USB 3.0 Receiver Compliance Testing

Methods of Implementation Using Tektronix BERTScope BSA85C Analyzer, CR125A Clock Recovery, DPP125B Digital De-Emphasis Processor, Instrument Switch, and DSA/DSO/MSO71254B Real-Time Oscilloscope

22 June 2011 Version 1.0

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Universal Serial Bus 3.0 Specification, Revision 1.0, November 12, 2008.
http://www.usb.org/developers/docs/

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Version	Date	Summary of Changes
1.0	22 June 2010	Initial Release

1 Overview

This Method of Implementation (MOI) is based on the USB-IF Universal Serial Bus Revision 3.0 Specification, Version 1.0, released 12 November 2008, and describes how to use Tektronix equipment to test a USB 3.0 receiver contained within a Host or Device.

This MOI was developed using the following Tektronix instruments and software:

- BERTScope Bit Error Ratio Analyzer, model BSA85C[1,2] configured with Options STR (Stressed Eye) and SF (Symbol Filtering)
- BERTScope Digital Pre-Emphasis Processor, model DPP125B[2]
- BERTScope Clock Recovery, model CR125A
- USB 3.0 Instrument Switch, model BSASWITCH
- USB 3.0 Receiver Testing Software, BSAUSBSFT
- Real-Time Oscilloscope, model DSA/DSO/MSO71254B

Table 1 summarizes the requirements for receiver testing and how Tektronix instruments and software address them.

	Requirement	Test Instrument	Comment
Pattern Generator	Stressed pattern generation at 5 Gb/s	BSA85C	Generates integrated stressed pattern up to 8.5 Gb/s. Built-in stress includes RJ, SJ, and others.
	De-emphasis	DPP125B	Adds programmable de-emphasis and differential output amplitude to the test signal
	SSC	BSA85C	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.
Error Detector	Clock recovery	CR125A	Performs clock recovery on the incoming data stream from the DUT, which may use a slightly different clock frequency than the Pattern Generator.
	Asynchronous BER testing	BSA85C	Filters out user-designated clock compensation symbols such as SKPs for accurate BER synchronization and measurement of 8b/10b systems when in loopback.
	Jitter tolerance testing	BSA85C	Performs automated Jitter Tolerance testing.
	Stressed eye calibration	DSA / DSO / MSO71254B	Real-Time Oscilloscope for eye calibration
Automation	Automated switching and loopback	BSASWITCH	Creates low frequency periodic signaling (LFPS) required to initiate loopback mode on the DUT. Included Switch Control software automates channel switching.
		BSAUSBSFT	Software automates control of the Instrument Switch for USB 3.0 Host and Device compliance testing, including stressed eye calibration and Loopback training.

Table 1: Tektronix BERTScope USB 3.0 Receiver Test Solution

[1] USB 3.0 testing requires BERTScope Application software version 10.13 or later.
[2] USB 3.0 testing requires equipment with these model numbers or later.

The test instrumentation performs two functions – pattern generation, with the ability to add various types of stresses, and signal analysis, such as jitter and eye measurements.

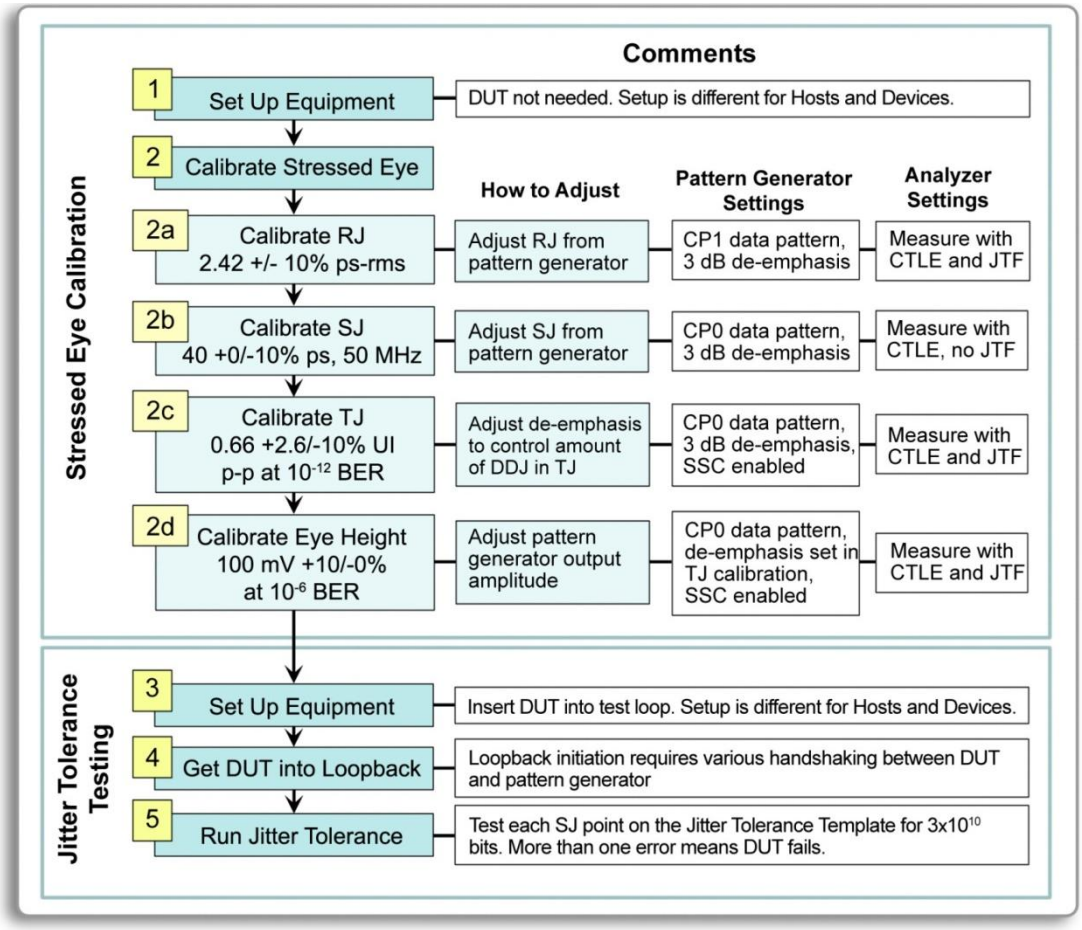

Figure 1: USB 3.0 Receiver Test Sequence

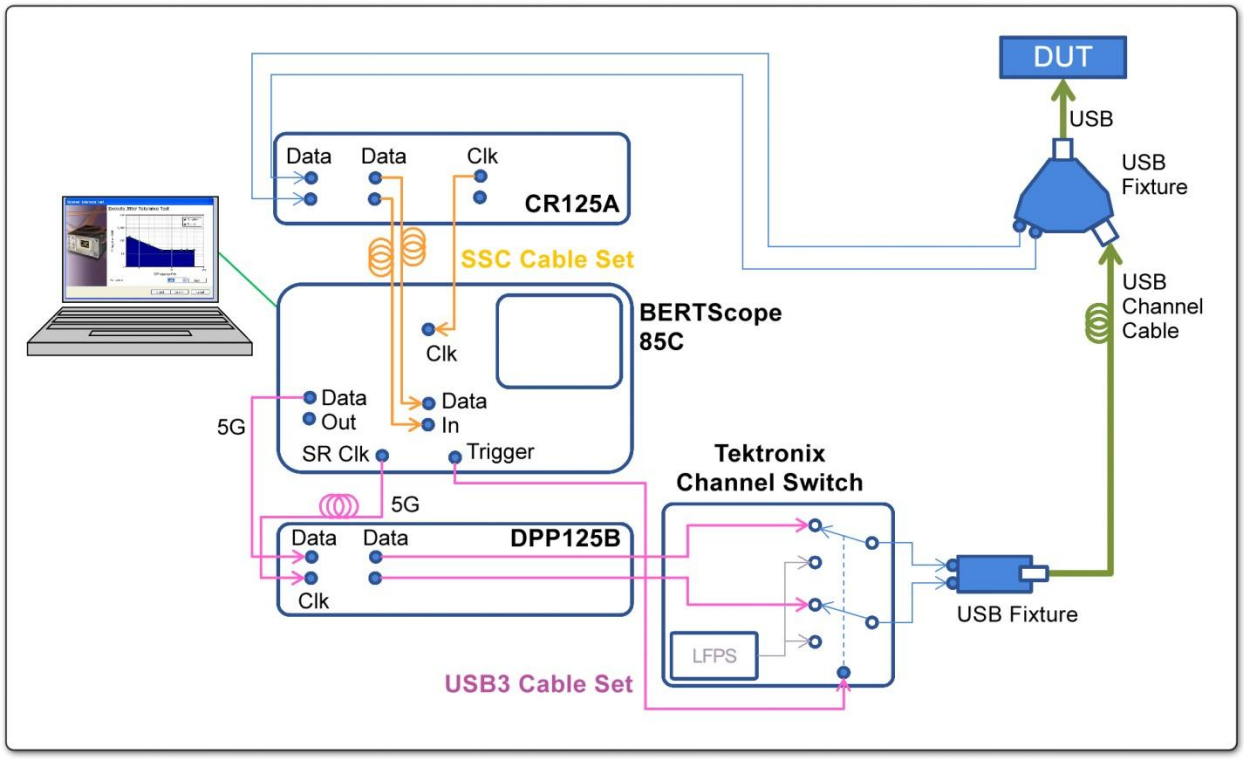

Figure 2: Overview of BERTScope USB Receiver Test Solution

2 Equipment and Software Requirements

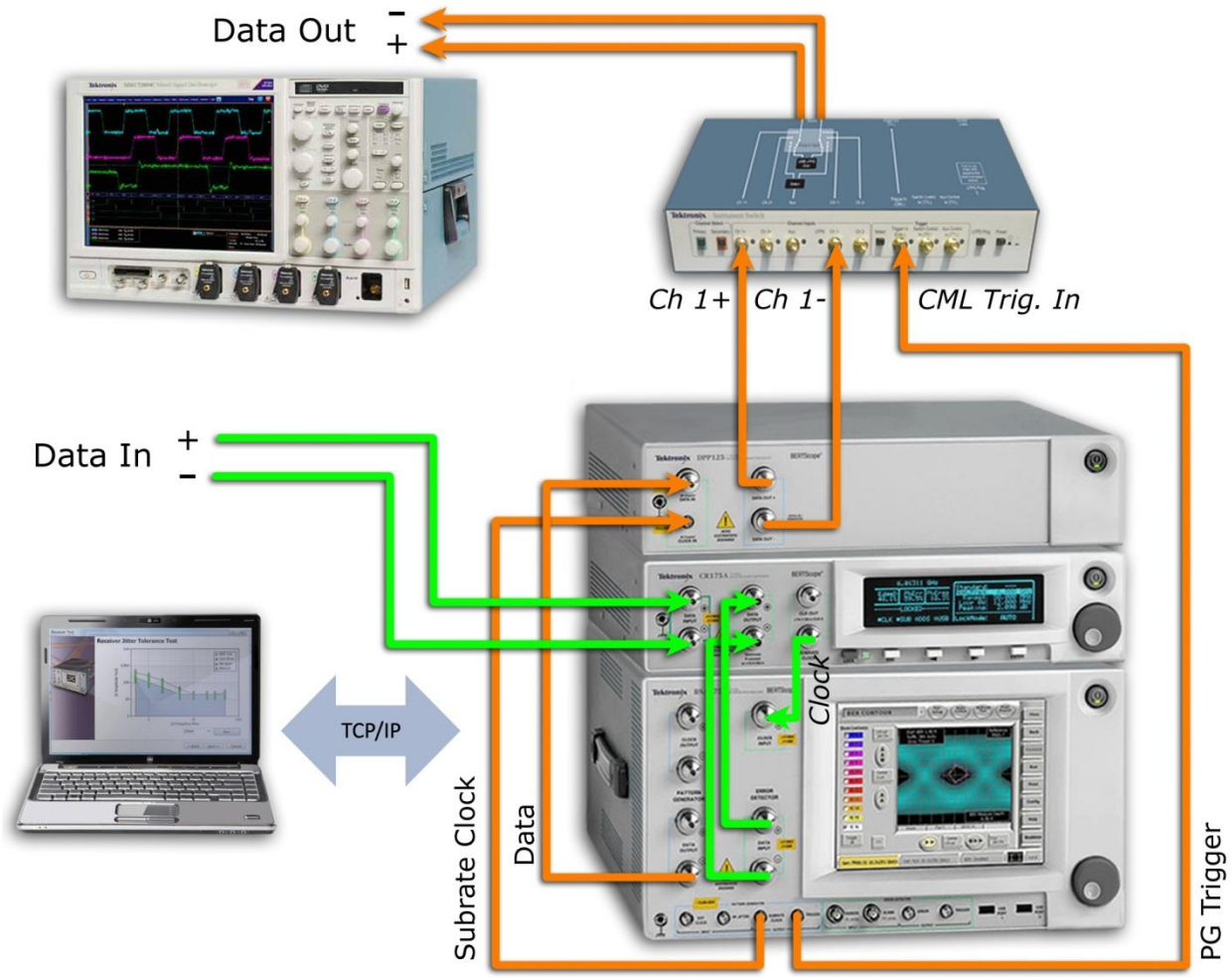

Figure 3: USB 3.0 Receiver Testing Hardware Setup

2.1 BERTScope Bit Error Ratio Analyzer

The BERTScope BSA85C Bit Error Ratio Analyzer, when configured with Options STR (Stressed Eye) and SF (Symbol Filtering), includes integrated SSC generation, symbol filtering, pattern memory, and BER analysis. The BSA must be running BERTScope application software version 10.13 or newer. The current version of BERTScope software is available for download at http://www.tek.com/downloads/.

Figure 4: BERTScope BSA85C Bit Error Ratio Analyzer

2.2 BERTScope Clock Recovery Instrument

The BERTScope CR125A Clock Recovery instrument provides hardware clock recovery, used to recover the clock from the signal returning from the DUT.

Figure 5: BERTScope CR125A Clock Recovery Instrument

2.3 BERTScope Digital Pre-Emphasis Processor

The BERTScope DPP125B takes in single-ended inputs of data and clock, and conditions the signal by adding programmable amounts of pre-emphasis/de-emphasis, including a compliant 3 dB of de-emphasis for USB 3.0.

