Version 1.0
Feb-2019

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

Table of Contents

MODIFICATION RECORD

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

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:
  (https://www.intel.com/content/www/us/en/design/technology/high-speed-io/tools.html)

REQUIRED EQUIPMENTS

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

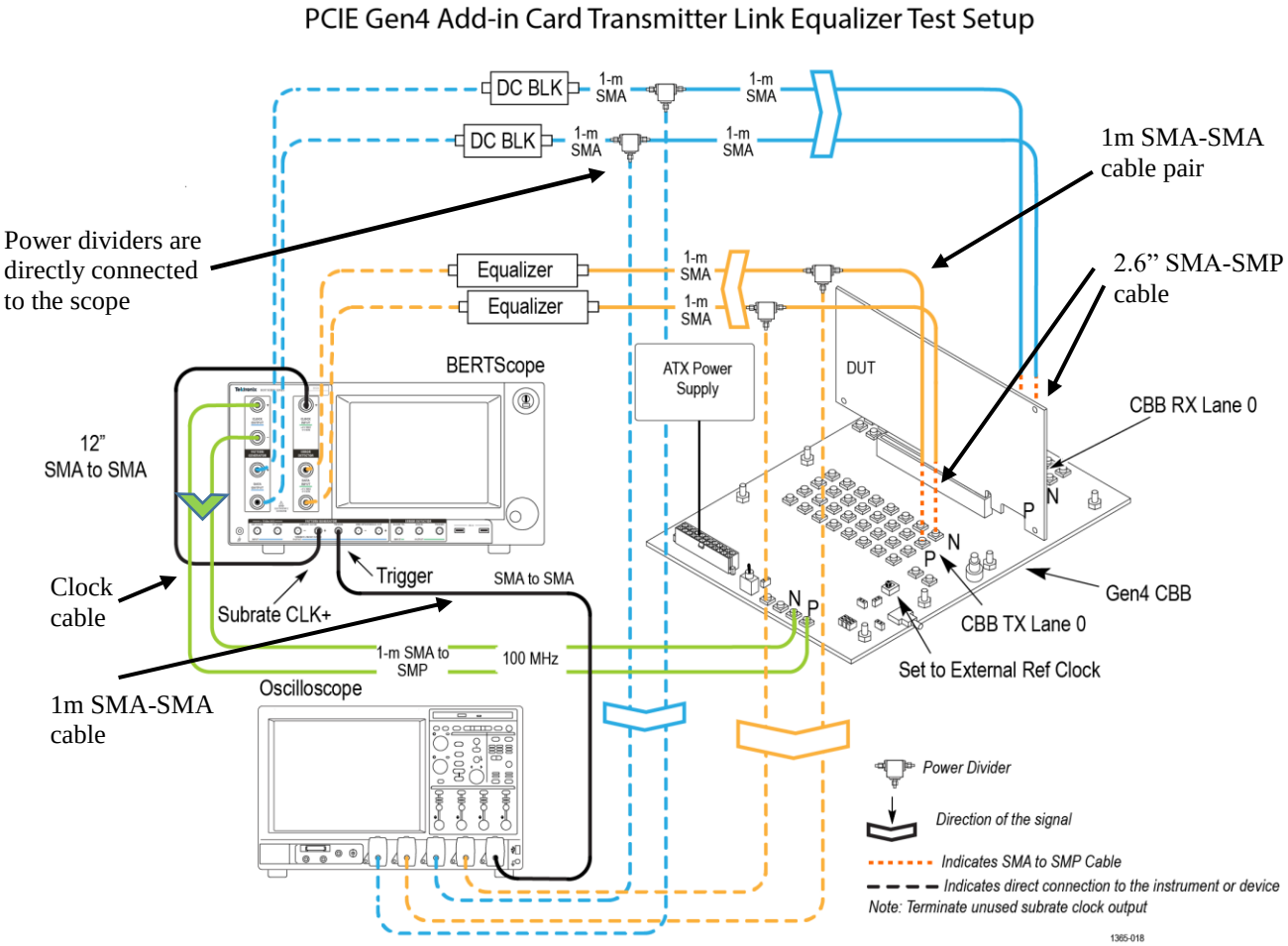

Figure 1: Gen4 Add-In-Card Tx Setup

2.2 System Board Tx Link Eq Setup

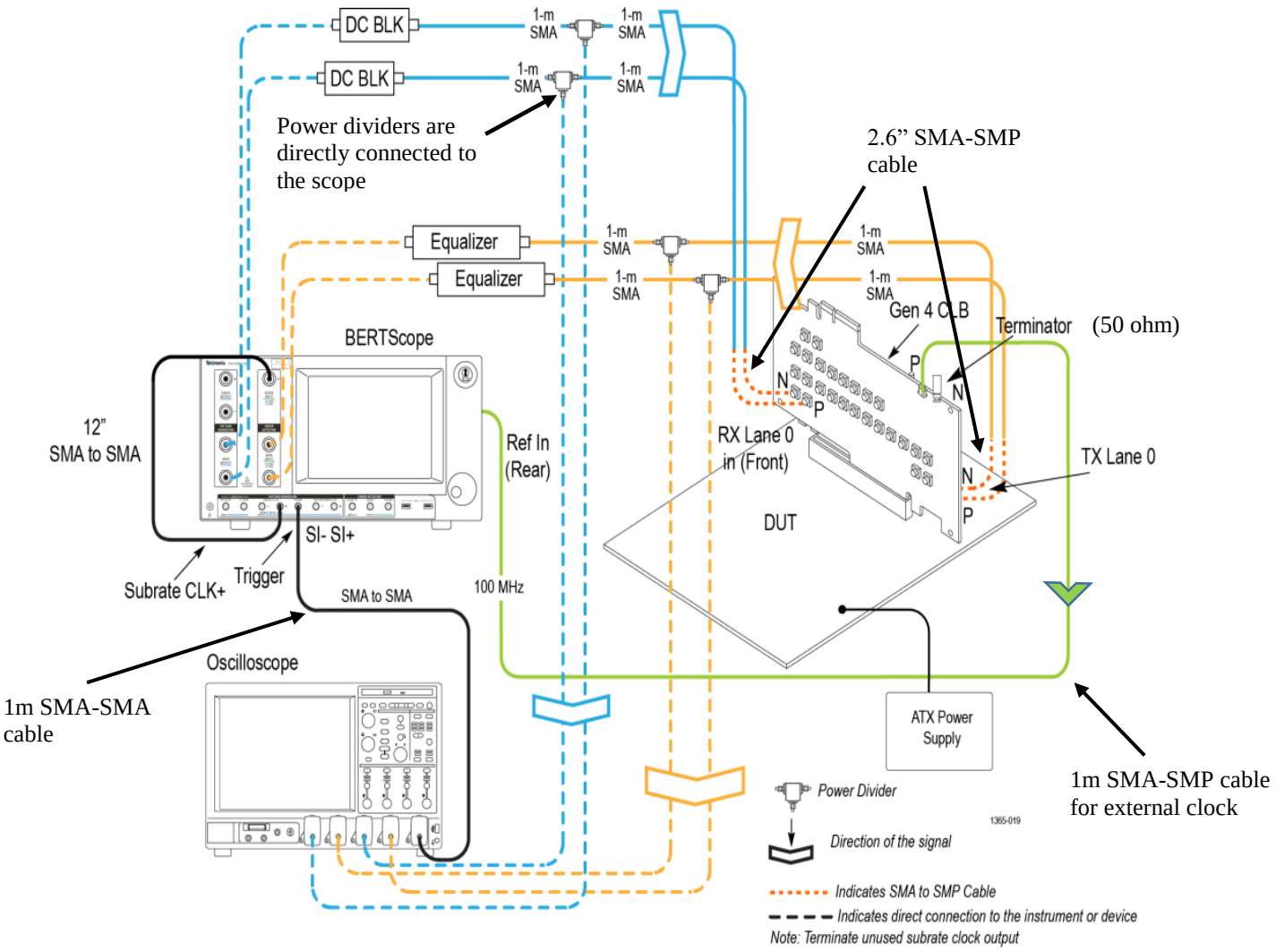

Figure 2: Gen4 System Board Tx Setup

