Granite River Labs USB4 Receiver Test Method of Implementation (MOI) Using Anritsu MP1900A BERT, High Performance Real-time Oscilloscope, and GRL-USB4-RXA Calibration and Test Automation Software

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1 Introduction

This MOI & User Guide contains the procedure for testing an electrical receiver for USB4[™] certification using the Anritsu MP1900A BERT, High Performance Real Time Oscilloscope, and GRL-USB4-RXA Test Automation Software as per USB-IF standards.

The main body of this MOI & User Guide describes how to perform automated Calibration and Testing of USB4 Gen2/Gen3 Hosts and Devices using the GRL-USB4-RXA Software, with an appendix describing the manual calibration process as a technical reference.

The tests in this MOI are the tests carried out by USB Independent Test Labs (ITL's). If performing the tests yourself, it is important for you to follow the MOI's as described in this document before submitting your Device Under Test (DUT) for Certification in order for you to be confident that your device will pass. ITL's also provide pre-compliance test services if your company does not have the equipment or resources to carry out the tests. Contact Granite River Labs @ <u>support@graniteriverlabs.com</u> for USB pre-compliance and compliance test services.

For Devices and Hosts with a USB Type-C[™] Connector, the USB-IF, VESA (DisplayPort over Type-C), and Thunderbolt[™] Compliance programs all require USB4 Gen2/Gen3 receiver compliance testing.

The solution in this MOI can also be used for USB4 receiver compliance for Type-A, Type-B and micro-B Hosts and Devices.

In summary, this User Guide & MOI basically describes using the GRL-USB4-RXA software to:

- 1. Calibrate and Test a USB4 Gen2/Gen3 Receiver.
- 2. Generate Test Report for Compliance Reporting.

2 Reference Documents

- [1] Universal Serial Bus 4 (USB Type-C) Router Assembly Electrical Compliance Test Specification, Revision 0.96, January 30, 2020.
- [2] Universal Serial Bus 4 (USB4[™]) Specification Version 1.0, August 2019, and associated ECNs.

3 Resource Requirements

3.1 Equipment Requirements

 TABLE 1. EQUIPMENT REQUIREMENTS – SYSTEMS AND ACCESSORIES

System	Qty.	Description	Key Specification Requirement		
Oscilloscope	1	High Performance Real-time	≥ 21 GHz bandwidth ^[b]		
		Oscilloscope ^[a]	16 GB and above memory RAM		
BERT	1	Anritsu MP1900A Signal Quality Analyzer (SQA)	SQA Software Version 4.00.00 or above		
		MP1900A Signal Quality Analyzer, with following modules:			
		• MU181000A/B 12.5 GHz Synthesizer			
		MU181500B Jitter Modulation Source			
		MU195020A 32G bit/s SI Pulse Pattern Generator			
		MU195050A Noise Generator			
Accessory	Qty.	Description	Key Specification Requirement		
TP3' Plug Test Fixture	1	Test Point 3' (Case 1) Plug Test Fixture			
TP3 Channel Components	2	Test Point 3 (Case 2) Receptacle Fixture			
TP3 Fixed ISI Trace	1	Test Point 3 (Case 2) Fixed ISI Board			
TP3 Test	1	2m USB Type-C Cable	Insertion Loss -18.5dB at 5GHz		
Cables	1	0.8m USB Type-C Cable	Insertion Loss -16.5dB at 10GHz		
USB4	1	Wilder-Tech USB4	CG3-TPA-TR, with USB Cable [C]		
Controller		Microcontroller	• Optional for some test configurations, see Appendix F.		
Cable Deskew Fixture	1	Anritsu Splitter	K241B		
DC Block	2		Bandwidth of at least 33GHz		
Computer	1	Laptop or Desktop PC	Windows 7+ OS		
			For automation control (running GRL-USB4- RXA software)		

^[a] Oscilloscope with scope software requirements as specified in vendor specific MOI's. For example, when using the Keysight Scope, scope software such as Keysight InfiniiSim / EZ-JIT / Serial Data Analysis / Serial Data Equalization that are required for testing and signal processing must be pre-installed on the Scope. Similarly, the Tektronix Scope shall be used with DPOJET (Jitter and Eye Analysis Tools) software for making measurements.

^[b] Oscilloscope with scope bandwidth as specified in vendor specific MOI's.

^[c] Intel TenLira test scripts loaded on the PC/oscilloscope running GRL-USB4-RXA software. Provides sideband SBU control of the DUT for reading BER values from the DUT Rx registers.

Note: Cable connector type and length requirements may vary according to the lab setup and the dimensions of the DUT board. Table below is a recommended list. Please also refer to the respective manufacturer for detailed cabling recommendations related to USB4.

Connection Cable		Key Specification Requirement
MU181000A/B to MU181500B	1	Anritsu J1624A SMA-SMA cable (0.3m)
MU181500B to MU195020A	1	Anritsu J1624A SMA-SMA cable (0.3m)
MU195020A to MU195050A		Anritsu J1746A K-K skew matched pair short semirigid cable
Matched Cable Pairs	3	Rosenberger UFC142A 2.92m (x2), 1m Phase Matched ±2° at 40GHz Insertion Loss 1dB maximum in 10GHz
RPC-2.92 Jack to SMP Jack	4	Rosenberger 02K119-K00E3
JTAG Ribbon Cable	1	For connecting USB4 microcontroller and test fixture
USB Type-C Cable	1	For connecting controller PC to DUT

 TABLE 2. EQUIPMENT REQUIREMENTS – CONNECTION CABLES

3.2 Software Requirements

Software	Source			
GRL-USB4-RXA	Granite River Labs USB4 Receiver Calibration and Test Automation Software – <u>www.graniteriverlabs.com</u> (Support > Download Center)			
	Includes test setup and pattern files for USB4 Rx testing			
	Included with Node Locked License to single oscilloscope of PC 05			
VISA (Virtual Instrument	VISA Software is required to be installed on the controller PC running GRL- USB4-RXA software. GRL's software framework has been tested to work with all three versions of VISA available on the Market:			
Software Architecture)	1. NI-VISA: http://www.ni.com/download/ni-visa-17.0/6646/en/			
AFISOItwale	2. Keysight IO Libraries: <u>www.keysight.com</u> (Search on IO Libraries)			
	3. Tektronix TekVISA: <u>www.tek.com</u> (Downloads > Software > TekVisa)			
MX190000A	Anritsu High-Speed Serial Data Test Software – Mainframe MX190000A SQA Control Software (Version 4.00.00 or above). This software is located on the BERT.			
SigTest Application	Downloadable from USB-IF's website. (Note: Approval and NDA as a USB-IF Adopter is required to gain access to USB-IF products.)			

Software	Source		
USB4 Electrical Test Tool (ETT)	Downloadable from USB-IF's website. See Section 4.1.1 for more details.		
Intel TenLira Test Scripts (For Thunderbolt 3 DUT's)	Downloadable from Intel Corporation IBL's website. See Appendix F for more details.		
ctiveTcl	Version 8.5.18.0 or above (downloadable from ActiveState's website: <u>http://www.activestate.com/activetcl/downloads</u>).		
(For Thunderbolt 3 DUT's)	Refer to ActiveState's website for specific system requirements and other information for installing the Tcl installation package. Also see the documentation available on the website for installation instructions.		

4 Installing and Setting Up GRL-USB4-RXA Software

This section provides the procedure for installing, configuring and verifying the operation of the GRL-USB4-RXA software. It also helps you familiarize yourself with the basic operation of the software.

The software installer automatically creates shortcuts in the Desktop and Start Menu.

To open the software application, follow the procedure in the following section.

4.1 Download and Set Up GRL-USB4-RXA Software

Install, launch and set up the GRL-USB4-RXA software on a PC or an oscilloscope (where GRL-USB4-RXA is referred to as 'Controller PC' or 'Scope' respectively in this MOI & User Guide):

- 1. Install VISA (Virtual Instrument Software Architecture) on to the PC/Scope where GRL-USB4-RXA is to be used (see Section 3.2).
- 2. Download the GRL-USB4-RXA ZIP file package from the Granite River Labs support site.
- 3. The ZIP file contains:
 - a) **USB4RxANPatternFilesInstallation00xxxxxxSetup.exe** Run this on the Anritsu Signal Quality Analyzer to install the test pattern setup files.
 - b) **USB4RxANTestApplication00xxxxxxSetup.exe** Run this on the controller PC or scope to install the GRL-USB4-RXA application.
 - c) **USB4RxANTestScopeSetupFilesInstallation00xxxxxxx.exe** Run this on the scope to install the scope setup files.
- 4. Launch and set up the software as follows:
 - a) Open the **GRL** folder from the Windows Start Menu. Click on **GRL Automated Test Solutions** within the GRL folder to launch the GRL software framework.



FIGURE 1. LAUNCHING GRL SOFTWARE FRAMEWORK

b) From the Application → Rx Test Solution drop-down menu, select Anritsu USB4 Rx Test. If the selection is grayed out, it means that your license has expired.

ľ	🔞 Anritsu USB4 Rx Te	st		
	Application Optio	ns License	Windows	Help
ľ	Framework Test	Solution 🔹 🕨		
l	Rx Test Solution	•	Anrit	tsu USB4 Rx Test

FIGURE 2. LAUNCHING ANRITSU USB4 RX TEST APPLICATION

i) To enable license, go to **License** \rightarrow **License Details**.

🕅 GRL - Automated Test Solution								
Application Options	License	Windows	Help					
→ > → > →	Lice							

FIGURE 3. LICENSE DETAILS

ii) Review the installed application.

Granite River Labs	
Framework License Details	
stalled Products:	
Anritsu USB4 Rx Test - Permanent	
lost ID (For enquiries or license request please send this information):	
AqEx06bSTAGvNJXI9MZ1IPUpODrJkTEKNwze1r2sC7xLY3KAe+p (T4cslo1WorbZe6E+E9yKt7/Nhmg++AAEImiXCTuNcJ5y3cVn6JDbr IqGqAFZ77aBQgQnRz2vte7CRCrBIYiyWg6wTKRRub8SUC+jAT4s QMWBqD9uool9nGYtxQmITalkJ0	Copy to Clipboar
For license enquiries send the Host ID to support@GraniteRiverLabs.c	om
Activation Key Received:	
	A
Activation License File Received: Browse	Activate

FIGURE 4. INSTALLED APPLICATION

- iii) Activate a License:
- [1] If you have an Activation Key, enter it in the box provided, and select Activate.
- [2] If you do not have an Activation Key, select **Close** to use the software for 10 days free of charge.

Note: Once the 10-day trial times out, you will need to request an Activation Key for future usage on the same computer or oscilloscope. The demo software is also limited in its capability,

in that it will only calibrate the maximum frequency for each data rate. Thus, the demo version cannot be used to full calibrate and test a device.

For Demo and Beta Customer License Keys, please request an Activation Key by contacting support@graniteriverlabs.com.

4.1.1 Download and Install USB4 Electrical Test Tools (ETT)

For USB4 Rx measurements, the Host/Device's CIO PHY must be in an active state during testing. Its transmitters shall be transmitting PRBS31 into the analyzer measurement channel during testing and its receivers shall have their terminations enabled during testing. Thus, a PHY microcontroller must be used to put the DUT into the right state for USB4 Rx testing.

Download ETT:

Visit the USB-IF official website and download "USB4 Electrical Test Tool" (ETT) at <u>https://www.usb.org/usb4tools</u>.

Install ETT:

Before running ETT, configure the Control PC's environment using the instructions in **USB4ETT_Documentation.pdf** from the ETT package downloaded from USB-IF.



For USB4 Host Testing:

• The ETT can be loaded on the Control PC with the GRL-USB4-RXA software. In this case, the Wilder-Tech μ Controller is required. The DUT is controlled using a 0.8m Type-C cable from the Wilder-Tech μ Controller to the USB4 Test Fixture.

For USB4 Device Testing:

- **Upstream Facing Port (UFP):** The ETT can be loaded on the Control PC with the GRL-USB4-RXA software. In this case, the Wilder-Tech μController is required. The DUT is controlled using a 0.8m Type-C cable from the Wilder-Tech μController to the USB4 Test Fixture.
- **Downstream Facing Port (DFP):** Connect the DUT's UFP to any USB4 Host via the USB4 Type-C cable. The ETT tools can be loaded on the Control PC with the GRL-USB4-RXA software. In this case, the Wilder-Tech µController is required. The DUT is controlled using a 0.8m Type-C cable from the Wilder-Tech µController to the USB4 Test Fixture. *Take note for the device DUT, if the port under test is a Downstream Facing Port (DFP), a USB4 Host will be required to connect to the DUT's Upwards Facing Port (UFP).*

4.1.2 Launch and Set Up GRL-USB4-RXA Software

4.1.2.1 On the Scope or Controller PC

- 1. Launch GRL Host Application from **Start Menu** -> **GRL** -> **GRL** -> **Automated Test Solutions**.
- 2. Select **Application -> Rx Test Solution -> Anritsu USB4 Rx Test**.
- 3. Select the Equipment Setup icon icon for the GRL-Anritsu USB4 Rx Test Application menu.
- 4. Connect the Anritsu MP1900A BERT via LAN to the GRL automation control enabled Scope or PC. The BERT and MX190000A software can be connected using connection string formats similar to the following examples:
 - BERT: "TCPIP0::192.168.0.14::5001::SOCKET" or "192.168.0.14:5001"
 - MX190000A: "TCPIP0::192.168.0.14::5000::SOCKET" or "192.168.0.14:5000"

Note the IP addresses listed above are only examples and should be changed according to the actual network connection being used.

- 5. On the Scope or controller PC, obtain the network addresses for all the connected instruments from the device settings. Note these addresses as they will be used to connect the instruments to the GRL automation software.
- 6. On the Equipment Setup page of the GRL-Anritsu USB4 Rx Test Application, type in the address of each connected instrument into the 'Address' field.
- 7. (Note: If the GRL software is installed on the **Tektronix Scope**, ensure the Scope is connected via GPIB and type in the GPIB network address, for example "GPIB8::1::INSTR".)

(Note: If the GRL software is installed on the **Keysight Scope**, type in the Scope IP address, for example "TCPIP0::127.0.0.1::inst0::INSTR".)

If the GRL software is installed on the PC to control the Scope, type in the Scope IP address, for example "TCPIP0::192.168.0.35::inst0::INSTR". Note to *omit* the Port number from the address.

(Note: If the GRL software is installed on the **Keysight Scope**, and if there is error in connection, type in the Scope IP address as "TCPIP0::192.168.0.35::5025::SOCKET".)

- 8. If the GRL software is installed on the PC to control the Scope, set up the Remote File Server as described in Section 4.1.3.
- 9. Then select the "lightning" button (🖌) for each connected instrument.

The "lightning" button should turn green (4) once the software has successfully established connection with each instrument.

1	+ 🔅 ;	X 💿 🕇 🕨	→ 📄			
Name	ID	Address	Туре	Vendor	Lib	
Scope	Scope	TCPIP0::localhost::ii	Oscilloscope	Agilent ∨	AgilentScope ~	9 🔳
BERT	BERT	TCPIP0::192.168.0.	BERT	Anritsu 🗸	Anritsu1900Ber ∨	4
ASG	ASG1	192.168.0.205	BERT	Anritsu 🗸	AnritsuBert 🗸 🗸	5 🔳

FIGURE 5. GRL SOFTWARE INSTRUMENT CONNECTION SETUP

Note: Additional information for connecting supported vendor oscilloscopes (Keysight and Tektronix) to the controller PC is provided in the Appendix of this document.

4.1.3 Set Up Remote File Server

1. The **GRLRemoteProxyServer.exe** will also be installed along with the **USB4RxANTestScopeSetupFilesInstallation0xxxxxxxSetup.exe** on the Scope. The GRLRemoteProxyServer.exe is installed under the *"C:\GRL\GRLRemoteProxyServer"* directory.

Local Dis	k (C:) ▶ GRL ▶ (GRLRemot	eProxyServer				
rary 🔻	Share with 🔻	Burn	New folder				
Name	^						
AppFrameWork.dll							
📄 GRI	IPAddress		(
💷 GRI	RemoteProxySen	ver	1				

FIGURE 6. INSTALLED GRLREMOTEPROXYSERVER.EXE FILE DIRECTORY

- 2. If the GRL software is installed on the PC to control the Scope and SigTest is selected as the test method to be used (refer Section 6.4), the GRLRemoteProxyServer.exe must be run on the Scope to move large waveform files back to the controller PC. The GRL software will then perform post-processing and analysis of these waveforms using SigTest.
- 3. When running the GRLRemoteProxyServer.exe, make sure that the controller PC and Scope are connected to the same network, using IP addresses as in following example:
 - Controller PC IP address: 192.168.100.8
 - Scope IP address: <u>192.168.100.35</u>

Status Log				23	
TCP/IP Server Start TCP/IP Server started PortNo: 53320					
GRL Remote Proxy Server					
Proxy Server Address:	192.168.100.35	Port No:	53320		

FIGURE 7. VERIFY PROXY SERVER CONNECTION FOR CONTROLLER PC AND SCOPE

4. On the GRL USB4 Rx Test Application, configure the "Remote File Server IP Address" and

"Remote File Server Port Number" parameters on the Configurations page to match the network settings of the GRL Remote Proxy Server as shown in the example below:

SigTest Version:		※ ◎ → ▶ → 🖻
Sigtest Path: C:\USB4Sigtest	Sigtest	0.5 C:\USB4Sigtest
Remote File Server IP Address: 192.168.100.35 Remote File Server Port Number: 53320	192.168.100.35 53320	ver IP Address: 192.168.100.35 ver Port Number: 53320

FIGURE 8. CONFIGURE GRL REMOTE PROXY SERVER NETWORK SETTINGS ON GRL SOFTWARE

Refer Section 6.4 for more details on parameters available on the Configurations page.

5 Receiver Calibration Setups

The following sections show the setup connection diagrams for the Anritsu MP1900A BERT Calibration. The fixtures and channels used for USB4 Compliance testing are available from the USB-IF.

5.1 Connection Setup for Anritsu MP1900A BERT Generator Set

Figure 9 shows the connection setup between each module of the Anritsu MP1900A BERT Generator Set.



FIGURE 9. CONNECTION SETUP FOR MP1900A BERT GENERATOR SET MODULES

Connection Steps:

- 1. Using the J1624A SMA-SMA (0.3m) cable, connect the Clock Output of the MU181000A/B Synthesizer to the Ext Clock Input of the MU181500B Jitter Modulator.
- 2. Using the J1624A SMA-SMA (0.3m) cable, connect the Jittered Clock Output of the MU181500B Jitter Modulator to the Ext Clock Input of the MU195020A Pulse Pattern Generator.
- 3. Using the J1746A K-K skew matched pair short semirigid cable, connect the MU195020A Data Outputs to the MU195050A Data Inputs.

5.2 Connection Setup for TP3' (Case 1) Calibration

Figure 10 shows the calibration setup diagram for TP3' (Test Point 3') using the Anritsu MP1900A BERT. TP3' (Case 1) is a physical test point for calibration without the effect of a channel.

Note: Cables connecting the signal to the Scope should be < 1m.



