

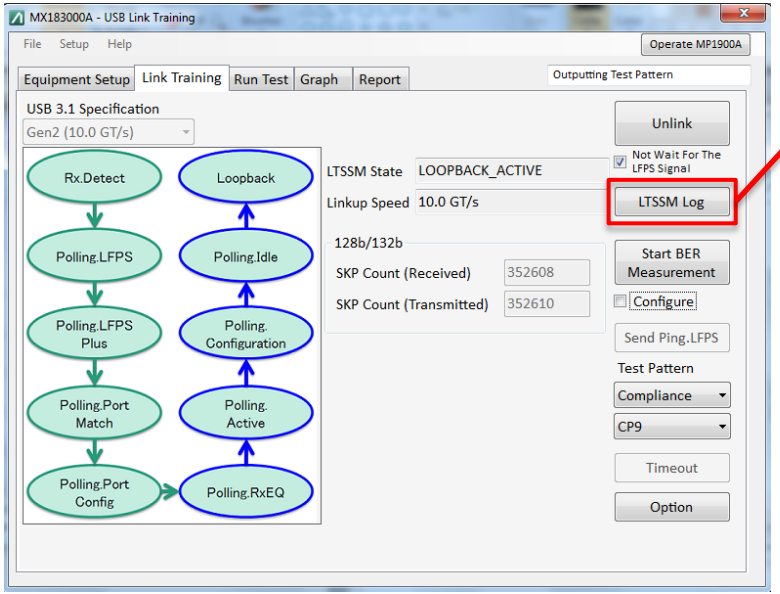
BERT Output

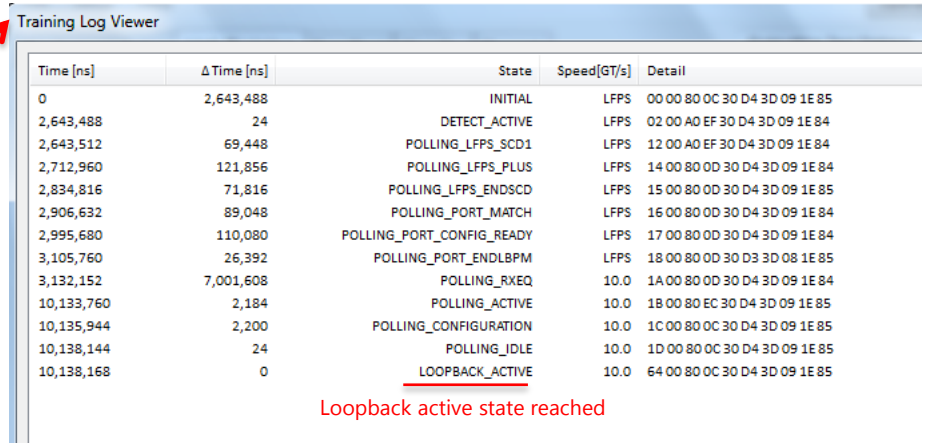
Gen1 Training



Rx Link Training: LTSSM Log (1/2)

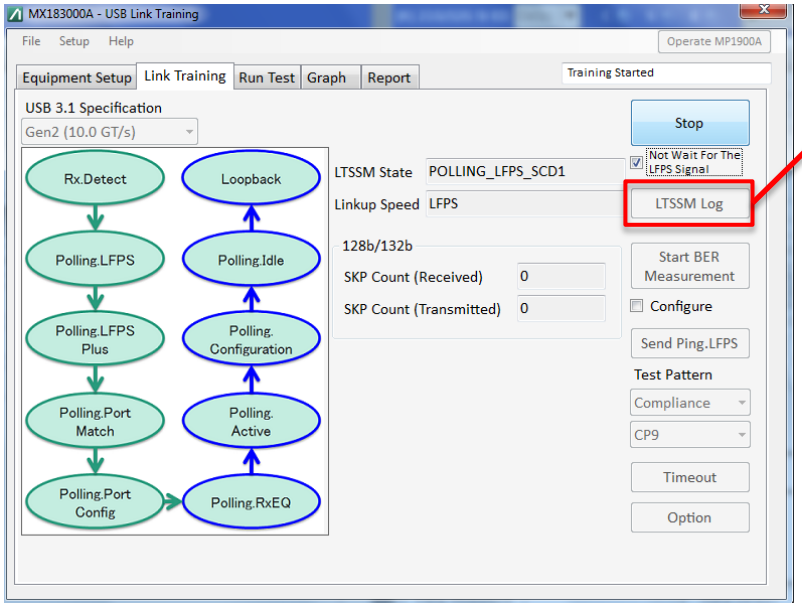
– Checking State Machine Status with LTSSM Log Function





Example of LTSSM Log with Successful Link

Rx Link Training: LTSSM Log (2/2)



Training Log Viewer

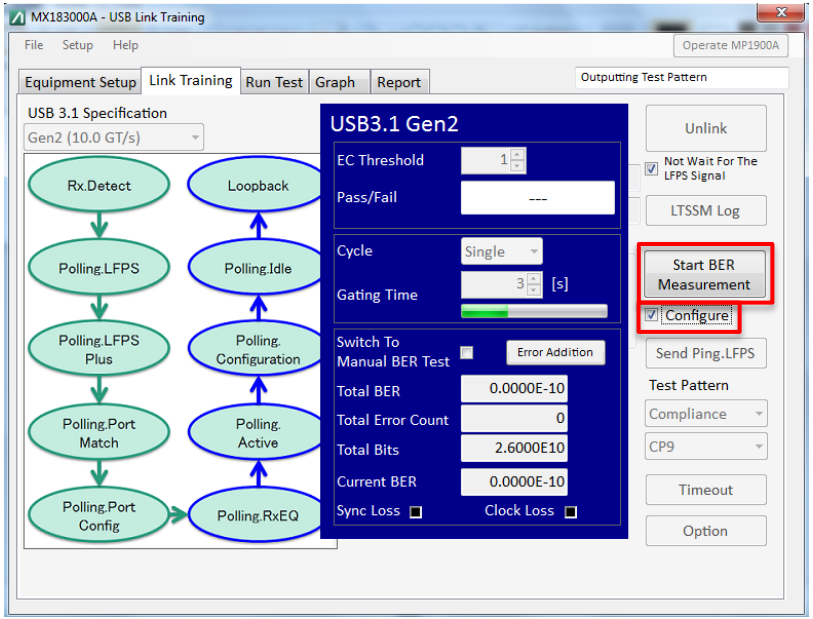
Time [ns]	Δ Time [ns]	State	Speed[GT/s]	Detail
0	2,648,568	INITIAL	LFPS	00 00 80 0C 31 2C 3D 77 1E BB
2,648,568	24	DETECT_ACTIVE	LFPS	02 00 A0 EF 30 D4 3D 09 1E 84
2,648,592	360,000,000	POLLING_LFPS_SCD1	LFPS	12 00 A0 EF 30 D4 3D 09 1E 84
362,648,592	1,785,376	INITIAL	LFPS	00 00 80 0D 30 D3 3D 08 1E 84
364,433,968	24	DETECT_ACTIVE	LFPS	02 00 A0 ED 30 D4 3D 09 1E 84
364,433,992	360,000,000	POLLING_LFPS_SCD1	LFPS	12 00 A0 ED 30 D4 3D 09 1E 84
724,433,992	1,782,672	INITIAL	LFPS	00 00 80 0D 30 D4 3D 08 1E 84
726,216,664	24	DETECT_ACTIVE	LFPS	02 00 A0 ED 30 D4 3D 09 1E 85
726,216,688	360,000,000	POLLING_LFPS_SCD1	LFPS	12 00 A0 ED 30 D4 3D 09 1E 85
1,086,216,688	1,781,176	INITIAL	LFPS	00 00 80 0D 30 D4 3D 09 1E 84
1,087,997,864	24	DETECT_ACTIVE	LFPS	02 00 A0 ED 30 D4 3D 09 1E 84
1,087,997,888	360,000,000	POLLING_LFPS_SCD1	LFPS	12 00 A0 ED 30 D4 3D 09 1E 84
1,447,997,888	1,788,880	INITIAL	LFPS	00 00 80 0D 30 D4 3D 09 1E 85
1,449,786,768	24	DETECT_ACTIVE	LFPS	02 00 A0 ED 30 D4 3D 09 1E 85
1,449,786,792	360,000,000	POLLING_LFPS_SCD1	LFPS	12 00 A0 ED 30 D4 3D 09 1E 85
1,809,786,792	1,788,272	INITIAL	LFPS	00 00 80 0D 30 D4 3D 09 1E 84
1,811,575,064	24	DETECT_ACTIVE	LFPS	02 00 A0 ED 30 D4 3D 09 1E 85

Retrain by timeout

Example of LTSSM Log with Polling State Timeout

BER and JTOL Test: BER Measurement (1/2)

– BER Measurement Settings



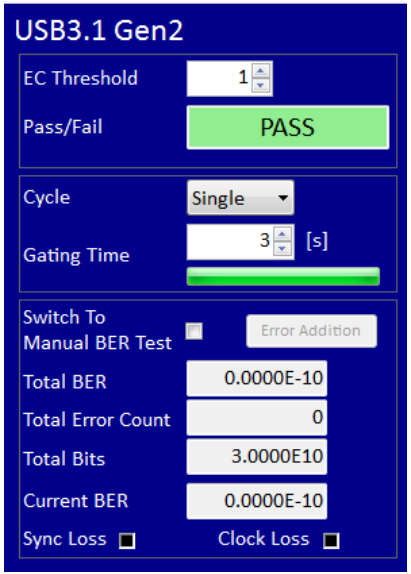
- Set the following parameters at the BER Measurement setting display.
  - Cycle: Single
  - EC Threshold: 1
  - Gating Time for Gen1: 60*
  - Gating Time for Gen2: 120*
- Put a checkmark in [Configure].
- Click [Start BER Measurement].

*Defined in Compliance Test specifications

BER and JTOL Test: BER Measurement (2/2)

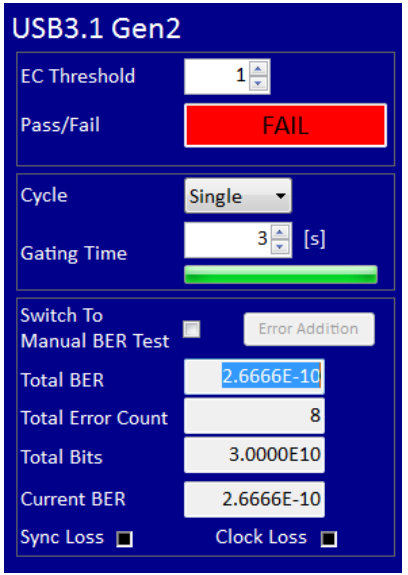
- Compliance Test Pass Criteria

- If the total error count is ≤1, the DUT passes the test at that SJ frequency.
- Repeat BER measurement by changing the SJ frequency from 500 kHz to 100 MHz.
- The DUT must pass at all SJ frequencies to pass the Rx Compliance Test.



