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Tektronix Method of Implementation for PCIe Gen 4.0 Rx & Link Equalization Test Procedure

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Version	Date	Changes done
0.1Draft	Feb-2018	All
0.2	June-2018 All Preset run and Power Switch automation	
1.0	Feb-2019	Added Rx Test Procedure

MODIFICATION RECORD

References

The following documents are referenced in this document:

- PCI Express® Architecture PHY Test Specification Revision 4.0
- PCI Express® Card Electromechanical (CEM) Specification Revision 4.0
- PCI Express® Base Specification Revision 4.0 Version 1.0

Software

- BERT Firmware above 12.03.5275
- PCIe Rx-Test Software Application
- SigTest Post-Processing Analysis Tool Latest version available: (<u>https://www.intel.com/content/www/us/en/design/technology/high-speed-io/tools.html</u>)

REQUIRED EQUIPMENTS

Equipment	Details	Quantity	Vender
BSX BERT Scope	BSX240 or BSX320	1	Tektronix
Real Time	DPO72504DX,	1	Tektronix
Oscilloscope with	DPO73304DX,		
BW of 25GHz and	DPO70KDX, SX		
above			
Pick-Off Tee	PSPL15079000	2	Tektronix
Power Divider	PSPL5333 (or similar	4	Tektronix
	part)		
SMA Cable (9.4")	PN 0174619900	2 (cables)	Tektronix
DC Block	PSPL5500A or	2	Tektronix
	PSPL5501A or		
	PSPL5508		
Equalizer	BSXPCI4EQ	2	Tektronix
PCIe Gen4 CEM	CBB, CLB, & Variable	1 (set)	PCI-SIG
fixtures	ISI board		
SMP-SMP Cables	Typically included with	4 (cables)	PCI SIG
	CEM fixtures		
SMA-SMP (2.6")	Typically included with	4 (cables)	PCI SIG
	CEM fixtures		
SMA-SMA Cables	1m phase matched cables	10 (cables)	Huber-
	(PMCABLE1M)		Suhner
SMA-SMP 1m	1m phase matched cable	2 (cables)	Huber-
Cable (Clock)	pair (PN 174-6659-01)		Suhner
ATX Power Supply	Any ATX Power	1	Any
SMP terminator	50 ohm (Female)	**	Any

* * The number of SMP terminators needed is based on the number of lanes in the System or Add-in Card under test. i.e. – a x16 DUT will require 30 SMP terminators (2 * (Number of unused Lanes – 1))

1. INTRODUCTION

This document provides the procedures for PCIe CEM 4.0 (16 GT/s) Tx/Rx Link Equalization tests using the Tektronix BSX Series BERT Scope. The purpose of this document is to provide the approved test equipment, connections, setup, and procedure for performing these tests.

2. CONNECTION DIAGRAMS

Connection diagrams used for testing Add-In-Cards and System Cards are provided in this section.

2.1 Add-In-Card Tx Link Eq Setup



PCIE Gen4 Add-in Card Transmitter Link Equalizer Test Setup

Figure 1: Gen4 Add-In-Card Tx Setup



2.2 System Board Tx Link Eq Setup

Figure 2: Gen4 System Board Tx Setup

2.3 Add-In-Card Rx Link Eq Setup



Figure 3: Gen4 Add-In Card Rx Setup

2.4 System Board Rx Link Eq Setup



Figure 4: Gen4 System Board Rx Setup

3. EQUIPMENT CONNECTIONS

The BERT scope PCIe4.0 Receiver Testing Application, henceforth referred to as Rx-Test app, communicates with BERT scope, oscilloscope and SigTest server using a remote server/client model to perform signal generation, data acquisition and analysis. Before performing any test, the remote servers on the respective instruments/tools must be launched to establish connections as described in the following sections.

In Figure-5, the interconnection between the different instruments and tools are shown along with the various software applications and services they host.



Figure 5: PCIe Gen4 Test Solution Equipment and Software Communication

Note: PC is optional. The Rx-Test app can be installed either on a Tektronix BERT scope or a Tektronix Real-Time oscilloscope. SigTest service must be installed on the oscilloscope.

3.1 Connection to BERT Scope

The remote client is launched by clicking on Start—> All Programs —> BERTScope —> BERT Scope Remote Client. After launching the remote client, the TCP/IP mode of communication must be enabled as shown in Figure-6 below.

Remote Client Version: 12.0	14 Build: 5488.	
✓ Trace Messages		
Scroll Output		
Timestamp		
GUI Lockout		
Identity: BSX320		
Terminator: None 💌		
C IEEE488 @ TCP/IP		
TCP/IP Settings IP Addr: 134.64.245.48 Port: 23 default		
Connected Disconnect		
Save Log to File		

Figure-6: Launching remote client on the BERT scope

3.2 Connection to Oscilloscope

The TekVISA Socket Server application on the oscilloscope provides the necessary connectivity between the Rx-Test app and scope. It is launched by clicking on the Desktop Tray —> TekVISA LAN Server Control —> Start Socket Server as shown in Figure-7 below.

About TekVISA LAN Server Control			
Start VXI-11 Server			
Stop VXI-11 Server			
Start Socket Server			
Stop Socket Server			
Server Status			
Server Properties			
Exit			
▲ 💭 🌓 📭 🛱 4:49 PM 6/18/2018			

Figure-7: Launching server application in the oscilloscope

3.3 BERTScope PCIE 4.0 Receiver testing Application Connection Set-up

The Rx-Test app interfaces with the scope for data acquisition and with SigTest for analyzing data and obtaining results from the analysis. SigTest application runs inside the scope and the Rx-Test app communicates with it through a SigTest server application. The latter is made available in the folder location C: $\$ Program Files $\$

Tektronix $\ BERTScope \ RxTest30 \ Tools \ SigTestService \ 2.7$ at the time of installation. The SigTest server application is launched by double clicking on the executable file by the name SigTestService.exe located inside the folder. Upon launching the application, the following window appears as shown in Figure-8.

If Rx-Test app is not installed in the oscilloscope (but installed in any other device), then the SigTestService.exe will not be present in the oscilloscope for analysis and results. To enable this, the user must copy the folder 2.7 from the location where application is installed (As in the path mentioned above) and copy it in the oscilloscope at a desired location.



Figure-8: Launching SigTest service

As a first step after launching the Rx-Test app, connection between the various instruments and tools are required to be established. By clicking on the 'Start Connect' button in the Rx-Test app, the 'Connect to Devices' panel is opened where the IP addresses of the instruments/tools is required to be provided. Connection is established by pressing the 'Connect' button. Note that, before attempting to establish the various connections, the remote server applications in all the instruments/tools must be launched (The procedure has been described in sections 3.1, 3.2 and beginning of 3.3). Once the instrument/tool is connected, the button turns to 'Disconnect' and the instrument-ID is displayed at the bottom highlighted in green color as shown in Figure-9 below.