FIGURE 10. SETUP FOR TP3' (CASE 1) CALIBRATION

Connection Step:

Using the MP1900A BERT setup connections (Section 5.1), connect the MU195050A data outputs through DC blocks to Channels 1 and 3 on the scope using phase matched K-K coaxial cables.

5.3 Connection Setup for TP3 (Case 2) Calibration

Figure 11 and Figure 12 show the calibration setup diagrams for TP3 (Test Point 3) using the Anritsu MP1900A BERT. TP3 (Case 2) is a physical test point that will affect the eye opening due to the sum of a fixed channel length (representing the fixed ISI on the transmitter side of a host or device) and a physical USB Type-C Cable.

For USB4 Gen2 speed (10Gb/s) or Thunderbolt 3 compatible Gen2 speed (10.3125Gb/s), the total Insertion Loss is -18.5dB at 5GHz, which uses a 2M USB Type-C cable.

For USB4 Gen3 speed (20Gb/s) or Thunderbolt 3 compatible Gen3 speed (20.625Gb/s), the total Insertion Loss is -16.5dB at 10GHz, which uses a 0.8M USB Type-C cable. The cable's downstream plug connector is connected to a calibration fixture to measure the signal with the scope. The scope uses software equalization to open the eye for calibration.

Note: Cables connecting the signal to the Scope should be de-embedded and ≤ 1 m.



Figure 11. Setup for TP3 (Case 2) Calibration at 10G or 10.3125G

Connection Steps:

- 1. Continuing from the MP1900A BERT TP3' (Case 1) calibration setup (Section 5.1), disconnect the MU195050A data outputs from the scope channels.
- Connect the MU195050A data outputs through DC blocks to ISI channels (for 10Gb/s or 10.3125Gb/s) and then to the test fixtures with a 2M USB Type-C cable, and then to Channels 1 and 3 on the scope.



FIGURE 12. SETUP FOR TP3 (CASE 2) CALIBRATION AT 20G OR 20.625G

Connection Steps:

- 1. Continuing from the MP1900A BERT TP3' (Case 1) calibration setup (Section 5.1), disconnect the MU195050A data outputs from the scope channels.
- 2. Connect the MU195050A data outputs through DC blocks to ISI channels (for 20Gb/s or 20.625Gb/s) and then to the test fixtures with a 0.8M USB Type-C cable, and then to Channels 1 and 3 on the scope.

6 Calibrating Using GRL-USB4-RXA Software

6.1 Enter Calibration/Test Session Information

Select from the software menu to access the **Session Info** page. Enter the information as required for the calibration/test session that is currently being run. The information provided will be included in the test report generated by the software once calibration/tests are completed.

- The fields under **DUT Info** and **Test Info** are defined by the user.
- The **Software Info** field is automatically populated by the software.

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	Info Software Info
DUT Manufacturer:	GRL Comments
DUT Model Number:	USB4_AX001
DUT Serial Number:	1000838ABC

FIGURE 13. ENTER CALIBRATION/TEST SESSION INFORMATION

6.2 Set Up Conditions for Calibration/Testing

Select **from** the software menu to access the Conditions page.

In this section, conditions for Testing and Calibration will need to be set.

1. Select the Test Point(s). [Note: Case 1 calibration (Total Jitter & Eye Height @ TP3') must be performed first prior to Case 2 calibration (Optimized EQ Lookup, Eye Height & Eye Width @ TP3).]



FIGURE 14. SELECT TEST POINT

2. Select the test Port(s) and Lane(s) for the DUT. (*Note: This is only applicable for DUT compliance test and NOT for calibration.*)

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Test Point Lane	Data Rate SJ F	Frequency		
 ✓ Port ✓ Port ✓ Port ✓ Port 	A L0 A L1 B L0 B L1			*This tab is for test only and not applicable calibrations

FIGURE 15. SELECT DUT PORT AND LANE UNDER TEST

3. Select the Data Rate(s) of USB4 Gen2 speed (10Gb/s), USB4 Gen3 speed (20Gb/s), Thunderbolt 3 compatible Gen2 speed (10.3125Gbps) and Thunderbolt 3 compatible Gen3 speed (20.625Gbps).

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Т	est Point	Lane	Data Rate	SJ F	requenc	y										
E																
		✓ 10 0	ib/s													
		200	ib/s													
		10.3	125 Gb/s													
		20.6	25 Gb/s													

FIGURE 16. SELECT DATA RATE

4. Select the SJ Frequency.



FIGURE 17. SELECT SJ FREQUENCY

6.3 Select Calibration

The test selection page allows calibration/tests that need to be performed to be selected. Initially when starting for the first time or changing anything in the setup, it is suggested to run Calibration first. If the calibration is not completed, the Rx Tests will throw an error message.

The GRL-USB4-RXA software automatically runs the selected calibration when initiated. See Section 6.6 on running the calibration.



FIGURE 18. SELECT CALIBRATION

Note: The marking shown on the left of each test parameter indicates the status of the calibration/test result of the parameter. In the above example, \diamondsuit indicates that calibration/testing has not been run for the specific calibration/test parameter. When calibration/testing has been run and completed successfully for the specific calibration/test parameter with a Pass result, this will be indicated with \checkmark .

6.3.1 Calibrations Group

Select the main Calibrations checkbox to perform all USB4 Rx calibration supported by the GRL-USB4-RXA software.

Calibration	Description
SSC Offset	Calibrates the frequency offset to achieve the start of the Spread Spectrum Clock (SSC) deviation as required by USB4 Specs.
Initial Eye Height	Calibrates the initial eye height to requirement by USB4 Specs.
Optimized Pre-set Look Up	Searches for the optimized preset out of 15 possible presets defined in the USB4 Specs. Optimized preset is defined as the preset which yields the lowest number of DDJ.
АССМ	Calibrates the ACCM as required by USB4 Specs.
Random Jitter	Calibrates random jitter of the BERT using the PRBS15 pattern.
Periodic Jitter	Calibrates sinusoidal jitter of all five of the frequencies as required by the USB4 Specs, and forms a linear curve fit for each SJ frequency.
Case 1, Total Jitter	Calibrates all total jitter and eye height for Case 1 setup at TP3'.

TABLE 3. SUPPORTED CALIBRATION

and Eye Height	
Optimized EQ Look Up	Searches for the optimized equalization for the TP3_EQ test point. Note: This option will only be enabled if "Other" is selected as the Calibration method from the Configurations page.
Case 2, Eye Height and Eye Width	Calibrates eye height and eye width for Case 2 setup at TP3.

6.4 Configure Calibration/Test Parameters

After selecting the desired calibration, select if from the software menu to access the Configurations page. Set the required parameters for calibration and tests as described below.

To return all parameters to their default values, select the 'Set Default' button.

↓ ① 🛧 🕸 📉 👁 → 🕨 → 🖻	
All Tests	Set Default
PG Delay: Auto	
Overwrite PG Delay:	
PG Delay Value:	
ACCM Channel:	
Manual ACCM:	
Enable DeEmbedding:	
Cable DeEmbedding File:	
Custom Preset Table	
False	
False	
EQ DC Gain 20G: Default 🗸	
EQ DC Gain 10G: Default ~	
Calibrations	
Tek Scope Channel+ Skew(ps):	
Tek Scope Channel- Skew(ps):	
Rj Bandwidth: Narrow	
Fit Rj From Calibration:	
Rj Sampling Method: Single	
Fine Stepping:	
Tj Sampling Method: Single	•
Enable Test Characterization Mode: False EQ DC Gain 20G: Default EQ DC Gain 10G: Default Calibrations Tek Scope Channel+ Skew(ps): O Tek Scope Channel- Skew(ps): O Fit Rj From Calibration: True Rj Sampling Method: Single Single Tj Sampling Method: Single Single	

FIGURE 19. CONFIGURE CALIBRATION/TEST PARAMETERS

Parameter	Description								
PG Delay	Set input Data and Clock delay of the Pulse Pattern Generator (PPG) if used. "Auto" is usually the case. Select "Manual" only if you are sure that the PPG does not require any calibration.								
Overwrite PG Delay	"False" is usually the case. If you change this to "True", then you will need to provide a value in the "PG Delay Value" field.								
PG Delay Value	If the "Overwrite PG Delay" field is set to "True", enter the Delay value of the PPG.								
ACCM Channel	Select "Both" or single channel (splitter required) as the AC Common Mode (ACCM) source if used.								
Manual ACCM	Set to "True" to manually set the ACCM source or "False" to apply calibrated values from ACCM calibration.								
Enable DeEmbedding	Set to "True" to de-embed cable while calibrating.								
Cable DeEmbedding File	Define the cable transfer function file. Applicable only when the "Enable DeEmbedding" field is set to "True".								
Custom Preset Table	Set to "True" to use the list of user-defined measurement preset values for calibration.								
Enable Test Characterization Mode	Set to "True" to run eye diagram tests to determine worst-case margins.								
EQ DC Gain (20G & 10G)	Select the DC Gain setting index for the 10G and 20G TP3_EQ systems.								
Tek Scope Channel+ & Channel- Skew	If the Tektronix ATI based Scope is to be used for measurements, enter the channel skew or timing to perform alignment of the Scope channels.								
Rj Bandwidth	Select to use "Narrow" or "Wide" band for jitter decomposition algorithm to separate random jitter.								
Fit Rj From Calibration	Set to "True" to fit random jitter value from calibration when running total jitter calibration.								
Rj Sampling Method	Select the method to be used to perform random jitter sampling.								
Fine Stepping	Set to "True" to enable fine stepping for the eye mask.								
Tj Sampling Method	Select the method to be used to perform total jitter sampling.								
10G & 20G Damping Factor	Define the 10G and 20G damping factor rates to use for calibration.								
Tj Adjust Param	Select whether to use "Rj" or "Sj" for total jitter calibration for both <100 MHz and 100 MHz cases.								
Eye Width Tuning	Select "Retune" to repeat the tuning cycle or "Retry" the current tuning procedure when measuring eye width.								
Align Eye Mask Delay	Set to "True" to perform alignment for the delay in between validating the eye mask.								

TABLE 4. CALIBRATION/TEST PARAMETERS DESCRIPTION

Maximum Retry	Enter the number of times to repeat calibration for pass/fail condition.
Calibration Method	Select the method to be used to perform post processing waveform analysis for Rx stressed eye calibration. The SigTest signal quality test method will be used by default or select "Other" to use other supported vendor specific method (Keysight or Tektronix Scope measurement tools). <i>Note: The vendor specific method option will eventually be obsolete and</i> <i>replaced with SigTest instead.</i>
	Note: Selecting "Other" will enable the "Optimized EQ Look Up" calibration option under the Case 2, TJ and Eye Height Calibration group. See Table 3Table 3. Supported Calibration.
	and checked against the specified pass/fail criteria. <i>Refer to Appendix of this document for additional information on SigTest requirements.</i>
SigTest Version	Enter the Version number of the SigTest signal quality test to be run during calibration to ensure waveform compliance. Make sure that the SigTest application is already installed in the test controller system.
SigTest Path	Enter the full path of the SigTest location in the test controller system.
SigTest Max Thread Count	Set the maximum process threads to generate for checking the Rx device functionality when running SigTest.
Remote File Server IP Address	Enter the IP address for the GRL Remote Proxy Server. See Section 4.1.3 on how to set up the remote file server.
Remote File Server Port Number	Enter the Port number for the GRL Remote Proxy Server. See Section 4.1.3 on how to set up the remote file server.
Perform Link Training	Select the option to run or disable link training for Rx test.
BER Automation	Select the method to be used to run Rx BER tests.
Save BERT Setup Only	"False" is usually the case. Set to "True" if you are sure that you only want to save the BERT test setup in the Rx test.
Prompt Before Link Training	"False" is usually the case. Set to "True" if you want to be prompted prior to start running link training. Ensure that the "Always" or "Once" run option is selected in the "Perform Link Training" field.
Skip DUT Reset	"False" is usually the case. Set to "True" if you want to reset the DUT when performing tests.
Script Version	Select the version of the TenLira test script ("ver 0.8.3" or above) or the ETT test script ["ETT(v0.9.4)" or "ETT(v0.9.5)"] to be used.
Run ETT with Tiger Lake	If the Host DUT is selected as the "DUT Type" in the <i>DUT Configuration</i> page and if the ETT test script is selected in the "Script Version" field, set to "True" to run the ETT script on Intel's Tiger Lake processor.
DUT with Re-timer	If the ETT test script is selected in the "Script Version" field, set to "True" if the DUT has additional re-timer.
ETT Test Port Mapping for	If the Device DUT is selected as the "DUT Type" in the <i>DUT Configuration</i>

Device DUT	page and if the ETT test script is selected in the "Script Version" field, specify the test connector lanes to validate the port mapping of the device DUT connectors.
Set Swap Lane with ETT	If the ETT test script is selected in the "Script Version" field, select the router and/or re-timer setup to perform lane switching for the DUT.
Ridge	If the Tenlira test script is selected in the "Script Version" field, select the number of ports to be tested for the ridge DUT.
DUT Chipset (When Using Tenlira Only)	If the Tenlira test script is selected in the "Script Version" field, select the Titan Ridge "TR" or Alpine Ridge "AR" processor as supported by the DUT.
Remote/Local Working Directory	Set the working directory to the path where the test script is installed in the host PC.
Remote IP Address	Enter the IP address of the remote host of the test script.
Remote Port Number	Enter the port number of the remote host of the test script.
Remote Script	Enter the name of the remote test script.
Remote Script Arguments	Set the arguments for executing the remote test script.
Run Post Test Script	Select the option to run the remote test script in the post-test stage.
Post Test Remote Script	Enter the name of the remote test script for post-test.
Post Test Remote Script Directory	Set the working directory to the path where the post-test script is installed in the host PC.
Short Test Link Training Cycle	Define the number of times to perform link training for short BER loopback.
Maximum Error	Define the maximum error count for error checking during Rx test.
Prompt When BER Overflow	"False" is usually the case. Set to "True" if you want to be prompted if there is buffer overflow during BER testing.
10G & 20G Compliance Test Duration	Set how long it would take (in seconds) to test the DUT for 10G or 20G compliance.
Margin Step Size (%)	Set the step size for stepping through SJ or amplitude margins when running the optional margin search tests.
Maximum Margin Test Error	Define the maximum error count for error checking during margin search tests.
Maximum Steps	Define the maximum number of steps to step through margins.
10G & 20G Margin Test Duration(s)	Set how long it would take (in seconds) to run full margin search tests for the 10G and 20G data rates.
Short Margin Test Duration	Set the duration in seconds to run a brief margin search test.
Quick Margin Search Scan	Set to "True" to perform a quick scan for worst-case margins during margin search tests.

Margin Limit Line	Select the option to use a limit based on calibrated or specification values for margin search tests.
Final Eye Preset	Select the option to use a preset from calibration or link training for final eye measurements.
CTLE DC Gain	Select the DC Gain value to be used based on the CTLE model to measure eye heights for TP3_EQ tests.
10G & 20G User Defined CTLE Gain	If "User Defined" is selected in the "TP3 CTLE DC Gain" field, select the optimized CTLE Gain setting index for the 10G and 20G TP3_EQ systems.

6.5 Configure Calibration Target Values

Select in the main software menu to access the Calibration Target page. User may change the calibration target value for any of the calibration items. By default, the target values are those defined in the specification. Change the values only when debugging.

To change the values, un-select the Use Default Value checkbox. Also at any point in time if the default values are required, just select the checkbox and the default values will replace all the current values.

Note: The PID Control setting is used to adjust the step width for steps calculation if the target measurement cannot be met with the current step. To adjust, use a lower PID Control value to reduce the subsequent step or increase the control value to make the subsequent step bigger.

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	🗸 Use	Default	Value										
	Case 1 Eu	Hoight	Calibrat	ion Coo		loiabt C	alibration	C 200 2	Evo Width Calibra	tion			
l f	Case 1, Eye	Colibrat			ez, cyer	eight C			, Eye width Calibra	luon .	Destable black California	Correct Total Inter Coltheasting	
	55C Olisel	Calibrat	ion int	а Еуе не	eight Calib	ration	ACCIVI Call	bration	Random Jitter Ca	alibration	Penodic Jitter Calibration	Case 1, Total Jitter Calibration	
	Rate_	10G F	Rate_200	a Rate_	10p31250	G Rat	e_20p625G						^
			_	_									
	Initial	Cal		300		P	pm						
	-												
	Targe	t Value		99.96	5	p	s						
	Min L	imit:		99 96		p	s						
				00.00									
	Max	_imit :		99.98	3	p	s						
	PID	Control		20									
				30									~
	I												

FIGURE 20. OVERWRITE EXISTING CALIBRATION TARGETS

6.6 Run Calibration

Select **Select** in the main software menu to access the Run Tests page.

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	Run Opt S F	i on kip Test leplace I	lf Result f Result I	Exists Exists							F	Run Te	sts	

FIGURE 21. RUN CALIBRATION

Select the Run Option before clicking the "Run Tests" button to start selected calibration:

- **Skip Test if Result Exists.** If previous calibration results exist, then the software will *skip* the calibration steps that have existing reports.
- **Replace if Result Exists.** If previous calibration results exist, then the software will *replace* each step in the calibration with new results.

When calibration is running, the connection setup diagram of the respective calibration will initially appear as a guide for the user to make sure all connections are proper before calibration is performed.



FIGURE 22. CONNECTION SETUP DIAGRAM DIALOG EXAMPLE

If you need to re-run only certain calibration on certain conditions, delete the calibration results from the Report tab and Run with **Skip Test if Result Exists.** The GRL software will keep track of the missing calibration results in the report and perform those calibration only. See Section 8.2, Delete Test Results for details.

7 Compliance Testing Using GRL-USB4-RXA Software

After calibration has completed successfully, receiver BER (Bit Error Rate) compliance and optional margin testing can then be performed on the device under test (DUT). The GRL-USB4-RXA software automates the Gen2 & 3 receiver compliance testing for BER tolerance, at the spec-defined or user-defined jitter frequency steps. The receiver will also undergo signal frequency variations during Link training for the Case 2 setup, before obtaining steady state.

If desired, optional receiver margin testing can be additionally performed via the GRL-USB4-RXA software to search for SJ and amplitude margins.

When testing is completed, the results will be logged in an aggregated test report which can be generated into PDF format.

7.1 Connection Setups for BER Testing

This section describes the test setups for the host/device DUT using the USB4 microcontroller and MP1900A BERT. Test scripts as listed in Section 3.2 are required to run the automation tests. Also refer to Section 4.1.1 or Appendix F for options on how to configure the test setup.

7.1.1 BER Test Setup for TP3' (Using USB4 Microcontroller Method and MP1900A BERT)

Figure 23 shows the USB4 host/device DUT test setup diagram for TP3' (Test Point 3', Case 1) using the USB4 microcontroller method and the MP1900A BERT. The calibrated stressed signal is attached to a plug style test fixture and crosstalk is added to the fixture from the DUT which generates crosstalk signals. The microcontroller is used to directly control the DUT by executing microcontroller test scripts.