Pass

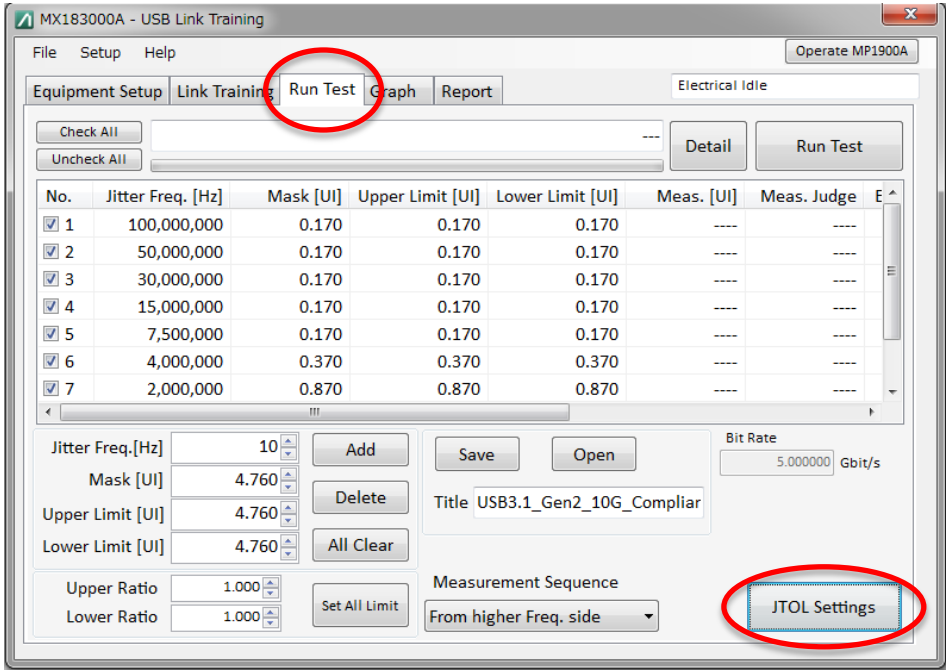
- The DUT fails the Compliance Test if the total error count is >1.



Fail

BER and JTOL Test: Automatic Compliance Test (1/4)

– Automatic Jitter Compliance Test Setting



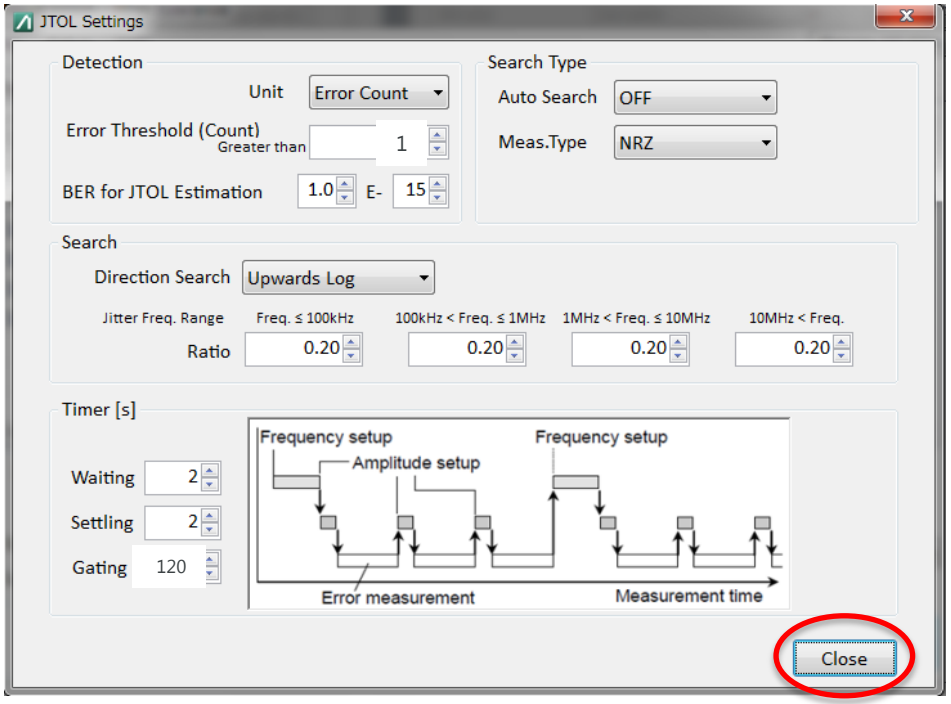
- Click the [Run Test] tab.
- Click the [JTOL Settings] button to set the Jitter Tolerance test parameters.

BER and JTOL Test: Automatic Compliance Test (2/4)

- Set the following parameters at the JTOL Setting display.
  - Unit: Error Count
  - Error Threshold: 1
  - Gen1 Gating Timer: 60*
  - Gen2 Gating Timer: 120*

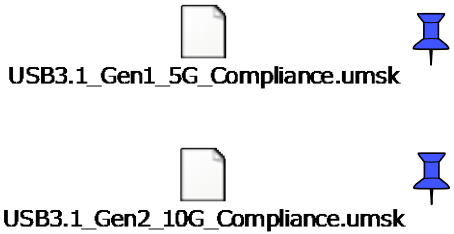
- Click the [Close] button to finish this setting.

*Defined in the Compliance Test specifications
This Compliance Test requires at least 10 minutes.

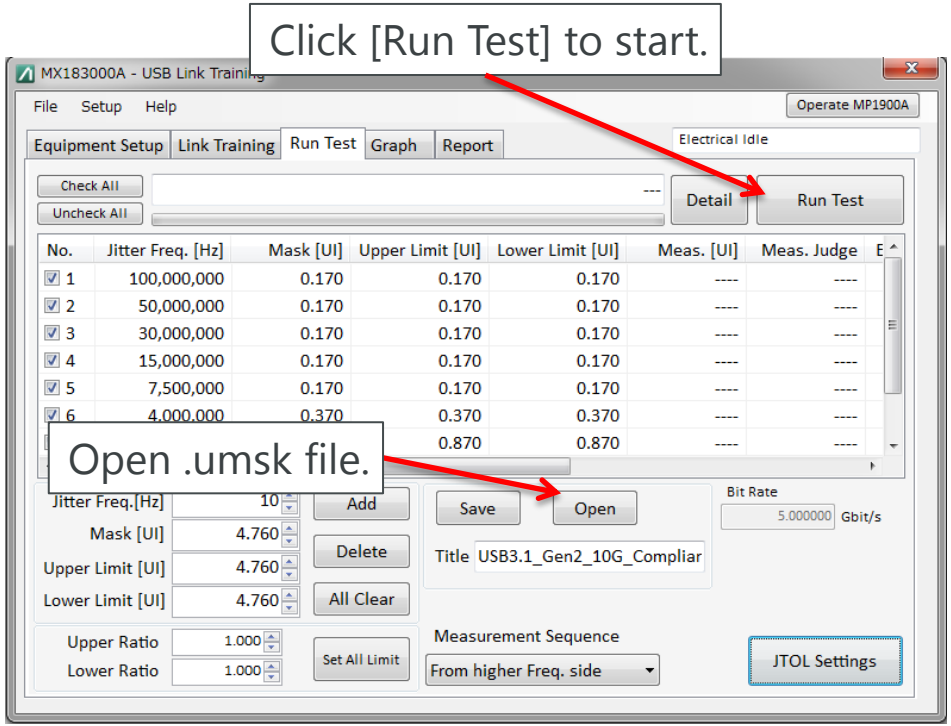


BER and JTOL Test: Automatic Compliance Test (3/4)

- Load the appropriate mask file for the target generation :

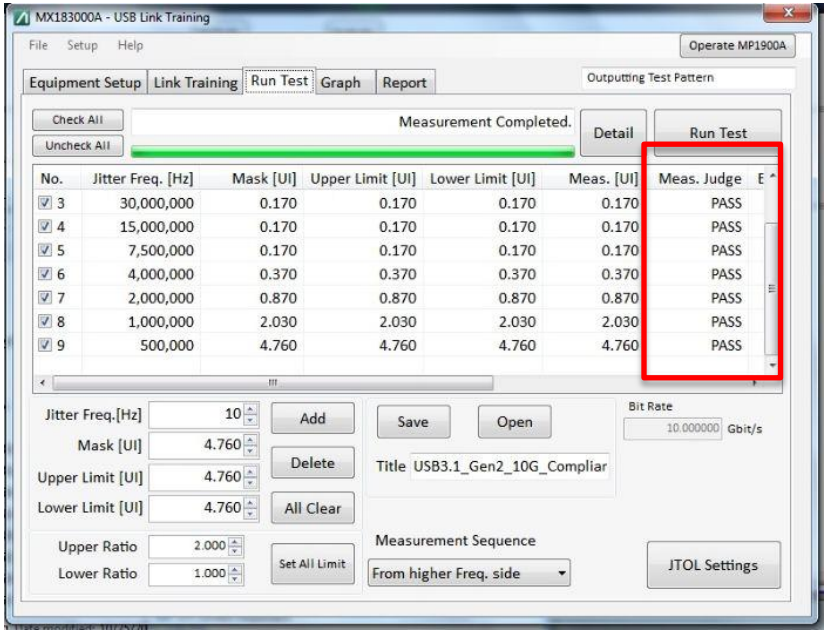


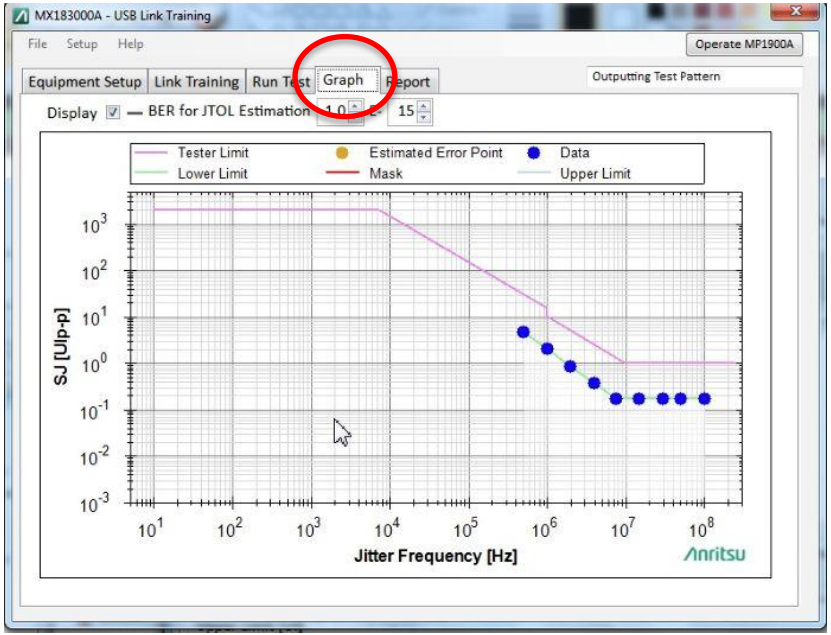
- Confirm that the DUT is in the Loopback Mode and click the [Run Test] button.



