Keysight N5991 PCI Express Link Training Suite

User Guide

KEYSIGHT TECHNOLOGIES

Notices

© Keysight Technologies 2019

No part of this manual may be reproduced in any form or by any means (including electronic storage and retrieval or translation into a foreign language) without prior agreement and written consent from Keysight Technologies as governed by United States and international copyright laws.

Trademarks

Manual Part Number

N5991-91210

Manual Edition

Edition 1.0, December 2019

Keysight Technologies Deutschland GmbH
Herrenberger Strasse 130,
71034 Böblingen, Germany

Technology Licenses

The hardware and/or software described in this document are furnished under a license and may be used or copied only in accordance with the terms of such license.

U.S. Government Rights

The Software is “commercial computer software,” as defined by Federal Acquisition Regulation (“FAR”) 2.101. Pursuant to FAR 12.212 and 27.405-3 and Department of Defense FAR Supplement

(“DFARS”) 227.7202, the U.S. government acquires commercial computer software under the same terms by which the software is customarily provided to the public. Accordingly, Keysight provides the Software to U.S. government customers under its standard commercial license, which is embodied in its End User License Agreement (EULA), a copy of which can be found at http://www.keysight.com/find/sweula. The license set forth in the EULA represents the exclusive authority by which the U.S. government may use, modify, distribute, or disclose the Software. The EULA and the license set forth therein, does not require or permit, among other things, that Keysight: (1) Furnish technical information related to commercial computer software or commercial computer software documentation that is not customarily provided to the public; or (2) Relinquish to, or otherwise provide, the government rights in excess of these rights customarily provided to the public to use, modify, reproduce, release, perform, display, or disclose commercial computer software or commercial computer software documentation. No additional government requirements beyond those set forth in the EULA shall apply, except to the extent that those terms, rights, or licenses are explicitly required from all providers of commercial computer software pursuant to the FAR and the DFARS and are set forth specifically in writing elsewhere in the EULA. Keysight shall be under no obligation to update, revise or otherwise modify the Software. With respect to any technical data as defined by FAR 2.101, pursuant to FAR 12.211 and 27.404.2 and DFARS 227.7102, the U.S. government acquires no greater than Limited Rights as defined in FAR 27.401 or DFAR 227.7103-5 (c), as applicable in any technical data.

Warranty

THE MATERIAL CONTAINED IN THIS DOCUMENT IS PROVIDED "AS IS," AND IS SUBJECT TO BEING CHANGED, WITHOUT NOTICE, IN FUTURE EDITIONS. FURTHER, TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, KEYSIGHT DISCLAIMS ALL WARRANTIES, EITHER EXPRESS OR IMPLIED WITH REGARD TO THIS MANUAL AND ANY INFORMATION CONTAINED HEREIN, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. KEYSIGHT SHALL NOT BE LIABLE FOR ERRORS OR FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES IN CONNECTION WITH THE FURNISHING, USE, OR PERFORMANCE OF THIS DOCUMENT OR ANY INFORMATION CONTAINED HEREIN. SHOULD KEYSIGHT AND THE USER HAVE A SEPARATE WRITTEN AGREEMENT WITH WARRANTY TERMS COVERING THE MATERIAL IN THIS DOCUMENT THAT CONFLICT WITH THESE TERMS, THE WARRANTY TERMS IN THE SEPARATE AGREEMENT WILL CONTROL.

Safety Notices

CAUTION

A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Contents

1 Introduction

Overview of this guide 6

Document History 7

Overview 8

2 Software Installation and Update

Software Update 10

Software Installation 11

3 Test Instrument Setup

M8040A BERT Setup 18

M8020A J-BERT Setup 20

4 Using the Software

Connecting to the Instruments 24

Main User Interface 27

Basics 28

Demo Mode 29

Applying 29

PCIe Physical Parameters 30

Link Training Pattern 31
Loopback Pattern 35
Clock Tolerance Compensation 36
Error Detector 37
Link Training Result 38
Power Switch 40
Timing 41
Jitter/SSC 43
Interferences 45
Voltage Levels 46
DeEmphasis 46
Bit Error Rate Measurement 47
Sequencer 48
BERT Control 48
Saving and Loading Settings 49
Expert Mode 49
Exporting the Scripts 49

Script Editing 50
Limitations 52

5 Troubleshooting

Startup Fails 56

Slow Response 57

Loopback Training Fails 58

1 Introduction

Overview of this guide / 6
Document History / 7
Overview / 8

KEYSIGHT TECHNOLOGIES

Overview of this guide

This guide provides a detailed description of the N5991 PCIe Link Training Suite.

Document History

First Edition (December, 2019):
The first edition of this guide describes the functionality of the software version 1.0

Overview

The Keysight PCIe Link Training Suite (N5991) is a flexible tool for trouble-shooting and debugging. It controls the pattern sequencer of a Keysight J-BERT (M8040A or M8020A) to bring the device under test into the loopback mode. Enabling the loopback mode is usually a prerequisite for receiver compliance testing. The PCIe LTS complements the full Test Automation Software, which provides automated physical layer compliance tests and device characterization. The software runs on a standard Windows PC and controls the hardware test resources through appropriate interfaces such as a LAN (Local Area Network).

2 Software Installation and Update

Software Update / 10
Software Installation / 11

The Keysight PCIe Link Training Suite (N5991) runs on the PC that controls the J-BERT. If is already installed on the PC and is not to be updated, proceed to the next chapter.

Software Update

If you want to upgrade a previous version of the PCIe Link Training Suite, uninstall it first from the PC and then continue with the software installation.

