PCI Gen3 (8GT/s) Receiver Test

Tektronix MOI for PCIe Gen3 (8GT/s) Receiver Jitter Tolerance Test (Add-In Card and System) using *BSX* Series BERTScope Bit Error Tester and '*BERTScope PCIE3.0 Receiver Testing*' Application.

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Modification Record

Version	Date	Changes done
1.0.0Draft	31-Aug-2017	All

References

The following documents are referenced in this document.

- PCI Express® Architecture PHY Test Specification Revision 3.0
- PCI Express Base Specification Revision 3.1a.

1. INTRODUCTION

This MOI (Method of Implementation) provides the test procedures for testing PCIe Gen3 devices to the PCI Express Architecture PHY Test Specification (Test Specification) using *Tektronix BSX Series BERTScope Bit Error Rate Tester*. The purpose of the document is to provide the approved test equipment, test connections and setup, for the PCI Express Gen3 compliance program.

This MOI reduces the '*PCI Express Architecture PHY Test Specification*' test description to practice using the Tektronix test equipment and procedures.

TABLE 1 Lists the requirements for receiver testing and how Tektronix instruments and software address them.

	Requirement	Test Instrument	Comment
Pattern Generator	Stressed pattern generation at 8 Gb/s	BSX Series BERTScope	Generates integrated stressed pattern up to 32 Gb/s. Built-in stress includes RJ, SJ, and others.
	De-emphasis	BSX Series BERTScope	Adds programmable de-emphasis and differential output amplitude to the test signal.
	SSC	BSX Series BERTScope	Generates up to 5000 ppm of SSC. Use high performance cables between the Analyzer and Clock Recovery to reduce residual SSC presented to the Error Detector on signals with SSC.
	Asynchronous BER testing	BSX Series BERTScope	Filters out user-designated clock compensation symbols such as SKPs for accurate BER synchronization and measurement of 8b/10b/PCIE compliance pattern when in loopback.
	Jitter tolerance testing	BSX Series BERTScope	Performs automated Jitter Tolerance testing.
	Stressed eye calibration	DSA / DSO / MSO70000 Series	Real-Time Oscilloscope for amplitude and eye calibration using SigTest
	Automated loopback	BSXPCI4	Software automates control of the Instrument PCIE3.0 Add-In Card and System compliance testing, including stressed eye calibration and Loopback training.

Table 1 : *Tektronix BERTScope PCIE3.0 Receiver Test Solution*

2. TEST OBJECTIVE

- Receiver Jitter Tolerance test:
    - Add In Card

      This test is run on all card electromechanical form factor add-in cards. The test verifies that the add-in card can function normally in systems with jitter near the specification allowed limits and does not exceed the allowed receiver error rate in loopback mode.

    - System

      This test is run on all Card Electromechanical (CEM) form factor system boards. The test verifies that the system can function normally with an add-in card with jitter near the specification allowed limits and does not exceed the allowed receiver error rate in loopback mode.

3. Overview of test Steps (As per CTS)

3.1. Add-in Card Receiver Jitter Tolerance Test

This test is run on all card electromechanical form factor add-in cards. The test verifies that the add-in card can function normally in systems with jitter near the specification allowed limits and does not exceed the allowed receiver error rate in loopback mode.

Overview of the calibration and measurement steps:

BERTScope is connected to the device under test (DUT) via a compliance base board. BERTScope must be able to perform the loopback sequence which is necessary to test Add in card at all the supported data rates.

- *Note*: Refer Appendix A(Getting into Loopback 8GT/s) in '*PCI Express Architecture PHY Test Specification*' for the loopback training sequence.

Calibration is done by connecting a CLB to a CBB. For add-in cards, the CLB takes the place of the DUT for calibration purposes thus the signal is monitored at the Tx SMP connectors for lane 0 of the CLB.

- *Note*: Refer Section 2.8 in '*PCI Express Architecture PHY Test Specification*' for the calibration procedure and test/measurement requirement.

3.2. System Receiver Jitter Tolerance Test

This test is run on all Card Electromechanical (CEM) form factor system boards. The test verifies that the system can function normally with an add-in card with jitter near the specification allowed limits and does not exceed the allowed receiver error rate in loopback mode.

Overview of the calibration and measurement steps:

BERTScope is connected to the device under test (DUT) via a compliance base board. BERTScope must be able to perform the loopback sequence which is necessary to test the system board at all the supported data rates.

- *Note*: Refer Appendix A (Getting into Loopback for 8GT/s) in '*PCI Express Architecture PHY Test Specification*' for the loopback training sequence.

- *Note*: Refer Section 2.9 in '*PCI Express Architecture PHY Test Specification*' for the calibration procedure and test/ measurement requirement.

4. REQUIRED EQUIPMENT

Below table, contain the list of equipment's required for performing the test.

Equipment	Details/Part Number	Quantity	Remarks
BSX BERT Scope	Tektronix BERTScope BSX125(PCIe3.0), BSX240(PCIe3.0/4.0) or faster with Option STR, TXEQ	1	
Real time Oscilloscope	Tektronix DPO/DSA/MSO71604 or faster with option DJA.	1	
Software	BSXPCI4, Automated calibration, link training, loopback initialization and handshaking (Protocol aware) test software.	1	
Interference combiner	BSXSICOMB	1	

Table 2: Equipment required

4.1. BSX Series BERTScope Bit Error Rate Tester

The BSX Series BERTScope® is the quickest path to compliance. This BERT receiver test solution has unique features that take the complexity out of receiver testing and brings confidence to Gen3/4 designs.

- Single solution for Receiver stress testing, debug and compliance.
- Test Gen3/Gen4 standards - PCIe, USB3.1, SAS/SATA, DP + propriety standards.
- Handshaking and link training for devices running up to 32 Gb/s.

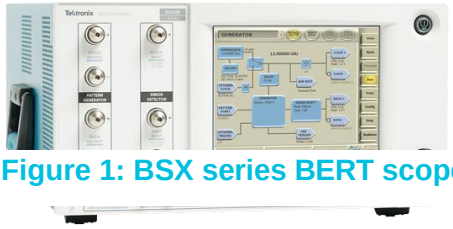


Figure 1: BSX series BERT scope

4.2. Real Time Oscilloscope

The Tektronix DSA/DSO/MSO70000 Real-Time Oscilloscope with SigTest is used to calibrate de-emphasis and stressed eye, and to perform the transmitter test portion.

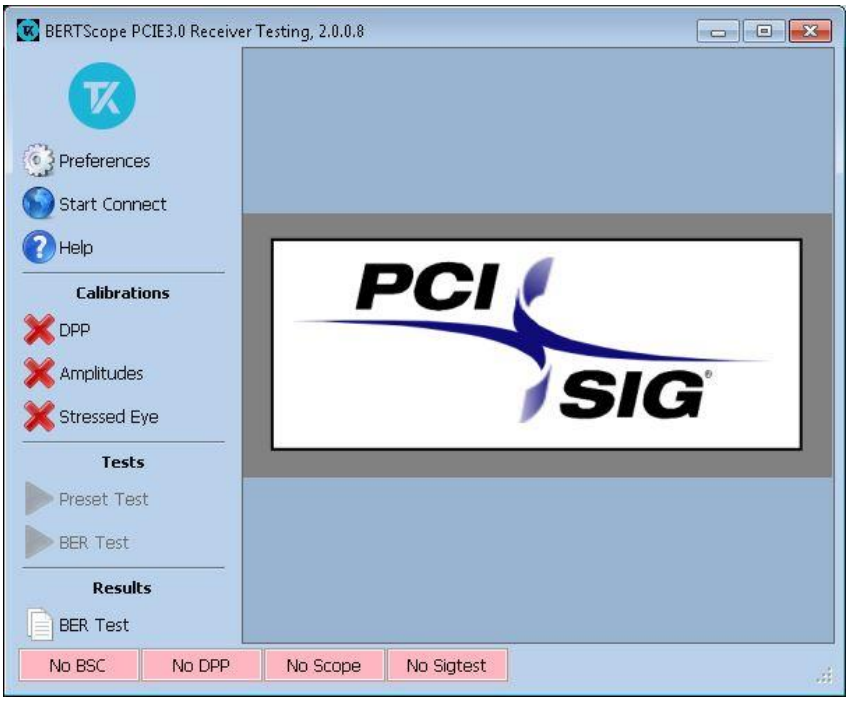
4.3. BERTScope® Clock Recovery(Optional)

Enables clock recovery on high ISI signals without impacting the data stream under test. Recovered clock enables other analysis including "clean eye", application of FIR filtering to signal, and BER testing.

4.4. Software

4.4.1. BERTScope Receiver Test Application

This application can be run from BERTScope or Tektronix Real Time Oscilloscope or an external computer.



BSXPCI4 software provides the following:

- Automated calibration, link training, loopback initiation, and testing
- BER Map feature for TXEQ optimization
- Reduces the time and minimizes the skill-set required to perform the calibration and testing
- Increases the reliability and accuracy by removing inconsistencies with manual calibration

BSXPCI4 also provides extensive online help and wizards for cabling, system calibration, and test execution. This MOI depends heavily upon BSXPCI4 features.

4.4.2. Oscilloscope VISA Socket Gateway and SigTest Server

VISA Socket Gateway: This program is intended for installation on a Tektronix 70000-series real-time oscilloscope, to allow communication between RX test automation software and real time oscilloscope.

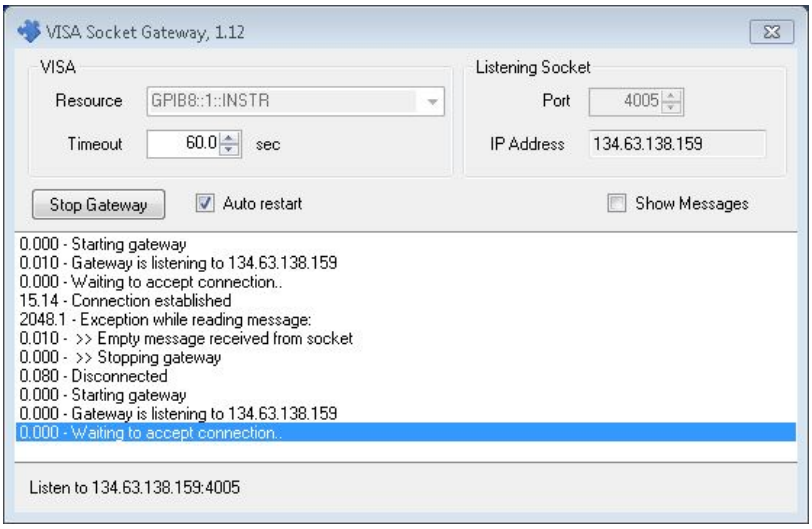


Figure 2 : VISA Socket Gateway

SigTest Server: This program is intended for installation on a Tektronix 70000-series real-time oscilloscope, to allow communication between RX test automation software and SigTest.

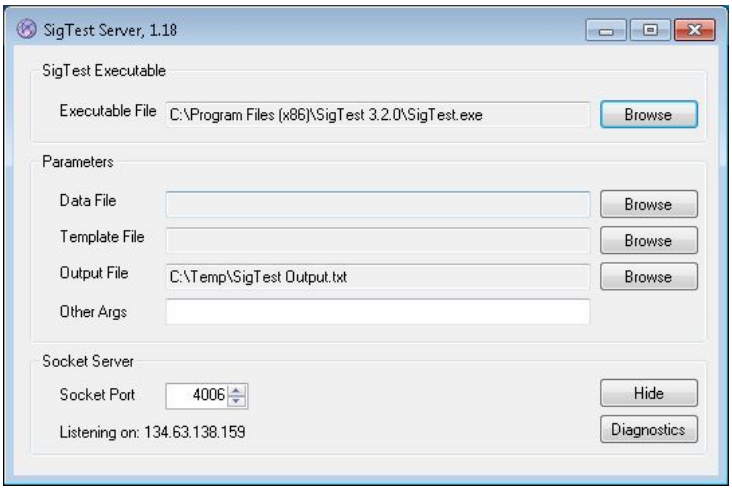


Figure 3 : SigTest Server

4.4.3. PCISIG SigTest Analysis Software

SIGTEST software is required for CEM stress calibration. It has to be installed on the Real-Time Oscilloscope used for calibration.

SIGTEST software is available directly from the PCISIG, and may be downloaded at:

http://www.pcisig.com/specifications/pciexpress/compliance/compliance_library.

4.5. Test Fixture

Test fixtures are required for compliance testing in order to connect the signal to the test equipment and vice versa.

Below are the PCI-Sig recommended test fixtures.

Description	Image
Description: PCI Express Compliance Base Board (CBB) test fixture, revision 3.0. For testing PCI Express add-in cards, x1/x4/x8/x16 PCIe connectors on PCIe devices/add-in cards. **Vendor:** PCI-SIG **www.pcisig.com/specifications/order_form** **Vendor PN:** CBB3 **Tektronix PN:** Only available from PCI-SIG	
Description: PCI Express Compliance Load Board (CLB3) test fixture, revision 3.0. For testing PCI Express Platforms, x1 & x16 PCIe connectors on PCIe systems/mother boards. **Vendor:** PCI-SIG **www.pcisig.com/specifications/order_form** **Vendor PN:** x1/x16 CLB3 **Tektronix PN:** Only available from PCI-SIG	
Description: PCI Express Compliance Load Board (CLB3), Revision 3.0. For testing PCI Express Platforms, x4 & x8 PCIe connectors on PCIe systems/mother boards. **Vendor:** PCI-SIG **www.pcisig.com/specifications/order_form** **Vendor PN:** x4/x8 CLB3 **Tektronix PN:** Only available from PCI-SIG	

Description: PCI Express Compliance Load Board (U.2 CLB3) test fixture, revision 3.0. For testing PCI Express Platforms, x1 & x4 PCIe connectors on PCIe devices/add-in cards. **Vendor:** PCI-SIG **www.pcisig.com/specifications/order_form** **Vendor PN:** U.2 CLB3 **Tektronix PN:** Only available from PCI-SIG	
Description: PCI Express Compliance Load Board (U.2 CLB3), Revision 3.0. For testing PCI Express Platforms, x1 & x4 PCIe connectors on PCIe systems/mother boards. **Vendor:** PCI-SIG **www.pcisig.com/specifications/order_form** **Vendor PN:** U.2 CLB3 **Tektronix PN:** Only available from PCI-SIG	

4.6. Cables

Item	Image
***Description*:** DC Block, SMA, 26GHz ***Vendor*:** Tektronix ***Tektronix PN*:**PSPL5500A, PSPL5501A, or PSPL5508 ***Note*:** This is optional accessory and not shown in any of connection diagrams, but can be used if DC offset is encountered in any signal path.	
***Description*:** SMA-to-SMA, Straight, 500mm, 1.5ps phase matched. ***Vendor*:** HUBER+SUHNER www.hubersuhner.com/en ***Vendor PN*:** 84210099, T+M SF104PE/11PC35/11PCC35/500mm ***Tektronix PN*:** 174-6663-xx. ***Quantity* :** 2Cable pairs	
***Description*:** SMA-to-SMA, Straight, 1000mm, 1.5ps phase matched. ***Vendor*:** HUBER+SUHNER www.hubersuhner.com/en ***Vendor PN*:** 84210103, T+M SF104PE/11PC35/11PCC35/1000mm ***Tektronix PN*:** PMCABLE1M **Quantity :** 1Cable pairs	
***Description*:** SMA-to-SMA, Right-Angle, 300mm ***Vendor*:** HUBER+SUHNER www.hubersuhner.com/en ***Vendor PN*:** 84210131, T+M MF141/16SMA/16SMA/300mm **Tektronix PN:** 174-6665-00 ***Quantity* :** 1Cable pairs	
***Description*:** SMA-to-SMA, Right-Angle, 102mm, 1ps Phase-matched. ***Vendor*:** Rosenberger www.rosenberger.com/us_en ***Vendor PN*:** 71L-19K2-32K1-00102B ***Tektronix PN*:** 174-6657-xx ***Quantity*:** 2Cable pairs	

***Description*:** SMA-to-SMP, Right-Angle cable Pari, 1m, 1ps Phase-matched. ***Vendor*:** Rosenberger www.rosenberger.com/us_en ***Vendor PN*:** 71L-19K2-32S1-01000D ***Tektronix PN*:** 174-6659-xx **Quantity :** 1Cable pairs	

5. JITTER TOLERANCE TEST

5.1. Launch the Application

Launch the Multiprotocol Rx test application, Application will open as in FIGURE 4.

Select the appropriate (PCIE3.0) Standard.

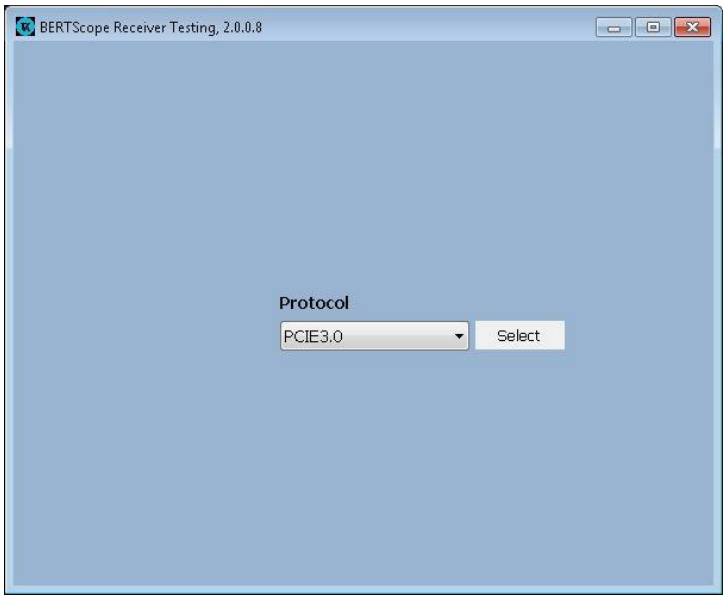


Figure 4 : BERTScope Receiver Testing Application (Multi-Protocol Application)

'*BERTScope PCIE3.0 Receiver Testing*' application will open as in Figure 5

Figure 5: PCIE3.0 Receiver Testing Application.

5.2. Connect to the instrument

'*BERTScope PCIE3.0 Receiver Testing*' application communicates with instruments (BERTScope, RT Scope and SigTest Server) using Remote server/client model. Fallow the instructions in Section 6 (Instrument Connectivity) to start the remote servers

5.3. Calibration

Perform the Calibration before staring the Jitter Tolerance test. Two types of calibration needs to be performed.

1. Amplitude Calibration: Details are in Section 7.1
2. Stressed Eye Calibration: Details are in Section 7.2

Once the calibration step is completed, proceed to the next step.