BER and JTOL Test: Automatic Compliance Test (4/4)

– Jitter Compliance Test Results





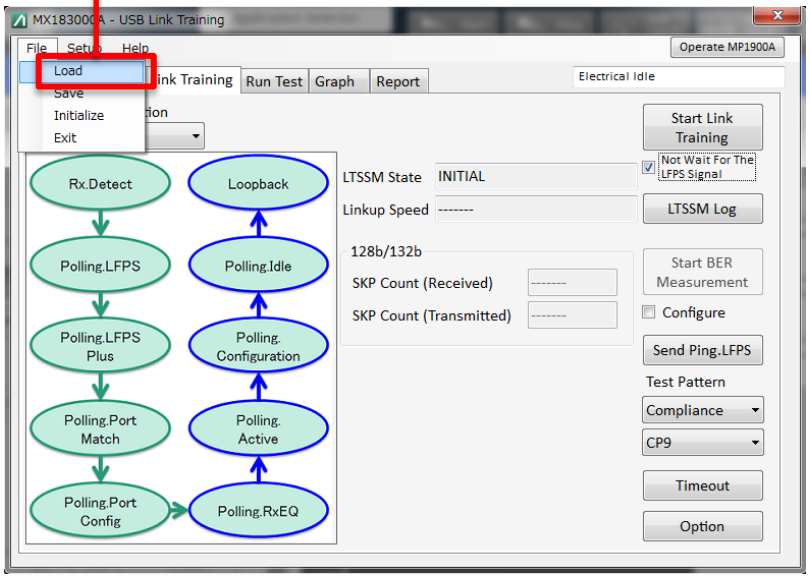
- Move to the [Report] tab and click [Make HTML/CSV] to create a report.

BER and JTOL Test: Jitter Margin Test (1/2)

- Both the Compliance Test and Jitter Margin Test are important to test the DUT.
- Load the appropriate xml setup file for the target generation, or set the following parameters at the JTOL Setting display.

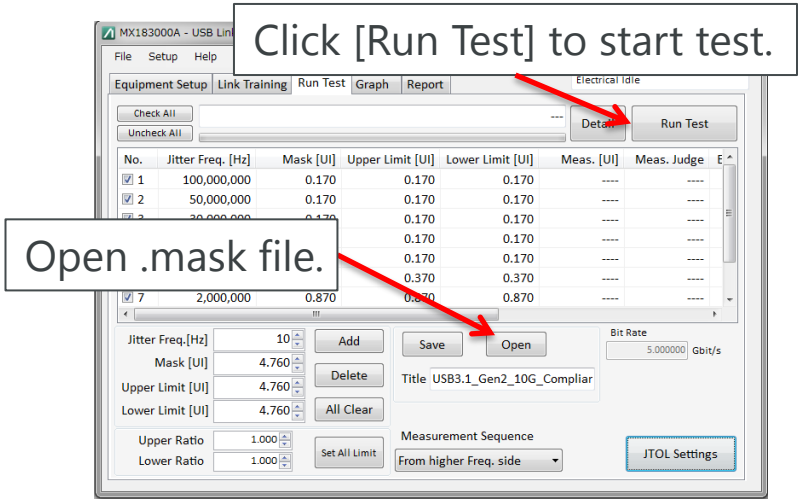
–	Unit:	Error Count
–	Error Threshold:	1
–	Gating Timer:	6
–	Direction Search:	Upwards Linear
–	100 kHz < Freq. < 1 MHz:	0.300
–	1 MHz < Freq. < 10 MHz:	0.030
–	10 MHz < Freq. :	0.01

Click [File] and [Load] to open .xml file.



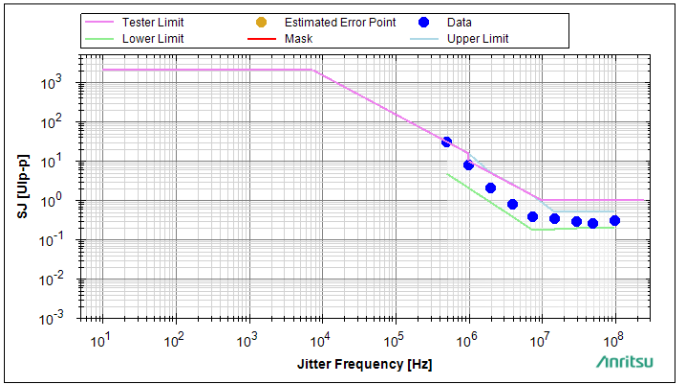
BER and JTOL Test: Jitter Margin Test (2/2)

- Load the appropriate mask for the target generation.
  - Gen1
    - C:¥Anritsu¥MX183000A¥Mask
    - USB3.0-5G.mask
  - Gen2
    - C:¥Anritsu¥MX183000A¥Mask
    - USB3.1-10G.mask



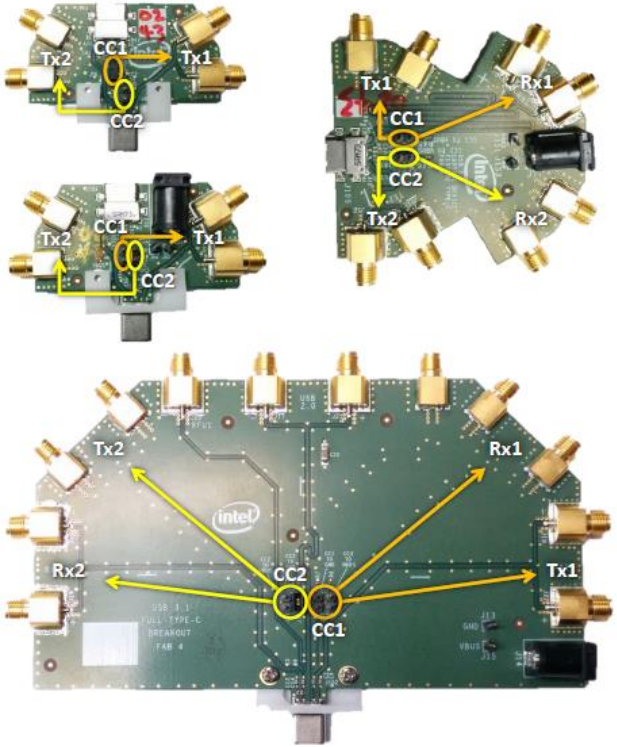
- Confirm that the DUT is in the Loopback Mode and click the [Run Test] button.

- Move to the [Report] tab and click [Make HTML/CSV] to create the report.



Contents

Appendix A-0: Fixture Topologies – Type-C CC Jumpers

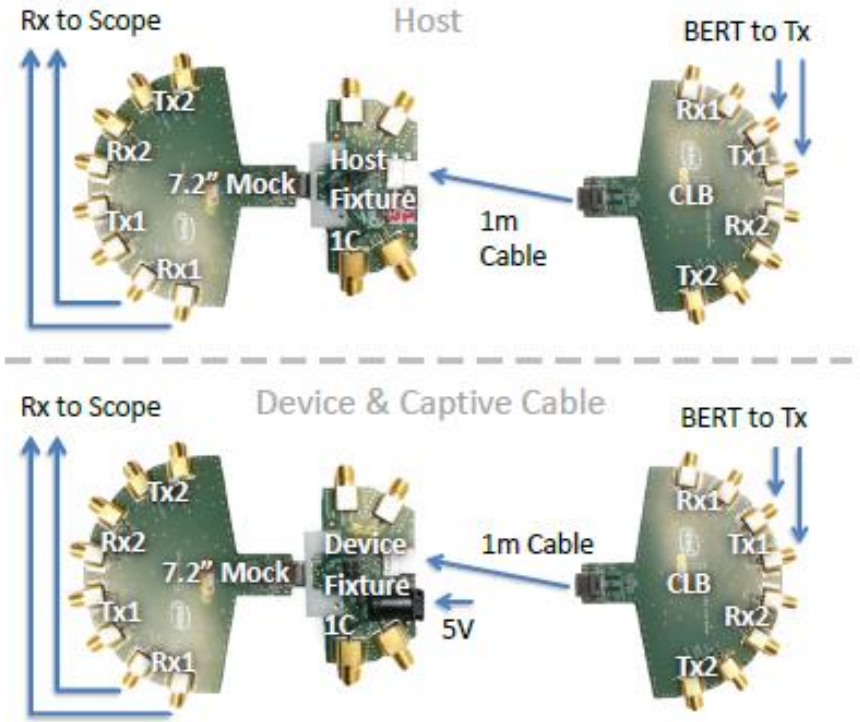


- Only use one jumper.
- Set jumper on CC1 if SMAs are connected to Tx1/Rx1.
- Set jumper on CC2 if SMAs are connected to Tx2/Rx2.
- When using the Full Breakout, connect CC to Vbus for devices, or connect CC to GND for hosts.

Appendix A-1: Calibration Topologies – Type-C Gen2

- Set jumpers as shown in Appendix A-0.
- Ensure the Tx port number used in CLB is the same as the Rx port number used in the mock board (Tx1 CLB: Rx1 Mock/Tx2 CLB: Rx2 Mock)
- There is no fixture calibration for Type-C Gen1.

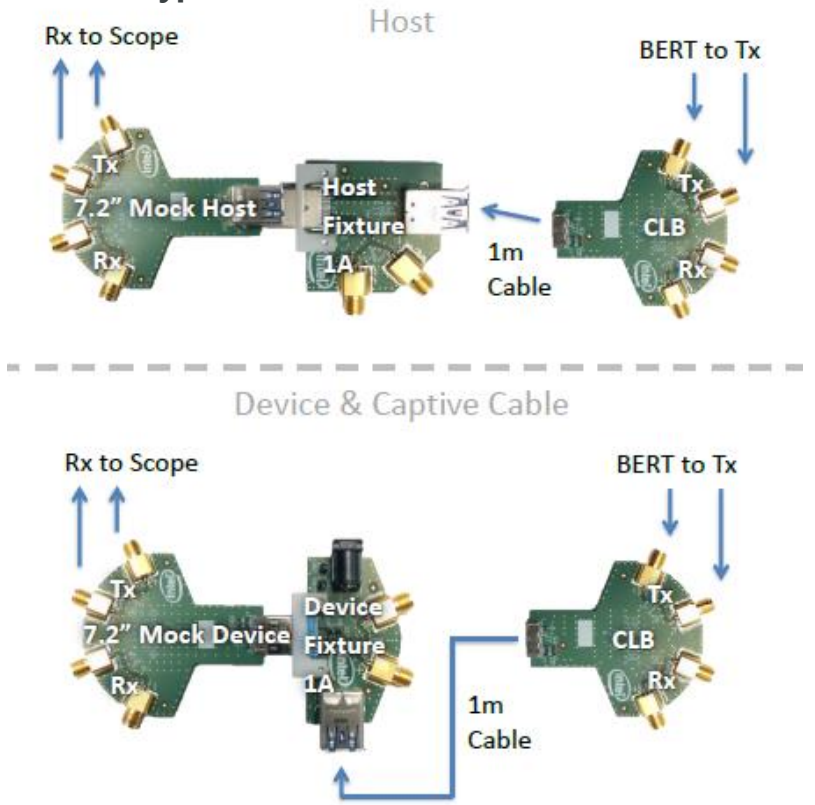
USB3.1 (10 GT/s) Type-C™ Electrical Test Fixture Kit