Figure 6: BERTScope DPP125B Digital Pre-Emphasis Processor

2.4 Instrument Switch

The Tektronix BSASWITCH Instrument Switch features a built-in pattern generator for creating the Low Frequency Periodic Signaling (LFPS) required to initiate Loopback mode on the DUT.

Figure 7: Instrument Switch

2.5 Real-Time Oscilloscope

The Tektronix DSA/DSO/MSO71254B Real-Time Oscilloscope with DPOJET is used to calibrate de-emphasis and stressed eye, and to perform the transmitter test portion of the USBIF Compliance Test Specification (CTS).

Figure 9: 70000 Series Real-Time Oscilloscope

2.6 Software

The BERTScope USB 3.0 Receiver Testing system ships with all software and drivers necessary for automated USB 3.0 testing.

Locate and review the included Installation Instructions and Read-Me files before installing and using the software.

Figure 8: USB Test Software

2.6.1 BSAUSBSFT BERTScope USB 3.0 Receiver Test Application

The USB 3.0 Receiver Testing automation software runs on a PC connected to the BERTScope Analyzer (BSA)/ De-Emphasis Preprocessor (DPP)/Clock Recovery (CR) stack of test equipment via TCP/IP, using remote control automation protocols to perform automated receiver tolerance testing.

The software automates calibration of the connection between the DPP and BSA, and saves calibration results in a Microsoft® Access 2007 database. The software also automates stressed eye calibration for performing receiver tolerance testing.

A wizard-style user interface automates loopback initiation and jitter tolerance testing, which sweeps amplitudes of sinusoidal jitter insertion at selected frequencies. Results are stored in a built-in database and may be reported as HTML files or exported to CSV files.

2.6.2 BSASWITCH Control Software

The Switch Control program is normally installed on the BERTScope Analyzer, and connects to the Instrument Switch plugged into the BERTScope via its USB port. The program provides user-interface control of switch properties, and a TCP/IP socket-based automation protocol for remotely controlling the switch.

2.6.3 Oscilloscope VISA Socket Gateway

This program is intended for installation on a Tektronix 70000-series real-time oscilloscope, to allow communication with the USB 3.0 test automation software. Please see the software's installation instructions for additional information.

2.7 Test PC

The USB 3.0 Receiver Testing software (BSAUSBSFT) is installed on a Windows® PC running Windows XP, Windows Vista, or Windows 7.

2.8 Adapters and Cabling

2.8.1 USBIF Adapters and Cables

Adapters (or fixtures) are needed for compliance testing in order to convert signals available on USB ports to SMA connectors that the test equipment can connect to.

Figure 10 shows the compliant adapters. Connections between the adapters and the test equipment are shown in the calibration and test sections.

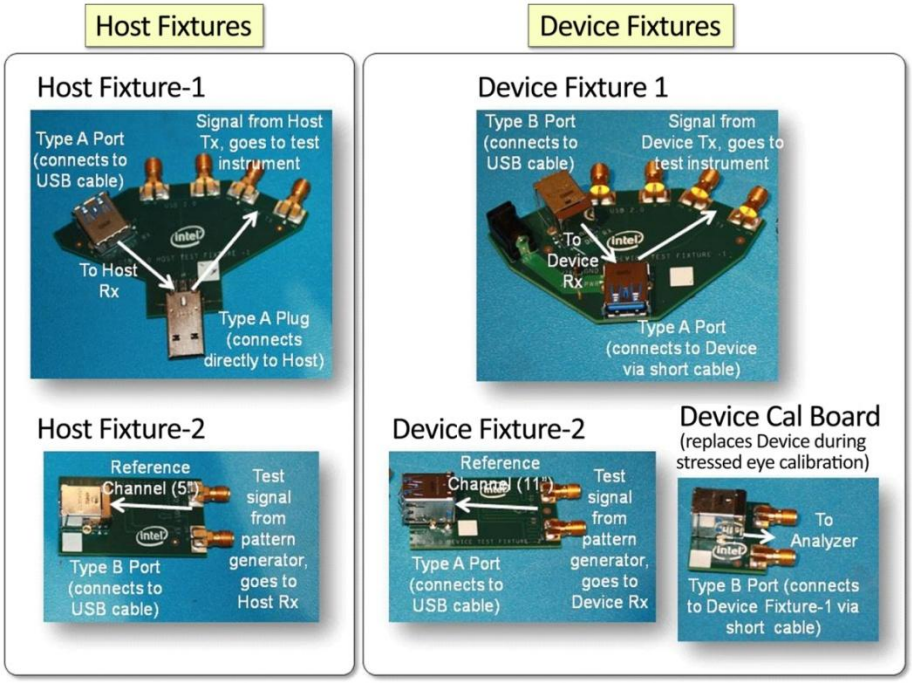

Figure 10: Adapters Used for Compliance Testing

Two lengths of USB 3.0 cables are used in compliance testing – a long, 3-meter cable, and a short cable.

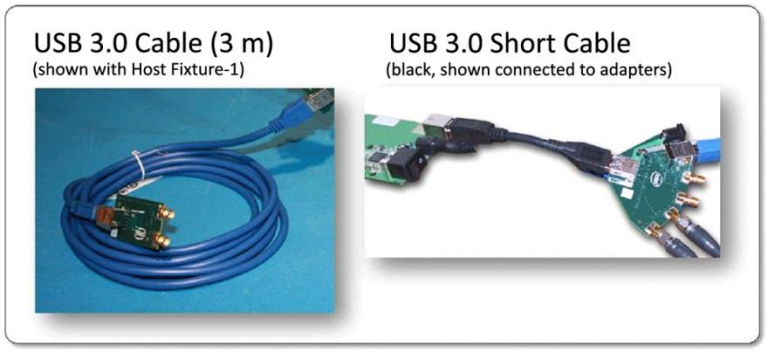

Figure 11: USB 3.0 Cables Used for Compliance Testing.

2.8.2 Instrument Interconnection Cables

All required signal cables are included in the BSAUSB product bundle. Interconnection diagrams are included here and as part of the automation software.

3 Configuration for Control Communication

3.1 TCP/IP & USB Cabling for Instrument Communication

TCP/IP connections are used to connect a Windows PC, a Tektronix real-time oscilloscope, and a BERTScope Analyzer to form the nucleus of the USB 3.0 Test Solution. The BERTScope Analyzer is also connected to the Instrument Switch, Clock Recovery, and DPP systems using USB 2.0 connections.

Figure 12 outlines the instrument communication interconnections, as well as the software requirements for the instruments.

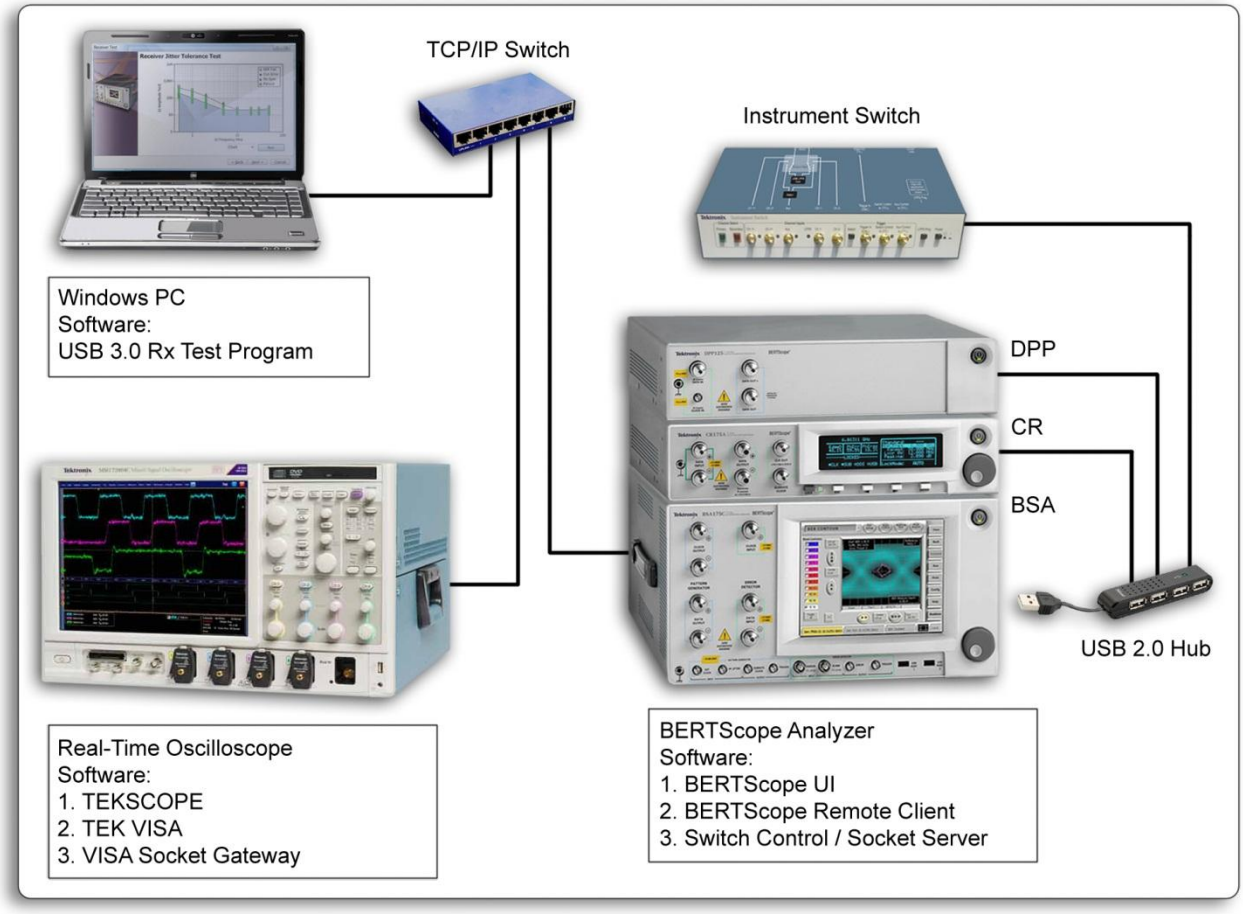

Figure 12: USB 3.0 Test Solution Equipment and Software Communication

NOTE:

- *The USB hub integrated in the BERTScope CR may be used in lieu of a stand-alone USB hub.*

3.2 Establishing Communication

Use your computer's file browser to locate the USB 3.0 Receiver Test executable file, or select the program from the Start Menu. Navigate by pressing an item in the left sidebar.

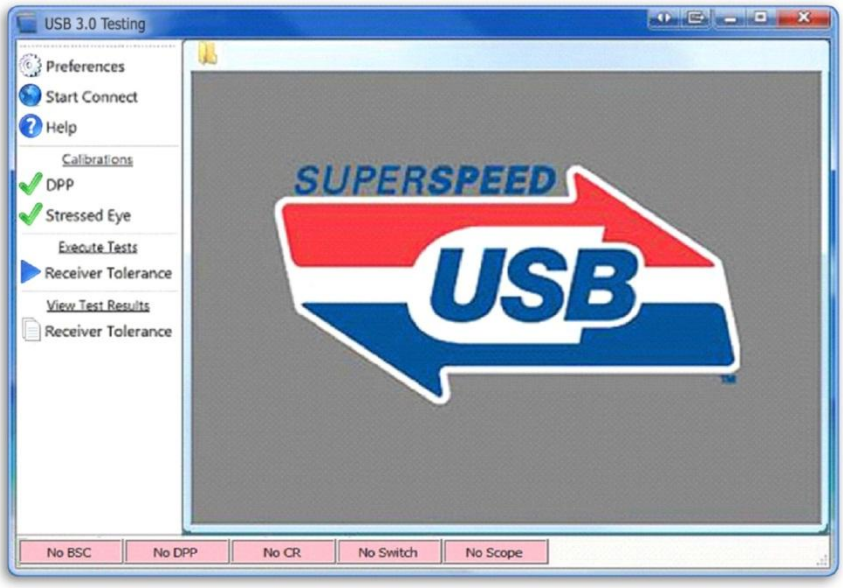

Figure 13: Launch the USB 3.0 Receiver Test Software

NOTE:

- *Prior to establishing connection with the USB Switch, open the Switch Control application from the Windows Programs menu on the BERTScope Analyzer.*
- *Prior to establishing connection with the Real Time Oscilloscope, open the VISA Socket Gateway application from the Windows Programs menu on the Scope.*

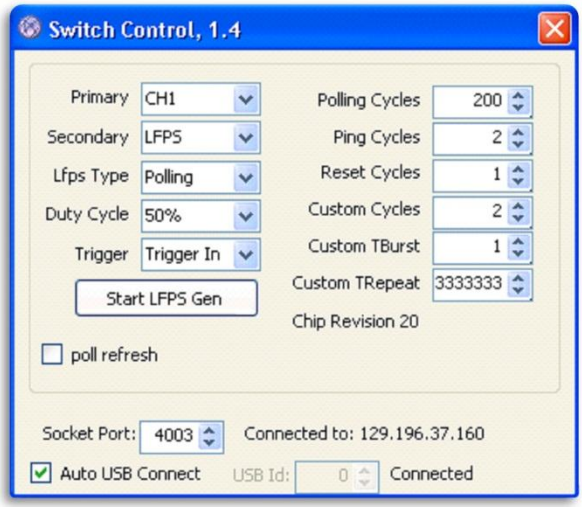

Figure 14: Switch Control Application

Press **Start Connect** on the USB 3.0 Testing software navigation panel to connect to other devices.