2.3 Add-In-Card Rx Link Eq Setup

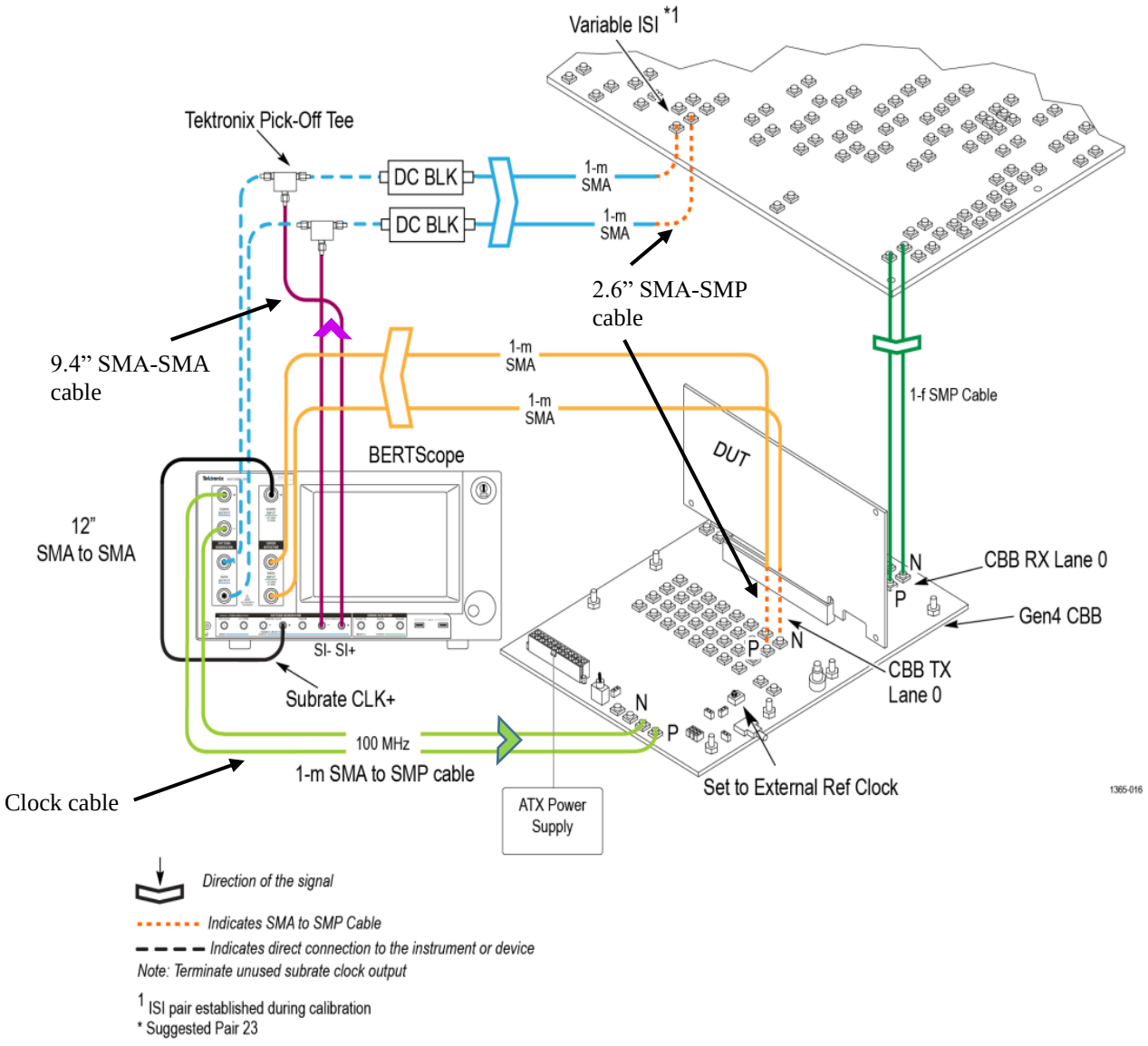

Figure 3: Gen4 Add-In Card Rx Setup

2.4 System Board Rx Link Eq Setup

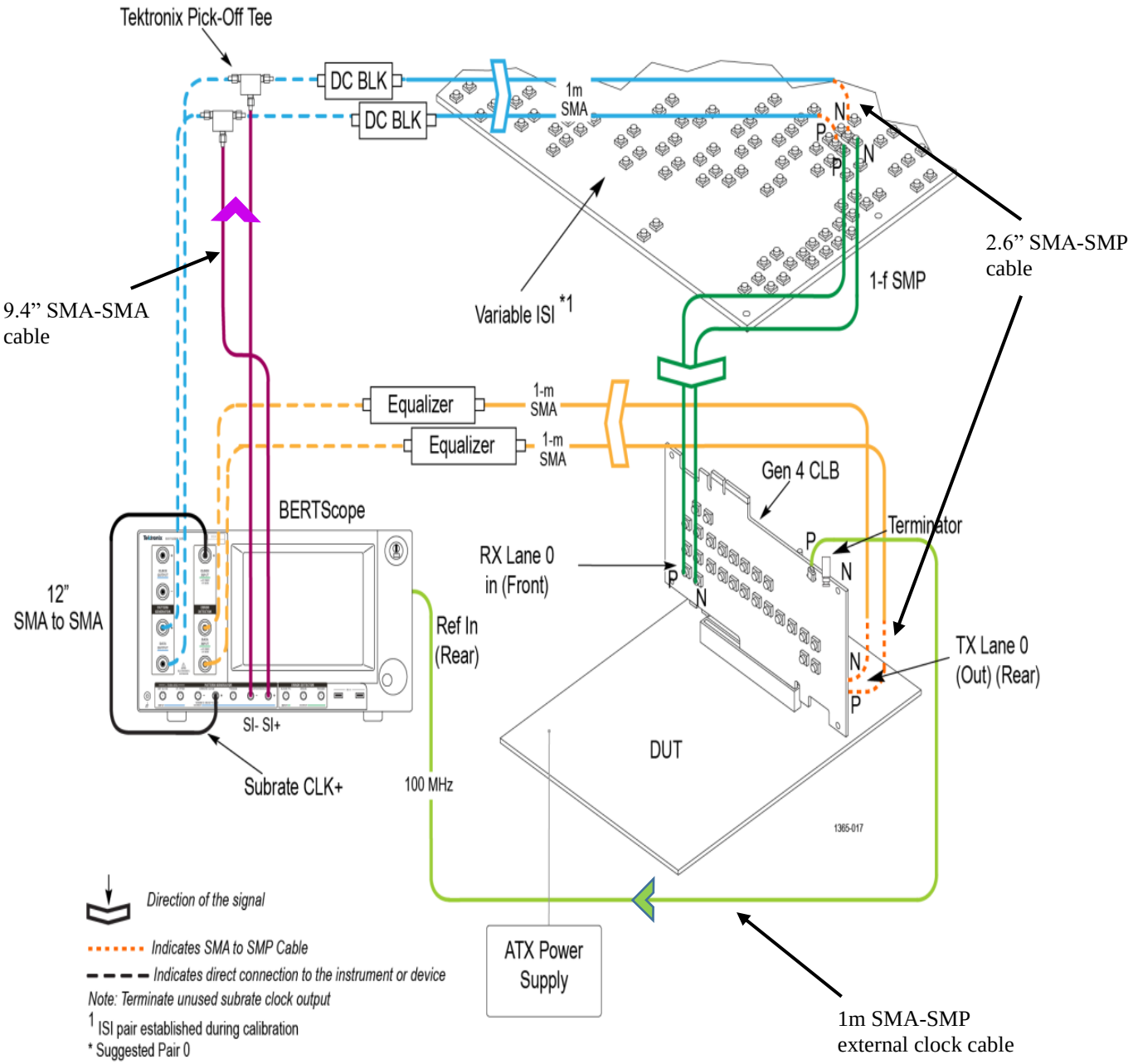

Figure 4: Gen4 System Board Rx Setup

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.

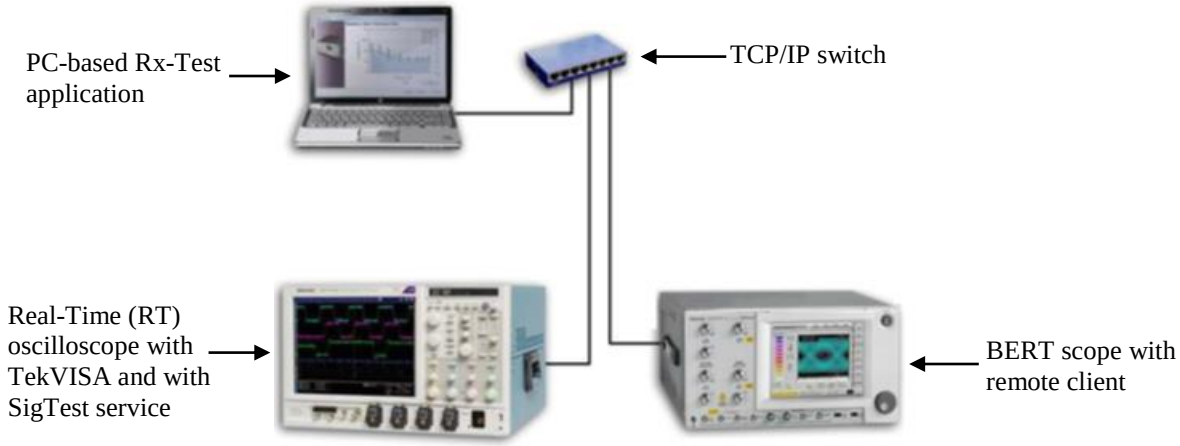

Figure 5: PCIe Gen4 Test Solution Equipment and Software Communication

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.

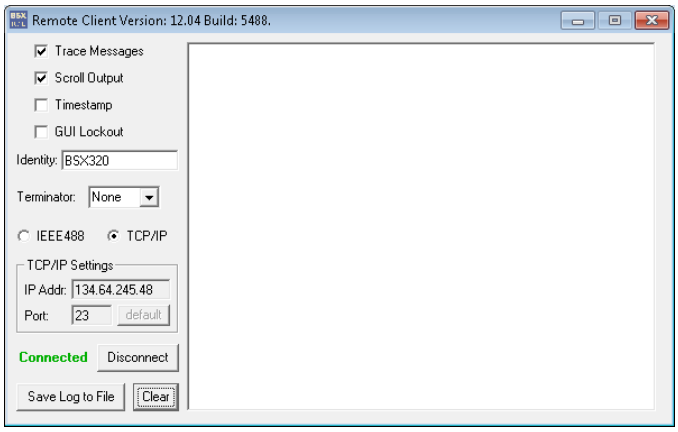

Figure-6: Launching remote client on the BERT scope

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.