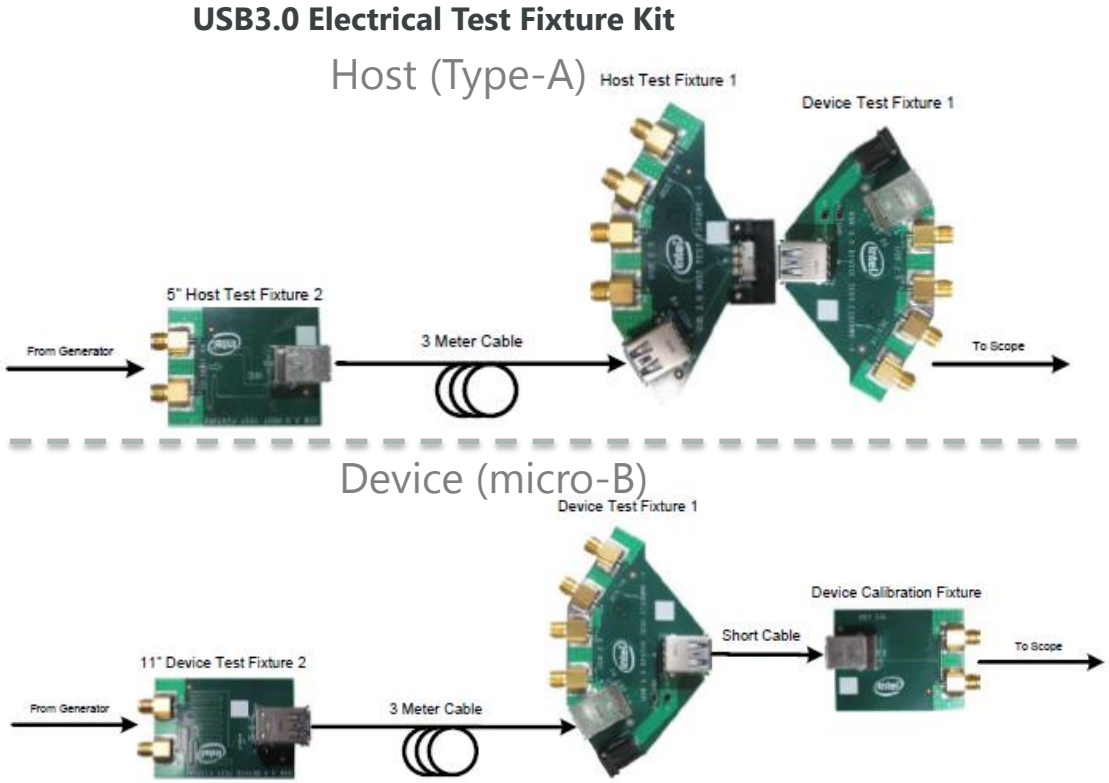
Appendix A-2: Calibration Topologies – Type-A, micro-B Gen2

- Hold the root of the micro-B connector firmly when plugging/unplugging cables, mockup boards, and DUTs

USB3.1 (10 GT/s) Type-A and Micro-B Electrical Test Fixture Kit



Appendix A-3: Calibration Topologies – Type-A, micro-B Gen1

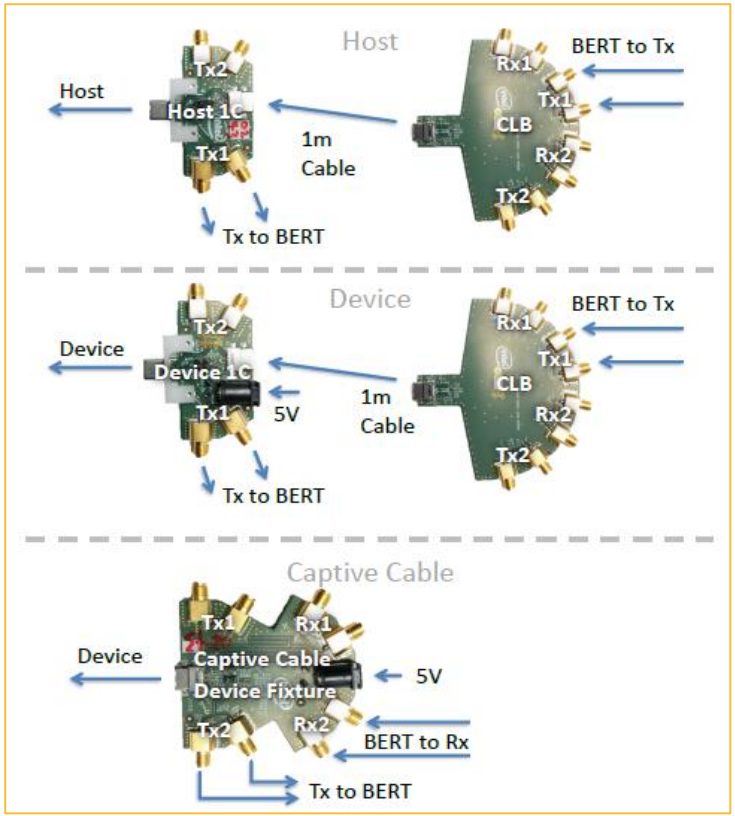


Appendix A-4: Receiver Test Topologies – Type-C Gen2

- Connect jumpers as shown in Appendix A-0.
- Ensure the Tx port number used in the CLB is the same as the Tx port number used in the fixture
  (Tx1 CLB: Tx1 fixture/ Tx2 CLB: Tx2 fixture)

- Similarly, for captive fixture, ensure the same port number is used for both Tx and Rx ports.
  (Tx1: Rx1 or Tx2: Rx2)

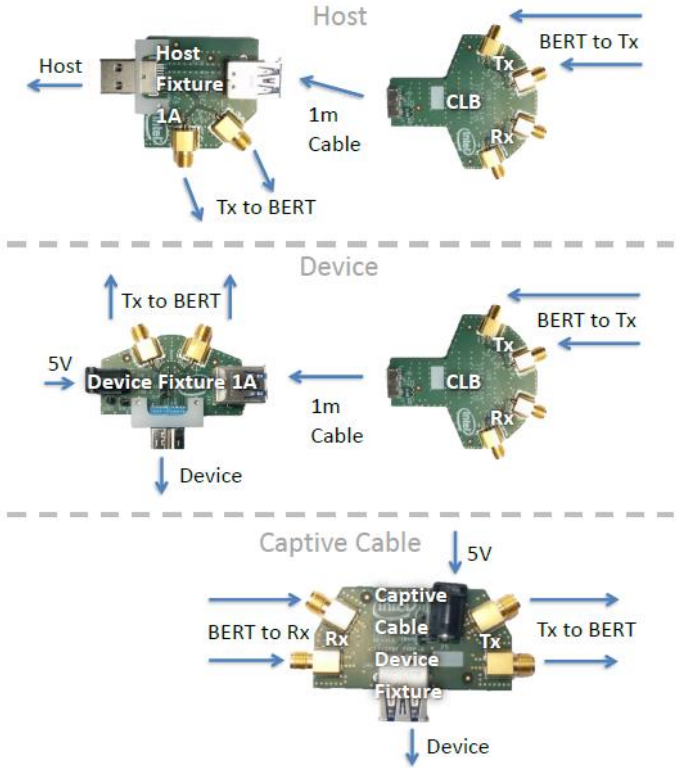
USB3.1 (10 GT/s) Type-C™ Electrical Test Fixture Kit



Appendix A-5: Receiver Test Topologies – Type-A, micro-B Gen2

- Hold the root of the micro-B connector firmly when plugging/unplugging cables, mockup boards, and DUTs.

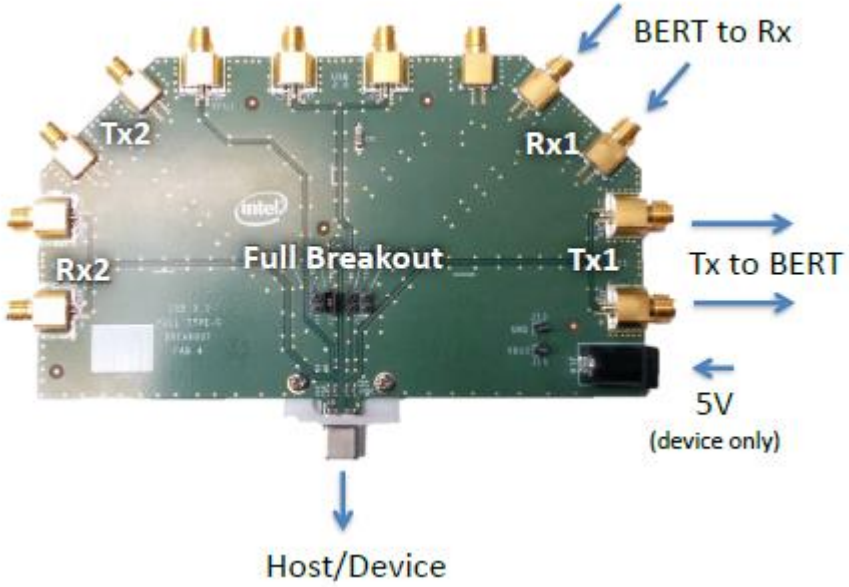
USB3.1 (10 GT/s) Type-A and Micro-B Electrical Test Fixture Kit



Appendix A-6: Receiver Test Topologies – Type-C Short Channel

- Set jumpers as shown in Appendix A-0.
- For Full Breakout, ensure the same port number is used for both Tx and Rx ports. (Tx1: Rx1 or Tx2: Rx2)

USB3.1 (10 GT/s) Type-C™ Electrical Test Fixture Kit



Appendix B-0: SigTest Templates for Rx

- Gen1

SigTest* Software Version 3.2.11.2 or higher

Test #	Description	Rx SigTest Folder	SigTest Template File Name
TD.1.8	Rj Calibration	USB_3_5GB	USB_3_5Gb_CP1.dat
TD.1.9	Rj Calibration (Type-C)	USB_3_5GB	USB_3_5Gb_CP1_Rj_Cal_Type_C.dat
TD1.8	Sj Calibration	USB_3_5GB	USB_3_5Gb_CP0_RjIN_SjCal.dat
TD.1.9	Sj Calibration (Type-C)	USB_3_5GB	USB_3_5Gb_CP0_RjIN_SjCal_Type_C.dat
TD.1.8	EW/EH Calibration	USB_3_5GB	USB_3_5Gb_CP0_RjIN.dat

*Software download link
http://www.usb.org/developers/tools/

Appendix B-1: SigTest Templates for Rx

- Gen2

SigTest* Software Version 4.0.23.3 or higher

Test #	Description	Rx SigTest Folder	SigTest Template File Name
TD.1.10	Rj Calibration	USB_3_10GB	USB_3_10Gb_Rj_Cal.dat
TD.1.10	Rj Calibration (Type-C)	USB_3_10GB	USB_3_10Gb_Sj_Cal.dat
TD.1.10	Sj Calibration	USB_3_10GB	USB_3_10Gb_CP9_Rx_CAL_CTLE_N5dB.dat

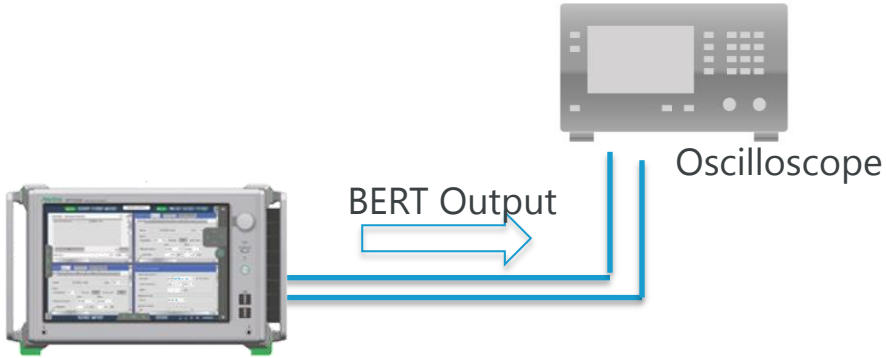
*Software download link
http://www.usb.org/developers/tools/

Appendix C-0: Calibration Procedure Overview – Emphasis and Amplitude

- First, calibrate Swing and De-emphasis without test channel.

