**Initial Draft version 1.1**
**Sep-2018**

# Tektronix Method of Implementation for PCIe Gen 3.0 Link Equalization System and Add-In Card Test Procedure

# Table of Contents

## MODIFICATION RECORD

| Version | Date | Changes done |
|---|---|---|
| **0.2Draft** | Dec-2017 | All |
| **0.3** | Feb-2018 | Updated according to Revision 4.0 and Screenshots |
| **0.4** | June-2018 | All Preset run and Power Switch automation |

**References:**
The following documents are referenced in this document:

- *PCI Express® Card Electromechanical (CEM) Specification Revision 4.0, Version 0.7*
- *PCIe Architecture PHY Test Spec Rev 4.0*
- *PCI Express® Base Specification Revision 4.0 Version 1.0*

**Software:**

- BERT Fw above 12.03.5275
- PCie Rx Software Application
- SIGTEST Post postprocessing analysis tools (3.2.0)

**REQUIRED EQUIPMENT**

| Equipment | Details | Quantity | Vender |
|---|---|---|---|
| BSX BERT Scope | BSX125 or BSX240 or BSX320 | 1 | Tektronix |
| Real Time Oscilloscope > 12GHz | DPO72504DX, DPO73304DX, DPO70KDX | 1 | Tektronix |
| Pick-off Tee | PSPL5331 | 2 | Tektronix |
| Power Divider | PSPL5333 (or similar part) | 4 | Tektronix |
| CBB/ CLB | CBB/CLB | 1 | PCI-SIG |
| SMA Cables | PMCABLE1M | 8 | Tektronix |
| DC Block | PSPL5500A or PSPL5501A or PSPL5508 | 2 | Tektronix |
| Equalizer | BSXPCI3EQ | 2 | Tektronix |
| ATX Power Supply | Any ATX Power | 1 | Any |
| SMA-to-SMP connector | TEK part number 174-6657-00 | 6 | Any |

## 1.INTRODUCTION

This MOI (Method of Implementation) provides the test procedures for testing PCIe Gen3 Tx/Rx Link Equalization measurements using Tektronix BSX Series BERTScope. The purpose of the document is to provide the approved test equipment, procedure, connections and setup, for the PCI Express Gen3 Link Equalization compliance program.

## 2. CONNECTION DIAGRAM

This section list the connections diagram used for testing Add-in-Cards and System cards.

## Add-In-Card Tx Link Eq Setup

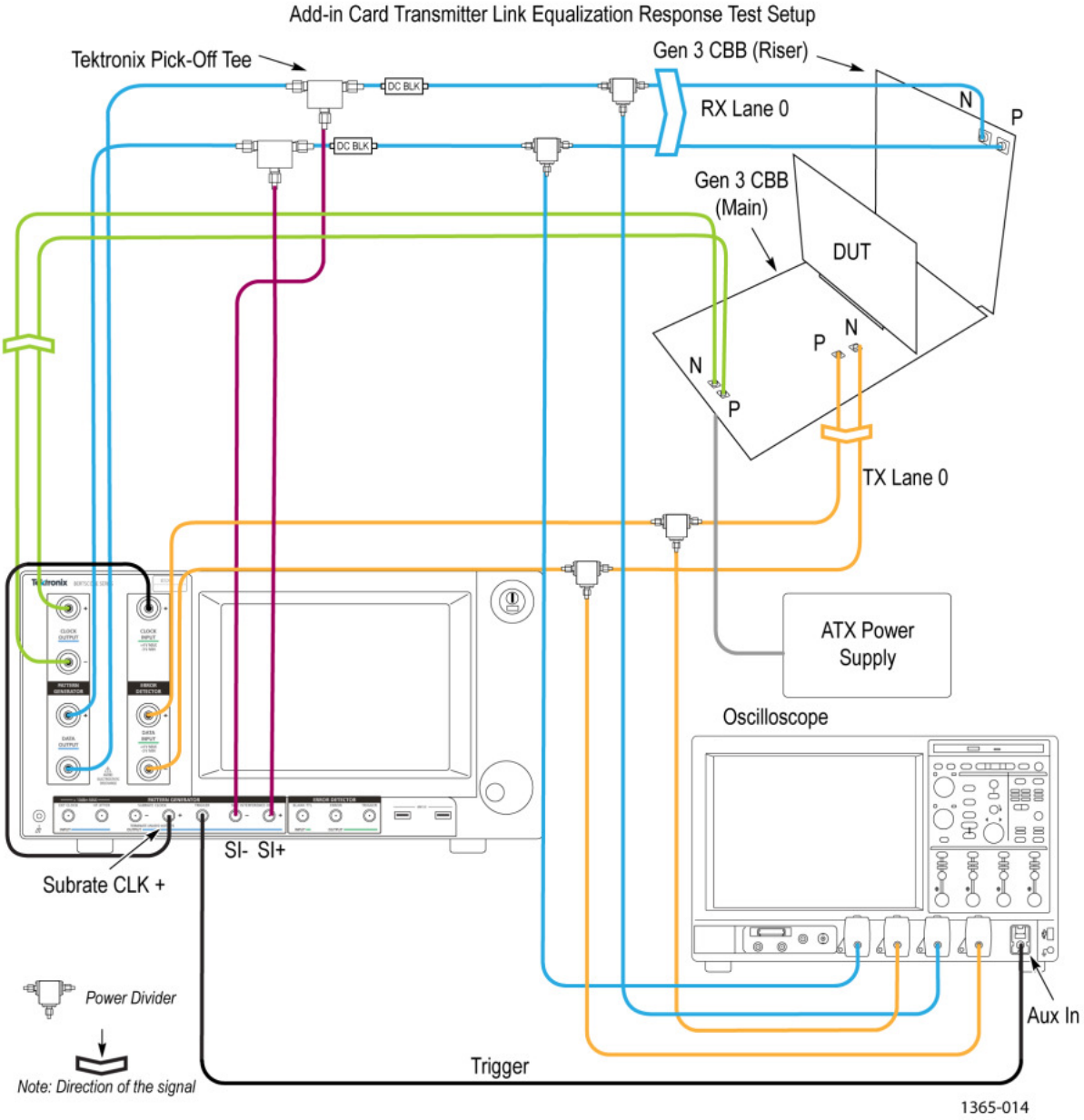



Figure 1: Gen3 Add-In-Card Tx Setup

## System Board Tx Link Eq Setup

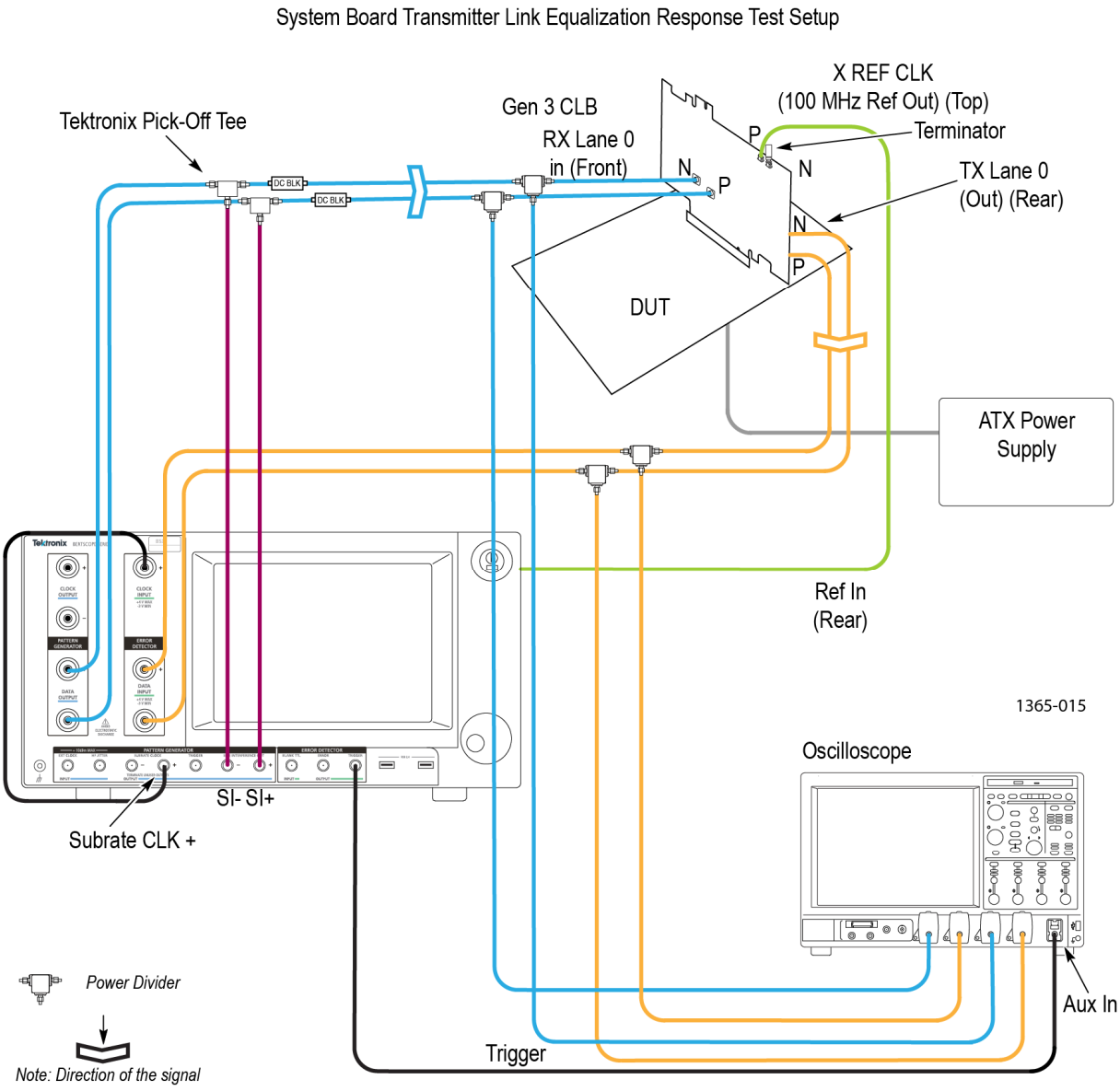



Figure 2: Gen3 System Board Tx Setup

## Add-In-Card Rx Link Eq Setup

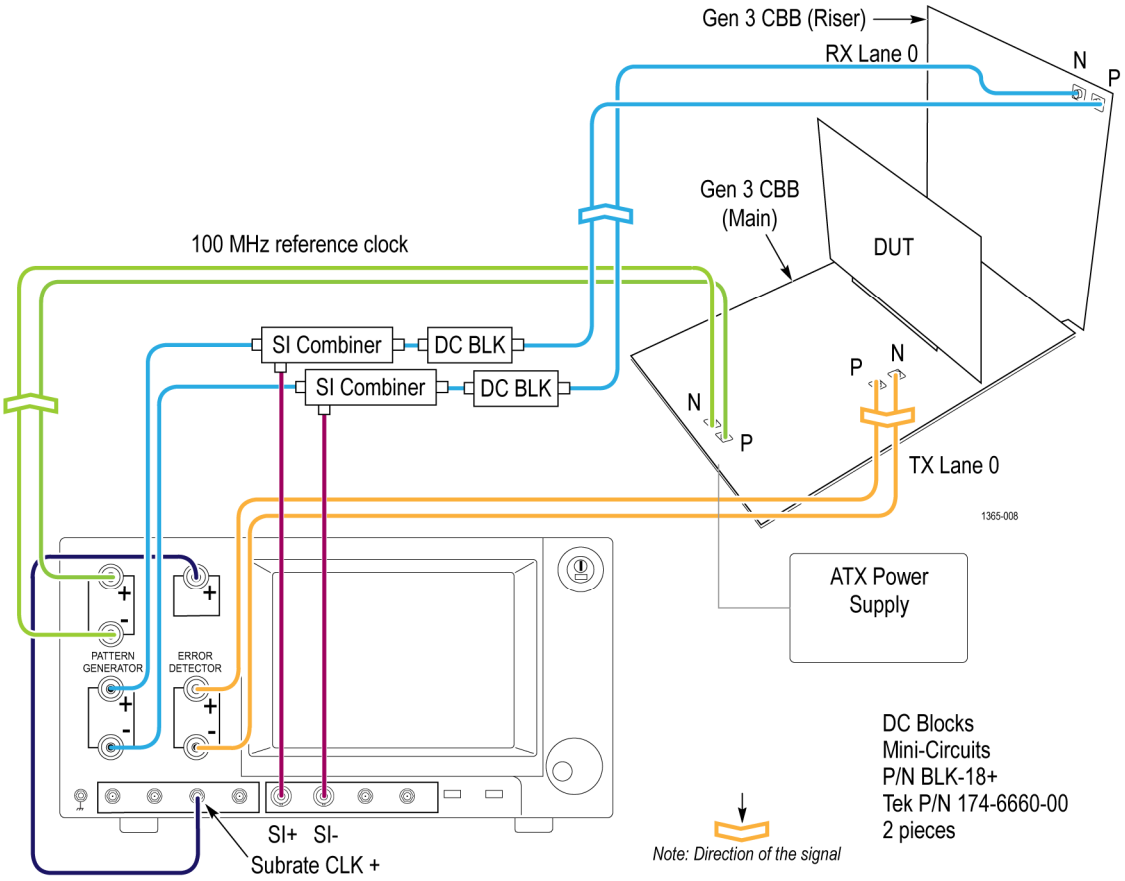



Figure 3: Gen3 Add-In-Card Rx Setup

## System Board Rx Link Eq Setup

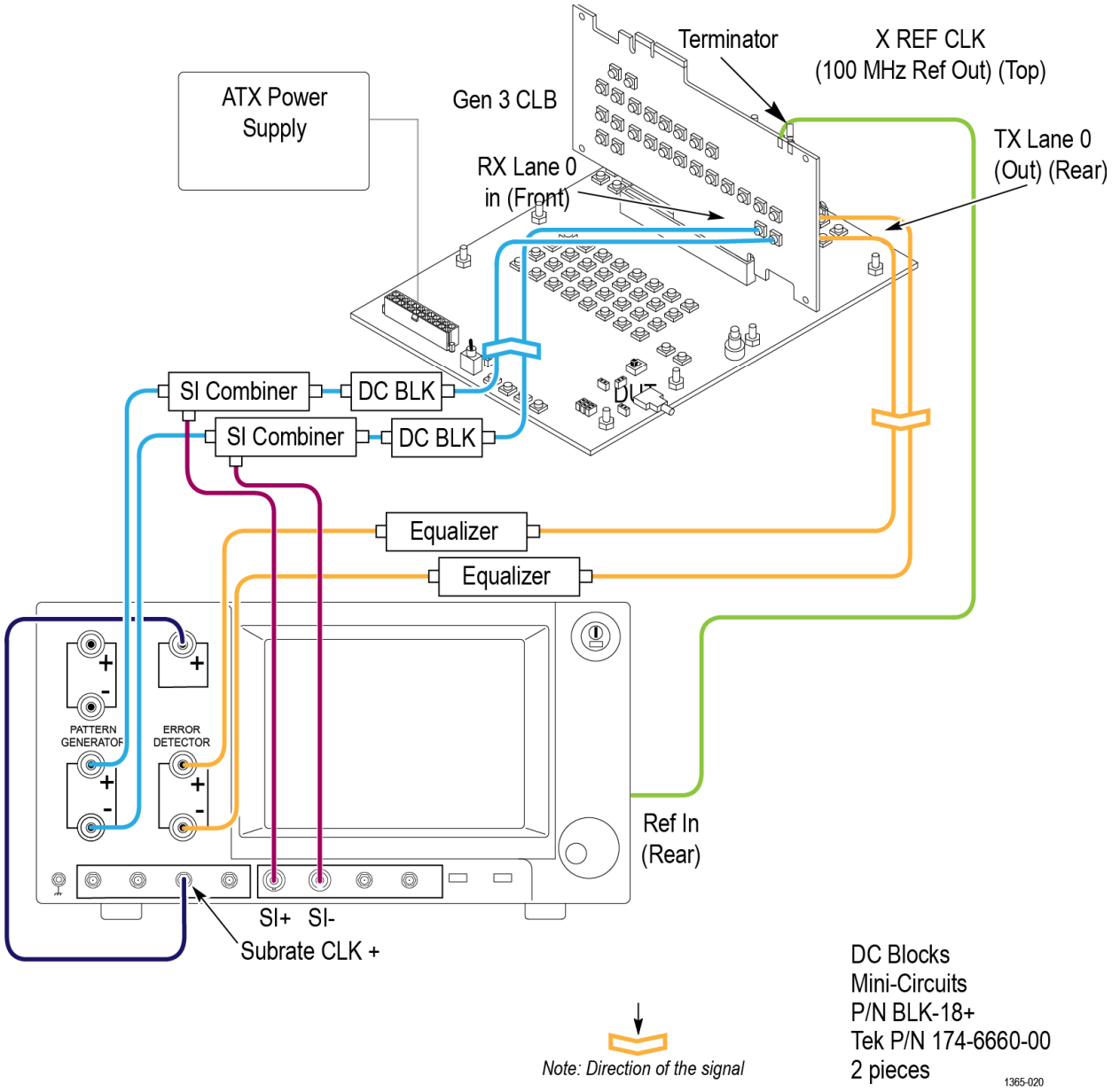



Figure 4: Gen3 System Board Rx Setup

## 3. PRE-REQUISITES

'BERTScope PCIE3.0 Receiver Testing' application communicates with instruments (BERTScope, RT Scope and SigTest Server) using Remote server/client model. Before performing any measurements, it is important to start the Remote Servers on respective instruments. Below are the various Remote Servers that needs to be started before connecting to the instrument. Below Figure shows the PCIe Gen3 Test solution equipment and Software communication.

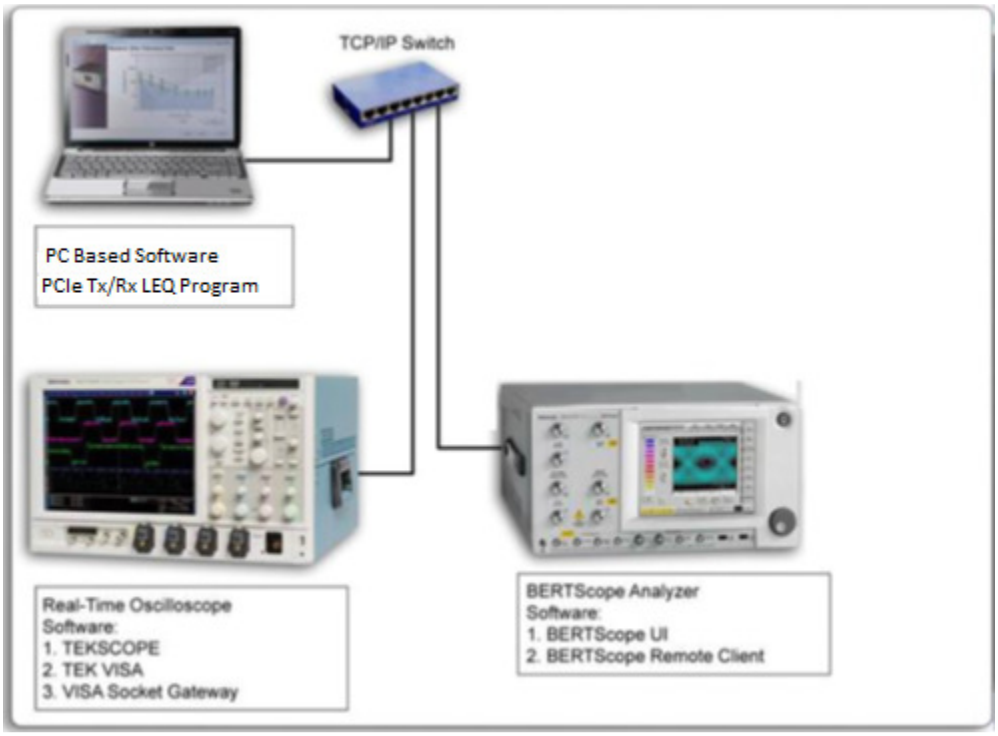



Figure 5

PCIe Gen3 Test Solution Equipment and Software Communication

Note 1: Windows PC is optional. The Receiver test application can be installed either on a Tektronix BERT scope or a Tektronix Real Time Oscilloscope.

### Connect to BERTScope

Start the BERTScope Remote Client app by going to Start->All Programs -> BERTScope
->BERTScope Remote Client. After launching the BERTScope Remote client, change the mode to *'TCP/IP'* from IEEE488 as in below figure.