5.4. Preset Test

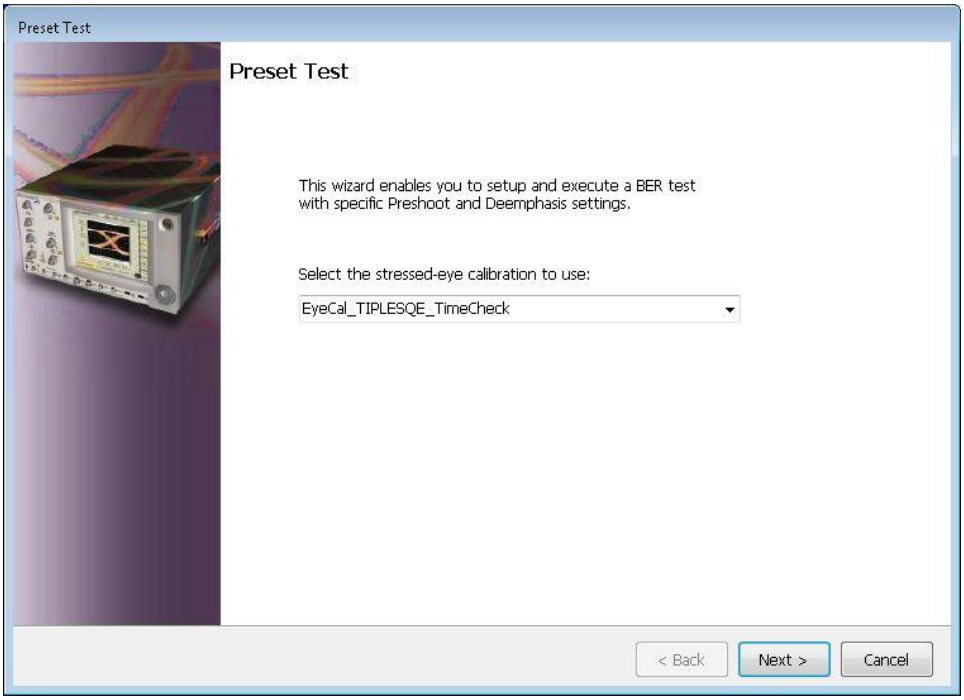
Once the system has been calibrated, receiver testing can commence. Make sure that steps 5.1, 5.2, 5.3, are done before running the BER tests.

Preset test allows BER testing of various TX equalization presets (combinations of preshoot and de-emphasis). Another feature of preset testing allows for link equalization auto-negotiation during loopback training. In this case the BERTScope/DPP will respond to TxEQ requests from the DUT. Once the DUT is trained into loopback, the final requested TxEQ value will be used for the BER test.

Press the ***Tests→Preset Test*** navigation button to launch a pop-up wizard to guide you through the process of preset testing. This wizard will automate the complete preset testing.

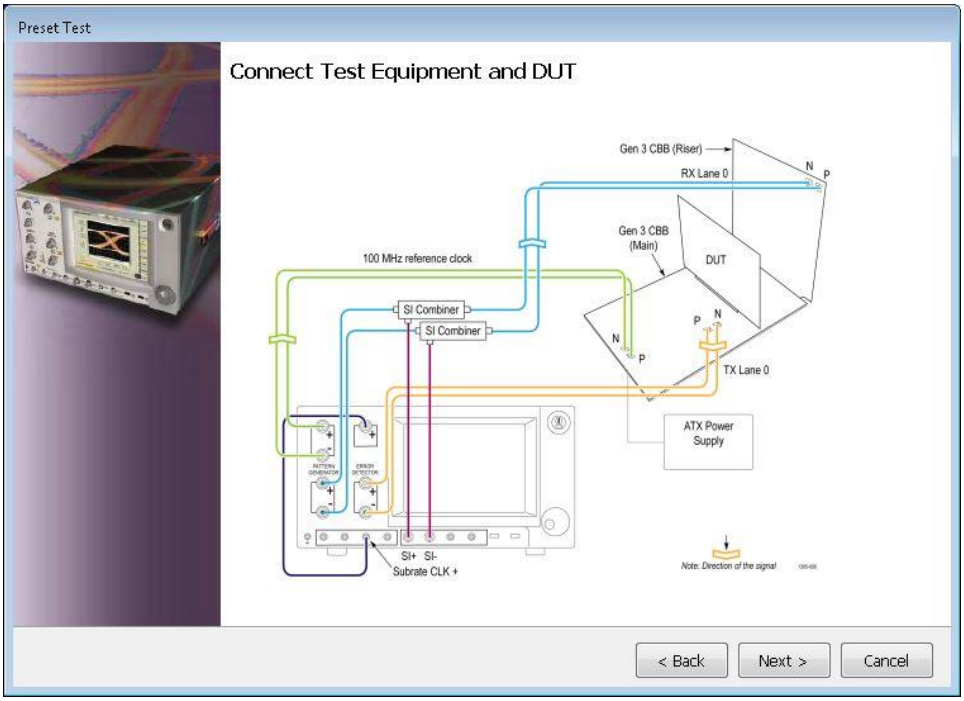
5.4.1. Select 'Stressed Eye' Values:

Select the '*Stressed Eye*' values using the drop down. All the calibrated values are listed in this dropdown.



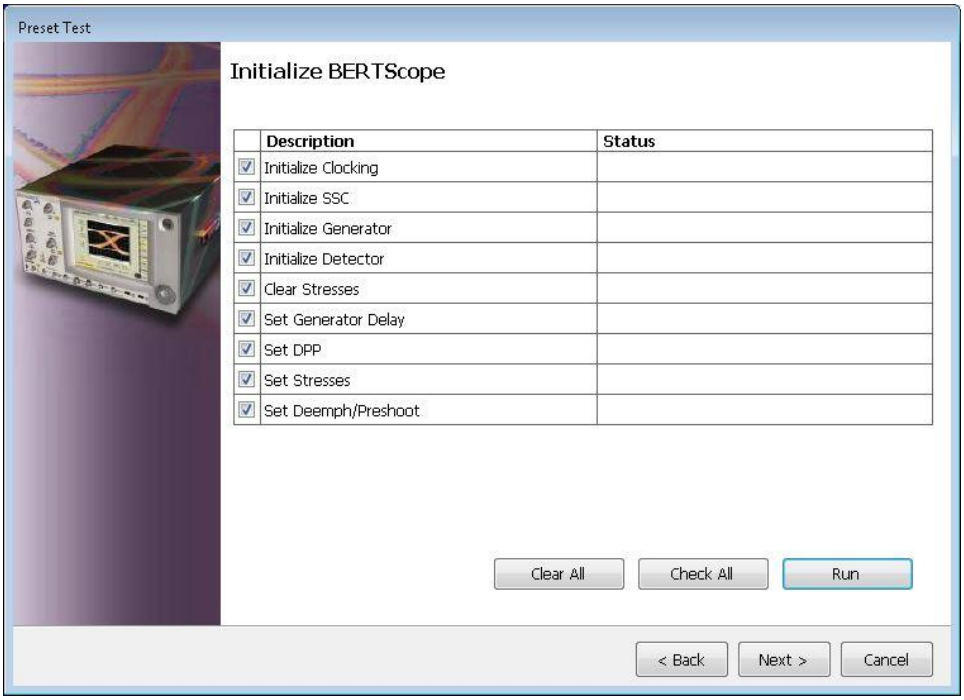
5.4.2. Connect Test Equipment and DUT:

Connection diagrams are different for Add-In Card and System testing. (High resolution connection diagram are in Section 8.3.1). Once the connections are done, press '*Next*'.



5.4.3. Initialize the Equipment: Press 'Run'.

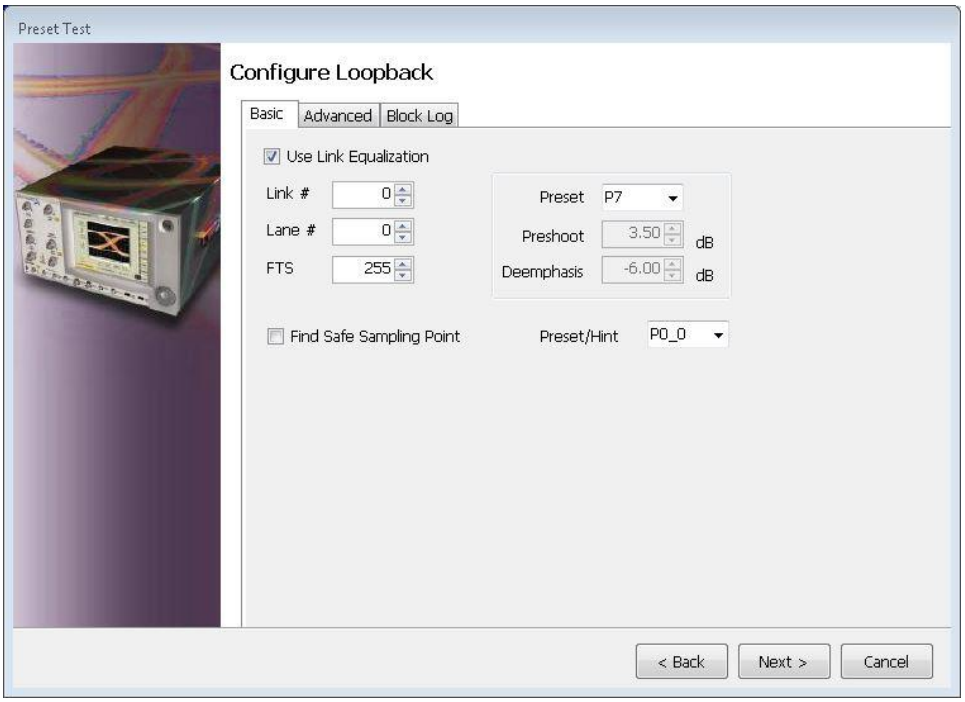
Press '*Run*' to initialize the equipment's. Once all the equipment's are initialized, press 'Next'



5.4.4. Configure Loopback

Below section describes various configuration and debug features available for loopback initialization.

- Basic



Use Link Equalization: Determines the loopback training mode used for the test. If this box is checked, the DUT will be trained to loopback through the Recovery state (commonly referred to as 'Loopback through Recovery', with link equalization performed during the Recovery.Equalization substate. If this box is unchecked, the DUT will be trained to loopback through the Config.Linkwidth.Start state (commonly referred to as 'Loopback through Config', and no link equalization training is performed.

/ *Note 1:* For the BER Test, the Use Link Equalization box is disabled; loopback training is always performed using 'Loopback through Config' for this test, since a transmit coefficient sweep is performed to validate DUT receiver performance rather than the link equalization protocol process for this test).

Link #: PCIe link number expected (if DUT is a system) or advertised by the BERTScope (if DUT is an add-in card).

Lane #: PCIe lane number expected (if DUT is a system) or advertised by the BERTScope (if DUT is an add-in card).

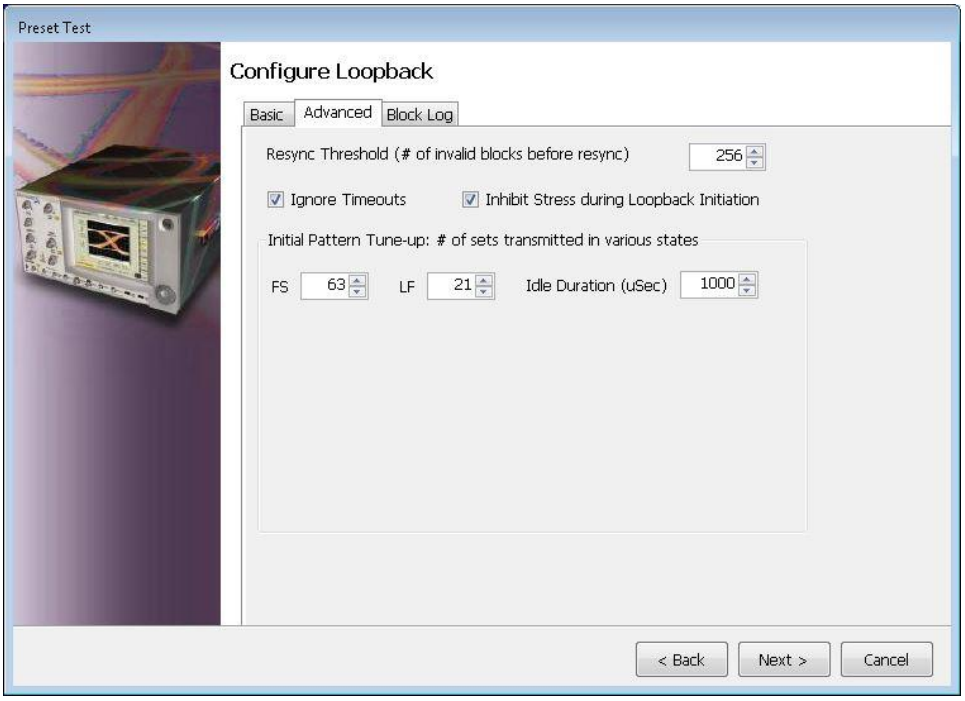
FTS: Number of Fast Training Sequence ordered sets advertised as needed by the BERTScope for PCIe L0s -> L0 state transitions. Since the L0s state is not entered at any time during testing, this value may normally be left at its default value.

Preset: Specifies the initial PCIe transmit preset used for the BERTScope transmitter for loopback training. When the Use Link Equalization checkbox is unchecked, this will also be the transmit setting used by the BERTScope when the Loopback state is entered. When the Use Link Equalization checkbox is checked, this will be the transmit setting for Recovery.Equalization phase 1, with the BERTScope's transmit setting modified based on DUT requests during Recovery.Equalization phase 2 or 3.

Preset/Hint: Specifies two values in the form Px_y, where x is the PCIe transmit preset value requested by the BERTScope for the DUT's transmitter during loopback training, and y is a receiver preset hint from the BERTScope to the DUT that may be used for initial receiver equalization tuning. The encoded values for the preset hint field are described in section 4.2.3.2 of the PCIe Base Specification (revision 3.1).

Use Safe Sampling Point: The BERTScope's Detector requires a valid sampling point for incoming Gen3 data from a DUT so that Gen3 protocol data is correctly interpreted by the BERTScope. This sampling point will vary for different DUTs. When the Use Safe Sampling Point box is checked, the BERTScope will perform a quick scan of the incoming data stream after a transition to the Gen3 data rate has occurred in order to set this sampling point. If the Use Safe Sampling Point box is unchecked, the currently set Detector sampling point will be used for loopback training. It is recommended that the Use Safe Sampling Point feature be enabled the first time loopback training is performed for a DUT; subsequent test runs can then be performed with the Use Safe Sampling Point feature either enabled or disabled.

- Advanced



Resync Threshold: Specifies the number of invalid (incorrectly decoded) PCIe protocol blocks after which the BERTScope's PCIe link training state machine will attempt to reacquire protocol block alignment and resynchronize to the PCIe Gen3 data stream sent from a DUT. This field should normally be left at its default setting.

Ignore Timeouts: If this box is checked, the BERTScope's PCIe link training state machine will not enforce timeout values for each PCIe LTSSM state during loopback training. If this box is unchecked, the BERTScope's PCIe link training state machine will detect a timeout condition if any LTSSM state timeout occurs during loopback training due to a lack of an expected response from a DUT. It is recommended that this box be left checked during normal testing.

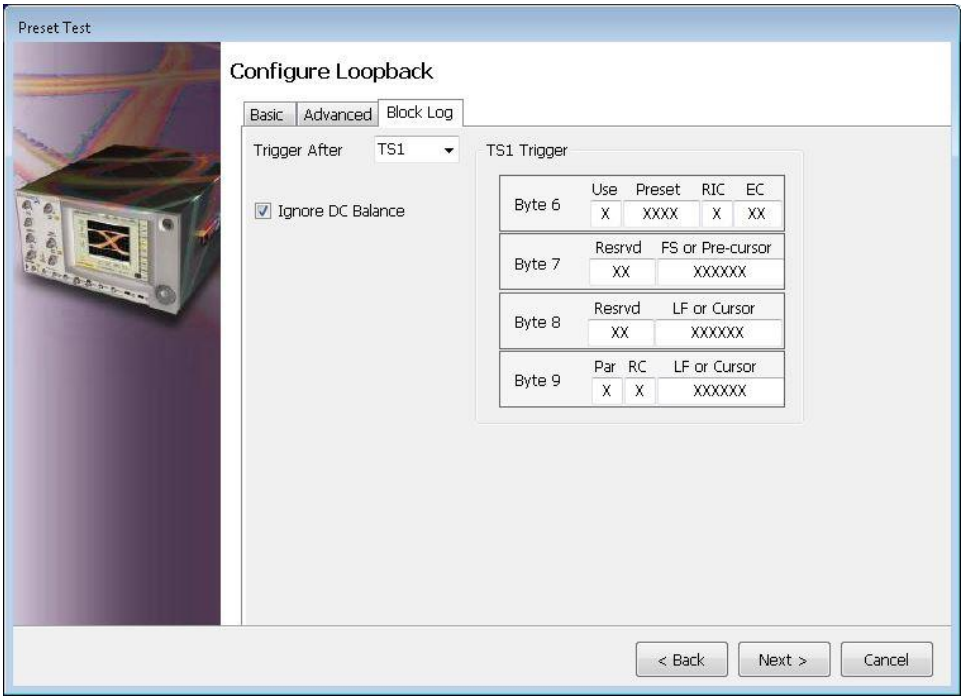
Inhibit Stress during Loopback Initiation: If this box is checked, stress (RJ, SJ, DMSI) will not be applied to the data transmitted by the BERTScope during loopback training. If this box is unchecked, calibrated RJ, SJ, and DMSI will be applied to the BERTScope's transmit data during the loopback training process.

FS: Specifies the FS (Full Swing) value advertised by the BERTScope during the link equalization process. The FS value specifies the granularity of the BERTScope transmitter's coefficient tap settings. For normal testing, this setting should be left at its default value of 63 (maximum tap resolution).

LF: Specifies the LF (Low Frequency) value advertised by the BERTScope during the link equalization process. This value corresponds to the minimum differential voltage that can be generated by the BERTScope transmitter. For normal testing, this setting should be left at its default value.

Idle Duration: Specifies the electrical idle transition time for Gen1->Gen3 data rate transitions during loopback training. For normal testing, a value of 1000 microseconds (1 millisecond) is appropriate.

- Block Log



During loopback training, the BERTScope's link training state machine can record incoming Gen3 protocol traffic from the DUT based on the detection of a specific protocol block type. When this block type (and for TS1 ordered sets, accompanying link training field values) is detected in the incoming Gen3 protocol stream, subsequent protocol blocks are recorded until the link training state machine's log buffer has filled; these blocks may then be seen in the block log status tab.

Trigger After: Specifies the type of protocol block (data or ordered set) that should be used as a trigger for block capture.

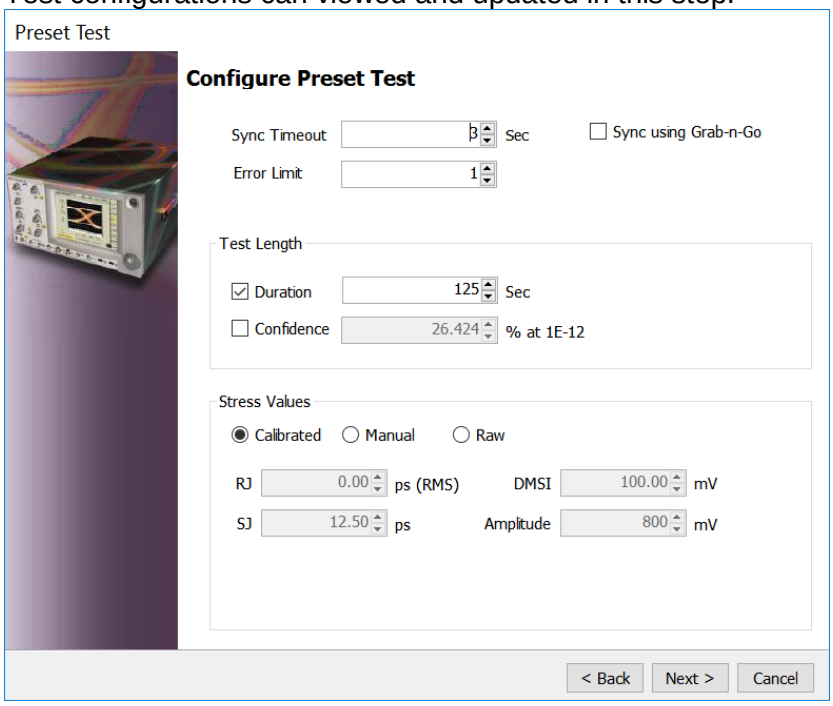
Ignore DC Balance: The block logging mechanism will compress multiple identical blocks into a single log entry in order to extend the amount of block data captured.