Software Installation

Prior to installing N5991, if not yet installed, the following software has to be installed, items 1 through 3, in the order given below:

1. Microsoft Windows XP or higher
2. Keysight VISA IO Library
3. Microsoft.NET Framework

Perform the following steps:

- Execute the installer file “PCIeLinkTrainingSuiteInstaller” (see Figure 1)
- The second and third page of the installer wizard will show the software license agreement (see Figure 2 and Figure 3).
- Read it carefully and select **I accept the terms of the License Agreement** option
- Click **Next** to continue
- **Choose Components** window is displayed; **PCIe N5991 Link Training Suite** is already selected.
- Click **Next** to continue
- App checks for required softwares; again click **Next** to continue
- The install location window is displayed as shown in Figure 6.
- Click **Browse...** to select the destination folder, in which the software will be installed.
- Click **Install**

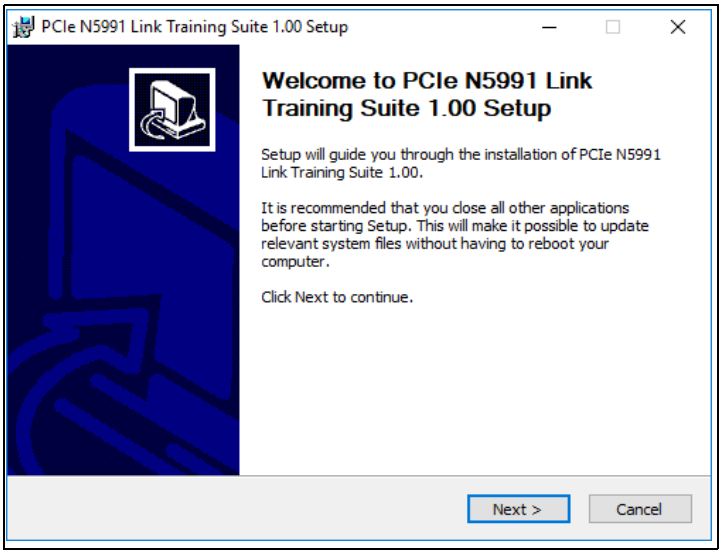

Figure 1 Installer Wizard

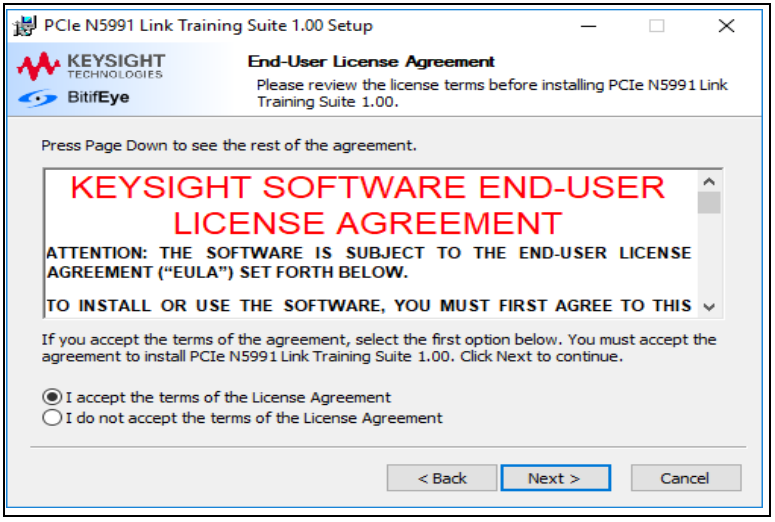

Figure 2 Installer License Agreement Window

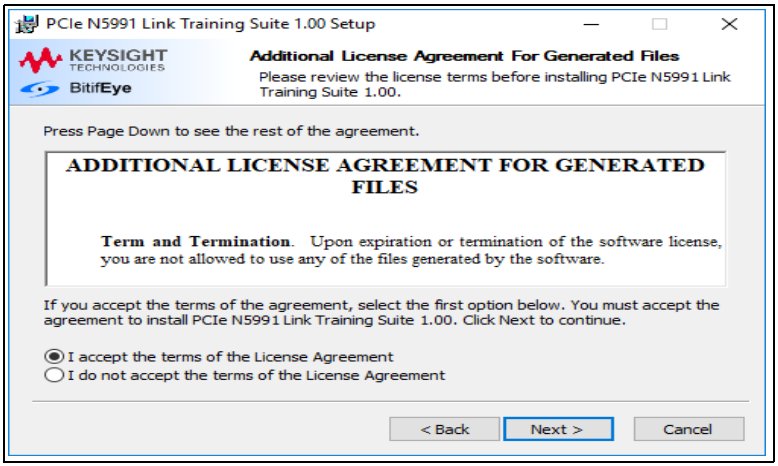

Figure 3 Installer Additional License Agreement Window

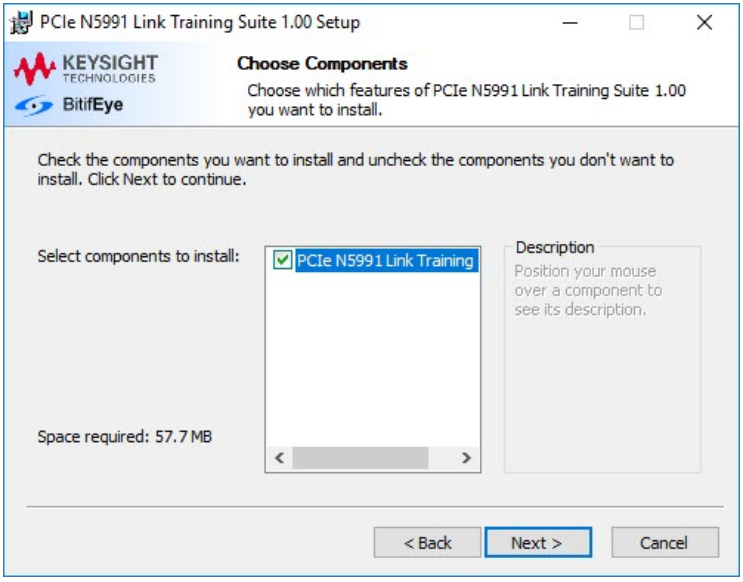

Figure 4 Choose Components Window

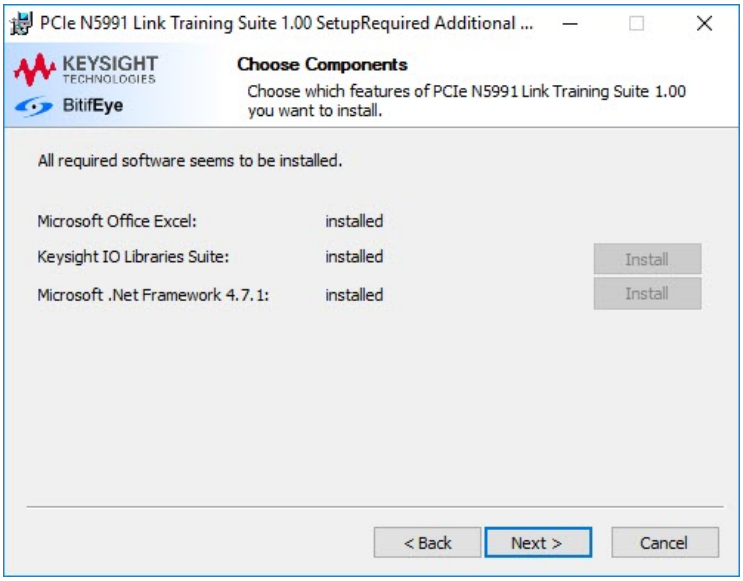