- Emphasis and Amplitude are calibrated using 64 ones (1s) followed by 64 zeros (0s) followed by 128 bits of a 1010 clock pattern.
  - C:¥Anritsu¥MP1900A¥AppServers¥bin¥Pattern Files¥USB
  - 64ones_64zeros_128bit10.ptn

- All Jitter sources are turned on but set to zero.



Appendix C-1: Calibration Procedure Overview – Emphasis and Amplitude

- Take the difference between Ch1 and Ch2 (channel combination of differential pair depends on oscilloscope)
- Before starting any test or data acquisition, heat-run and calibrate the oscilloscope, and use de-skewed cables.

Oscilloscope Settings

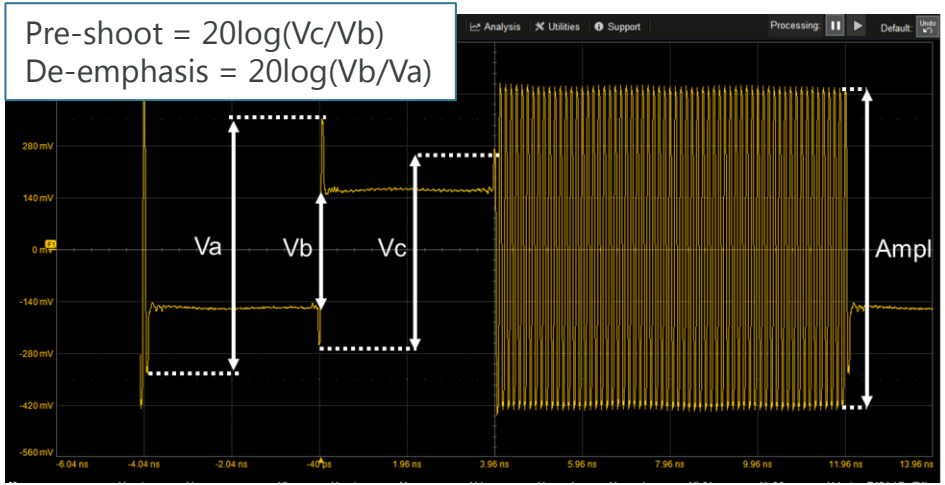
	Vertical Scale	Horizontal Scale	Sample Rate	Bandwidth	Record Length
Gen1	Set to full screen without clipping	4 ns (enough to capture >1 pattern sequence)	40 GS/s	16 GHz	4 kpts (enough to capture >1 pattern sequence)
Gen2	Set to full screen without clipping	2 ns (enough to capture >1 pattern sequence)	80 GS/s	16 GHz	4 kpts (enough to capture >1 pattern sequence)

Appendix C-2: Calibration Procedure Overview – Emphasis and Amplitude

- Pre-shoot and De-emphasis are derived from three measurements: Va, Vb, and Vc.
- Amplitude is measured towards the end of the toggle section.
- Adjust Amplitude, Pre-shoot and De-emphasis at the BERT until reaching the target value.

- Calibrate three Tx EQ points.
  - Pre = 2.2 dB, Post = –1.0 dB
  - Pre = 2.2 dB, Post = –3.0 dB
  - Pre = 2.2 dB, Post = –5.0 dB

Pre-shoot = 20log(Vc/Vb)
De-emphasis = 20log(Vb/Va)



Emphasis and Amplitude Target Values

	Differential Amplitude p-p	Pre-shoot	De-emphasis
Gen1	800 mV	-	–3.0 to 0.3/+0 dB
Gen2	800 mV	2.2 ±0.1 dB	-1.0 ±0.1 dB -3.0 ±0.1 dB -5.0 ±0.1 dB

Appendix C-3: Calibration Procedure Overview – RJ

- Calibrate RJ using a Nyquist pattern.
  - Gen1: CP1
    - C:¥Anritsu¥MP1900A¥AppServers¥bin¥Pattern Files¥USB
    - CP1.ptn
  - Gen2: CP10
    - C:¥Anritsu¥MP1900A¥AppServers¥bin¥Pattern Files¥USB
    - CP10.ptn
- Set the oscilloscope to the values in the table.
- Set Emphasis to 0.
  - Pre-shoot = 0 dB, De-emphasis = 0 dB
- Set SSC to OFF and all other Jitter sources to ON but set to zero.
- Capture a single waveform and save the waveform file.

Oscilloscope Settings

	Vertical Scale	Horizontal Scale	Bandwidth	Sample Rate	Record Length
Gen1	Set to full screen without clipping	100 µs	16 GHz	40 GS/s	> 16 Mpts*
Gen2	Set to full screen without clipping	50 µs	16 GHz	80 GS/s	> 16 Mpts*

*For Gen1 5 GT/s:
1 UI = [1/5GT/s] = 200 ps
(200 ps/UI) x (2M UI) = 400 µs
400 µs x 40 GS/s = 16 M

*For Gen2 10 GT/s:
1 UI = [1/10 GT/s] = 100 ps
(100 ps/UI) x (2M UI) = 200 µs
200 µs x 80 GS/s = 16 M

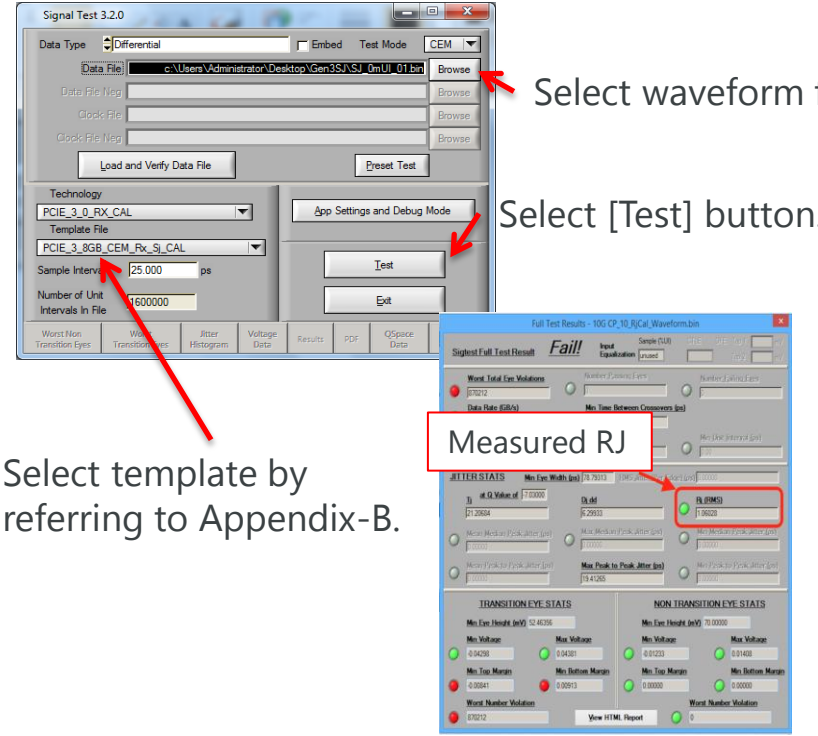
Appendix C-4: Calibration Procedure Overview – RJ

- Measure RJ using SigTest* Software ***Version 4.0.23.2*** *or higher* (for Gen2) and SigTest Software ***Version 3.2.11.3*** (for Gen1).
- The analysis result is RJ(RMS) in SigTest.
- Adjust RJ at the BERT until reaching the target value.

RJ Target Value

	Random Jitter
Gen1	2.42 ±10% ps RMS (30.8 ±10% ps p-p)
Gen2	1.0 +0/–0.1 ps RMS

*Software download link
http://www.usb.org/developers/tools/



Appendix C-5: Calibration Procedure Overview – SJ

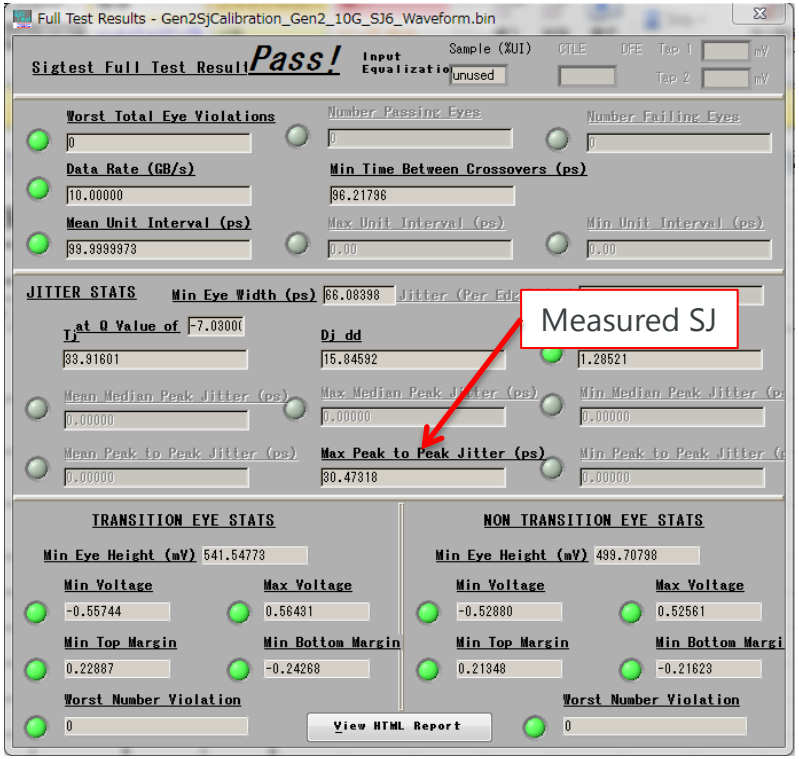
- Capture the CP0/CP9 waveform.
  - Gen1: CP0
    - C:¥Anritsu¥MP1900A¥AppServers¥bin¥Pattern Files¥USB
    - CP0_RD+.ptn
  - Gen2: CP9
    - C:¥Anritsu¥MP1900A¥AppServers¥bin¥Pattern Files¥USB
    - CP9.ptn
- Set Emphasis to 0.
  - Pre-shoot = 0 dB, De-emphasis = 0 dB
- Set SSC to OFF and all other Jitter sources to ON but set to zero.
- Select the template by referring to Appendix-B.

SJ Target Value

	SJ Frequency (MHz)	Amplitude (ps)
Gen1	0.5	400 ±10%
	1	200 ±10%
	2	100 ±10%
	4.9	40 ±10%
	10	40 ±10%
	20	40 ±10%
	33	40 ±10%
	50	40 ±10%
Gen2	0.5	476 ±10%
	1	203 ±10%
	2	87 ±10%
	4	37 ±10%
	7.5	17 ±10%
	15	17 ±10%
	30	17 ±10%
	50	17 ±10%
	100	17 ±10%

Appendix C-6: Calibration Procedure Overview – SJ

- First, measure SJ Baseline using SigTest.
- The analysis result is Max Peak to Peak Jitter (ps) in SigTest.
- Adjust SJ at the BERT until SJ – SJ Baseline reaches the target value.