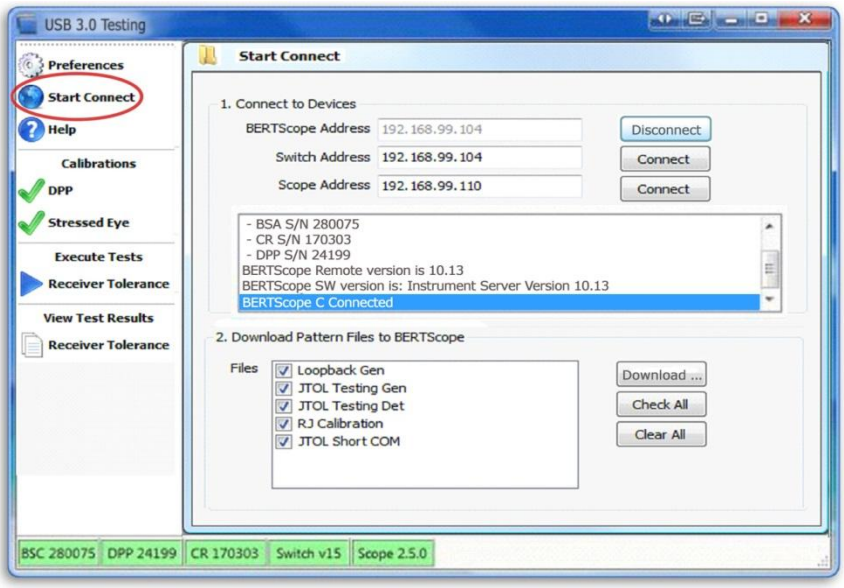

Figure 15: Connect Devices

Once devices are connected, the status indicators at the bottom of the screen turn green and display the serial numbers (or version numbers) of the attached devices.

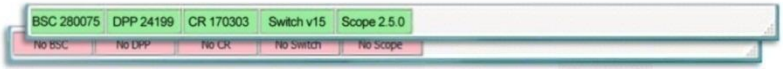

Figure 16: Device Status

Press **Download** to load test pattern files to the BERTScope Generator and/or Detector for calibration and testing.

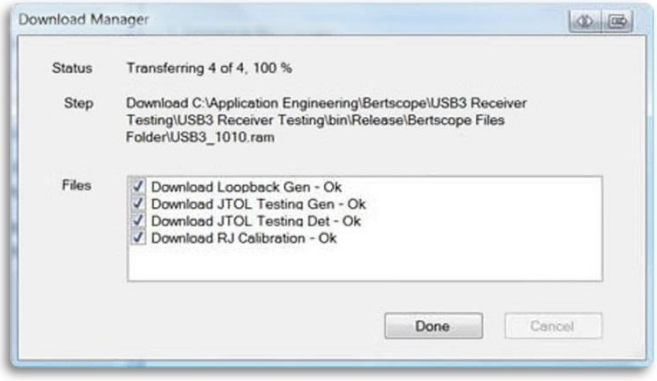

Figure 17: Download Test Pattern Files

NOTE:

- *The appropriate USB 3.0 test pattern files must be present on the BERTScope Analyzer. See the instructions on downloading pattern files under the "Start Connect" heading in the USB 3.0 Testing software help.*

4 USB 3.0 Calibration Requirements

Calibration files must be loaded prior to running the USB tests. If calibration files for the current equipment configuration do not exist, create new calibrations using the Calibration Wizard, as described in Appendix A, DPP Calibration, and Appendix B, Stressed Eye Calibration.

4.1 DPP Calibration

Press **Calibrations → DPP** in the left sidebar navigation to view the DPP Calibrations panel.

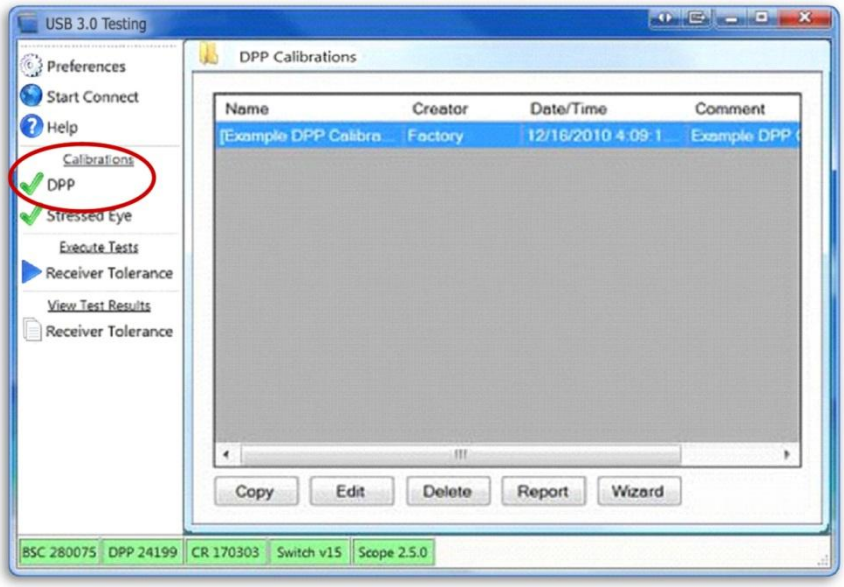

Figure 18: Saved DPP Calibrations

From the DPP 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 described in Appendix A, DPP Calibration.

Calibrations stored in the system database may be managed using the controls below the 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 system database

Figure 19: Calibration Wizard

4.2 Stressed Eye Calibration

Stressed eye calibration involves iteratively measuring and adjusting various types of applied stresses such as jitter. The calibration step is performed without the DUT, using specific data patterns generated by the test equipment.

Press **Calibrations → Stressed Eye** to view the Stressed Eye Calibrations panel.

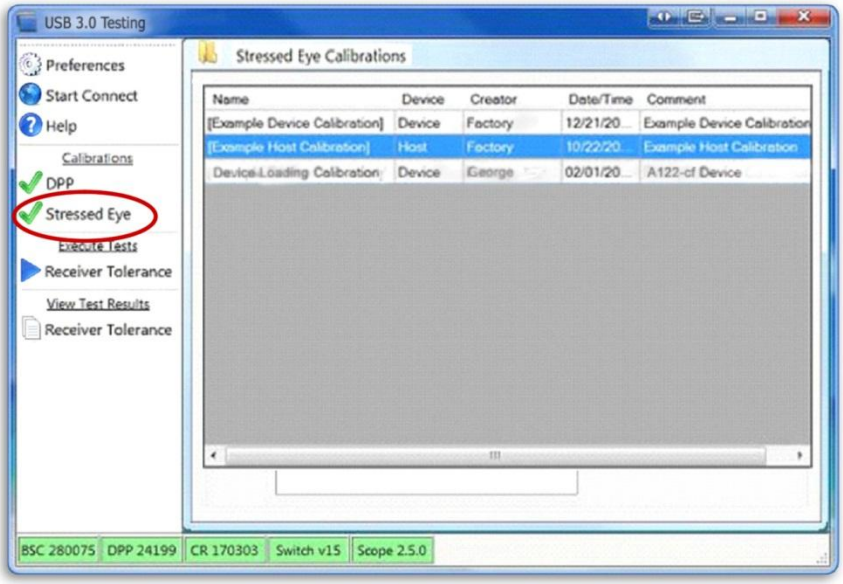

Figure 20: Saved Stressed Eye Calibrations

From the Stressed Eye Calibrations view, select the appropriate calibration file, or select the "Wizard" button to proceed to the automated step-by-step calibration function described in Appendix B, Stressed Eye Calibration.

Calibrations stored in the system database are managed using the buttons below the 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 system database

5 USB 3.0 Receiver Testing

5.1 Cabling for Receiver Testing

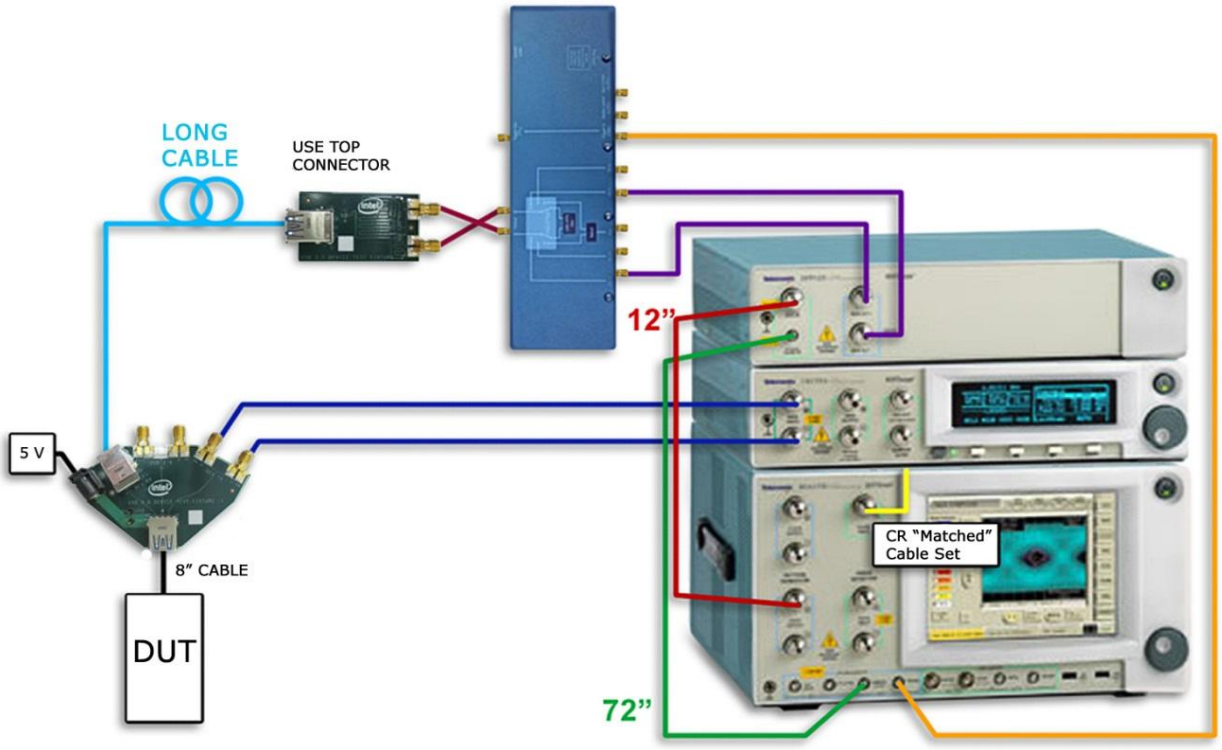

Figure 21: Test Equipment and DUT Cabling Diagram

5.2 Receiver Test Procedure

Press the Receiver Test navigation button to launch a pop-up wizard to guide you through the process of receiver testing on a DUT. Begin by selecting the type of DUT.