X	Connect to Devic	es			
	IP Addresses				
Preferences					
Start Connect	BERTScope	134.64.245.48		Disconnect	
?) Help	Scope	134.64.244.126		Disconnect	
Calibrations	Sigtest Server	134.64.244.126		Disconnect	
TP2					
Tests	Status				
Preset Test	Connecting to	Sigtest Server 134.64.244.126:4006			
BER Test	- SigTestServi	ce version 2.7	2402	22402040	
Margin Test	Using SigTest	3.2.0.3	.3,4.0.2	.5.2,4.0.36,4.0.	
Link EQ Test					
Results	- Download Pattern F Files	Files to BERTScope			
BER Test Result	Amplitude C	al	^	Download	
	RJ Calibration	1	E		
LEO Test Result	SJ Calibration	ר הו		Check All	
LEQ Test Result			-	Clear All	
LEQ Test Result Margin Test Result	V Loopback G	21			

Figure-9: Instrument connection panel in Rx-Test app

4. CALIBRATIONS

Before carrying out DUT testing, the RX-Test app requires necessary information from two different types of calibration, referred to as TP1 and TP2 calibrations. Both the calibration procedures are automated in the Rx-Test app. Calibration wizards in the app indicates the different steps during execution of the procedures. The Rx-test app also provides a repository to store the completed calibration results which can be used for DUT testing or recalled later.

The Rx-Test app window shown in Figure-9 shows a listing of the various activities that one can perform using the app. Under the heading 'Calibrations', both TP1 and TP2 calibrations are listed. Note that, the TP2 calibration wizard mandates the inclusion of a TP1 calibration result. Hence it is necessary to have a TP1 calibration done already or have it stored in the Rx-test app repository from a previous TP1 calibration event, before TP2 calibration activity is taken up.

4.1 TP1 Calibration

During this process, the Rx-Test app calibrates the following items:

- 1. Amplitude The differential voltage swing is required to be within 720 800 mV. This is required to be done only after the transition and non-transition bit levels are made equal using a small amount of de-emphasis.
- 2. Tx Equalization Presets The various levels of de-emphasis and pre-shoot are required to be calibrated within the tolerance as specified.
- 3. SJ The SJ is calibrated over the desired range of 5-10 ps (p-p) including the nominal SJ specification of 0.1 UI (or 3.125 ps) at 100 MHz frequency.
- 4. RJ It is calibrated to be 1 ps (RMS value).

TP1 calibration procedure is initiated from the Rx-Test app window (Shown in Figure-9) by clicking on the 'TP1' button which leads to the window shown in Figure-10.

	TP1 Calibrations			
	Name	Creator	Date/Time	Comment
eferences	TP1-Cal-B300133	Operator	12/11/2018 10:58:03 PM	D-Box
aut Connect	TP1-Cal-B300164	Operator	2/3/2019 3:26:02 AM	
art connect	TP1_CAL_PICE3_BUILD_3_0_0_154	Operator	1/29/2019 2:06:31 AM	
4p	[Example_TP1_Calibration]	Operator	7/30/2018 8:40:19 AM	
Calibrations				
21				
-				
2				
Tests				
eset Test				
eset Test R Test				
eset Test R Test irgin Test				
eset Test R Test irgin Test ik EQ Test				
eset Test R Test Irgin Test Ik EQ Test Results				
eset Test R Test Irgin Test k EQ Test Results R Test Result				
eset Test R Test Irgin Test k EQ Test Results R Test Result				
eset Test R Test wrgin Test k EQ Test Results R Test Result Q Test Result				
eset Test R Test wgin Test k EQ Test Results R Test Result Q Test Result wgin Test Result				
eset Test R Test wrgin Test k EQ Test Results R Test Result Q Test Result wrgin Test Result	Edt Dakin Same	Minud		

Figure-10: TP1 calibration window

The 'TP1 Calibrations' view, lists the different TP1 calibration results from previous events as shown in Figure-10. If the required calibration file can be identified from the list, then one may proceed to TP2 calibration or else the automated step-by-step TP1 calibration procedure can be started by clicking on the 'Wizard' button.

The window shown in Figure-10 also provides controls for managing the previously stored TP1 calibration results as mentioned below:

Control	Description
Edit	Edit the selected calibration file
Delete	Delete the selected calibration file
Report	Create an HTML report for the selected file
Wizard	Open a pop-up wizard dialog to step through
	making a new TP1/ TP2 Calibration based on
	Calibrations selection.

When the 'Wizard' button is pressed, the following window appears as shown in Figure-11 with important information for the user related to TP1 calibration. One can proceed with the steps by clicking on the 'Next' button that is present in each window.



Figure-11: TP1 information window

The next window is where the Rx-Test app shows the 'TP1 Calibration Diagram' as in Figure-12. The connection diagram is same for Add-In-Card and System Board in case of TP1 calibration.

🔛 TP1 Calibration	- 🗆 X
TP1 Calibration Cabling Diagram	
	< Back Next > Cancel

Figure-12: TP1 calibration connection diagram

Note: Upon completion of the TP1 calibration process or in the event of cancellation of the process, the BERT data generator is turned off automatically by the Rx-Test app.

Before proceeding further with calibration, the instruments need to be initialized and made ready for signal generation, acquisition etc. In the next window, initialization of the BERT scope and oscilloscope is carried as a preparation for the calibration procedure. By default, all the check boxes are enabled as shown below in Figure-13 and should be "Run".

Description	Status
[BERTScope] Initialize	
[BERTScope] Setup Generator	
[BERTScope] Disable SSC	
[BERTScope] Disable Stress	
[BERTScope] Load Ampl Test Pattern	
[DPP] Disable Deemphasis	
[RT Scope] Reset	
[RT Scope] Setup Math	
[RT Scope] Setup Ch2/Ch4 Vertical	
[RT Scope] Setup Horizontal	
[RT Scope] Setup Trigger	
[RT Scope] Setup Acquisition	
[RT Scope] Setup Cursors	
[RT Scope] Setup Measurements	
	Clear Al Check Al Run

Figure-13: Initialization of BERT and oscilloscope for TP1 calibration

In the next window as shown in Figure-14, default nominal stress targets as per the Base specification is displayed which are used to obtain the calibration plots. These are editable fields in the Rx-Test app to provide flexibility to the user for selecting nominal stress levels that are different from the default values.

💀 TP1 Calibration			-		×
Nominal Stre	ss Targets				
Amplitude	₿00.0 🗭 mV				
RJ	1.00 🗭 ps (RMS)				
SJ	6.25 🌩 ps				
		< Back	Next >	Cano	el

Figure-14: Nominal stress targets for TP1 calibration

The user can either choose to manually perform all the calibration steps in which case the user must manually click on 'Next' upon completion of each calibration step. If the user enables the check box 'Start all calibration automatically upon pressing "Next" below', then automatic calibration of amplitude, Tx Equalization Presets, RJ and SJ parameters is initiated without the user having to click on 'Next' in each panel.

Shown below in Figure-15 through 19 are the representative calibration plots of Tx Equalization Presets (De-emphasis and Pre-shoot), Amplitude, RJ and SJ jitter respectively.



Figure-15: De-emphasis calibration







Figure-17: Amplitude calibration



Figure-18: RJ calibration



Figure-19: SJ calibration

At the end of TP1 calibration, the results can be saved in a repository provided in the Rx-Test app as shown below in Figure-20. After entering the 'Unique ID', 'Creator Name' and 'Comments' the results can be saved for further use by clicking on 'Save' button. It is to be noted that TP1 calibration results are required during TP2 calibration and while performing DUT testing.