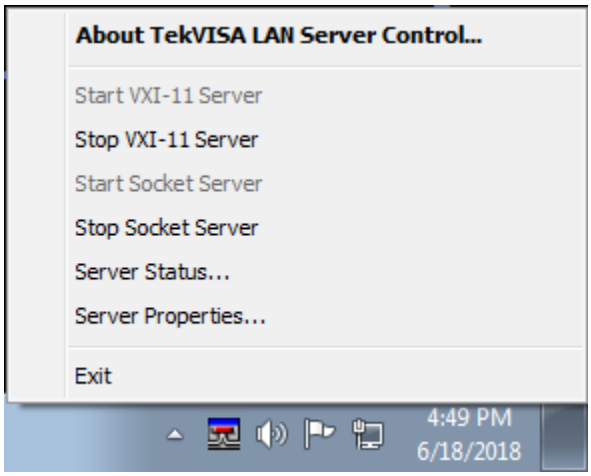

Figure-7: Launching server application in the oscilloscope

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.

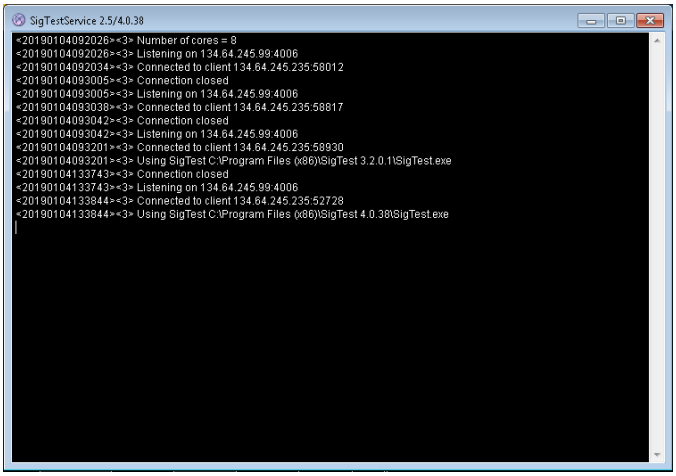

Figure-8: Launching SigTest service

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.

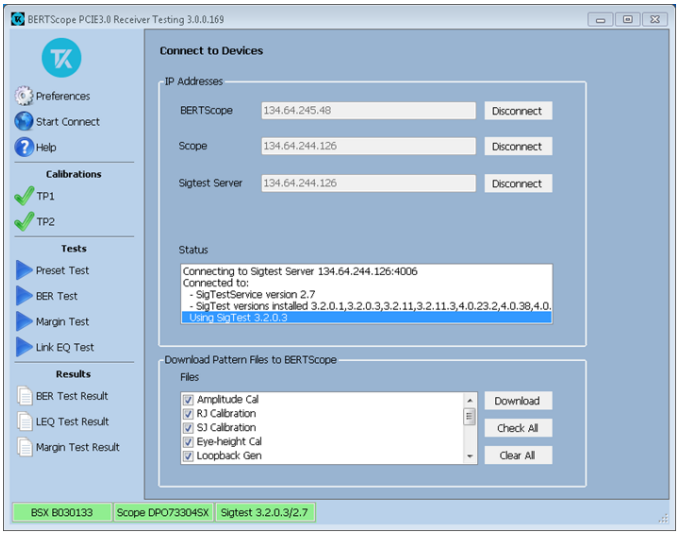

Figure-9: Instrument connection panel in Rx-Test app

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.

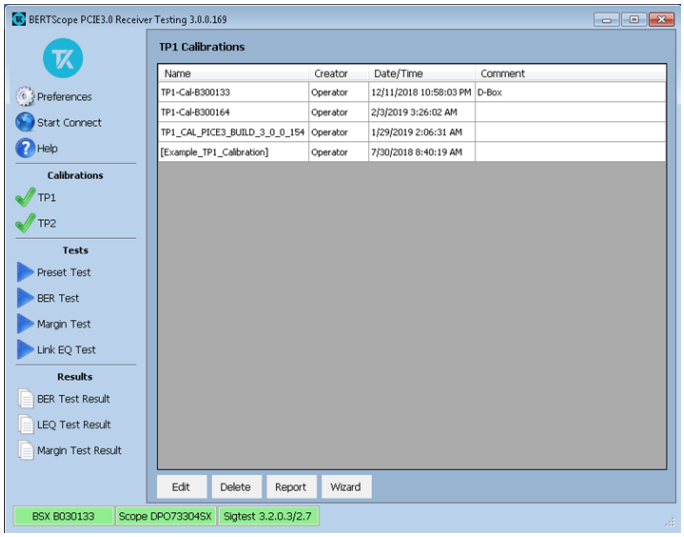

Figure-10: TP1 calibration window

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.

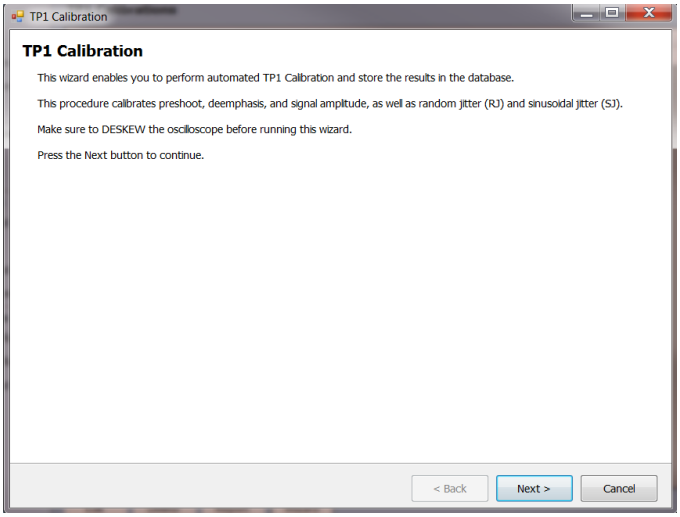

Figure-11: TP1 information window

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.

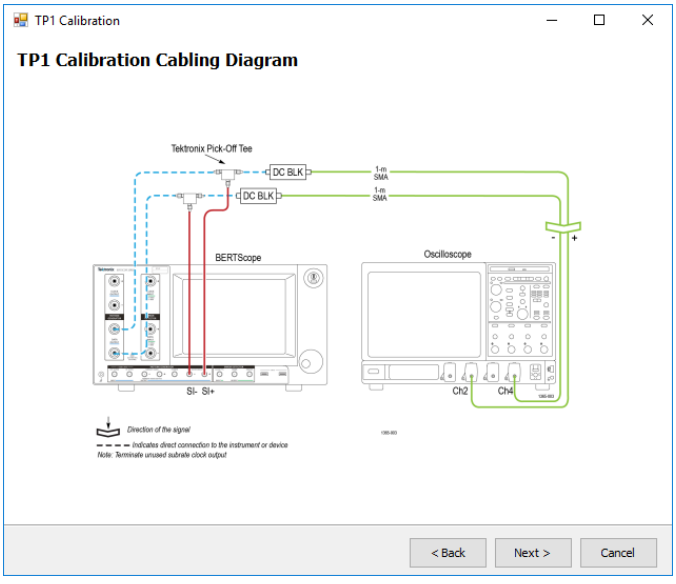

Figure-12: TP1 calibration connection diagram

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”.

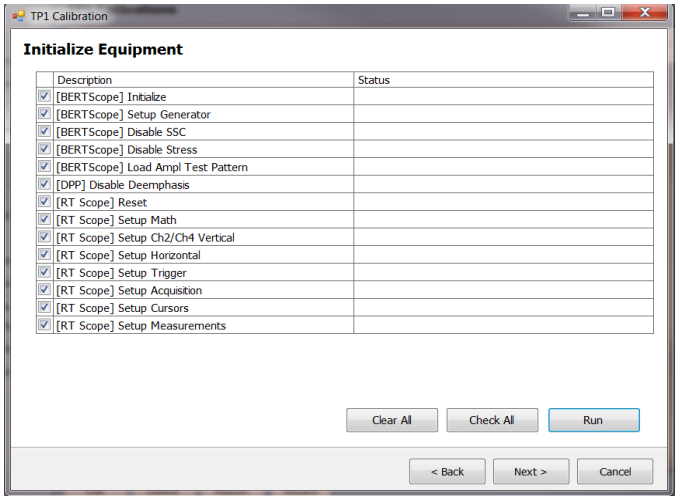

Figure-13: Initialization of BERT and oscilloscope for TP1 calibration

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.

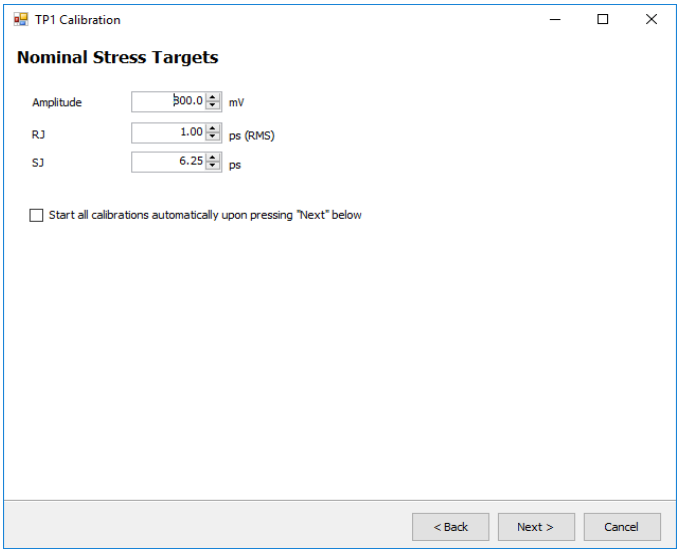

Figure-14: Nominal stress targets for TP1 calibration

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.