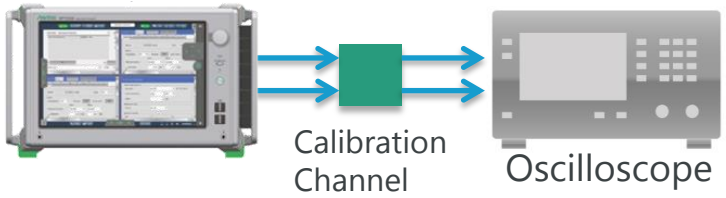


Appendix C-7: Calibration Procedure Overview – Select CLB Gen2

Gen2

- The Eye Height and Eye Width calibration procedures are different for Gen1 and Gen2.
- Refer to Appendix-A for the Calibration Channel to use.
- Apply calibrated SJ and RJ values with SSC enabled.
- Capture three CP9 waveforms.
- Select the template by referring to Appendix-B.
- The analysis result is Eye Height (mV) in SigTest.
- Measure with all three Compliance Load Board variants (5.6”, 7.1”, & 8.1”).
- Choose the Compliance Load Board achieving the results closest to 70 mV EH (usually 5.6”).

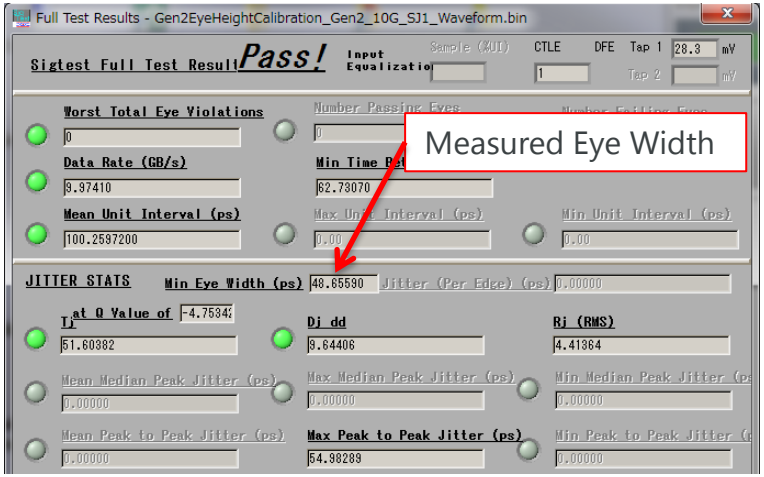
With Calibration Fixture



Appendix C-8: Calibration Procedure Overview – Eye Width Gen2

Gen2

- Capture three CP9 waveforms.
- Select the template by referring to Appendix-B.
- The analysis result is Min Eye Width (ps) in SigTest.
- Choose the De-emphasis setting giving the closest to 48 ps.
- Try the following steps until reaching the target Eye Width value.
  - ➢ If the width is too big, then add a second SJ tone at 87 MHz and adjust until the width target is met.
    - If an 87-MHz tone is used, hold it at the same magnitude for each SJ frequency.
  - ➢ If the width is too small, reduce the 100-MHz SJ tone until the reaching the target width.
    - If the 100-MHz SJ tone is reduced, the SJ targets at every other frequency are reduced by the same amount in ps.
- Try the following steps until reaching the target Eye Width value.



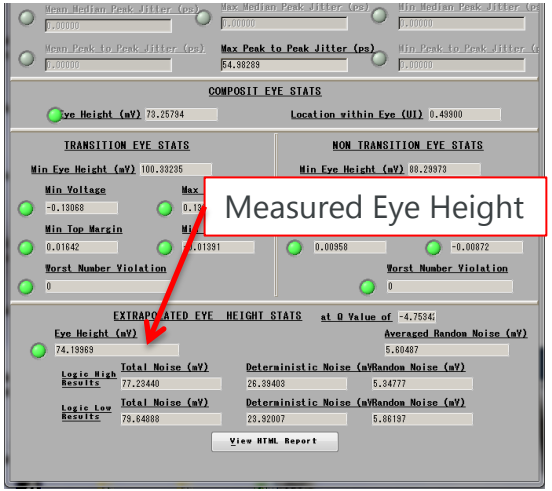
Eye Width Target Value (Gen2)

	Eye Width
Gen2	48.0 +2/–0 ps

Appendix C-9: Calibration Procedure Overview – Eye Height Gen2

Gen2

- Capture the CP9 waveform.
- Select the template by referring to Appendix-B.
- The analysis result is Eye Height (mV) in SigTest.
- Adjust amplitude at the BERT until reaching the target Eye height.



Eye Height Target Value (Gen2)

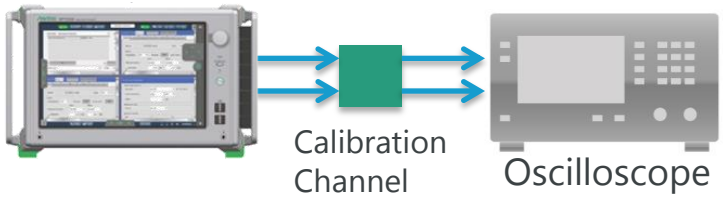
	Eye Height
Gen2	70 mV +5/–0 mV

Appendix C-10: Calibration Procedure – Eye Height Gen1 micro-B/Type-A

Gen1

- There is no fixture calibration for Type-C Gen1.
- Use the Calibration Channel by referring to Appendix-A.
- Capture three CP0 waveforms and average the result.
- Select the template by referring to Appendix-B.
- The analysis result is Eye Height (mV) in SigTest.
- Adjust amplitude at the BERT until reaching the target Eye height value.

With Calibration Fixture



Eye Height Target Value (Gen1)

	Eye Height
Gen1 Type-A	180 mV +5/–0 mV
Gen1 micro-B	145 mV +5/–0 mV

Appendix C-11: Calibration Procedure – TJ Gen1 micro-B/Type-A

Gen1

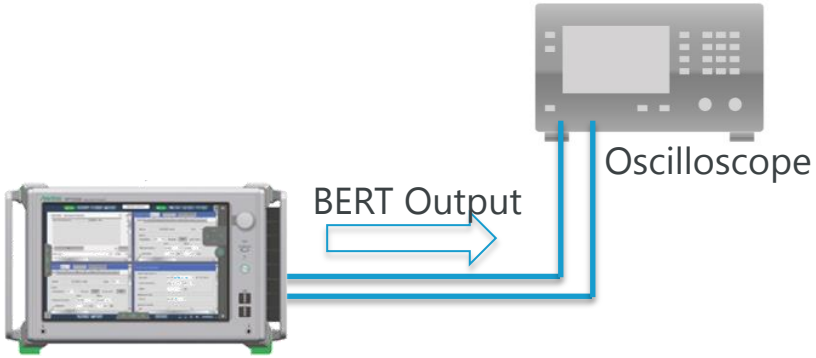
- There is no fixture calibration for Type-C Gen1.
- Use the Calibration Channel by referring to Appendix-A.
- Capture three CP0 waveforms and average the result.
- Select the template by referring to Appendix-B.

TJ Target Value (Gen1)

	TJ
Gen1	90 ps +5/–0 ps

Appendix C-12: Calibration Procedure – Short Channel Amplitude

- There is no calibration fixture calibration for short channel.
- Short channel amplitude is calibrated using 64 ones (1s) followed by 64 zeros (0s) followed by 128 bits of a 1010 clock pattern.
  - C:¥Anritsu¥MP1900A¥AppServers¥bin¥Pattern Files¥USB
  - 64ones_64zeros_128bit10.ptn
- Set Emphasis to 0.
  - Pre-shoot = 0 dB, De-emphasis = 0 dB
- Set SSC to OFF and all other Jitter sources to ON but set to zero.
- Adjust Amplitude to provide a maximum peak to peak differential voltage of 1200 mV +0/–20 mV using the clock portion of the pattern for measurement.



Amplitude for Short Channel Target Value

	Differential Amplitude p-p
Gen1	1200 mV +0/–20 mV
Gen2	1200 mV +0/–20 mV

Appendix D-0: Rx Link Training

Negotiation (Handshake) Signals

- LFPS (Low Frequency Periodic Signaling)
  - Polling.LFPS – Logic 0, Logic 1
  - SCD (SuperSpeedPlus Capability Declaration) – SCD1, SCD2
  - LBPM (LFPS Based PWM Message) – LBPM CAP, LBPM RDY

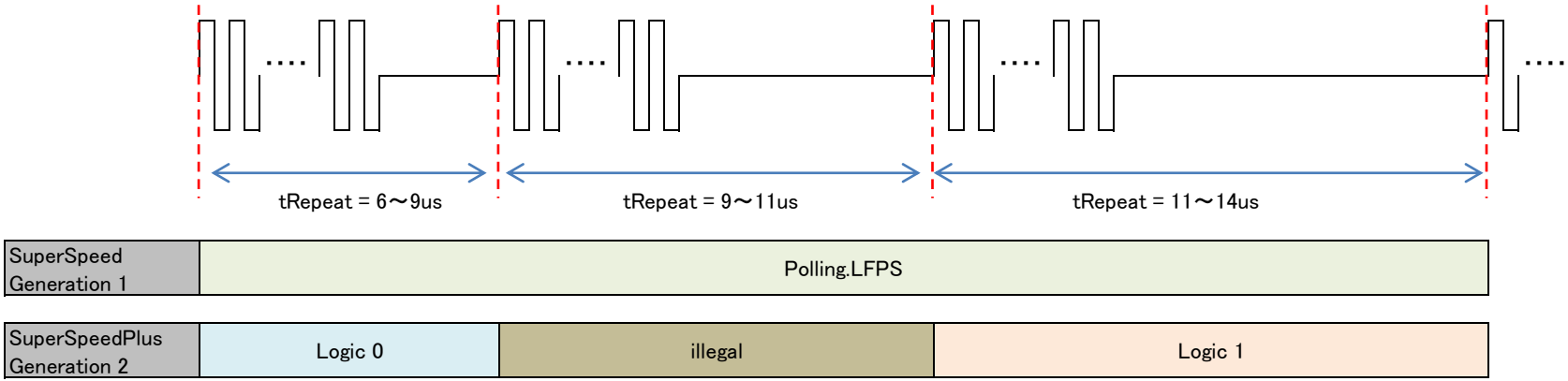
- Training Sequences
  - TSEQ
  - TS1
  - TS2