Figure 5 Required Software Check Window

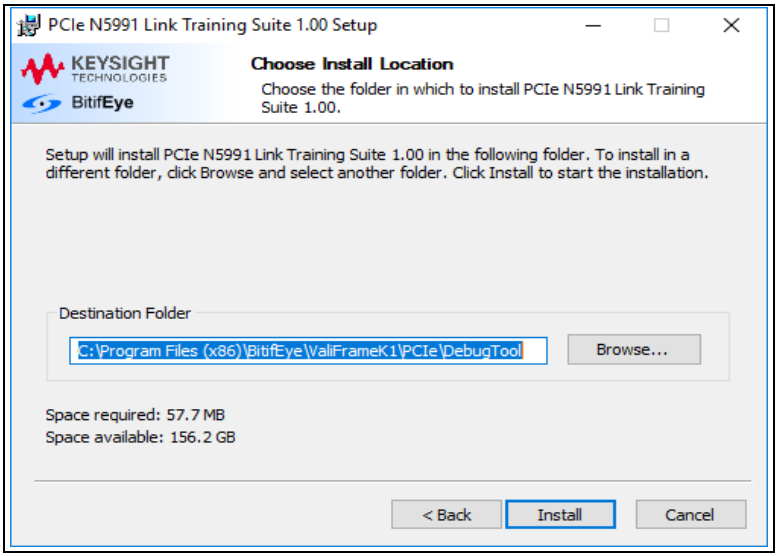

Figure 6 Installer Location Window

After installation, the PCIe Link Training Suite icon will be available on your desktop (see Figure 7).

Figure 7 PCIe Link Training Suite Icon

3 Test Instrument Setup

M8040A BERT Setup / 18
M8020A J-BERT Setup / 20

Prior to using the PCIe Link Training Suite software for connecting instruments, it is recommended that you set up the test instruments and establish the required connections.

- Connect the instruments to the controller PC by LAN
- Establish all required cable connections between the instruments and the DUT (device under test)
- Switch on the PC and instruments
- Start Keysight “IO (Input Output) VISA (Virtual Instrument Software Architecture) Connection Expert” and check the connections for the instruments
- Set the correct IP addresses of the instruments

There are two possible configurations:

M8040A BERT Setup

The M8040A setup requires the following modules and instruments:

- M8045A Data Generator Module
- M8057B Remote Head
- AWG Module (used as interference source). This can be a M8195A, M8196A, or a M8054A)
- M8046 Error Detector Module

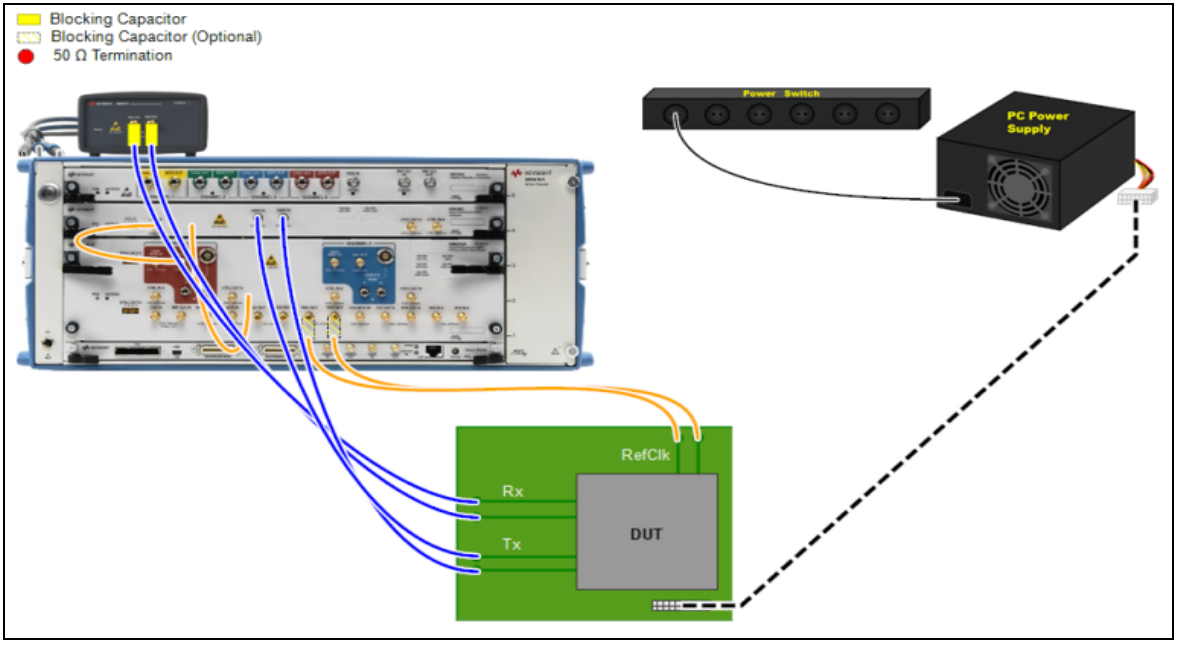

Figure 8 Connection diagram for M8040A

A Netlo230B Power Switch can be used to power cycle the DUT automatically.