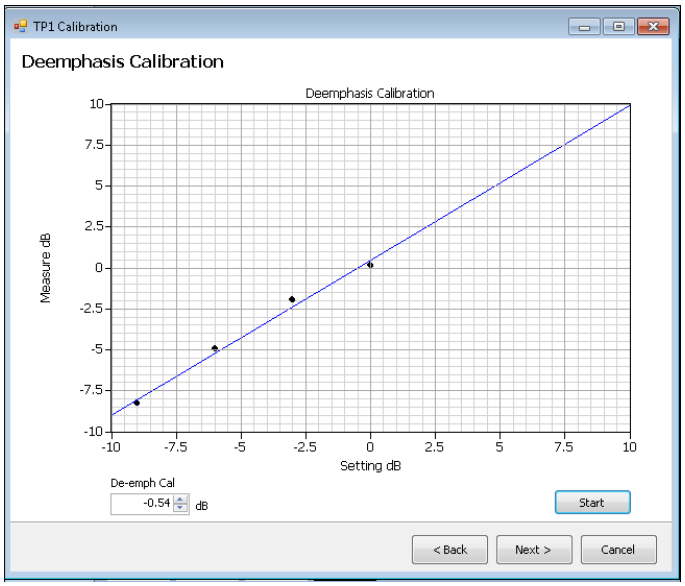

Figure-15: De-emphasis calibration

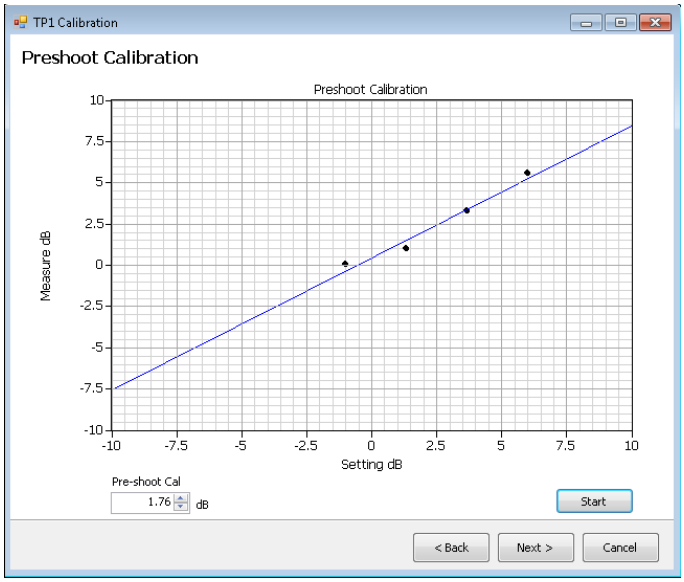

Figure-16: Pre-shoot calibration

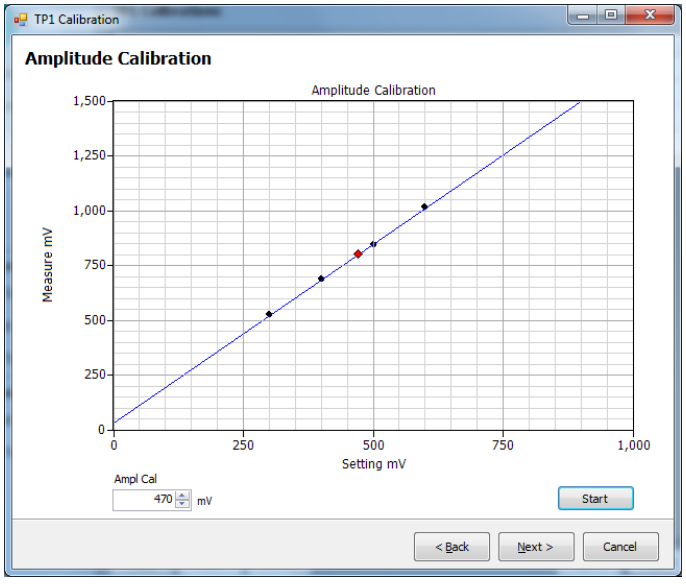

Figure-17: Amplitude calibration

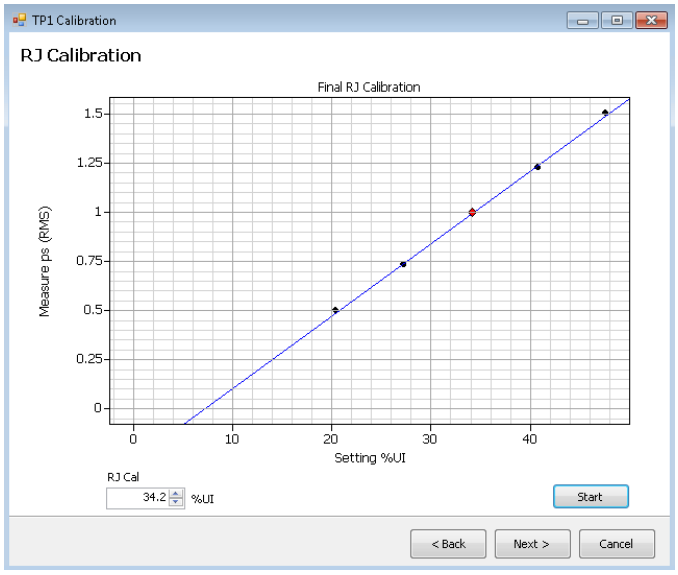

Figure-18: RJ calibration

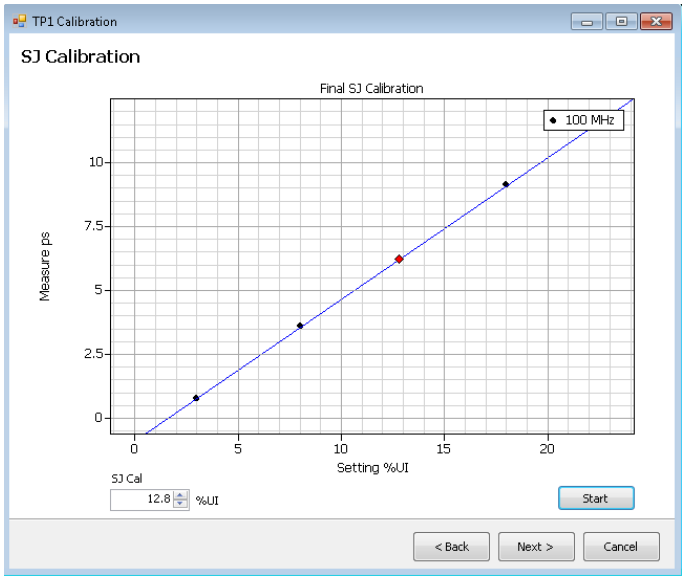

Figure-19: SJ calibration

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.

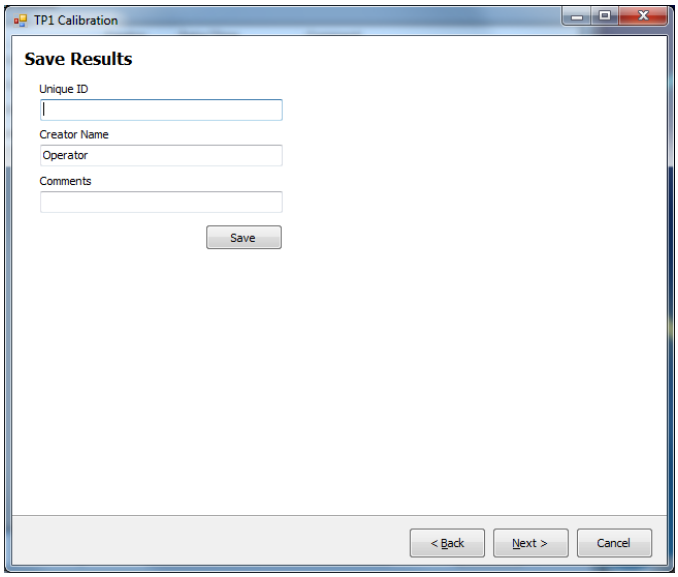

Figure-20: Saving TP1 calibration results

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.

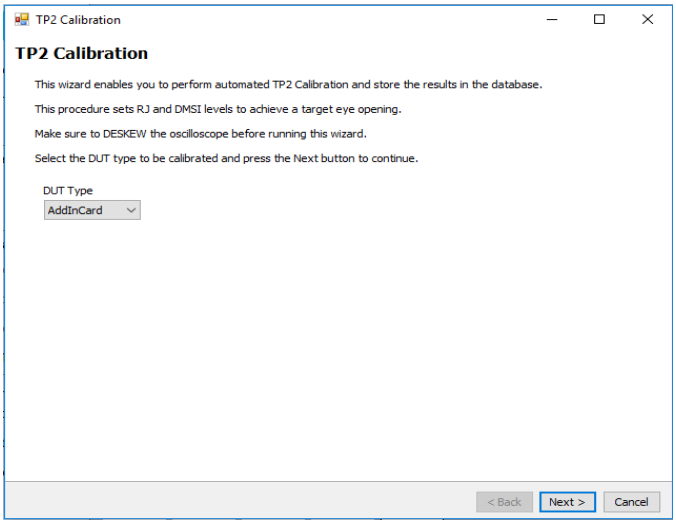

Figure-21: TP2 information window

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.