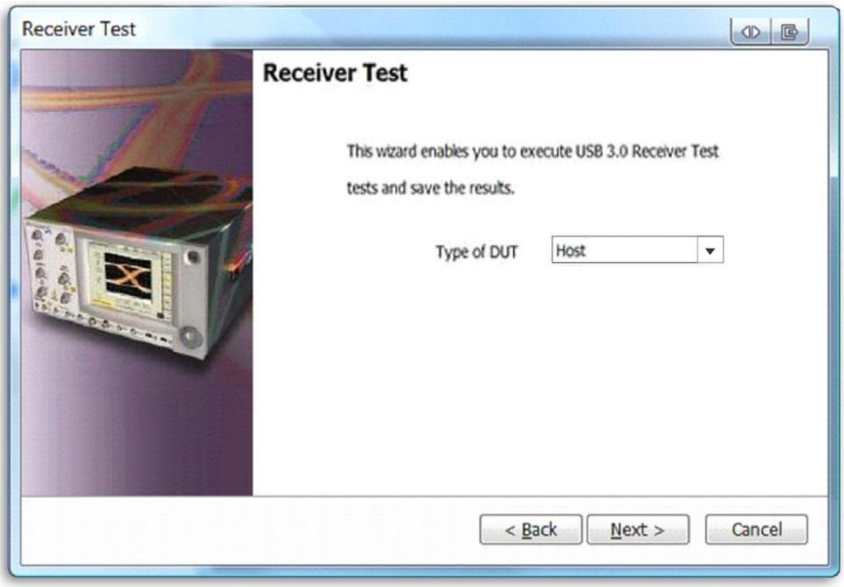

Figure 22: Select Type of DUT

5.2.1 Select Calibrations

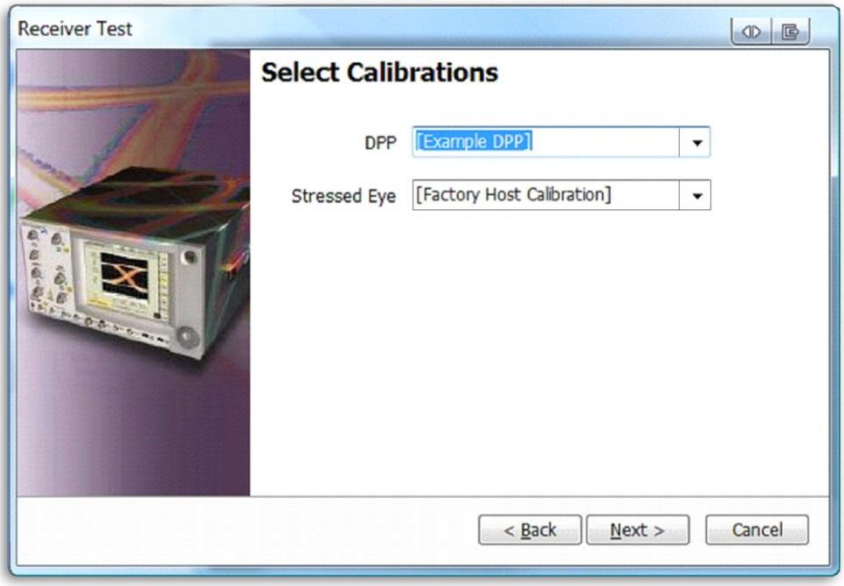

Figure 23: Select Calibrations

5.2.2 Connect Test Equipment and DUT

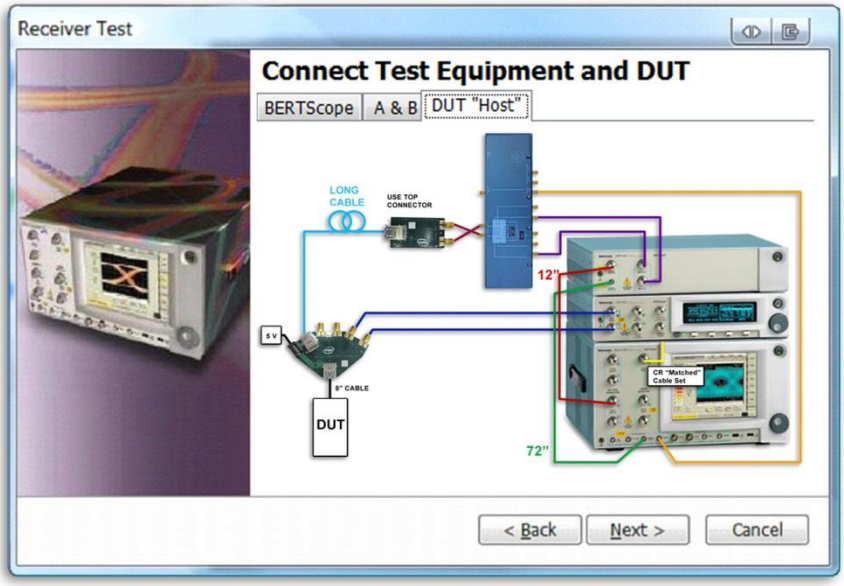

Figure 24: Test Equipment and DUT Cabling Diagram

5.2.3 Initialize BERTScope Analyzer

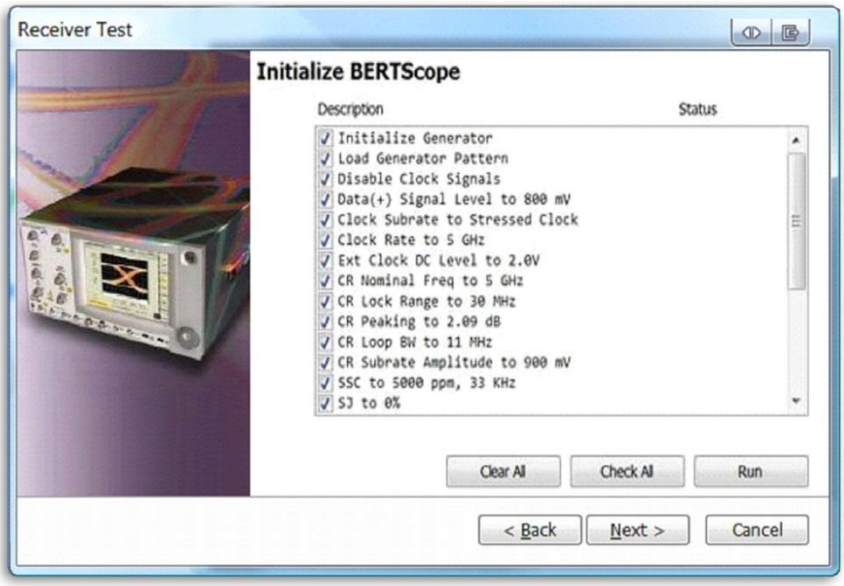

Figure 25: Initialize BERTScope Analyzer

5.2.4 DUT Loopback Training

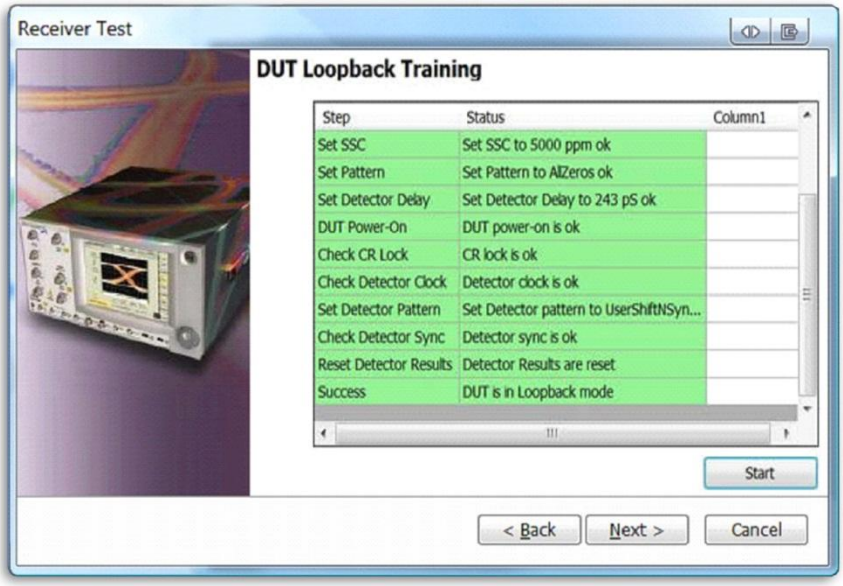

Figure 26: Loopback Training

For a Device DUT, use the "Use Warm Reset" feature, selectable in the Loopback Preferences dialog. Power-on the DUT and connect a 5 V supply to the USB interface fixture, and then press the Start button on this page.

If the Device fails to enter loopback after the training process, it is possible that the “Warm Reset” is not functioning. If this is the case, refer to the “power-on” technique described for Host DUTs, below. In this case, it will be necessary to disable the “Use Warm Reset” selection in the Loopback Preferences menu.

For a Host DUT, you cannot use the "Use Warm Reset" feature because Hosts do not respond to this protocol message. In this case, it will likely be necessary to power-off the Host, press the Start button on this view, and then power-on the Host when the Status message begins to blink, indicating that it is time to power-on the Host DUT.

5.2.5 Select Testing Mode

With the DUT successfully placed in Loopback Mode, select **Next** to proceed to the Testing Mode selection page.

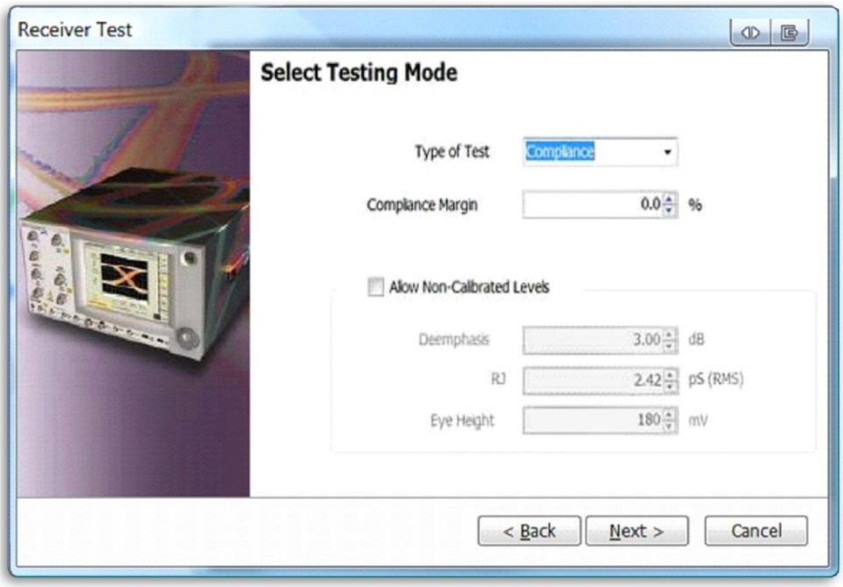

Figure 27: Select Testing Mode

5.2.6 Compliance Mode Test

Compliance Mode will test the DUT to the default USB 3.0 Stress Template. You have the option to add a compliance margin to the template in terms of percent.

The following test result shows compliance failure for excessive BER at two points.

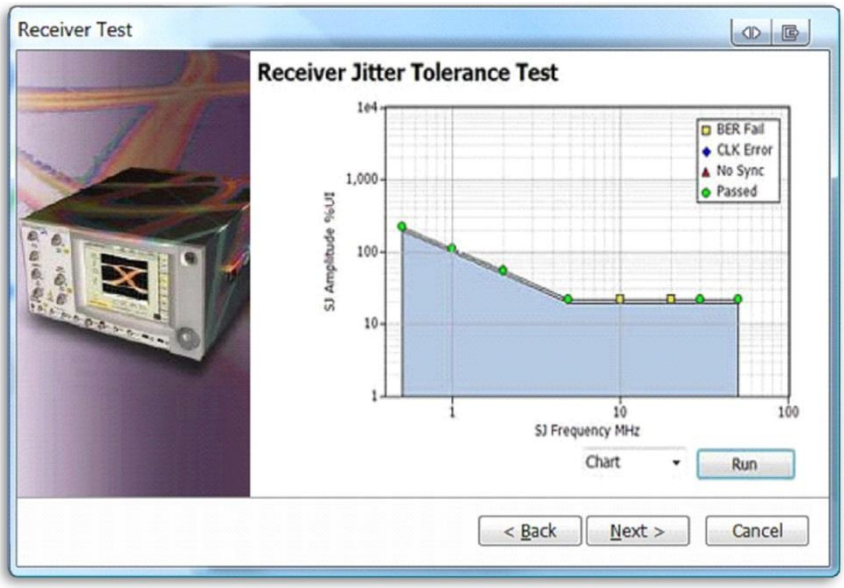

Figure 28: Compliance Mode Test

NOTE:

- *Test results can be displayed as a chart or a table, selected from the pull-down menu to the left of the **Run** button.*

5.2.7 Search Mode Test

To establish the limits of the DUT beyond the Compliance levels, select "Search Mode" from the "Type of Test" pull-down menu (see Figure 27). Testing at each modulation frequency will proceed until the stress limits of the DUT are reached, or the limits of the stress modulation are reached.

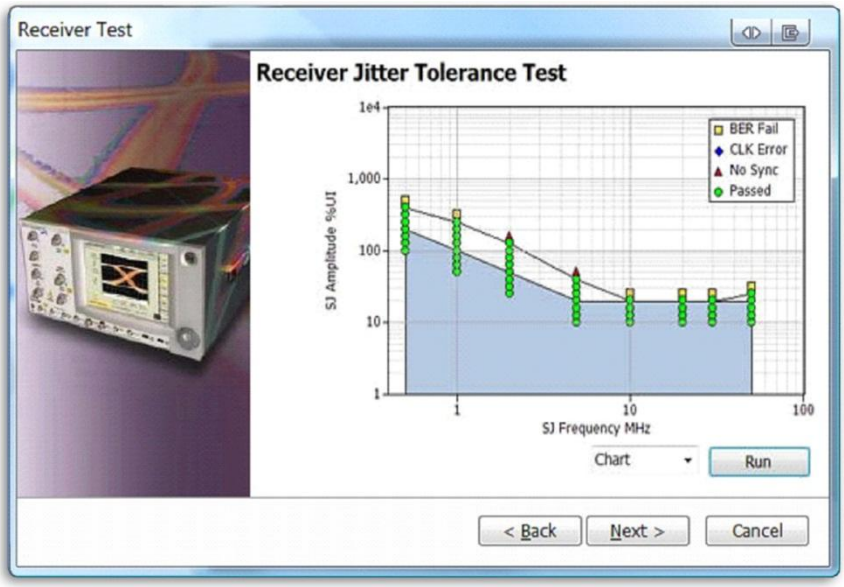

Figure 29: Search Mode Test

As with the compliance test, the results are available as a table or a chart.

5.2.8 Save Results

The results may now be saved in the local database.

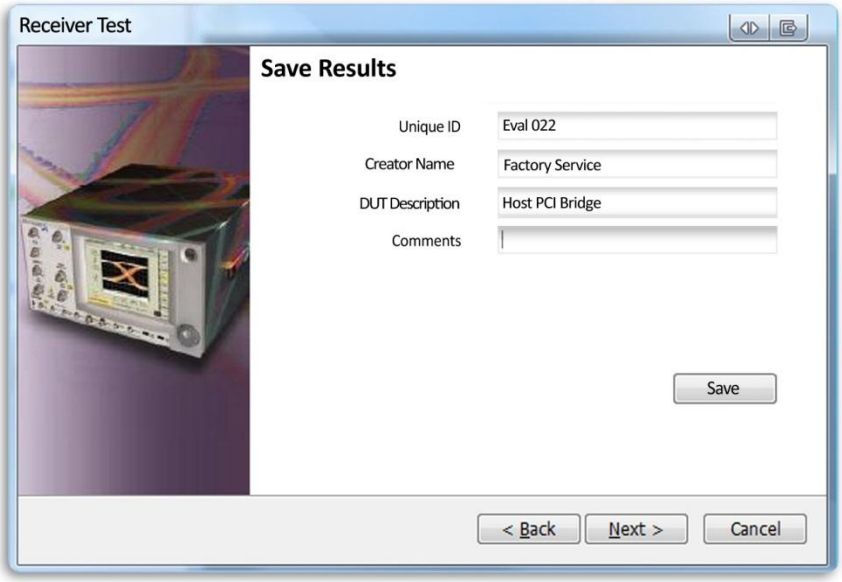

Figure 30: Save Test Results

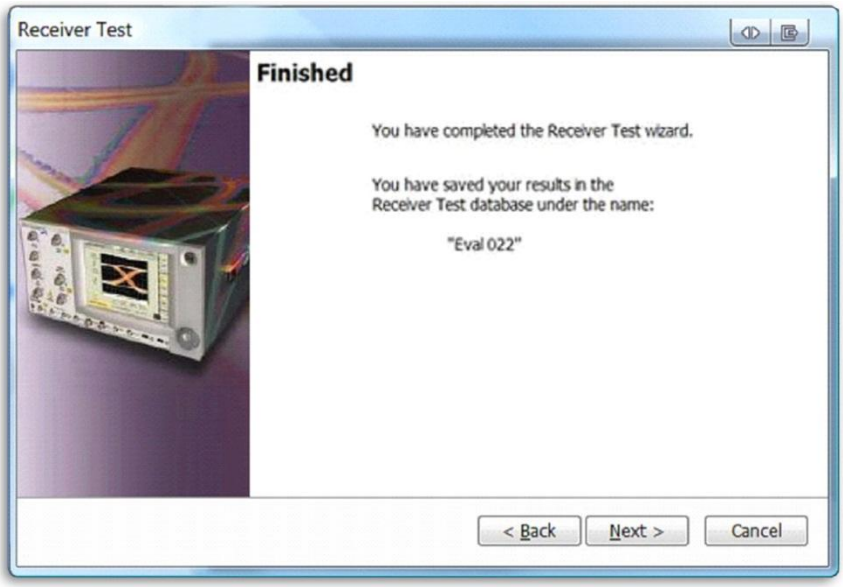

Figure 31: Receiver Test Complete

6 Storing and Documentation of Test Results

Select **Receiver Test** on the navigation panel to see the list of Receiver Test results.