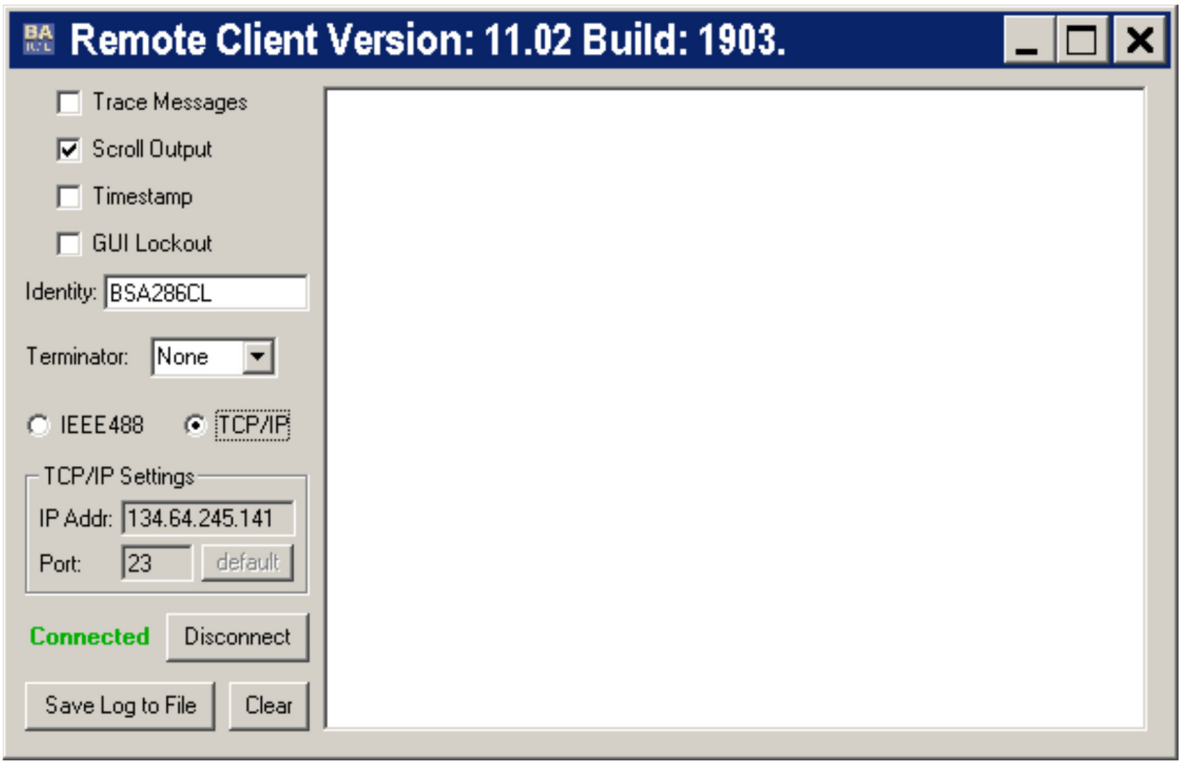



Figure 6

**BERTScope Remote Client**

### Connect to Scope.

Before connecting to the scope, Check the TekVISA Socket Server is running. If Socket Server is not running then Start it from Oscilloscope desktop tray. This server will provide the connectivity between *'BERTScope PCIE3.0 Receiver Testing'* and Oscilloscope. (Desktop Tray -> TekVISA LAN Server Control -> Start Socket Server)

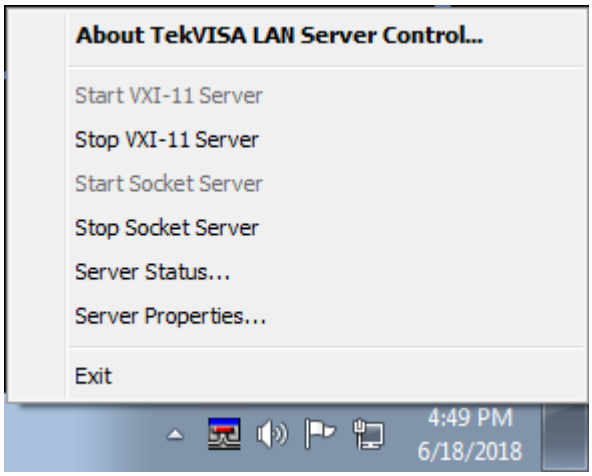



Figure 7

## Connect to SigTest Server

SigTest application runs inside the scope, hence SigTest Server also needs to be launched inside the Oscilloscope from the below location (C:\ProgramFiles\Tektronix\BERTScope\RxTest30\Tools\SigTestService\2.5\ SigTestService.exe). The appropriate version gets reflected based upon the PCIe generation under SigTestService. If application is not installed in Oscilloscope Then Copy 2.5 Folder from the installed location and keep it anywhere in Oscilloscope.

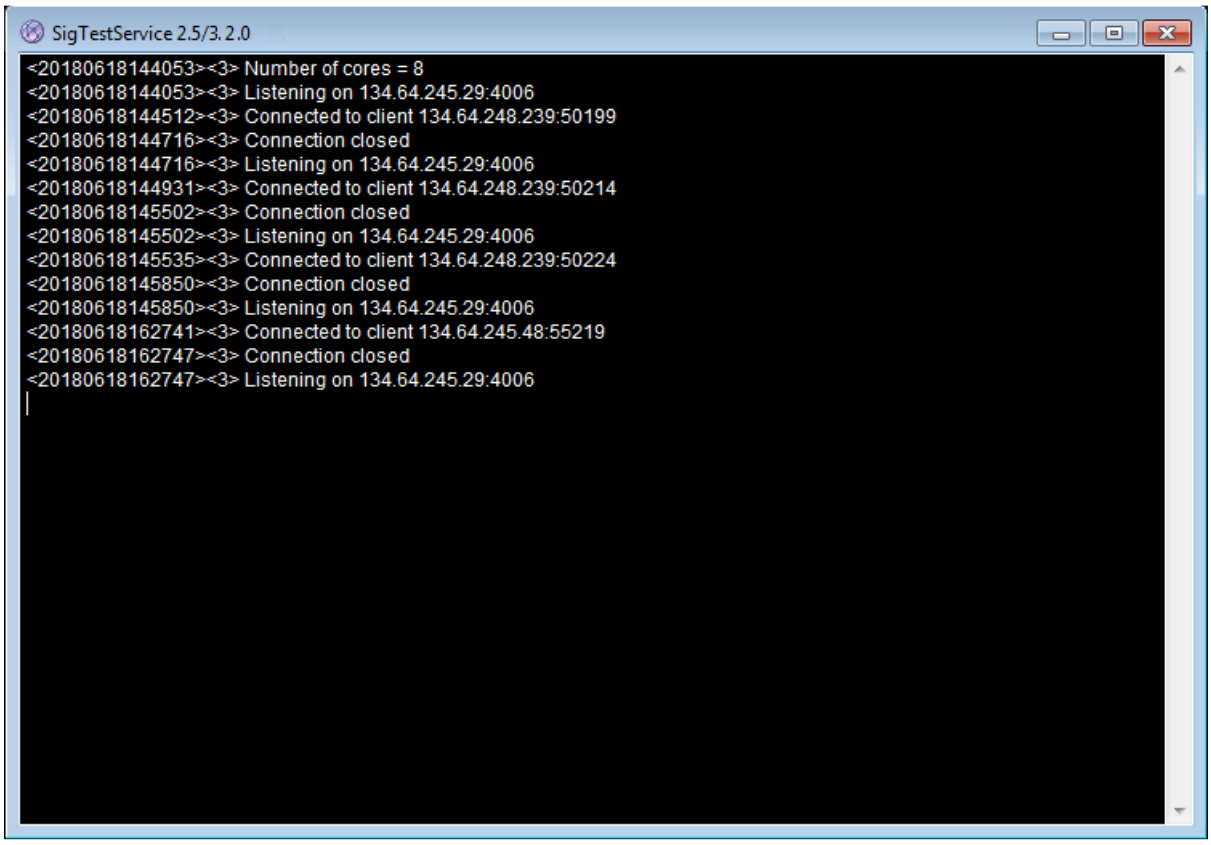



Figure 8

## 2.1. Connect to Devices (BERTScope RX App).

Press '*Start Connect'* to open the *'Connect to Devices'* panel. Enter the IP address of the instrument and then press *'Connect'* (this should be done after doing steps 2.1, 2.2, 2.3). Once the instrument is connected then the button turns to *'Disconnect'* and Instrument ID is displayed at the bottom and it is highlighted with Green color.

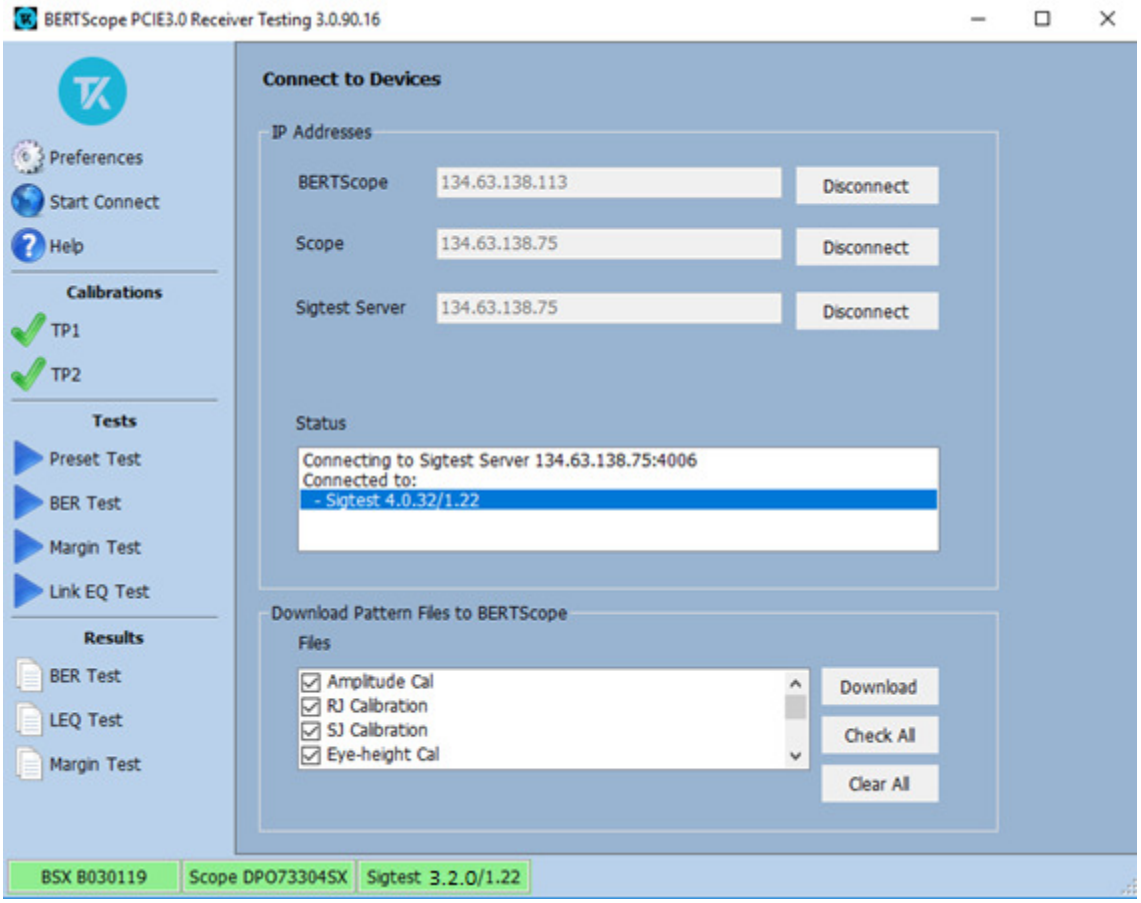



Figure 9

# 4. CALIBRATION

Calibration is performed to compensate for cable/fixture losses. Two types of calibration need to be performed.

- TP1 Calibration.
- TP2 Calibration.

Calibration wizard automates the calibration procedure. Calibration wizard will walk you through different calibration steps. Once the calibration is done, the results can be stored in a database and re-used later.

## 4.1TP1 Calibration

4.1.1 Press TP1 Calibration to launch the 'TP1 Calibration' Wizard.

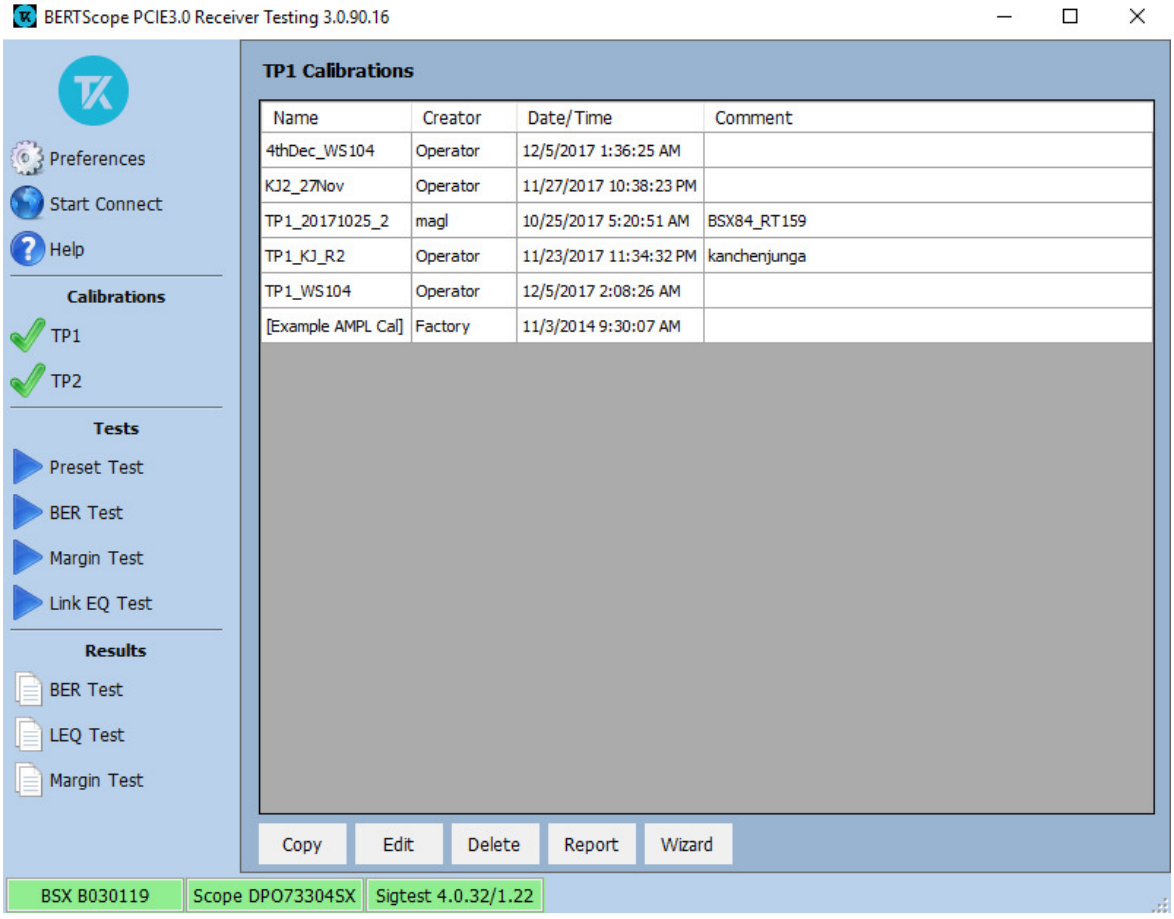



Figure 10

4.1.2 From the TP1 Calibrations view, select the appropriate calibration file or, if an appropriate calibration file does not exist, press Wizard to begin the automated step-by-step calibration procedure.

4.1.3 Calibrations stored in the system database may be managed using the controls as in the below list:

| **Control** | **Description** |
|---|---|
| Copy | Copy the selected file as a new database entry |
| Edit | Edit the selected file |
| Delete | Delete the selected 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. |

### 4.1.4 TP1 Calibration Wizard

Below is the TP1 Calibration Wizard. Read the instruction and Press '*Next*'.

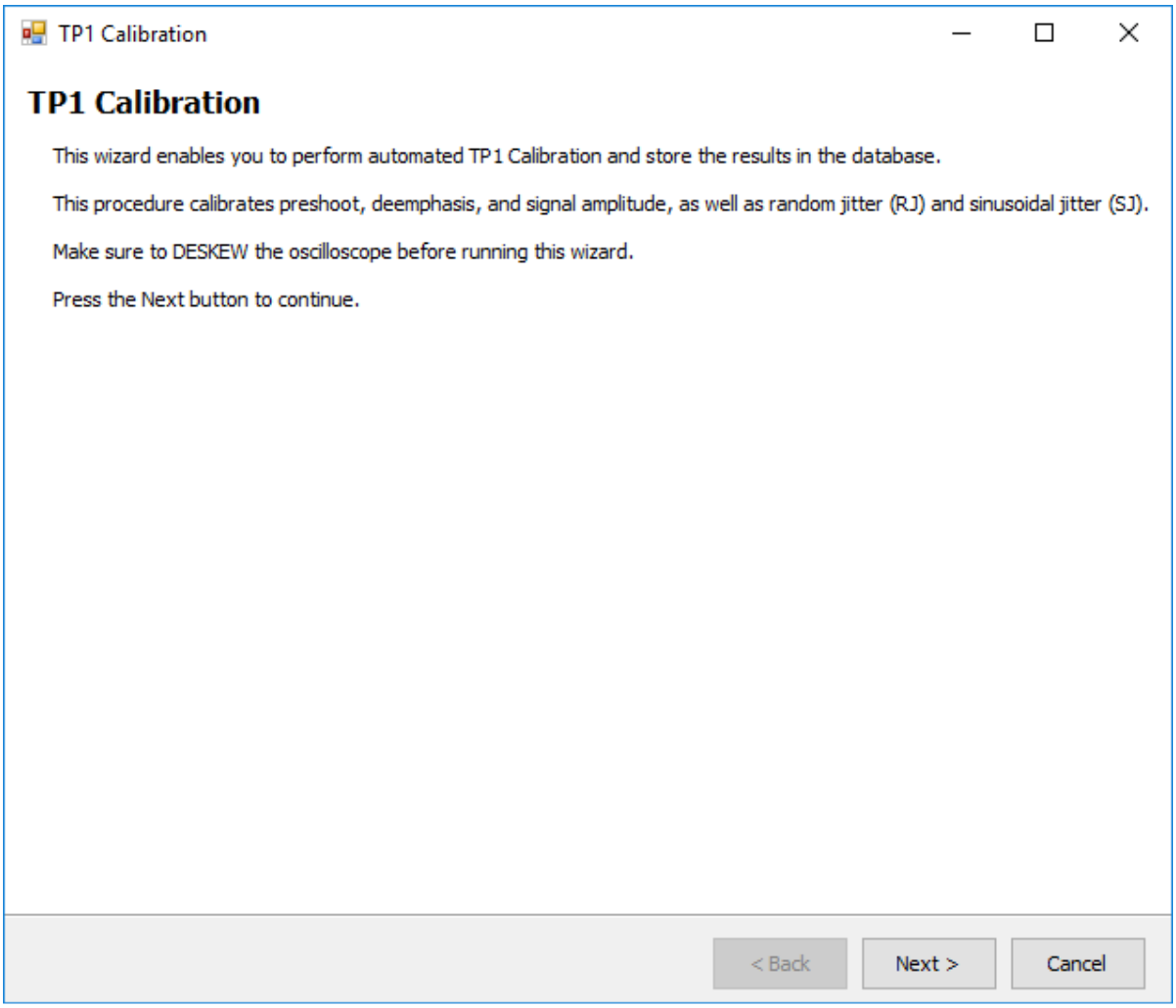
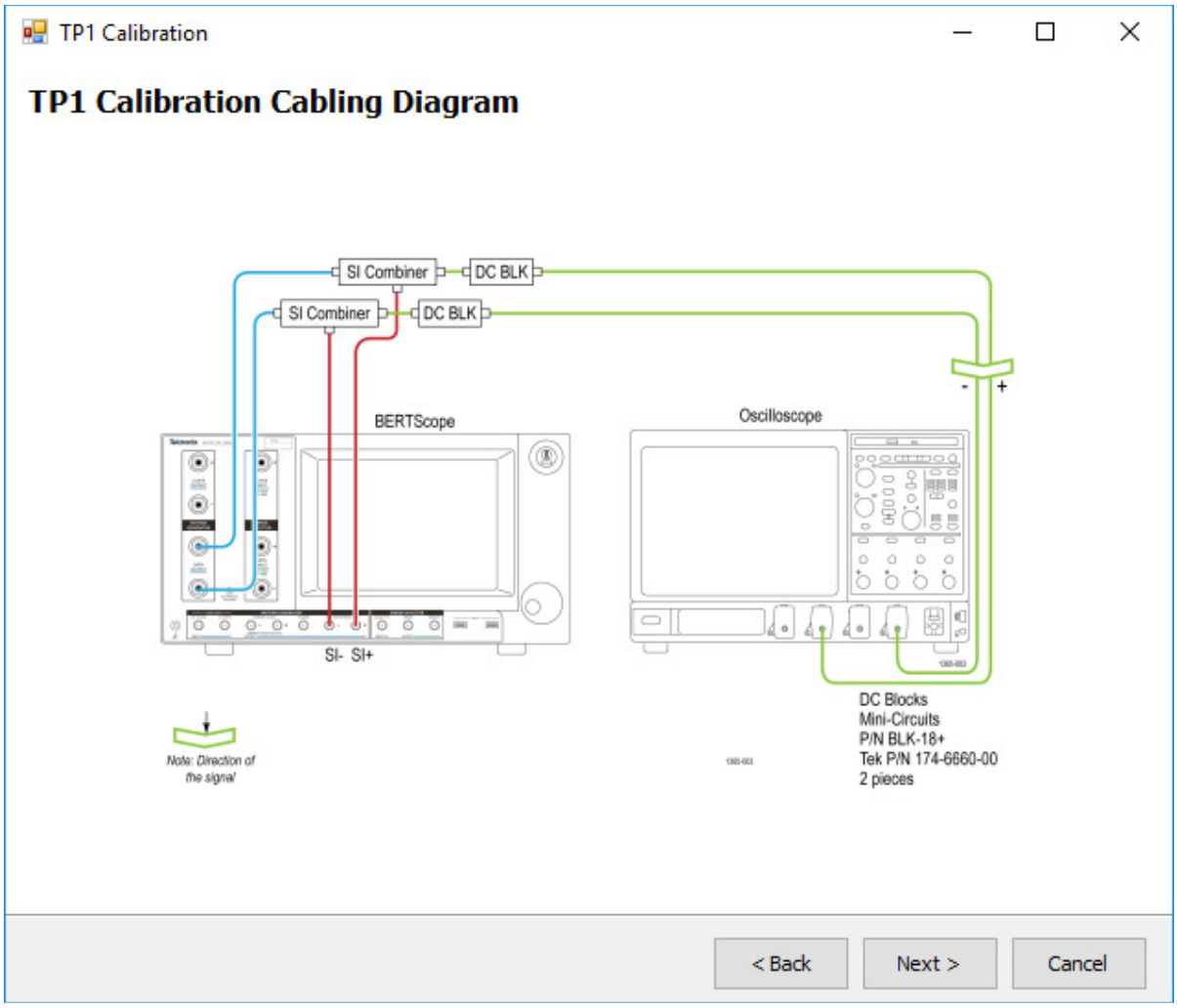



Figure 11

### 4.1.5 TP1 calibration Cabling Diagram

Application shows the 'TP1 Calibration Diagram' as in Figure 12. Do the connection as in the figure and then press 'Next'.