When this setting is checked, the block logging mechanism will ignore DC balance symbols (symbols 14 and 15 in TS1 and TS2 ordered sets) when determining whether consecutive TS1/TS2 ordered sets are identical. It is recommended that this setting be enabled for normal testing.

TS1 Trigger Byte 6-9: When the Trigger After block type is set to TS1, these fields may be used to further qualify the block log capture trigger based on the link equalization values present in symbols 6-9 of the TS1 ordered set. An 'X' indicates a don't-care value for the specified bit in these symbols; field values may be set by setting the corresponding bits in the desired fields to '0' or '1'. Only TS1s that exactly match the specified field values in entirety will cause the block log capture to begin.

5.4.5. Configure Test

Test configurations can viewed and updated in this step.

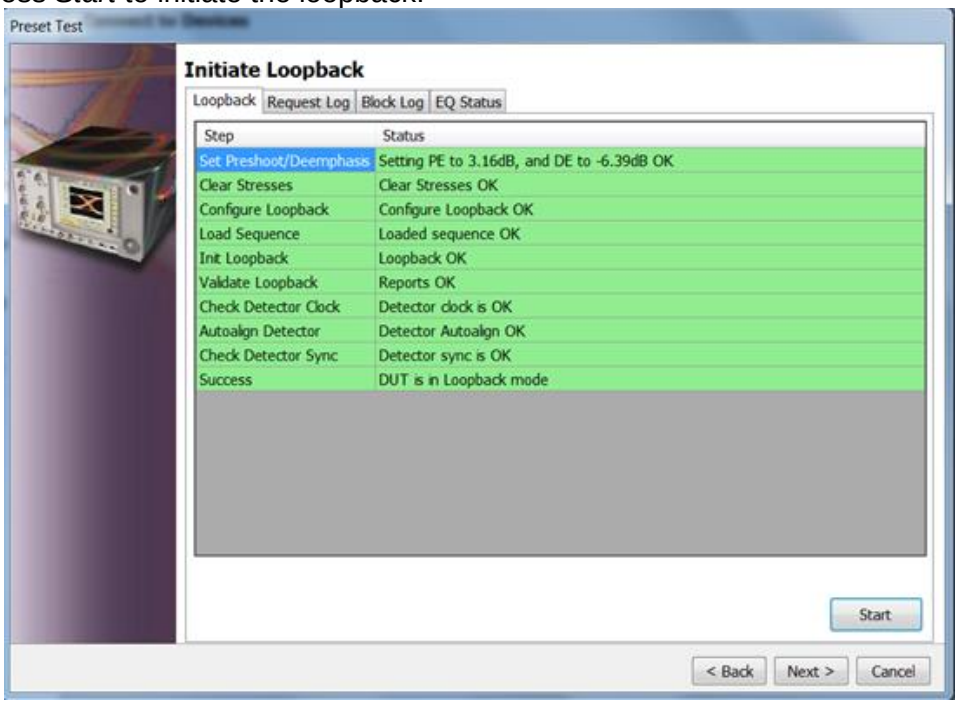


- Sync timeout: Application will try to *Sync* for the specified time. If the *Sync* does not happen then the application will error out.
- Error Limit : Maximum error allowed.
- Sync using Grab-n-Go:
- Test Length
  Test length can be specified either as a absolute test '*Duration*' or '*Confidence*' level.
  - Duration : Specify the test duration in Seconds.
  - Confidence: Required confidence level at the BER 1e-12.
- Stress Value
  - Calibrated: Takes the stress values which are specified in the specification and uses the calibration curves to find the actual settings to be used on the BERTScope.
  - Manual: Manually specify the stress value. This is useful for doing measurement outside the specification limits. RJ, SJ, DMSI and Amplitude values can be varied.

- Raw: Use the raw stress value. Entered stress values are directly used.

5.4.6. Initiate Loopback:

Press *Start* to initiate the loopback.



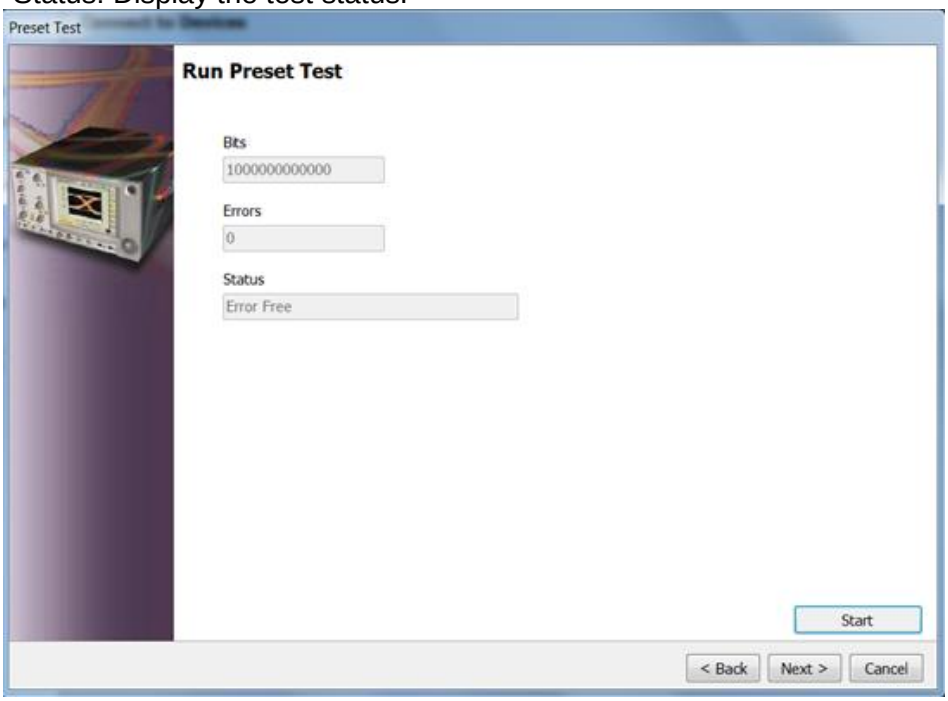
When all the steps in the loopback are successfully performed then press *Next* to proceed to the Preset test.

5.4.7. Run Preset Test

Preset test is run for the specified duration/bits. Number of errors counted are displayed.

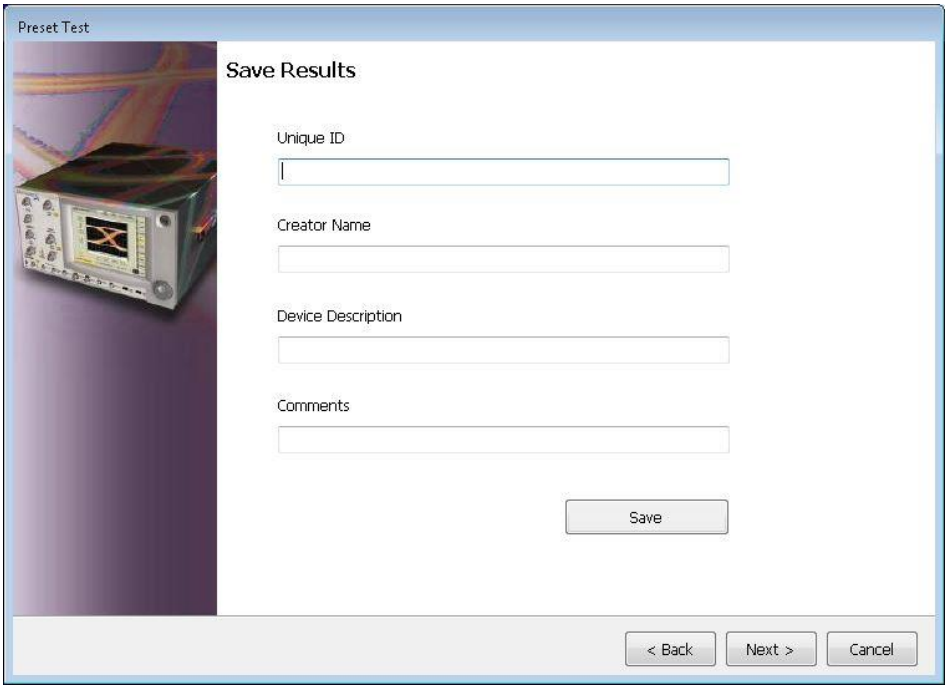
- Bits: Total number of bits tested. This depends on the test duration.
- Errors: Show the number of bit errors.

  Status: Display the test status.



5.4.8. Save Results

Click '*Save*' button to save the results to a local database.



Below information can be provided while saving the results

- Unique ID: Name of the report.
- Creator Name: Operator name can be entered for future reference.
- Device Description: Enter the device description.
- Comments: Add comments if any.

5.5. BER Test

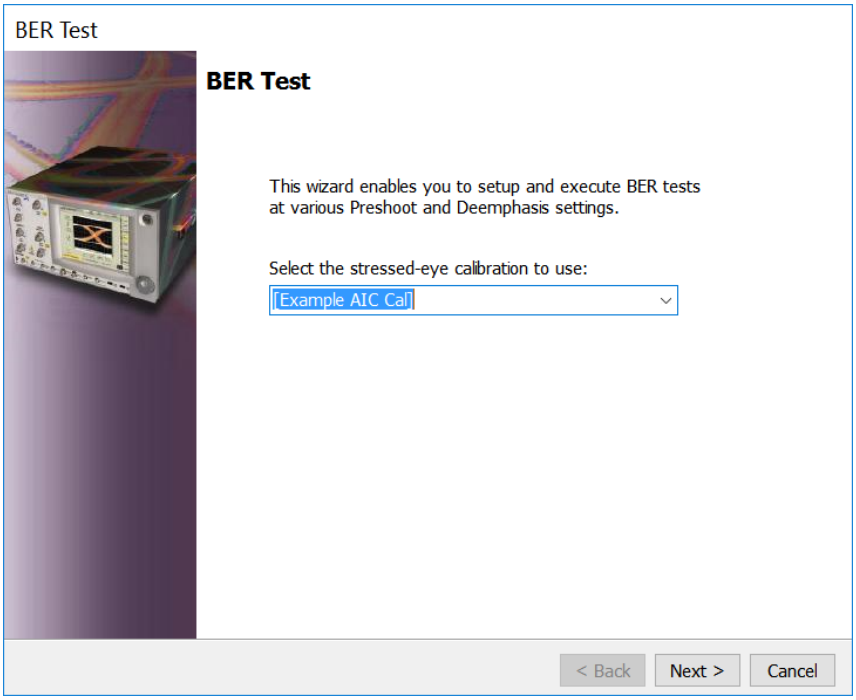
Once the system has been calibrated, receiver testing can commence. Make sure that steps 5.1, 5.2, 5.3, are done before running the BER tests.

BER Test allows BER testing of various TX equalization presets (combinations of preshoot and de-emphasis). During the BER test, the BERTScope system will step through various combination of preshoot and de-emphasis levels and measures the BER at each setting. Link equalization is not used for BER test.

Press the ***Tests→BER Test*** navigation button to launch a pop-up wizard which will guide you through the process of preset testing. This wizard will automate the complete preset testing.

5.5.1. Select 'Stressed Eye' Values

Select the '*Stressed Eye*' values using the drop down. All the calibrated values are listed in this dropdown. Based on the 'Stressed Eye' selection, either '*Add-In Card*' or '*System*' Test is performed.



5.5.2. Connect Test Equipment and DUT

Connection diagrams are different for Add-In Card and System testing. (High resolution connection diagram are in Section 8.3.1). Once connections are done, press '*Next*'.

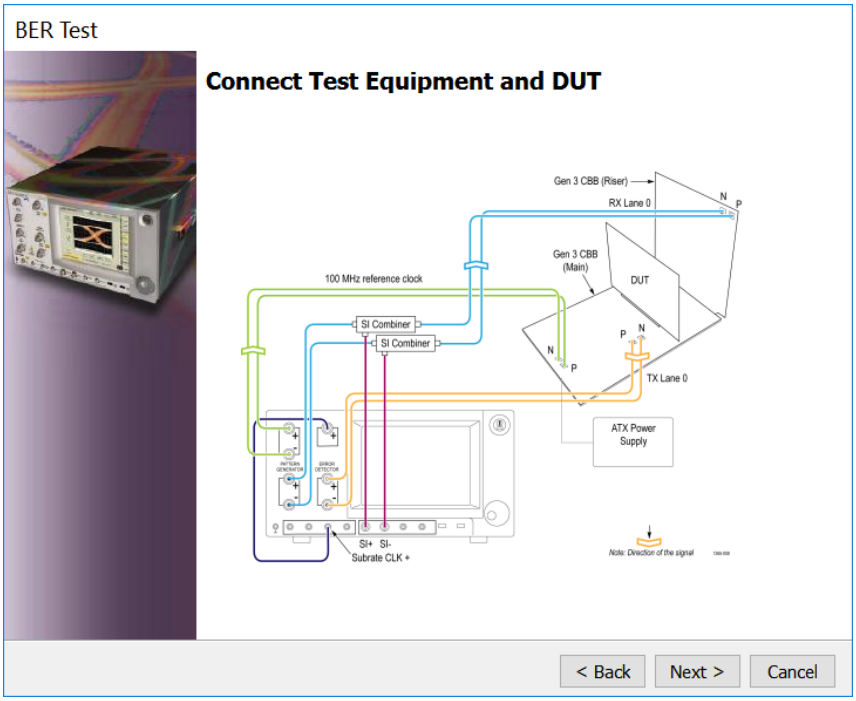


Figure 6: Add-In Card Test Connection

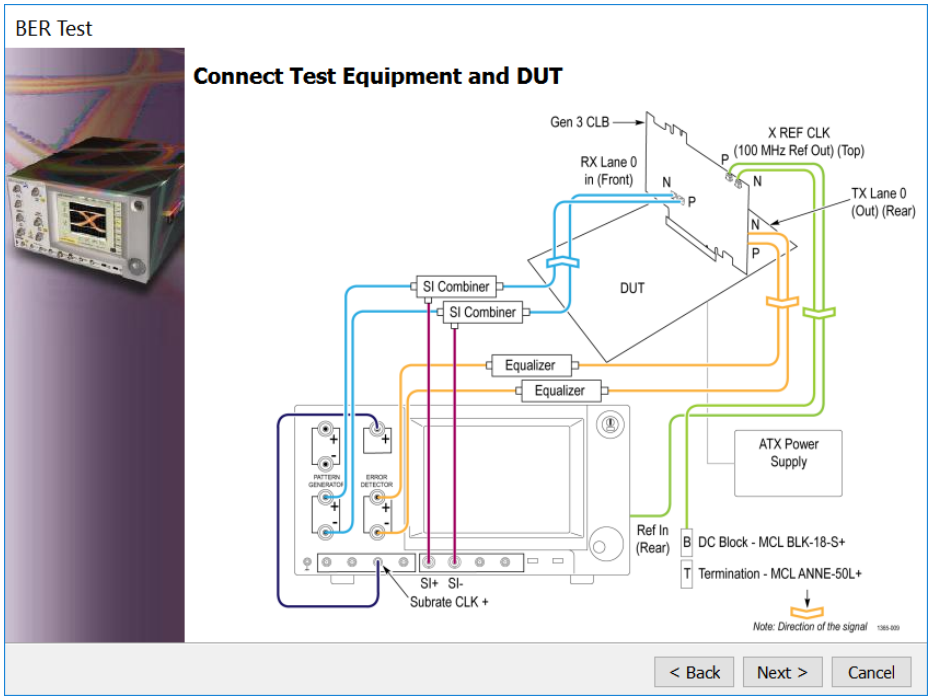
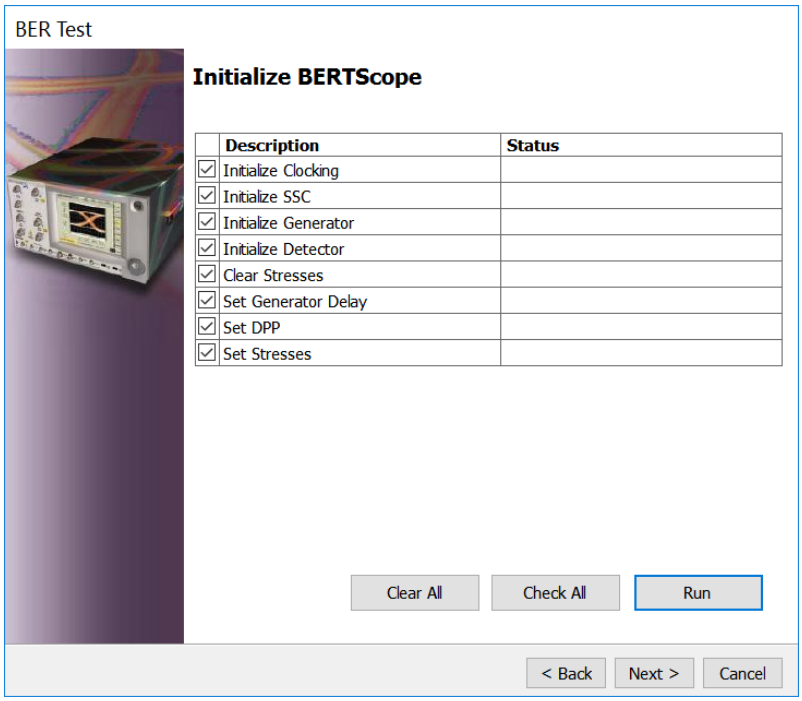


Figure 7 : System Test Connection

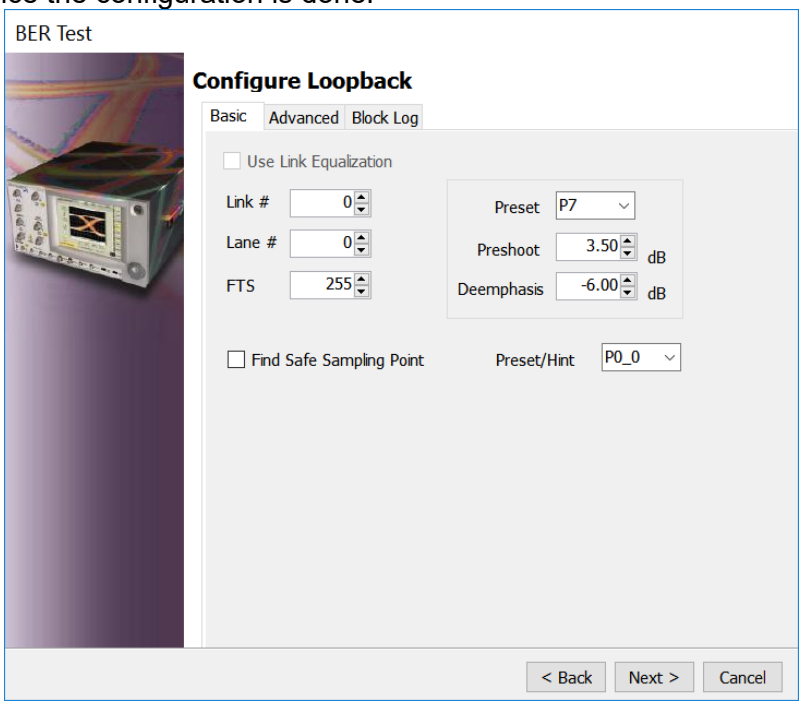
5.5.3. Initialize BERTScope: Press Run

Once all the equipment's are initialized, press 'Next'