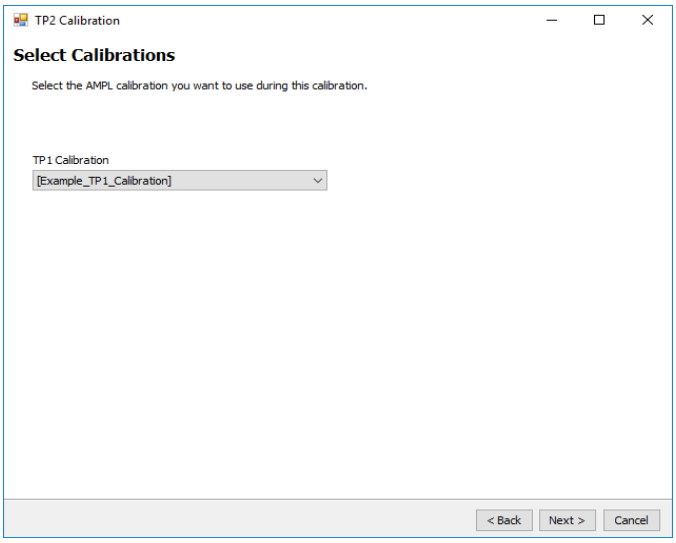

Figure-22: Selection of TP1 calibration results for TP2

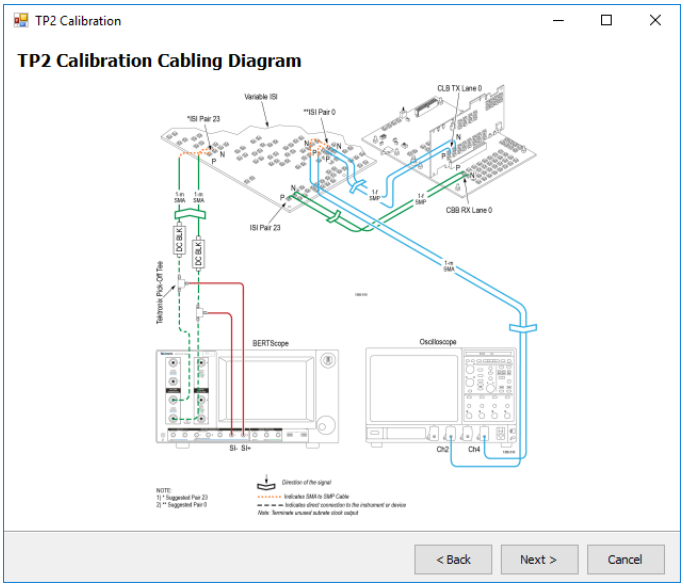

Figure-23(a): TP2 calibration connection diagram for Add-In-Card

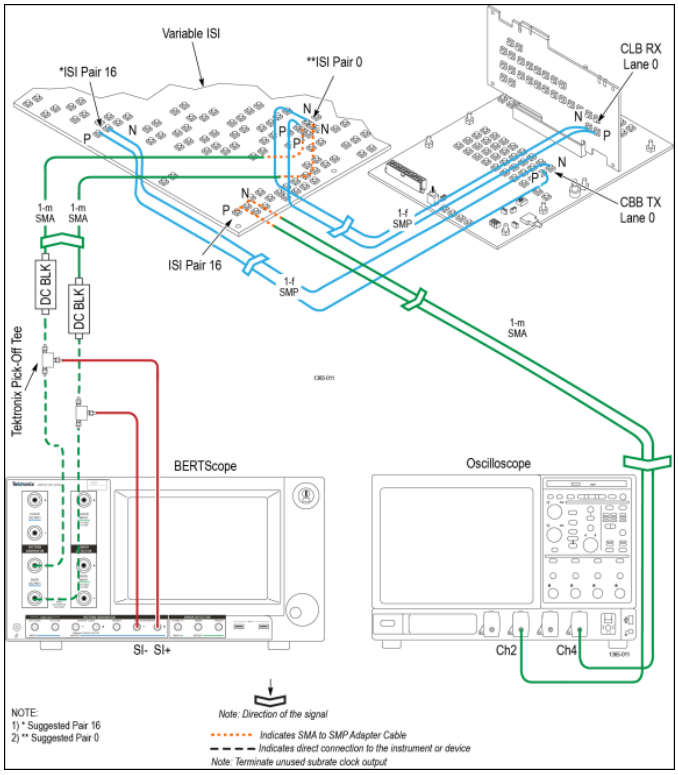

Figure-23(b): TP2 calibration connection diagram for system DUT

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.

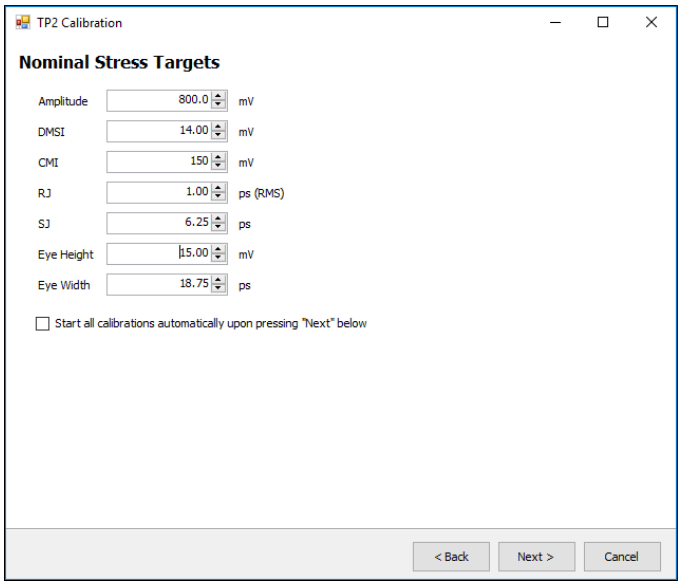

Figure-24: Nominal stress targets for TP2 calibration

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

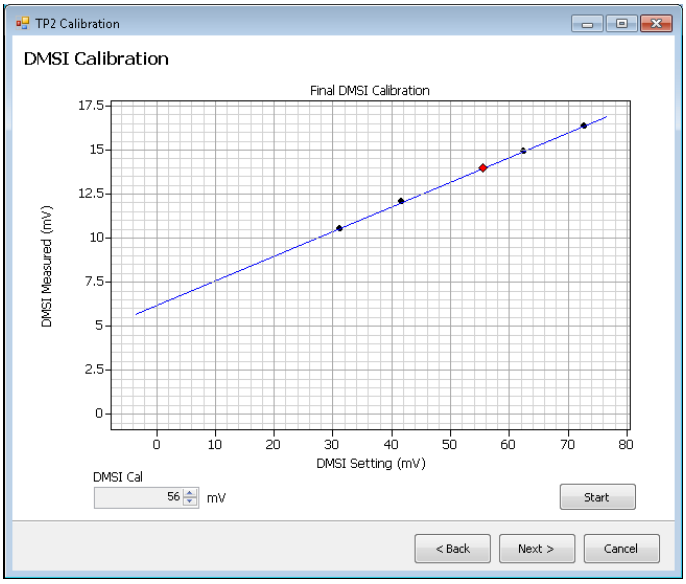

Figure-25: DMSI calibration

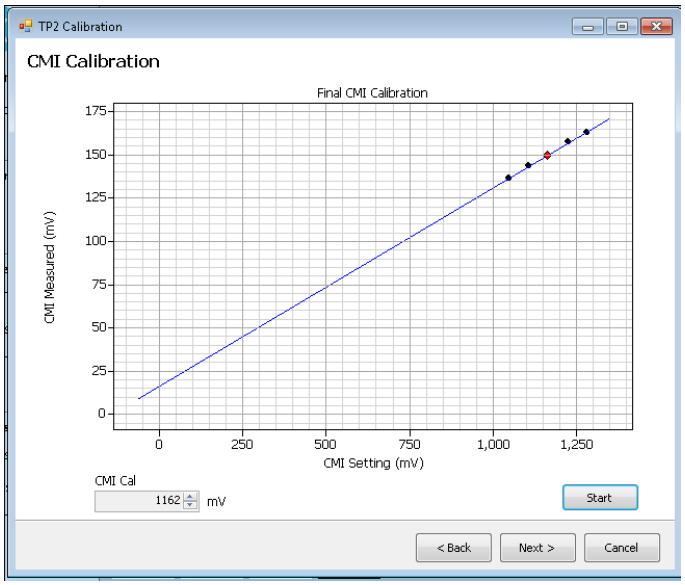

Figure-26: CMI calibration

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.