- Mount the optional Blocking Capacitors to the TRIG OUT and TRIG OUT BAR of the M8040A

- Connect these optional blocking capacitors or the TRIG OUT BAR of the M8040A to the test fixture reference clock input
- Mount the N9398C blocking capacitors to the DATA OUT and DATA OUT BAR of M8040A.
- Connect Clk Output of output channel to Clk Input of M8046A
- Connect the Link Output of output channel to Link Input of M8046A using the M8041-61601 cable
- Connect the N9398C blocking capacitors to Rx+ and Rx- of the test fixture
- Connect Tx+ and Tx- of the test fixture to M8040A Data Inputs
- Connect Channel IN1 of the Power Switch to the Power Supply
- Terminate all connectors as indicated

M8020A J-BERT Setup

For 2.5, 5.0, 8.0 and 16GT/s, the M8020A J-BERT setup requires:

- M8041A Module with one channel generator and error detector

The J-BERT internally generates the de-emphasis and all the necessary distortions (interference) without any further instruments.

A Netlo230B Power Switch can be used to power cycle the DUT automatically.

The M8020A also supports 32GT/s. For this case, the following modules are required:

- M8041A Module with two channel generator and error detector
- M8062A Multiplexer Module
- AWG Module (used as interference source). This can be a M8195A, M8196A or a M8054A)

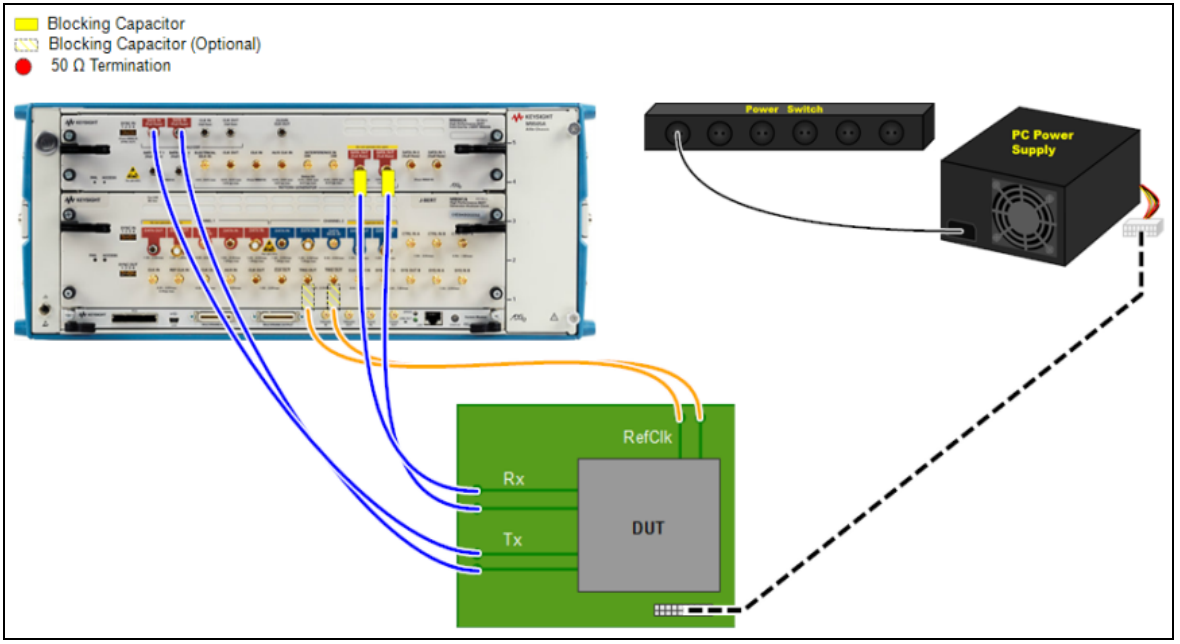

Figure 9 Connection diagram for M8020A

- Mount the optional Blocking Capacitors to the TRIG OUT and TRIG OUT BAR of the M8020A
- Connect these optional blocking capacitors or the TRIG OUT BAR of the M8020A to the test fixture reference clock input pins
- Connect the M8041A to the M8062A as described after pressing the 32G BERT Configuration Button left to the Parameters bar in the M8070 Software Interface
- Mount the N9398C blocking capacitors to the DATA OUT and DATA OUT BAR of M8020A
- Connect the N9398C blocking capacitors to Rx+ and Rx- of the test fixture
- Connect Tx+ and Tx- of the test fixture to M8020A Data Inputs
- Connect Channel IN1 of the Power Switch to the Power Supply
- Terminate all connectors as indicated

4 Using the Software

Connecting to the Instruments / 24
Main User Interface / 27
Script Editing / 50

KEYSIGHT TECHNOLOGIES

Connecting to the Instruments

After the PCIe Link Training Suite has started, the software is in “offline” mode. This means that the user input has no effect until the software is connected to the instruments. Click **Connect** (see Figure 10) to open the **Connection** dialog. In the Connection dialog, enter all parameters that are necessary to establish connections to the Signal Generator and complementary instruments.

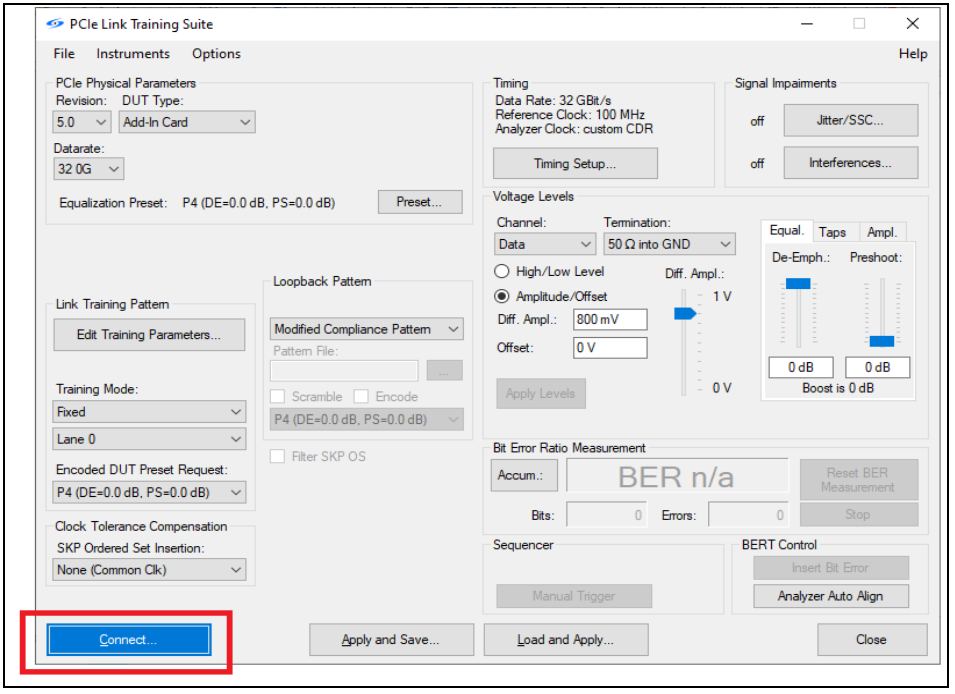

Figure 10 Main window (Instruments disconnected)

In the **Instrument Connection Dialog** window (see Figure 11), configure the test instrument setup:

- JBERT
  - Select the BERT configuration as either:
    - J-BERT M8040A
    - J-BERT M8020A

- Enter the address of the selected J-BERT

- Configuration
  - If you have a remote-controllable power switch, select the **Power Switch** check-box and enter its address. The default address format is "IP;Username;Password". You must also select a channel number.