FIGURE 23. RX BER TEST SETUP AT TP3' (USING USB4 MICROCONTROLLER AND MP1900A BERT)

Connection Steps:

- 1. Attach the USB Type-C connector of the plug fixture to the DUT receptacle.
- 2. Using the MP1900A BERT TP3' (Case 1) calibration setup (Section 5.2), disconnect the MU195050A data outputs from the scope channels.
- 3. Connect the MU195050A data outputs through DC blocks to Rx Lane0/Lane1 of the DUT through the plug fixture.
- 4. Connect the USB4 microcontroller to power supply and to the controller PC.
- 5. Connect a 0.8M USB Type-C cable between the microcontroller and plug fixture.
- 6. Connect Tx Lane0/Lane1 of the plug fixture to the Rx lanes of the plug fixture that are not under test to inject crosstalk.
- 7. Terminate the Tx lanes of the plug fixture that are not under test with 50Ω termination.
- 8. Run the microcontroller test scripts to control the DUT.

7.1.2 BER Test Setup for TP3 (Using USB4 Microcontroller Method and MP1900A BERT)

Figure 24 shows the USB4 host/device DUT test setup diagram for TP3 (Test Point 3, Case 2) at 10G using the USB4 microcontroller method and the MP1900A BERT. The USB Type-C cable is disconnected from the calibration fixture and connected to the host/device DUT's USB Type-C receptacle connector. The microcontroller is used to directly control the host/device DUT by executing microcontroller test scripts.

For USB4 Gen2 speed (10Gb/s) or Thunderbolt 3 compatible Gen2 speed (10.3125Gb/s), the setup uses a 2M USB Type-C cable.



FIGURE 24. SETUP FOR TP3 Rx BER TEST AT 10G OR 10.3125G (USING USB4 MICROCONTROLLER AND MP1900A BERT)

Connection Steps:

- 1. Using the MP1900A BERT TP3 (Case 2) calibration setup (Section 5.3), disconnect the test fixture that connects to the scope.
- 2. Attach the 2M USB Type-C cable to the DUT receptacle.
- 3. Connect the ISI channels to Rx Lane0/Lane1 of the test fixture.
- 4. Connect the USB4 microcontroller to power supply and to the controller PC.
- 5. Attach the microcontroller to the test fixture.
- 6. Connect Tx Lane0/Lane1 of the test fixture to the Rx lanes of the test fixture that are not under test to inject crosstalk.
- 7. Terminate the Tx lanes of the test fixture that are not under test with 50Ω termination.
- 8. Run the microcontroller test scripts to control the DUT.

Figure 25 shows the USB4 host/device DUT test setup diagram for TP3 (Test Point 3, Case 2) at 20G using the USB4 microcontroller method and the MP1900A BERT. The USB Type-C cable is disconnected from the calibration fixture and connected to the host/device DUT's USB Type-C receptacle connector. The microcontroller is used to directly control the host/device DUT by executing microcontroller test scripts.

For USB4 Gen3 speed (20Gb/s) or Thunderbolt 3 compatible Gen3 speed (20.625Gb/s), the setup uses a 0.8M USB Type-C cable.



FIGURE 25. SETUP FOR TP3 RX BER TEST AT 20G OR 20.625G (USING USB4 MICROCONTROLLER AND MP1900A BERT)
Connection Steps:

- 1. Using the MP1900A BERT TP3 (Case 2) calibration setup (Section 5.3), disconnect the test fixture that connects to the scope.
- 2. Attach the 0.8M USB Type-C cable to the DUT receptacle.
- 3. Connect the ISI channels to Rx Lane0/Lane1 of the test fixture.
- 4. Connect the USB4 microcontroller to power supply and to the controller PC.
- 5. Attach the microcontroller to the test fixture.
- 6. Connect Tx Lane0/Lane1 of the test fixture to the Rx lanes of the test fixture that are not under test to inject crosstalk.
- 7. Terminate the Tx lanes of the test fixture that are not under test with 50Ω termination.
- 8. Run the microcontroller test scripts to control the DUT.

7.2 Select DUT Type

Select **o** from the software menu to access the Setup Configuration page.

Select either a USB4 Host or Device to be tested.



FIGURE 26. SELECT DUT TYPE

7.3 Select DUT Rx Tests

On the test selection page, deselect all Calibration selections as they were completed in the previous section. Scroll down to access the Rx Test selections. Select the check boxes of the respective tests to be run.



FIGURE 27. SELECT DUT RX TESTS TO BE RUN

7.3.1 Receiver Test Group

Select the main Rx Tests checkbox to perform all USB4 Rx tests for the DUT supported by the GRL software with parameters from the calibration steps.

Rx Test	Description
Receiver BER Tests	Runs all BER compliance tests as required by the USB4 Specs.
Receiver Signal Frequency Variation Training Tests	Applies transmitter frequency variations during link training for the Case 2 setup, before obtaining steady state.
Sj Margin Search Tests	Runs Optional tests to search for SJ Margin (for information purpose only)

TABLE 5. SUPPORTED RX TESTS

Amplitude Margin Search	Runs Optional tests to search for Amplitude Margin (for
Tests	information purpose only)

7.4 Set Up USB4 Microcontroller Environment

Select from the software menu to access the Configurations page.

The fields for setting up the USB4 microcontroller environment are as shown below:

		C_+ D_+(
BER Automation:	iController 🗸 🗸	Set Delau
Save BERT Setup Only:	False 🗸	
Prompt Before Link Training:	False ~	
Skip DUT Reset:	alse 🗸	
Script Version:	T(v0.9.5) ~	
Run ETT with Tiger Lake:	True ~	
DUT with Re-timer:	True ~	
ETT Test Port Mapping for Device	DUT: 1,3,5,7	
Set Swap Lane with ETT:	None ~	
Ridge: 1	~	
DUT Chinset (When Using Tenlira	Oply):	

FIGURE 28. SETUP FOR USB4 MICROCONTROLLER ENVIRONMENT

To set up the software to call the microcontroller script from a controller PC:

- 1. Set the **BER Automation** field to "uController".
- 2. Set the **Remote/Local Working Directory** field to the path where the microcontroller script is installed in the controller PC.

7.5 Set Up Intel's TenLira Environment

Select Korn the software menu to access the Configurations page.

BER Automation:	Tenlira	~	^	Set De
Save BERT Setup Only:	False	~		
Prompt Before Link Training:	False	~		
Skip DUT Reset:	False	~		
Script Version:	ver 0.8.3	~		
Run ETT with Tiger Lake:	True	~		
DUT with Re-timer:	True	\sim		
ETT Test Port Mapping for D	evice DUT: 1,3,5,	7		
Set Swap Lane with ETT:	None	~		
Ridge: 1		~		
DUT Chipset (When Using T	enlira Only): TR		~	
Remote/Local Working Direc	ctory: C:\Tenlira\			

The fields for setting up the TenLira environment are as shown below:

FIGURE 29. SETUP FOR TENLIRA ENVIRONMENT

To set up the software to call the TenLira script from a remote host:

- 1. Set the **BER Automation** field to "Tenlira".
- 2. Select the **TenLira Script Version** to be used.
- 3. Select the number of ports for the **Ridge** DUT.
- 4. Select the supported **DUT Chipset**.
- 5. Set the **Remote/Local Working Directory** field to the path where the TenLira script is installed in the host PC.
- 6. Provide the **Remote IP Address** and **Remote Port Number** of the remote host.
- 7. Enter the name of the **Remote Script** to be used.

7.6 Set Up USB4 ETT Environment

Select K from the software menu to access the Configurations page.

BER Automation:	uController	A	Set Def
Save BERT Setup Onl	False 🗸		
Prompt Before Link Tra	ning: False ~		
Skip DUT Reset:	False ~		
Script Version:	ETT(v0.9.4) ~		
Run ETT with Tiger La	e: True ~		
DUT with Re-timer:	True ~		
ETT Test Port Mapping	for Device DUT: 1,3,5,7		
Set Swap Lane with E	T: Router ~		
Ridge:	~		
DUT Chipset (When U	ing Tenlira Only): TR	\sim	
Remote/Local Working	Directory: C:\USB4 Electrical\uController		
Remote IP Address:	102 100 0 2		

The fields for setting up the ETT environment are as shown below:

FIGURE 30. SETUP FOR ETT ENVIRONMENT

To set up the software to call the ETT script from a remote host:

- 1. Set the **BER Automation** field to "uController".
- 2. Select the **ETT Script Version** to be used.
- 3. Select "True" to **Run ETT with Tiger Lake** processor if supported by the **Host** DUT.
- 4. Select "True" if to use the **DUT with Re-timer**.
- 5. If the DUT Type is set as **Device** in the *DUT Configuration* page, specify the test connector lanes to validate **ETT Test Port Mapping for Device DUT**.
- 6. To perform lane switching for the DUT, select the router and/or re-timer setup in the **Set Swap Lane with ETT** field.
- 7. Set the **Remote/Local Working Directory** field to the path where the ETT script is installed in the host PC.
- 8. Provide the Remote IP Address and Remote Port Number of the remote host.
- 9. Enter the name of the **Remote Script** to be used.

7.7 Run DUT Rx Tests

Select **I** from the software menu to access the Run Tests page. Select the Run Option as desired before clicking the Run Tests button to start testing the DUT. *(This is similar to Section 6.6; refer for more details.)*

FIGURE **31.** RUN TESTS

8 Test Results and Reports Using GRL-USB4-RXA Software

The **Report** page has all the results from all the test runs displayed. If some of the results are not desired, they can be individually deleted by using the **Delete** button. Also for a PDF report, select the **Generate report** button. To have the calibration data plotted in the report, make sure the **Plot Calibration Data** box is checked.

Result					
No	TestName	Result	Limits	Va 🔺	Generate report
1	SSC Offset Calibration	PASS	N/A	N/	S Delete
2	Initial Eye Height Calibration	PASS	N/A	N/	
3	Initial Eye Height Calibration	PASS	N/A	N/	O Delete All
4	Initial Eye Height Calibration	PASS	N/A	N/ -	
5	Initial Eye Height Calibration	PASS	N/A	N/	
6	Optimized Pre-set Look Up	PASS	N/A	N/	
7	Optimized Pre-set Look Up	PASS	N/A	N/	
8	Optimized Pre-set Look Up	PASS	N/A	N/	
9	Optimized Pre-set Look Up	PASS	N/A	N/	
10	ACCM Calibration	PASS	N/A	N/	
11	ACCM Calibration	PASS	N/A	N/	
12	ACCM Calibration	PASS	N/A	N/	
13	ACCM Calibration	PASS	N/A	N/	
14	Random Jitter Calibration	PASS	N/A	N/	
15	Random Jitter Calibration	PASS	N/A	N/	
16	Random Jitter Calibration	PASS	N/A	N/	
17	Random Jitter Calibration	PASS	N/A	N/	
18	Sinusoidal Jitter Calibration	PASS	N/A	N/	
19	Sinusoidal Jitter Calibration	PASS	N/A	N/	
20	Sinusoidal Jitter Calibration	PASS	N/A	N/	
21	Sinusoidal Jitter Calibration	PASS	N/A	N/	
22	Sinusoidal Jitter Calibration	PASS	N/A	N/	
23	Sinusoidal Jitter Calibration	PASS	N/A	N/	
24	Sinusoidal Jitter Calibration	PASS	N/A	N/	

FIGURE 32. REPORT RESULTS PAGE

8.1.1 DUT Information

This portion is populated from the information in the DUT tab from the **Session Info** tab.

	Anritsu USB4 Rx Test Report
DUT Information	
DUT Manufacturer	: GRL
DUT Model Number	: USB4_AX001
DUT Serial Number	: 1000888ABC
DUT Comments	:
Test Information	
Test Lab	: Granite River Labs
Test Operator	: John
Test Date	: April 1, 2020
Software Version	
Software Revision	: 0.00.43

FIGURE 33. DUT INFORMATION

8.1.2 Results Summary Table

This portion is populated from the calibration and tests performed with their respective results. This gives an overall view of all the results and test conditions.

No	TestName	Limits	Value	Results	Test Point	Lane	Data Rate	SJ Frequency
1	SSC Offset Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10G	N/A
2	SSC Offset Calibration	N/A	N/A	Pass	N/A	N/A	Rate_20G	N/A
3	SSC Offset Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10p3125G	N/A
4	SSC Offset Calibration	N/A	N/A	Pass	N/A	N/A	Rate_20p625G	N/A
5	Initial Eye Height Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10G	N/A
6	Initial Eye Height Calibration	N/A	N/A	Pass	N/A	N/A	Rate_20G	N/A
7	Initial Eye Height Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10p3125G	N/A
8	Initial Eye Height Calibration	N/A	N/A	Pass	N/A	N/A	Rate_20p625G	N/A
9	Optimized Pre-set Look Up	N/A	N/A	Pass	N/A	N/A	Rate_10G	N/A
10	Optimized Pre-set Look Up	N/A	N/A	Pass	N/A	N/A	Rate_20G	N/A
11	Optimized Pre-set Look Up	N/A	N/A	Pass	N/A	N/A	Rate_10p3125G	N/A
12	Optimized Pre-set Look Up	N/A	N/A	Pass	N/A	N/A	Rate_20p625G	N/A
13	ACCM Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10G	N/A
14	ACCM Calibration	N/A	N/A	Pass	N/A	N/A	Rate_20G	N/A
15	ACCM Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10p3125G	N/A
16	ACCM Calibration	N/A	N/A	Pass	N/A	N/A	Rate_20p625G	N/A
17	Random Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10G	N/A
18	Random Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_20G	N/A
19	Random Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10p3125G	N/A
20	Random Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_20p625G	N/A
21	Periodic Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10G	SJ1
22	Periodic Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10G	SJ2
23	Periodic Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10G	SJ3
24	Periodic Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10G	SJ4
25	Periodic Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10G	SJ5
26	Periodic Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_20G	SJ1
27	Periodic Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_20G	SJ2
28	Periodic Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_20G	SJ3
29	Periodic Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_20G	SJ4
30	Periodic Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_20G	SJ5
31	Periodic Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10p3125G	SJ1
32	Periodic Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10p3125G	SJ2
33	Periodic Jitter Calibration	N/A	N/A	Pass	N/A	N/A	Rate_10p3125G	SJ3

FIGURE 34. RESULTS SUMMARY TABLE EXAMPLE

8.1.3 Compliance Test Results

This portion is populated from the results of all Rx compliance tests performed.

j Frequency	SJ1	SJ2	SJ3	SJ4	SJ5																														
Lane0	-	-	-	-	-																														
Lane1	-	-	-	-	-																														
Lane2	-	-	-	-	-																														
Lane3	-	-	-	-	-																														
ase1 20G BER	R at TP3'																																		
Sj Frequency	SJ1	SJ2	SJ3	SJ4	SJ5																														
Lane0	-	-	-	-	-																														
Lane1	-	-	-	-	-																														
Lane2	-	-	-	-	-																														
Lane3	-	-	-	-	-																														
Si Frequency	SJ1	SJ2	\$J3	S.J4	S J5																														
Lano0			0.50		000																														
Laneu	-	-	-	-	-																														
Lane1	-	-	-	-	-																														
Lane2	-	-	-	-	-																														
Lane3	-	-	-	-	-																														
Sj Frequency	SJ1	SJ2	SJ3	614	6 15																														
Lane0	-	-	-	-	-																														
Lane0 Lane1	-	-																																	
Lane0 Lane1 Lane2					- - - -																														
Lane0 Lane1 Lane2 Lane3	- - - -	- - - -	- - - - -		- - - - -																														
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Si Frequency	G BER at TP3	- - - -	- - - - -		- - - - - -																														
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency	- - - - G BER at TP3																																		
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0				SJ4 - - - - - - - - - - - - - - - - - - -	SJ5 - - - - - - - - - - - - - - - - - - -																														
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2		- - - - - - - - - - -		SJ4 - - - - - - - - - - - - -	SJ5 - - - - - - - - - - - - -																														
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3			SJ3 - - - - - - - - - - - - -	SJ4 - - - - - - - - - - - - -	SJ5 - - - - - - - - - - - - -																														
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20G BEF				SJ4 - - - - - - - - - - - - -	SJ5 - - - - - - - - - - - - -																														
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20G BEF Sj Frequency				SJ4 - - - - - - - - - - - - -	SJ5 - - - - - - - - - - - - -																														
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20G BEF Sj Frequency Lane0				SJ4	SJ5 - - - - - - - - - - - - -																														
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 Sj Frequency Lane0 Lane0 Lane1				SJ4	SJ5 - - - - - - - - - - - - -																														
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20G BEF Sj Frequency Lane0 Lane1 Lane0 Lane1 Lane2 Lane2 Lane2			- -	SJ4 - - - - - - - - - - - - -	SJ5 - - - - - - - - - - - - -																														
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 Sj Frequency Lane0 Lane1 Lane2 Lane1 Lane2 Lane3			- - - - <tr <="" td=""><td>SJ4 - - - - - - - - - - - - -</td><td>SJ5 - - - - - - - - - - - - -</td></tr> <tr><td>Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20G BEF Sj Frequency Lane0 Lane1 Lane2 Lane1 Lane2 Lane3 ase2 20g 625G</td><td></td><td></td><td>- - <t< td=""><td>SJ4</td><td>SJ5 - - - - - - - - - - - - -</td></t<></td></tr> <tr><td>Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 Sj Frequency Lane0 Lane1 Lane2 Lane1 Lane2 Lane3 Sj Frequency Sj Frequency Sj Frequency</td><td></td><td></td><td>SJ3 - - - <t< td=""><td>SJ4 </td><td>SJ3 - - - <t< td=""></t<></td></t<></td></tr> <tr><td>Lane0 Lane1 Lane2 Lane3 ase2 10p3125 sj Frequency Lane0 Lane1 Lane2 Lane3 sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20p625G sj Frequency Lane0</td><td></td><td></td><td>- -</td><td>SJ4</td><td>SJ5 - - - - - - - - - - - - -</td></tr> <tr><td>Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20p625G Sj Frequency Lane0 Lane3</td><td></td><td></td><td>SJ3 -</td><td>SJ4</td><td>SJ5 - - - - - - - - - - - - -</td></tr> <tr><td>Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20G BEF Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20p625G Sj Frequency Lane0 Lane1 Lane2 Lane3</td><td></td><td></td><td>SJ3 - - - <t< td=""><td>SJ4</td><td>SJ5 - - - - - - - - - - - - -</td></t<></td></tr>	SJ4 - - - - - - - - - - - - -	SJ5 - - - - - - - - - - - - -	Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20G BEF Sj Frequency Lane0 Lane1 Lane2 Lane1 Lane2 Lane3 ase2 20g 625G			- - <t< td=""><td>SJ4</td><td>SJ5 - - - - - - - - - - - - -</td></t<>	SJ4	SJ5 - - - - - - - - - - - - -	Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 Sj Frequency Lane0 Lane1 Lane2 Lane1 Lane2 Lane3 Sj Frequency Sj Frequency Sj Frequency			SJ3 - - - <t< td=""><td>SJ4 </td><td>SJ3 - - - <t< td=""></t<></td></t<>	SJ4 	SJ3 - - - <t< td=""></t<>	Lane0 Lane1 Lane2 Lane3 ase2 10p3125 sj Frequency Lane0 Lane1 Lane2 Lane3 sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20p625G sj Frequency Lane0			- -	SJ4	SJ5 - - - - - - - - - - - - -	Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20p625G Sj Frequency Lane0 Lane3			SJ3 -	SJ4	SJ5 - - - - - - - - - - - - -	Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20G BEF Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20p625G Sj Frequency Lane0 Lane1 Lane2 Lane3			SJ3 - - - <t< td=""><td>SJ4</td><td>SJ5 - - - - - - - - - - - - -</td></t<>	SJ4	SJ5 - - - - - - - - - - - - -
SJ4 - - - - - - - - - - - - -	SJ5 - - - - - - - - - - - - -																																		
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20G BEF Sj Frequency Lane0 Lane1 Lane2 Lane1 Lane2 Lane3 ase2 20g 625G			- - <t< td=""><td>SJ4</td><td>SJ5 - - - - - - - - - - - - -</td></t<>	SJ4	SJ5 - - - - - - - - - - - - -																														
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 Sj Frequency Lane0 Lane1 Lane2 Lane1 Lane2 Lane3 Sj Frequency Sj Frequency Sj Frequency			SJ3 - - - <t< td=""><td>SJ4 </td><td>SJ3 - - - <t< td=""></t<></td></t<>	SJ4 	SJ3 - - - <t< td=""></t<>																														
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 sj Frequency Lane0 Lane1 Lane2 Lane3 sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20p625G sj Frequency Lane0			- -	SJ4	SJ5 - - - - - - - - - - - - -																														
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20p625G Sj Frequency Lane0 Lane3			SJ3 -	SJ4	SJ5 - - - - - - - - - - - - -																														
Lane0 Lane1 Lane2 Lane3 ase2 10p3125 Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20G BEF Sj Frequency Lane0 Lane1 Lane2 Lane3 ase2 20p625G Sj Frequency Lane0 Lane1 Lane2 Lane3			SJ3 - - - <t< td=""><td>SJ4</td><td>SJ5 - - - - - - - - - - - - -</td></t<>	SJ4	SJ5 - - - - - - - - - - - - -																														

FIGURE 35. COMPLIANCE TEST RESULTS EXAMPLE

8.1.4 Calibration & Test Result Details

This portion is populated with results from each of the calibration and test runs. Here the results are explained in depth with supporting data points and screenshots. If the Plot Calibration Data checkbox is selected, then the plots are also displayed.