• TP1 Calibration	
Save Results	
Unique ID	
1	
Creator Name	
Operator	
Comments	
Save	
3476	
	< Back Next > Cancel

Figure-20: Saving TP1 calibration results

4.2 TP2 Calibration

During this process, the Rx-Test app calibrates the following items:

- 1. DMSI The differential mode sinusoidal interference is required to be calibrated within 10-25 mV (p-p) by capturing the 2.1 GHz sinusoidal output for a duration of at least 125 us.
- 2. CMI The common mode sinusoidal interference is required to be calibrated for a nominal voltage of 150 mV (p-p) by capturing the 120 MHz sinusoidal output for a duration of at least 125 us.
- 3. Optimum equalizer selection Tx Equalization Presets P5 and P6 are used to find the optimal Eye Area with the optimal CTLE
- 4. Stressed-Eye calibration Based upon the procedure mentioned in the specification, various signal parameters and stress levels are computed to generate a signal that meet the stressed eye targets

TP2 calibration procedure is initiated from the Rx-Test app window shown in Figure-9 by clicking on the 'TP2' button which leads to the TP2 calibration wizard shown in Figure-21. It contains important information for the user related to TP2 calibration.

The TP2 calibration procedure for an Add-In-Card and a System Board is different from each other in terms of connection and physical loss. Therefore, the user must make a choice between calibration of either one of the DUT types by clicking on the drop-down button under the heading 'DUT Type'. From this point, the user can proceed with the steps by clicking on the 'Next' button that is present in each window.

🚪 TP2 Calibration	-	
P2 Calibration		
This wizard enables you to perform automated TP2 Calibration and store the results in the	database.	
This procedure sets RJ and DMSI levels to achieve a target eye opening.		
Make sure to DESKEW the oscilloscope before running this wizard.		
Select the DUT type to be calibrated and press the Next button to continue.		
DUT Type		
AddInCard 🗸		

Figure-21: TP2 information window

TP2 calibration for stressed-eye requires information from TP1 calibration that is performed for the set-up under consideration or from one of the saved TP1 results. The relevant TP1 calibration file can be chosen in the window shown in Figure-22 titled 'TP1 Calibration' with a drop-down button listing all the TP1 calibration files stored in the Rx-Test app repository.

TP2 Calibration		-		
elect Calibrations				
Select the AMPL calibration you want to use during this calibration.				
TD1 Calibration				
[Example_TP1_Calibration]				
	< Back	Next	> Ca	ance









Figure-23(b): TP2 calibration connection diagram for system DUT

Note: Upon completion of the TP2 calibration process or in the event of cancellation of the process, the BERT data generator is turned off automatically by the Rx-Test app.

Upon clicking on the 'Next' button, the Rx-Test app shows the 'TP2 Calibration Diagram' as in Figure-23(a) for Add-In-Card and Figure-23(b) for System DUT. The connection diagram is shown based upon the choice made earlier regarding the DUT type in Figure-21.

Before proceeding further with calibration, the instruments need to be initialized and made ready for signal generation, acquisition etc. In the next window, initialization of the BERT scope and oscilloscope is carried as a preparation for the calibration procedure. By default, all the check boxes are enabled as shown below in Figure-13 and should be "Run".

In the next window as shown in Figure-24, default nominal stress targets as per the Base specification are displayed which will be used to obtain the calibration plots.

These are editable fields in the Rx-Test app to provide flexibility to the user for selecting nominal stress levels that are different from the default values.

🖶 TP2 Calibration					-		>
Nominal Stre	ss Targets						
Amplitude	800.0 🜩	mV					
DMSI	14.00 🜲	mV					
CMI	150 🌲	mV					
RJ	1.00 🜩	ps (RMS)					
SJ	6.25 🜲	ps					
Eye Height	15.00 🜲	mV					
Eye Width	18.75 🜲	ps					
			< Back	Nex	t >	Canc	el

Figure-24: Nominal stress targets for TP2 calibration

As in the case of TP1, the user can either choose to manually perform all the calibration steps in which case the user must manually click on 'Next' upon completion of each calibration step. If the user enables the check box 'Start all calibration automatically upon pressing "Next" below', then automatic calibration of DMSI, CMI, optimum CTLE selection and stressed-eye is initiated without the user having to click on 'Next' in each panel.

Shown below in Figure-25 and 26 are the representative calibration plots of DMSI, and CMI



Figure-25: DMSI calibration



Figure-26: CMI calibration

The Rx-Test app provides the facility to automatically compute and present the total physical channel loss in the TP2 set-up to the user. Selection of optimum physical channel loss (obtained by means of changing the ISI pair), optimum CTLE and Preset is a pre-requisite to obtain the stressed eye as per the specification. In arriving at the optimum combination of the parameters, the Rx-Test app guides the user through the various steps in this process by means of pop-up messages in taking suitable actions.

Figure-27 shows the 'Channel Loss Computation & ISI Pair Iteration' wizard where the user is provided with a choice between skipping the channel loss computation procedure (in case the user is aware of the optimum channel, CTLE and Preset) or proceeding with it as shown in Figure-27 using the buttons 'Skip' and 'Start' respectively.

🖷 TP2 Calibration
Channel Loss Computation & ISI Pair Iteration
1. This module returns the total physical channel loss in the present set-up
2. The user can decide whether to proceed further with the loss or to suitably change the ISI pair number on the board
3. The user can skip the procedure if the physical channel loss is already known
4. In the event of an error/undesired observation during the loss computation, for example:
a. Waveform data is not available for analysis
(i) Check presence of trigger
(ii) Check availability of waveform in the path
b. Communication error between the loss computation module and SigTest service due to time-out
(i) The current SigTest service needs to be terminated and re-launched
c. Very high/unexpected loss
(i) Check for loose connections
(ii) Faulty cables
(iii)Component failures
Skip Start
< Back Next > Cancel

Figure-27: Total physical channel loss computation and ISI pair iteration wizard

🖳 TP2 Calibration	
Channel Loss Co	omputation & ISI Pair Iteration
1. This module returns th	ne total physical channel loss in the present set-up
2. The user can decide v	whether to proceed further with the loss or to suitably change the ISI pair number on the board
3. The user can skip the	procedure if the physical channel loss is already known
4. In the event of an er	or/undesired observation during the loss computation, for example:
a. Waveform (i) ⊂ (ii) ⊂ b. Communic (i) T c. Very high/ (i) ⊂ (ii) F	Physical Channel Loss Calculation and ISI Pair Iteration Image: Calculation and ISI Pair Iteration Specified range of physical channel loss: -26.5dB to -30.5dB. Physical channel loss in the present set-up: -26.15 dB Do you want to proceed? Press: Ytes' for eye measurements or 'No' to re-compute the loss Note: Physically change the ISI pair before pressing 'No'
	Skip Cancel



After performing ISI pair iterations and automated loss calculations as indicated in Figure-28, when the desired ISI pair is selected (which yields a loss within the specified range of physical channel losses), the CTLE selection procedure is initiated.

Shown in Figure-29 is the optimum CTLE and Preset selection page. During the selection procedure, SigTest is used to analyze a pre-defined number of waveforms (as defined in the 'Preference' panel of Figure-9) before average measurements are presented as shown.