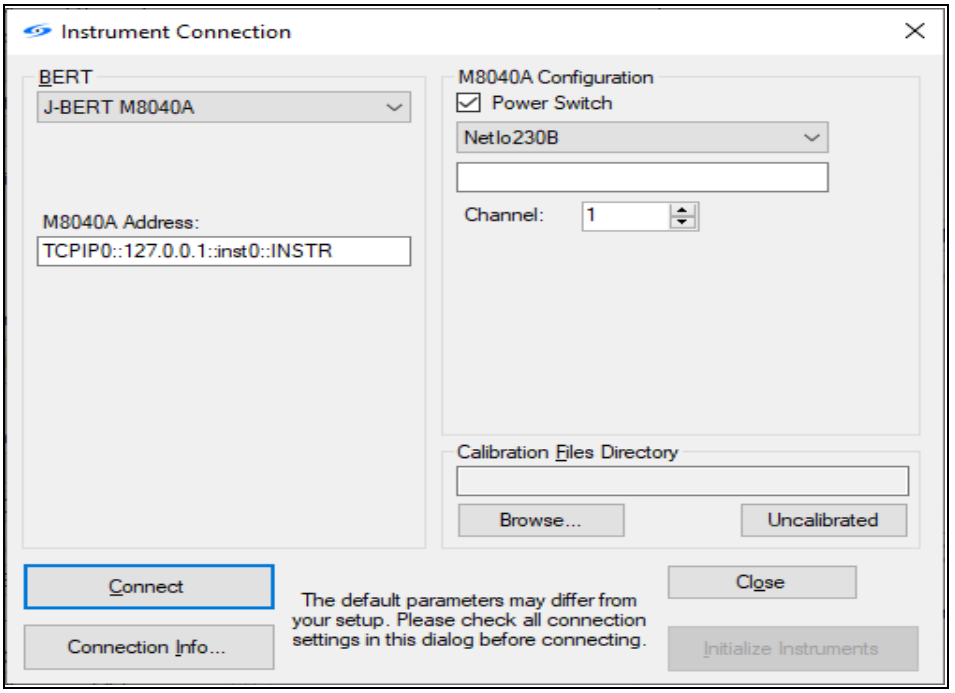

Figure 11 Instrument Connection Dialog

If you want to use calibration data from the Keysight N5991 automated test solution, select the calibration data folder in the **Calibration_Files Directory** box.

Once the configuration settings are done, click the **Connect** button. If the connections are successful, the **Initialize Instruments** button will be enabled (see Figure 12). Click the **Initialize Instruments** button to reset and initialize the instruments.

If you don't want to reset the instruments, click the **Close** button. However, clicking the **Initialize Instruments** button is recommended in order to set the instruments to a well-known state.

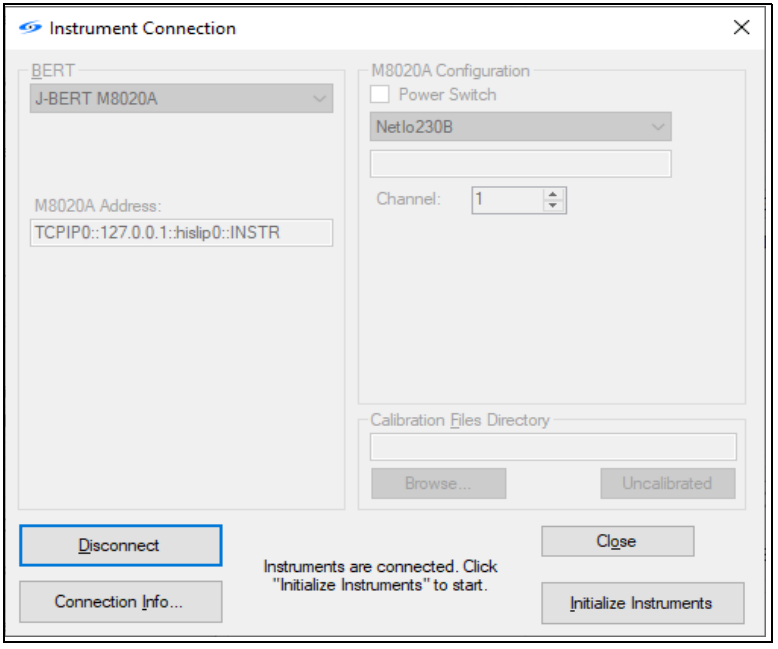

Figure 12 Instrument Connection Dialog (Instruments Connected)

NOTE You can use instruments connected via Ethernet, USB, or GPIB. The instruments must already be configured in the Keysight IO Expert in order to be able to control them remotely using the PCI Express Link Training Suite. Please refer to the Keysight IO Libraries Suite Quick Start Guide when connecting the instruments to your PC the first time. As soon as this is done, you can find out the VISA address of an instrument by selecting it in the instruments list in the Keysight IO Expert. Note that socket connections are not supported.