FIGURE 36. CALIBRATION/TEST RESULT DETAILS EXAMPLE

8.2 Delete Test Results

If some of the results are not desired, they can be individually deleted by selecting the **Delete** button.

esult					
lo	TestName	Result	Limits	Val 🔺	Generate report
1	SSC Offset Calibration	PASS	N/A	N/	Delete
2	Initial Eye Height Calibration	PASS	N/A	N/	
3	Initial Eye Height Calibration	PASS	N/A	N/	Delete All
4	Initial Eye Height Calibration	PASS	N/A	N/ =	
5	Initial Eye Height Calibration	PASS	N/A	N/	
6	Optimized Pre-set Look Up	PASS	N/A	N/	
7	Optimized Pre-set Look Up	PASS	N/A	N/	
В	Optimized Pre-set Look Up	PASS	N/A	N/	
9	Optimized Pre-set Look Up	PASS	N/A	N/	
10	ACCM Calibration	PASS	N/A	N	
11	ACCM Calibration	PASS	N/A	N/	
12	ACCM Calibration	PASS	N/A	N/	
13	ACCM Calibration	PASS	N/A	N/	
14	Random Jitter Calibration	PASS	N/A	N/	
15	Random Jitter Calibration	PASS	N/A	N/	
16	Random Jitter Calibration	PASS	N/A	N/	
17	Random Jitter Calibration	PASS	N/A	N/	
18	Sinusoidal Jitter Calibration	PASS	N/A	N/	
19	Sinusoidal Jitter Calibration	PASS	N/A	N/	
20	Sinusoidal Jitter Calibration	PASS	N/A	N/	
21	Sinusoidal Jitter Calibration	PASS	N/A	N/	
22	Sinusoidal Jitter Calibration	PASS	N/A	N/	
23	Sinusoidal Jitter Calibration	PASS	N/A	N/	
24	Sinusoidal Jitter Calibration	PASS	N/A	N/	

FIGURE 37. DELETE INDIVIDUAL CALIBRATION/TEST RESULTS EXAMPLE

To remove all results, select the **Delete All** button.

Result				Generate report
No	Fest Name	Result	Limits Y	Delete All

FIGURE 38. DELETE ALL RESULTS

9 Saving and Loading Test Sessions

The GRL-USB4-RXA software enables Calibration and Test Results to be created and maintained as a 'Live Session' in the application. This allows you to quit the application and return later to continue where you left off.

Save and Load Sessions are used to Save a Test Session that you may want to recall later. You can 'switch' between different sessions by Saving and Loading them when needed.

To save a session, with all of the parameter information, the test results, and any waveforms, use the "Options" command on the menu bar, then the "Save Session" command.

To load a session back into the software, including the saved parameter settings, use the "Options" command on the menu bar, then the "Load Session" command.

To create a New session and return the application back to a default configuration, use "Options" command on the menu bar, then the "New Session" command.



FIGURE 39. SAVING AND LOADING CALIBRATION AND TEST SESSIONS

The configuration and session results are saved in a file with the extension '.ses', which is a compressed zip-style file, containing a variety of information.

10 Appendix A: Manual Calibration & Test Methodologies

Note the MP1900A BERT is used in the following calibration and test methodologies.

10.1 Calibrate Receiver Stressed Eye for 10Gb/s or 10.3125Gb/s Test Case 1 at TP3'

- 1. Set up the physical equipment connections without the ISI channel, as per Figure 10.
- 2. Set up the MP1900A BERT as follows:
 - a) Go to Menu Bar \rightarrow File \rightarrow Initialize.
 - b) Go to Jitter tab and set Clock Source to "Unit1:Slot2:MU181000B". See Figure 40.
 - c) Go to PPG \rightarrow Misc2.
 - d) Set Clock Source to "Unit1:Slot4:MU181500B". See Figure 46.
 - e) Set Bit Rate to 10Gbit/s or 10.3125Gbit/s. See Figure 46.
 - f) Set Offset (ppm) to 300ppm for rounded rate (10G) and 400ppm for legacy rate (10.3125G). See Figure 46.
 - g) Set Output Clock Rate to "Fullrate". See Figure 46.
 - h) Set Test Pattern on PPG to "PRBS" and Length to "2^15-1" bits. See Figure 42.
 - i) Turn on PPG Data Output.
 - j) Go to PPG \rightarrow Emphasis tab and turn on "Manual Setting". See Figure 43.
 - k) Turn on "SSC", with settings of 32kHz (for 10G) or 36kHz (for 10.3125G) with 5600ppm (for 10G) and 5800ppm (for 10.3125G) triangle down spread. (SSC will remain on for all of the following steps.) See Figure 44.
 - l) Set DATA+ amplitude to 620mV. A differential amplitude just over the 700mV EH should show as an initial value. (See the lower left in Figure 45.)
 - m) Set initial CM frequency to 400MHz. See Figure 46.
 - n) Turn the CM output to "Off" until the CM Calibration Step.

[4] litter Modulation Sour	rra	
SJ1 Off SJ2 10 Hz 0.000 Ulp-p 0	Off SSC Off BUJ Off RJ Off 10 Hz 33 000 Hz 0.000 Ulp-p 0.000 Ulp-p 0.000 Ulp-p 0.000 Ulp-p	Ext Off
Clock Source Unit1:Slot2:MU18 12 500 00	Clock to PPG Half-rate (MUX) 25.000 000 Gbit/s Ref Clock	
AUX Input Clock	12 500 000 kHz Sub-rate Clock 1/8	
Clock Source	1 302 300 KHZ	
Clock Source Unit1:Slot	t2:MU181000B)
Center Frequency	12 500 000 kHz	
Offset	0 ppm	
Reference Clock	Internal 🔍	
Calibrated Module S/N		

FIGURE 40. JITTER CLOCK SOURCE SETTING

[7] 21G/32G SI PPG Data	al 🔻 G: OFF
© Output © Emph	asis 🖻 Pattern Error Addition Miscl Misc2
_Clock Setting	
Clock Source	Unit1:Slot4:MU181500B
Bit Rate	Variable To.312 500 Gbit/s
Output Clock Rate	Fullrate Offset 400 ppm
Reference Clock	Internal
_Noise Setting	
Noise Generator	Not use 🔽
Offset	0.000 dB

FIGURE 41. PPG MISC2 SETTINGS

Menu University Output	Applica
[7] 21G/32G SI PPG Data1 🔻 📴 OFF	
Output Emphasis Pattern Error Addition Misc1 Misc2	
Test Pattern C PRBS	
Length 🖸 2^15-1 🔽 bit	
Mark Ratio 🛛 1/2	

FIGURE 42. PATTERN SETTING

7] 21G/32G SI PPG	Data1 🔻 🖻: OFF
C Output C E	Emphasis De Pattern Error Addition Miscl Misc2
Manual Setting	$\begin{array}{c} On \\ \hline \\ $
Manual Setting	
File Operation	Recall Store Initialize
Standard/Preset 🖻	USER 🛛 Coefficient 🔷 - Preset0 🔍
Amplitude	0.620 Vpp
Coefficient 🖪	_Output Monitor
	Simulated Pulse[Vpp]
0.000 000	Cursor dB
C-2 0.000 000	Post1 0.000
C-1 0.000 000	Post2 0.000
C0 1.000 000	Post3 0.000
C1 0.000 000	Post4 0.000
C2 0.000 000	Post5 0.000 Va vb Vc Vd Ve Vf Vg Vh Vi Vj
C3 0 000 000	Post6 0.000
0.000 000	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$
0.000 000	Pre3 0.000 Vc 0.620 Vg 0.620
C5 0.000 000	Pre2 0.000 Vd 0.620 Vi 0.620
C6 0.000 000	Pre1 0.000 Ve 0.620 Vj 0.620

FIGURE 43. PPG EMPHASIS SETTING







FIGURE 45. DATA+ AMPLITUDE SETTING

[8] Noise Generat	tor	
Data Input 1 Data Input 1	Ext Off	Data Output 1 Data Output 1
External Input External Input	CM Off	
	10 mVpp 400 MHz	
	DM Off	
	WN Off 0.200 mVrms	
Data Input 2 Data Input 2		Data Output 2 Data Output 2
Common mode no	Dise	
Presets M	anual	1
An	nplitude Frequency Band	
		1



10.1.1 Set Up Oscilloscope

10.1.1.1 Oscilloscope Vertical and Horizontal Setup

Set up the Scope as listed in Table 6.

TABLE 6. OSCILLOSCOPE VERTICAL AND HORIZONTAL SETUP

Setting	Setup			
Vertical	Ch1-Ch3 (using the full range of the Scope's D/A)			
Record Length	40M in a single acquisition			
Sample Rate	80Gs/s			
Averaging	OFF			

Setting	Setup
Sample Mode	Real Time
Bandwidth	16GHz (which allows for 3 rd harmonic capture at 10.3125Gb/s)
Vertical Scale	Set to full screen without clipping
Sin x/x	OFF



FIGURE 47. OSCILLOSCOPE VERTICAL AND HORIZONTAL SETUP

10.1.1.2 Oscilloscope Clock Recovery Setup

Enter the Clock Recovery menu and set up the Scope as listed in Table 7.

TABLE 7. OSCILLOSCOPE CLOCK RECOVERY SETUP

Setting	Setup
Nominal Data Rate	10Gb/s (Rounded), 10.3125Gb/s (Thunderbolt 3 Legacy)
Clock Recovery Method	Second Order PLL
PLL Specification	OJTF Loop Bandwidth: 5.000MHz Damping factor: 0.94

Clock Recovery	æ 2 🗙				
Clock recovery applies to pr analysis, Rj/Dj, and TIE jitte	otocol decode, real time eye, serial data er measurements.				
Clock Recovery Applies To					
O All Waveforms	Clock Recovery Source				
O Individual Waveforms					
Preset	Damping				
Custom					
Clock Recovery Method					
Second Order PLL					
	Frequency				
Nominal Data Rate					
10.312500000 Gb/s V					
PLL Specification					
● JTF	OJTF				
Loop Bandwidth	Loop Bandwidth				
8.373 MHz	5.000 MHz				
Loop Bandwidth Divisor	Loop Bandwidth Divisor				
1.23164 k	2.06250 k				
Peaking	Damping Factor				
1.37 dB					
Transition Density Dependent					
	Advanced				

FIGURE 48. OSCILLOSCOPE CLOCK RECOVERY SETUP

10.1.1.3 Oscilloscope AC Common Mode (ACCM) Setup

Set up the Scope as listed in Table 8.

TABLE 8. OSCILLOSCOPE ACCM SETUP

Setting	Setup
Sample Rate	≥ 80Gs/s
Record Length	40Mpts per channel
Bandwidth	16GHz
Vertical Scale	20mV/div
CDR	OFF
Averaging	OFF
Sin x/x	OFF

10.1.1.4 Jitter Setup

Enter the Jitter menu and set up the Scope as listed in Table 9.

TABLE 9. OSCILLOSCOPE JITTER SETUP

Setting	Setup
Units	Unit Interval
Jitter Method	Spectral
Source for Jitter & Eye Diagram	Channel 1-3
BER Level	1E-12
Pattern	Periodic, Repeating Pattern (2 ¹⁵ -1 = 32,767 bits)



File Control Setup Display Trigger	Measure Math Analyze	Utilities Dem	os Help	_	- 44	KEYSIG	
Titter / Noise Setup		×	~~~~	$\sim\sim\sim$	$\sim \mathcal{J}$	T 0.0 V	- A
w: Setup Wizard 🅢 🌾 Thre	sholds Clock Recovery.		_	_	_		(
Jitter Noise Advanced							4.00
Enable							3.00 \
Measurement	Edges						
🗿 TIE (Phase)	🗶 Both 💟						1.00 V
🚊 🕒 Period	RJ Bandwidth						
N-Unit Interval	Narrow (Pink)						-2.00 \
Number of UI						Ve	ertical Scale
		0.0 s	100 ns	200 ns	300 ns	Click a graticul the scal	waveform in the e or right-click le to change the l displayed.
Display Units RJ Method					_	Chaine	and and a straight of the stra
Second Spectral On	l v	<u> </u>					
O Unit Interval O Spectral & T	ail Fit	PJ Histogra	im				
Common Pattern	Length	51					
Source	ndie 🖸 Arbitrany						
Channel 1-3							
BER Level							
1E-12 💽 63	Y A						
Results (Measure All Edges)							
Measurement Current	Mean Min	I I I	Source	Channel 1R - 3R	84	ms.narrow	Incomplete
Frequency(1+3) Incomplete	Incomplete Incomplete		RJ Method		DA	55	Incomplete
erne.			Data Rate	0.0 b/s	Tra	insitions ·	The second state
			TJ(1E-12)	Incomplete	PX	55	Incomplete

FIGURE 49. OSCILLOSCOPE JITTER SETUP

10.1.1.5 Eye Diagram Vertical Setup

Set up the Scope as listed in Table 10.

 TABLE 10. OSCILLOSCOPE EYE DIAGRAM VERTICAL SETUP

Setting	Setup
Vertical Scale	200 mV/div
Horizontal Scale	2 UI's
Eye Mask Height	700 mV (for final Eye Height Calibration)
Eye Mask Width	650 mUI

10.1.2 Record ISI Measurements

1. Step through Pre-set coefficients 0 to 14 and use a Preset which gives minimum DDJ Measurement. Although these are not calibrated values, record ISI measurement as part of the measurement table.

Preset	Pre-shoot [dB]	Pre-shoot [dB] De-emphasis		Informative Filter Coefficients			
Number		[ub]	C-1	Co	C1		
0	0	0	0	1	0		
1	0	-1.9	0	0.90	-0.10		
2	0	-3.6	0	0.83	-0.17		
3	0	-5.0	0	0.78	-0.22		
4	0	-8.4	0	0.69	-0.31		
5	0.9	0	-0.05	0.95	0		
6	1.1	-1.9	-0.05	0.86	-0.09		
7	1.4	-3.8	-0.05	0.79	-0.16		
8	1.7	-5.8	-0.05	0.73	-0.22		
9	2.1	-8.0	-0.05	0.68	-0.27		
10	1.7	0	-0.09	0.91	0		
11	2.2	-2.2	-0.09	0.82	-0.09		
12	2.5	-3.6	-0.09	0.77	-0.14		
13	3.4	-6.7	-0.09	0.69	-0.22		
14	3.6	0	-0.17	0.83	0		
15	1.7	-1.7	-0.05	0.55	-0.05		

FIGURE 50. ISI MEASUREMENT PRESET TABLE

2. In 4Tap Emphasis Ch1 Menu, create 15 Presets with coefficients which match the Table in the Thunderbolt Interconnect Specification. See Figure 51 below.

Menu Units Output Output Err. Single Err.	Applic
[7] 21G/32G SI PPG Data1 💌 🖻: OFF	
Output E Emphasis Pattern Error Addition Misc1 Misc2	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	off 241 → 101
Manual Setting	
File Operation Recall Store Initialize	
Standard/Preset 🖬 USER 🛛 🔻 - Coefficient 🔷 - Preset0	▼
Amplitude 0.620 Vpp	-
Output Monitor	
C-3 0 000 000	
Cursor dB	
0.000 000 Post1 0.000	
C-1 0.000 000 Post2 0.000	
C0 1.000 000 Post3 0.000	
C1 0.000 000 Post4 0.000	
C2 0 000 000 Post5 0.000 Va Vb Vc Vd Ve Vf Vg Vh Vi Vj	
Post6 0.000	
0.000 Va 0.620 Vf 0.620	
C4 0.000 000 Pre3 0.000 V6 0.620 Vg 0.620 Vg 0.620	
C5 0.000 000 Pre2 0.000 Vd 0.620 Vi 0.620	
C6 0.000 000 Prel 0.000 Ve 0.620 Vj 0.620	

FIGURE 51. 4TAP EMPHASIS CH1 INTERFACE

- 3. Step through all 15 Presets. The Preset with the minimum DDJpp measurement is the optimized preset.
- 4. For SigTest measurement, use the following template:
 - Test Point: tp3_prime
 - CTS Test Template: jitter
- 5. Retrieve DDJ measurement.