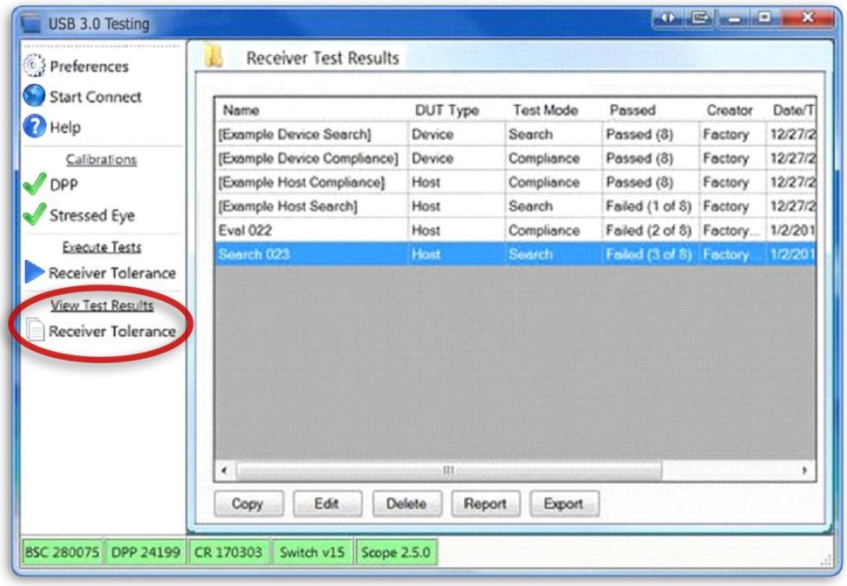

Figure 32: Receiver Test Results

From the Receiver Test Results view, you can list and sort the test results stored in the database using the controls below the 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
Export	Export test results as a .CSV format text file

7 Appendix A, DPP Calibration

7.1 Running the DPP Calibration Wizard

The DPP Calibration Wizard automates as much of the procedure as possible. You will be prompted with diagrams to make test equipment connections, then begin the automated calibration procedures, and store the results when completed.

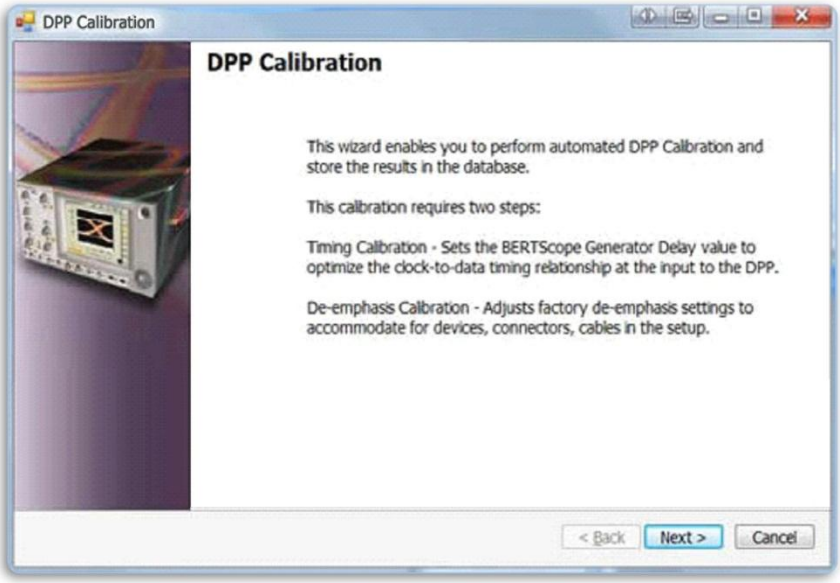

Figure 33: DPP Calibration Wizard

7.1.1 Timing Calibration

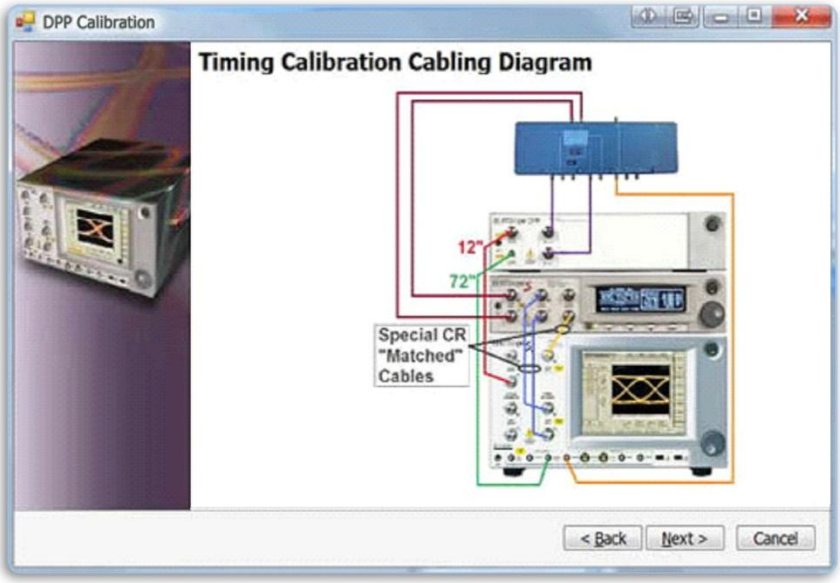

Figure 34: Timing Calibration Cabling Diagram

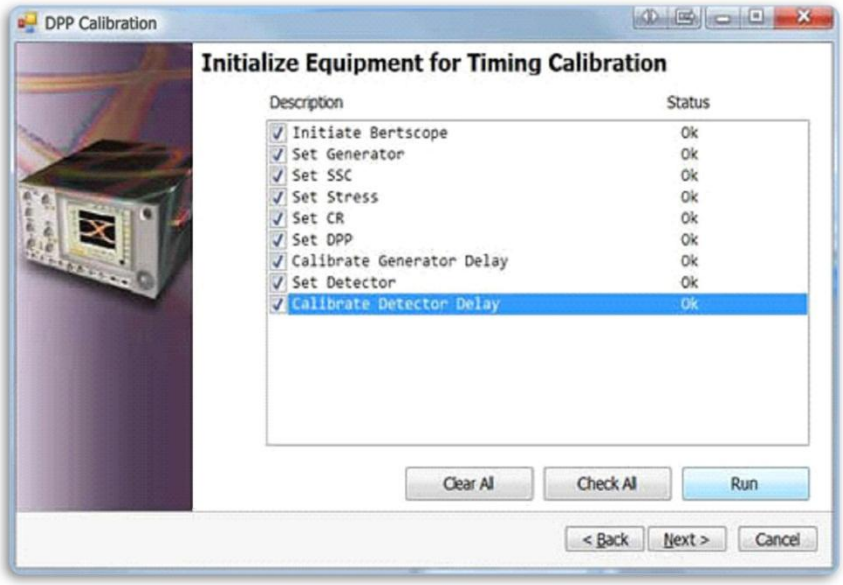

Figure 35: Initialize Equipment for Timing Calibration

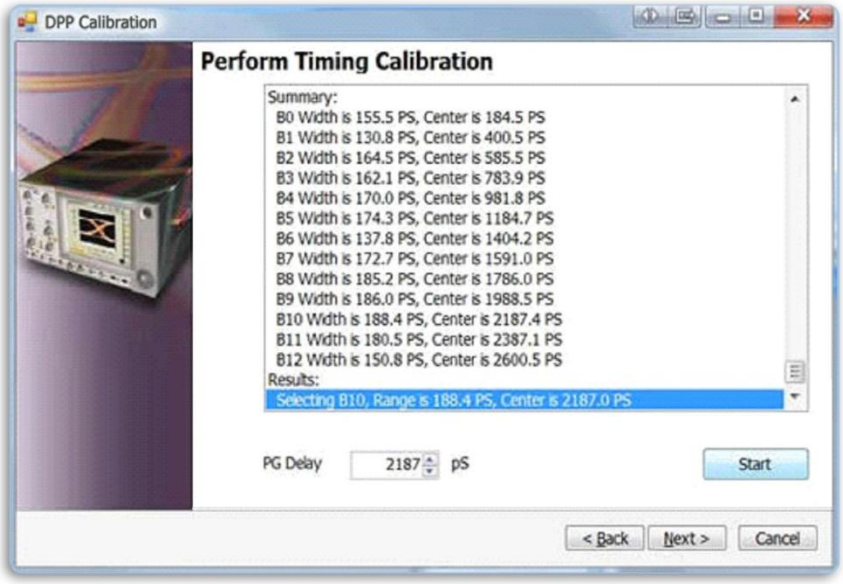

Figure 36: Perform Timing Calibration

7.1.2 De-Emphasis Calibration

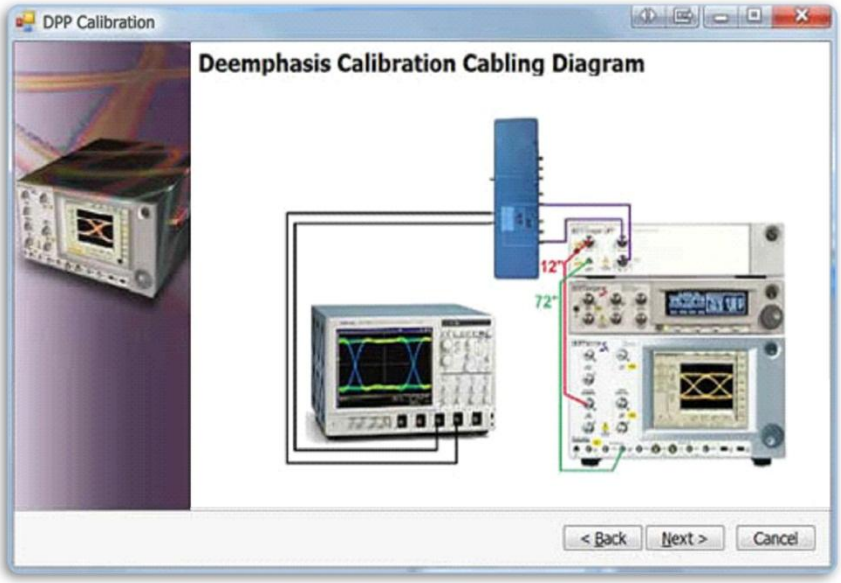

Figure 37: De-Emphasis Calibration Cabling Diagram

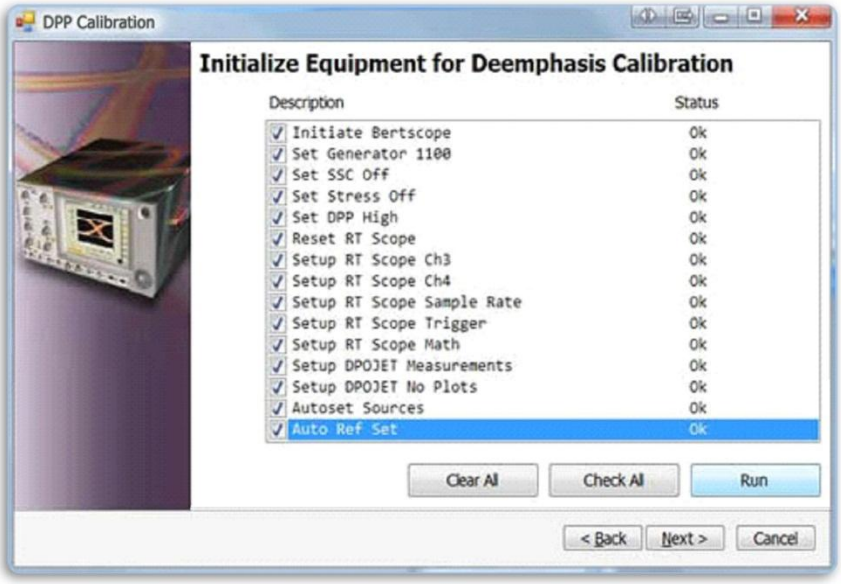

Figure 38: Initialize Equipment for De-Emphasis Calibration

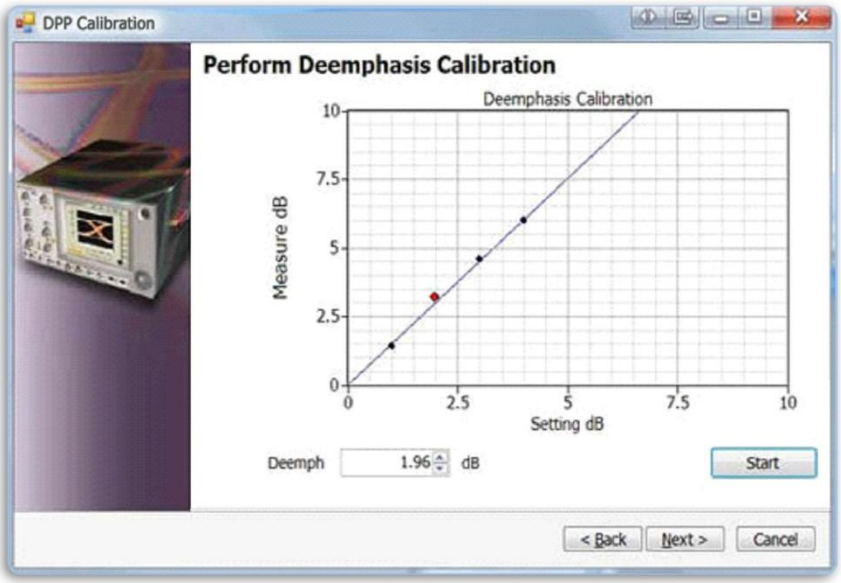

Figure 39: Perform De-Emphasis Calibration

The chart shows black dots representing measurements taken with settings evenly spaced throughout the calibration range. Once these measurements are recorded, a straight line is fit through them and a calibrated setting is calculated based on the fit line and the calibration measurement target. This calibrated setting is then measured and presented as a red dot.

7.1.3 Save Results

Enter identifying information and save the calibration results.