Description	Preset	CTLE	EW (ps)	EH (mV)	EA
1	P5	9.25	23.5	16.6	389
2	P5	9.25	23.2	16.6	386
3	P5	9.25	22.2	9.7	216
AVERAGE(1	P5	9.25	23.0	14.3	328
4	P5	9.50	23.4	16.7	391
5	P5	9.50	22.4	16.3	364
6	P5	9.50	21.9	15.9	347
AVERAGE(4	P5	9.50	22.6	16.3	367
7	P5	9.75	23.1	18.5	427
8	P5	9.75	22.0	19.1	420
9	P5	9.75	21.1	15.2	321
AVERAGE(7	P5	9.75	22.1	17.6	388
10	P5	10.00	21.3	16.7	357
11	P5	10.00	20.9	14.5	303
12	P5	10.00	19.1	17.5	336
AVERAGE(1	P.5	10.00	20.5	16.2	332
/iew	Preset	CTLE	DFE		

Figure-29: Optimum CTLE and Preset selection

During the ISI pair iteration process, when the specified eye criterion is not met, the Rx-test app allows re-iterating through the ISI pairs and carrying out the measurements once again. Shown in Figure-30 is the pop-up message that indicates the choices to either proceed with iteration or to refine the stresses to meet the stressed eye targets with the channel under consideration.

If the choice is made to refine the stresses or such a requirement arises during ISI pair iteration (like reaching 30 dB pair without meeting the stressed eye targets), then Rx-Test app automatically initiates the stressed eye calibration algorithm that adjusts the SJ, DMSI and Amplitude to meet the eye targets as shown in Figure-31.

Description	Preset	CTLE	EW (ps)	EH (mV)	EA	
1	P5	8.75	17.9	3.4	60	
2	P9					
3 BAD	P: Eye-Cri	terion Compari:	son		83	
AVERAGE(1-3)	P!					
4	PS Specif	ied range of ey 3 5 to 16 5	e parameters	:		
5	PS EW - :	18.25 to 19.25				
6	PS Manu	und some of a				
AVERAGE(4-6)	P: EH - 1	urea range or ey .0.7	/e parameter	5:		
7	PS EW - 2	20.91				
8	PS Physic	al channel loss	in the prese	nt set-up	: -26.27 dB	
9	PS _					
AVERAGE(7-9)	P: Ves':	u want to chan Physically chan	ge ISI pairr ge the ISI pai	r before	proceeding	
10	P5 'No': I	Proceed to refin	e stresses			
11	P\$					
12	P\$		Ve	_	No	
/iew	С		Yes		140	
Table •	7.20	30	o 🗢 my		Ca	ance

Figure-30: Eye-criterion comparison

There is provision to stop the refinement iteration in between and manually feed the parameter values to the stressed eye calibration algorithm and arrive at the adequate stresses that is required for meeting the specified targets in case the algorithm fails to converge or it is stopped in between.

ye Target:	, Width =	- 18.75 (18	.25 - 19.25	5)ps, Height	= 15 (13.	5 - 16.5)mV			
able									
Descriptio	SJ (ps)	SJ Setting (% UI)	DMSI (mV)	DMSI Setting (mV)	Ampl (mV)	Ampl Setting (mV)	EW (ps)	EH (mV)	*
13	7.75	16.3	14.0	50	800.0	452	22.2	19.1	1
14	7.75	16.3	14.0	50	800.0	452	22.0	16.2	
15	7.75	16.3	14.0	50	800.0	452	20.8	17.2	
AVERA	7.75	16.3	14.0	50	800.0	452	21.6	17.5	
17	8.25	17.2	14.0	50	800.0	452	22.9	7.6	
18	8.25	17.2	14.0	50	800.0	452	21.6	16.8	Ε
19	8.25	17.2	14.0	50	800.0	452	22.1	14.4	
AVERA	8.25	17.2	14.0	50	800.0	452	22.2	12.9	-
SJ		DMSI		Amplitude					
8.25	∲ ps	14.00	mV	800.0	mV				
							Refine	Cano	:el

Figure-31: Stressed eye calibration wizard

When the selection is made to start all the calibration steps automatically, then the Rx-Test app does not allow any iteration of ISI pair under the assumption that the

appropriate ISI pair is already known. In that case, either the stressed eye algorithm converges and the next step to save the TP2 result is initiated or the Rx-Test app prompts for a manual adjustment of the stresses to meet the stressed eye targets.

At the end of TP2 calibration, the results are saved in a repository provided in the Rx-Test app as shown below in Figure-32. After entering the 'Unique ID', 'Creator Name' and 'Comments' the results can be saved for further use by clicking on 'Save' button.

Save Results Urique ID TP2-AddinCard Creator Name Operator Comments Success Save	TP2 Calibration	
Unique ID TP2-AddinCard Creator Name Operator Comments Success Save	Save Results	
TP2-AddinCard Creator Name Operator Comments Success Save	Unique ID	
Creator Name Operator Comments Success Save	TP2-AddinCard	
Operator Comments Success Save	Creator Name	
Comments Success Save	Operator	
Success Save	Comments	
Save	Success	

Figure-32: Saving TP2 calibration results

5. LINK-EQ TESTS

5.1 Add-In Card Transmitter Initial TX EQ Test for 16.0 GT/s

Purpose: This test verifies that the Add-In Card will start with the correct TX EQ preset requested through the protocol.

Test Setup: As per Test Setup shown in Figure-1

Test Procedure:

- 1. Ensure power to the CBB is off.
- 2. Set-up connection should be as shown in the Figure-1
- 3. Tx lanes other than the lane under test should be unterminated
- 4. BERT scope PCIE4.0 Receiver Testing application (Rx-Test app) should be launched and 'LEQ Test' selected from the list of tests supported by the Rx-Test app
- 5. Upon clicking on the 'Link EQ Test' button, the Link EQ Test wizard is displayed as shown in Figure-33
- 6. Two drop-down menus in the wizard displays the options for choosing the different TP2 calibration results for AIC cards from the Rx-Test app database and the various LEQ tests

Link EQ Test	
Link EQ Test	
This wizard enables you to setup and execute a LEQ tests	
TP2 calibration	
[Example_TP2_AIC_Calibration]	
Measurement	
Add-In Card Transmitter Initial TX EQ Test	
Add-In Card Transmitter Link Equalization Response Test System Board Transmitter Link Equalization Response Test	
Add-In Card Receiver Link Equalization Test System Receiver Link Equalization Test	
	< Pack Next > Cancel
	Caliber

Figure-33: Link EQ test wizard

- 7. Upon choosing the '2.4.2 Add-In Card Transmitter Initial TX EQ Test' followed by clicking on 'Next', the connection diagram is displayed for reference
- 8. Upon clicking on the 'Next' button, BERT scope initialization screen is displayed where the necessary settings on the BERT is carried out
- 9. The user should allow the default choices in this window and select 'Run' to proceed with the initialization
- 10.When 'Next' button is clicked after the initialization process, 'Configure Loopback' wizard is displayed which shows 'BERT Initial Preset' parameter which provides the user with an option to select an initial Tx-preset for the BERT that the DUT prefers for its receivers
- 11. Upon clicking 'Next', the 'Configure Link EQ Test' wizard is displayed as shown in Figure-34, in which all the stresses are greyed out and disabled for the TX EQ tests

Sync Timeo	Jr B€	Sec Sync using Grab-n-C	D		
Error Limit	1				
Test Lengt	h				
Ourat	ion 62.	50 🚔 Sec			
Confic	lence 26.4.	²⁴ ∲ % at 1E-12			
Confi Stress Valu Calibr	es ated Manual (10) 1,00 as (RMS)	24 (☆) % at 1E-12			All stres are grey out
Confid Stress Valu © Calibr RJ SJ	es ated Manual (* 1.00 × ps (RMS) 8.00 × ps	24 x % at 1E-12 0 Raw DMSI 10.00 mV Amplitude 800.0 mV	•		All stres are grey out
© Confu Stress Valu © Calibr RJ SJ	es	24 (m) % at 1E-12		_	All stres are grey out