Electrical Compliance Test Specification for gen2_rounded					
Date:	21-Oct-20				
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3_Prime\					
File: TP3_Prime_Gen2_Rounded.bin					
Total Jitter (BER=1e-12) Measurement Ulp-p:	Tj	0.363443			
PJ Jitter Measurement mUI:	PJ-rms	58.981258			
RJ Jitter Measurement mUI:	RJ-rms	12.812331			
DDJ Measurement Ulp-p:	DDJ jitter Ulp-p	0.038398			
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	9.974974	Drift [PPM]	-2502.56



Fil	e (Control	Setup D	isplay	Trigger I	Measure Ma	ath Analyze	Utilities D	emos Help		- 4	KEYSIG		
Ru		Stop Sir	ngle	40.0 G	Sa/s 40	0.0 Mpts	~~~~	$\sim\sim\sim$	ļ~~~~	~~~[16.0 GHz	T 0.0 V		↓
Way	refo	rm Wind	ow 1											
-		160 m	W/ 0.0	v	ΔΠ									
İm		100 11	0.0	<u> </u>										070
A														654 mV
eas		A THE COLOR					动动的 的		输出的基础设施					004 mV
\$														436 MV
erti		194												218 mV
cal	T													0.0 V
Me														-218 mV
Se							Million Law	بالم الما المالية المالية	A decreased at	an ben an a the beach	ال فانجليا المري	alation and a	le an all at a le a	-436 mV
		A A A	All about	LA JUNEA	Lis build also	ministrations	and which there are	and the local land	She was a state of	di Addina hook h	a all and a college series	ALLA ADDINE.	and the first of	-654 mV
														-872 mV
		-500 ns	-400 ns		300 ns	-200 ns	-100 ns	0.0 s	100 ns	200 ns	300 ns	400 n	; 50	0 ns 1-3
														872 mV
>			Real-Time	- Eve			COLORIS COLORIS							654 mV
0		The local division of	3.33255	MUI								A second second		436 mV
S B			1 Wfms											218 mV
S	T)					1		+ + + + + +			× l		· · · · ·	0.0 V
Q)	Ĩ				11									-218 mV
ne														-210 111
ž.														-436 MV
ίΩ,		of the second second	Constant of Constant of Constant	and this and the second	Constant of the second	and a second	The second second		State based on the state of the	the number of the states of	A CONTRACTOR OF THE OWNER		and the second second	-654 mV
		05	76		57	29	10	÷	10	20		76	05	-8/2 mV
\sim	<u> </u>	-ap bs	-76 ps		-37 ps	-36 ps	-19 bs	0.0 s	19 bs	30 ps	57 ps	70 ps	93	ps 1-3
\gg	2.	00 UI	0.0 UI		J 🕕 4	<u> </u>								
Jitte	er/N	oise			_	_	_	FFFF	_	_	_	_	_	6
	Re	sults (M	leasure All	Edges)						_				0
olo	itte	Source	Cha	nnel 1 - 3		RJrms	10.1 mUI		DDJpp	75.1 mUI	E	dge Direction	Both	
rGra		RJ Metho	d Tail	Fit		DJδδ	69.0 mUI		DCD	10.0 mUI	N	leasurement	TIE (Phase)	
de		Data Rate	10.3	1259 Gb/	s	Transitions	5.151239 M		ISIpp	57.0 mUI	A	BOJrms	0.0 UI	
0		TITE 12	211 211	07 (2 -1) 211		PJrms	5.5 mUI		Clock Passwark	32./ mUI				
\odot		TJ(1E-12)	211	.3 mUI		Βυιδδ	19.0 mUI		Clock Recovery	Second Order				

FIGURE 52. OPTIMIZED PRESET (MINIMUM DDJPP) MEASUREMENT ON KEYSIGHT SCOPE



FIGURE 53. OPTIMIZED PRESET (MINIMUM DDJPP) MEASUREMENT ON TEKTRONIX SCOPE

- 6. Set up the scope so that Channel 1 and Channel 3 scale to 80% of screen.
- 7. Turn on function 1 of scope to do subtraction of Channel 1 and Channel 3.
- 8. Measure VPP on Function1.
- 9. For SigTest measurement, use the following template:
 - Test Point: tp3_prime
 - CTS Test Template: ac_common_mode
- 10. Retrieve AC CM measurement.



FIGURE 54. CALIBRATION TO PHASE MATCH ON KEYSIGHT SCOPE



FIGURE 55. CALIBRATION TO PHASE MATCH ON TEKTRONIX SCOPE

- 11. Calibrate ACCM to be 100mVpp at 400MHz Clock, using ACCM Scope Setup. Then return CM Amplitude to zero.
 - a) Turn On SSC and turn Off all jitter components on the MP1900A Generator. Change the test pattern to PRBS31 and transmit the PRBS31 pattern from the MP1900A.
 - b) Set the frequency to 400MHz on the MP1900A CM Generator.

Menu Juput Addition Single Err.	Applicati	ion Selector	Start Stop Auto Auto
[4] Jitter Modulation Source		[8] Noise Gene	erator
SJ1 Off SJ2 Off SSC On BUJ Off RJ Off Ext 100 000 000 Hz 10 Hz 33 000 Hz 0.000 Ulp-p 0.232 Ulp-p	Off	Data Input 1 Data Input 1 External Input	Ext Off Data Output 1 Data Output 1 Data Output 1
Clock Source Unit1:Slot2:MU181000B 8 000 000 kHz Clock to PPG 32G PPG 32.000 000 Gbit/s Ref Clock	⇒	External Input	CM On 10 mVpp 400 MHz
AUX Input Clock			DM Off 53 mVpp 2.100 GHz
SSC 1 000 000 KH2			WN Off
Type Down 💌		Data Input 2 Data Input 2	Data Output 2 Data Output 2
Deviation 5 400 ppm		Common mode	à noise
		Presets	Manual
C Fc Down			Amplitude Frequency Band 10 mVpp 400 MHz Low V
1.Fmod			
Divide Kondule System	BERT	AUTO MEAS	REC Creator 🗵 🗖 🗐 /nritsu 🗤 52

FIGURE 56. CALIBRATE ACCM

c) Measure Ch1 and Ch3 Signals on the scope to have an amplitude of a Mean Peak-to-Peak measurement of 100mVpp.

 $V_{AC-CM} = (V_{TX-P} + V_{TX-N})/2$

d) Turn Off the CM output.



FIGURE 57. CALIBRATE ACCM PEAK-TO-PEAK AMPLITUDE

12. Turn on all remaining Jitter terms (RJ-Filtered (User); HPF (10MHz); SJ@100MHz); and set all jitter amplitudes to zero.

[4] Jitter Modulation Sou	urce				
SJ1 On SJ2 100 000 000 Hz 0.000 Ulp-p	Off SSC 10 Hz 3 0.000 Ulp-p 5	On 2 000 Hz 600 ppm	BUJ Off 0.000 Ulp-p	RJ On 0.000 Ulp-p	Ext Off
Clock Source	External	§	Clock to PPG Full- 10.329 Ref Clock 2 58	rate (PPG) 130 Gbit/s 1/4 32 282 kHz	
AUX Input Clock			Sub-rate Cloo	2k 1/8 91 141 kHz	
Frequency	100 000 000 H	z			
Amplitude	0.000 U	Ір-р			
	0.000) p	s p-p			
100 40 1 1 0.5 0.1					
0.00001 0.0001 0.001 Mode	0.01 0.1 1 Jation Frequency (I	10 1 MHz)	00 250 1000		

FIGURE 58. JITTER AMPLITUDES

- 13. Return the Scope setup to the jitter setup.
- 14. Set the PRBS15 pattern on the MP1900A.
- 15. Calibrate RJ amplitude to 140mUI peak-to-peak or 10mUI RMS.
- 16. For SigTest measurement, use the following template:
 - Test Point: tp3_prime
 - CTS Test Template: jitter
- 17. Retrieve RJ measurement.

Electrical Compliance Test Specification for gen2_rounded					
Date:	21-Oct-20	1			
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3_Prime\					
File: TP3_Prime_Gen2_Rounded.bin					
Total Jitter (BER=1e-12) Measurement Ulp-p:	Tj	0.363443			
PJ Jitter Measurement mUI:	PJ-rms	58.981258			
RJ Jitter Measurement mUI:	RJ-rms	12.812331			
DDJ Measurement Ulp-p:	DDJ jitter Ulp-p	0.038398			
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	9.974974	Drift [PPM]	-2502.56

18. Return amplitude to zero.

19. Capture a screen shot.



FIGURE 59. CALIBRATE RJ AMPLITUDE #1





FIGURE 60. CALIBRATE RJ AMPLITUDE #2 ON KEYSIGHT SCOPE



FIGURE 61. CALIBRATE RJ AMPLITUDE #2 ON TEKTRONIX SCOPE

- 20. Calibrate SJ amplitude to 170mUI peak-to-peak at 100MHz, where "peak-to-peak" is 170mUI.
- 21. For SigTest measurement, use the following template:
 - Test Point: tp3_prime
 - CTS Test Template: jitter
- 22. Retrieve PJ measurement in RMS. Convert to peak-to-peak by multiplying PJ-rms with a factor of 2.82.

clectrical compliance rest specification for genz_rounded					
Date:	21-Oct-20				
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3_Prime\					
File: TP3_Prime_Gen2_Rounded.bin					
Total Jitter (BER=1e-12) Measurement Ulp-p:	Tj	0.363443			
PJ Jitter Measurement mUI:	PJ-rms	58.981258			
RJ Jitter Measurement mUI:	RJ-rms	12.812331			
DDJ Measurement UIp-p:	DDJ jitter Ulp-p	0.038398			
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	9.974974	Drift [PPM]	-2502.56

23. Capture screen shot.

GRL-USB4-RXA MOI & User Guide © *Granite River Labs 2021*

[4] Jitter Modulation Source	
SJ1 On SJ2 Off S 100 000 000 Hz 10 Hz 10 Hz 0.000 Ulp-p 0.000 Ulp-p	SSC On BUJ Off RJ On Ext Off 32 000 Hz 0.000 Ulp-p 0.140 Ulp-p
Clock Source External	Clock to PPG Full-rate (PPG) 10.329 129 Gbit/s Ref Clock
AUX Input Clock	1/4 2 582 282 kHz Sub-rate Clock 1/8 1 291 141 kHz
	L1-
Amplitude 0.170	Ulp-p
16.450) ps p-p
100 40 40 1 0.5 0.5 0.1 0.00001 0.0001 0.001 0.01 0.1 Modulation Frequenc	1 10 100 250 1000 y (MHz)

FIGURE 62. CALIBRATE SJ AMPLITUDE #1
ne Meas						niki proslavati	623 mV 467 mV 312 mV 156 mV -156 mV -312 mV -467 mV -623 mV
-500 ns -400 ns	-300 ns -200 ns	-100 ns	0.0	s 100 ns	200 ns 3	00 ns 400 n	is 500 ns
Results (Measure All Edges) Measurements				Jitter Results			- 1 () - 1
Measurement Cu	urrent Mean	Min	м	Source	Channel 1 - 3	DCD	2.3 mUI
V max(1-3) 550.2	0 mV 550.20 mV	550.20 mV	550.20	RJ Method	Spectral	ISIpp	51.2 mUI
				Data Rate	10.28673 Gb/s	DDPWS	11.4 mUI
				Pattern Length	32767 (215-1)	F/2 (Even/Odd)	100 µUI
				TJ(1E-12)	274.6 mUI	Clock Recovery	Second Order
				RJrms, narrow	4.5 mUI	Edge Direction	Both
				DJ&&	210.6 mUI	Measurement	TIE (Phase)
				Transitions	2.566583 M		
				Dirme	56.7 ml II		
				ριδδ	171.3 mUI		
				qqUU	53.2 mUI		

FIGURE 63. CALIBRATE SJ AMPLITUDE #2 ON KEYSIGHT SCOPE



FIGURE 64. CALIBRATE SJ AMPLITUDE #2 ON TEKTRONIX SCOPE

- 24. Return all remaining impairment sources (CM, RJ, SJ) to their calibrated values.
- 25. Calibrate the TJ measurement to 350mUI ± 12.5mUI, using the SJ Amplitude control (for SJ frequency of 100MHz) and RJ Amplitude control (for SJ frequencies of less than 100MHz) as an adjustment on the BERT.
- 26. Capture screen shot.

Tim	1-3	140	m1//		<u>v</u>											
le N			Infini	ium ha	s saved	your setu	p to file	e Case1Tj	Calibra	tion_	_Case1_Lane0	D_Rate_:	10G_SJ1.se	:t.		661 m\
lea				والمروحين المراقبين												406 m
N S				and the fa	and the fideral	Market		HEADDANNAN	MAN			CHERONAL PROPERTY AND		Links and substant	A REAL AND A REAL	490 111
/ert																330 m\
lca																165
M																105 m
eas	Ŷ															0.0 \
																-165 m\
Me																-330 m\
B,		h transf		a trades have				No.		and a			in the second second	Contraction of the local	Arghedelph (Replace)	
2		And and show				A CONTRACTOR OF A			a state of the	Ť						-496 m\
<u>n</u>										-						-661 m\
77.6	-50.0) µs	-40.	0 µs	-30.0 µ	s -2	0.0 µs	-10.0 µ	s	0.0	s 10.0	μs	20.0 µs	30.0 µs	40.0 µs 5	0.0 µs
3	8	10.0) µs/	0.0	S			>₽								
Rest	dts ()	Measure	All Edge	+c)												- 1
Mea	surem	ients		-1						• •	Jitter Results					-
	Me	easurem	nent		Current	Mea	n	Min	Ť	м	Source	Chann	el 1 - 3	DCD	2.2 mUI	
0	V max	(1-3)		517	.94 mV	517.94 n	٦V	517.94 mV	5	17.94	RJ Method	Spectr	al	ISIpp	44.6 mUI	
											Data Rate	9.9750	24 Gb/s	DDPWS	12.8 mUI	
											Dattern Length	22767	(715.1)	F/2 (Even/Oc	dd) 600 µUI	
										l	TJ(1E-12)	339.1	mUI	Clock Recov	ery Second Ord	er
										- 44	IOTTIS, Harrow	20.0 11	ius -	Edge Directi	on Both	
											DJSS	189.8	mUI	Measuremen	nt TIE (Phase)	
											Transitions	2.4887	98 M			
											PJrms	60.1 m	UI			
											PJSS	171.3	mUI			
											DDJpp	44.6 m	U			

FIGURE 65. TJ MEASUREMENT ON KEYSIGHT SCOPE



FIGURE 66. TJ MEASUREMENT ON TEKTRONIX SCOPE

- 27. Adjust the memory depth to capture 1,000,000 (1E6) bits.
- 28. Change the Pattern on the MP1900A BERT to PRBS31.
- 29. Calibrate Inner Eye Height to 700mV (top and bottom of the triangle eye mask are V:700mV, H:650mUI).
- 30. For SigTest measurement, use the following template:
 - Test Point: tp3_prime
 - CTS Test Template: ui_ssc_eye

31. Retrieve Eye Height measurement.

Electrical Compliance Test Specification for gen2_rounded					
Date:	21-Oct-20				
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3_Prime\					
File: TP3_Prime_Gen2_Rounded_prbs31.bin					
Eye Diagram Measurement:	EyeWidth [pS]	89.281492	EyeHeight[mV]	593.984184	
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	9.975472	Drift [PPM]	-2452.82



32. Capture screen shot.

[7] 21G/32G SI PPG Data1 🔽 🖙 OFF
Output Emphasis Pattern Error Addition Misc1 Misc2
$\begin{array}{c c c c c c c c c c c c c c c c c c c $
Manual Setting
File Operation Recall Store Initialize
Standard/Preset 🛛 USER 🛛 🔻 - Coefficient 🔷 - Preset0 🔷
Amplitude 0.620 Vpp
Output Monitor
Simulated Pulse [Vpp]
C-3 0.000 000 Cursor dB
C-2 0.000 000 Post1 0.000
C-1 0.000 000 Post2 0.000
C0 1.000 000 Post3 0.000
C1 0.000 000 Post4 0.000
Post5 0.000 Va Vb Vc Vd Ve Vf Vg Vh Vi Vj
Post6 0.000
C3 0.000 000 Va 0.620 Vf 0.620
C4 0.000 000 Pre3 0.000 Vb 0.620 Vg 0.620
C5 0.000 000 Pre2 0.000 Vd 0.620 Vi 0.620
C6 0.000 000 Prel 0.000 Ve 0.620 Vj 0.620

FIGURE 67. EYE AMPLITUDE



FIGURE 68. EYE MASK ON KEYSIGHT SCOPE

F	ile	Edit	Vertical	Horiz/Acc	q Trig	Display	Cursors	Measure	Mask	Math	MyScop	e Analyze	Utilities	Help		DP075902S	Tek	_	X	
				- 111													Pos	ition	a	
M			Sourc														50.	0%	-	Ξ
																++++++	Fac	tor	•	
	TANK .															alite at it for it all since weat	20	00	-	-
																1.1			П	-
	H																		1	-
M																				
																				-
														Libraria at 1						-
							1 1 1 1 1 1 1 1						- <u> </u>			The design of the	T T T			Ĩ
	ſ	M1 1	118.0mV	1:	2.25µs								A' C1	 -9.44m	۱V	12.25µs/div	100GS/s	1	0.0ps	٦
		1M1)	118.0mV	-	306.3ns	306.3ns										Stopped	Single Se	iq DI :12 2		I
																Man Septen	nber 27, 20	20 10	:29:28	
	5°																		_	-
											Source	15			Stand	Options		X		2
		Jitter	r, Noise	and Eye	Diagra	m Analy	sis Tool	s			MATH1	Bit Rat	te : 19.998Gb/s		Details	▼ Expar	R	ecalc		1
		Sele	ect	_								No Pat	Itern Detected	View	v			۲.		~
		Confi		Heigh	tti, Sour	ce Mil	683.6 8mik	/ 0.000	10V	683.68r	nW (183.68mV	0.000	0V 1	0.0	X-CC 0.0000V	Ċ			
		Count	gure															Run		
		Resu	ults															0		
		Dia																		
		PIO																		
		Repo	orts																	

FIGURE 69. EYE MASK ON TEKTRONIX SCOPE

- 33. Save the BERT setup to "10G_TC1_100MHz".
- 34. Return CM, RJ and PJ sources to zero amplitude.
- 35. Repeat step 8-21 for 1MHz, 2MHz, 10MHz and 50MHz PJ frequencies, saving the setups after each frequency as "10G_TC1_1MHz", "10G_TC1_2MHz", "10G_TC1_10MHz" and "10G_TC1_50MHz" respectively.

10.2 Test Receiver at 10Gb/s or 10.3125Gb/s for Test Case 1 at TP3'

After completing the calibration in Section 10.1, proceed to perform the test.

- 1. Set up the physical equipment connections, as per Figure 23.
- 2. Use TenLira scripts on the PC to ensure that the crosstalk generator is sending PRBS31 signals at 800mV to 10Gb/s or 10.3125Gb/s.
- 3. Connect the test fixture to Port A of the DUT.
- 4. Recall the BERT test setup for 10G_TC1_100MHz (as saved in Section 10.1.2).
- 5. Configure the DUT transmitter to output PRBS31 on all lanes with SSC turned ON.
- 6. Initiate negotiation with the preset chosen in calibration.

- 7. Change the preset in the BERT according to the newly acquired preset.
- 8. Configure the DUT for the next negotiation step with the new preset.
- 9. Change the preset in the BERT according to the newly requested preset.
- 10. Configure the DUT for the next negotiation step with the new preset.
- 11. If needed, change the preset in the BERT according to the newly requested preset.
- 12. Run the 10Gb/s or 10.3125Gb/s test script for Rx testing to determine the BER measured by the Receiver and record the error count for 10 seconds.