Appendix D-1: Rx Link Training

Negotiation (Handshake) Signals

- Logic Representation of Polling.LFPS

*for Polling.LFPS, tRepeat determines Logic0 or Logic1

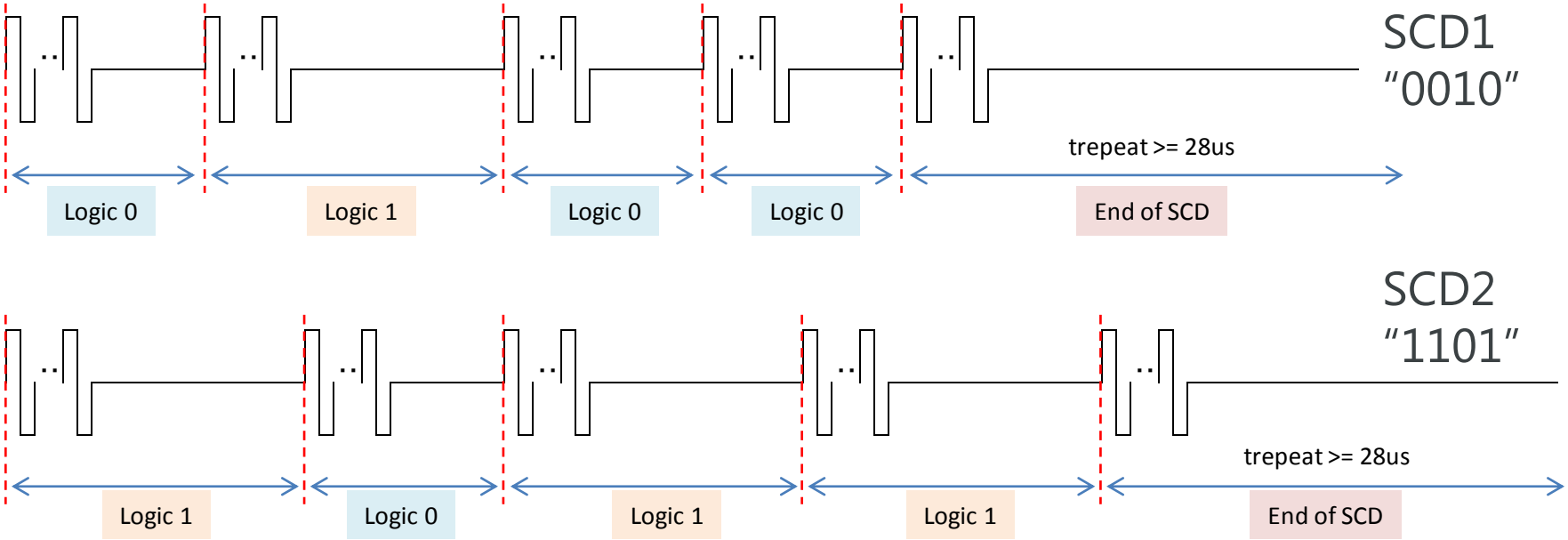


Appendix D-2: Rx Link Training

Negotiation (Handshake) Signals

*for SCD1/SCD2, trepeat determines Logic0 or Logic1

- SCD

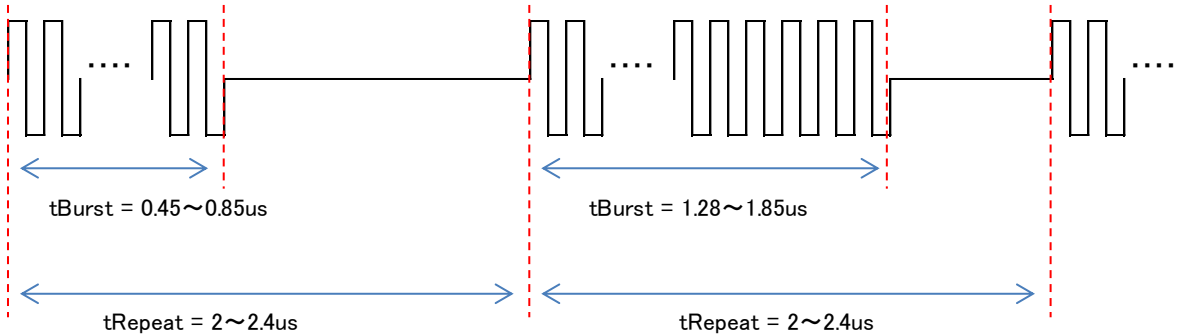


Appendix D-3: Rx Link Training

Negotiation (Handshake) Signals

- Logic Representation of LBPM

*for LBPM CAP/RDY, tBurst determines Logic0 or Logic1



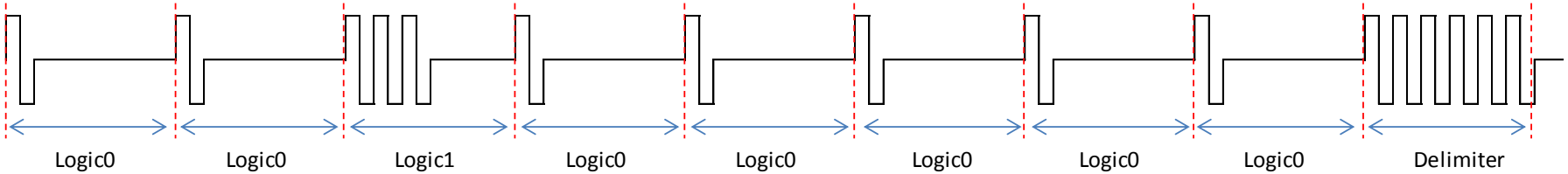
Appendix D-4: Rx Link Training

Negotiation (Handshake) Signals

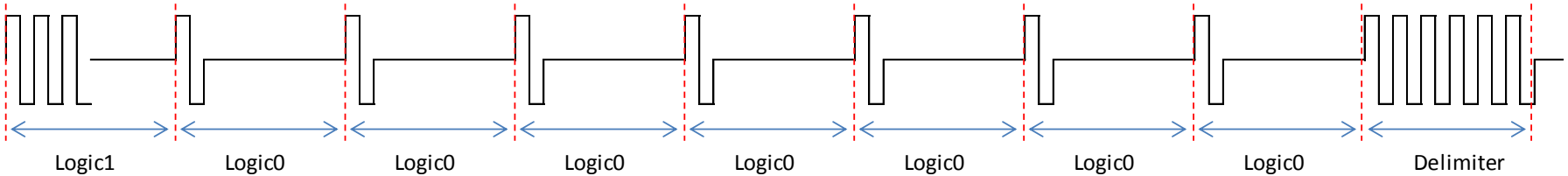
- LBPM

b1~0: LBPM Type	b3~2: LBPM Subtype	
00: PHY Capability	PHY Rate	b7~b4: Reserved (0000)
	00: 5Gbps 01: 10Gbps	
01: PHY Ready	Reserved (00)	

LBPM CAP

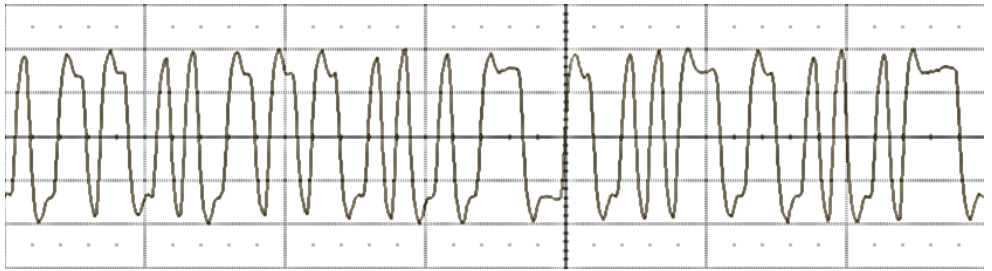
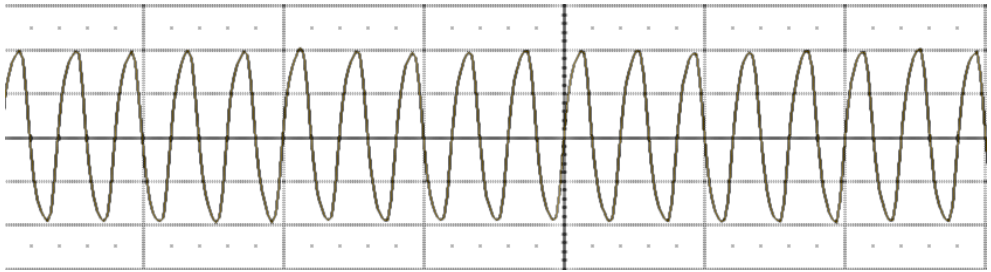


LBPM RDY

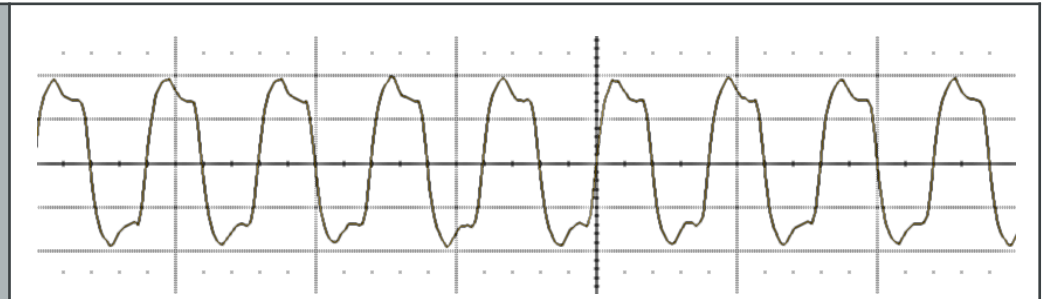
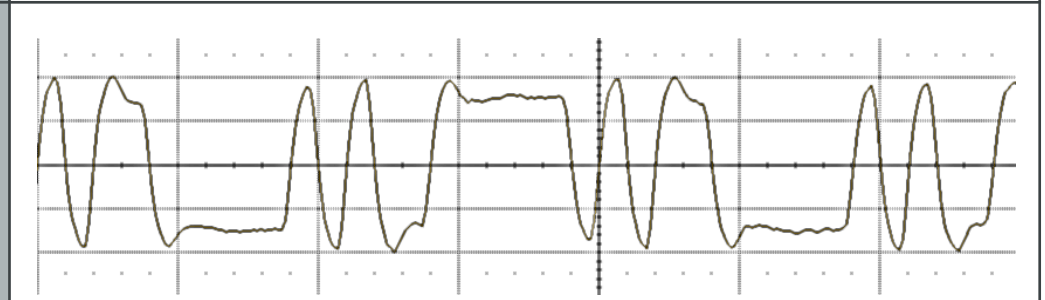


Appendix E-0: Compliance Patterns (CPs)

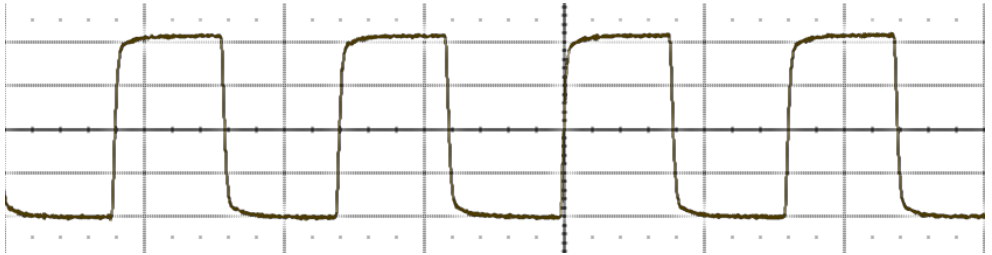
- Different CP sequence per Generation:
  i. Gen1: CP0 (1st pattern) → CP8 (last pattern)
  ii. Gen2: CP0 (1st pattern) → CP15 (last pattern)

CP0 (D0.0 Scrambled)	
CP1 (D10.2 Nyquist frequency)	