Figure 12




Note: TP1 Cabling diagram is same for Add-in Card and System Board

### 4.1.6 Initialize Equipment

Application will initialize the equipment's like, BERTScope and RT scope. It will set the required impairments on the BERTScope and calibrates the signals using the RT Scope. Press 'Run' to execute the instrument initialization and after initialization press 'Next'.

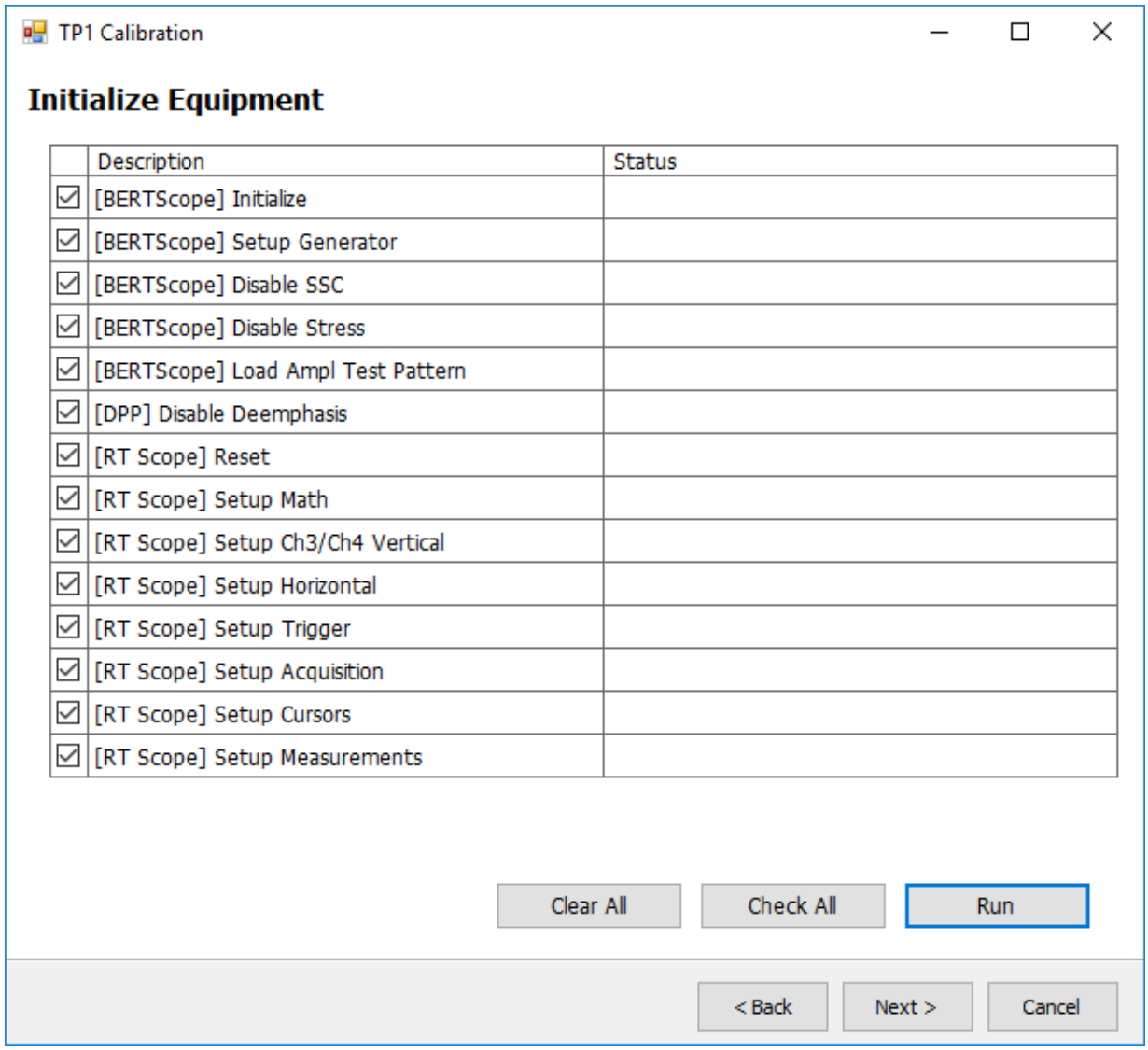



Figure 13

### 4.1.7 Select the Stress Targets

Application will show the stress targets as per the *PCI Express® CEM Specification Revision 4.0 Version 0.7*. If user wishes to test the application with different stress targets then they can change the values in this panel.

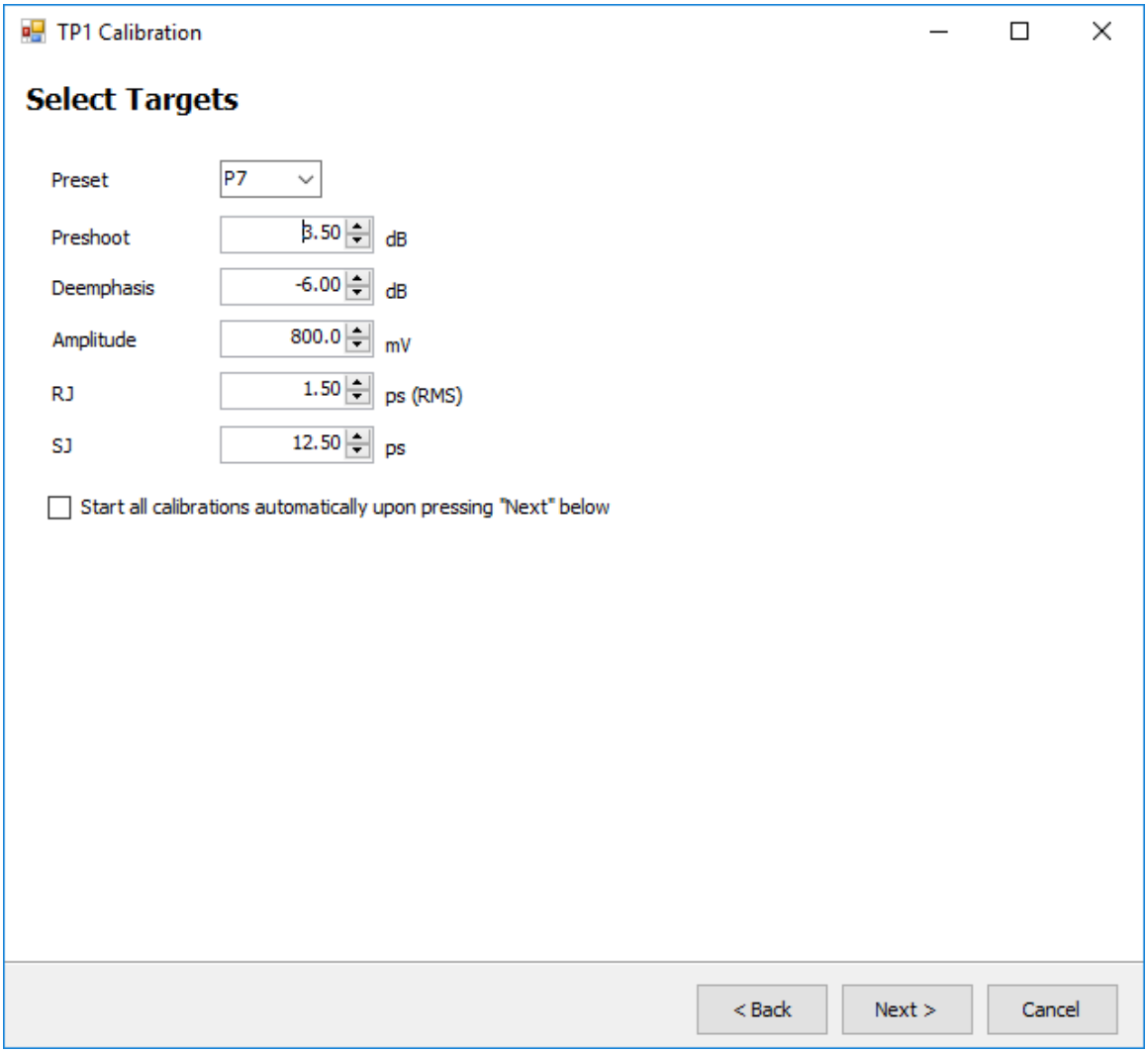



Figure 14

Check the ‘Start all calibration automatically upon pressing “Next” below’, to start the automatic calibration of amplitude, Rj and Sj parameters without having to press ‘Next’ in each of the panel/Step. If this checkbox is un-checked then user must manually press ‘Next’ upon completion of each of the calibration step.

### 4.1.8 Perform AC-DC Amplitude Balance Calibration

The graph shows black dots representing measurements taken with settings evenly spaced throughout the calibration range. Using the set value and measured value, a straight line is fit. Using the straight-line equation (slope and intercept), settings for the target value is calculated. This value is set on the BERTScope and measured value is shown with a red dot.

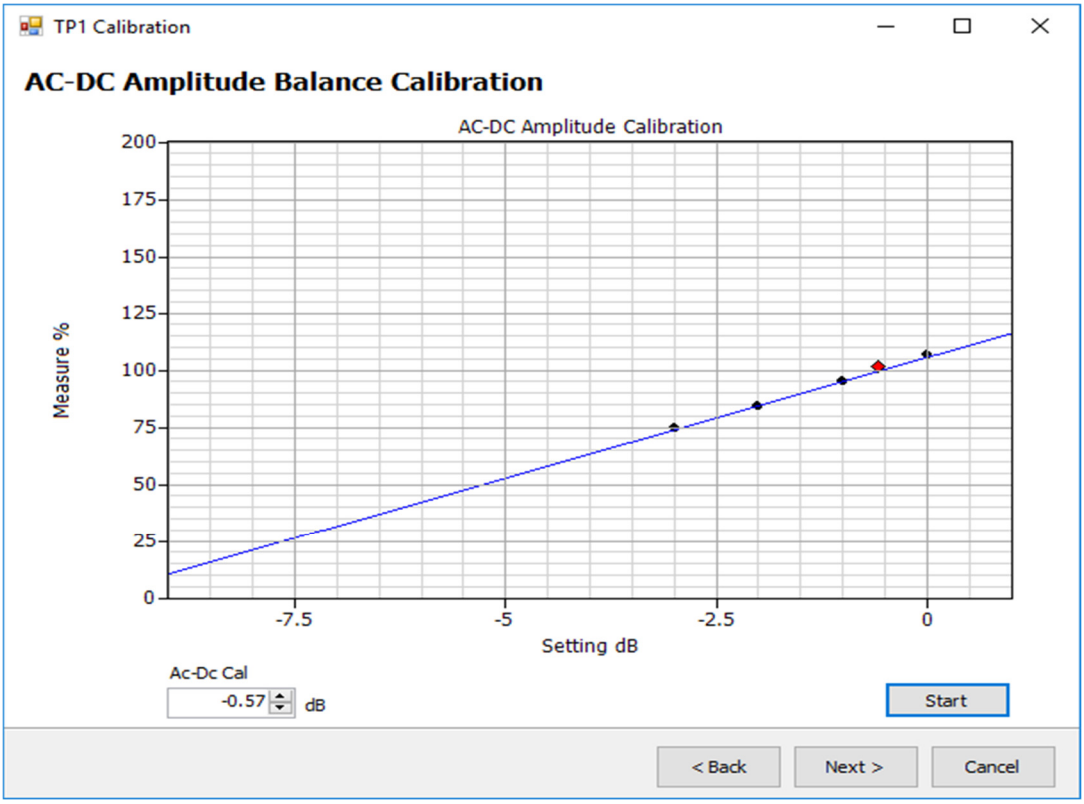



Figure 15

### 4.1.9 Perform Deemphasis Calibration

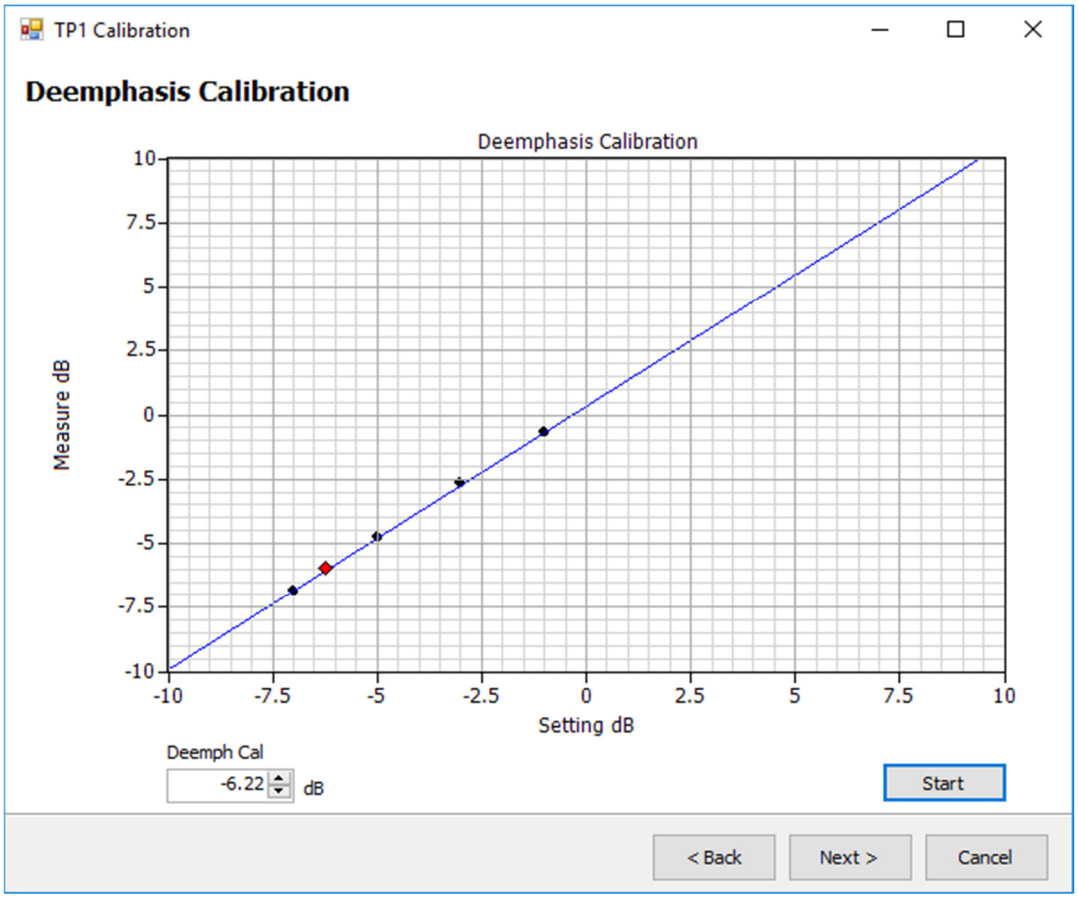



Figure 16

### 4.1.10 Perform Preshoot Calibration

Press '*Start*' to start the calibration. Press '*Next*' once the calibration is done.

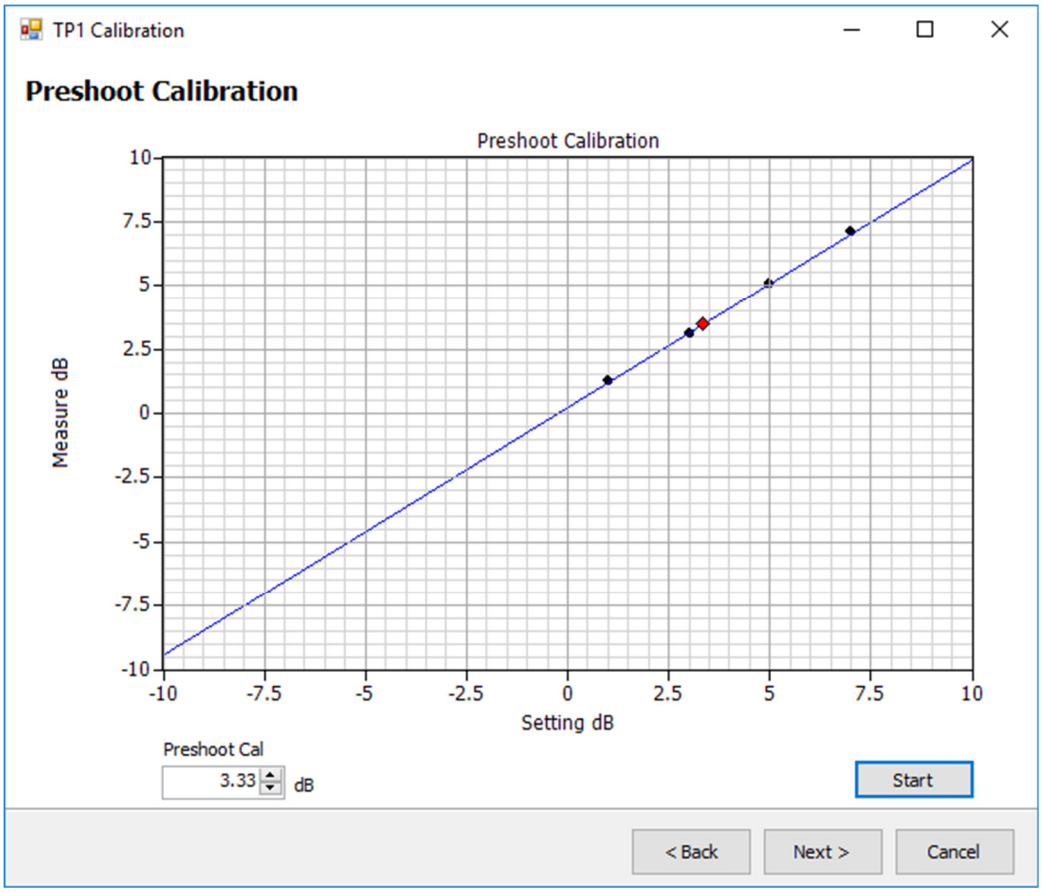



Figure 17

### 4.1.11 Perform Amplitude calibration

Press '*Start*' to start the calibration. Press '*Next*' once the calibration is done.