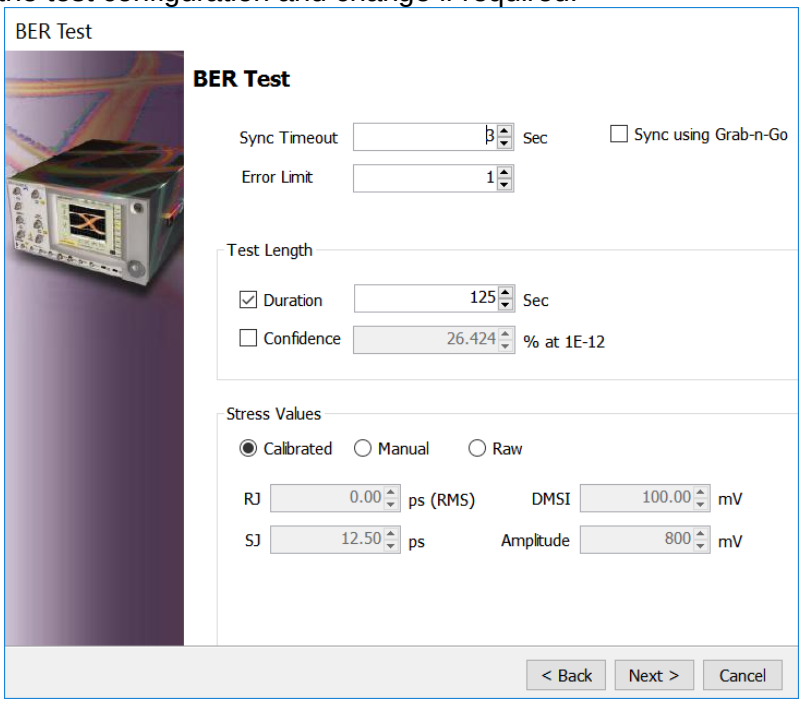
5.5.4. Configure Loopback

'*Configure Loopback*' details can be found in section 5.4.4 (Configure Loopback). Press '*Next*' once the configuration is done.



5.5.5. Configure Test

Review the test configuration and change if required.



- Sync timeout: Application will try to *Sync* for the specified time. If the *Sync* does not happen then the application will error out.
- Error Limit: Maximum error allowed.
- Sync using Grab-n-Go:
- Test Length
  Test length can be specified either as a absolute test '*Duration*' or '*Confidence*' level.
  - Duration : Specify the test duration in Seconds
  - Confidence: Required confidence level at the BER 1e-12
- Stress Values
  - Calibrated: Takes the stress values which are specified in the specification and uses the calibration curves to find the actual settings to be used on the BERTScope.
  - Manual: Manually specify the stress value. This is useful for doing measurement outside the specification limits. RJ, SJ, DMSI and Amplitude values can be varied.
  - Raw: Use the raw stress value. Entered stress values are directly used.

5.5.6. Select BER Sweep Values

Select the required BER Sweep values. The table (sweep matrix) looks as in FIGURE 8. This screen allows selection of the preshoot/de-emphasis combinations to be tested. One of the key challenges setting up the link is tuning or determining the optimal RxEQ settings. The BER Map feature provides an automated way to scan the PCIe TxEQ coefficient matrix to determine the optimal TxEQ settings.

The matrix may be interpreted as follows: Pre-shoot and de-emphasis coefficients are mapped onto the Y-axis and X-axes, respectively. In both cases the maximum granularity of 1/24 is assumed. Each matrix cell corresponding to a valid combination of preshoot and

de-emphasis coefficients has three entries corresponding to preshoot (PS), de-emphasis (DE), and boost (as shown in the upper left hand corner). The table also shows the corresponding preset value where ever applicable.

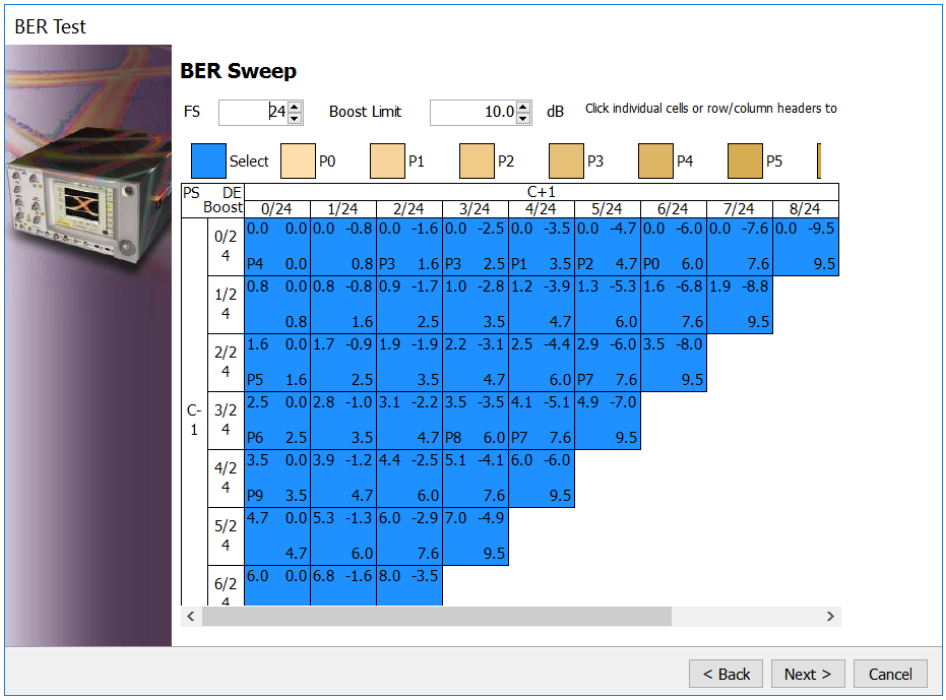
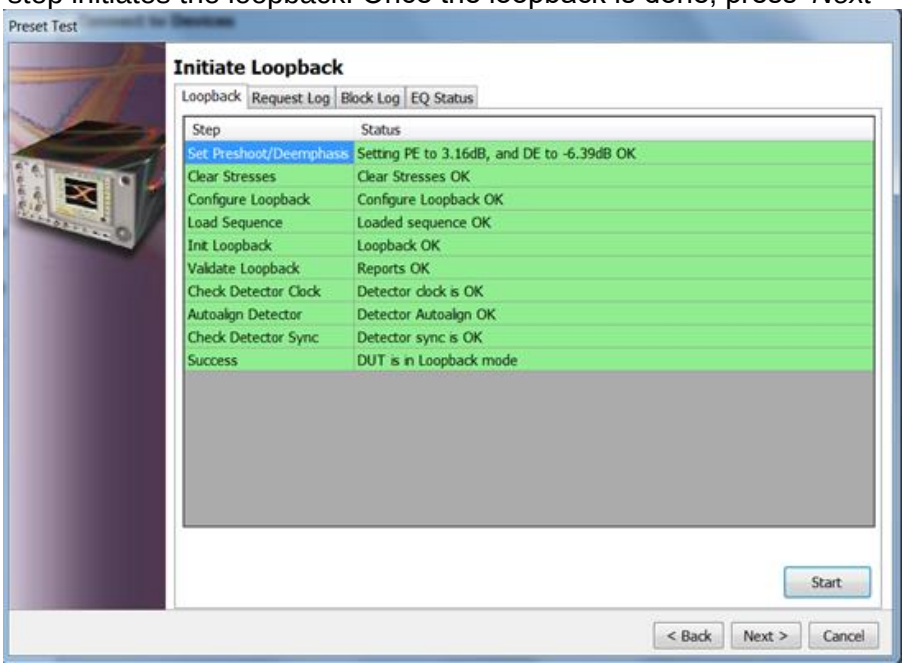


Figure 8: BER Sweep matrix

- FS: Adjust the FS to change the resolution of the table.
- Boost Limit: Maximum boost that needs to be used.

5.5.7. Initiate Loopback:

This step initiates the loopback. Once the loopback is done, press '*Next*'

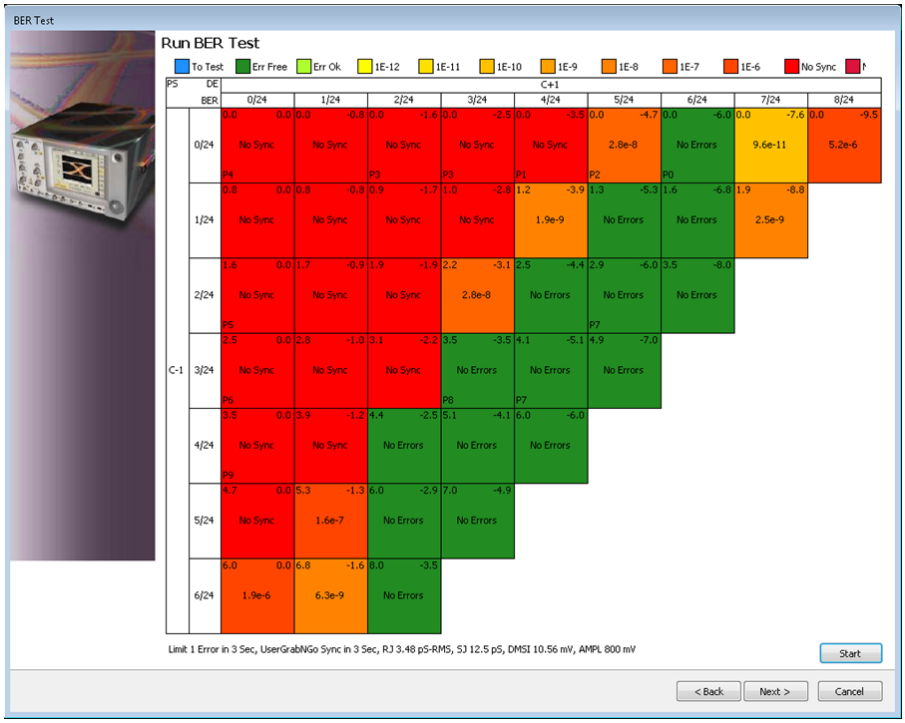


When all the steps in the loopback are successfully performed then press '*Next*' to go to '*Preset Test*'.

5.5.8. Run BER Test

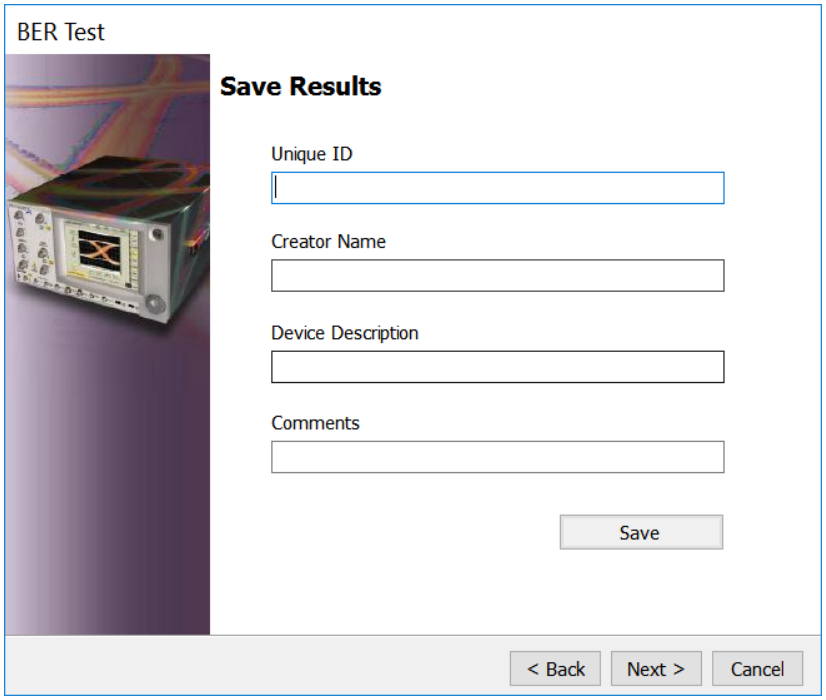
Run the BER test. The following figure shows the results of a BER test. The BER for each TxEQ setting is shown in the table.

Fallow the onscreen instructions to understand more about the pass and failure cases.



5.5.9. Save Results

Press '*Save*' button to save the results in a local database.



Below information can be provided while saving the results

- Unique ID: Name of the report.
- Creator Name: Operator name can be entered for future reference.
- Device Description: Enter the device description.
- Comments: Add comments if any.

6. INSTRUMENT CONNECTIVITY

'*BERTScope PCIe Gen3 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.

Figure 9 shows the PCIe Gen3 Test solution equipment and Software communication.

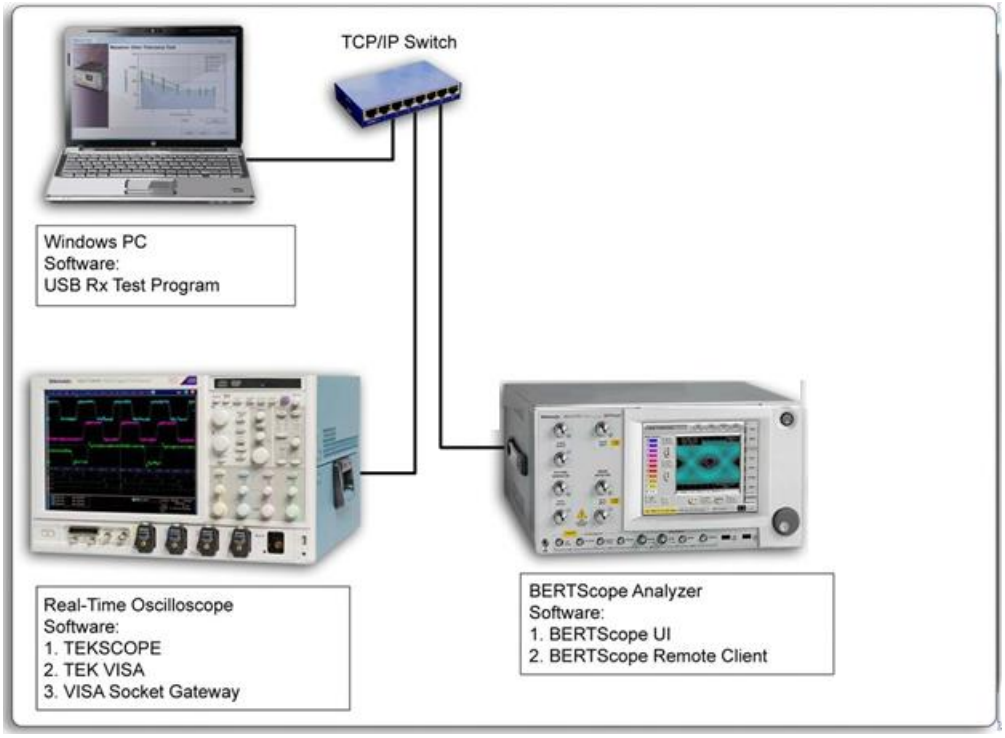


Figure 9 PCIe *Gen3 Test Solution Equipment and Software Communication*

/ 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.

6.1. 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 the Figure 10.

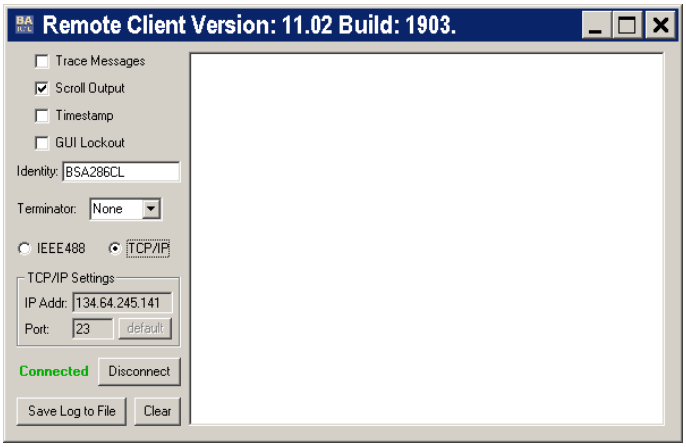


Figure 10 : BERTScope Remote Client

6.2. Connect to Scope.

Before connecting to the scope, start 'VISA Socket Gateway'. This server will provide the connectivity between '*BERTScope PCIE3.0 Receiver Testing*' and Oscilloscope. (Start → All Programs → Visa Socket Gateway → Visa Socket Gateway)

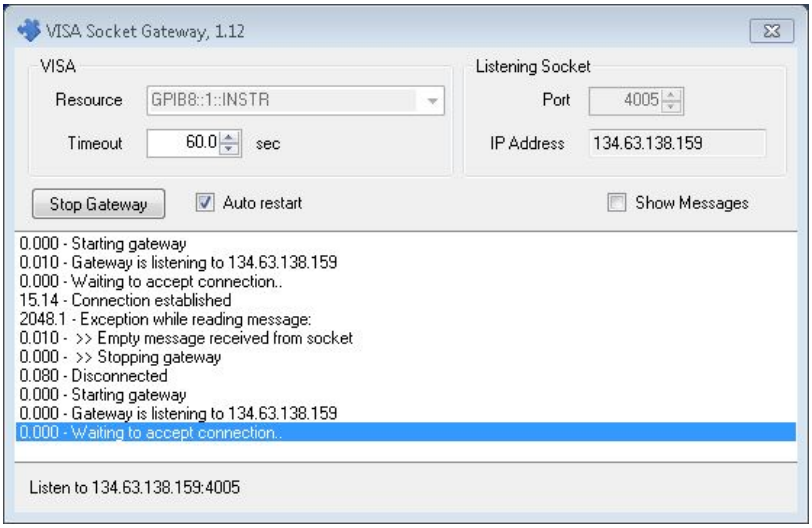
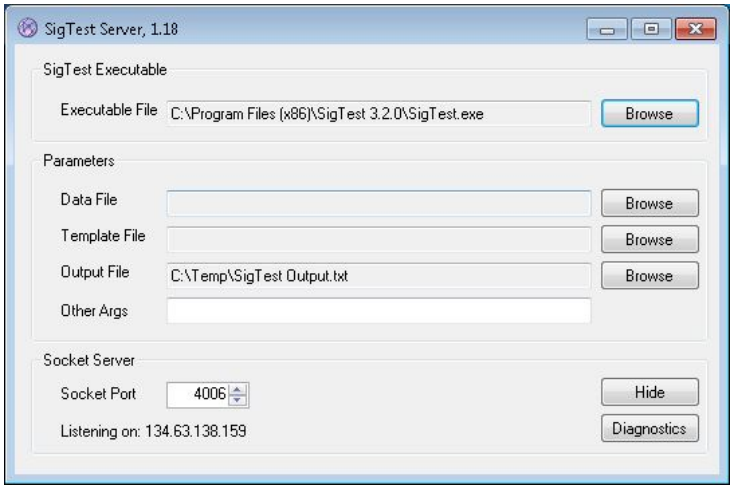