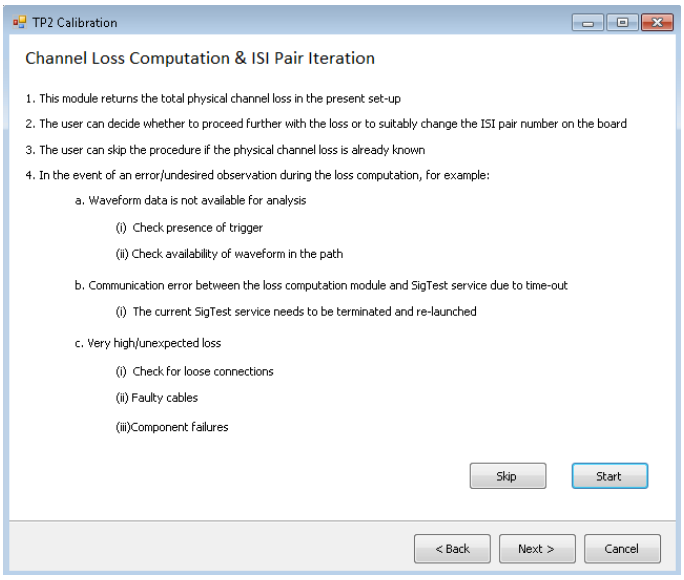

Figure-27: Total physical channel loss computation and ISI pair iteration wizard

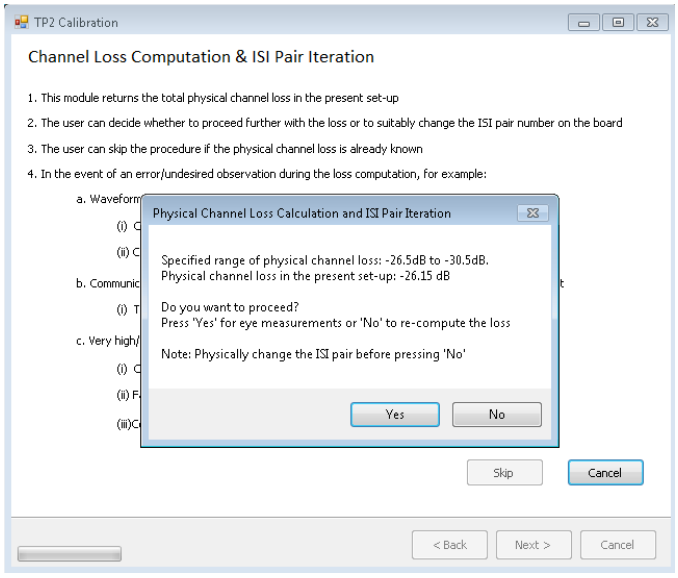

Figure-28: ISI pair iteration

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.

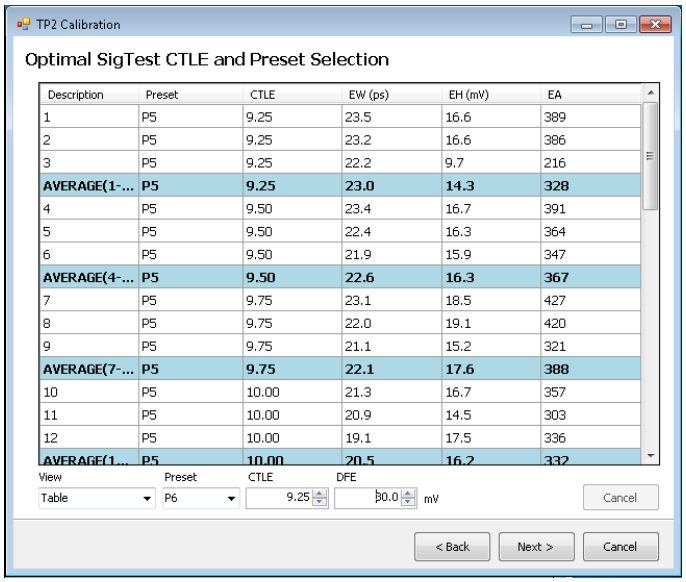

Figure-29: Optimum CTLE and Preset selection

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.

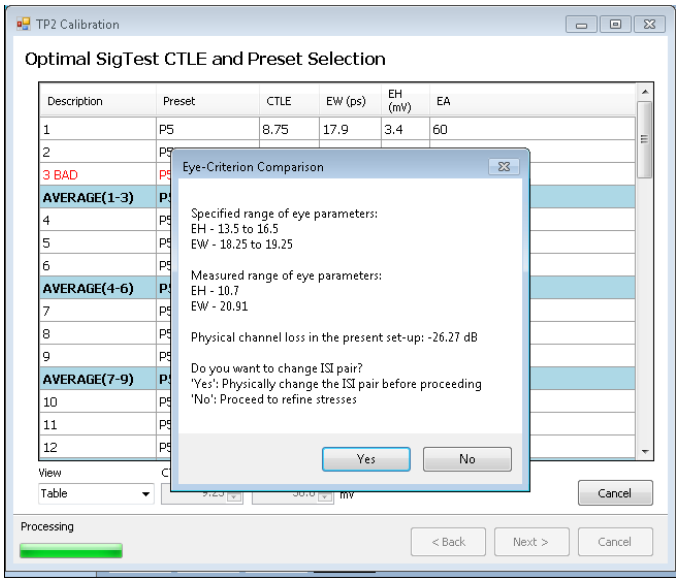

Figure-30: Eye-criterion comparison

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.

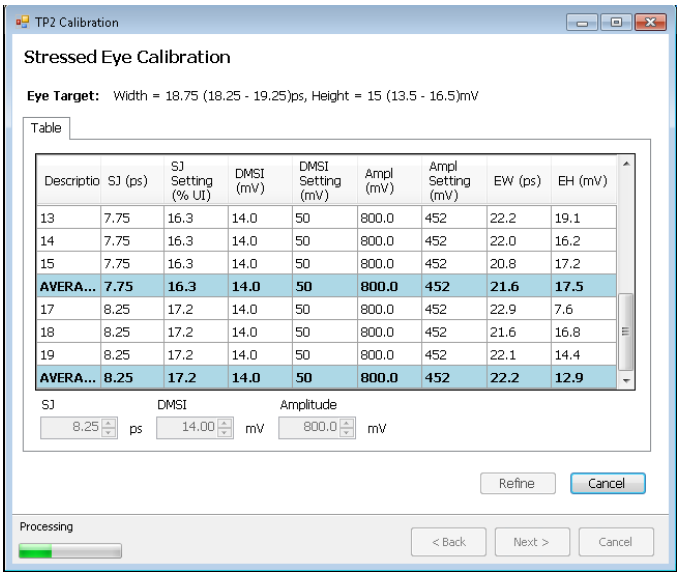

Figure-31: Stressed eye calibration wizard

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.

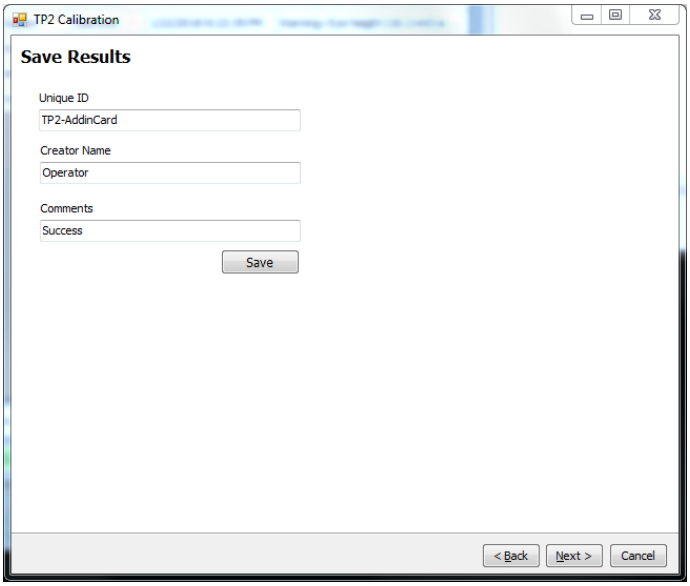

Figure-32: Saving TP2 calibration results

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

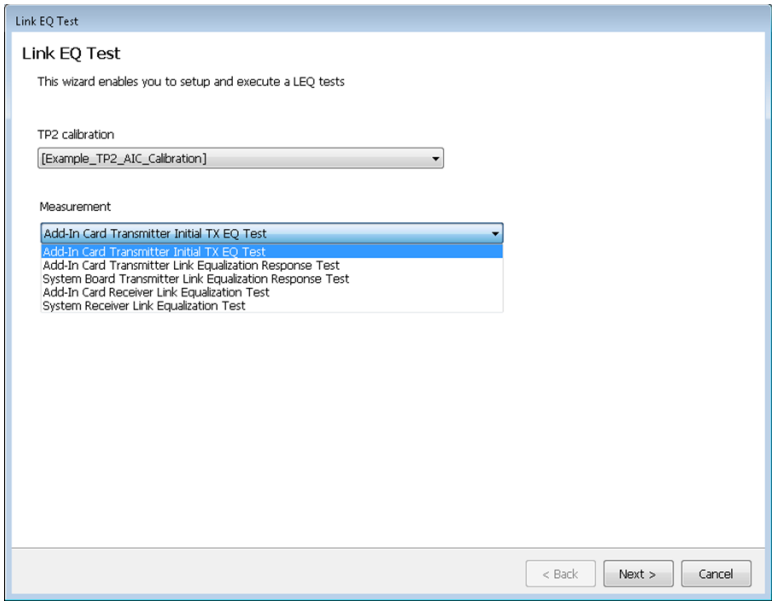

Figure-33: Link EQ test wizard

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

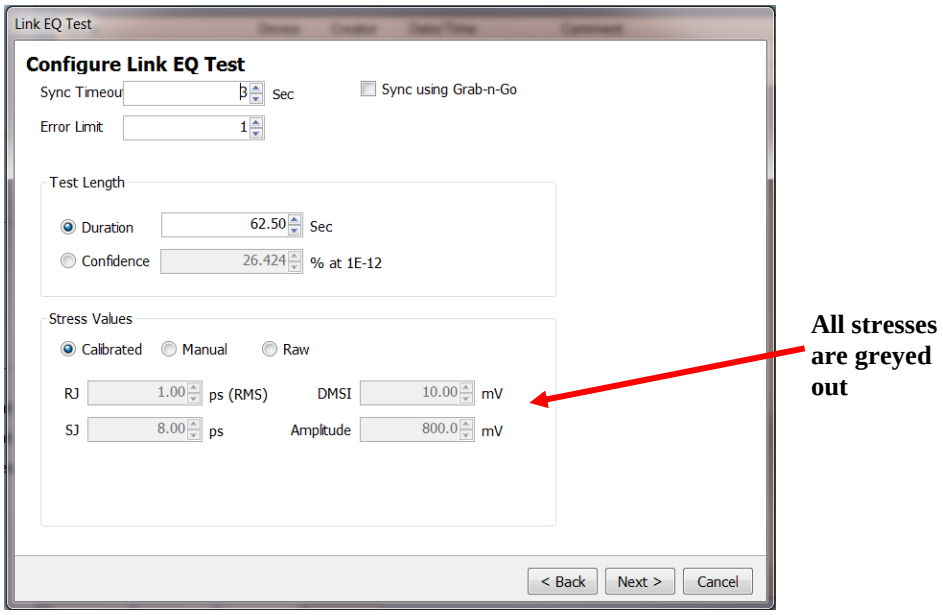

Figure-34: Configure Link EQ Test

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)