Figure-34: Configure Link EQ Test

12.After clicking on 'Next', the 'Initiate Loopback' window is displayed as shown in Figure-35 where upon clicking on 'Start' button, a preliminary test to carried out to ensure that the DUT gets into loopback before the tests (The DUT needs to be powered-on for the loopback test and then powered-off)

EQ Test	
itiate Loopback	
Loopback Request Log E	Block Log Gen3 EQ Status Gen4 EQ Status LTSSM
Step	Status
Set Preshoot/Deemphasis	Setting PE to 3.50dB, and DE to -6.00dB OK
Clear Stresses	Clear Stresses OK
Configure Loopback	Configure Loopback OK
Load Sequence	Loaded sequence OK
Init Loopback	Loopback OK
Validate Loopback	Reports OK
Check Detector Clock	Detector clock is OK
Autoalign Detector	Detector Autoalign OK
Check Detector Sync	Detector sync is OK
Success	DUT is in Loopback mode
	Start
Save Logs	Power Switch Automation
📝 Retrieve log 🛛 🛛 S	ave Isers\BSA286\Desktop\PowerUSB\bin\Debug\Tek_PowerUSB.exe Browse
	🔲 Use Setup File
	< Back Next > Cancel

Figure-35: Loopback initiation

13.On clicking the 'Next' button, a table is displayed as shown in Figure-36 where the user may choose either to run the test for all Tx equalization presets or for some of them by selectively enabling the desired Presets

P0 P1		()	result
P1			
l na			
PZ			
P3			
P4			
P5			
P6			
P7			
P8			
P9			
	DUT_ID	Clear All Ch	neck All Ru

Figure-36: Result table for AIC transmitter initial Tx EQ test

- 14.Upon clicking the 'Run' button as shown in Figure-36, Rx-Test app starts the automated test procedure
- 15. The DUT must be powered-on at this stage to enable loopback
- 16.The Rx-Test app interacts with the scope and SigTest to capture the waveforms, analyze them and subsequently populates the result table as shown in Figure-37



Figure-37: Test report

17. After the test execution is complete, the test results can be saved by clicking on 'Next' and providing the necessary details for reference as shown in Figure-38.

ink EQ Test	Deven Counter	Date: Tang	Comment
Save Results			
Unique ID			
Creator Name			
Device Description			
Comments			
	Save		
	June		
			< Back Next > Cancel

Figure-38: Saving the results

5.2 Add-in Card Transmitter Link Equalization Response Test for 16.0 GT/s

Purpose: This test verifies that the Add-In-Card will respond correctly to transmitter equalization commands sent through the link protocol.

Test Setup: As per Test Setup shown in Figure-1

Test Procedure:

- 1. Ensure power to the CBB is off.
- 2. Set-up connection should be as shown in the Figure-1
- 3. Tx lanes other than the lane under test may be terminated with 50 ohms or left unterminated as per DUT provider
- 4. The variable ISI board is not used for this test
- 5. BERT scope PCIE4.0 Receiver Testing application (Rx-Test app) should be launched and 'LEQ Test' selected from the list of tests supported by the Rx-Test app

- 6. Upon clicking on the 'Link EQ Test' button, the Link EQ Test wizard is displayed as shown in Figure-33
- 7. Two drop-down menus in the wizard displays the options for choosing the different TP2 calibration results for AIC cards from the Rx-Test app database and the various LEQ tests
- 8. Upon choosing the '2.5.2 Add-In Card Transmitter Link Equalization Response Test' followed by clicking on 'Next', the connection diagram is displayed for reference
- 9. Upon clicking on the 'Next' button, BERT scope initialization screen is displayed where the necessary settings on the BERT is carried out
- 10. The user should allow the default choices in this window and select 'Run' to proceed with the initialization
- 11.When 'Next' button is clicked after the initialization process, 'Configure Loopback' wizard is displayed which shows 'BERT Initial Preset' parameter which provides the user with an option to select an initial Tx-preset for the BERT that the DUT prefers for its receivers
- 12.Upon clicking 'Next', the 'Configure Link EQ Test' wizard is displayed as shown in Figure-34, in which all the stresses are greyed out and disabled for the TX EQ tests
- 13.After clicking on 'Next', the 'Initiate Loopback' window is displayed as shown in Figure-35 where upon clicking on 'Start' button, a preliminary test to carried out to ensure that the DUT gets into loopback before the tests (The DUT needs to be powered-on for the loopback test and then powered-off)
- 14.On clicking the 'Next' button, a table is displayed as shown in Figure-39 where the user may choose either to run the test for all Tx Equalization Presets P0-P9 (Coefficients cannot be chosen independently without the corresponding Preset) or for some of them by selectively enabling the desired Initial Presets

	Initial Prese	t	Preset/Co Value	Preshoot (dB)	De-emph (dB)	Vb (mV)	Electrical Response Time (ns)	Protocol Response Time (ns)	Coefficien	Result	[
v	P4	•	P0								
/	P4	•	P0(Co								_
/	P4	•	P1								
/	P4	•	P1(Co								
/	P4	-	P2								
1	P4	-	P2(Co								
1	P7	-	P3								
/	P7	-	P3(Co								
1	P7	-	P4								
1	P7	-	P4(Co								
7	P7	-	P5								
1	P7	-	P5(Co								
1	P7	-	P6								
1	P7	-	P6(Co								
1	P4	-	P7								
1	D4	-	D7(Co								

Figure-39: Result table for AIC transmitter link EQ response test

- 15.User may choose any Initial Preset, but the defaults provided ensure that the waveforms from BERT (with Initial Preset) and from the DUT (with Preset/Coefficients) are maximally discriminated for accuracy of test results
- 16.Upon clicking the 'Run' button as shown in Figure-39, Rx-Test app starts the automated test procedure
- 17. The DUT must be powered-on at this stage to enable loopback
- 18. The Rx-Test app interacts with the scope and SigTest to capture the waveforms, analyze them and subsequently populates the result table as shown in Figure-40