Main User Interface

After the successful connection to the instruments, the main window is displayed as given in Figure 13. This window is split into two major parts:

The left part of the window displays PCIe specific parameters:

- PCIe spec version and DUT type
- The training sequence and loopback pattern
- PCIe specific presets

The right part of the window displays common J-BERT parameters:

- Data rate and clock generation
- Voltage levels
- De-emphasis
- Jitter injection and interference
- Bit error rate measurement
- BERT control

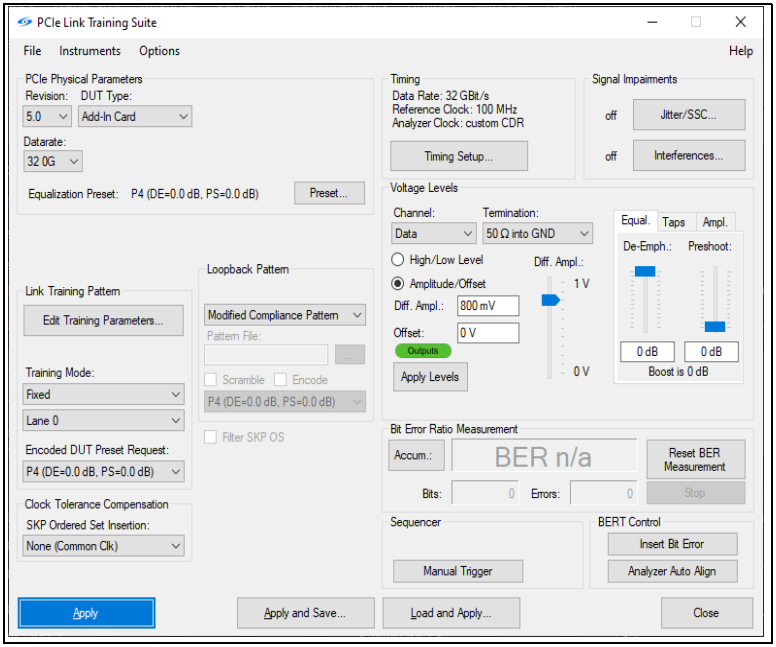

Figure 13 PCIe LTS Main Window

Basics

The basic operation of the PCIe Link Training Suite would be as follows:

- Select a PCIe revision.
- Select a loopback pattern.
- Apply the settings to the instruments and train the DUT into loopback.

Now you can adjust the instrument settings to debug the DUT, e.g. reduce the differential amplitude until bit errors are observed or deviate the data rate to test the DUT's margins.

One of the main features of the PCIe Link Training Suite is to modify the training sequence and the loopback pattern. You can let the PCIe Link Training Suite generate those automatically, or you can fine-tune the sequence and patterns using a simple macro language.

Two terms you might encounter from time to time are "sequence" and "pattern". A pattern is a stream of bits that is sent out by the BERT. In order to be more flexible, the entire bit stream is divided into multiple patterns, which are then processed by a sequencer. The sequencer can loop patterns and step from one pattern to another. In this way, it is possible to generate very long data streams with only short patterns, which fit perfectly into the instrument's limited memory.

CAUTION

Since the PCIe Link Training Suite is mainly intended for debugging and troubleshooting, the parameters are not constrained to the compliance values. Therefore, you must take care not to increase critical parameters beyond the ratings of the DUT. Note also that the parameters you apply should be calibrated with the corresponding instrument; however they are typically not calibrated with regard to your specific setup!

Demo Mode

When you close the connection dialog without connecting to the instruments, you enter the Demo Mode.

The Demo Mode is intended for demonstration purposes, where no actual hardware is available. Most functions will be available, but no instruments will be affected.

Applying

When changing any parameter in the user interface, you will have to apply those changes to the instruments by clicking the **Apply** button in the bottom left corner of the main window. This applies all parameters at once. Pressing [F6] on the keyboard has the same effect, as using the menu command **Apply** under the **Instruments** menu.

Many group boxes and windows have a dedicated "Apply" button, which only applies the parameters contained in that group or window.

There is also the menu command “Apply Pattern Only" to apply just the pattern while all other parameters remain unmodified. You can find this command under the **Instruments** menu. You can also press [Shift+F6] on your keyboard, or click the main **Apply** button while holding the shift-key.

Track bars (or sliders) are a special case. For example, there is a track bar in the **Voltage Levels** group box. When you move a track bar, the affected parameter is immediately applied to the hardware.

PCIe Physical Parameters

The corresponding controls are shown in Figure 14.

To test a PCIe DUT, you must define the PCIe specification revision, data rate and a DUT type. These parameters affect the available settings and the way calibration data is handled. For PCIe ASIC tests, you will also have to select the calibration channel.

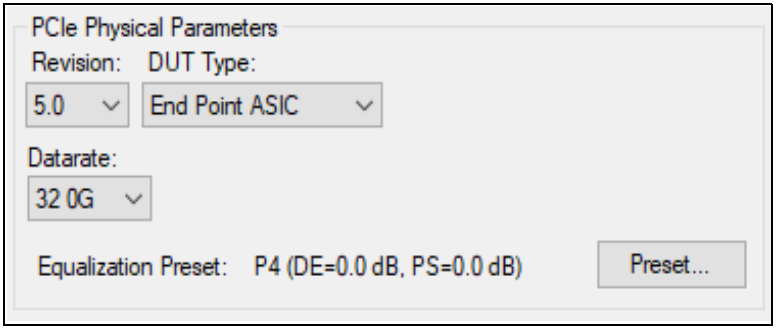

Figure 14 PCIe Physical Parameter Settings

When you change one of these settings, your instruments will automatically be re-configured.

The current preset is also shown. The **Preset...** button allows a preset to be selected from a list. The selected preset is applied to the de-emphasis parameters on the right side of the main window, and to the encoded preset hint in the "Loopback Pattern" box. When the de-emphasis levels on the right side of the main window are changed, the corresponding preset is shown in the Physical Parameters panel.

Link Training Pattern

The link training sequence is supposed to train the DUT into loopback. By default, it is generated automatically. However, you have the option to parameterize the sequence to adjust it to the DUT's needs.

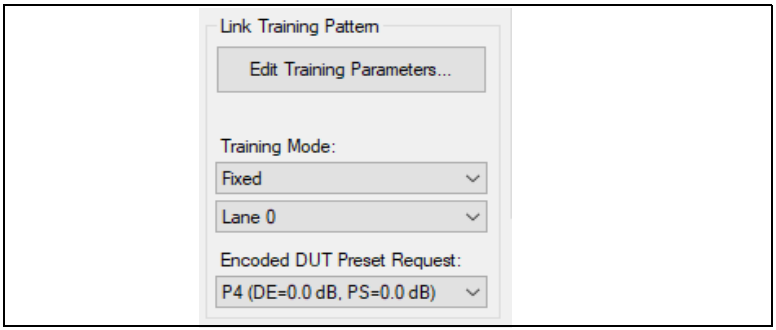

Figure 15 Link Training Pattern

There are two training modes: Fixed and Interactive.