Figure 11: VISA Socket Gateway

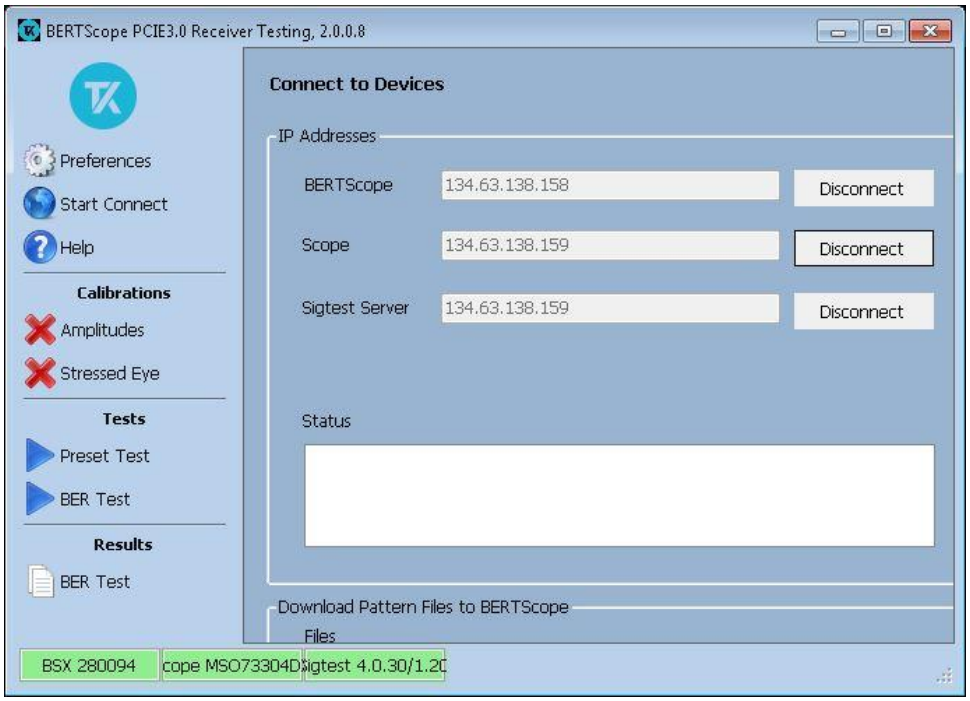
6.3. Connect to SigTest Server

SigTest application runs inside the scope, hence SigTest Server also needs to be launched inside the scope. (*Start → All Programs → SigTest Server → SigTest Server*)
User can change the SigTest version by browsing a different 'Executable File'.



6.4. 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 6.1, 6.2, 6.3). 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.



7. CALIBRATION

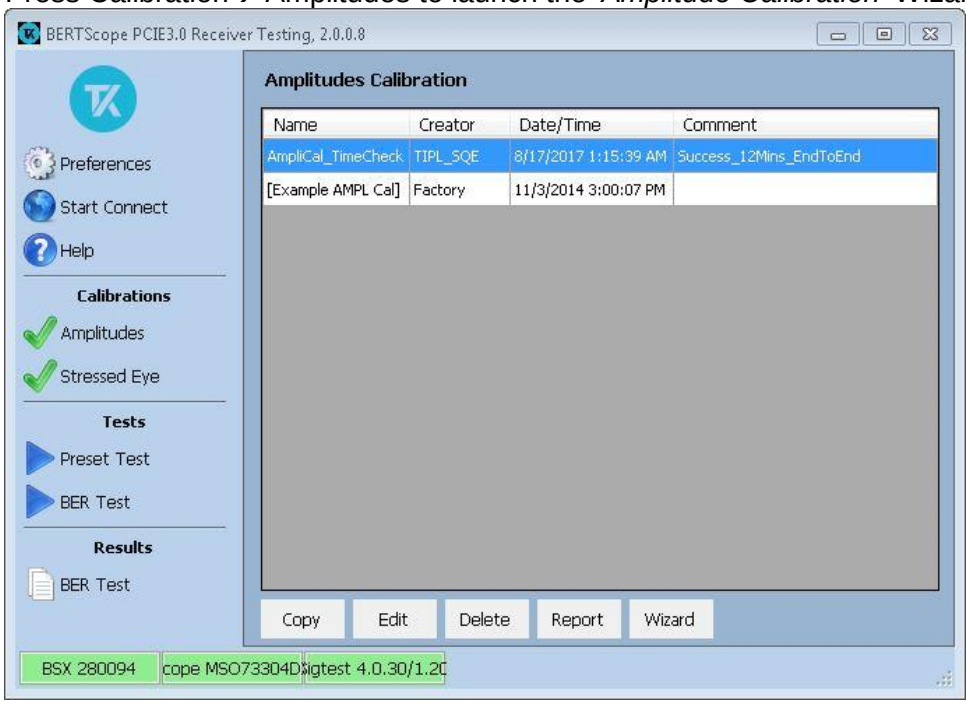
Calibration is performed to compensate for cable/fixture losses. Two types of calibration needs to be performed.

- Amplitude Calibration.
- Stressed Eye 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.

7.1. Amplitude Calibration

7.1.1. Press Calibration→ Amplitudes to launch the '*Amplitude Calibration*' Wizard.



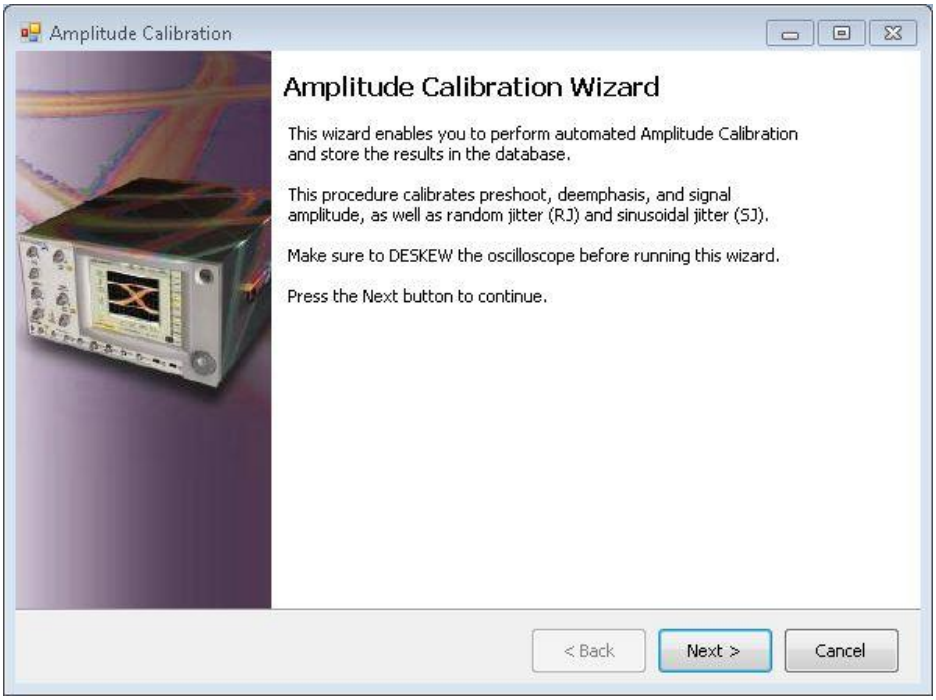
From the Amplitude Calibrations view, select the appropriate calibration file or, if an appropriate calibration file does not exist, press ***Wizard*** to begin the automated step-by-step calibration procedure.

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 Stressed Eye calibration and storing it in the

7.1.2. Amplitude Calibration Wizard

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



7.1.3. Amplitude calibration Cabling Diagram

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

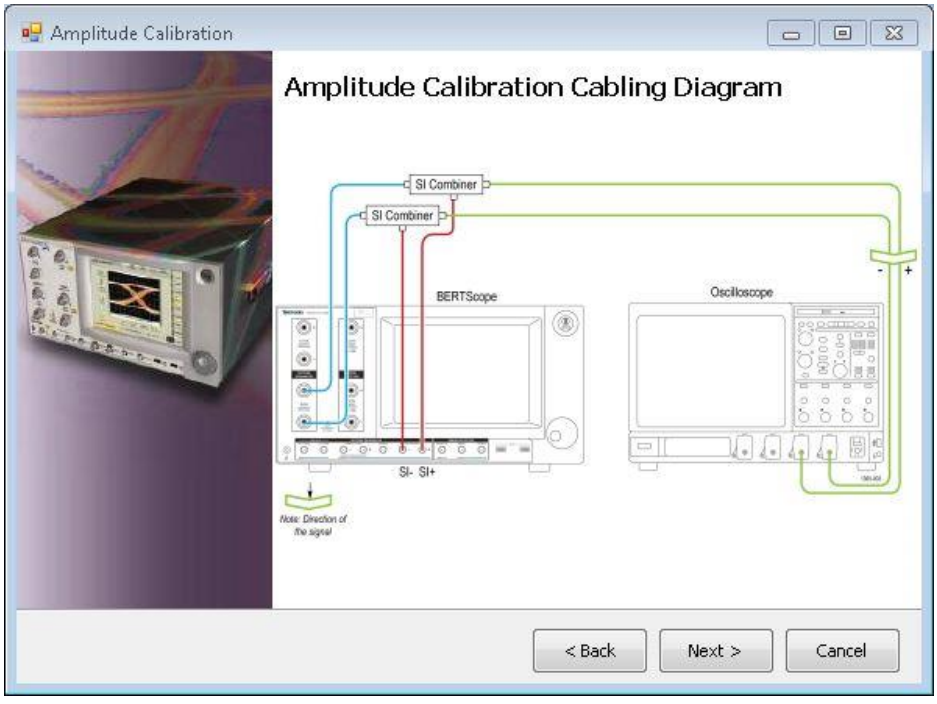
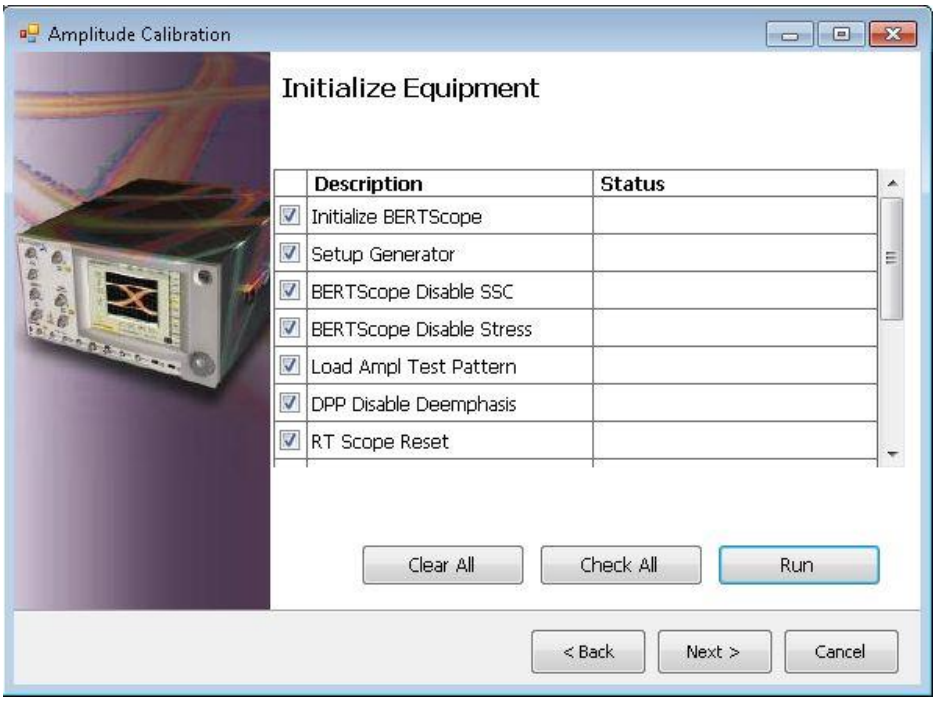


Figure 12: Amplitude Calibration Cabling Diagram.

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

7.1.4. 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*'.



7.1.5. Select the Stress Targets

Application will show the stress targets as per the CEM Specification. If user wishes to test the application with different stress targets then they can change the values in this panel.

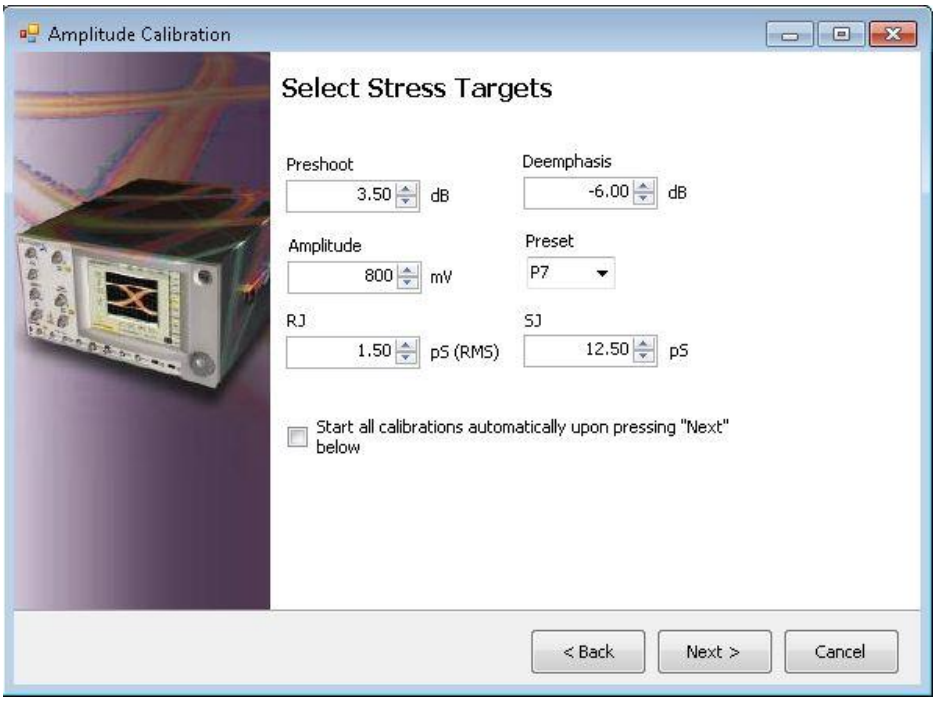
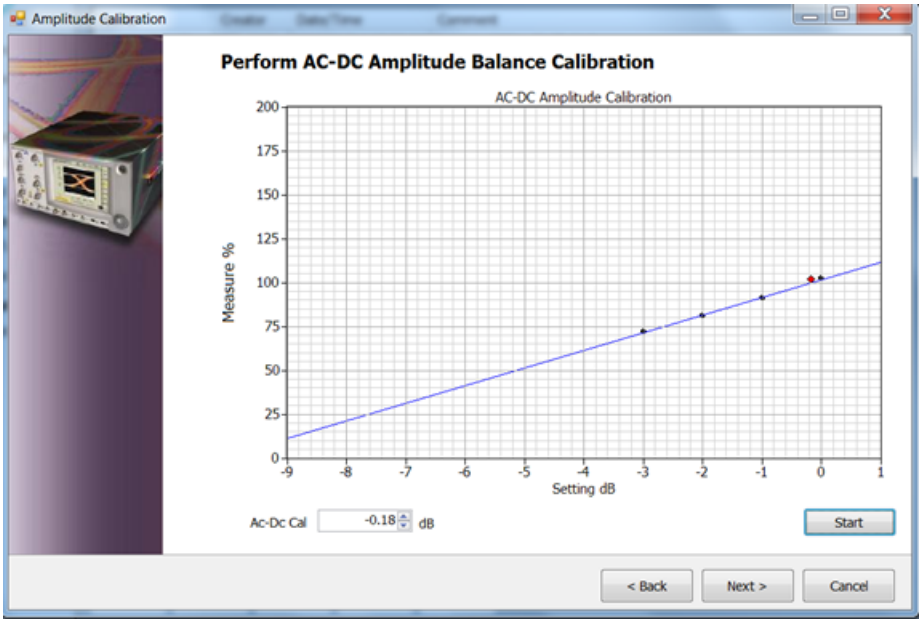


Figure 13 : Select Stress Targets

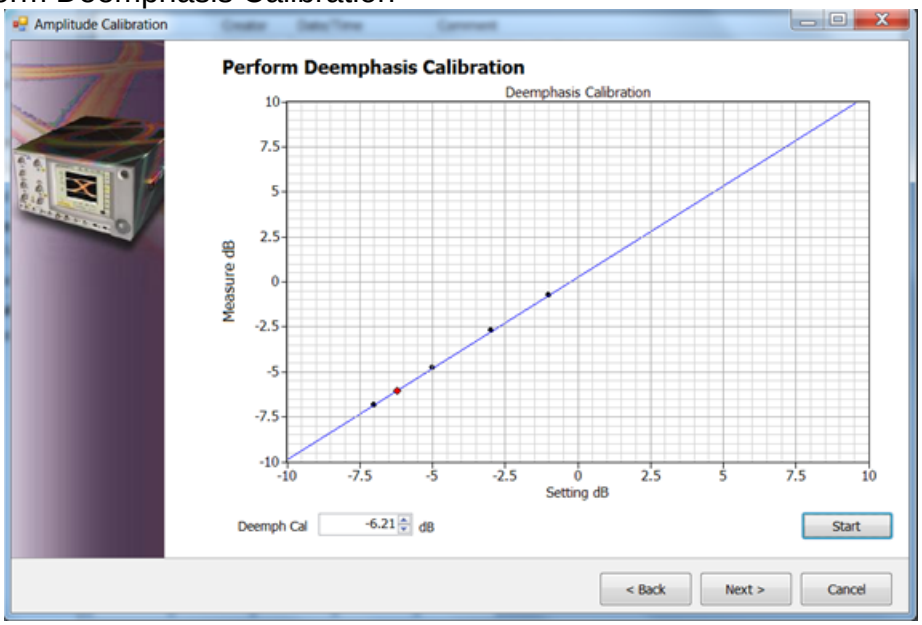
Check the '*Start all calibration automatically upon pressing "Next" below*', to start the automatic calibration of amplitude, Rj and Sj parameters without having to press 'Next' in each of the panel/Step. If this checkbox is un-checked then user has to manually press 'Next' upon completion of each of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

7.1.6. 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.