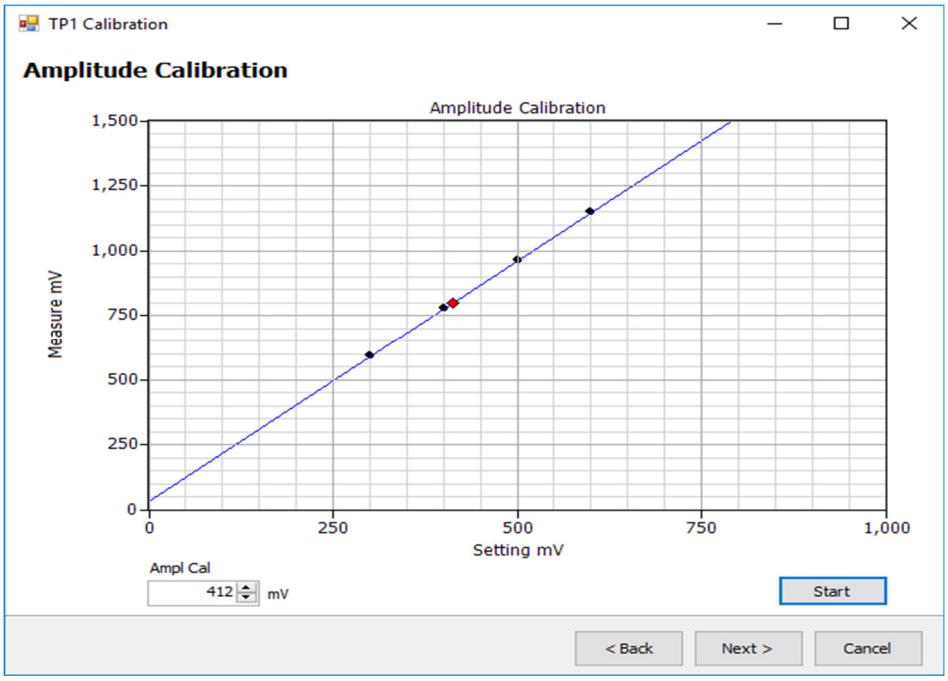



Figure 18

### 4.1.12 Perform RJ Calibration

Perform the RJ calibration. Waveform is saved on the oscilloscope and SigTest is used for RJ measurement. Press 'Start' to start the calibration. Press 'Next' once the calibration is done.

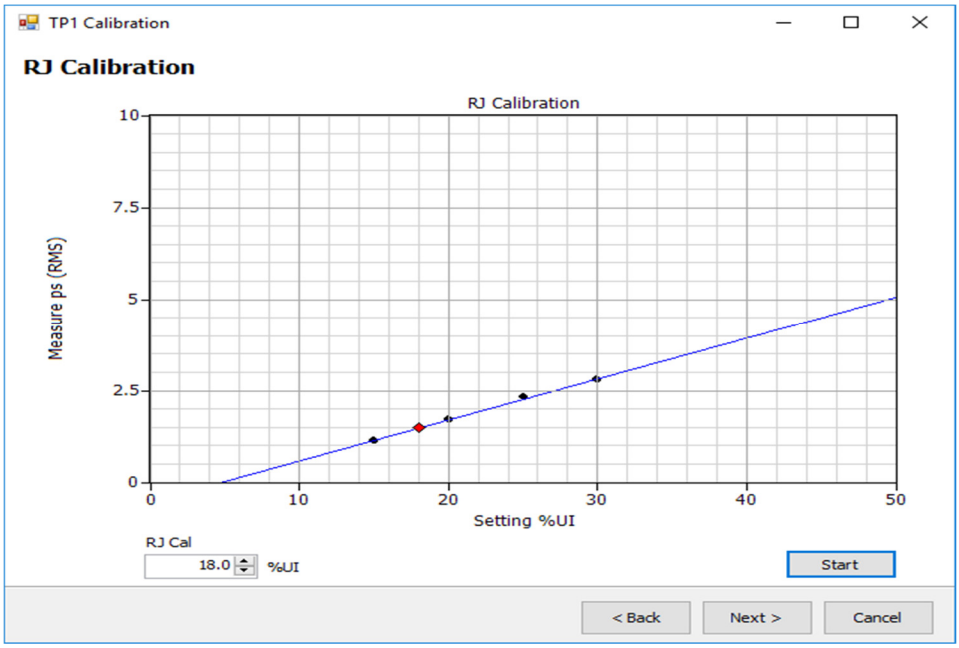



Figure 19

### 4.1.13 Perform SJ calibration

Perform the SJ calibration. Waveform is saved on the oscilloscope and SigTest is used for SJ measurement. Press 'Start' to start the calibration. Press 'Next' once the calibration is done.

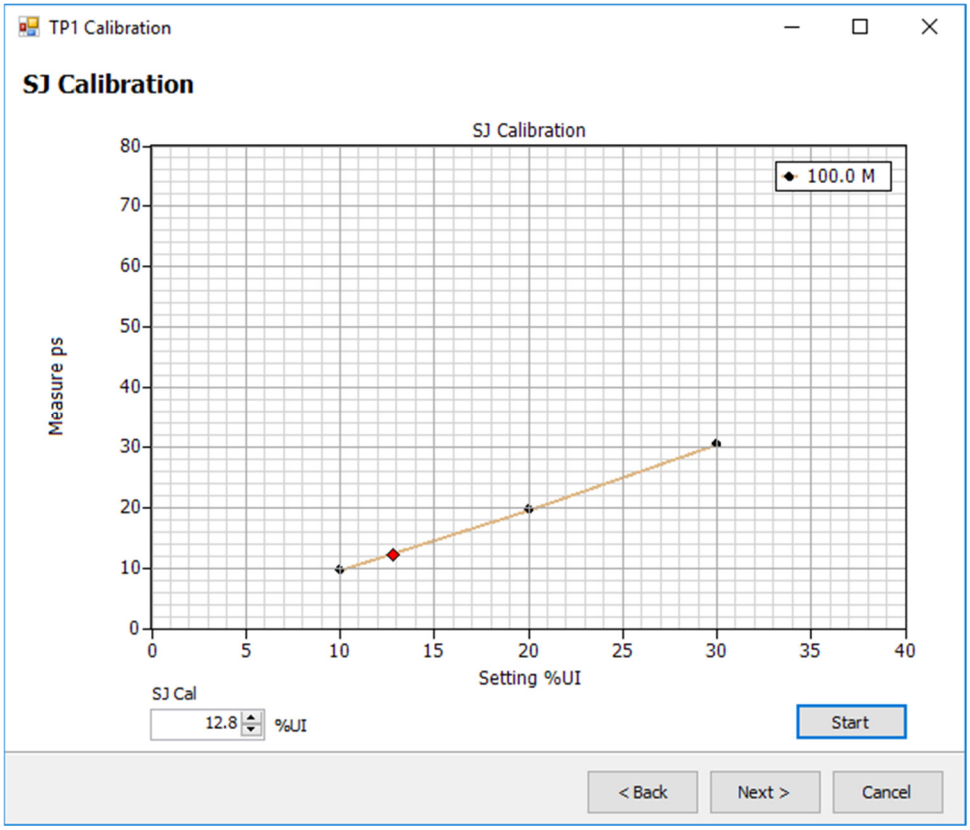



Figure 20

### 4.1.14 Save Calibration results:

Calibrated results can be saved in a data base. To save the values, enter the '*Unique ID*', '*Creator Name*' and 'Comments' and press '*Save*'.
TP1 Calibrated values can be used for performing the TP2 Calibration and to perform 'Jitter Tolerance' test.

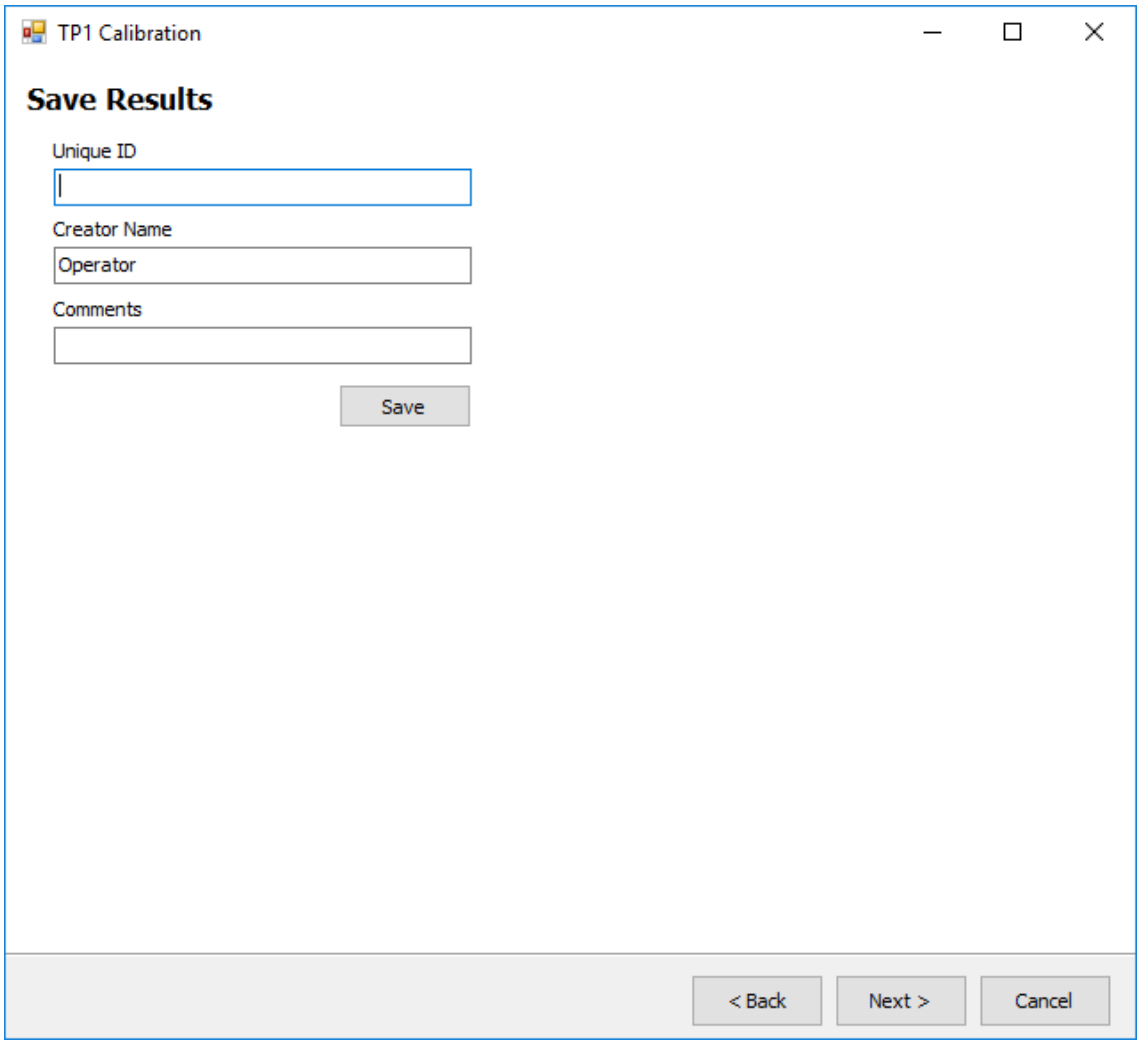

TP1 Calibration
Save Results
Unique ID
Creator Name
Operator
Comments
Save
< Back
Next >
Cancel

Figure 21

## 4.2 TP2 Calibration

The TP2 Calibration Wizard automates the calibration as per the Specification. You will be prompted with diagrams to make certain test equipment connections, then begin the automated calibration procedures, and store the results when completed.

### 4.2.1. TP2 Wizard

This wizard helps to perform the automated Eye Calibration and helps to store the results in the Data Base
One of the below configuration can be selected ('Type of Calibration')
- 'AddInCard'
- 'System'

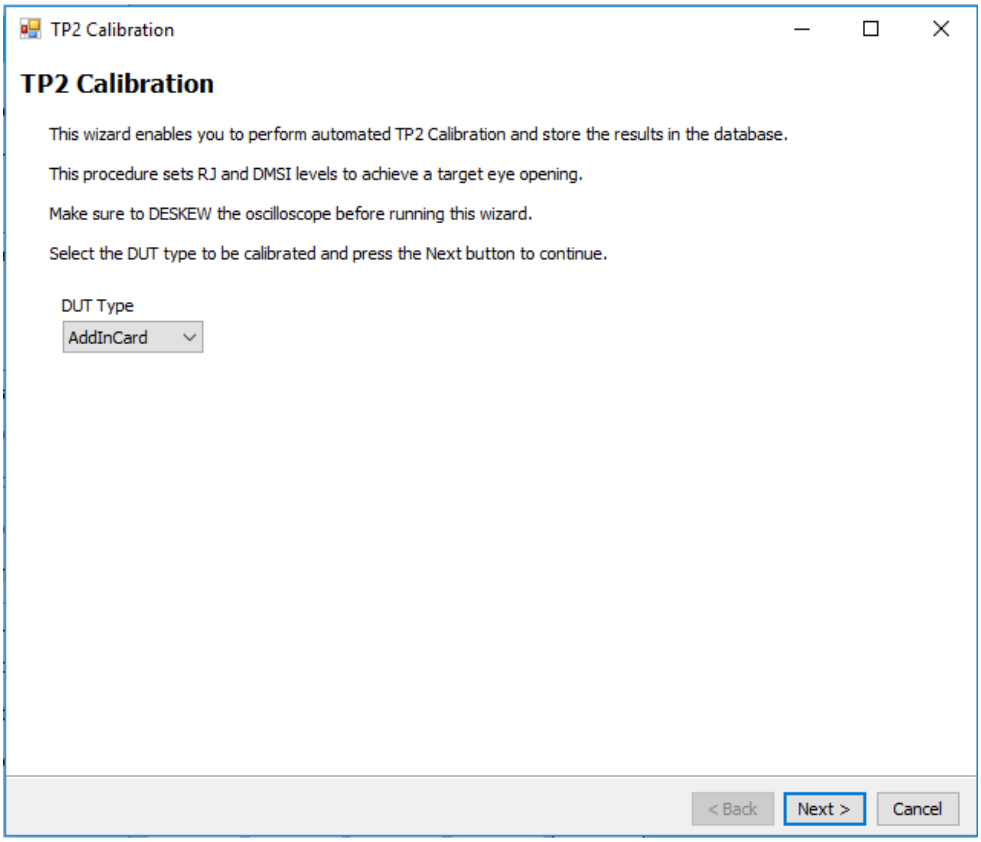



Figure 22

### 4.2.2. Select the TP1 calibration file.

For performing the 'Stressed Eye' calibration, 'Amplitude calibration' results are required. Use the TP1 Calibration drop down to select the required Calibrated file. Press 'Next' once the selection is done.

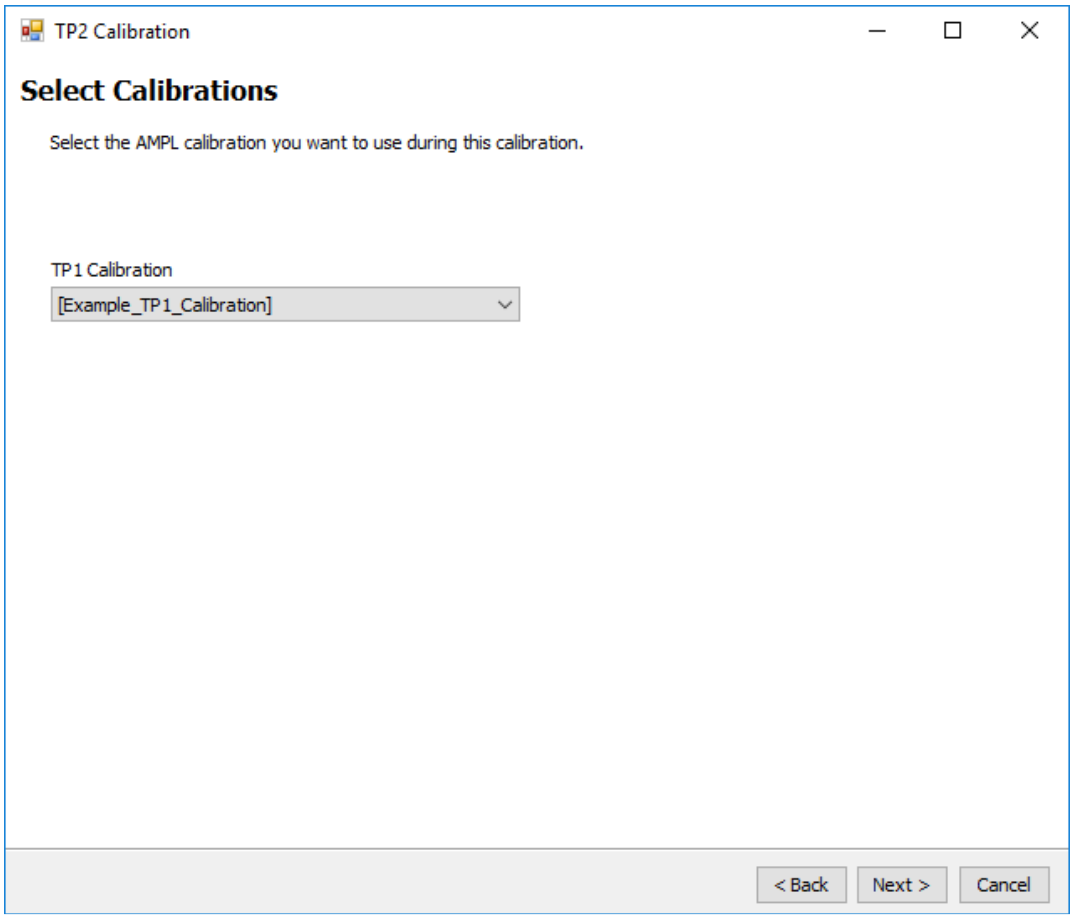

TP2 Calibration
Select Calibrations
Select the AMPL calibration you want to use during this calibration.
TP1 Calibration
[Example_TP1_Calibration]
< Back
Next >
Cancel

Figure 23

4.2.3. Eye Calibration Cabling Diagram:
Connect all the equipment as in the below diagram and then press ‘Next’.

Note: The connection diagram depends on the selection in 3.2.1. The connection diagrams are different for ‘Add-In Card’ and ‘System’.

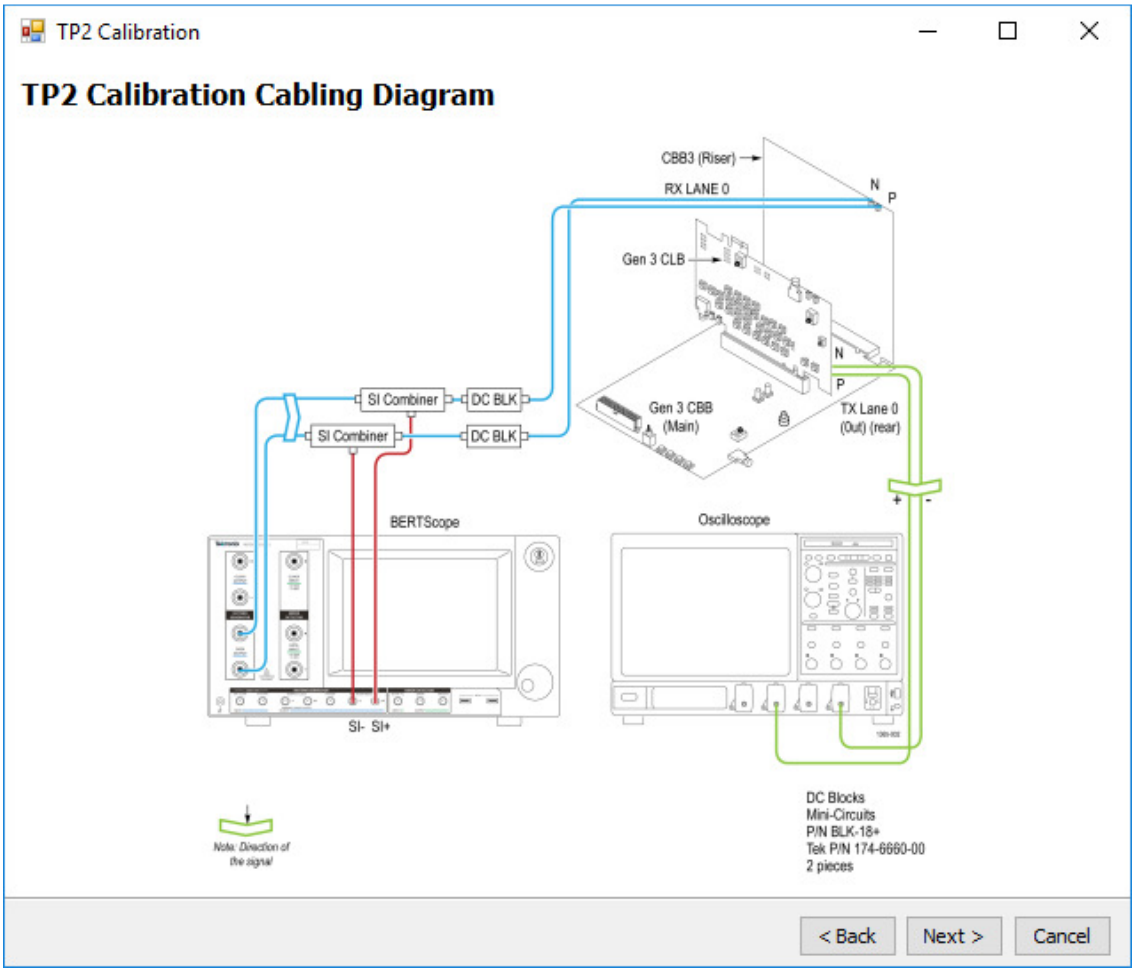



Figure 24

4.2.4. Initialize Equipment
Application will initialize the equipment’s like, BERTScope and RT scope. It will set the required impairments on the BERTScope and calibrates the signals using the RT Scope. Press ‘Run’ to execute the instrument initialization and after initialization press ‘Next’.