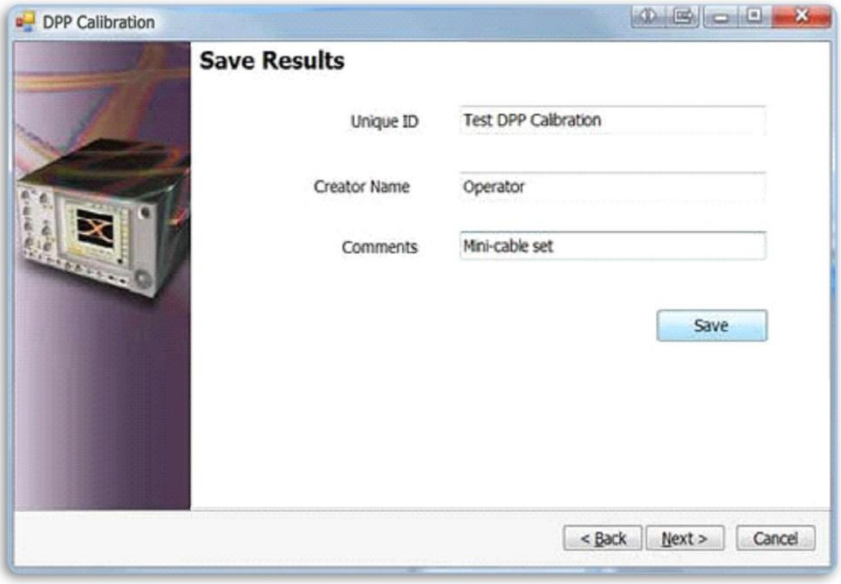

Figure 40: Save DPP Calibration Results

The final “Finished” screen allows you to save this calibration as the default.

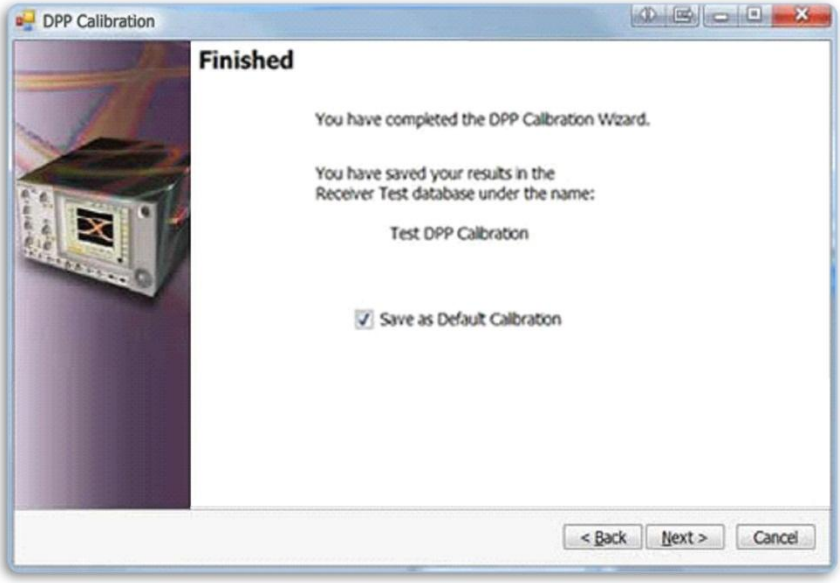

Figure 41: DPP Calibration Complete – Save as Default

8 Appendix B, Stressed Eye Calibration

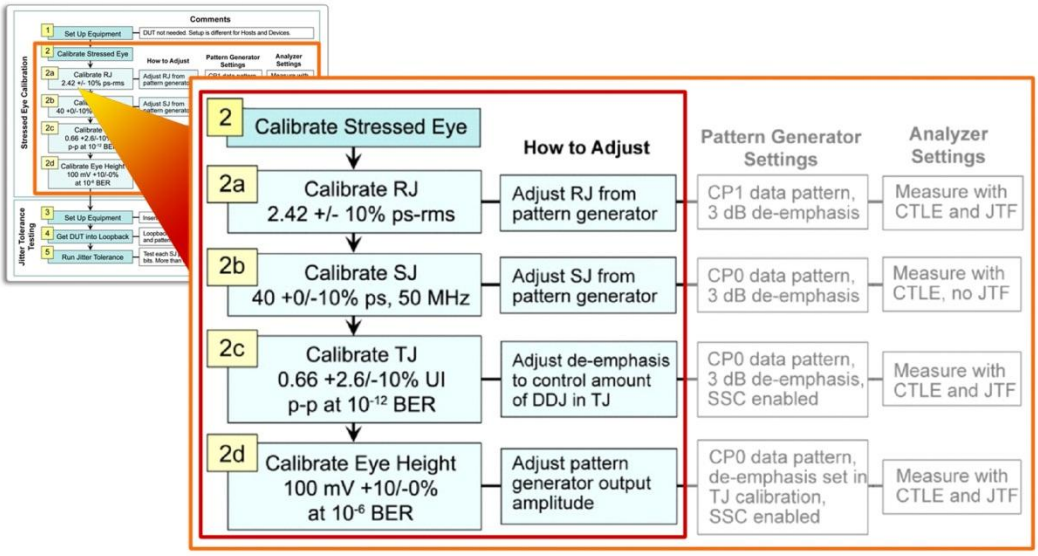

Figure 42: Stress Calibration Flowchart

Stressed eye calibration only needs to be performed once per set of hardware, and may be saved for subsequent tests. Host and Device setups should each have their own calibration.

The Device Under Test (DUT) is not needed for stressed eye calibration; instead, the signal is looped back to the analyzer through adapters and cabling.

8.1 Pattern Generator Settings

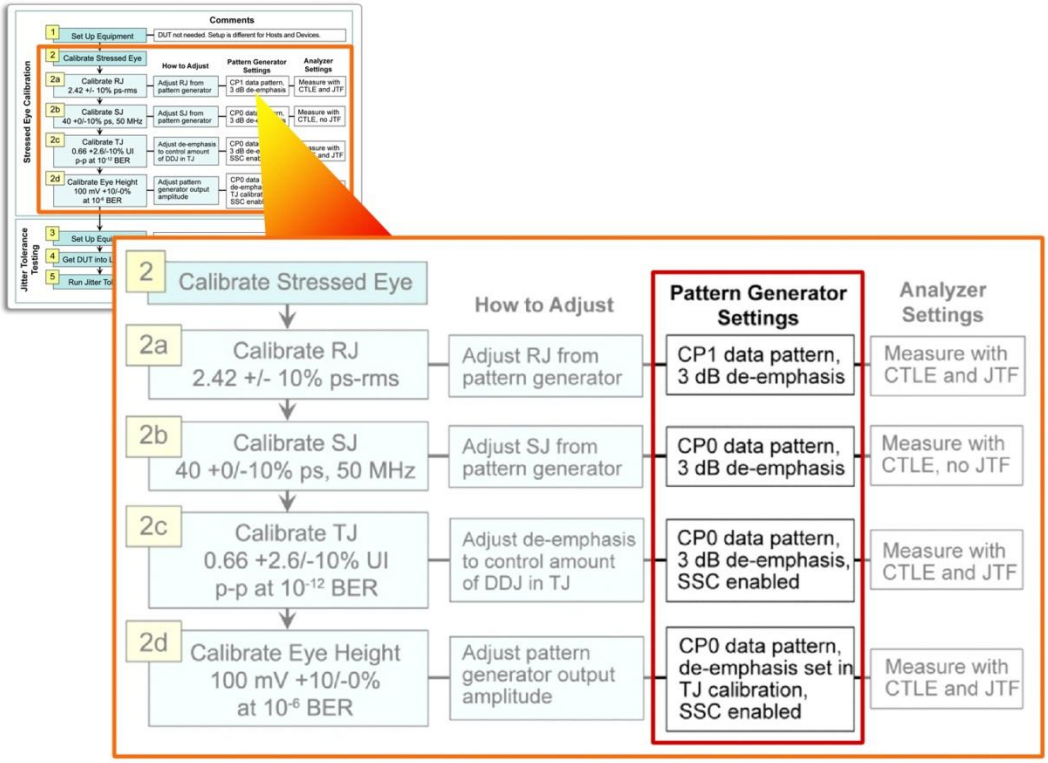

Figure 43: Pattern Generator Settings used for Stressed Eye Calibration

8.1.1 Data Patterns

There are two patterns listed in the stressed eye calibration recipe, CP0 and CP1. For reference, all USB 3.0 compliance patterns are listed in Table 2.

- ***CP0*** is an 8b/10b encoded PRBS-16 data pattern (the result of subjecting the D0.0 character to scrambling and encoding in a USB 3.0 transmitter). After 8b/10b encoding, the longest run length of ones or zeros is 5 bits, reduced from the longest run length of 16 bits in a PRBS-16 pattern. CP3 (see Table 2) is a pattern similar to the 8b/10b encoded PRBS-16, in that it contains both the shortest (lone bit) and longest sequences of identical bits.
- ***CP1*** is a clock pattern used for the RJ calibration. Many instruments use a dual-Dirac method of random and deterministic jitter separation for the RJ measurement. Using a clock pattern circumvents one of the drawbacks of the dual-Dirac method, which is the tendency to report data dependent jitter (DDJ) as RJ, especially on long patterns. By using a clock pattern, DDJ as a result of Inter-symbol Interference (ISI) is eliminated from the jitter measurement, resulting in a more accurate RJ measurement. The CP2 pattern, which is a 1100 clock pattern, could also be used for RJ measurement.

Compliance Pattern	Value	Bit Sequence Description
CP0	Scrambled D0.0	8b/10b encoded PRBS-16
CP1	D10.2	Repeating 1010 (Nyquist frequency)
CP2	D24.3	Repeating 1100 (Nyquist frequency / 2)
CP3	K28.5	Repeating 0011111010110000010, contains runs of 5 ones and zeroes and lone bit sequences, representative of longest and shortest runs in 8b/10b system
CP4	LFPS	Low Frequency Periodic Signaling (refer to standard for more on LFPS)
CP5	K28.7	Repeating 0011111000 (for use with de-emphasis)
CP6	K28.7	Repeating 0011111000 (for use without de-emphasis)
CP7	50-250 1's and 0's	Repeating 50-250 1's followed by 50-250 0's (for use with de-emphasis)
CP8	50-250 1's and 0's	Repeating 50-250 1's followed by 50-250 0's (for use without de-emphasis)

Table 2: USB 3.0 Compliance Patterns

8.2 Calibrating the Stressed Eye

Press **Calibrations → Stressed Eye** to view the Stressed Eye Calibrations panel.

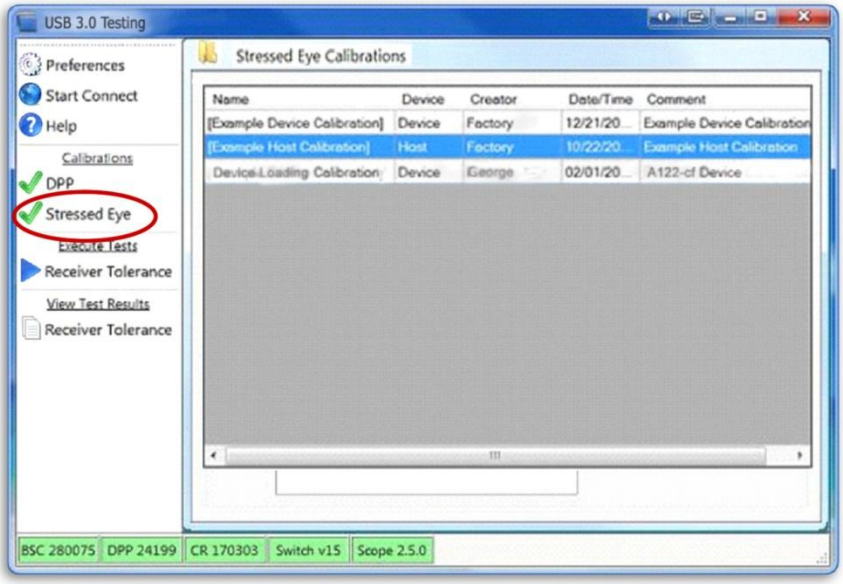

Figure 44: Saved Stressed Eye Calibrations

From the Stressed Eye Calibrations view, manage calibrations stored in the system database using the buttons below the 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 dialog to step through making a new DPP calibration and storing it in the system database