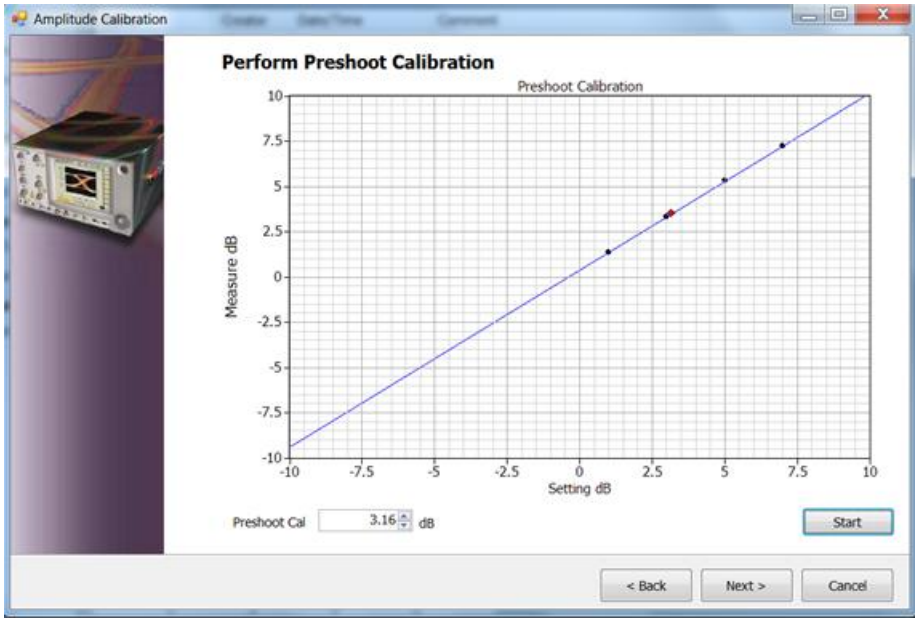


7.1.7. Perform Deemphasis Calibration



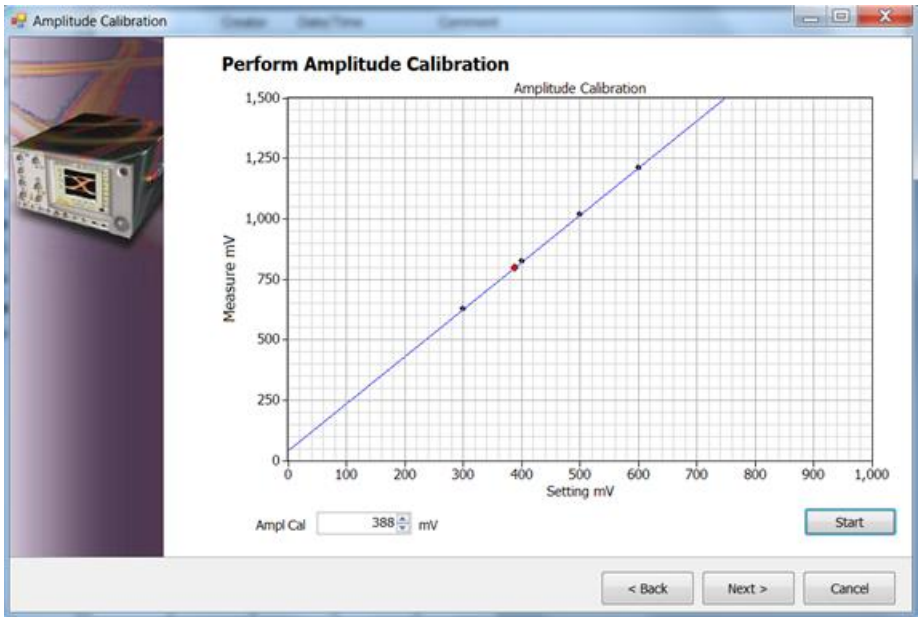
7.1.8. Perform Preshoot Calibration

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



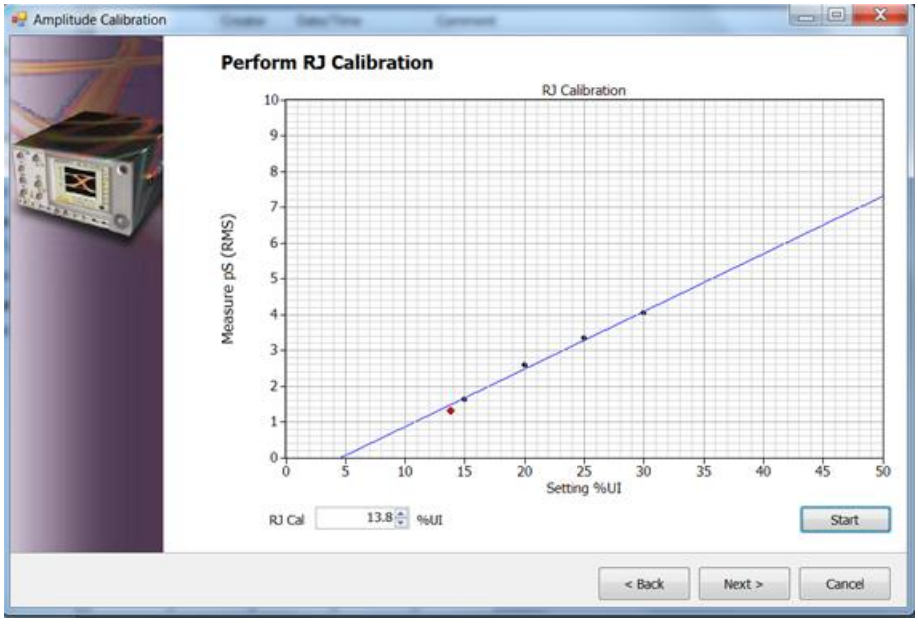
7.1.9. Perform Amplitude calibration

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



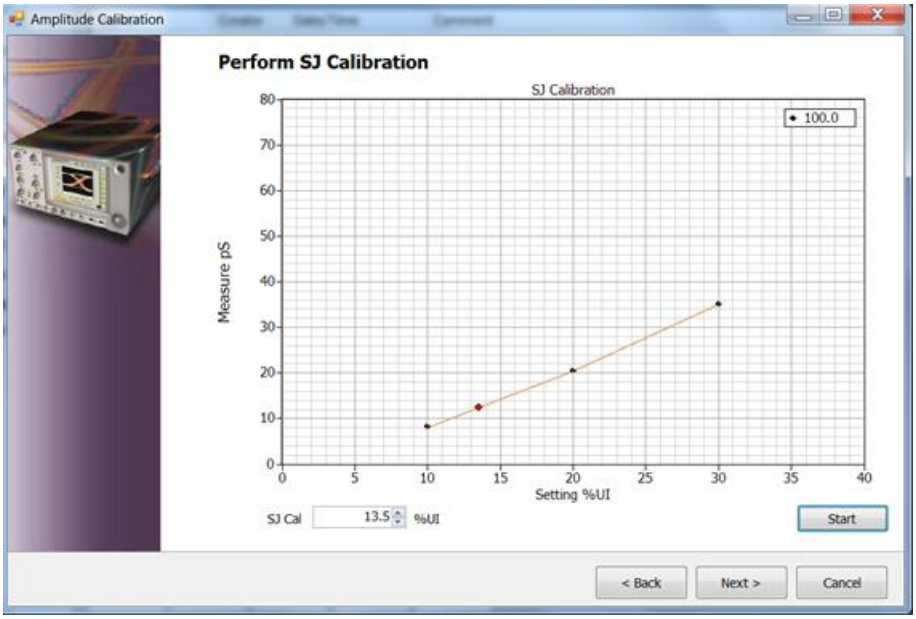
7.1.10. Perform RJ Calibration

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.



7.1.11. Perform SJ calibration

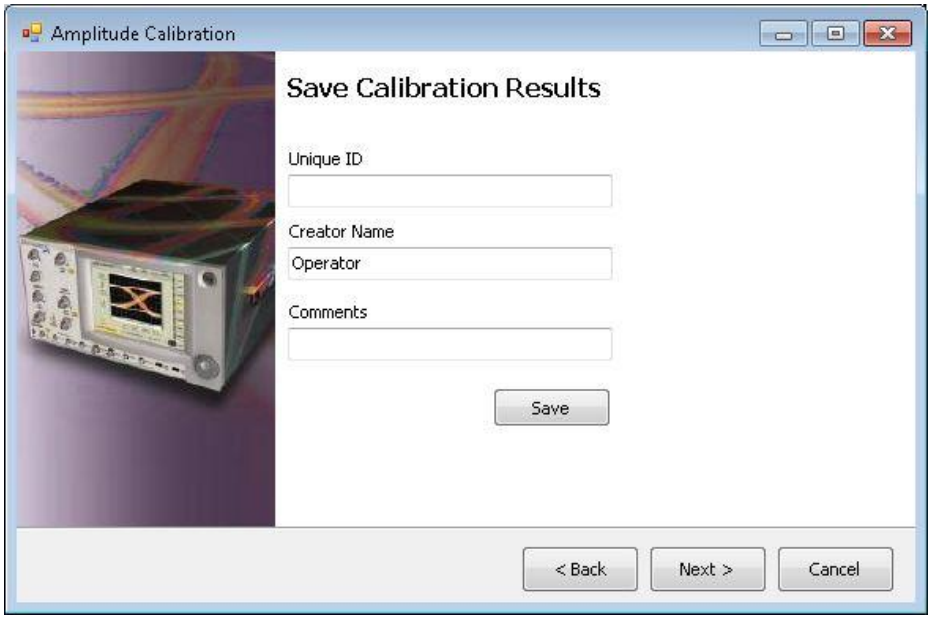
Perform the SJ calibration. Waveform is saved on the oscilloscope and SigTest is used for SJ measurement. Press ‘Start’ to start the calibration. Press ‘Next’ once the calibration is done.



7.1.12. 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*'.

Amplitude Calibrated values can be used for performing the 'Stressed Eye' Calibration and to perform 'Jitter Tolerance' test.



7.2. Stressed Eye Calibration

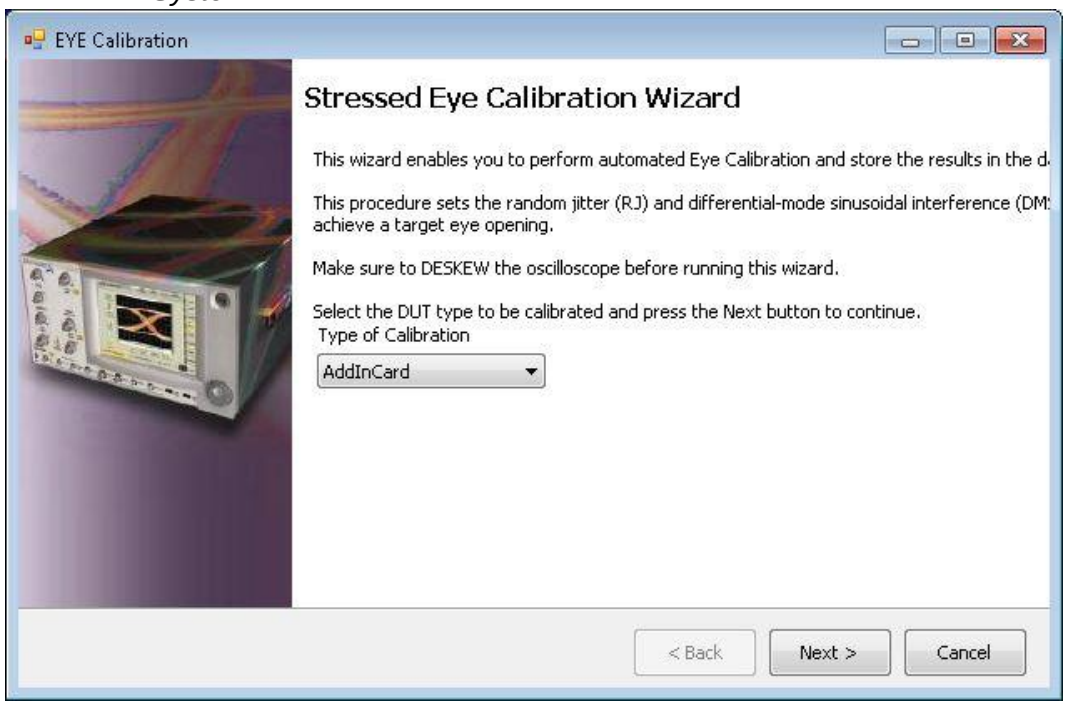
The Stressed Eye Calibration Wizard automates the calibration as per the CEM Specification. You will be prompted with diagrams to make certain test equipment connections, then begin the automated calibration procedures, and store the results when completed.

7.2.1. Stressed Eye Calibration Wizard

This wizard helps to perform the automated Eye Calibration and also helps to store the results in the Data Base

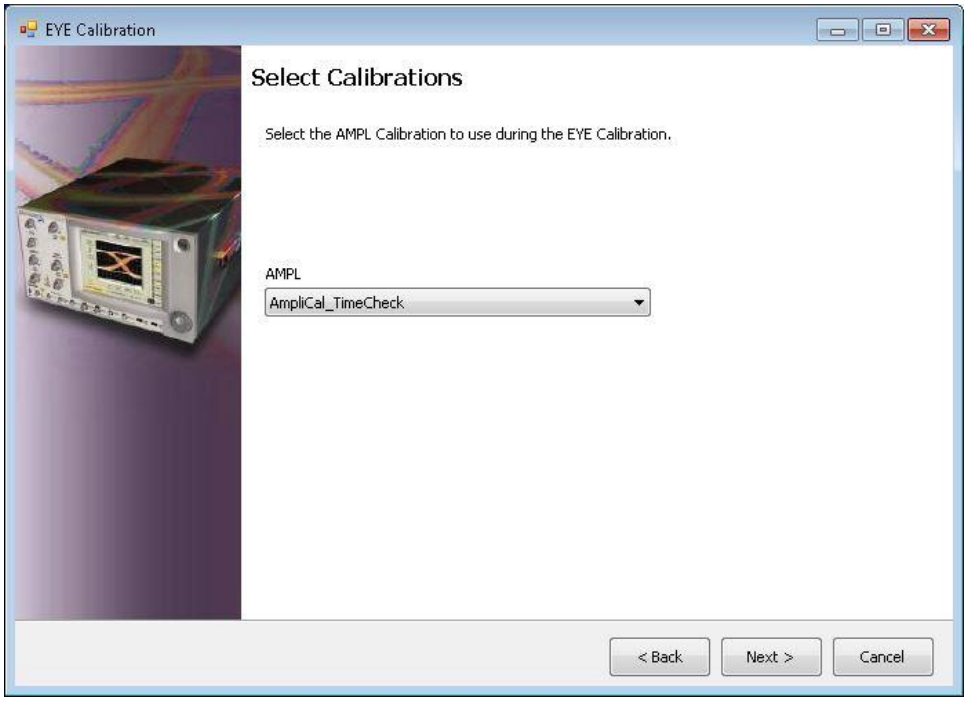
One of the below configuration can be selected ('*Type of Calibration*')

- '*AddInCard*'
- '*System*'



7.2.2. Select the Amplitude calibration values.

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



7.2.3. 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 7.2.1. The connection diagrams are different for '*Add-In Card*' and '*System*'. Please refer section 8.2 for hi resolution connection diagrams.

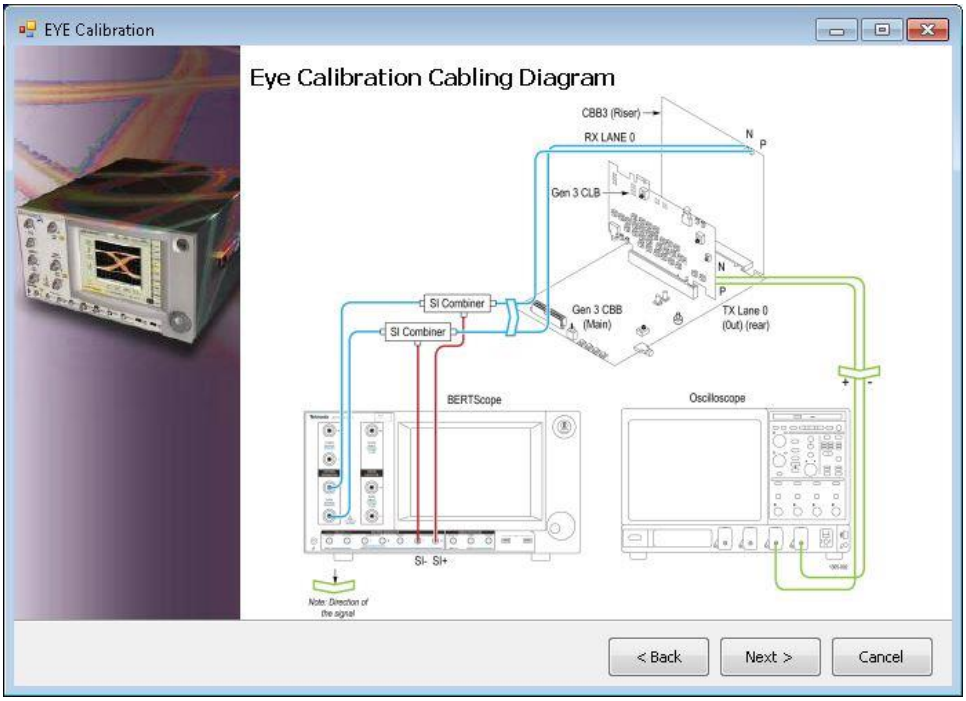


Figure 14 : Cabling Diagram: Add-In Card

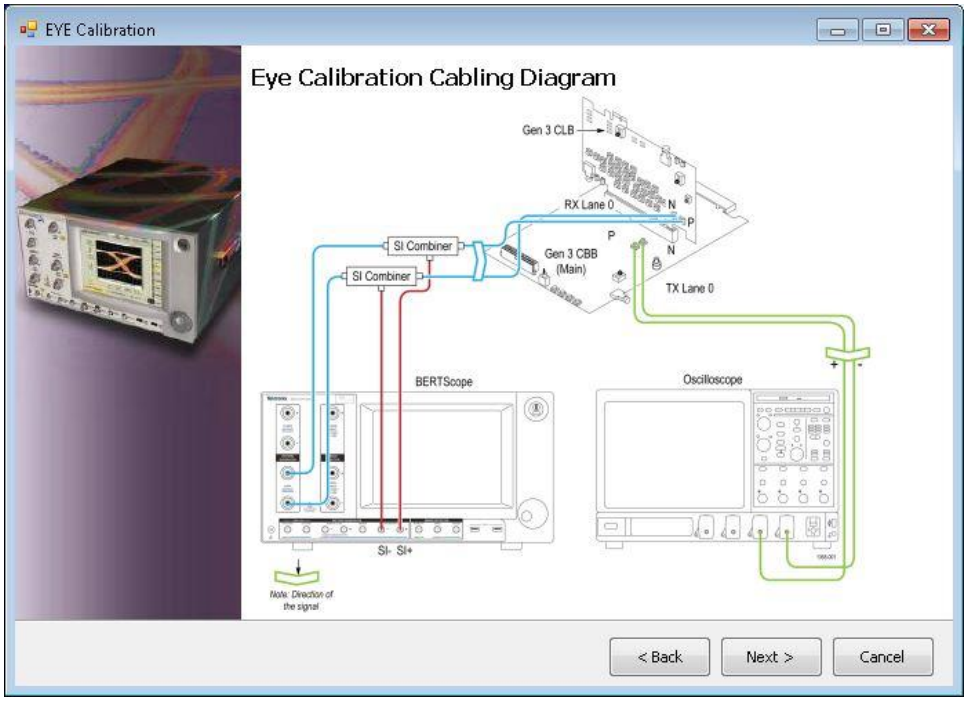
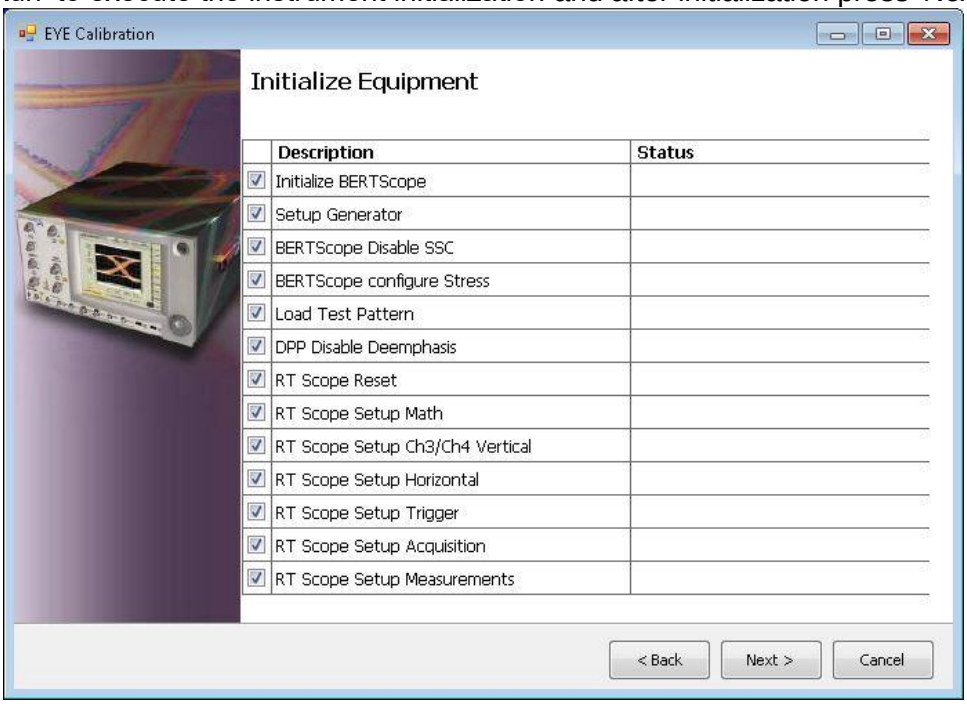