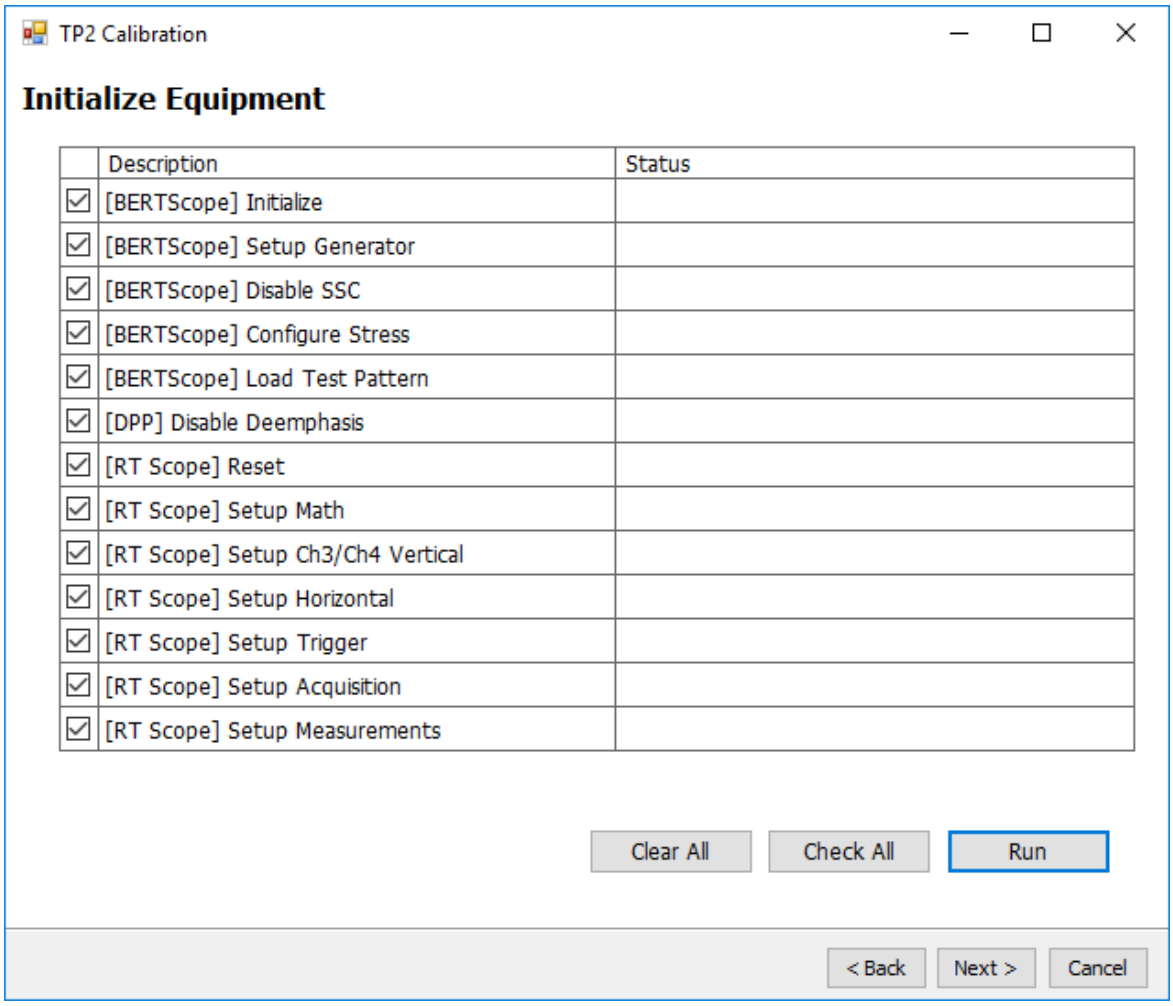

TP2 Calibration
Initialize Equipment
Description
Status
[BERTScope] Initialize
[BERTScope] Setup Generator
[BERTScope] Disable SSC
[BERTScope] Configure Stress
[BERTScope] Load Test Pattern
[DPP] Disable Deemphasis
[RT Scope] Reset
[RT Scope] Setup Math
[RT Scope] Setup Ch3/Ch4 Vertical
[RT Scope] Setup Horizontal
[RT Scope] Setup Trigger
[RT Scope] Setup Acquisition
[RT Scope] Setup Measurements
Clear All
Check All
Run
< Back
Next >
Cancel

Figure 25

4.2.5. Select Calibration Levels

Application will show the stress targets as per the *PCI Express® CEM Specification Revision 4.0 Version 0.7*. If user wishes to test the application with different stress targets then they can change the values in this panel. Press 'Next' to go to next panel.

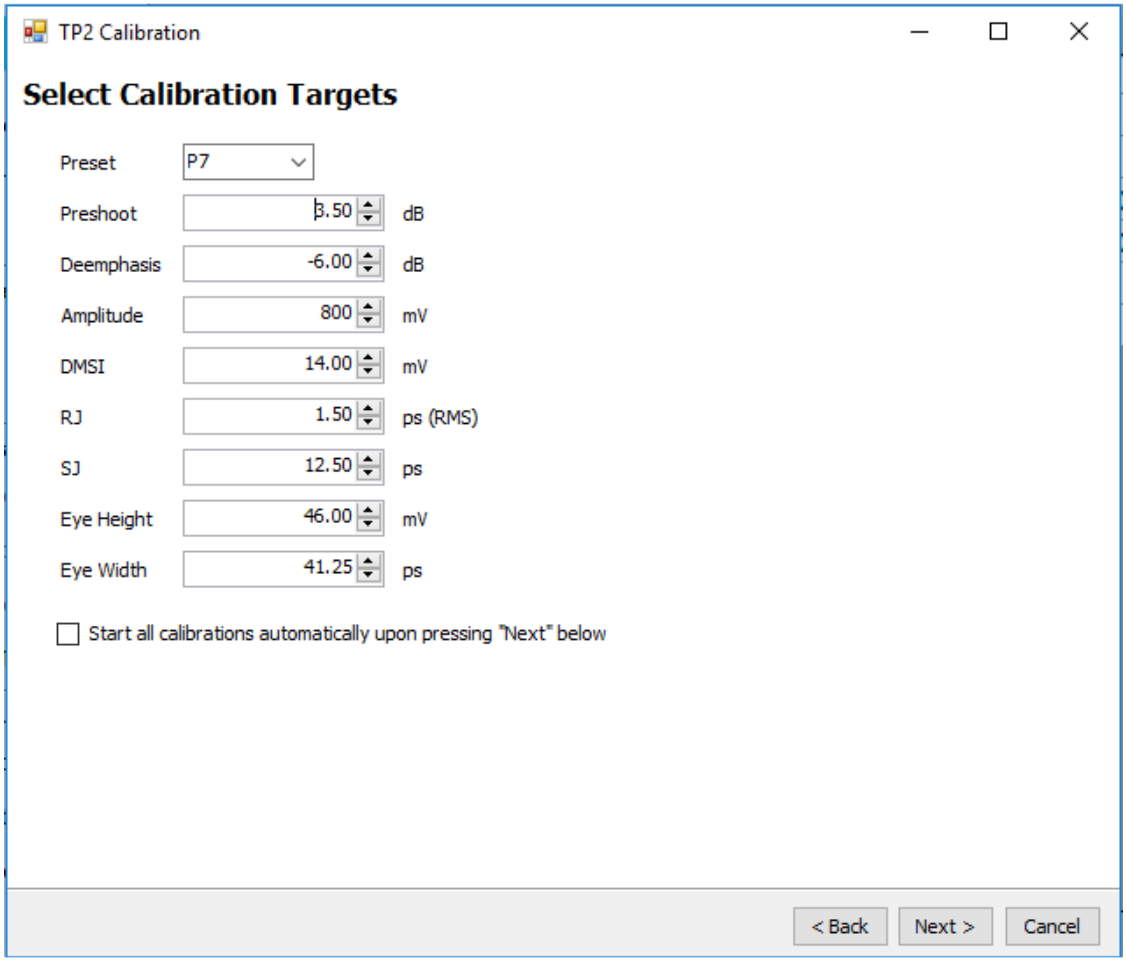



Figure 26

Check the 'Start all calibration automatically upon pressing "Next" below', to start the automatic calibration without having to press 'Next' in each of the panel/Step. If this checkbox is un-checked then user should manually press 'Next' upon completion of each of the calibration step.

4.2.6. Perform DMSI Calibration

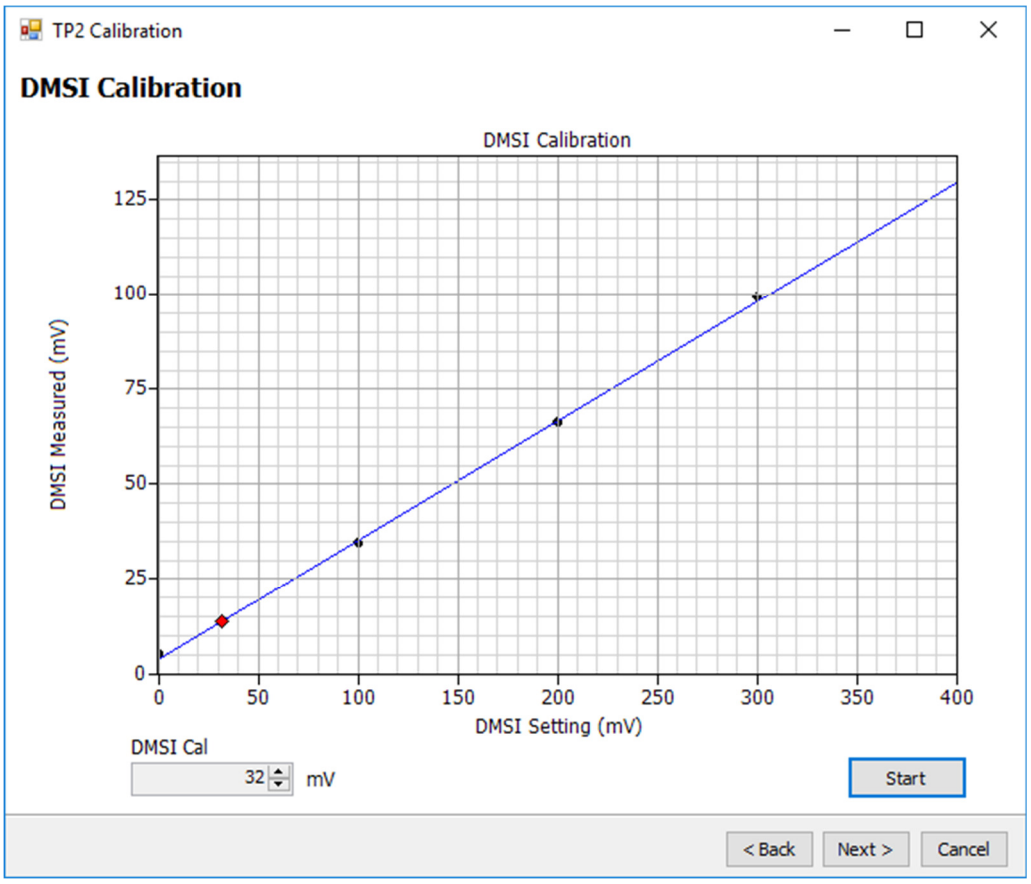



Figure 27

4.2.7. Perform SigTest Equalizer Selection

Press 'Start' to start the Equalizer selection. Press 'Next' once done.

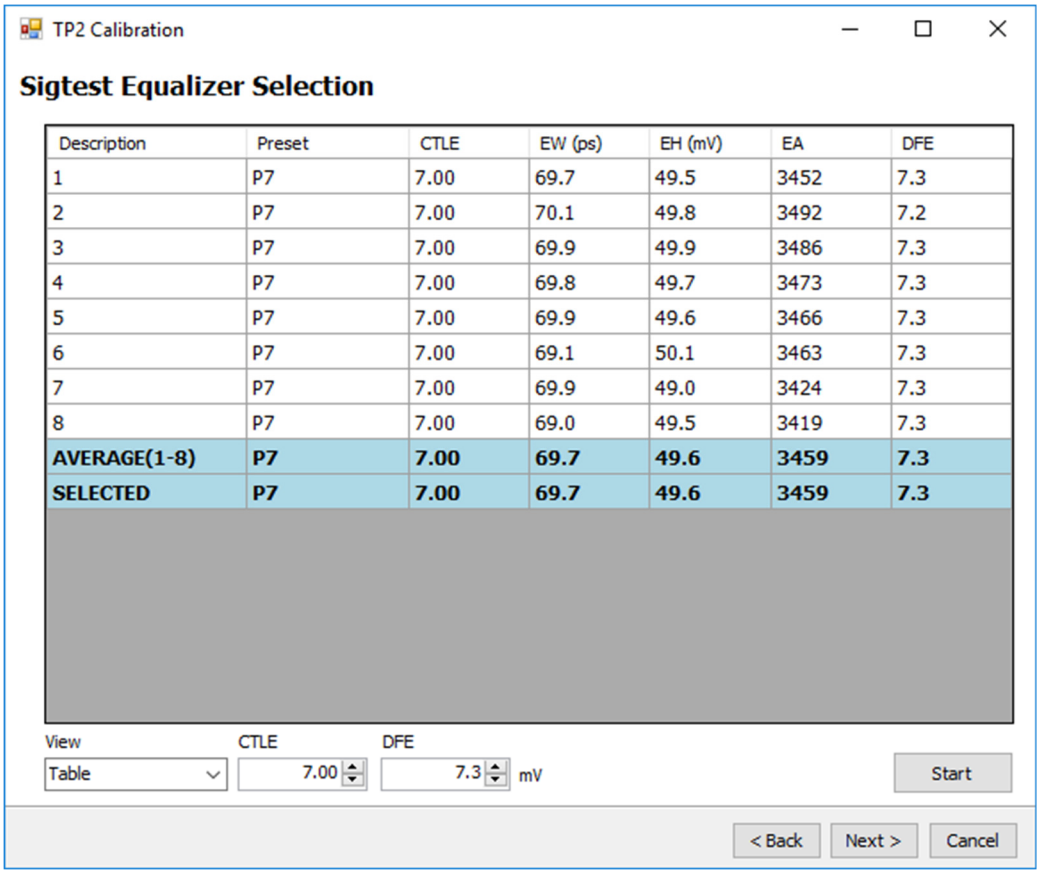



Figure 28

In this step, application selects the required equalizer. Application performs 3 captures and analyze them. If there are any suspicious results, then that result will be marked as 'Bad'. Application displays 'Average' values for each of the setting and displays 'Selected' setting.

### 4.2.8. Perform RJ Eye Opening Sweep

This step sweeps the Rj values and find the Eye area. It shows the impact of Rj on eye area. Press 'Start' to start the sweep and once the Eye-opening sweep is done, press 'Next'.

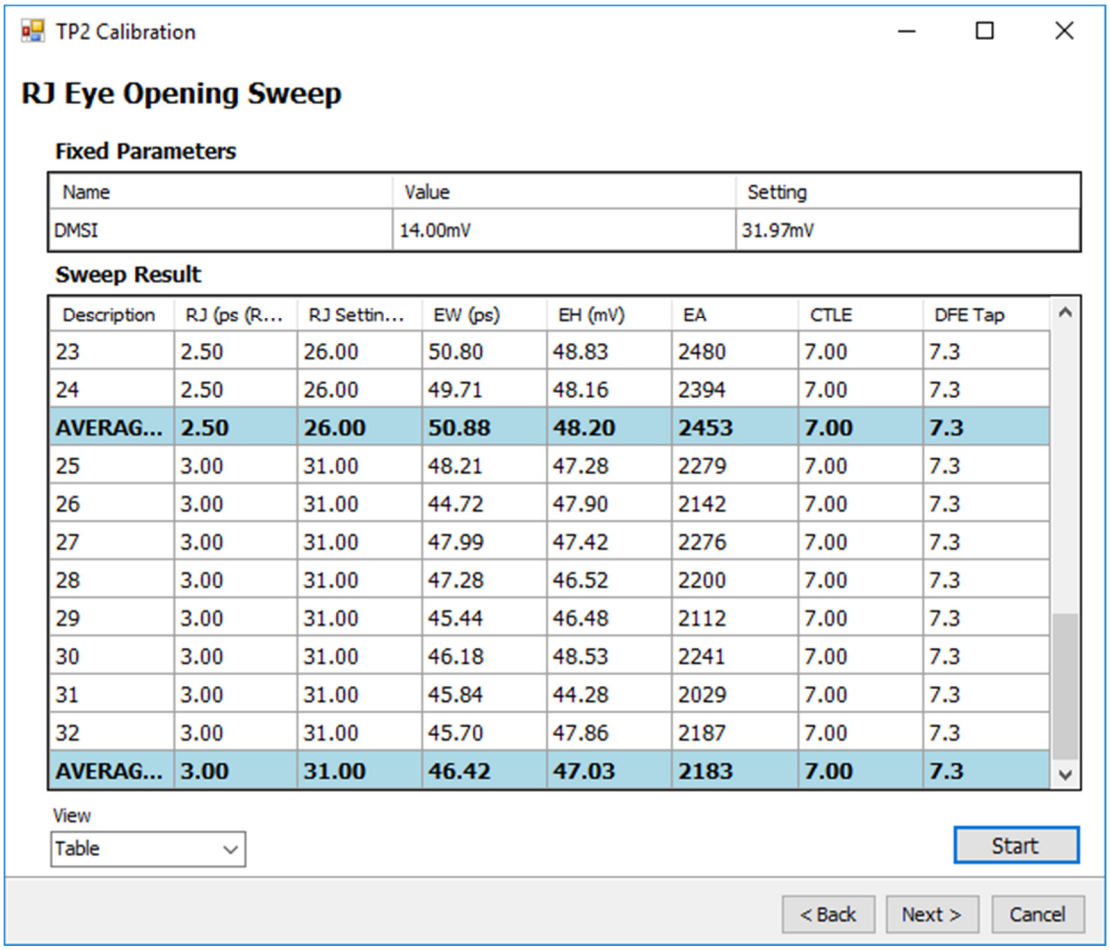



Figure 29

### 4.2.9. Perform DMSI Eye Opening Sweep

This step sweeps the DMSI values and finds the Eye area. It shows the impact of DMSI on eye area. Press 'Start' to start the sweep and press 'Next' once it is done.