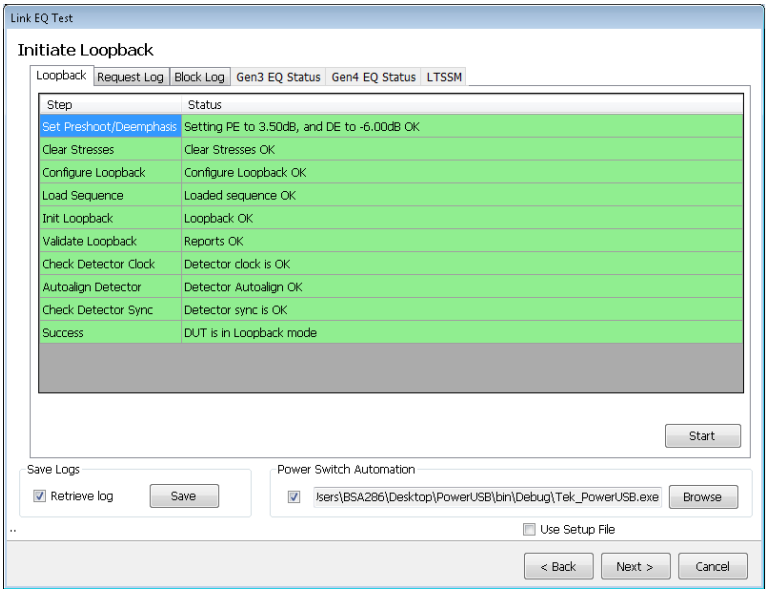

Figure-35: Loopback initiation

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

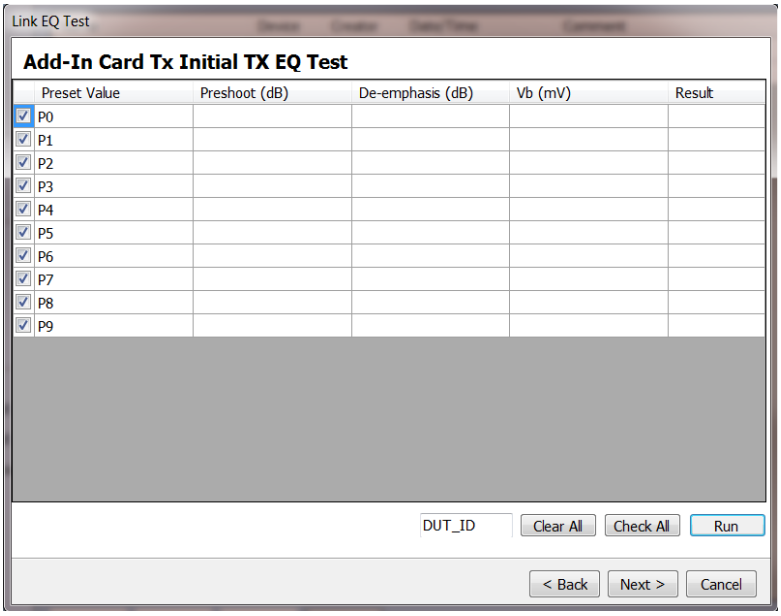

Figure-36: Result table for AIC transmitter initial Tx EQ test

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

BERTScope PCIE4.0 Receiver Testing

RECEIVER TEST RESULTS

Printed 3/2/2018 4:08:57 AM

Information

Name: 242_Bld27
Creator: Niveditha
Description: AIC
Comment:

Date/Time: 3/2/2018 6:08:32 AM
DUT Type: AddInCard

Test Calibrations

TP2: [Example AIC Cal]

BSC S/N: 280094

2.4.2 Add-In Card Transmitter Initial TX EQ Test

Lane0

DUT Initial 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)	Result
P0	0.000	0 , 0	0 , 0	-6.13	-7.5 , -4.5	1.37 , 1.63	213.1	Pass
P1	0.000	0 , 0	0 , 0	-3.60	-4.5 , -2.5	0.9 , 1.1	285.3	Pass
P2	0.000	0 , 0	0 , 0	-4.52	-5.9 , -2.9	1.38 , 1.62	256.5	Pass
P3	0.000	0 , 0	0 , 0	-2.45	-3.5 , -1.5	1.05 , 0.95	325.7	Pass
P4	0.000	0 , 0	0 , 0	0.000	0 , 0	0 , 0	431.9	Pass
P6	2.454	1.5 , 3.5	0.954 , 1.046	0.000	0 , 0	0 , 0	325.6	Pass
P8	3.966	2.5 , 4.5	1.466 , 0.534	-3.96	-4.5 , -2.5	0.54 , 1.46	206.3	Pass
P9	3.636	2.5 , 4.5	1.136 , 0.864	0.000	0 , 0	0 , 0	284.2	Pass

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.

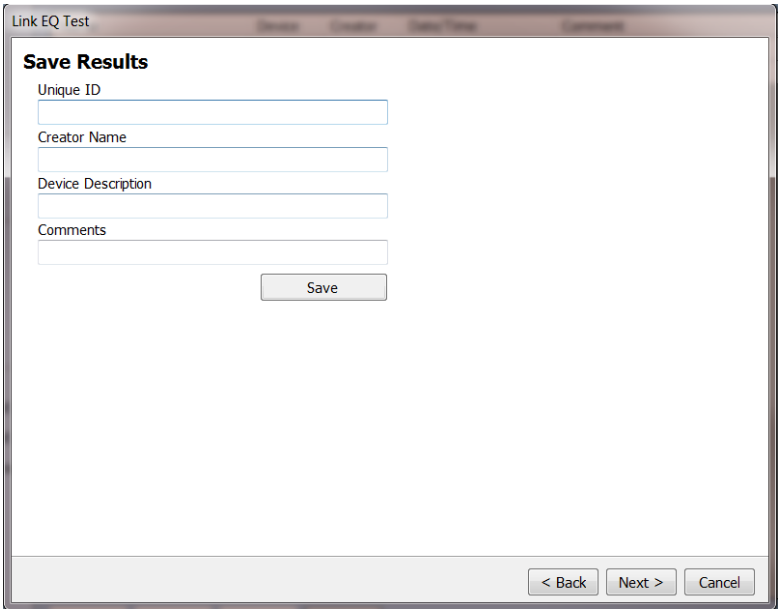

Figure-38: Saving the results

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

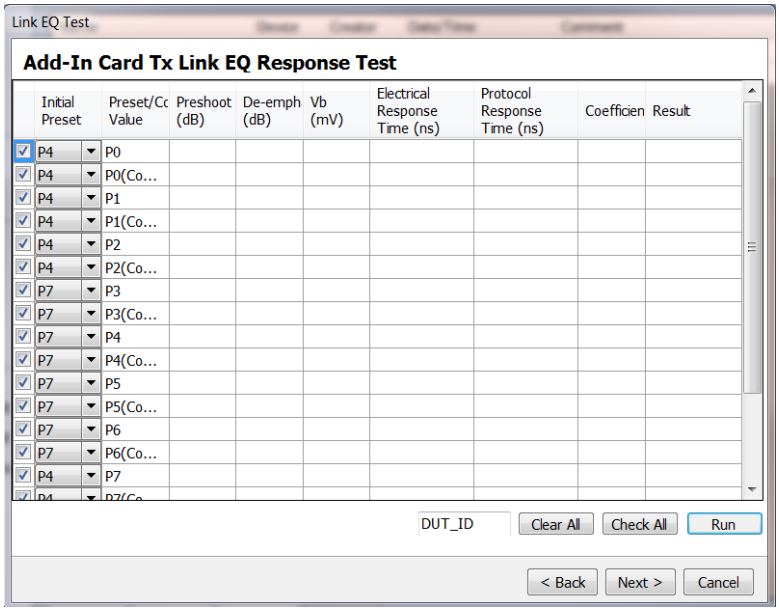

Figure-39: Result table for AIC transmitter link EQ response test

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 PCIE4.0 Receiver Testing

RECEIVER TEST RESULTS

Printed 3/18/2018 7:44:47 PM

Information

Name: 2_5_2
Creator: Suryakant
Description:
Comment: Gen4_Completed_12Min

Date/Time: 3/19/2018 2:44:35 AM
DUT Type: AddInCard

Test Calibrations

TP2: TP2-Cal-B30053

BSC S/N: 280094

2.5.2 Add-In Card Transmitter Link Equalization Response Test

Lane0

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	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	175.6	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}
P7	P5	1.806	0.9 , 2.9	0.906 , 1.094	0.000	0 , 0	0 , 0	330.1	121.3	878.7	171.6	828.4	1000	Pass	{6,57,0}
P7	P6	2.519	1.5 , 3.5	1.019 , 0.981	0.000	0 , 0	0 , 0	304.1	128.1	871.9	174.6	825.4	1000	Pass	{8,55,0}
P4	P7	3.227	2.5 , 4.5	0.727 , 1.273	-6.11	-7.5 , -4.5	1.39 , 1.61	163.3	113.9	886.1	170.8	829.2	1000	Pass	{7,45,11}
P4	P8	3.958	2.5 , 4.5	1.458 , 0.542	-3.94	-4.5 , -2.5	0.56 , 1.44	193.1	109.0	891	169.7	830.3	1000	Pass	{8,47,8}
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}