Figure 15: Cabling Diagram: System

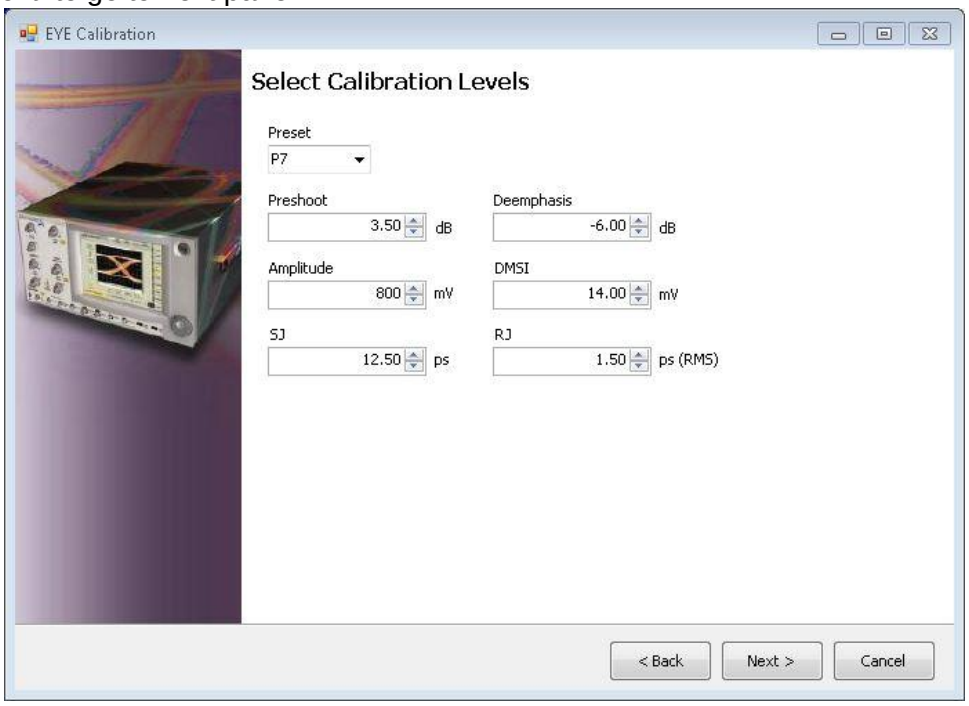
7.2.4. Initialize Equipment

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*'.



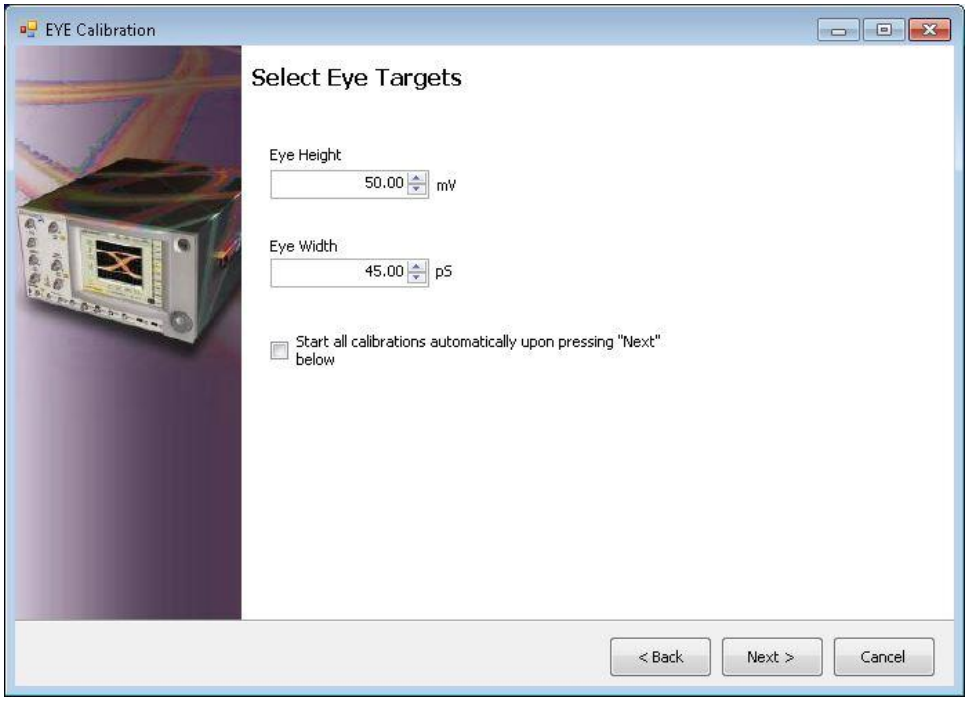
7.2.5. Select Calibration Levels

Application will show the stress targets as per the CEM Specification. 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.



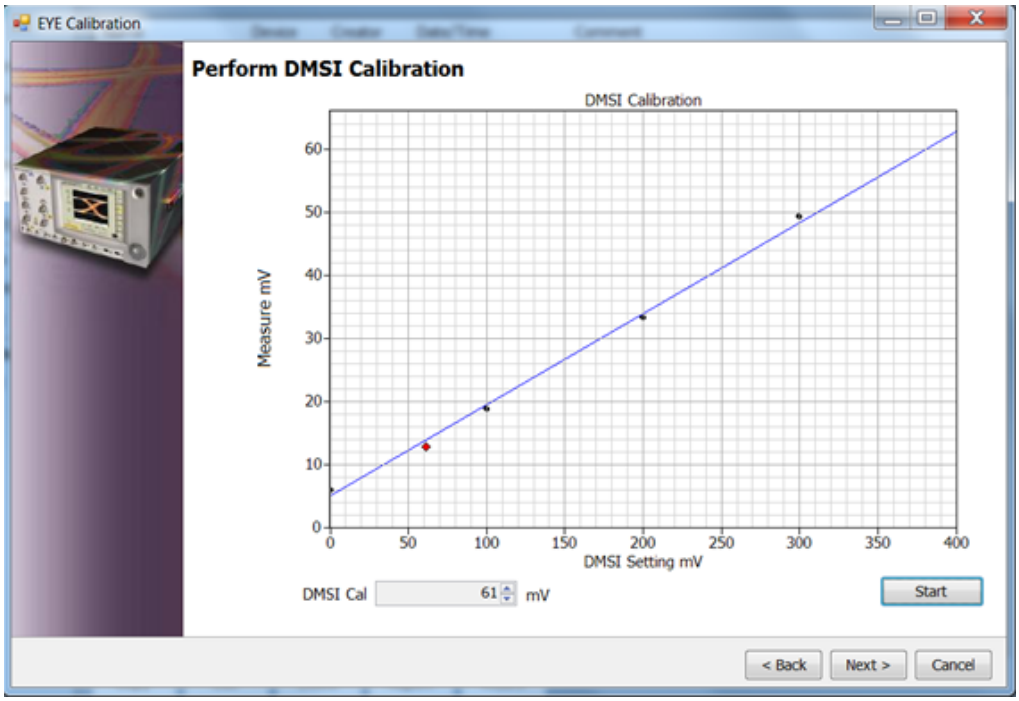
7.2.6. Select Eye Targets

Application will show the stress targets as per the CEM Specification. If user wishes to test the application with different stress targets then they can change the values in this panel.



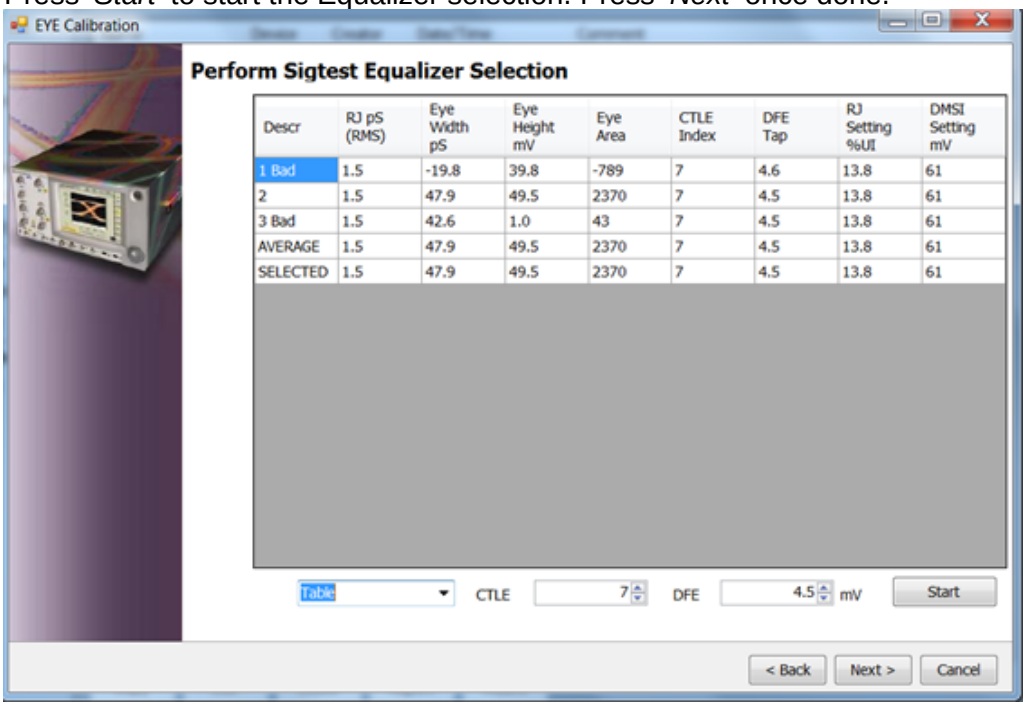
Check the '*Start all calibration automatically upon pressing "Next" below*', to start the automatic calibration without having to press 'Next' in each of the panel/Step. If this checkbox is un-checked then user has to manually press 'Next' upon completion of each of the calibration step.

7.2.7. Perform DMSI Calibration



7.2.8. Perform SigTest Equalizer Selection

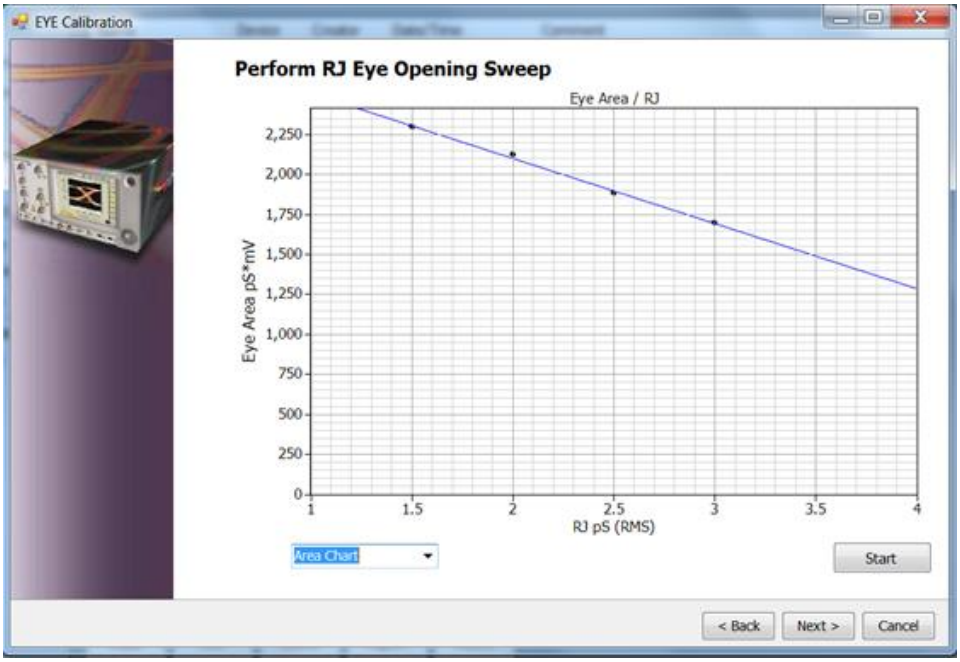
Press '*Start*' to start the Equalizer selection. Press '*Next*' once done.



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.

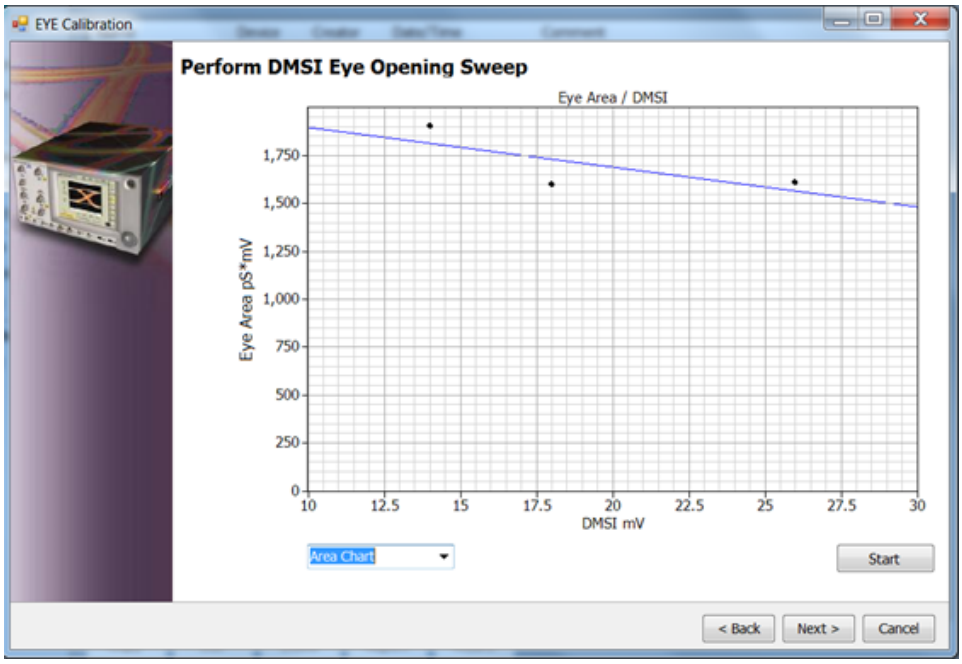
7.2.9. Perform RJ Eye Opening Sweep.

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*'.



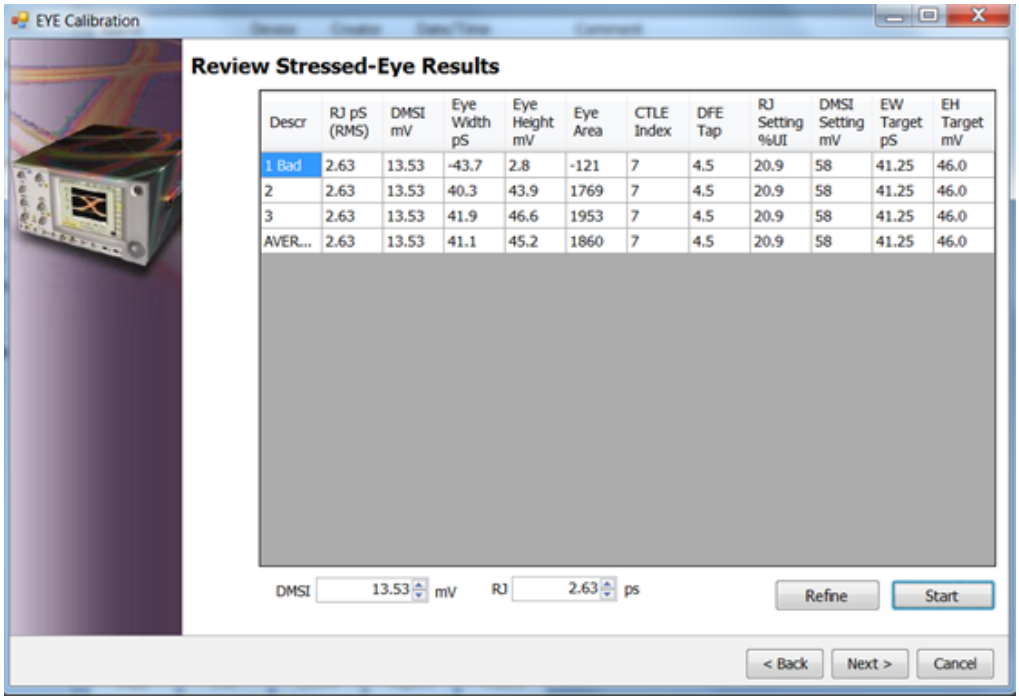
7.2.10. Perform DMSI Eye Opening Sweep

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.