Note the error checking procedure is different between Host or Device types:

- a) For Windows Host testing, TenLira scripts are run on the Host Under Test, to determine the error count. Refer to the release notes of the scripts for details on how to run the scripts.
- b) For Non-Windows Host testing, proprietary methods are used for error count.
- c) For Device testing, TenLira scripts are run on a separate controller PC that is connected to the device under test if TenLira is not installed. For details on how to run the test scripts to determine the error count, refer to the release notes of the scripts.
- 13. Repeat steps #4 to #12 three more times and record the error count for 10 seconds for each cycle.
- 14. Again, repeat steps #4 to #12 and then record the error count for 400 seconds.
- 15. Record the BER in the test results for 10G_TC1_100MHz.
- 16. If the error count equals to 0 then PASS.
- 17. If the error count is more than 0 then run steps #4 to #12 and then record the error count for 700 seconds.
- 18. If the error count is more than 1 then FAIL.
- 19. Repeat all the steps above for each of the four TC1 frequencies.
- 20. Swap Data and Crosstalk signals, applying Data to Lane1 and Crosstalk to Lane0.
- 21. Repeat all the steps above for Lane1 of the same port if the DUT is a 2-lane Device.
- 22. Repeat all the steps above on Port B if the DUT is a multi-port Device.

23. Include the Eye Diagram for 10G_TC1_100MHz in the Compliance Test Report.

10.3 Calibrate and Save for 10Gb/s or 10.3125Gb/s Rx Test Case 2 at TP3

For this test case, the total ISI of a channel should be around -18.5dB @ 5GHz. The test fixture should have 1 to 1.5dB per mated pair.

- 1. Recall the BERT setup from 10G_TC1_100MHz.
- 2. Connect the physical setup with ISI Channel, as per Figure 11, as follows:
 - a) Output of MU195050A connected to 40GHz K Cable
 - b) -3.5dB Fixed Channel Board connected to 40GHz K Cable
 - c) SMP Type-C Receptacle Fixture connected to -12dB Characterized 2 meter Type-C Cable
 - d) SMP Type-C Receptacle Fixture connected to short 40GHz Cables into Ch1 and Ch3 of Scope

- 3. Search for the optimized DC Gain starting from DC Gain of 1 in Oscilloscope Equalization Setup, adjust the DC Gain to obtain the largest Eye Height with cable de-embedding. *Note: This step is not required if the SigTest method is used.*
 - a) Set up the Scope as follows for CTLE:
 - i) Number of Poles set to USB 3.1
 - ii) DC Gain set to 1.00
 - iii) AC Gain set to 1.41
 - iv) Pole #1 Frequency set to 1.50 GHz
 - v) Pole #2 Frequency set to 5.00 GHz
 - b) Use the DC Gain Setting in Table 11 which yields the largest Eye Height.

TABLE 11. DC GAIN SETTINGS

Index	DC Gain Setting	Index	DC Gain Setting
0	1.000	-5	0.562
-1	0.891	-6	0.501
-2	0.794	-7	0.446
-3	0.708	-8	0.398
-4	0.630	-9	0.354

Equaliz	zation
Set	up Wizard 🏑 🏷 📄 Show Eq settings table Real-Time Eye Analysis Diagram
Eq 1	Source Copy settings to Equalize in place
Eq 2	O Display as function
Eq 3	
<u> </u>	✓ Enable CTLE
Eq 4	Nominal Data Rate Preset
	# of Poles Linear Bandwidth
	2 Pole, AC Gain 🝸 Track Source Bandwidth
	Equation Graph 16.0000 GHz
	$\mathbf{H}(s) = \mathbf{A}_{ac} \cdot \boldsymbol{\omega}_{p2} \cdot \frac{\mathbf{s} + \frac{\mathbf{A}_{dc}}{\mathbf{A}_{ac}} \cdot \boldsymbol{\omega}_{p1}}{\left(\mathbf{s} + \boldsymbol{\omega}_{p1}\right) \cdot \left(\mathbf{s} + \boldsymbol{\omega}_{p2}\right)}$
	DC Gain Pole 1 Frequency
	708 m 1.500 GHz
	AC Gain Pole 2 Frequency
	1.410 V A 5.000 GHz V A

FIGURE 70. DC GAIN SETTING

- c) Set up the DFE:
 - i) Set Max Tap to 50mV.
 - ii) Run Auto DFE.

qualiz	zation		_	_	4	X
Set	up Wiza	rd / 🍥	📄 📃 Show E	q setting	js table Real-Time Eye Analysis Diagra	m
Eq 1 Eq 2	✓ ✓ On	Scaling	Gource Channel 1 - 3		ppy settings to	
Eq 3	CTLE	FFE DFE 🙏	<u>]</u>		Lane	
Eq 4	Taps # of 1	able DFE	Auto Set	Tap Seti	Eye Width 0.0 UI Max Tap Value 50 mV Min Tap Value 0.0 V V	
					Normalize DC Gain	
2.00 U	JI 0.	O UI				
:s (Me uremen 1easu <u>re</u>	asure All E ts ment	dges) Current	Mean	Mi	Configure the setup and press the Run Auto Set button	

FIGURE 71. DFE SETTING

- d) Change the BERT Data pattern to PRBS31.
- e) Adjust the memory depth to capture 1,000,000 (1E6) bits with 5 acquisitions (100,000 UIs per Acquisition).
- f) For each acquisition, measure the Eye Width and Eye Height. Calculate the average of the five measurements and compute the Eye area via *Eye Width * Eye Height*.
- g) Measure the Eye area by iterating through each CTLE gain. The CTLE gain with the biggest eye area is used for the following measurements.
- 4. By adjusting data amplitude, calibrate the Inner Eye Height to 120 ± 10mV diff p-p (top and bottom of the triangle eye mask) using the PRBS31 pattern.

[7] 21G/32G SI PPG Data1 💌 🖻: OFF
Output B Emphasis B Pattern Error Addition Misc1 Misc2
$ \begin{array}{c} \begin{tabular}{ c c c c c c c c c c c c c c c c c c c$
Manual Setting
File Operation Recall Store Initialize
Standard/Preset 🛛 USER 🛛 🔻 - Coefficient 🔷 - Preset0 🔍
Amplitude 0.620 V p
C-3 0.000 000 Cursor dB
C-2 0.000 000 Post1 0.000
C-1 0.000 000 Post2 0.000
C0 1.000 000 Post3 0.000
C1 0.000 000 Post4 0.000
C2 0.000 000 Post5 0.000 Va Vb Vc Vd Ve Vf Vg Vh Vi Vj
C3 0.000 000 Post6 0.000 Va 0.620 Vf 0.620
C4 0.000 000 Bro2 0.000 Vb 0.620 Vg 0.620
C5 0.000 000 Pre2 0.000 Vd (0.620 Vi (0.620)
C6 0.000 000 Pre1 0.000 Ve 0.620 Vj 0.620

FIGURE 72. EYE AMPLITUDE





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FIGURE 73. EYE AMPLITUDE MEASUREMENTS

- 5. For SigTest measurement, use the following template:
 - Test Point: tp3
 - CTS Test Template: tp3
- 6. Retrieve Eye Height measurement.



Date	25-Oct-20	5													
Diff.C. Dealster) Statistic USB4 CTT) Manufacers) TRN R.(ab oct at														
Direct/Desktop/sigrest_0584_c15/waveforms/iP5/rk/															
File: tp3.bin	633.627			-											
Eye Diagram Measurement:	EyeWidth [pS]	81.841387	EyeHeight[mV]	207.027864											
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	9.975465	Dritt [PPM]	-2453.53										
CTLE-Adc[dB]	CTLE-DC Gain[dB]	DFE[mV]	Eye Height[mV]	EYE Width[p5]	Eye Height[mV]	EYE Width[p5]	Eye Height[mV]	EVE Width[p5]	Eye Height[mV]	EYE Width[pS]	Eye Height[mV]	EYE Width[pS]	Avg. Height[mV]	Avg. Width[p5]	Area[mV*p5]
1		50	1.409	0.783	0.285	1.175	0.318	1.175	1.457	0.783	0.313	0.783	0.76	0.94	\$ 0.6
0.891	1	48.2	142.647	62 262	129.546	59.129	140.216	63.437	141.373	61.479	136.547	61.479	138.07	61.557	/ 8504.5
0.794		2 42	170.9	71.269	162.341	70.877	172.953	70.485	172.992	70.485	168.59	70.485	169.56	70.72	11990.6
0.708	1 2	3 36.7	197.61	78.317	191.643	77.925	199.418	79.883	198.652	80.275	194.414	79.1	196.35	79.1	1 15533.0
0.631		4 32	208.352	82.233	205.568	80.667	206.991	81.058	208.858	82.233	205.37	83.016	207.03	81.841	1 16943.6
0.562		5 27.8	196.69	80.275	195.141	82.233	197.331	83.016	199.43	82.625	194,586	81.45	196.64	81.92	16108.9
0.501		5 24	185.353	76.751	182.983	76.359	185.388	79.883	185.091	79.492	181.683	74.01	184.1	77.299	14233.4
0.447		7 20.7	170.463	70.877	168.146	72.443	172.005	72.443	171.527	71.269	168.334	72.052	170.09	71.817	/ 12215.3
0.398	1 8	8 17.8	154.847	66.57	153.365	67.744	156.741	67,744	156.386	67.744	154.618	67.744	155.19	67.505	10476.9
0.355		9 15.2	138.71	62.262	139.772	61.87	142.913	63.045	140.059	63.828	140.079	63.045	140.31	62.81	1 8813.0
Ontimal CTLE 4															

- 7. If the Eye width is not within the 580 ± 25mUI p-p specification, tune RJ (if the SJ frequency is below 100MHz) or tune SJ (if the SJ frequency is 100MHz) so that the eye width is within specification.
- 8. For SigTest measurement, use the following template:
 - Test Point: tp3
 - CTS Test Template: tp3
- 9. Retrieve Eye Width measurement.

Electrical Compliance Test Specification for gen2_rounded															
Date:	25-Oct-20														
DIR:C:\Desktop\SigTest_USB4_CT5\Waveforms\TP3\Rx\															
File: tp3.bin															
Eye Diagram Measurement:	EyeWidth [pS]	81.841387	eHeight[mV]	207.027864											
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	9.975465	Drift [PPM]	-2453.53										
CTLE-Adc[d8]	CTLE-DC Gain[dB]	DFE[mV]	Eye Height[mV]	EYE Width[p5]	Eye Height[mV]	EYE Width[pS]	Avg. Height[mV]	Avg. Width[p5]	Area[mV*p!						
1	C	50	1.409	0.783	0.285	1.175	0.318	1.175	1.457	0.783	0.313	0.783	0.76	0.94	0.
0.891	1	48.2	142.647	62.262	129.546	59.129	140.216	63.437	141.373	61.479	136.547	61.479	138.07	61.557	8504.
0.794	2	42	170.9	71.269	162.341	70.877	172.953	70.485	172.992	70.485	168.59	70.485	169.56	70.72	11990
0.708	3	36.7	197.61	78.317	191.643	77.925	199.418	79.883	198.652	80.275	194.414	79.1	196.35	79.1	15533
0.631	4	32	208.352	82.233	205.568	80.667	206.991	81.058	208.858	82.233	205.37	83.016	207.03	81.841	16943
0.562	5	27.8	196.69	80.275	195.141	82.233	197.331	83.016	199.43	82.625	194.586	81.45	196.64	81.92	16108
0.501	6	24	185.353	76.751	182.983	76.359	185.388	79.883	185.091	79.492	181.683	74.01	184.1	77.299	14233
0.447	7	20.7	170.463	70.877	168.146	72.443	172.005	72.443	171.527	71.269	168.334	72.052	170.09	71.817	12215
0.398	8	17.8	154.847	66.57	153.365	67.744	156.741	67.744	156.386	67.744	154.618	67.744	155.19	67.509	10476.
0.355	9	15.2	138.71	62.262	139.772	61.87	142.913	63.045	140.059	63.828	140.079	63.045	140.31	62.81	8813

10. Save the BERT Setup to "10G_TC2_100MHz".

11. Repeat steps #1 to #10 for 1MHz, 2MHz, 10MHz and 50MHz PJ frequencies, saving each setup as 10G_TC2_1MHz, 10G_TC2_2MHz, 10G_TC2_10MHz and 10G_TC2_50MHz respectively.

10.4 Test Receiver at 10Gb/s or 10.3125Gb/s for Test Case 2 at TP3

- 1. Set up the physical equipment connections, as per Figure 24.
- 2. Use TenLira scripts on the PC to ensure that the crosstalk generator is sending PRBS31 signals at 800mV to 10Gb/s or 10.3125Gb/s.
- 3. Connect the test fixture to Port A of the DUT through the 2M USB Type-C cable.
- 4. Recall the BERT test setup for 10G_TC2_100MHz (as saved in Section 10.3).
- 5. Configure the DUT transmitter to output PRBS31 on all lanes with SSC turned ON.
- 6. Initiate negotiation with the preset chosen in calibration.
- 7. Change the preset in the BERT according to the newly acquired preset.
- 8. Configure the DUT for the next negotiation step with the new preset.
- 9. Change the preset in the BERT according to the newly requested preset.
- 10. Configure the DUT for the next negotiation step with the new preset.
- 11. If needed, change the preset in the BERT according to the newly requested preset.
- 12. Run the 10Gb/s or 10.3125Gb/s test script for Rx testing to determine the BER measured by the Receiver and record the error count for 10 seconds.

Note the error checking procedure is different between Host or Device types:

- a) For Windows Host testing, TenLira scripts are run on the Host Under Test, to determine the error count. Refer to the release notes of the scripts for details on how to run the scripts.
- b) For Non-Windows Host testing, proprietary methods are used for error count.
- c) For Device testing, TenLira scripts are run on a separate controller PC that is connected to the device under test if TenLira is not installed. For details on how to run the test scripts to determine the error count, refer to the release notes of the scripts.
- 13. Repeat steps #4 to #12 three more times and record the error count for 10 seconds for each cycle.
- 14. Again, repeat steps #4 to #12 and then record the error count for 400 seconds.
- 15. Record the BER in the test results for 10G_TC2_100MHz.
- 16. If the error count equals to 0 then PASS.
- 17. If the error count is more than 0 then run steps #4 to #12 and then record the error count for 700 seconds.
- 18. If the error count is more than 1 then FAIL.
- 19. Repeat all the steps above for each of the four TC2 frequencies.
- 20. Swap Data and Crosstalk signals, applying Data to Lane1 and Crosstalk to Lane0.
- 21. Repeat all the steps above for Lane1 of the same port if the DUT is a 2-lane Device.
- 22. Repeat all the steps above on Port B if the DUT is a multi-port Device.
- 23. Include the Eye Diagram for 10G_TC2_100MHz in the Compliance Test Report.

10.5 Calibrate and Save for 20Gb/s or 20.625Gb/s Rx Test Case 1 at TP3'

The initial setups for the BERT and Scope are the same as defined for the 10Gb/s or 10.3215Gb/s section above, except for the settings highlighted in **bold** below.

- 1. Set up the physical equipment connections without ISI Channel, as per Figure 10.
- 2. Set up the BERT as follows:
 - a) Set the Data Rate to **20Gb/s** or **20.625Gb/s**.
 - b) Set the Pattern to PRBS15.
 - c) Turn on "SSC", with settings of 32kHz (for 20G) or 36kHz (for 20.625G) with 5600ppm (for 20G) and 5800ppm (for 20.625G) triangle down spread. (SSC will remain on for all of the following steps.)
 - d) Set DATA+/DATA- Launch Amplitude to 750mV. This should set the differential amplitude just above the 700mV Eye Height target value as an initial value.
 - e) Set the initial CM interference amplitude to 0mV.

10.5.1 Set Up Oscilloscope

10.5.1.1 Oscilloscope Vertical and Horizontal Setup

Set up the Scope as listed in Table 12.

Setting	Setup
Vertical	Ch1-Ch3 (using the full range of the Scope's D/A)
Horizontal	20Gb/s or 20.625Gb/s
Record Length	40M
Sample Rate	80Gs/s
Averaging	OFF
Sample Mode	Real Time
Bandwidth	21GHz (The Calibration Bandwidth is limited to the Bit Rate of the signal, which is 2 * 1 st harmonic. This is done intentionally to be on the order of a Thunderbolt Receiver's Bandwidth. This is essentially acting as an "Electrical Reference Receiver", used for calibration. It reduces the noise measured by the Scope which a real Receiver will never perceive.)
Vertical Scale	Set to full screen without clipping
Sin x/x	OFF

TABLE 12. OSCILLOSCOPE VERTICAL AND HORIZONTAL SETUP

10.5.1.2 Oscilloscope Clock Recovery Setup

Enter the Clock Recovery menu and set up the Scope as listed in Table 13.

TABLE 13. OSCILLOSCOPE CLOCK RECOVERY SETUP

Setting	Setup
Nominal Data Rate	20Gb/s or 20.625Gb/s
Clock Recovery Method	Second Order PLL
PLL Specification	OJTF Loop Bandwidth: 5.000 MHz Damping factor: 0.94

10.5.1.3 Oscilloscope AC Common Mode (ACCM) Setup

Set up the Scope as listed in Table 14.

TABLE 14. OSCILLOSCOPE ACCM SETUP

Setting	Setup
Sample Rate	≥ 80Gs/s
Record Length	27Mpts per channel
Bandwidth	21GHz
Vertical Scale	20mV/div

Setting	Setup
CDR	OFF
Averaging	OFF
Sin x/x	OFF

10.5.1.4 Jitter Setup

Enter the Jitter menu and set up the Scope as listed in Table 15.

 TABLE 15. OSCILLOSCOPE JITTER SETUP

Setting	Setup
Units	Unit Interval
Jitter Method	Spectral
Source for Jitter & Eye Diagram	Channel 1-3
BER Level	1E-12
Pattern	Periodic, Repeating Pattern (2^{15} -1 = 32,767 bits)

10.5.1.5 Eye Diagram Vertical Setup

Set up the Scope as listed in Table 16.

 TABLE 16. OSCILLOSCOPE EYE DIAGRAM VERTICAL SETUP

Setting	Setup
Vertical Scale	200 mV/div
Horizontal Scale	2 UI's
Eye Mask Height	700 mV (for final Eye Height Calibration)
Eye Mask Width	620 mUI

10.5.2 Record ISI Measurements

- 1. Step through the Preset Coefficients 0-15 and use the Preset which yields the minimum DDJ Measurement. Although this is not a Calibrated value, record this ISI Measurement as part of the measurements table.
- 2. Change the pattern on the BERT to PRBS31. Calibrate ACCM to be 100mVpp at 400MHz Clock, using the ACCM Scope Setup.
- 3. Return CM Amplitude to zero.
- 4. Turn on all remaining Jitter terms (RJ-Filtered [10MHz HPF] and SJ at 100MHz).
- 5. Set all jitter amplitudes to zero.
- 6. Return the Scope setup to the setup in Section 10.5.1.