						BERTScope RECI Printe	PCIE4.0 Re EIVER TEST RI d 3/18/2018 7:4	e ceiver Testir ESULTS 4:47 PM	ıg							
							Information	1								
		Name: 2_ Creator: Su Description: Comment: G	5_2 iryakant en4_Completed_	_12Min		Date DUT	Time: 3/19/2018 Type: AddInCar	2:44:35 AM d								
						Te	st Calibratio	ns								
		TP2: TI	P2-Cal-B30053			BSC	C S/N: 280094									
				2.5.3	2 Add-In Ca	rd Transmitt	er Link Equ	alization Res	sponse Test							
La	ne0															
D	UT Initial Preset	DUT Request Preset	Preshoot (dB)	Preshoot Limits (Low , HIgh) (dB)	Preshoot Margins (Low , HIgh) (dB)	De- emphasis(dB)	De-emphasis Limits (Low , HIgh) (dB)	De-emphasis Margins (Low , HIgh) (dB)	Vb (mV) (Informative)	Electrical Response Time (ns)	Electrical Response Time Margin (ns)	Protocol Response Time (ns)	Protocol Response Time Margin (ns)	Electrical / Protocol Response Time Limit (ns)	Result	DUT Reported Coefficients
	P4	P0	0.000	0,0	0,0	-6.30	-7.5 , -4.5	1.2,1.8	196.6	103.0	897	170.1	829.9	1000	Pass	{0,47,16}
	P4	P1	0.000	0,0	0,0	-3.74	-4.5 , -2.5	0.76,1.24	264.2	114.7	885.3	173.6	826.4	1000	Pass	{0,52,11}
	P4	P2	0.000	0,0	0,0	-4.68	-5.9 , -2.9	1.22,1.78	236.9	113.3	886.7	173.9	826.1	1000	Pass	{0,50,13}
	P7	P3	0.000	0,0	0,0	-2.50	-3.5 , -1.5	1,1	304.7	127.6	872.4	165.9	834.1	1000	Pass	{0,55,8}
	P7	P4	0.000	0,0	0,0	0.000	0,0	0,0	406.5	121.4	878.6	167.6	832.4	1000	Pass	{0,63,0}
F	P/	P)	1.806	0.9,2.9	0.906, 1.094	0.000	0,0	0,0	330.1	121.3	8/8./	1/1.0	828.4	1000	Pass	{0,57,0}
	P/	P7	2.019	25.45	0.727 1.272	6.11	75 45	1 20 1 61	162.2	128.1	006.1	174.0	820.4	1000	Pass	{8,33,0}
F	P4	 	3.958	2.5,4.5	1 458 0 542	-0.11	-1.5,-4.5	0.56 1.44	103.5	109.0	801	169.7	830.3	1000	Pass	{8.47.83
F	P7	P9	3.710	2.5,4.5	1.21.0.79	0.000	0.0	0.0	265.1	115.0	885	163.6	836.4	1000	Pass	{11.52.0}
D	UT Initial Preset	DUT Request Coefficients	Preshoot (dB)	Preshoot Limits (Low , HIgh) (dB)	Preshoot Margins (Low , HIgh) (dB)	De- emphasis(dB)	De-emphasis Limits (Low , HIgh) (dB)	De-emphasis Margins (Low , HIgh) (dB)	Vb (mV) (Informative)	Electrical Response Time (ns)	Electrical Response Time Margin (ns)	Protocol Response Time (ns)	Protocol Response Time Margin (ns)	Electrical / Protocol Response Time Limit (ns)	Result	
	P4	P0{0,47,16}	0.000	0,0	0,0	-6.31	-7.5 , -4.5	1.19 , 1.81	195.7	87.57	912.43	161.8	838.2	1000	Pass	
	P4	P1{0,52,11}	0.000	0,0	0,0	-3.71	-4.5 , -2.5	0.79, 1.21	264.0	88.26	911.74	154.4	845.6	1000	Pass	
	P4	P2{0,50,13}	0.000	0,0	0,0	-4.64	-5.9 , -2.9	1.26,1.74	237.0	95.15	904.85	164.6	835.4	1000	Pass	
\vdash	P/	P5{0,55,8}	0.000	0,0	0,0	-2.46	-5.2, -1.3	1.04,0.96	504.9	184.9	815.1	108.0	851.4	1000	Pass	-
	P7	P4{0,03,0}	1.783	00.20	0.993 1.117	0.000	0,0	0,0	404.8	109.5	894.0	157.8	845.4	1000	Pass	-
H	P7	P6(8 55 0)	2.465	15 35	0.065 1.035	0.000	0,0	0,0	304.8	113.1	885.2	161.7	838.3	1000	Pass	-
F	P4	P7{74511}	3 227	25.45	0.727 1.273	-6.09	-75 -45	141 1 59	163.5	101.3	898.7	157.6	842.4	1000	Pass	
F	P4	P8{8,47,8}	3.982	2.5,4.5	1.482,0.518	-3.97	-4.5 , -2.5	0.53, 1.47	192.7	101.4	898.6	158.2	841.8	1000	Pass	-
F	P7	P9{11,52,0}	3.698	2.5,4.5	1.198,0.802	0.000	0,0	0,0	264.4	116.8	883.2	160.0	840	1000	Pass	1

Note: 'NA' not applicable due to minimal electrical changes for response time OR in case of Sigtest not run for the Preshoot/De-emphasis/Vb results



19.After the test execution is complete, the test results can be saved by clicking on 'Next' and providing the necessary details for reference as shown in Figure-38

5.3 System Board Transmitter Link Equalization Response Test For 16.0 GT/s

Purpose: This test verifies that the System Board will respond correctly to transmitter equalization commands sent via the link protocol.

Test Setup: As per Test Setup shown in Figure-2.

Test Procedure:

- 1. The power supply on the System DUT should be turned-off until all connections are complete
- 2. Set-up connection should be as shown in the Figure-2
- 3. Tx lanes other than the lane under test may be terminated with 50 ohms or left unterminated as per DUT provider

- 4. BERT scope PCIE4.0 Receiver Testing application (Rx-Test app) should be launched and 'LEQ Test' selected from the list of tests supported by the Rx-Test app
- 5. Upon clicking on the 'Link EQ Test' button, the Link EQ Test wizard is displayed as shown in Figure-33
- 6. Two drop-down menus in the wizard displays the options for choosing the different TP2 calibration results for AIC cards from the Rx-Test app database and the various LEQ tests
- 7. Upon choosing the '2.10.2 System Board Transmitter Link Equalization Response Test' followed by clicking on 'Next', the connection diagram is displayed for reference
- 8. Upon clicking on the 'Next' button, BERT scope initialization screen is displayed where the necessary settings on the BERT is carried out
- 9. The user should allow the default choices in this window and select 'Run' to proceed with the initialization
- 10.When 'Next' button is clicked after the initialization process, 'Configure Loopback' wizard is displayed which shows 'BERT Initial Preset' parameter which provides the user with an option to select an initial Tx-preset for the BERT that the DUT prefers for its receivers
- 11.Upon clicking 'Next', the 'Configure Link EQ Test' wizard is displayed as shown in Figure-34, in which all the stresses are greyed out and disabled for the TX EQ tests
- 12.After clicking on 'Next', the 'Initiate Loopback' window is displayed as shown in Figure-35 where upon clicking on 'Start' button, a preliminary test to carried out to ensure that the DUT gets into loopback before the tests (The DUT needs to be powered-on for the loopback test and then powered-off)
- 13.On clicking the 'Next' button, a table is displayed as shown in Figure-41 where the user may choose either to run the test for all Tx Equalization Presets P0-P9 (Coefficients cannot be chosen independently without the corresponding Preset) or for some of them by selectively enabling the desired Initial Presets

	Preset/Coef Value	Preshoot (dB)	De-emphas (dB)	Vb (mV)	Electrical Response Time (ns)	Protocol Response Time (ns)	Coefficients	Result	-
1	P0								
1	P0(Coeffi								
1	P1								
1	P1(Coeffi								
1	P2								
1	P2(Coeffi								
1	P3								
1	P3(Coeffi								
1	P4								
1	P4(Coeffi								
1	P5								
1	P5(Coeffi								
1	P6								
1	P6(Coeffi								
1	P7								
7	D7(Cooff								

Figure-41: Result table for system board transmitter link EQ response test

- 14.Upon clicking the 'Run' button as shown in Figure-41, Rx-Test app starts the automated test procedure
- 15. The DUT must be powered-on at this stage to enable loopback
- 16.The Rx-Test app interacts with the scope and SigTest to capture the waveforms, analyze them and subsequently populates the result table as shown in Figure-42