In Fixed mode the training pattern is defined by several blocks, following the standard sequence described in the CTS.

In Interactive mode the training sequence consists of three blocks: "Link Down", a wait block, and "Link Up". The loopback training is managed by the J-BERT internally. It can run the link equalization phase to optimize the performance of the communication.

Edit Training Parameters in Fixed Mode

If you click **Edit Training Parameters...** (Figure 15) and Fixed mode is selected, you can adjust the number of packets transmitted for every stage of the link training (Figure 16).

The "Initial delay" is a sequence of zeros transmitted before the link training. By default, you will have to start the link training by exiting this block via the "Manual Trigger" button (main window). However, you can specify a time span instead.

The "Add EIEOS" check-box allows some EIEOS (Exit From Electrical Idle Ordered Sets) to be inserted before the loopback pattern starts. This is not required by the CTS, but might be helpful for some DUTs. Every 32nd TS1 ordered set will be replaced by an EIEOS. This number is fixed in order to match the J-BERT's pattern granularity.

All other parameters reflect the standard sequence described in the CTS. Note that "Min. initial TS1 count" and "Min TS1 count before Loopback" are only arbitrary numbers. The actual number of transmitted ordered sets might be slightly different in order to match the J-BERT pattern granularity.

There are two presets, which can be selected using the "Preset..." button. Trying both can be helpful for debugging. The "Optimized Parameters" is used as default, since it works with most DUTs. The "CTS Parameters" represent the link training procedure recommended by the CTS. However, this link training procedure might not work with every DUT.

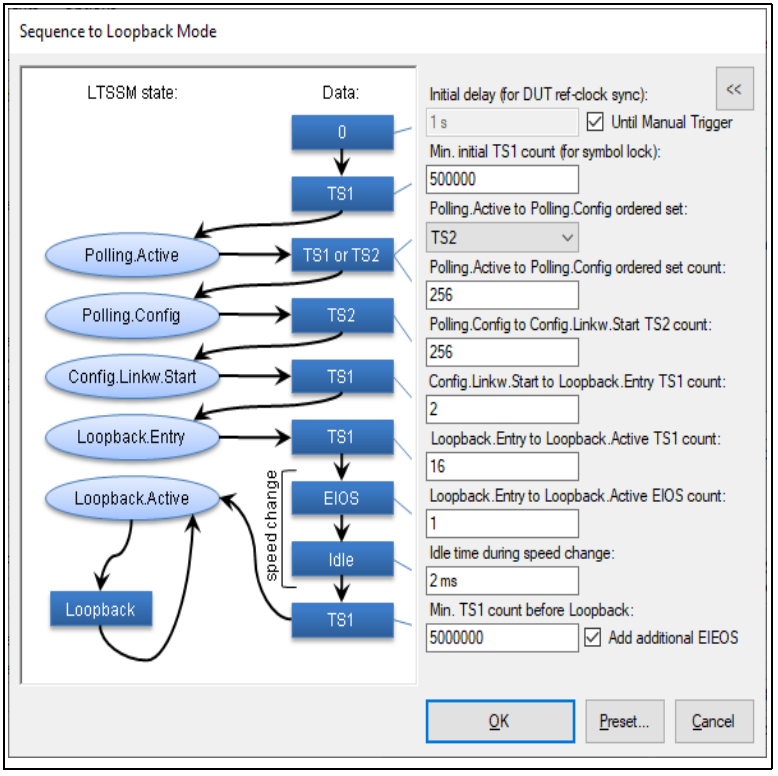

Figure 16 Sequence for Fixed Loopback Mode

Edit Training Parameters in Interactive Mode

In interactive mode, you also can adjust some link training parameters (Figure 14) by clicking on "Edit Training Parameters..." (Figure 17).

The "Generation", "DUT Type" and "Lane Number" must be selected in the main window in "PCIe Physical Parameters" and "Encoding Lane Number" respectively.

The "Link Number" is the number of the link encoded in the TS1/TS2 Training Ordered Sets.

For "Link EQ" there are three options:

- Bypass: In that case no equalization training is done and the equalization preset selected from the "PCIe Physical Parameters" is used for the whole link training and later in loopback mode.
- Preset Only: Only presets P0 to P9 can be requested from the DUT during the equalization training.
- Full: Any combination of pre-shoot and de-emphasis can be requested by the DUT during the equalization training,

The Speed Change Control specifies whether the speed change to Gen3 (i.e. 8 Gbps), Gen4 (i.e. 16 Gbps) or Gen5 (i.e. 32 Gbps) will be initiated by DUT or BERT during link training. It is only used when the BERT operates as a downstream device. If not specified DUT will initiate the speed change and will also request BERT for the same. It is only used for the DUT type as System Board.

The "Generator Start Preset" is the start preset for the link training at J-BERT output. It must be selected at the main window: "equalization preset" in "PCIe Physical Parameters".

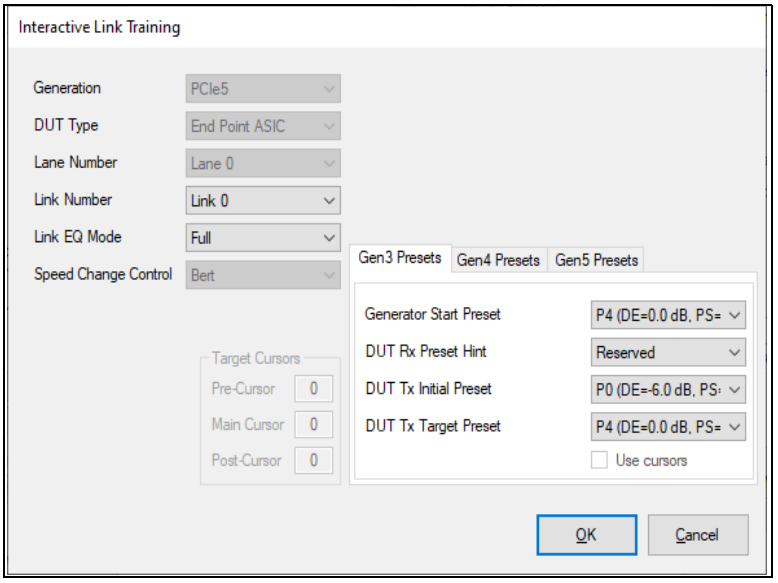

Figure 17 Interactive Link Training

The "DUT Rx Preset Hint" is the preset value that the J-BERT sends to the DUT as a Hint for the Rx Equalization value.