- 7. Change the pattern on the BERT to PRBS15.
- 8. Calibrate RJ Amplitude to 140mUI peak-to-peak (10mUI RMS).
- 9. Return amplitude to zero.
- 10. Capture screen shot.
- 11. Calibrate SJ Amplitude to 170mUI peak-to-peak at 100MHz.
- 12. Capture screen shot.
- 13. Return all remaining impairment sources (CM, RJ, SJ) to their calibrated values.
- 14. Calibrate the TJ measurement to 380mUI ± 25mUI using SJ Amplitude control (for SJ Frequency of 100MHz) and RJ Amplitude control (for SJ Frequencies of less than 100 MHz) as an adjustment on the BERT.
- 15. Capture screen shot.
- 16. Change the pattern on the BERT to PRBS31.
- 17. Calibrate Inner Eye Height to 700mV (top and bottom of triangle eye mask, with V:700mV; H:620mUI).
- 18. Capture screen shot.
- 19. Save BERT Setup to "20G_TC1_100MHz".
- 20. Repeat steps #1 to #18 for 1MHz, 2MHz, 10MHz and 50MHz PJ frequencies, saving each BERT Setup as 20G_TC1_1MHz, 20G_TC1_2MHz, 20G_TC1_10MHz and 20G_TC1_50MHz.

10.6 Test Receiver at 20Gb/s or 20.625 Gb/s for Rx Test Case 1 at TP3'

- 1. Set up the physical equipment connections, as per Figure 23.
- 2. Use TenLira scripts on the PC to ensure that the crosstalk generator is sending PRBS31 (800mV) signals at 20Gb/s or 20.625Gb/s.
- 3. Connect the test fixture to Port A of the DUT.
- 4. Recall the BERT test setup for 20G_TC1_100MHz.
- 5. Configure the DUT transmitter to output PRBS31 on all lanes with SSC turned on.
- 6. Initiate negotiation with the preset chosen in calibration.
- 7. Change the preset in the BERT according to the newly acquired preset.
- 8. Configure the DUT for the next negotiation step with the new preset.
- 9. Change the preset in the BERT according to the newly requested preset.
- 10. Configure the DUT for the next negotiation step with the new preset.
- 11. If needed, change the preset in the BERT according to the newly requested preset.
- 12. Run the 20Gb/s or 20.625Gb/s test script for Rx testing to determine the BER measured by the Receiver and record the error count for 10 seconds.

Note the error checking procedure is different between Host or Device types:

- a) For Windows Host testing, TenLira scripts are run on the Host Under Test, to determine the error count. Refer to the release notes of the scripts for details on how to run the scripts.
- b) For Non-Windows Host testing, proprietary methods are used for error count.
- c) For Device testing, TenLira scripts are run on a separate controller PC that is connected to the device under test if TenLira is not installed. For details on how to run the test scripts to determine the error count, refer to the release notes of the scripts.
- 13. Repeat steps #4 to #12 three more times and record the error count for 10 seconds for each cycle.
- 14. Again, repeat steps #4 to #12 and then record the error count for 200 seconds.
- 15. Record the BER in the test results for 20G_TC1_100MHz.
- 16. If the error count equals to 0 then PASS.
- 17. If the error count is more than 0 then run steps #4 to #12 and then record the error count for 350 seconds.
- 18. If the error count is more than 1 then FAIL.
- 19. Repeat all the steps above for each of the four TC1 frequencies.
- 20. Swap Data and Crosstalk signals, applying Data to Lane1 and Crosstalk to Lane0.
- 21. Repeat all the steps above for Lane1 of the same port if the DUT is a 2-lane Device.
- 22. Repeat all the steps above on Port B if the DUT is a multi-port Device.
- 23. Include the Eye Diagram for 20G_TC1_100MHz in the Compliance Test Report.

10.7 Calibrate and Save for 20Gb/s or 20.625Gb/s Rx Test Case 2 at TP3

For this test case, the total ISI of a channel should be around -16.5dB@10GHz. The test fixture should have 1 to 1.5dB per mated pair.

- 1. Recall the BERT setup from 20G_TC1_100MHz.
- 2. Connect the physical setup with ISI Channel, as per Figure 12, as follows:
 - a) Output of MU195050A connected to 40GHz K Cable
 - b) -3.5dB Fixed Channel Board connected to 40GHz K Cable
 - c) SMP Type-C Receptacle Fixture connected to -12dB Characterized 0.8 meter Type-C Cable
 - d) SMP Type-C Receptacle Fixture connected to short 40GHz Cables into Ch1 and Ch3 of Scope
- 3. Search for Optimized DC Gain starting from DC Gain of 1 in Oscilloscope Equalization Setup, adjust the DC Gain to obtain the largest Eye Height with cable de-embedding. *Note: This step is not required if the SigTest method is used.*
 - a) Set up the Scope as follows for CTLE:
 - i) Number of Poles set to USB 3.1
 - ii) DC Gain set to 1.00
 - iii) AC Gain set to 1.41
 - iv) Pole #1 Frequency set to 5 GHz
 - v) Pole #2 Frequency set to 10 GHz
 - b) Use the DC Gain Setting in Table 17 which yields the largest Eye Height.

TABLE 17. DC GAIN SETTINGS

Index	DC Gain Setting	Index	DC Gain Setting
0	1.000	-5	0.562
-1	0.891	-6	0.501
-2	0.794	-7	0.446
-3	0.708	-8	0.398
-4	0.630	-9	0.354

Equali	zation 👘 ? 🔀
Set	up Wizard 🏑 🎸 📄 Show Eq settings table Real-Time Eye Analysis Diagram
Eq 1 Eq 2	Source Copy settings to Equalize in place Copy settings to Equalize in place Display as function
Eq 3	
Eq 4	<pre>✓ Enable CTLE Nominal Data Rate 20.00000000 Gb/s ✓▲ Custom </pre> <pre> # of Poles # of Poles Equation Graph</pre>
	DC Gain Pole 1 Frequency
	446 m 5.000 GHz
	AC Gain Pole 2 Frequency
	1.410 IO.000 GHZ

FIGURE 74. DC GAIN SETTING

- c) Set up the DFE:
 - i) Set Max Tap to 50mV.
 - ii) Run Auto DFE.

Equalization			_	🔹 ? 		
Setup Wiza	ard ⁄ 🌘	🗌 🔲 Show E	q settin	gs table Real-Time Eye Analysis Diagram		
Eq 1	Scaling	Source		opy settings to Equalize in place		
Eq 2	Scaling			Equalization Auto Tap Setup 😭 ? 🗙		
Eq. 2 CTLE	FFE DFE			Lane		
Eq 5	able DFF			Eq 2		
Eq 4 Taps				Eye Width		
# of ⁻	Taps			0.0 UI		
1 Auto Set Tap Set			May Tap Value			
				50 mV		
L S				Min Tap Value		
L				0.0 V V		
				Normalize DC Gain		
	1.00 ns -80	0 ps -600 ps	-4	400		
▼	.00 UI 0.0	UI	() » ·	Run Auto Set		
ltr. (Maarura All E				Auto Tap Status		
ts (Measure All Edges)			Configure the setup and press the			
Measurement	Current	Mean	Mi	Run Auto Set button		

FIGURE 75. DFE SETTING

- d) Adjust the memory depth to capture 1,000,000 (1E6) bits with 5 acquisitions (100,000 UI's per Acquisition).
- e) For each acquisition, measure the Eye Width and Eye Height. Calculate the average of the five measurements and compute the Eye area via *Eye Width * Eye Height*.
- f) Measure the Eye area by iterating through each CTLE gain. The CTLE gain with the biggest Eye area is used for the following measurements.
- 4. Calibrate the Inner Eye Height to 98 ± 10mV diff p-p (top and bottom of the triangle eye mask) using the PRBS31 pattern.

[7] 21G/32G SI PPG Data1 💌 🖙 OFF
Output Emphasis Pattern Error Addition Miscl Misc2
$\begin{array}{c c c c c c c c c c c c c c c c c c c $
Manual Setting
File Operation Recall Store Initialize
Standard/Preset 🛛 USER 🛛 🗨 - De-Emphasis 🛛 🗨 - Preset0 🖉
Amplitude 0.620 Vpp
Output Monitor
Cursor3 0,000 Simulated Pulse[Vpp]
Cursor2 0.000 Vpp Va 0.620
Cursor1 0.000 Vb 0.620
Post Vc 0.620
Cursor1 0.000 Vd 0.620
Cursor2 0.000 Ve 0.620 Va Vb Vc Vd Ve Vf Vg Vh Vi Vj
Cursor3 0.000 Vg 0.620
Cursor4 0.000 Vh 0.620
Cursor5 0.000 Vi 0.620
Cursor6 0.000 Vj 0.620

FIGURE 76. EYE AMPLITUDE





GRL-USB4-RXA MOI & User Guide © Granite River Labs 2021



FIGURE 77. EYE AMPLITUDE MEASUREMENTS

- 5. For SigTest measurement, use the following template:
 - Test Point: tp3
 - CTS Test Template: tp3
- 6. Retrieve Eye Height measurement.
- 7. If the Eye Width is not within the 540 ± 50mUI p-p specification, tune RJ (if the SJ frequency is below 100MHz) or tune SJ (if the SJ frequency is 100MHz) so that the Eye Width is within specification.
- 8. For SigTest measurement, use the following template:
 - Test Point: tp3
 - CTS Test Template: tp3
- 9. Retrieve Eye Width measurement.
- 10. Capture screen shot.
- 11. Save BERT Setup to "20G_TC2_100MHz".
- 12. Repeat steps #1 to #11 for 1MHz, 2MHz, 10MHz and 50MHz PJ frequencies, saving each setup as 20G_TC2_1MHz, 20G_TC2_2MHz, 20G_TC2_10MHz and 20G_TC2_50MHz respectively.

10.8 Test Receiver at 20Gb/s or 20.625Gb/s for Test Case 2 at TP3

- 1. Set up the physical equipment connections, as per Figure 25.
- 2. Use TenLira scripts on the PC to ensure that the crosstalk generator is sending PRBS31 signals at 800mV to 20Gb/s or 20.625Gb/s.
- 3. Connect the test fixture to Port A of the DUT through the 0.8M USB Type-C cable.
- 4. Recall the BERT test setup for 20G_TC2_100MHz (as saved in Section 10.7).
- 5. Configure the DUT transmitter to output PRBS31 on all lanes with SSC turned ON.
- 6. Initiate negotiation with the preset chosen in calibration.
- 7. Change the preset in the BERT according to the newly acquired preset.
- 8. Configure the DUT for the next negotiation step with the new preset.
- 9. Change the preset in the BERT according to the newly requested preset.
- 10. Configure the DUT for the next negotiation step with the new preset.
- 11. If needed, change the preset in the BERT according to the newly requested preset.
- 12. Run the 20Gb/s or 20.625Gb/s test script for Rx testing to determine the BER measured by the Receiver and record the error count for 10 seconds.

Note the error checking procedure is different between Host or Device types:

- a) For Windows Host testing, TenLira scripts are run on the Host Under Test, to determine the error count. Refer to the release notes of the scripts for details on how to run the scripts.
- b) For Non-Windows Host testing, proprietary methods are used for error count.
- c) For Device testing, TenLira scripts are run on a separate controller PC that is connected to the device under test if TenLira is not installed. For details on how to run the test scripts to determine the error count, refer to the release notes of the scripts.
- 13. Repeat steps #4 to #12 three more times and record the error count for 10 seconds for each cycle.
- 14. Again, repeat steps #4 to #12 and then record the error count for 200 seconds.
- 15. Record the BER in the test results for 20G_TC2_100MHz.
- 16. If the error count equals to 0 then PASS.
- 17. If the error count is more than 0 then run steps #4 to #12 and then record the error count for 350 seconds.
- 18. If the error count is more than 1 then FAIL.
- 19. Repeat all the steps above for each of the four TC2 frequencies.
- 20. Swap Data and Crosstalk signals, applying Data to Lane1 and Crosstalk to Lane0.
- 21. Repeat all the steps above for Lane1 of the same port if the DUT is a 2-lane Device.
- 22. Repeat all the steps above on Port B if the DUT is a multi-port Device.
- 23. Include the Eye Diagram for 20G_TC2_100MHz in the Compliance Test Report.

10.9 Test for Signal Frequency Variation Training (10Gb/s or 10.3125Gb/s)

- 1. Recall the BERT Test Setup for 10G_TC2_1MHz. Turn Off SSC.
- 2. Set SJ Frequency to 400 kHz.

- 3. Set SJ Amplitude to 22.4UI.
- 4. Configure the DUT transmitter to output PRBS15 on all lanes with SSC turned ON.
- 5. Initiate negotiation with the preset chosen in calibration.
- 6. Change the preset in the BERT according to the newly acquired preset.
- 7. Configure the DUT for the next negotiation step with the new preset.
- 8. Change the preset in the BERT according to the newly requested preset.
- 9. Configure the DUT for the next negotiation step with the new preset.
- 10. If needed, change the preset in the BERT according to the newly requested preset.
- 11. Run the 10Gb/s or 10.3125Gb/s test script for Rx testing to determine the BER measured by the Receiver and record the error count for 10 seconds.

Note the error checking procedure is different between Host or Device types:

- a) For Windows Host testing, TenLira scripts are run on the Host Under Test, to determine the error count. Refer to the release notes of the scripts for details on how to run the scripts.
- b) For Non-Windows Host testing, proprietary methods are used for error count.
- c) For Device testing, TenLira scripts are run on a separate controller PC that is connected to the device under test if TenLira is not installed. For details on how to run the test scripts to determine the error count, refer to the release notes of the scripts.

12. If the BER is \leq 1E-6, the test is considered passed, otherwise the test has failed.

13. Repeat all the above steps 20 times for each lane.

10.10 Test for Signal Frequency Variation Training (20Gb/s or 20.625Gb/s)

- 1. Recall the BERT Test Setup for 20G_TC2_1MHz. Turn Off SSC.
- 2. Set SJ Frequency to 400 kHz.
- 3. Set SJ Amplitude to 44.8UI.
- 4. Configure the DUT transmitter to output PRBS15 on all lanes with SSC turned ON.
- 5. Initiate negotiation with the preset chosen in calibration.
- 6. Change the preset in the BERT according to the newly acquired preset.
- 7. Configure the DUT for the next negotiation step with the new preset.
- 8. Change the preset in the BERT according to the newly requested preset.
- 9. Configure the DUT for the next negotiation step with the new preset.
- 10. If needed, change the preset in the BERT according to the newly requested preset.
- 11. Run the 20Gb/s or 20.625Gb/s test script for Rx testing to determine the BER measured by the Receiver and record the error count for 10 seconds.

Note the error checking procedure is different between Host or Device types:

- a) For Windows Host testing, TenLira scripts are run on the Host Under Test, to determine the error count. Refer to the release notes of the scripts for details on how to run the scripts.
- b) For Non-Windows Host testing, proprietary methods are used for error count.

c) For Device testing, TenLira scripts are run on a separate controller PC that is connected to the device under test if TenLira is not installed. For details on how to run the test scripts to determine the error count, refer to the release notes of the scripts.

12. If the BER is \leq 1E-6, the test is considered passed, otherwise the test has failed.

13. Repeat all the above steps 20 times for each lane.

11 Appendix B: Receiver Stressed Eye Calibration Using SigTest

The SigTest post processing analysis application can be run to ensure signal quality compliance for the USB4 receiver stressed eye calibration.

Note: When using SigTest, apply the same procedure for receiver stressed eye calibration (for all USB4 data rates) as described in Appendix A, but replace the Scope measurements with the SigTest results.

Below provides a summary of SigTest requirements. Please refer to the USB4 SigTest User Manual from USB-IF for the full set of instructions to perform SigTest measurements.

Note: It is required that you are a member of USB-IF and have attained the proper permissions from USB-IF in order to have access to the USB4 SigTest User Manual.

11.1 Install and Run SigTest

[Note: The following procedure was extracted from the "USB4 SigTest installation and running:" section in the USB4 SigTest User Manual.]

First, make sure that \geq 16GB RAM (or recommended 32GB RAM and higher) is available on the Controller PC or Scope where SigTest is to be run.

- 1. Install Matlab Runtime Compiler MCR R2019b (9.7).
- 2. Create a new folder, for example "SigTest_USB4_CTS" and place the "USB4_SigTest.exe" file into the folder. Run the "USB4_SigTest.exe".
- 3. Open PowerShell window from the folder by pressing SHIFT + Right mouse button and then click on "Open PowerShell window here".

11.2 Set Up Scope for Saving Waveforms

[Note: The following description was extracted from the "Scope definitions for saving waveforms:" section in the USB4 SigTest User Manual.]

- a) Scope requirements and settings:
 - Sampling Rate: ≥ 80GSa/s
 - Evaluated record length: 500µs per channel
 - No CDR, no average, no interpolation and no equalization applied
 - Bandwidth: 16GHz (for USB4 Gen2) or 21GHz (for USB4 Gen3)
 - Adjust vertical scale to fit signal into Scope screen
- b) The saved waveforms for all receiver tests should be differential (for example: CH1 CH3), except of the waveform for the AC Common Mode test that should be common (for example: (CH1 + CH3)/2).

- c) De-embedding and embedding of the waveform should be applied for the following receiver compliance test points:
 - TP3_Prime test point: No de-embedding and no embedding should be applied.
 - TP3 test point: De-embedding of the cable connecting from the last receptacle to the Scope should be applied.
- d) The waveforms should use the correct test pattern type and length for the respective test as specified in the CTS to avoid test interruption and termination.

12 Appendix C: Connecting Keysight Oscilloscope to PC

If using a Keysight oscilloscope, refer to the following procedure on how to connect the Scope to be used with a controller PC. The Keysight Scope can be connected to the controller PC through GPIB, USB or LAN.

- 1. Download the latest version of the Keysight IO Libraries Suite software from the Keysight website and install on the controller PC.
- 2. When installed successfully, the IO icon (^(C)) will appear in the taskbar notification area of the controller PC.
- 3. Select the IO icon to launch the Keysight Connection Expert.
- 4. Click Rescan.



FIGURE 78. KEYSIGHT CONNECTION EXPERT

5. Refresh the system. The Keysight Scope is shown on the left pane and the VISA address is shown on the right pane.

	Keysight Connection Expert				?	_ 7	×
Ins	truments PXI/AXIe Chassis Manual Confi	uration	Settings				
0	Rescan Filter Instruments:	Clear					
	Unknown Instrument		Details for KEYSIGHT TECHNOLOGIES DSAV334A				
••	TCPIP0::localhost::inst0::INSTR		Manufacturer: KEYSIGHT TECHNOLOGIES		View Instrument Information	Online	î
0	DSAV334A, KEYSIGHT TECHNOLOGIES USB0::0x2A8D::0x902C::MYS5170106::0::INSTR 	trument del	Model: DSAV334A Serial Number: MY55170106 imware Version: 05.50.0010				
0	PCSERNO, Agilent		Connection Strings				
	TCPIP0::WINDOWS-13983-2.100al::htslip0::INSTK		VISA Addresses US80::0x2A8D::0x902C::MY55170106::0::INSTR)	Send Commands To This Ins Start IO Monitor	trument	
			 VISA aliases <no aliases="" configured="" visa=""></no> SICL Addresses 		Add or Change Aliases		
							-
•	Messages: 5 Clear			Remote IO Server Off	32-Bit Keysight VISA is Primary	17.1.193	13.5
下午下午	 02:48:37 Removed connection TCPIP0::WINDOWS-6LSJQFE 02:48:37 Updated connection TCPIP0::localhost::inst0::INS 	:inst0::INST R	t from agilent,infiniium,js33635236				
下午下午	02:47:31 Rescan requested 02:36:10 Instruments are already discovered and configure	1					6
下午	02:36:10 User interface session started						

FIGURE 79. OSCILLOSCOPE'S VISA ADDRESS

6. When connecting the Keysight Scope to the PC through GPIB/USB, type in the VISA address into the 'Address' field on the Equipment Setup page of the GRL-Anritsu USB4 Rx Test Application. If the GRL-Anritsu USB4 Rx Test Application is installed on the Keysight Scope, type in the Scope IP address, for example "TCPIP0::127.0.0.1::inst0::INSTR". If the GRL software is installed on the controller PC to control the Scope via LAN, type in the Scope IP address, for example "TCPIP0::inst0::INSTR". Note to *omit* the Port number from the address.