8.3 Running the Stressed Eye Calibration Wizard

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

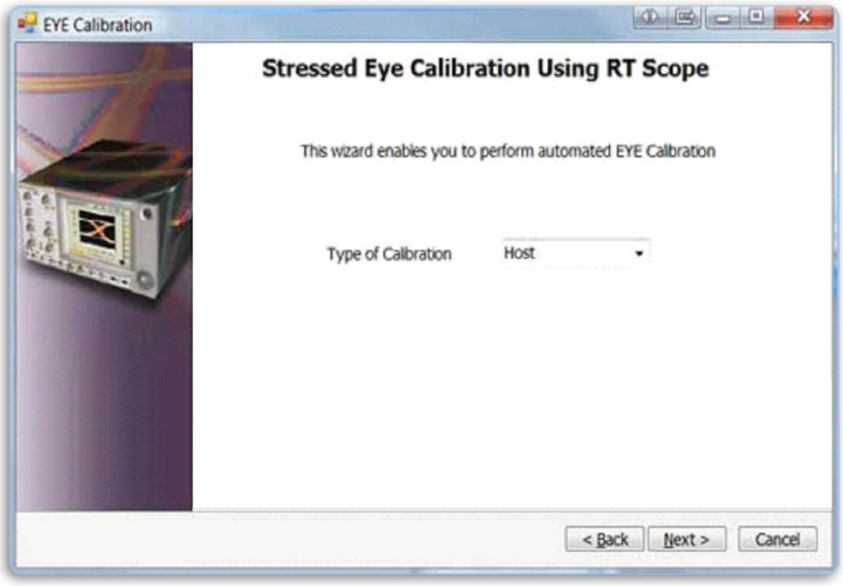

Figure 45: Stressed Eye Calibration Wizard

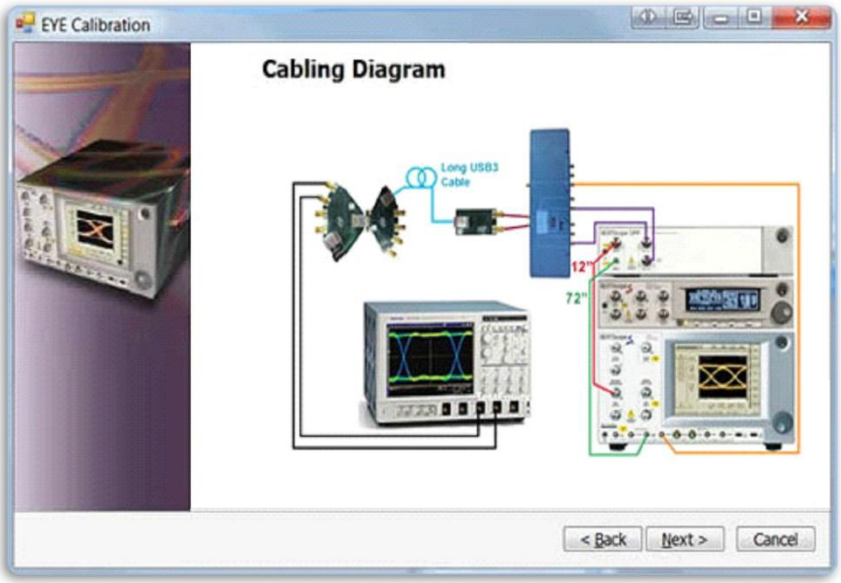

Figure 46: Stressed Eye Calibration Cabling Diagram

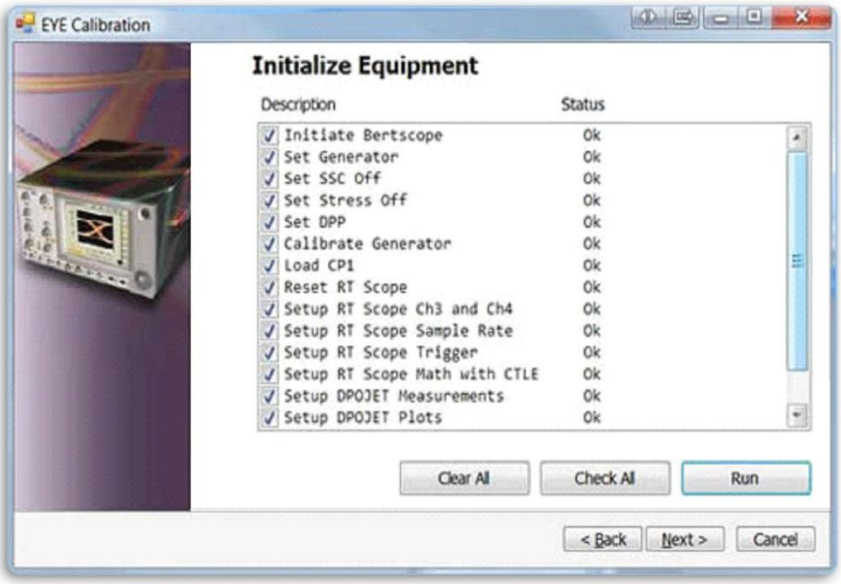

Figure 47: Initialize Equipment for Eye Calibration

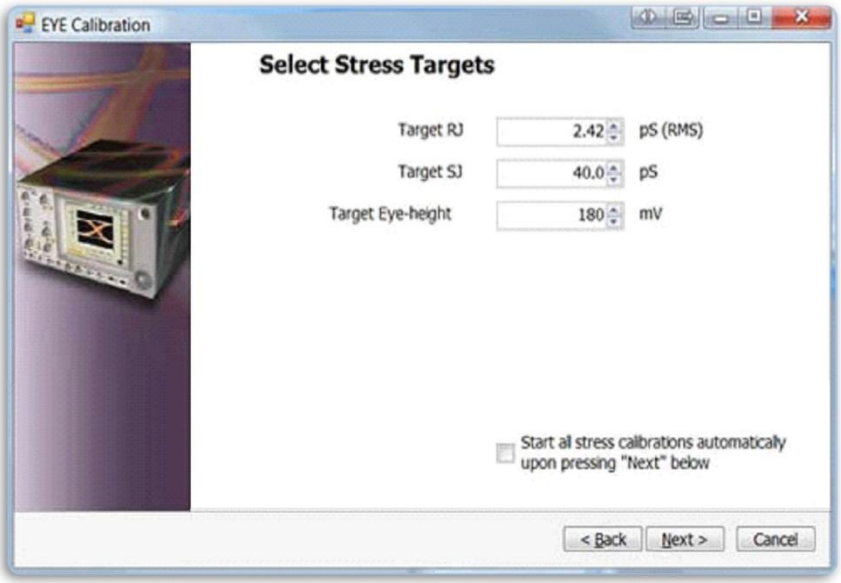

Figure 48: Select Stress Targets

The default Stress Target values match the USBIF Compliance Test Specification (CTS). You can change the settings for non-standards-compliant testing.

Select the checkbox at lower right to automatically continue through the next three stages of automated calibration (RJ, SJ, and Eye-Height).

8.3.1 RJ Calibration

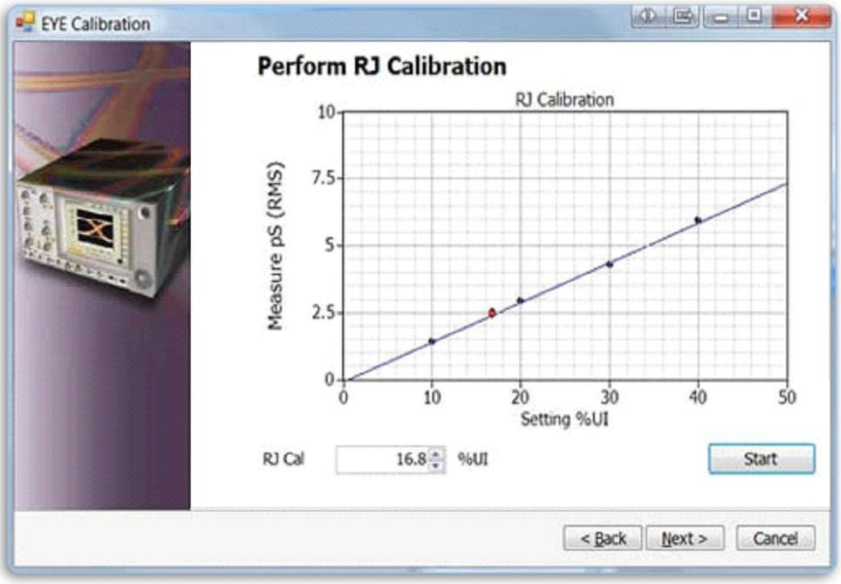

Figure 49: Perform RJ Calibration

The chart shows black dots representing measurements taken with settings evenly spaced throughout the calibration range. Once these measurements are recorded, a straight-line is fit through them and a calibrated setting is calculated based on the fit line and the calibration measurement target. This calibrated setting is then measured and presented as a red dot.

8.3.2 SJ Calibration

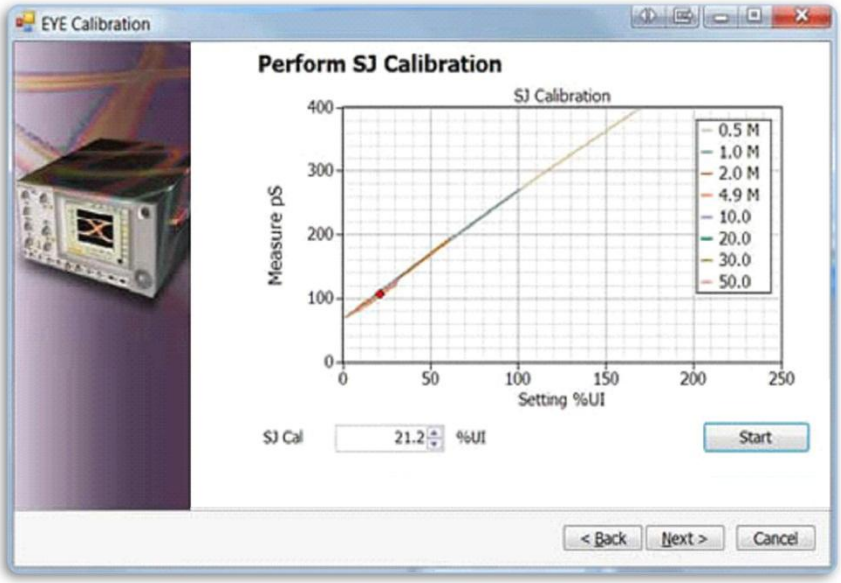

Figure 50: Perform SJ Calibration

The chart shows lines in different colors, representing measurements made for each SJ frequency being calibrated. Each set of results for a frequency are fit to a straight line, and these calibrations are stored in the database. The 50.0 MHz line is then used in conjunction with the final stressed eye SJ amplitude measurement target to calculate a calibrated setting. At the end of the calibration procedure, this setting is used to make a final measurement that is displayed as a red dot.

8.3.3 Eye Height Calibration

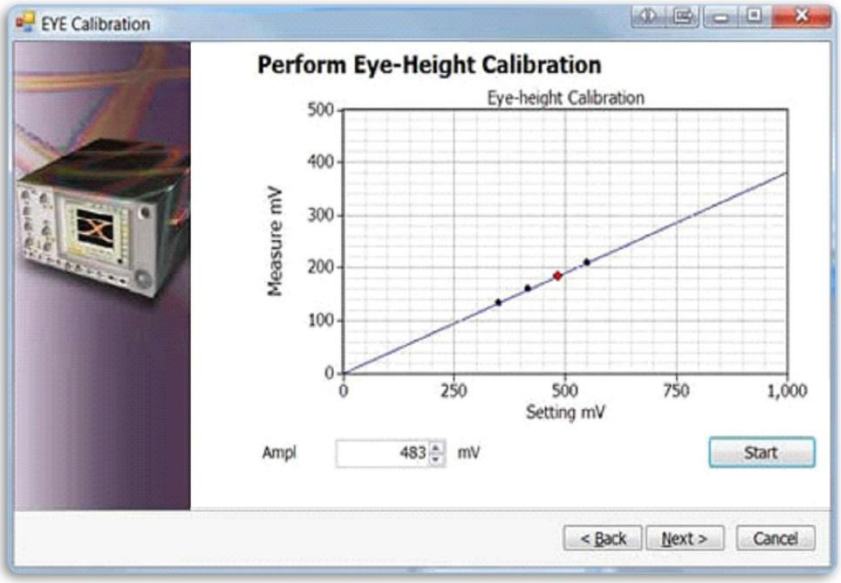

Figure 51: Perform Eye Height Calibration

8.3.4 Save Results

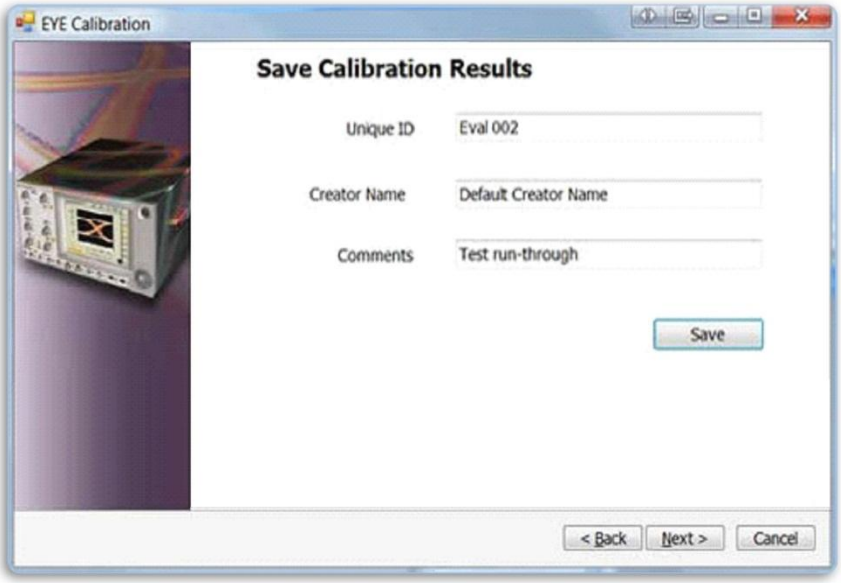

Figure 52: Save Eye Calibration Results

9 Appendix C, Modifying Preferences

Press **Preferences** on the navigation panel to open a pop-up dialog (Figure 53) for managing a variety of system properties. Select a category from the left column to access these settings.

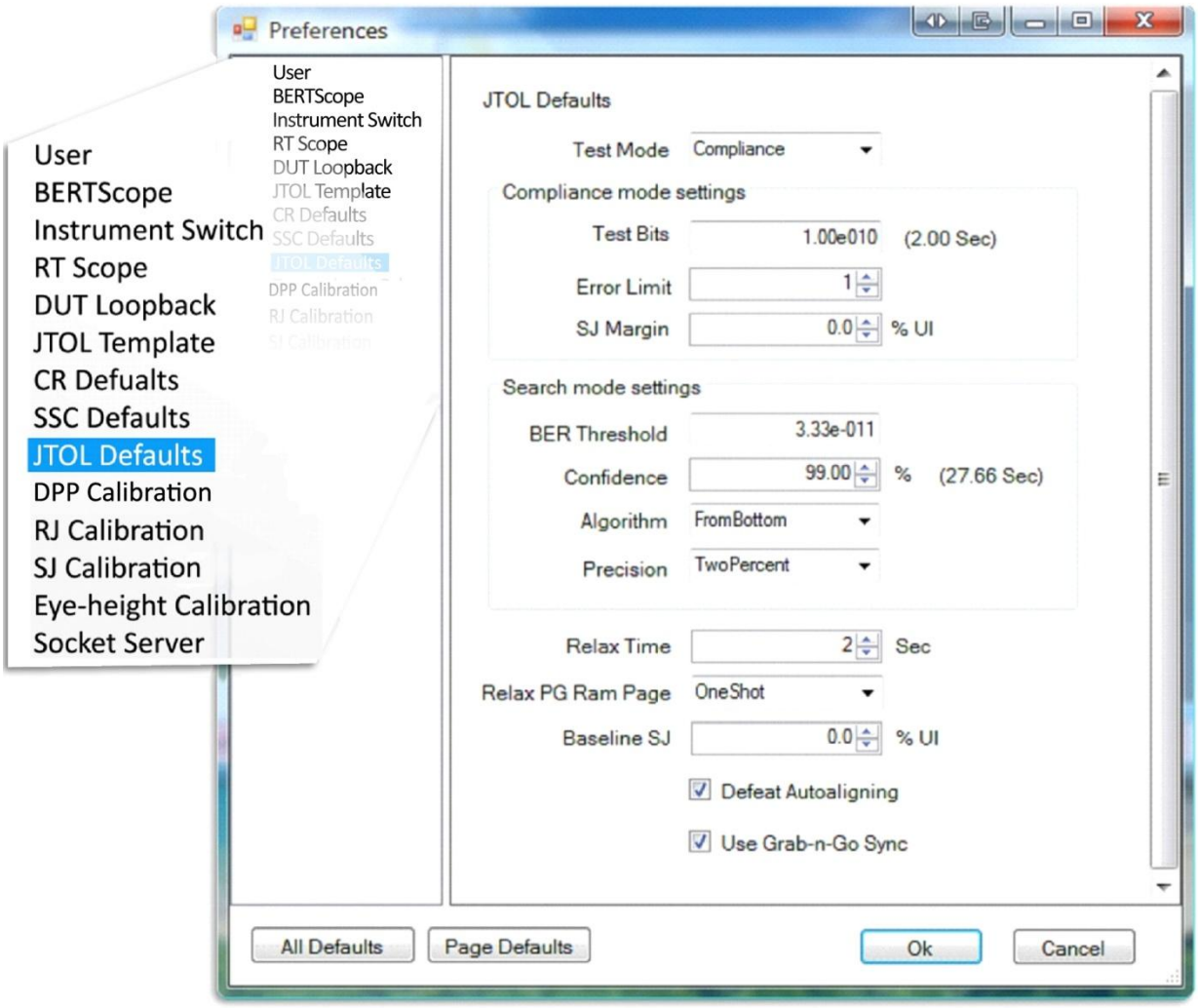

Figure 53: Modify System Preferences

9.1 User Preferences

User Preferences are system-wide properties representing a variety of functions.