DUT 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
P7	P3{0,55,8}	0.000	0 , 0	0 , 0	-2.46	-3.5 , -1.5	1.04 , 0.96	304.9	184.9	815.1	168.6	831.4	1000	Pass
P7	P4{0,63,0}	0.000	0 , 0	0 , 0	0.000	0 , 0	0 , 0	404.8	109.5	890.5	156.6	843.4	1000	Pass
P7	P5{6,57,0}	1.783	0.9 , 2.9	0.883 , 1.117	0.000	0 , 0	0 , 0	329.7	115.1	884.9	157.8	842.2	1000	Pass
P7	P6{8,55,0}	2.465	1.5 , 3.5	0.965 , 1.035	0.000	0 , 0	0 , 0	304.8	114.8	885.2	161.7	838.3	1000	Pass
P4	P7{7,45,11}	3.227	2.5 , 4.5	0.727 , 1.273	-6.09	-7.5 , -4.5	1.41 , 1.59	163.5	101.3	898.7	157.6	842.4	1000	Pass
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
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

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

Figure-40: Test report

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

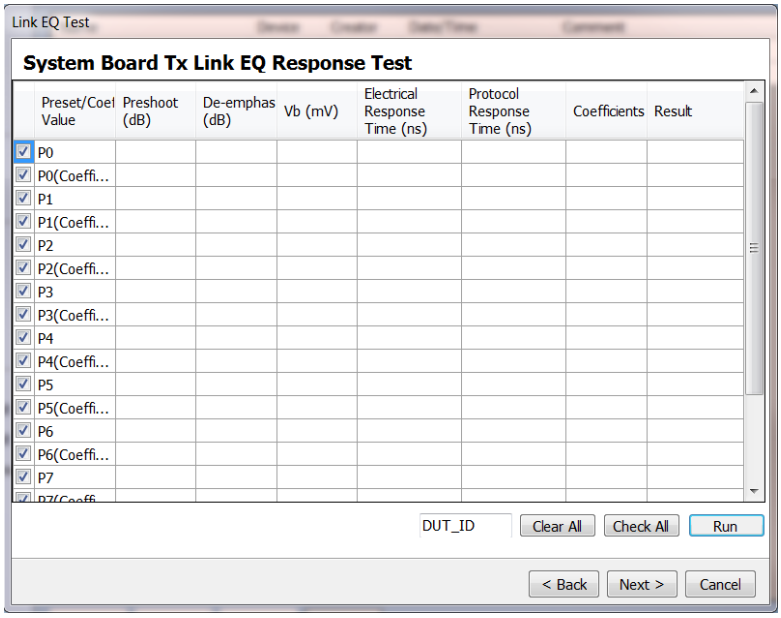

Figure-41: Result table for system board transmitter link EQ response test

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

BERTScope PCIE4.0 Receiver Testing

RECEIVER TEST RESULTS

Printed 3/16/2018 3:22:05 PM

Information

Name:2_10_2
Creator: Suryakant
Description: System
Comment:P7 As Default Init Preset in System

Date/Time:3/16/2018 10:21:21 PM
DUT Type:System

Test Calibrations

TP2: [Example System Cal]

BSC S/N:280094

2.10.2 System Board Transmitter Link Equalization Response Test

Lane0

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	P0	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	P9	3.249	2.5 , 4.5	0.749 , 1.251	0.000	0 , 0	0 , 0	363.9	187.1	812.9	426.6	573.4	1000	Pass	{5,27,0}

DUT Initial Preset	Coefficients value	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{0,24,8}	0.000	0 , 0	0 , 0	-6.57	-7.5 , -4.5	0.93 , 2.07	248.0	200.7	799.3	401.2	598.8	1000	Pass
P4	P1{0,27,5}	0.000	0 , 0	0 , 0	-3.24	-4.5 , -2.5	1.26 , 0.74	364.0	190.7	809.3	396.2	603.8	1000	Pass
P4	P2{0,26,6}	0.000	0 , 0	0 , 0	-4.12	-5.9 , -2.9	1.78 , 1.22	329.2	191.0	809	447.4	552.6	1000	Pass
P4	P3{0,28,4}	0.000	0 , 0	0 , 0	-2.44	-3.5 , -1.5	1.06 , 0.94	399.2	191.3	808.7	400.8	599.2	1000	Pass
P4	P4{0,32,0}	0.000	0 , 0	0 , 0	0.000	0 , 0	0 , 0	529.0	185.1	814.9	410.1	589.9	1000	Pass
P4	P5{3,29,0}	1.970	0.9 , 2.9	1.07 , 0.93	0.000	0 , 0	0 , 0	421.6	185.4	814.6	427.2	572.8	1000	Pass
P4	P6{4,28,0}	2.445	1.5 , 3.5	0.945 , 1.055	0.000	0 , 0	0 , 0	399.2	179.5	820.5	443.2	556.8	1000	Pass
P4	P8{4,24,4}	4.141	2.5 , 4.5	1.641 , 0.359	-4.14	-4.5 , -2.5	0.36 , 1.64	247.8	187.2	812.8	418.5	581.5	1000	Pass
P4	P9{5,27,0}	3.247	2.5 , 4.5	0.747 , 1.253	0.000	0 , 0	0 , 0	364.0	191.9	808.1	417.9	582.1	1000	Pass

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

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

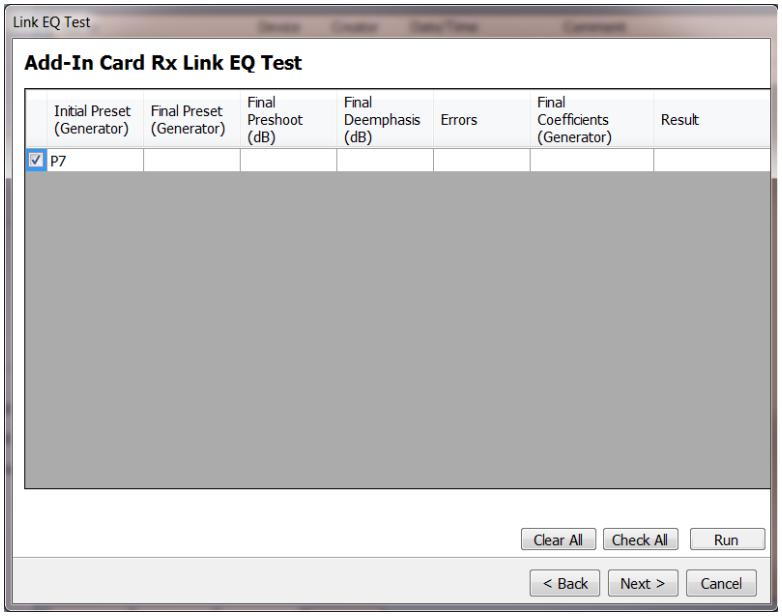

Figure-43: Result table for AIC Rx link EQ test

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

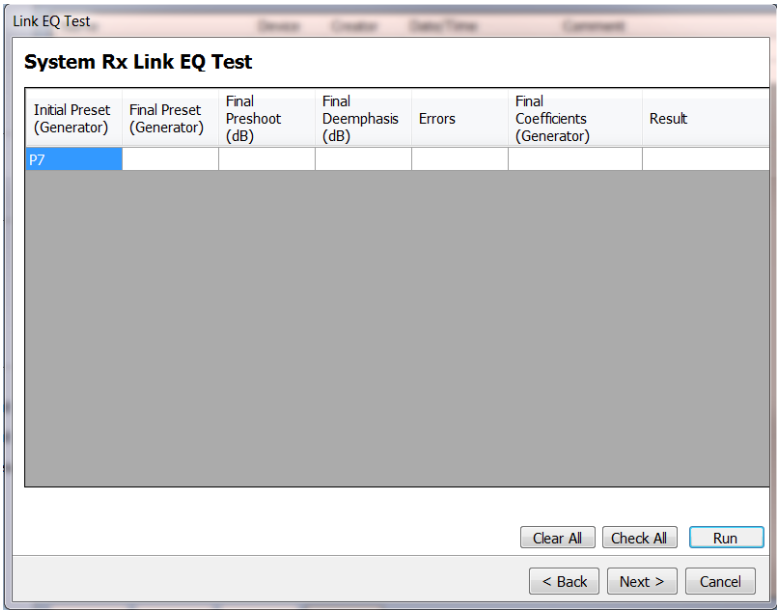

Figure-44: Result table for system Rx link EQ test

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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