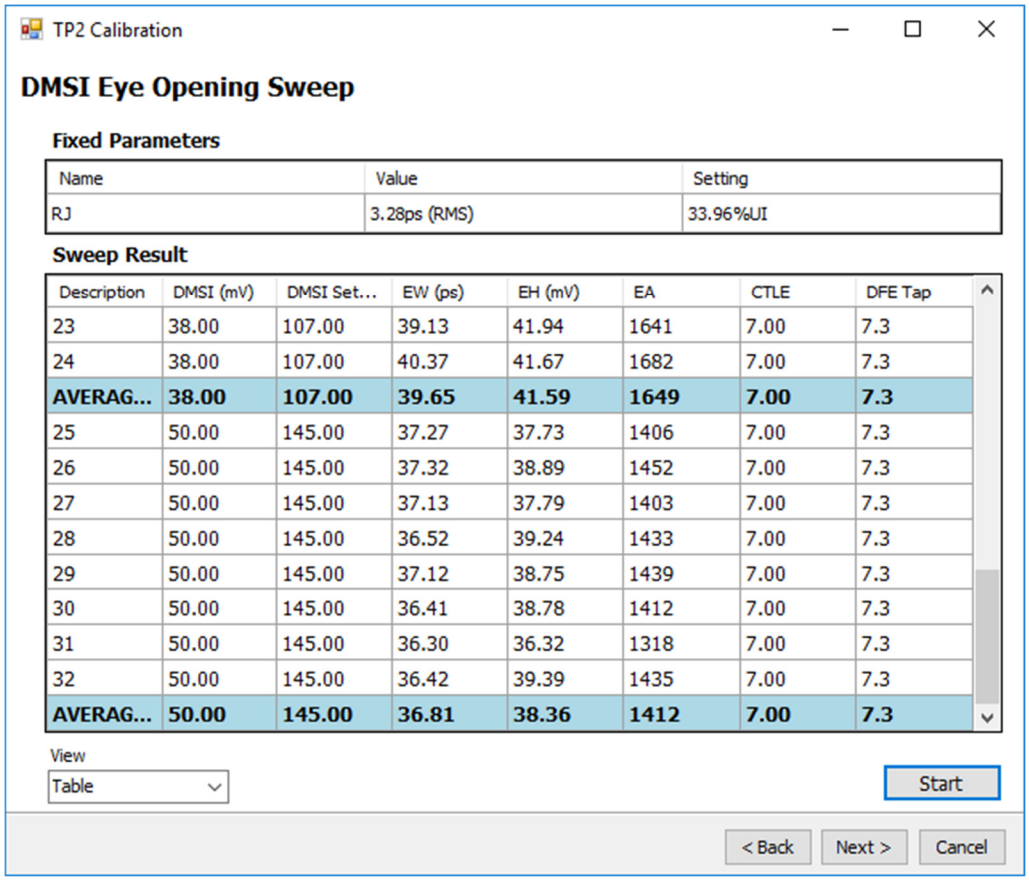



Figure 30

### 4.2.10. Review Stressed Eye Results

In this step, application adjusts the Rj and DMSI to achieve the required eye targets. Application captures three waveforms for the analysis. If there are any bad results, they are discarded from the results. Press ‘Next’ after the results are reviewed.

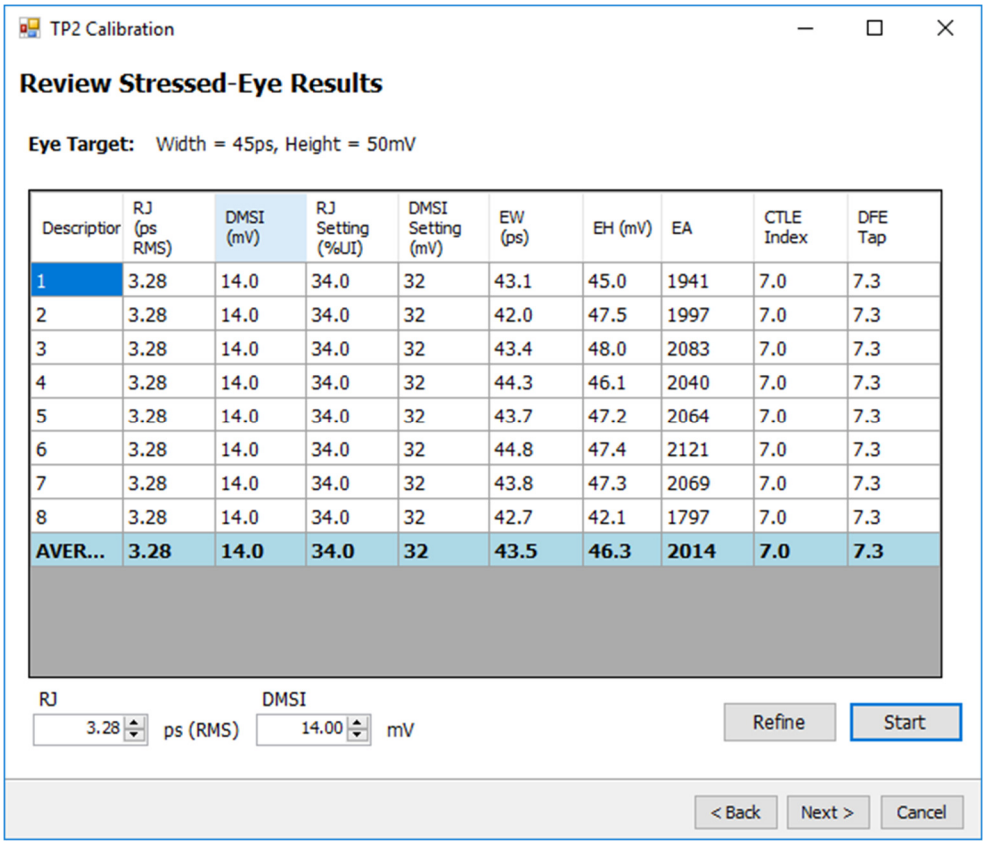



Figure 31

4.2.11. Save Calibration results:

Calibrated results can be saved in a data base. To save the values, enter the ‘Unique ID’, ‘Creator Name’ and ‘Comments’ and press ‘Save’.
Calibrated values can be used for doing the ‘Jitter Tolerance’ test.

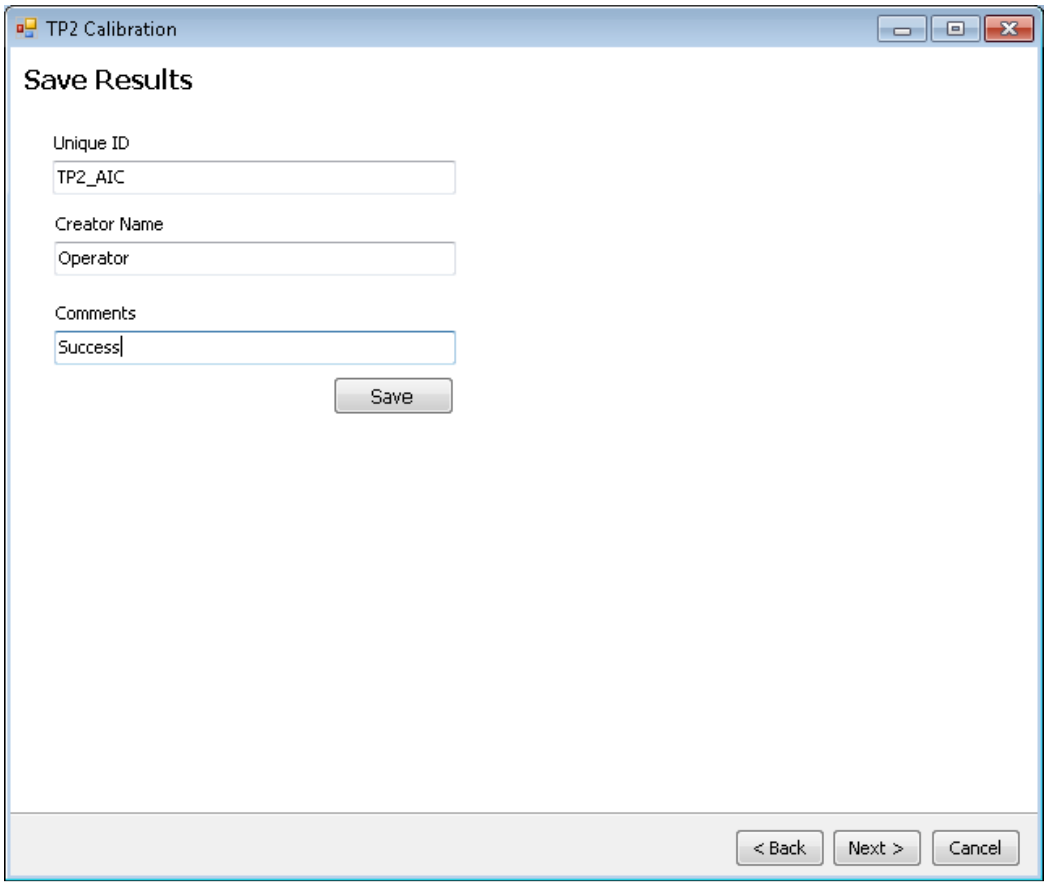

TP2 Calibration
Save Results
Unique ID
TP2_AIC
Creator Name
Operator
Comments
Success
Save
< Back
Next >
Cancel

Figure 32

# TEST MEASUREMENTS

## [2.4.1] Add-In Card Transmitter Initial TX EQ Test for 8.0 GT/s

**Purpose**: Test verifies that the add-in card will start with the correct TX EQ preset at 8 GT/s requested through the protocol.

**Test Setup:** As per Test Setup shown in Figure 1.

**Test Procedure:**

1. Make the setup Connection as shown in the Figure 1, Tx lanes other than lane under test can be terminated with 50-ohm terminations.
2. Launch the BERTScope PCIE4.0 Receiver Testing app and click on Preferences and configure the Oscilloscope to Sample rate 50GS/s, Record Length 10M. Set the Channels according to connection (Figure 1) and Bandwidth at least 16GHz as shown in Figure 33 in LEQ Test Panel inside Tests tree view (This is one-time Configuration).
3. Initialize the BSX Series BERTScope using PC based PCIe 3.0 Test application as shown in Figure 34 and train the DUT and negotiate to 8.0 GT/s requesting *Preset Value* (Shown in Figure 37) as the initial preset for the DUT. The test equipment does not request any TX EQ adjustments in phase 3.

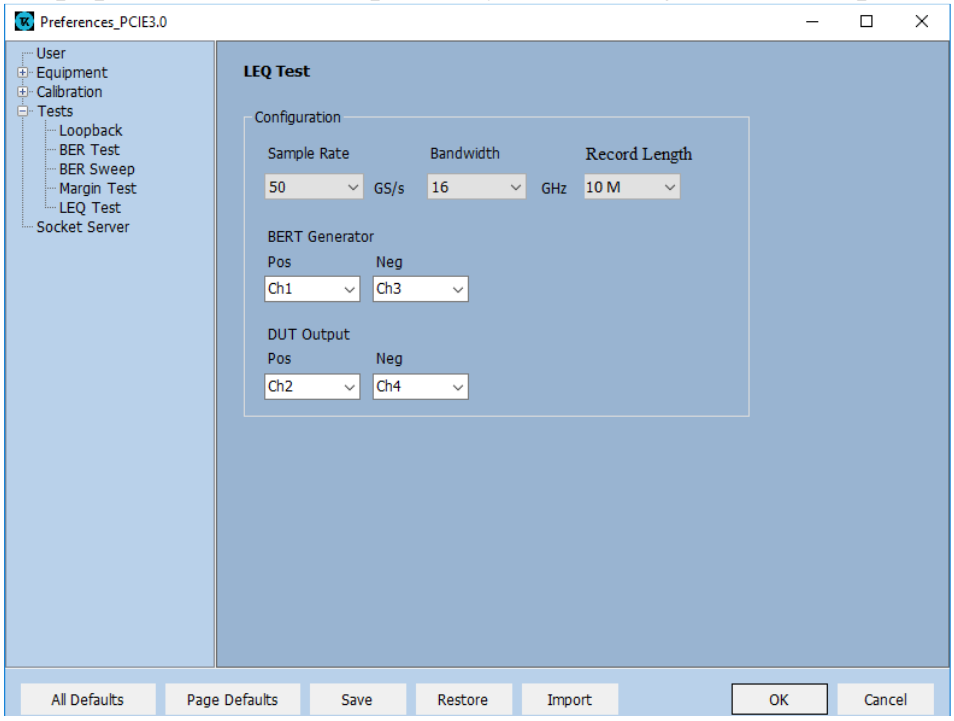



Figure 33

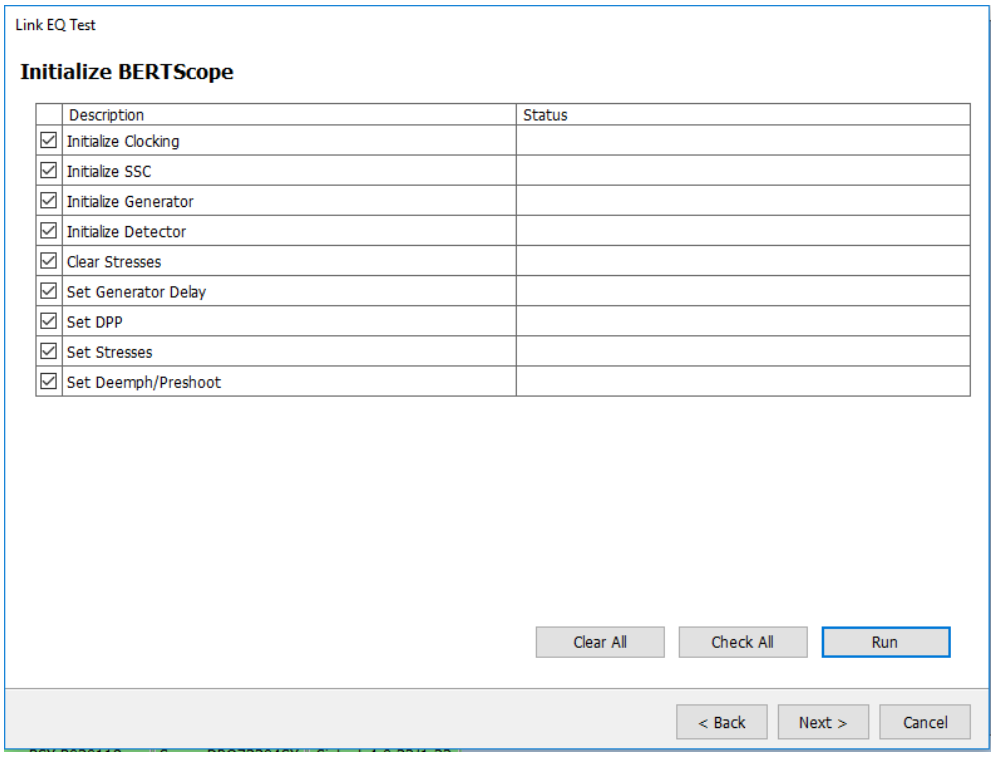



Figure 34

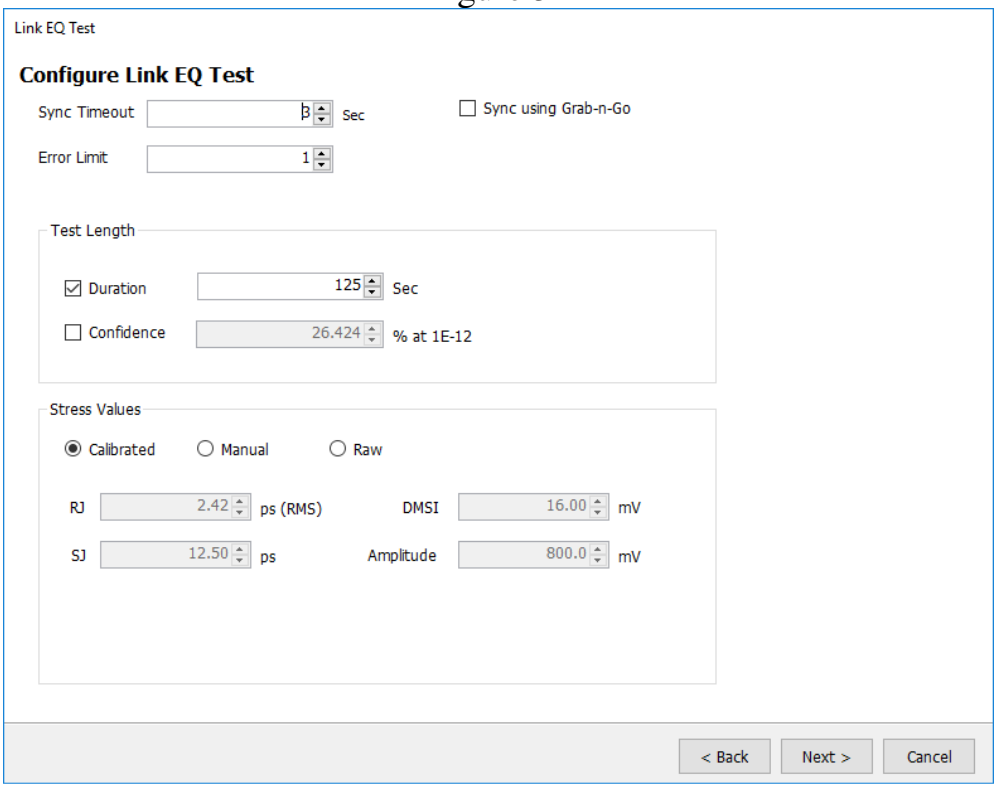



Figure 35

4. Enable the Power Switch Automation and load the Script .exe file which will Power ON the DUT during loopback as shown in Figure 36.

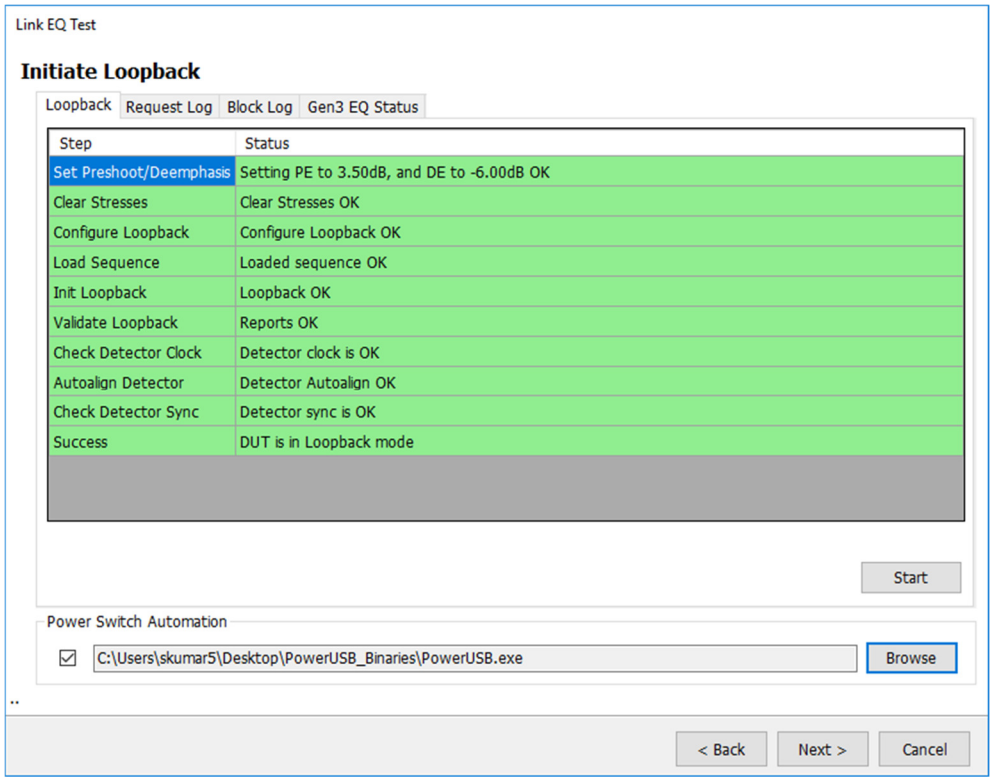



Figure 36

5. Check all or any Preset and click Run to put the DUT into Loopback and get the Values in the Measurement Panel as shown in Figure 37. If Step 4 is not enable then Power on the DUT when Red Flash message “Power ON DUT” shows up in Initiate Loopback Panel.