7.2.11. Review Stressed Eye Results

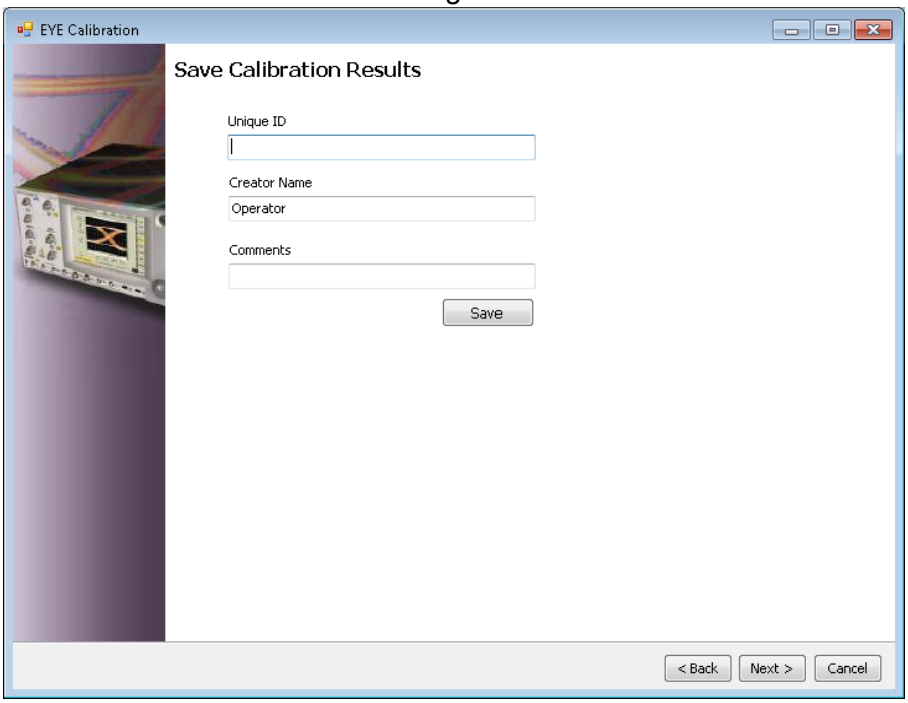
In this step, application adjusts the Rj and DMSI to achieve the required eye targets. Application captures three waveforms for the analysis. If there are any bad results, they are discarded from the results. Press '*Next*' after the results are reviewd.



7.2.12. 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.



8. Connection Diagram

This section lists all the connection diagrams used for calibrating the instrument and performing the jitter tolerance test.

Below table lists the available connection diagrams. Based on the DUT type, make the connection.

Calibration Type	Device Type	Reference Section
Amplitude Calibration	Add-in Card	8.1
	System Board	8.1
Stressed Eye Calibration	Add-in Card	8.2.1
	System Board	8.2.2
Jitter Tolerance Test	Add-in Card	8.3.1
	System Board	8.3.2

Table 3: Connection Diagrams

8.1. Connection Diagram: Amplitude Calibration (Add-in Card and System Board)

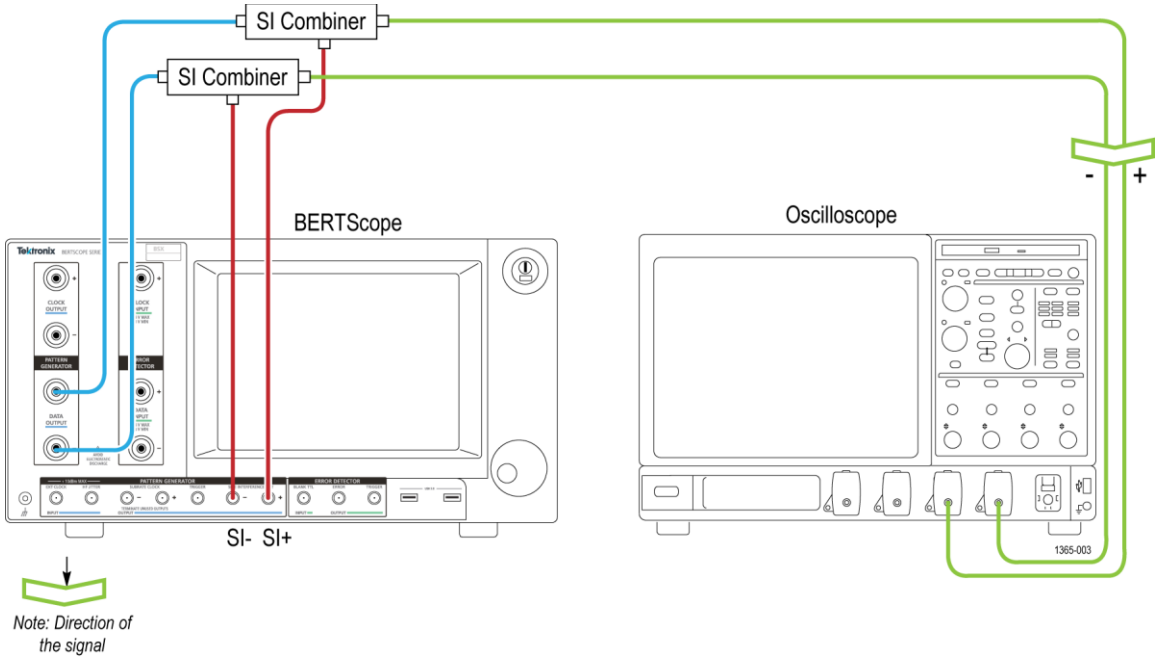


Figure 16 : Amplitude Calibration (Add-in Card and System Board)

8.2. Connection Diagram: Stressed Eye Calibration

8.2.1. Stressed Eye Calibration: Add-in Card

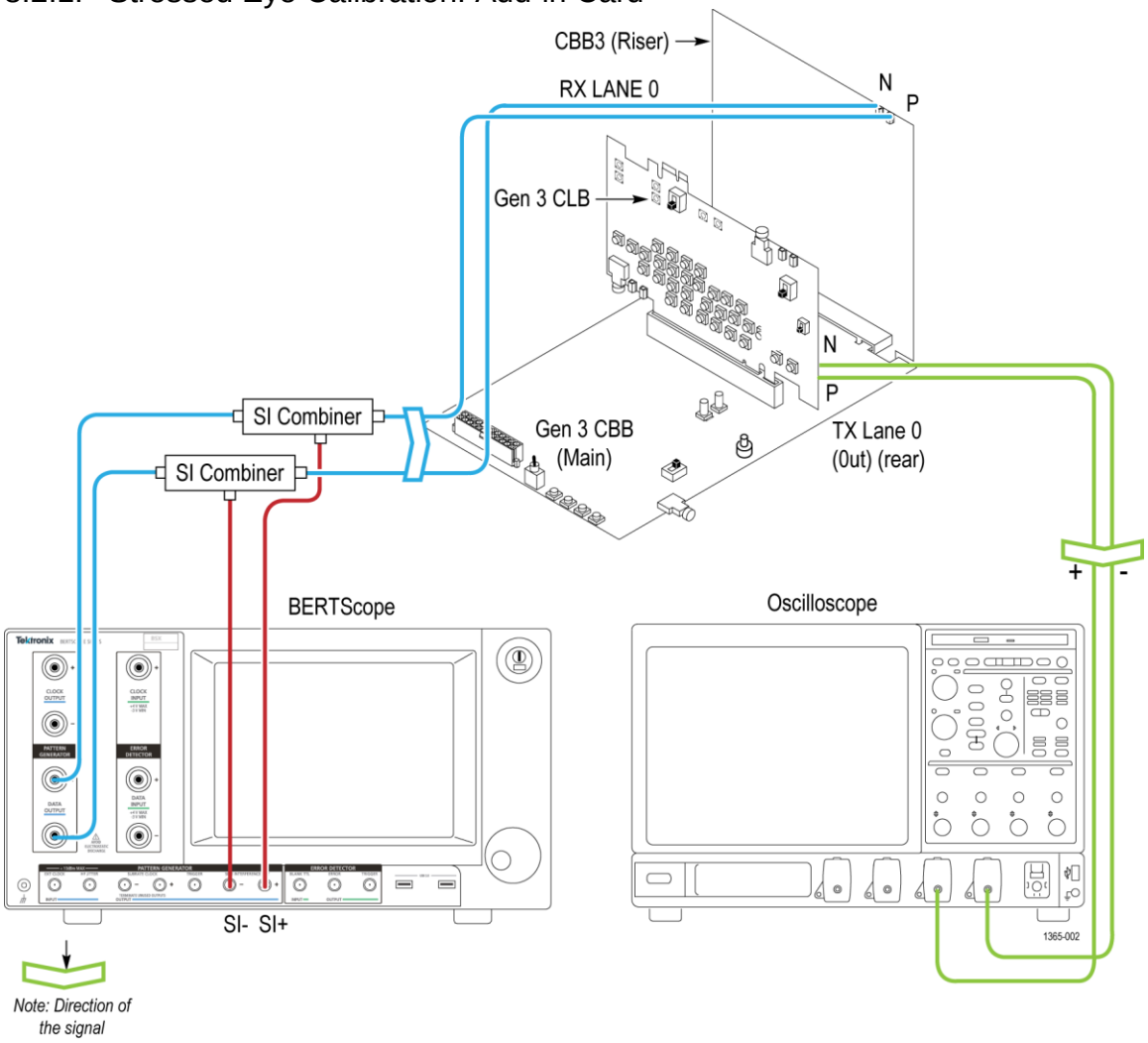


Figure 17: Stressed Eye Calibration –Add-in Calibration

8.2.2. Stressed Eye Calibration: System Board

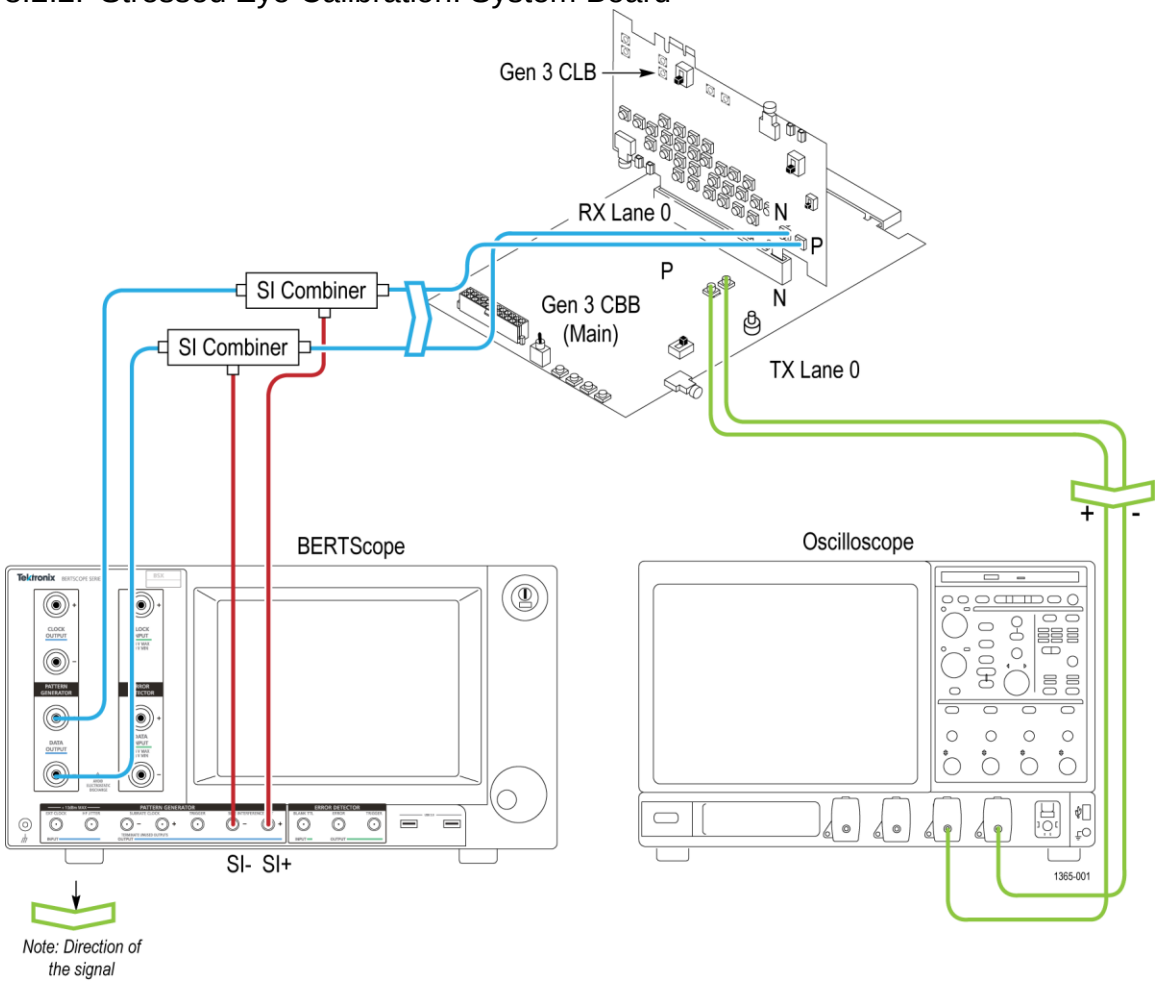


Figure 18 : Stressed Eye Calibration-System Board

8.3. Connection Diagram: Jitter Tolerance Test

8.3.1. JTOL – Add-In Card connection diagram.

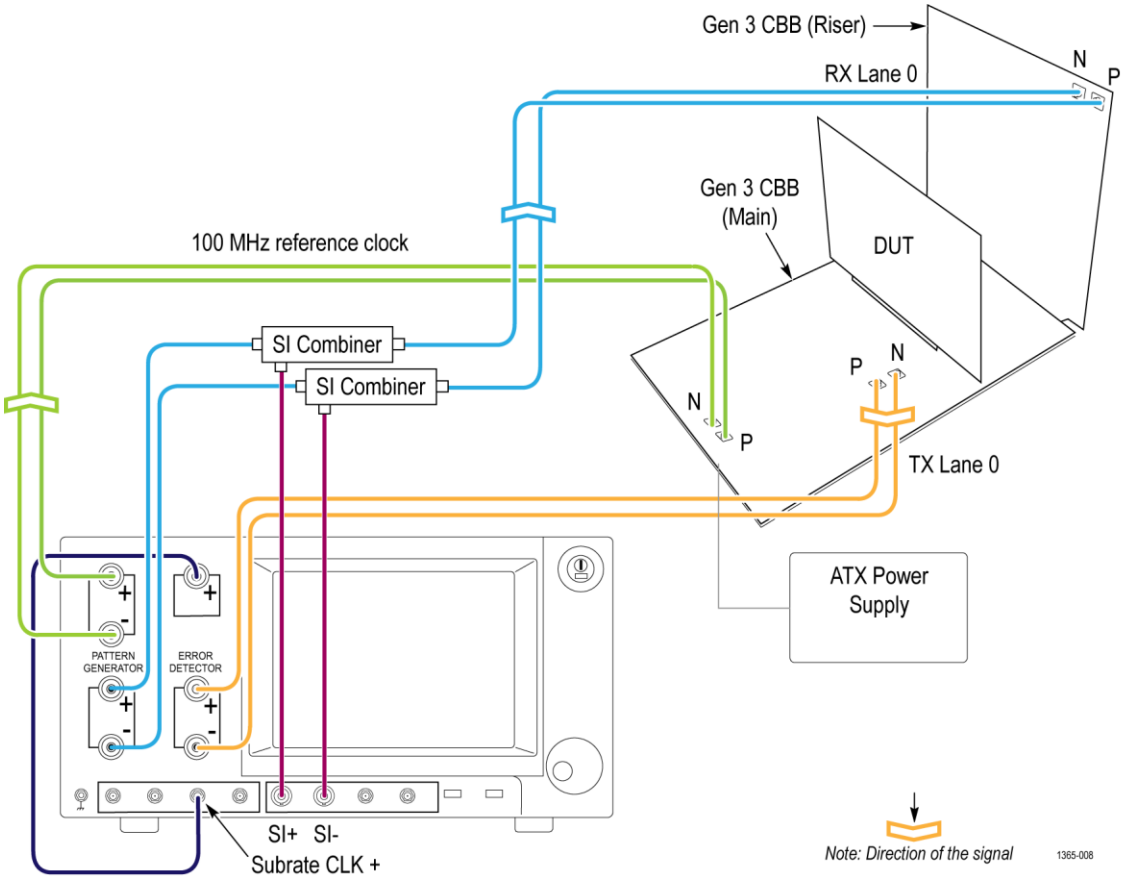


Figure 19 : JTOL- Add-In Card Connection Diagram

8.3.2. JTOL – System connection diagram.

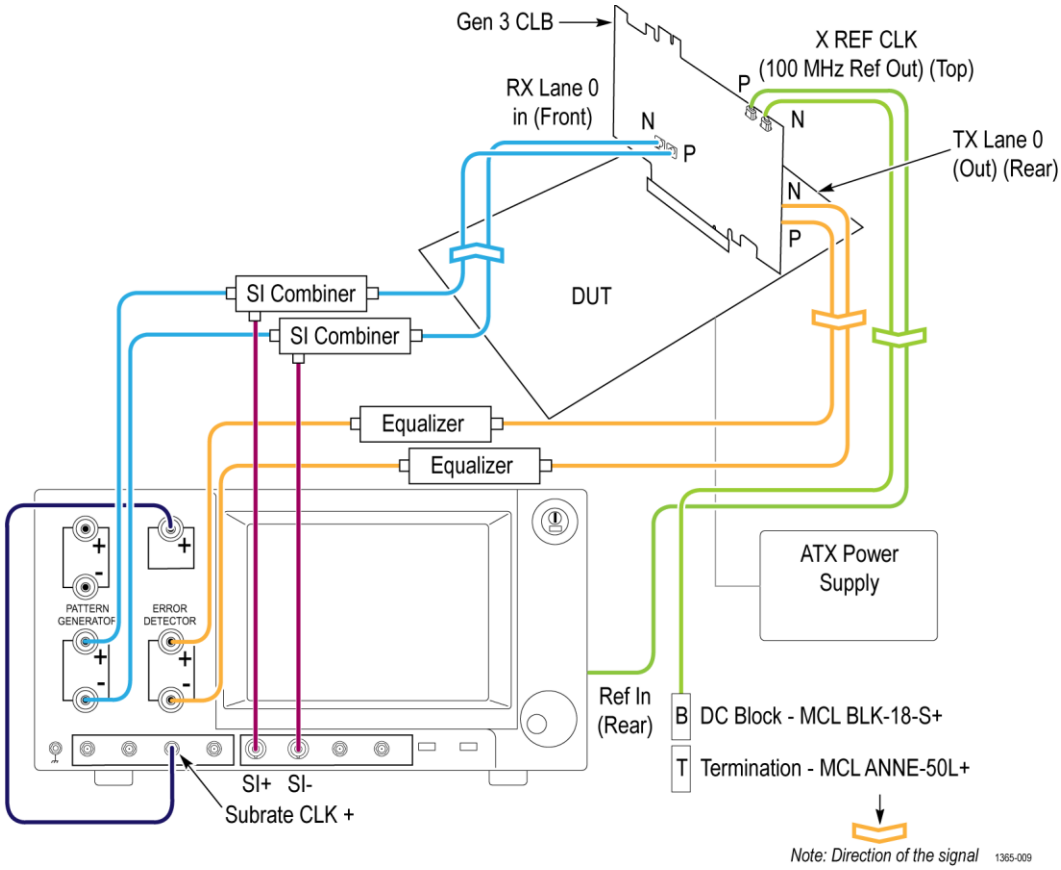


Figure 20 : JTOL –System Connection Diagram

9. Pre-Test Procedures

Prior to making the calibration, the following steps must be taken to assure accurate measurements on the Oscilloscope:

- Allow a minimum of 20 minutes warm-up time for oscilloscope.
- Run scope SPC calibration routine. It is necessary to remove all probes from the scope before running SPC.
- Perform deskew to compensate for skew between measurement channels.
- Use a torque wrench to make all SMA connections.