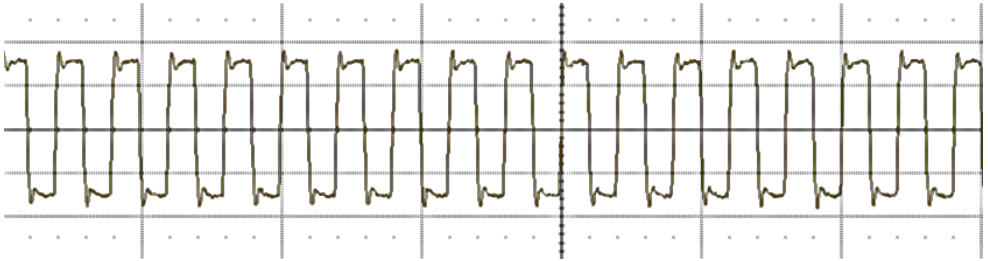
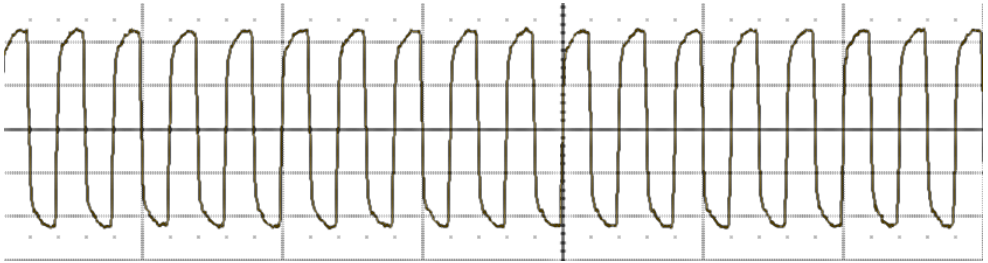
Appendix E-1: Compliance Patterns (CPs)

CP2 (D24.3 Nyquist/2)	
CP3 (K28.5 COM Pattern)	

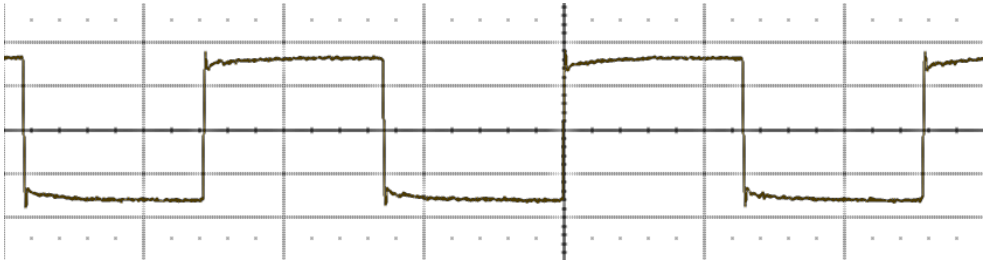
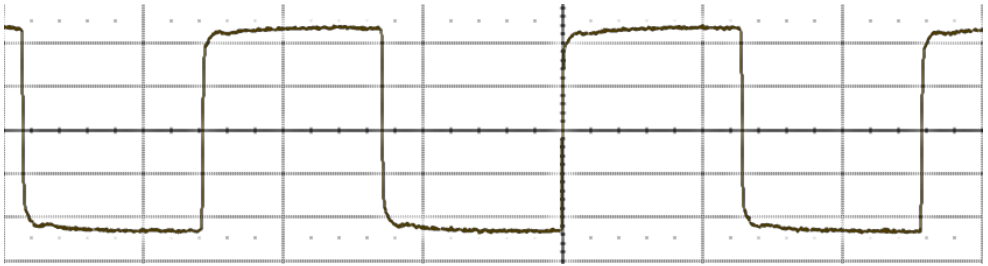
Appendix E-2: Compliance Patterns (CPs)

CP4 (LFPS)	

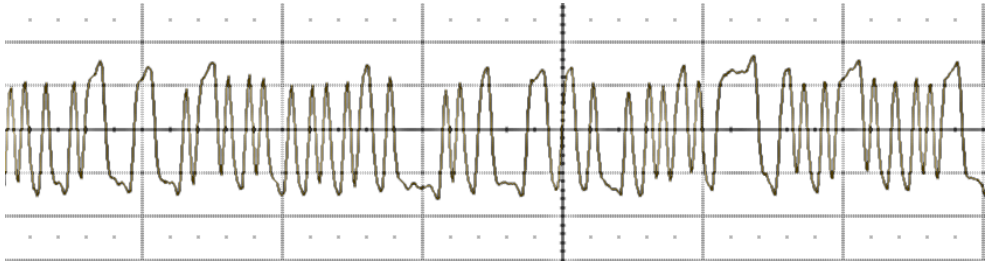
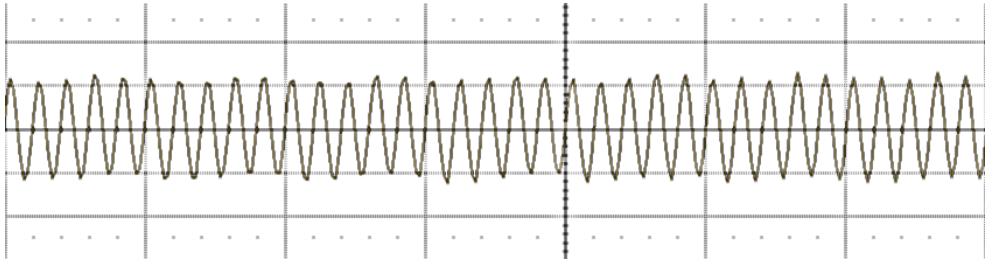
Appendix E-3: Compliance Patterns (CPs)

CP5 (K28.7 w/ de-emphasis)	
CP6 (K28.7 w/o de-emphasis)	

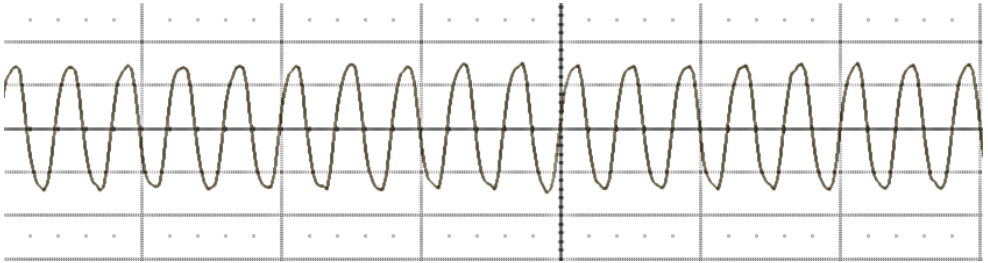
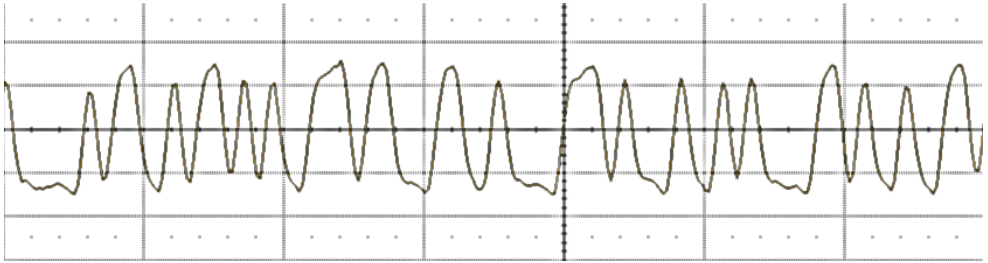
Appendix E-4: Compliance Patterns (CPs)

CP7 (50 to 250 1s and 0s, with de-emphasis)	
CP8 (50 to 250 1s and 0s, without de-emphasis)	

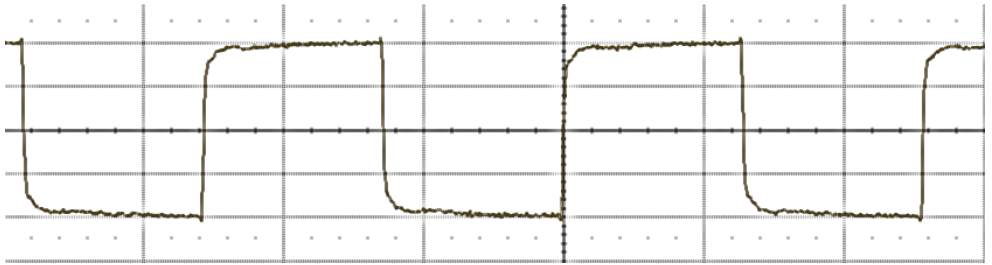
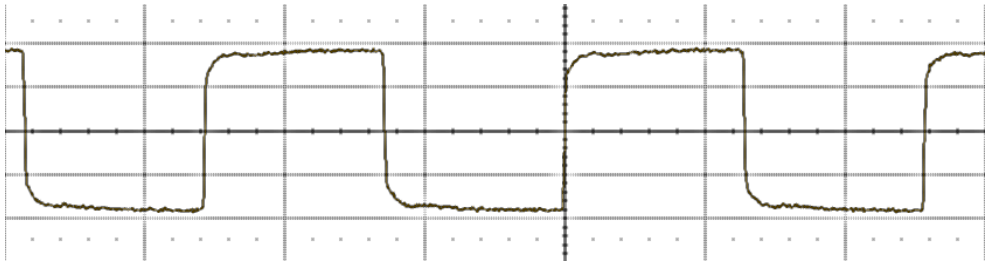
Appendix E-5: Compliance Patterns (CPs)

CP9 (Pseudorandom pattern)	
CP10 (AAh Nyquist pattern 10 Gb/s)	

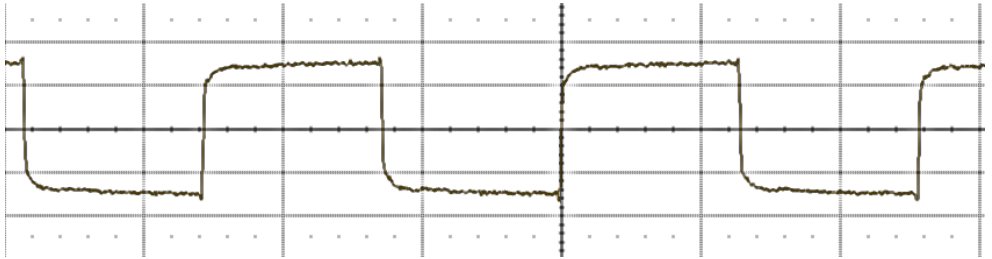
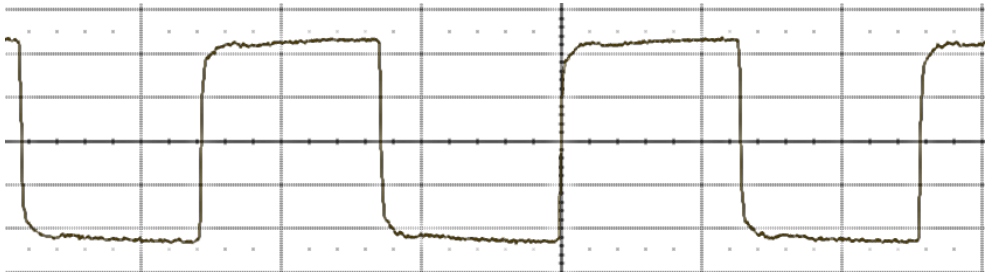
Appendix E-6: Compliance Patterns (CPs)

CP11 (CCh Nyquist/2 10 Gb/s)	
CP12 (LFSR15)	

Appendix E-7: Compliance Patterns (CPs)

CP13 (with pre-shoot)	
CP14 (with de-emphasis)	

Appendix E-8: Compliance Patterns (CPs)

CP15 (with pre-shoot + de-emphasis)	
CP16 (w/o pre-shoot w/o de-emphasis)	

Anritsu

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