						BERTSco	pe PCIE4.0	Receiver Tes	ting						
						R	ECEIVER TEST	RESULTS							
						D.	inted 3/16/2019	3-22-05 PM							
						FI	Inted 5/10/2018	5.22.05 FM							
							Informat	ion							
	Name: 2 Creator: Si Description: S Comment: P	_10_2 iryakant ystem 7 As Default Init	Preset in Syste	m	Date DUT	Time: 3/16/2018 Type: System	8 10:21:21 PM								
							Test Calib	rations							
	TP2:[E	xample System	Cal]		BSG	C S/N: 280094									
					2.10.2 Sy	stem Board	Transmitter	Link Equali:	zation Resp	onse Test					
ane0															
DUT Initial Preset	DUT Request Preset	Preshoot (dB)	Preshoot Limits (Low , HIgh) (dB)	Preshoot Margins (Low , HIgh) (dB)	De- emphasis(dB)	De-emphasis Limits (Low , HIgh) (dB)	De-emphasis Margins (Low , HIgh) (dB)	Vb (mV) (Informative)	Electrical Response Time (ns)	Electrical Response Time Margin (ns)	Protocol Response Time (ns)	Protocol Response Time Margin (ns)	Electrical / Protocol Response Time Limit (ns)	Result	DUT Reported Coefficients
P4	PO	0.000	0,0	0,0	-6.57	-7.5 , -4.5	0.93, 2.07	248.1	162.2	837.8	391.2	608.8	1000	Pass	{0,24,8}
P4	P1	0.000	0,0	0,0	-3.24	-4.5, -2.5	1.26,0.74	364.2	187.9	812.1	398.1	601.9	1000	Pass	{0,27,5}
P4	P2	0.000	0,0	0,0	-4.11	-5.9 , -2.9	1.79, 1.21	329.3	209.4	790.6	420.8	579.2	1000	Pass	{0,26,6}
P4	P3	0.000	0,0	0,0	-2.44	-3.5 , -1.5	1.06, 0.94	399.4	195.9	804.1	452.7	547.3	1000	Pass	{0,28,4}
P4	P4	0.000	0,0	0,0	0.000	0,0	0,0	529.0	191.7	808.3	480.6	519.4	1000	Pass	{0,32,0}
P4	P5	1.964	0.9 , 2.9	1.064,0.936	0.000	0,0	0,0	421.9	194.8	805.2	403.4	596.6	1000	Pass	{3,29,0}
P4	P6	2.451	1.5 , 3.5	0.951, 1.049	0.000	0,0	0,0	398.9	192.8	807.2	418.2	581.8	1000	Pass	{4,28,0}
P4	P8	4.127	2.5 , 4.5	1.627, 0.373	-4.11	-4.5 , -2.5	0.39, 1.61	248.3	196.5	803.5	397.5	602.5	1000	Pass	{4,24,4}
P4 OUT Initial Preset	Coefficients value	3:249 Preshoot (dB)	Preshoot Limits (Low , HIgh) (dB)	Preshoot Margins (Low , HIgh) (dB)	De- emphasis(dB)	0,0 De-emphasis Limits (Low, HIgh) (dB)	0,0 De-emphasis Margins (Low , HIgh) (dB)	Vb (mV) (Informative)	Electrical Response Time (ns)	Electrical Response Time Margin (ns)	426.6 Protocol Response Time (ns)	5/3.4 Protocol Response Time Margin (ns)	Electrical / Protocol Response Time Limit	Pass	{5,2/,0}
	DO(0.04.0)	0.000	0.0	0.0	-6.57	-75 -45	0.93 2.07	248.0	200.7	700 3	401.2	598.8	(ns) 1000	Pass	-
P4	P010.24.83							210.0				602.0	1000	Pass	-
P4 P4	P0{0,24,8} P1{0,27,5}	0.000	0.0	0.0	-3.24	-4.52.5	1.26.0.74	364.0	190.7	809.3	396.2	003.8	1000 1		-
P4 P4 P4	P0{0,24,8} P1{0,27,5} P2{0,26,6}	0.000	0,0	0,0	-3.24	-4.5, -2.5	1.26,0.74	364.0	190.7 191.0	809.3 809	396.2 447.4	552.6	1000	Pass	
P4 P4 P4 P4	P0{0,24,8} P1{0,27,5} P2{0,26,6} P3{0,28,4}	0.000 0.000 0.000	0,0	0,0 0,0 0,0	-3.24 -4.12 -2.44	-4.5 , -2.5 -5.9 , -2.9 -3.5 , -1.5	1.26,0.74 1.78,1.22 1.06,0.94	364.0 329.2 399.2	190.7 191.0 191.3	809.3 809 808.7	396.2 447.4 400.8	552.6 599.2	1000	Pass Pass	
P4 P4 P4 P4 P4 P4	P0{0,24,8} P1{0,27,5} P2{0,26,6} P3{0,28,4} P4{0,32,0}	0.000 0.000 0.000 0.000 0.000	0,0 0,0 0,0	0,0 0,0 0,0 0,0	-3.24 -4.12 -2.44 0.000	-4.5, -2.5 -5.9, -2.9 -3.5, -1.5 0, 0	1.26,0.74 1.78,1.22 1.06,0.94 0,0	364.0 329.2 399.2 529.0	190.7 191.0 191.3 185.1	809.3 809 808.7 814.9	396.2 447.4 400.8 410.1	552.6 599.2 589.9	1000 1000 1000 1000	Pass Pass Pass	
P4 P4 P4 P4 P4 P4 P4	P0{0,24,8} P1{0,27,5} P2{0,26,6} P3{0,28,4} P4{0,32,0} P5{3,29,0}	0.000 0.000 0.000 0.000 1.970	0,0 0,0 0,0 0,0 0,0	0,0 0,0 0,0 0,0 1.07,0.93	-3.24 -4.12 -2.44 0.000 0.000	-4.5, -2.5 -5.9, -2.9 -3.5, -1.5 0, 0 0, 0	1.26,0.74 1.78,1.22 1.06,0.94 0,0 0,0	364.0 329.2 399.2 529.0 421.6	190.7 191.0 191.3 185.1 185.4	809.3 809 808.7 814.9 814.6	396.2 447.4 400.8 410.1 427.2	552.6 599.2 589.9 572.8	1000 1000 1000 1000 1000	Pass Pass Pass Pass	
P4 P4 P4 P4 P4 P4 P4 P4	P0{0,24,8} P1{0,27,5} P2{0,26,6} P3{0,28,4} P4{0,32,0} P5{3,29,0} P6{4,28,0}	0.000 0.000 0.000 0.000 1.970 2.445	0,0 0,0 0,0 0,0 0.9,2.9 1.5,3.5	0,0 0,0 0,0 1.07,0.93 0.945,1.055	-3.24 -4.12 -2.44 0.000 0.000 0.000	-4.5, -2.5 -5.9, -2.9 -3.5, -1.5 0, 0 0, 0 0, 0	1.26,0.74 1.78,1.22 1.06,0.94 0,0 0,0 0,0	364.0 329.2 399.2 529.0 421.6 399.2	190.7 191.0 191.3 185.1 185.4 179.5	809.3 809 808.7 814.9 814.6 820.5	396.2 447.4 400.8 410.1 427.2 443.2	552.6 599.2 589.9 572.8 556.8	1000 1000 1000 1000 1000 1000	Pass Pass Pass Pass Pass	
P4 P4 P4 P4 P4 P4 P4 P4 P4	P0{0,24,8} P1{0,27,5} P2{0,26,6} P3{0,28,4} P4{0,32,0} P5{3,29,0} P6{4,28,0} P8{4,24,4}	0.000 0.000 0.000 0.000 1.970 2.445 4.141	0,0 0,0 0,0 0,0 0.9,2.9 1.5,3.5 2.5,4.5	0,0 0,0 0,0 1.07,0.93 0.945,1.055 1.641,0.359	-3.24 -4.12 -2.44 0.000 0.000 0.000 -4.14	-4.5, -2.5 -5.9, -2.9 -3.5, -1.5 0, 0 0, 0 0, 0 -4.5, -2.5	1.26,0.74 1.78,1.22 1.06,0.94 0,0 0,0 0,0 0,0 0.36,1.64	364.0 329.2 399.2 529.0 421.6 399.2 247.8	190.7 191.0 191.3 185.1 185.4 179.5 187.2	809.3 809 808.7 814.9 814.6 820.5 812.8	396.2 447.4 400.8 410.1 427.2 443.2 418.5	003.8 552.6 599.2 589.9 572.8 556.8 581.5	1000 1000 1000 1000 1000 1000	Pass Pass Pass Pass Pass Pass	