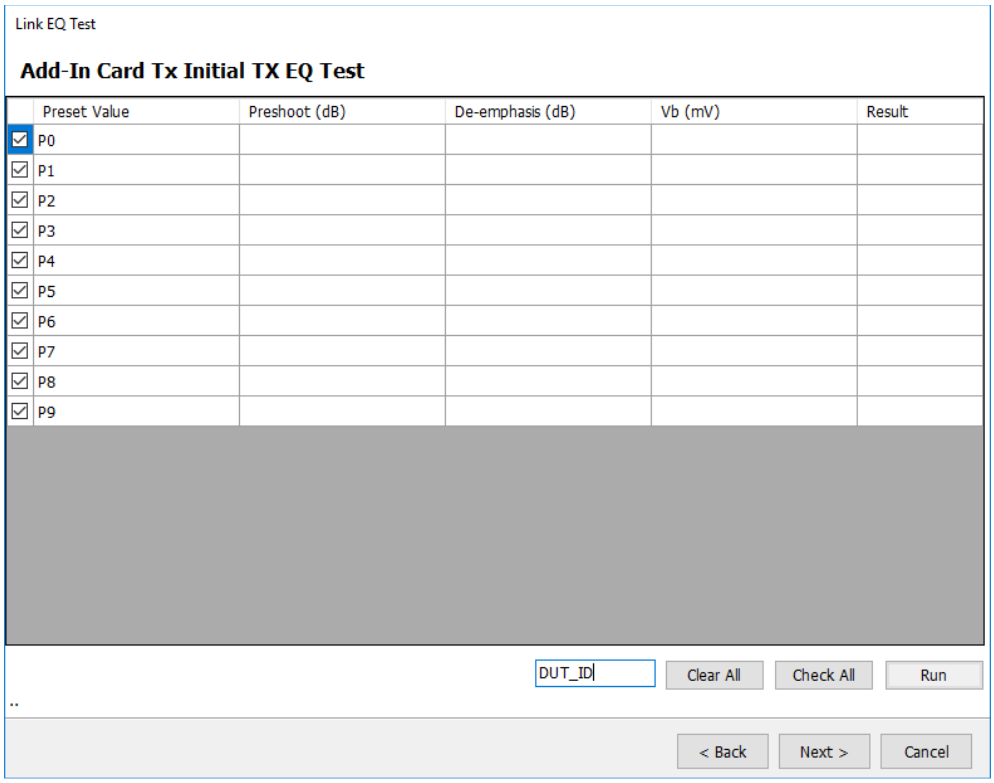



Figure 37

6. Scope gets trigger once DUT goes to loopback capture the waveform and name it as *preset value* to uniquely identify (Waveform will have saved at Oscilloscope C:\temp\LinkEQ\<DUT_ID>).
7. Use the SigTest Transmitter Preset Test option to read the saved waveform files and compute the preset values from these. All preset values computed must be within their specified limits.
8. For report Click "*Next*" and save the test execution.

**BERTScope PCIE3.0 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

**2.4.1 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 38

**Observable Results:** All Preset value should be within specified limits below.

| Preset Number | Preshoot (dB) | De-emphasis (dB) | c-1 | c+1 | Va/Vd | Vb/Vd |
|---|---|---|---|---|---|---|
| P4 | 0 | 0 | 0 | 0 | 1 | 1 |
| P1 | 0 | -3.5 ± 1 dB | 0 | -0.167 | 1 | 0.668 |
| P0 | 0 | -6.0 ± 1.5 dB | 0 | -0.25 | 1 | 0.5 |
| P9 | 3.5 ± 1 dB | 0 | -0.166 | 0 | 0.668 | 0.668 |
| P8 | 3.5 ± 1 dB | -3.5 ± 1 dB | -0.125 | -0.125 | 0.75 | 0.5 |
| P7 | 3.5 ± 1 dB | -6.0 ± 1.5 dB | -0.1 | -0.2 | 0.8 | 0.4 |
| P5 | 1.9 ± 1 dB | 0 | -0.1 | 0 | 0.8 | 0.8 |
| P6 | 2.5 ± 1 dB | 0 | -0.125 | 0 | 0.75 | 0.75 |
| P3 | 0 | -2.5 ± 1 dB | 0 | -0.125 | 1 | 0.75 |
| P2 | 0 | -4.4 ± 1.5 dB | 0 | -0.2 | 1 | 0.6 |

Table 1: Tx Preset Ratios and Corresponding Coefficient Values

### [2.5.1] Add-in Card Transmitter Link Equalization Response Test for 8.0 GT/s

**Purpose:** To Verify that the add-in-card respond correctly to transmitter equalization commands sent via the link protocol.

**Test Setup:** As per Test Setup shown in Figure 1.

**Test Procedure:**

1. Make the setup Connection as shown in the Figure 1, Tx lanes other than lane under test can be terminated with 50-ohm terminations.
2. Configure the Oscilloscope to Sample rate 50GS/s, Record Length 10M.Set the Channels according to connection (Figure 1) and Bandwidth at least 16GHz as shown in Figure 33 in Preferences LEQ Test Panel.
3. Initialize the BSX Series BERTScope using PC based PCIe 3.0 Test application and train the DUT and negotiate to 8.0 GT/s by setting the *Initial Preset* and *Preset Value* in Figure 40.
4. Enable the Power Switch Automation and load the Script .exe file which will Power ON the DUT during loopback as shown in Figure 39.

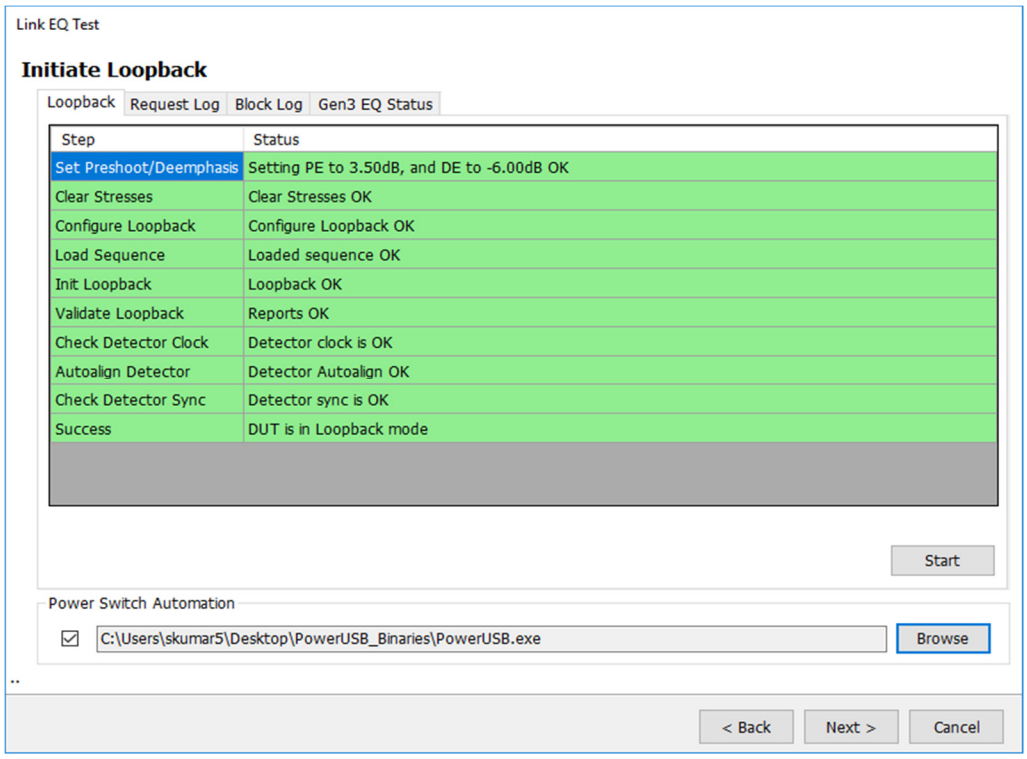



Figure 39

5. Check all or any Preset and click Run to put the DUT into Loopback and get the Values in the Measurement Panel as shown in Figure 40 (Use the default combination of *Initial Preset* and *Preset/Coefficients Value* to get the maximum electrical changes in waveform). If Step 4 is not enable then Power on the DUT when Red Flash message "Power ON DUT" shows up in Initiate Loopback Panel.

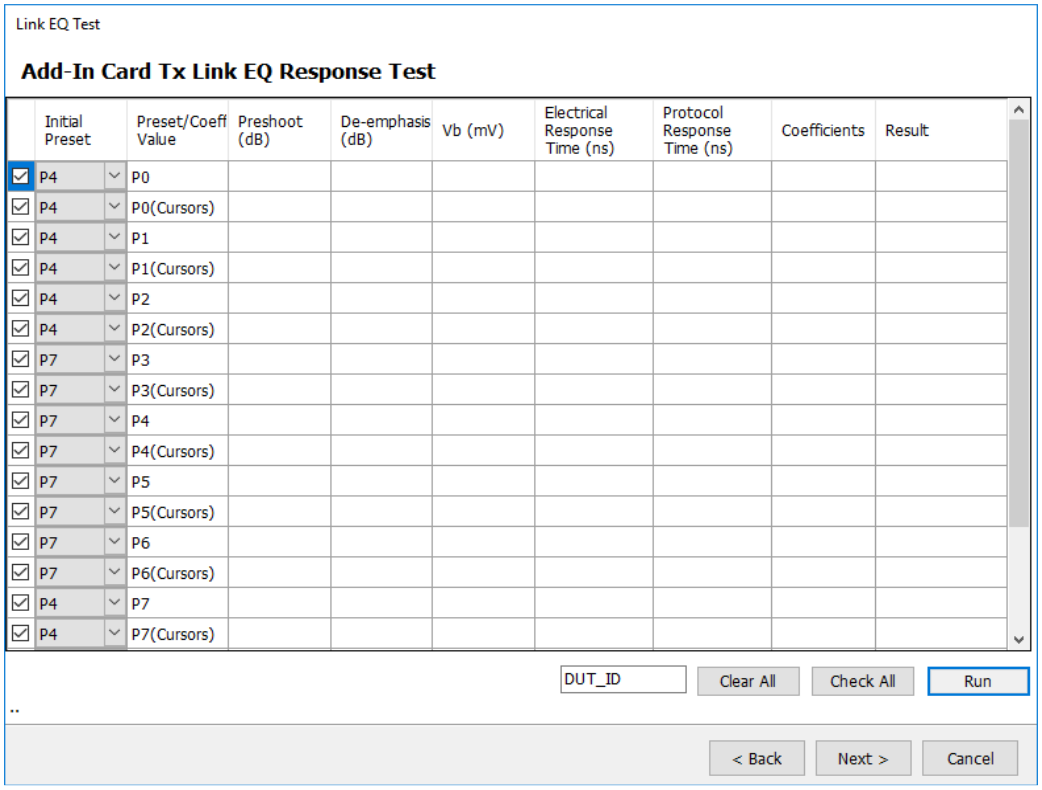



Figure 40

6. Scope gets trigger once DUT goes to loopback capture the waveform and name it as *preset value* to uniquely identify (Waveform will have saved at Oscilloscope C:\temp\LinkEQ\<DUT_ID>).
7. Use scope based PCIe protocol decoder to decode PCIe packets from Tx and Rx to calculate the response time.
8. Use the SigTest Transmitter Preset Test option to read the saved waveform files and compute the preset values from these. All preset values computed must be within their specified limits.
9. For report Click "*Next*" and save the test execution.

**BERTScope PCIE3.0 Receiver Testing**

RECEIVER TEST RESULTS

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

**Information**

Name: 2_5_1
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

**2.5.1 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 | 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} |
| 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 41

**Observable Results:** Test is PASS if the time response is less than 1 us. Test fails if time response is greater than 1us.

### [2.10.1] System Board Transmitter Link Equalization Response Test For 8.0 GT/s

**Purpose:** To Verify that the System respond correctly to transmitter equalization commands sent via the link protocol.

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

**Test Procedure:**

1. Make the setup Connection as shown in the Figure 2, Tx lanes other than lane under test can be terminated with 50-ohm terminations.
2. Configure the Oscilloscope to Sample rate 50GS/s, Record Length 10M.Set the Channels according to connection (Figure 2) and Bandwidth at least 16GHz as shown in Figure 33 in Preferences LEQ Test Panel.
3. Initialize the BSX Series BERTScope Bit Error Rate Tester in PC based PCIe 3.0 Test application and train the DUT and negotiate to 8.0 GT/s by setting *Preset/Coefficients Value (Shown in Figure 43)* and *Initial Preset* sets from System DUT.
4. Enable the Power Switch Automation and load the Script .exe file which will Power ON the DUT during loopback as shown in Figure 42.

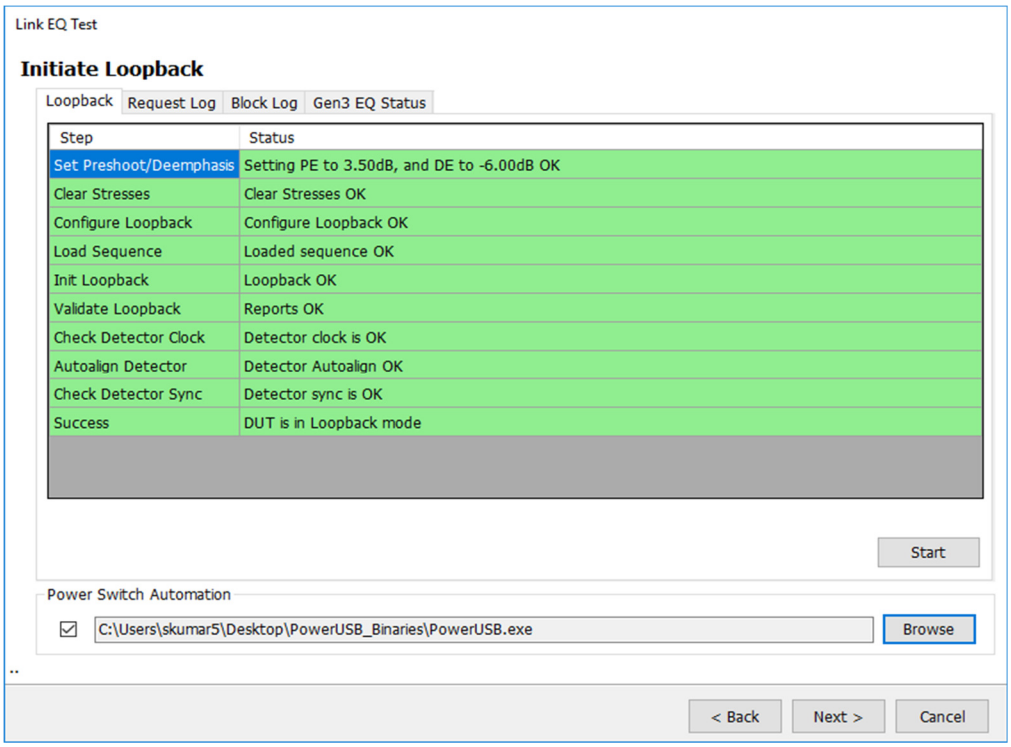



Figure 42

5. Check all or any Preset and click Run to put the DUT into Loopback and get the Values in the Measurement Panel as shown in Figure 43. If Step 4 is not enable then Power on the DUT when Red Flash message "Power ON DUT" shows up in Initiate Loopback Panel.

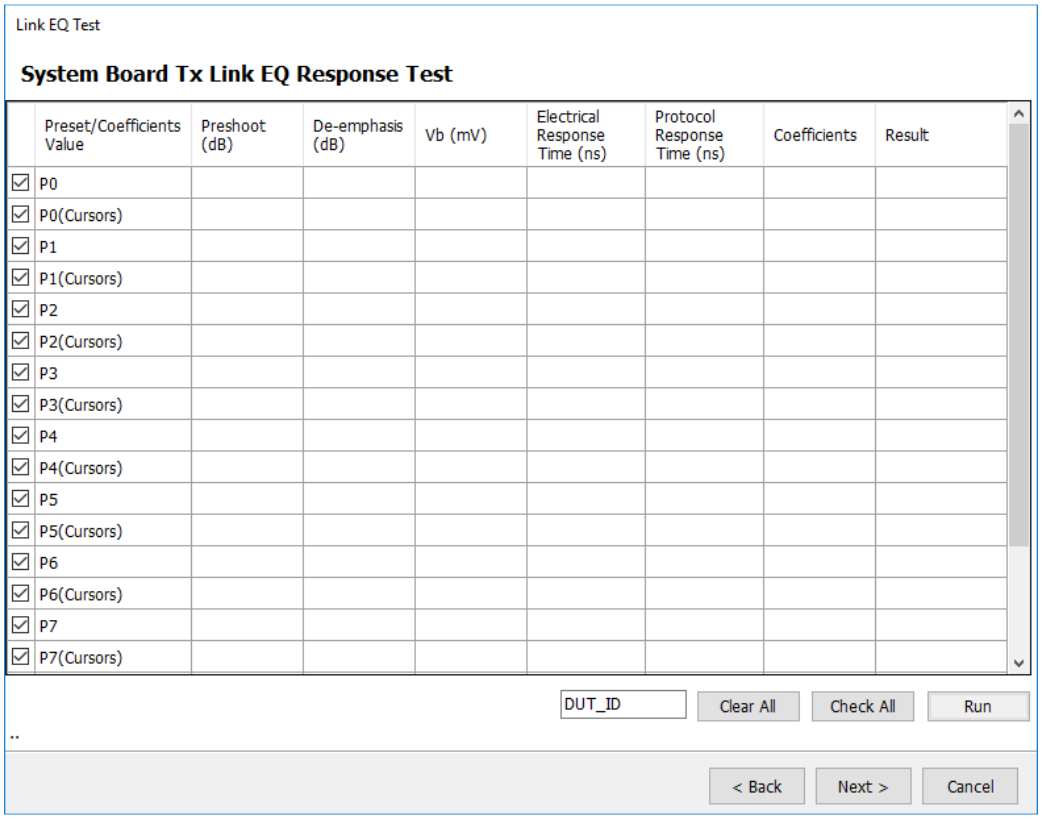



Figure 43

6. Scope gets trigger once DUT goes to loopback capture the waveform and name it as *preset value* to uniquely identify (Waveform will have saved at Oscilloscope C:\temp\LinkEQ\<DUT_ID>).
7. Use scope based PCIe protocol decoder to decode PCIe packets from Tx and Rx to calculate the response time.
8. Use the SigTest Transmitter Preset Test option to read the saved waveform files and compute the preset values from these. All preset values computed must be within their specified limits.
9. For report Click "*Next*" and save the test execution.

**BERTScope PCIE3.0 Receiver Testing**

RECEIVER TEST RESULTS

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

**Information**

Name:2_10_1
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

**2.10.1 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 44

**Observable Results:** Test is PASS if the time response is less than 1 us. Test fails if time response is greater than 1us.

### [2.13.1] Add-in Card Receiver Link Equalization Test at 8.0 GT/s

**Purpose:** To Verify 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. Connect the Test Equipment.
2. Insert the add-in card under test into the calibration revision 3.0 CBB without power. The signal source should be connected to the Rx lane under test on the CBB riser card, the receiver of the BERT Scope should be connected to the Tx lane under test on the CBB main board. Other TX lanes can be terminated with 50-ohm terminations or unterminated – as requested by the device under test operator.
3. Configure the BERTScope transmitter to initially transmit with *Initial Preset (Generators)* shown in Figure 47 at 8.0 GT/s.

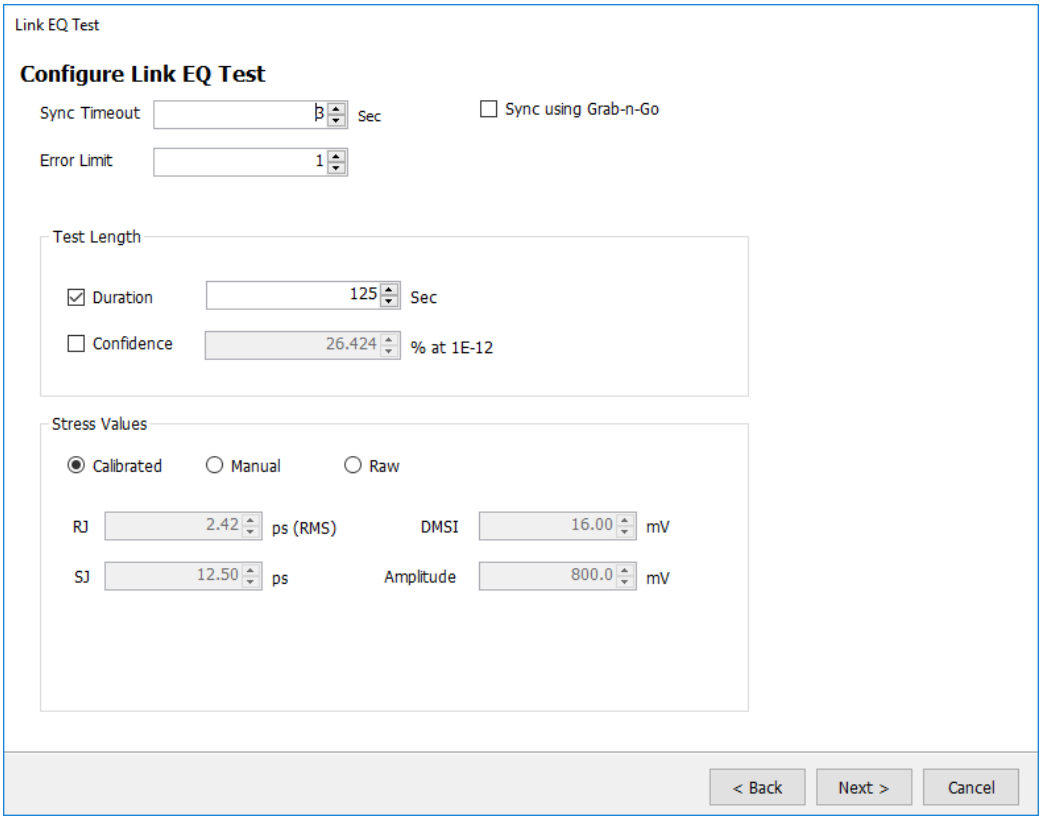



Figure 45

4. Use the Calibrated Stress Values as shown in Figure 45.
5. Have the BERTScope train the DUT and negotiate to 8.0 GT/s.
6. Have the BERTScope run the link equalization protocol.
7. Enable the Power Switch Automation and load the Script .exe file which will Power ON the DUT during loopback as shown in Figure 46.