Property	Default Value	Description
Default User Name	Operator	Default user name value that is stored with calibrations and test results that are stored in the database
Database Folder	Sub-folder in the Program Files installation folder	Location of Folder containing Microsoft Access 2007 database file USB3DB.accdb and accompanying PictureLink sub-folder: C:\Program Files\USB 3.0 Receiver Testing\Database Folder\
Temporary Folder		Folder location used for temporary data files: C:\Windows\Temp
Default DPP Calibration	Example DPP Calibration	Default DPP calibration used during stressed eye calibration and receiver testing
Default EYE Calibration	Example Host Calibration	Default EYE calibration (Host or Device) used during receiver testing

9.2 BERTScope Analyzer Preferences

BERTScope Preferences apply to connecting to and operating the BERTScope Analyzer.

Property	Default Value	Description
TCP/IP Address	127.0.0.1	TCP/IP address of BERTScope in the form of 999.999.999.999
Timeout	20 seconds	Timeout used when communicating with the BERTScope Analyzer
Folder on BERTScope		Folder location on the BERTScope where test patterns will be downloaded to and used from: D:\BitAlyzer\UserPatterns\USBTESTING\
List of Available Download Files		Specific test pattern files used in conjunction with different operations performed during calibration and test.

9.3 Instrument Switch Preferences

Instrument Switch Preferences are used to configure communications to the Switch Control program running on the same computer that is connected to the Instrument Switch.

Property	Default Value	Description
TCP/IP Address	127.0.0.1	TCP/IP address of host computer in the form of 999.999.999.999
Port	4003	TCP/IP port number of the port that the Switch Control program is listening to
Timeout	20 seconds	Timeout value used when communicating with BERTScope Analyzer

9.4 RT Scope Preferences

RT Scope Preferences are used in conjunction with connecting to and operating the real-time oscilloscope for calibration.

Property	Default Value	Description
TCP/IP Address	192.168.99.134	TCP/IP address of real-time oscilloscope in the form of 999.999.999.999
Port	4001	TCP/IP port that the real-time oscilloscope will accept socket-style connections on
Command Timeout	35 seconds	Timeout value used when communicating with real-time oscilloscope
Calibration Channels	Ch34	Pair of channels used during calibration procedures. Select Channels 1 and 2 (Ch12) or Channels 3 and 4 (Ch34)
CTLE Filter Filepath		Filter file location on the real-time oscilloscope where the USB 3.0 CTLE filter is stored. This file is installed on the real-time oscilloscope as a part of DPOJET installation: C:\TekApplications\POJET\Filters\USB\USB3_CTLE.flt
Jitter Transfer Function (JTF) Bandwidth	4.90 MHz	Selectable JTF -3 dB bandwidth property used to configure the Type-II PLL clock recovery during calibration
Measurement Timeout	60 seconds	Timeout value used during calibration in conjunction with DPOJET eye diagram measurements
Measurement Minimum Population	3	Minimum population number used during calibration when reading eye diagram measurements from DPOJET

9.5 DUT Loopback Preferences

DUT Loopback Preferences are used to configure parameters of the Loopback-mode training procedure.

If Loopback training is not working, it is possible that you can identify what is wrong using the Diagnostic Tools to disable certain impairments normally used during testing, or selecting override values for properties like signal amplitude, and encourage the DUT to accomplish Loopback training successfully.

The Diagnostic Tools assist you in diagnosing failures relating to Loopback negotiation. They should not be used during normal testing, as they are not in accordance with the USBIF Compliance Test Specification (CTS) for the level of impairments required during Loopback training.

Property	Default Value	Description
Default Type of DUT	Host	Specify the default type of DUT (Host or Device). This property is used to initialize the calibration and testing wizards to prompt you appropriately.
DUT Loopback Control		
Use Warm Reset	On	
Trigger Level	50 mV	The BERTScope Analyzer monitors the signal coming from the DUT to recognize when the DUT is in power-on state. Any signal levels above this threshold indicate power-on state.
Trigger Holdoff	0 ms	Normally as soon as the DUT is in power-on state, the BERTScope may send the Loopback-mode training sequence. Some DUTs, however, require a pause before Loopback-mode training can be initiated. This parameter accomplishes this pause. *It is apparent that some Host DUTs require 600 ms of holdoff to operate correctly.*
Loopback Diagnostic Tools		
Pause to arm scope	Off	
Disable SSC	Off	Disable SSC clock modulation during the Loopback-mode training interval
Disable Stress	Off	Disable SJ and RJ during the Loopback-mode training interval
Use Grab-n-Go Sync	Off	Select BERTScope "Grab-no-go" style pattern detection synchroni-zation instead of the normal "Shift-n-sync" style. Grab-n-go is much faster and permits synchronization even in modestly-high error rate conditions. However, this mode can be fooled if the DUT is generating a repeating pattern. This mode can be helpful in high error rate conditions and to diagnose if the polarity of the differential signal has been switched somewhere.
Use Training De-emphasis	3.00 dB	Select a non-calibrated de-emphasis level to be used only during the Loopback mode training interval. This value will be used during the TSEQ, TS1, and TS2 packet communications. LFPS levels are fixed.
Use Training Amplitude	900 mV	Select a non-calibrated amplitude setting to be used only during the Loopback-mode training interval. This setting will be used during the TSEQ, TS1, and TS2 packet communications. LFPS levels are fixed.

9.7 JTOL Template Preferences

Jitter Tolerance (JTOL) Template Preferences are used to specify which sinusoidal jitter (SJ) frequencies and amplitudes will be tested. The default is a list of 8 frequencies corresponding to the USBIF Compliance Test Specification (CTS).

In addition to the amplitude specified at each frequency, this table has entries for specifying the range of amplitudes that will be searched during the Search-mode test. The maximum values may have a specific value or may have the special code "[Limit]" indicating that testing should extend to the limit of the BERTScope Analyzer's capability to create sinusoidal jitter amplitude.

With BERTScope system software version 10.11 and onwards, BERTScope Analyzers may be calibrated to provide sinusoidal jitter frequencies in excess of the 100 MHz limit found in earlier systems. This High Frequency SJ (HFSJ) feature requires the BERTScope Analyzer to be calibrated at these higher frequencies. If these calibrations are detected on your Analyzer, then the maximum frequency is set to 1 GHz instead of the normal 100 MHz limit.

MHz	Template %UI	Search Min.	Search Max.
0.5	200.0	100.0	[Limit]
1.0	100.0	50.0	[Limit]
2.0	50.0	25.0	[Limit]
4.9	20.0	10.0	[Limit]
10.0	20.0	10.0	[Limit]
20.0	20.0	10.0	[Limit]
33.0	20.0	10.0	[Limit]
50.0	20.0	10.0	[Limit]

9.8 CR Default Preferences

Clock Recovery (CR) Default Preferences are used to configure the clock recovery device during DPP calibration and receiver testing. The default settings are in accordance with the USBIF Compliance Test Specification (CTS).

Property	Default Value	Description
Nominal Clock Rate	5.000 GHz	Nominal clock rate specified as 5.0 GHz in USB 3.0
Lock Range	30.00 MHz	Bandwidth about the nominal frequency within which clock recovery can occur. This value must be large enough to permit SSC on the received signal.
Peaking	2.09 dB	Peaking value for clock recovery operation
Subrate Output Amplitude	900 mV	Signal amplitude for sub-rate clock output used to provide the BERTScope with the received clock
Loop BW	11.00 MHz	Bandwidth setting for clock recovery operation

9.9 SSC Default Preferences

SSC Default Preferences are used to configure the SSC clock modulation circuitry in the BERTScope used during calibration and test. The default settings are in accordance with the USBIF Compliance Test Specification (CTS).

Property	Default Value	Description
Internal Clock Rate	5.000 GHz	Base frequency for the internal clock synthesizer
Modulation Frequency	33.00 KHz	Frequency used to modulate the internal clock synthesizer
Modulation Deviation	5000 ppm	Amplitude (specified in parts per million) of modulation signal
Modulation Type	Down	Orientation of the "spread" of the modulation signal: Up, Down, Center
Modulation Signal Type	Triangle	Shape of the modulation signal: Triangle or Sinusoidal

9.10 JTOL Default Preferences

Jitter Tolerance (JTOL) Preferences are used while performing receiver testing in either Compliance or Search modes. Compliance-mode testing performs a single test at each sinusoidal jitter (SJ) frequency specified in the jitter tolerance template. Search-mode testing sweeps a range of amplitudes for each SJ frequency. Use these settings to configure which mode is the default mode, and how long to execute individual tests.

Property	Default Value	Description
Test Mode	Compliance	Selects which test mode is the default. This property initializes the calibration and test wizards to prompt accordingly. This value can be changed inside the wizards.
Compliance Test Bits	3.0e10 (6.00 seconds)	Number of bits for each individual test. This value dictates how long the full test will be. The length of each individual test is shown for information.
Compliance Error Limit	1	The maximum number of errors that may occur during a successful test
Compliance SJ Margin	0.0 % (of setting)	A percentage of the template amplitude value above which the tests will be performed
Search mode BER Threshold	3.33e-11	The BER limit for a successful test. The default value corresponds to the 1/3e10 error limit threshold specified for compliance-mode testing.
Search mode Confidence	90.00 % (of setting)	A confidence value used in conjunction with the BER Threshold to determine the length of each individual test. This value dictates how long the full test will be. The length of each individual test is shown for information.
Search mode Log Resolution	0.10	The amplitude steps between individual tests during Search mode testing. The steps are made on a Logarithmic axis. A smaller number will produce more individual tests.

9.11 De-Emphasis Calibration Preferences

De-Emphasis Calibration Preferences are used to configure the de-emphasis steps performed during DPP calibration.

Property	Default Value	Description
Deemphasis Target	3.00 dB	Target de-emphasis level used during testing. The default value corresponds to the USBIF Compliance Test Specification (CTS)
Output Amplitude	600 mV	The DPP Output amplitude setting is used during De-emphasis calibration. The level should be somewhat close to the actual calibrated levels used during testing; however, good results are not very sensitive to this setting.
Begin-End Range	1.0 - 4.0 dB	Range of DPP De-emphasis settings that will be measured during calibration
Number of Points	4	Number of measurements made during calibration. Measurements are evenly spaced through the range
Timing Cal SJ Amplitude	30 %UI	
Timing Cal SSC Deviation	5000 ppm	

9.12 RJ Calibration Preferences

RJ Calibration Preferences configure how Random Jitter (RJ) calibrations are performed.

Property	Default Value	Description
RJ Target	2.42 ps (RMS)	Calibration target for random jitter source
Begin-End Range	10.0 - 40.0 %UI	Range of BERTScope settings measured during calibration
Number of Points	4	Number of measurements made throughout Begin-End range

9.13 SJ Calibration Preferences

SJ Calibration Preferences configure how Sinusoidal Jitter (SJ) calibrations are performed.

Property	Default Value	Description
SJ Target	40.0 ps	Calibration target for sinusoidal jitter source
Number of Points	3	Number of measurements made throughout the range specified individually for each frequency in the template
Calibration Template	0.5, 1.0, 2.0, 4.9, 10, 20, 33, 50 MHz	Selection of frequencies to calibrate, and amplitude calibration limits (in %UI) for each frequency

9.14 Eye Height Calibration Preferences

RJ Calibration Preferences configure how Random Jitter (RJ) calibrations are performed.

Property	Default Value	Description
Device Target Eye Height	145 mV	Calibration target for signal amplitude level source used when calibrating USB 3.0 Devices
Host Target Eye Height	180 mV	Calibration target for signal amplitude level source used when calibrating USB 3.0 Hosts
Begin-End Range	350 mv - 550 mV	Range of BERTScope settings measured during calibration
Number of Points	3	Number of measurements made throughout Begin-End range

9.15 Socket Server Preferences

Socket Server preferences are used to configure the listening port and timeout values for the built-in socket server which responds to SCPI-like ascii-string commands.

Property	Default Value	Description
Local TCP/IP Address	127.0.0.1	TCP/IP address of the local machine in the form of 999.999.999.999, to be used by any other machine for access to the Socket Server
Port	4004	TCP/IP port number of the port that the Socket Server is listening to
Timeout	20 Seconds	Timeout value used when communicating with the Socket Server

10 Appendix D, Abbreviations

BSA	BERTScope Analyzer, BSA85C
CP[0-9]	Compliance Patterns
CR	BERTScope Clock Recovery, CR125A
CTLE	Continuous Time Linear Equalizer
CTS	Compliance Test Specification
DDJ	Data-Dependent Jitter
DPP	BERTScope Digital Pre-Emphasis Processor, DPP125B
DUT	Device Under Test
JTF	Jitter Transfer Function
RJ	Random Jitter
SI	Sinusoidal Interference
SJ	Sinusoidal Jitter
SSC	Spread Spectrum Clocking
TJ	Total Jitter
UI	Unit Interval
USB 3.0	Universal Serial Bus Revision 3.0