If there is error in connection, type in the Scope IP address as "TCPIP0:: 192.168.0.100::5025::SOCKET".

13 Appendix D: Connecting Tektronix Oscilloscope to PC

If using a Tektronix DPOJET Series oscilloscope, refer to the following procedure on how to connect the Scope to be used with a controller PC. The Tektronix Scope can be connected to the controller PC through GPIB, USB, or LAN.

- 1. Download the latest version of the Tektronix TekVISA software from the Tektronix website and install on the controller PC.
- 2. When installed successfully, open the OpenChoice Instrument Manager application.



FIGURE 80. OPENCHOICE INSTRUMENT MANAGER IN START MENU

- 3. The left "Instruments" panel on the OpenChoice Instrument Manager will display all connected instruments. The functional buttons below the "Instruments" panel "Instrument List Update", "Search Criteria", "Instrument Identify" and "Properties" can be used to detect the Scope in case it does not initially appear under "Instruments".
 - a) "Instrument List Update": Select to refresh the instrument list and locate new instruments connected to the controller PC.
 - b) "Search Criteria": Select to configure the instrument search function.
 - c) "Instrument Identify": Select to use a supported programming language to send a query to identify the selected instrument.
 - d) "Properties": Select to display and view the selected instrument properties.



FIGURE 81. OPENCHOICE INSTRUMENT MANAGER MENU

- 4. If connecting the Tektronix Scope to the controller PC via USB, select the "Search Criteria" function to ensure that USB connection is enabled, and then select the "Instrument List Update" function. When the Scope appears on the "Instruments" panel, select it and then go to the "Instrument Identify" function. This will display the model and serial number of the Scope once detected. Select the "Properties" function to view the Scope address.
- 5. If connecting the Tektronix Scope to the controller PC via LAN, the Scope IP address must be pre-determined beforehand. Then select the "Search Criteria" function to ensure that LAN connection is enabled and type in the Scope IP address. When the Scope shows up in the list, select it followed by "Search". The Scope should then appear on the "Instruments" panel. Select it and access the "Instrument Identify" function to view the Scope model and serial number as well as the "Properties" function to view the Scope address.
- 6. On the Equipment Setup page of the GRL-Anritsu USB4 Rx Test Application, type in the Scope address into the 'Address' field. If the GRL-Anritsu USB4 Rx Test Application is installed on the Tektronix Scope, ensure the Scope is connected via GPIB and type in the GPIB network address, for example "GPIB8::1::INSTR". If the GRL software is installed on the controller PC to control the Scope, type in the Scope IP address, for example "TCPIP0:: 192.168.0.100::inst0::INSTR". Note to *omit* the Port number from the address.
14 Appendix E: SMA Cable Transfer Function Setup Procedure for Cable De-embedding

This section describes how to create and set up transfer function on the Scope for deembedding of SMA cables.

14.1 Set Up Transfer Function for the Keysight Scope

14.1.1 For SMA Cable De-embedding on Scope Channels 1 & 3

 On the Keysight Scope, select Setup → Channel 1 → Differential Channels 1 & 3 → 4 Port (Channels 1 & 3) on the InfiniiSim pane:



Figure 82. SMA Cable Transfer Function – Set Up Scope Channels $1 \ \& \ 3$

2. On the InfiniiSim Setup screen, select **Setup Wizard**:



FIGURE 83. SMA CABLE TRANSFER FUNCTION- SELECT SETUP WIZARD ON SCOPE

3. On the InfiniiSim Wizard screen, select Next:

nfiniiSim Wizard	2
General Satur	This wizard will help you quickly set up InfiniiSim on your Infiniium oscilloscope by walking you through the necessary steps.
Select Model	Any selections or changes you make in the wizard will be undone if you press Cancel at the
Measurement Block	bottom of a page. To begin setting up InfiniiSim, click the Next button
Simulation Block	To begin setting up minimum, citor the Next button.
Observation Nodes	
Save File	
	Cancel < Back Next > Einish

FIGURE 84. SMA CABLE TRANSFER FUNCTION – SET UP INFINIISIM ON SCOPE #1

4. On the InfiniiSim Wizard > General Setup screen, select **Next**:



FIGURE 85. SMA CABLE TRANSFER FUNCTION – SET UP INFINIISIM ON SCOPE #2

5. On the InfiniiSim Wizard > Select Model screen, select **Remove insertion loss of a fixture or cable** → **Next**:

Fi	le Control Setup D	Display Trigger Measure/Mark Math Analyze Utilities Demos H	elp
R	InfiniiSim Wizard		
Wa		Select the InfiniiSim model you want to use.	
F	General Setup	Remove insertion loss of a fixture or cable	
ne N	Select Model		
leas	Measurement Block Setup		
Verti	Simulation Block Setup		ļ
	Observation Nodes		
viea	Save File		

FIGURE 86. SMA CABLE TRANSFER FUNCTION – SET UP INFINIISIM ON SCOPE #3

- 6. On the InfiniiSim Wizard > Measurement Block Setup screen, set the following parameters for de-embedding of the SMA cable:
 - In the" Port Type" field, select **4 Port**.
 - In the "Block Type" field, select **S-parameter File**.
 - In the "S-parameter file" field, browse and select the SMA cable S4P file which has been measured using the ENA vector network analyzer.
 - In the "4 Port Numbering" field, select **1**↔**3**, **2**↔**4**. Select **Next** to proceed.

InfiniiSim Wizard	🗰 2
General Setup Select Model	Measurement Block Setup Block Name Channel 4 Port
Measurement Block Setup	Ports 1, 2, 3 & 4
Simulation Block Setup	S-parameter File
Observation Nodes	S-parameter file
Save File	C:\GRL\Agilent\Setup \USB4 Tx Test\s4p \#1.S4P 4 Port Numbering 1+3, 2+4
	Cancel < Back Next > Finish

FIGURE 87. SMA CABLE TRANSFER FUNCTION – SET UP INFINIISIM ON SCOPE #4

7. On the InfiniiSim Wizard > Save File" screen, specify the file name for the newly created transfer function file. Make sure the file is saved to the following default location– "C:\GRL\Agilent\Setup\ Anritsu USB4 Rx Test\TransferFunction\xxx.tf4" on the Scope and then select Next → OK → Finish.



InfiniiSim Wizard	* ?
	Congratulations! You have set up InfiniiSim. Click the Finish button to apply your settings.
General Setup	
Select Model	
Measurement Block Setup	
Simulation Block Setup	
Observation Nodes	
Save File	
	Successful computation of transfer function.
	Cancel < Back Next > Finish

FIGURE 88. SMA CABLE TRANSFER FUNCTION – SET UP INFINIISIM ON SCOPE COMPLETED

On the GRL-Anritsu USB4 Rx Test Application → Configurations page, select True for the "Enable DeEmbedding" field and specify the transfer function file to be used in the "Cable DeEmbedding File" field.

¢	1	🔶 🕲 🐇	
		oronniko i a bolaj.	False Set Default
		PG Delay Value:	0
		ACCM Channel:	Both ~
		Manual ACCM:	False ~
	ſ	Enable DeEmbedding:	True
		Cable DeEmbedding File:	Cable 1.tf4
		Custom Preset Table:	False ~
		Enable Test Characterization I	Mode: False ~
		EQ DC Gain 20G:	Default ~
		EQ DC Gain 10G:	Default ~

9. Repeat all the above steps to generate a new transfer function as required.

14.2 Create Filter Files for the Tektronix Scope

14.2.1 Convert Single-Ended S-Parameter Files to Mixed Mode

- 1. Turn on the "Serial Data Link Analysis" (SDLA) software on the Tektronix scope.
- 2. Select Analyze → Serial Data Link Analysis:



FIGURE 89. SELECT AND OPEN SERIAL DATA LINK ANALYSIS ON TEKTRONIX SCOPE

- 3. On the SDLA Visualizer screen, select the **Convert** tab button.
- 4. Click on the **Load** button to load the SMA cable S-parameters.
- 5. Select the correct port definition for the S-parameter file.
- 6. Click on the **Apply** button.

*	SDLA Visualize	r - De-embed					
Se	elect a single-e	ended S-parameter	file to convert to mixed mode				
	Cascade Normalize Convert Resample	Tx + Ref Ohms 50 50 50 50	Port 1 Load Port 3 S11 S12 S13 S14 S21 S22 S23 S24 S31 S32 S33 S34 S34 S42 S43 S44 SMA 406 #1.54P	Rx + Port 1	Sdd11 Sdd12 Sdc11 Sdc12 Sdd21 Sdd22 Sdc21 Sdc22 Scd11 Scd12 Scc11 Scc12 Scd21 Scd22 Scc21 Scc22 Scd21 Scd22 Scc21 Scc22	Port 2	Apply
	Limiter	Tx -	Port 2 V Plot Port 4 V	Rx			ок

FIGURE 90. CONVERT TO MIXED MODE S-PARAMETERS

7. Click on the **Save** button to save the mixed mode S-parameters after conversion.



FIGURE 91. SAVE CONVERTED MIXED MODE S-PARAMETERS

14.2.2 Create SMA Cable De-embedding Files for Scope Channels 1 & 3

1. On the Tektronix Scope, click on the **De-embed** button on the SDLA Visualizer screen.



FIGURE 92. CREATE SMA CABLE DE-EMBEDDING FILES – #1

2. Click on the **B1** button.



FIGURE 93. CREATE SMA CABLE DE-EMBEDDING FILES – #2

3. Click on the **Browse** button to load the mixed mode S-parameter file that has been created from Section 14.2.1. Then click **OK**.

🛃 SDLA Visualiz	zer - Block Configuration					
Select B1 mo	del and the applicable files if required					
	Madal		SMA 40G Diff #1.S4P		Labol	
Thru	4-Port Differential	Sdd11 Sdd12 Sdc11 Sdc12 Sdd21 Sdd22 Sdc21 Sdc22 Scd11 Scd12 Scc11 Scc12	Port1	Differential Browse Port2	B1	
File	 Typical Alternate 	Scd21 Scd22 Scc21 Scc22			Check	
T Line	Scaling Factor	S11 S12 S13 S14 S21 S22 S23 S24 S31 S32 S33 S34 S34 S42 S43 S44	Port1 💌	Single Port2 Ended	Passivity	Plot
			Port3 V	Port4 V		لكار

 $Figure \ 94. \ Create \ SMA \ Cable \ De-Embedding \ Files - \#3$

- 4. Make sure signals are actively flowing through **Channel 1** on the scope.
- 5. Select the **Tp1** radio button.

	SDLA Visualizer			
\square	Tektronix		💿 View 😐 GPIE	Help About
	Measurement Circuit Tp11 Tp12 Tx December	TP8 Tp7 Single Input Dual Input b1 De-embed src1 b2 De-embed src2 Ch1 T De-embed Rate: 100 GS/s Bit Rate: 20.625 Gb/s R4 Data		Apply Config Analyze
	NA Tp2 Simulation Circuit	o1 Image: Clock training trainig training trainig training training training training trai	Save	Plot Recall Default
L			<u>الــــــــــــــــــــــــــــــــــــ</u>	

FIGURE 95. CREATE SMA CABLE DE-EMBEDDING FILES – #4

6. Select the **Math2** radio button and then click **OK**.

📣 SDLA Visualizer - Test Poi	nt and Bandwid	th Configuration					200	
Tp1 - Map the desired te	st points to Mat	th to see the process	ed waveform					
Tp On/Off	Map Tp to	Math	L	abel Filters	Global BW Limit	Delay	١	
O Math1	None	•		NA Save	None	🔘 Keep Delay		
Math2	Tp1	•		Tp1 Save	Auto	Remove Delay		
C Math3	Tp2	-		Tp2 Save	Custom	Adjust Delay		
Math4	ТрЗ	•		Tp3 Save				
C Ref3	Tp5				BW: 19.9988GH	z		
© Ref4	Tp4	Scaling Fa	% ?	Export	filters for 32-bit scope ?		JL	ок

FIGURE 96. CREATE SMA CABLE DE-EMBEDDING FILES – #5

7. Click on the **Apply** button.

SDLA Visualizer	
Tektronix	View O GPIB Help About
Measurement Circuit Tp0 Tp7 Single Input Dual Input Tp1 Tp12 De-embed src1 Src1 Ch1 Single Input Tp10 Bit Rate:	Limit 19.998GHz te: 100 GS/s 20.625 Gb/s R4 Apply Config
IX De-embed Tp Tp3 Tp3 NA o1 MA d1 Tp2 o2 Embed d2 Simulation Circuit 0% gr 100%	R3 Clock Tp5 Clock Save Recall Default
Press Apply to update filter	

FIGURE 97. CREATE SMA CABLE DE-EMBEDDING FILES – #6

- 8. The filter file will be created at *"C:\Users\Public\Tektronix\TekApplications\SDLA\output filters\sdlatp1.flt"*. Copy this file to the *"C:\TekApplications\DPOJET\Setups\Anritsu USB4 Rx Test\TransferFunction"* directory on the Tektronix scope and rename the file for deembedding of channels 1 & 3.
- On the GRL-Anritsu USB4 Rx Test Application → Configurations page, select True for the "Enable DeEmbedding" field and specify the filter file to be used in the "Cable DeEmbedding File" field.

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		oronnito i a bolay.	False Set Default
		PG Delay Value:	0
		ACCM Channel:	Both ~
		Manual ACCM:	False ~
	ſ	Enable DeEmbedding:	True ~
		Cable DeEmbedding File:	Cable 1.fit
		Custom Preset Table:	False ~
		Enable Test Characterization I	Mode: V
	-	EQ DC Gain 20G:	Default ~
		EQ DC Gain 10G:	Default ~

15 Appendix F: Download and Install Intel TenLira Tools (Applicable for the Thunderbolt 3 DUT Only)

For USB4 Rx measurements, the Thunderbolt 3 Host/Device's CIO PHY must be in an active state during testing. Its transmitters shall be transmitting PRBS31 into the analyzer measurement channel during testing and its receivers shall have their terminations enabled during testing. Thus, a PHY microcontroller must be used to put the Thunderbolt 3 DUT into the right state for USB4 Rx testing.

For Thunderbolt 3 Host Testing:

- **Opt 1:** Intel TenLira tools can be loaded on the Thunderbolt 3 Host DUT. In this case, the Wilder-Tech µController is not needed. The GRL-USB4-RXA software is set up to use 'Remote Script' from the remote Host DUT in the software Configurations menu. **In this case, install the Intel TenLira Tools on the Host DUT**.
- **Opt 2:** Intel TenLira tools can be loaded on the Controller PC with the GRL-USB4-RXA software. In this case, the Wilder-Tech µController is required. The DUT is controlled using a ribbon cable from the Wilder-Tech µController to the Intel Test Fixture. **In this case, install the Intel TenLira Tools on the Controller PC with GRL-USB4-RXA**.

For Thunderbolt 3 2-Port Device Testing:

- **Opt 1:** Intel TenLira tools can be loaded on any Host. In this case, the Wilder-Tech µController is not needed. The GRL-USB4-RXA software is set up to use 'Remote Script' from the remote Host in the software Configurations menu, and the Thunderbolt 3 Device DUT is controlled through a Thunderbolt Cable on the second port of the DUT. **In this case, install the Intel TenLira Tools on the Host being used as the DUT Controller.**
- **Opt 2:** Intel TenLira tools can be loaded on the Controller PC with the GRL-USB4-RXA software. In this case, the Wilder-Tech µController is required. The Thunderbolt 3 DUT is controlled using a ribbon cable from the Wilder-Tech µController to the Intel Test Fixture. **In this case, install the Intel TenLira Tools on the Controller PC with GRL-USB4-RXA**.

For Thunderbolt 3 1-Port Device Testing:

• **Opt 1:** Intel TenLira tools must be loaded on the Controller PC with the GRL-USB4-RXA software. In this case, the Wilder-Tech µController is required. The Thunderbolt 3 DUT is controlled using a ribbon cable from the Wilder-Tech µController to the Intel Test Fixture. **In this case, install the Intel TenLira Tools on the Controller PC with GRL-USB4-RXA**.

After choosing the test configuration above, the Intel Thunderbolt Software Tools must be loaded on the **GRL-PC** or the **Remote Host** being used as the controller for testing. The Thunderbolt Tools are provided by Intel and can only be accessed if you are a Licensee of Thunderbolt Technology. The following procedure shows how to download and install the Intel Tools.

- 1. Access the Thunderbolt Developer's website.
- 2. Click on the 'My Intel' button.

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3. Log in to My Intel site.

Products Solutions Support	(intel	USA (English) 🌐 My Intel Sign Out 🔒 🝳
Welcome, Mike Engbre	tson	
Resources Business Applications & > Tools	My Intel My Intel is the dashboard for managing your profile, preferences, & the applications you us	e to do business with Intel.
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Profile Management	Thunderbolt3 Electrical Scripts Q Technical Library	
Personal Profile		

4. Search for 'Thunderbolt3 Electrical Scripts'.

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	What can we help you find?			
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Resource & Design Center Search Locations				
Document Library	Design Kits	Intel.com		
	Thunderbolt3_Electrical_Scripts_ver_0_8_8 https://cdrd.intel.com/vt/WfgetContent/972996 CNG LAN Access Division (LAD) - Datasheet describes all publicly disclosed specifications including electrical characteristics, mechanical, and component functionality, a list of major features, a functional description, and an architectural overview. View Details >			

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- 5. Download the Latest Electrical Scripts.
- 6. Open the PDF document and follow the directions in the PDF, which will include steps to Download and Install **TenLira Software** and Install **Active TCL Version 8.5**.

Name	Date Modified
Thunderbolt3_Electrical_Scripts_ver0_8_8	Mar 1, 2018, 3:18 PM
uController	Mar 1, 2018, 3:17 PM
▶ 📃 Jtag	Mar 1, 2018, 3:17 PM
▶ 📃 Host	Mar 1, 2018, 3:17 PM
Device	Mar 1, 2018, 3:17 PM
get_params_internal_use	Mar 1, 2018, 3:17 PM
Thunderbolt3 Electrical Coliance - Test Scripts 0.8.8.pdf	Mar 1, 2018, 3:16 PM
get_params_AR.tbc	Feb 28, 2018, 3:46 PM
get_params_TR.tbc	Feb 28, 2018, 3:46 PM
proc_lib_ar_cio.tbc	Feb 28, 2018, 3:46 PM
proc_lib_ar_dp.tbc	Feb 28, 2018, 3:46 PM
proc_lib_ar_usb3.tbc	Feb 28, 2018, 3:46 PM
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