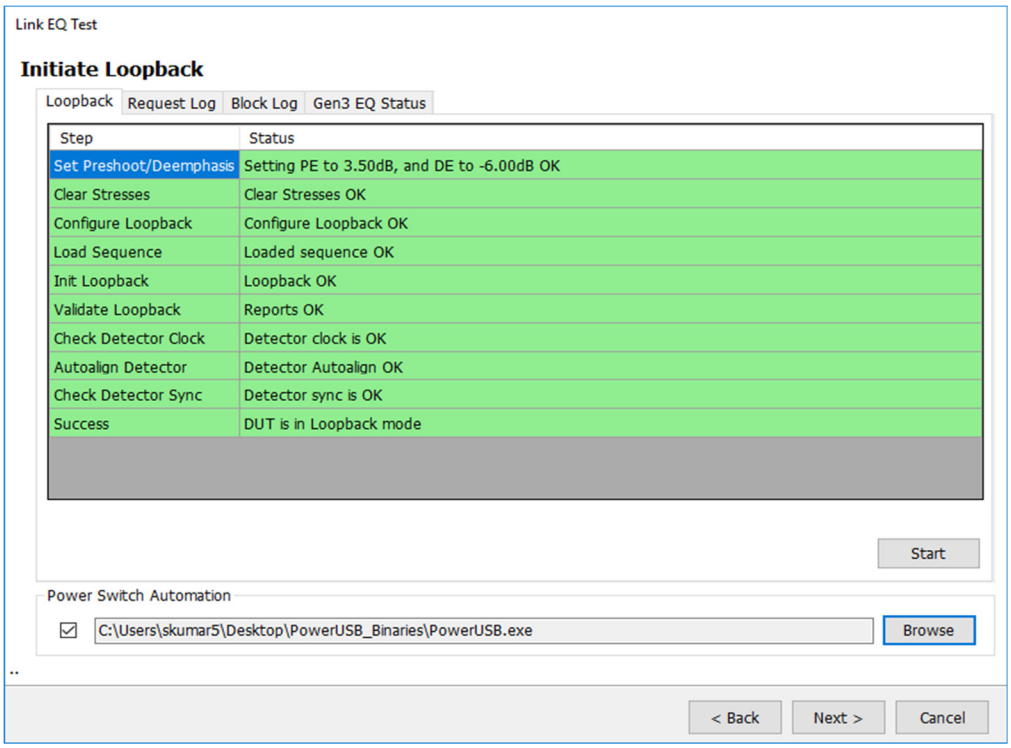



Figure 46

8. Check all or any *Initial Preset* (P7, P8, P1) and click Run to put DUT into Loopback and get the values in the Measurement Panel as shown in Figure 47. If Step 4 is not enable then Power on the DUT when Red Flash message "Power ON DUT" shows up in Initiate Loopback Panel.
9. Send the modified compliance pattern to the device under test
10. Verify that the error detector found no more than one errors in 10^12 bits transmitted.

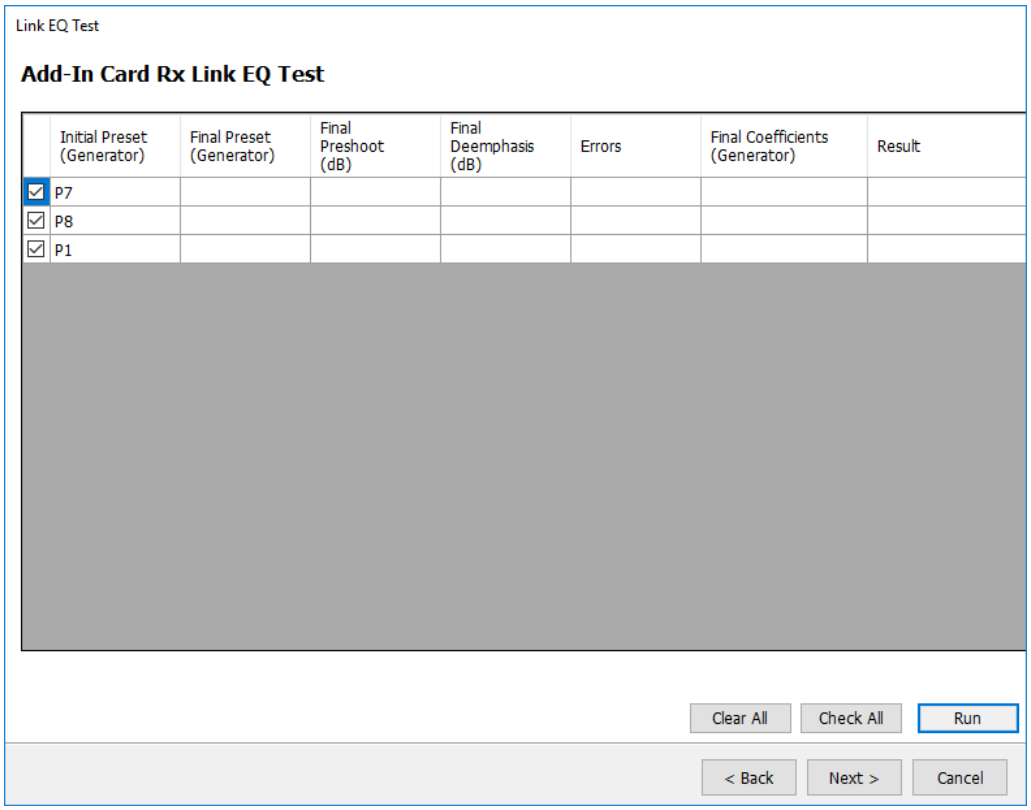



Figure 47

11. For report Click “Next” and save the test execution.

**BERTScope PCIE3.0 Receiver Testing**

RECEIVER TEST RESULTS

Printed 3/23/2018 3:49:22 PM

**Information**

Name: RX_EQ2_13_1 Test
Creator:
Description:
Comment: Done as Init P7 P8 P1 With Stress

Date/Time: 3/23/2018 10:49:15 PM
DUT Type: AddInCard

**Test Calibrations**

TP2: TP2-Cal-B30053

BSC S/N: 280094

**2.13.2 Add-in Card Receiver Link Equalization Test**

| Initial Preset (Generator) | Final Preset (Generator) | Final Preshoot (dB) | Final De-emphasis(dB) | Bits | Errors | BER | Final Coefficients (Generator) | Result |
|---|---|---|---|---|---|---|---|---|
| P7 | NA | 0 | 0 | 1.01e012 | 0 | 0.00e000 | 0, 63, 0 | Pass |
| P8 | P4 | 0 | 0 | 1.01e012 | 0 | 0.00e000 | , , | Pass |
| P1 | P4 | 0 | 0 | 1.01e012 | 0 | 0.00e000 | , , | Pass |

**Loopback Request Log for preset P7**

| Request # | Gen | Final Preset | Final Pre-Cursor | Final Cursor | Final Post-Cursor | Timestamp (us) | Valid |
|---|---|---|---|---|---|---|---|
| 0 | 3 | NA | 0 | 47 | 16 | 0 | x |
| 1 | 3 | 4 | NA | NA | NA | 1.19 | x |
| 2 | 3 | 4 | NA | NA | NA | 3.19 | x |
| 3 | 4 | NA | 0 | 47 | 16 | 16101.6 | x |
| 4 | 4 | 4 | NA | NA | NA | 16103 | x |
| 5 | 4 | 4 | NA | NA | NA | 16104.99 | x |
| 6 | 4 | NA | 1 | 62 | 0 | 29562.14 | x |
| 7 | 4 | NA | 0 | 63 | 0 | 30277.64 | x |

**Loopback Request Log for preset P8**

| Request # | Gen | Final Preset | Final Pre-Cursor | Final Cursor | Final Post-Cursor | Timestamp (us) | Valid |
|---|---|---|---|---|---|---|---|
| 0 | 3 | NA | 0 | 47 | 16 | 0 | x |
| 1 | 3 | 4 | NA | NA | NA | 1.6 | x |
| 2 | 3 | 4 | NA | NA | NA | 3.65 | x |
| 3 | 3 | NA | 1 | 62 | 0 | 15385.55 | x |
| 4 | 3 | NA | 0 | 63 | 0 | 16221.97 | x |
| 5 | 4 | NA | 0 | 47 | 16 | 17258.88 | x |
| 6 | 4 | 4 | NA | NA | NA | 17260.32 | x |
| 7 | 4 | 4 | NA | NA | NA | 17262.36 | x |

**Loopback Request Log for preset P1**

| Request # | Gen | Final Preset | Final Pre-Cursor | Final Cursor | Final Post-Cursor | Timestamp (us) | Valid |
|---|---|---|---|---|---|---|---|
| 0 | 3 | NA | 0 | 47 | 16 | 0 | x |
| 1 | 3 | 4 | NA | NA | NA | 1.08 | x |
| 2 | 3 | 4 | NA | NA | NA | 3.14 | x |
| 3 | 4 | NA | 0 | 47 | 16 | 14942.8 | x |
| 4 | 4 | 4 | NA | NA | NA | 14943.96 | x |
| 5 | 4 | 4 | NA | NA | NA | 14946.12 | x |

Figure 48

**Observable Results** (Pass/Fail Criteria): No more than one-bit error.

### [2.14.1] System Receiver Link Equalization Test for 8.0 GT/s

**Purpose:** To Verify that System 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. Insert the calibration revision 3.0 CLB into the system under test without power. The signal source should be connected to the Rx lane under test on the CLB, the receiver of the BERT Scope should be connected to the Tx lane under test on the CLB. The CLB 100 MHz clock output from the system under test shall be connected to the BERTScope and drive the BERTScope transmissions after being filtered by a PCI Express 3.0 base specification compliant PLL or equivalent. Other TX lanes can be terminated with 50-ohm terminations or unterminated – as requested by the device under test operator.

2. Configure the BERTScope transmitter equalization to match the initial TX EQ preset at 8 GT/s requested by the system board under test. This can be observed using separate protocol analysis equipment if necessary.
3. Have the BERTScope train the DUT and negotiate to 8.0 GT/s.
4. Have the BERTScope run the link equalization protocol.
5. Enable the Power Switch Automation and load the Script .exe file which will Power ON the DUT during loopback as shown in Figure 50.

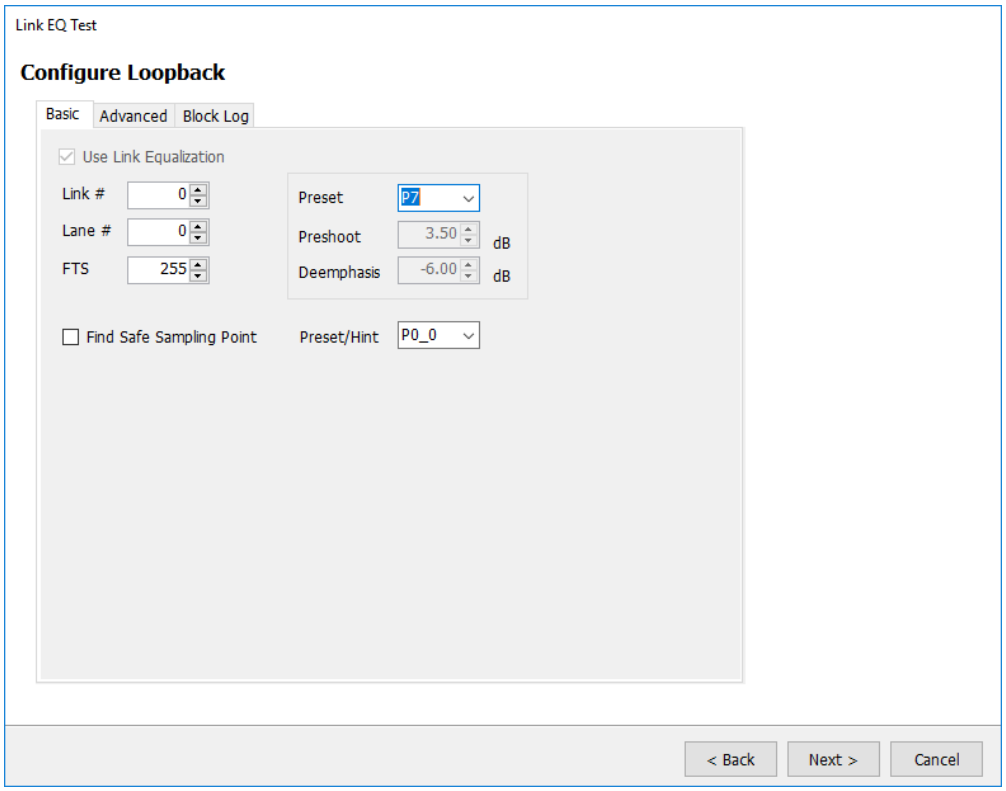



Figure 49

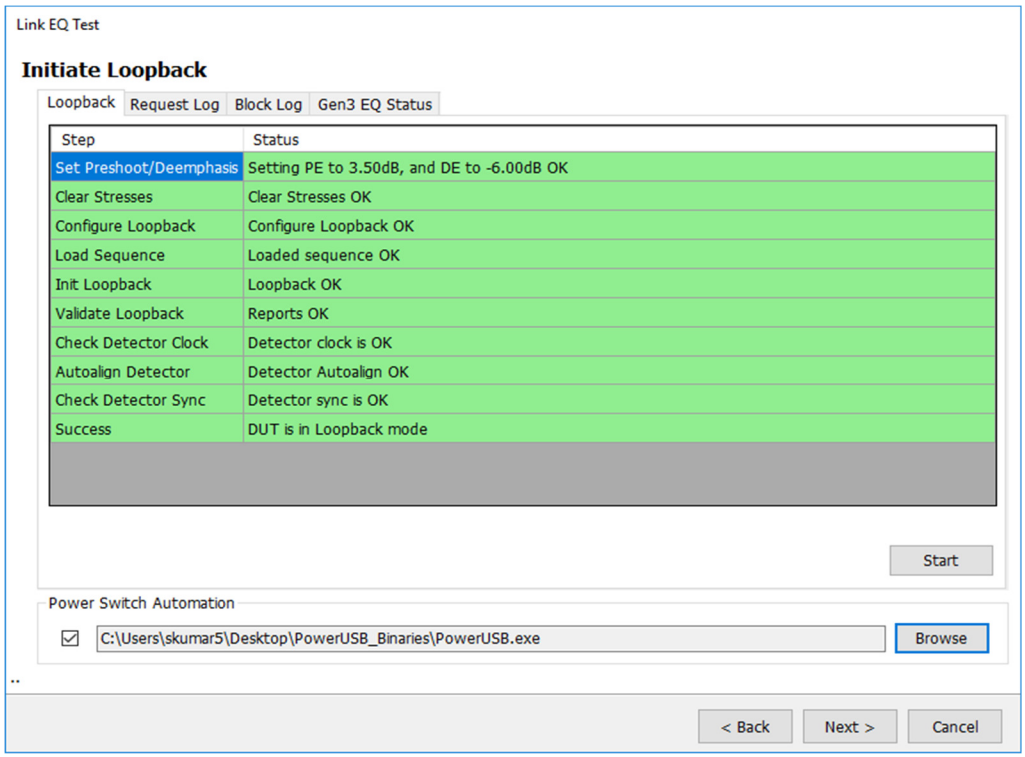



Figure 50

6. Click on Run to put DUT into Loopback and get the values in the Measurement Panel as shown in Figure 51, Any Preset (default P7) can be select from Configure Loopback panel as shown in Figure 49 and same will reflect as *Initial Preset (Generator)*. If Step 4 is not enable then Power on the DUT when Red Flash message "Power ON DUT" shows up in Initiate Loopback Panel.
7. Send the modified compliance pattern to the device under test

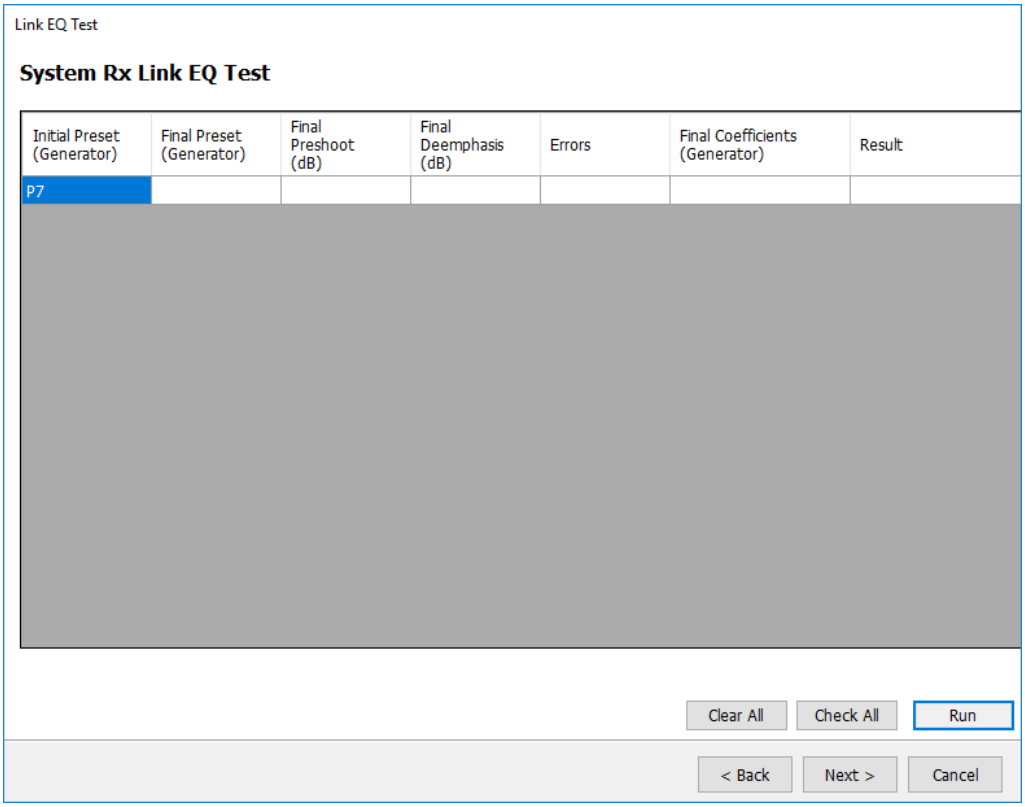



Figure 51

8. Verify that the error detector found no more than one errors in 10^12 bits transmitted.
9. For report Click "Next" and save the test execution.

**BERTScope PCIE3.0 Receiver Testing**

RECEIVER TEST RESULTS

Printed 3/23/2018 3:49:22 PM

**Information**

Name: RX_EQ2_14_1Test
Creator:
Description:
Comment: Done as Init P7 With Stress

Date/Time: 3/23/2018 10:49:15 PM
DUT Type: System

**Test Calibrations**

TP2: TP2-Cal-B30053

BSC S/N: 280094

**2.14.1 Add-in Card Receiver Link Equalization Test**

| Initial Preset (Generator) | Final Preset (Generator) | Final Preshoot (dB) | Final De-emphasis(dB) | Bits | Errors | BER | Final Coefficients (Generator) | Result |
|---|---|---|---|---|---|---|---|---|
| P7 | NA | 0 | 0 | 1.01e012 | 0 | 0.00e000 | 0, 63, 0 | Pass |

**Loopback Request Log for preset P7**

| Request # | Gen | Final Preset | Final Pre-Cursor | Final Cursor | Final Post-Cursor | Timestamp (us) | Valid |
|---|---|---|---|---|---|---|---|
| 0 | 3 | NA | 0 | 47 | 16 | 0 | x |
| 1 | 3 | 4 | NA | NA | NA | 1.19 | x |
| 2 | 3 | 4 | NA | NA | NA | 3.19 | x |
| 3 | 4 | NA | 0 | 47 | 16 | 16101.6 | x |
| 4 | 4 | 4 | NA | NA | NA | 16103 | x |
| 5 | 4 | 4 | NA | NA | NA | 16104.99 | x |
| 6 | 4 | NA | 1 | 62 | 0 | 29562.14 | x |
| 7 | 4 | NA | 0 | 63 | 0 | 30277.64 | x |

Figure 52

**Observable Results** (Pass/Fail Criteria): No more than one-bit error.