Figure-42: Test report

17.After the test execution is complete, the test results can be saved by clicking on 'Next' and providing the necessary details for reference as shown in Figure-38

5.4 Add-in Card Receiver Link Equalization Test at 16.0 GT/s

Purpose: This test verifies that the Add-In Card will correctly negotiate with its link partner to adjust the partner's transmitter equalization appropriately.

Test Setup: As per Test Setup shown in Figure-3.

- 1. Ensure power to the CBB is off.
- 2. Set-up connection should be as shown in the Figure-3
- 3. Tx lanes other than the lane under test may be terminated with 50 ohms or left unterminated as per DUT provider

- 4. BERT scope PCIE4.0 Receiver Testing application (Rx-Test app) should be launched and 'LEQ Test' selected from the list of tests supported by the Rx-Test app
- 5. Upon clicking on the 'Link EQ Test' button, the Link EQ Test wizard is displayed as shown in Figure-33
- 6. Two drop-down menus in the wizard displays the options for choosing the different TP2 calibration results for AIC cards from the Rx-Test app database and the various LEQ tests
- 7. The latest TP2 calibration results from the set-up under consideration should be used for performing the test
- 8. Upon choosing the '2.13.2 Add-In Card Receiver Link Equalization Test' followed by clicking on 'Next', the connection diagram is displayed for reference
- 9. Upon clicking on the 'Next' button, BERT scope initialization screen is displayed where the necessary settings on the BERT is carried out
- 10. The user should allow the default choices in this window and select 'Run' to proceed with the initialization
- 11. When 'Next' button is clicked after the initialization process, 'Configure Loopback' wizard is displayed which shows 'BERT Initial Preset' parameter which provides the user with an option to select an initial Tx-preset for the BERT that the DUT prefers for its receivers or it must be set to P7
- 12.Upon clicking 'Next', the 'Configure Link EQ Test' wizard is displayed as shown in Figure-34 in which the 'Calibrated' button is shown to be selected by default, indicating that the stresses will be enabled during this test
- 13.After clicking on 'Next', the 'Initiate Loopback' window is displayed as shown in Figure-35 where upon clicking on 'Start' button, a preliminary test to carried out to ensure that the DUT gets into loopback before the tests (The DUT needs to be powered-on for the loopback test and then powered-off)
- 14.Upon clicking the 'Next' button, a table is displayed as shown in Figure-43 with the 'Initial Preset (Generator)' set to P7

7 07	(Generator)	Preshoot (dB)	Deemphasis (dB)	Errors	Final Coefficients (Generator)	Result
P7		(ub)	(ub)		(Generator)	
	1	1	1	'		
					Clear All Che	ck All Ru
						Cre / III

Figure-43: Result table for AIC Rx link EQ test

- 15. The test is executed by clicking on the 'Run' button after which the Rx-Test app runs the automated test to compute the BER and displays the results
- 16. The DUT must be powered-on at this stage to enable loopback
- 17.After the test execution is complete, the test results can be saved by clicking on 'Next' and providing the necessary details for reference as shown in Figure-38

5.5 System Receiver Link Equalization Test for 16.0 GT/s

Purpose: This test verifies that System Board will correctly negotiate with its link partner to adjust the partner's transmitter equalization appropriately.

Test Setup: As per Test Setup shown in Figure-4.

- 1. The power supply on the System DUT should be turned-off until all connections are complete
- 2. Set-up connection should be as shown in the Figure-4
- 3. Tx lanes other than the lane under test may be terminated with 50 ohms or left unterminated as per DUT provider
- 4. BERT scope PCIE4.0 Receiver Testing application (Rx-Test app) should be launched and 'LEQ Test' selected from the list of tests supported by the Rx-Test app

- 5. Upon clicking on the 'Link EQ Test' button, the Link EQ Test wizard is displayed as shown in Figure-33
- 6. Two drop-down menus in the wizard displays the options for choosing the different TP2 calibration results for AIC cards from the Rx-Test app database and the various LEQ tests
- 7. The latest TP2 calibration results from the set-up under consideration should be used for performing the test
- 8. Upon choosing the '2.14.2 System Receiver Link Equalization Test' followed by clicking on 'Next', the connection diagram is displayed for reference
- 9. Upon clicking on the 'Next' button, BERT scope initialization screen is displayed where the necessary settings on the BERT is carried out
- 10. The user should allow the default choices in this window and select 'Run' to proceed with the initialization
- 11. When 'Next' button is clicked after the initialization process, 'Configure Loopback' wizard is displayed which shows 'BERT Initial Preset' parameter which provides the user with an option to select an initial Tx-preset for the BERT that the DUT prefers for its receivers
- 12.Upon clicking 'Next', the 'Configure Link EQ Test' wizard is displayed as shown in Figure-34 in which the 'Calibrated' button is shown to be selected by default, indicating that the stresses will be enabled during this test
- 13.After clicking on 'Next', the 'Initiate Loopback' window is displayed as shown in Figure-35 where upon clicking on 'Start' button, a preliminary test to carried out to ensure that the DUT gets into loopback before the tests (The DUT needs to be powered-on for the loopback test and then powered-off)
- 14.Upon clicking the 'Next' button, a table is displayed as shown in Figure-44 with the 'Initial Preset (Generator)' set to the same Preset as in 10

(Generator)	Final Preset (Generator)	Final Preshoot (dB)	Final Deemphasis (dB)	Errors	Final Coefficients (Generator)	Result
/						

Figure-44: Result table for system Rx link EQ test

- 15. The test is executed by clicking on the 'Run' button after which the Rx-Test app runs the automated test to compute the BER and displays the results
- 16. The DUT must be powered-on at this stage to enable loopback
- 17.After the test execution is complete, the test results can be saved by clicking on 'Next' and providing the necessary details for reference as shown in Figure-38

6. APPENDIX

6.1 Fixture Characterization (Preliminary)

This document talks about Gen4 fixture characterization with measurement setups for Add-In-Card and System-Board.



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