The "DUT Tx Initial Preset" is the preset which the DUT should use at the start of the equalization training.

The "DUT Target Preset" is the preset which the DUT should use to send out data after the Link Training. If the "Use cursor" option is unchecked, the target preset has to be selected at "Encoded DUT Preset Request" in the main window. If "Use cursors" is checked, the target preset it defined with the Pre-Cursor, Main-Cursor and Post-Cursor as shown in Figure 18.

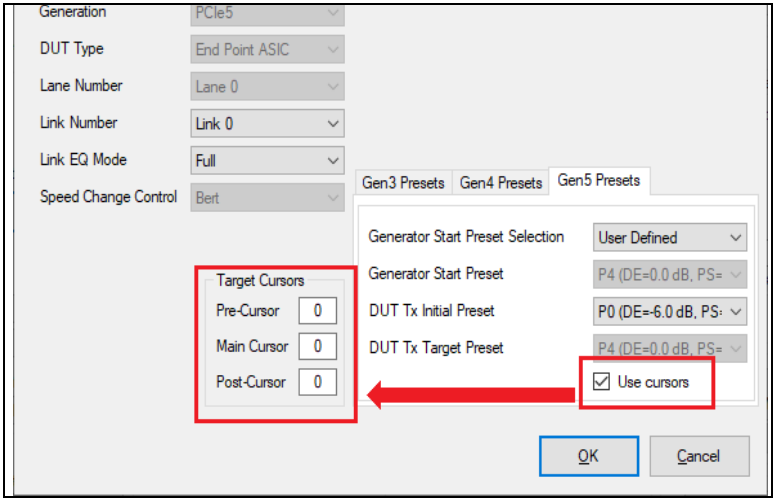

Figure 18 Target Cursors

The option "Encoded Lane Number" option (in the main window) allows you to define the lane number that is encoded in the training Pattern. The default value is "Lane 0". When you want to run link training on another physical port of the DUT, just connect that port to the J-BERT; the lane number can remain "Lane 0". However, some DUTs require the lane number to be set to the corresponding physical port number.

The option "Encoded DUT Preset Request" allows you to define the equalization preset that is requested for the DUT.

The option "Use Gen3 EIEOS" is available for Gen4. When a gen4 DUT is implemented against PCIe4 spec revision 0.5 it needs gen3 EIEOS for 16GT/s and this option should be selected. If it is implemented against PCIe4 spec revision 0.7 or higher it needs Gen4 EIEOS for 16GT/s.

Loopback Pattern

The pattern that is continuously transmitted in loopback mode can be defined in the "Loopback Pattern" box, as shown in Figure 19. You can select between the PCIe Compliance Pattern, the PCIe Modified Compliance Pattern, and a custom pattern file.

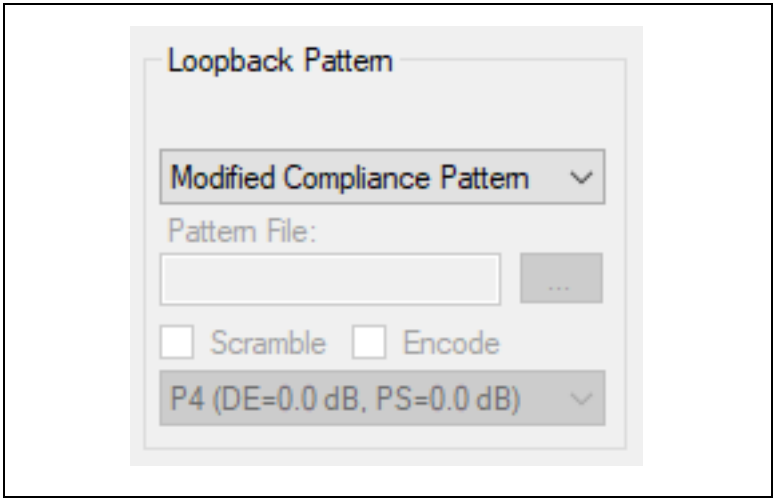

Figure 19 Loopback Patter Settings

In the simplest case, a custom pattern file can be a text-file containing only hexadecimal data.

NOTE The binary data represented by the custom pattern file must have a 512 bit granularity for M8040A and 80 bit for M8020A, otherwise the pattern cannot be loaded into the generator's pattern memory. The syntax of the selected file is automatically verified before the file can be used. For details about the syntax and the possibilities of custom pattern files, please refer to the "PCI Express Link Training Suite Language Guide".

When the Compliance Pattern is used, the generator's equalization preset hint is also encoded in the pattern. The encoded value can be manually changed.

Clock Tolerance Compensation

In this group box you can select how SKP ordered sets are inserted into the training and loopback pattern. By default, no extra SKP ordered sets are generated (except at points where the PCI Express specification explicitly requires them, e.g. in the Gen 3 modified compliance pattern).

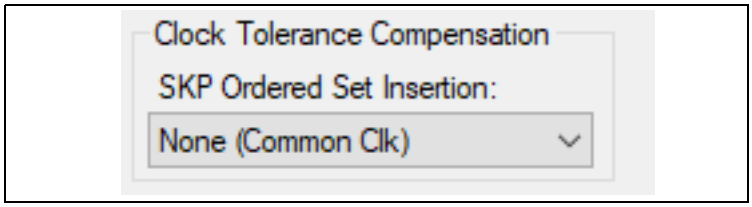

Figure 20 Clock Tolerance Compensation Settings

When the DUT has its own reference clock, and no SSC is used ("SRNS", Separate Reference Clocks with No SSC), SKP ordered sets must be inserted at an interval defined in the PCI Express specification. When the DUT has its own reference clock, and SSC is used on both the generator and the DUT side ("SRIS", Separate Reference Clocks with Independent SSC), SKP ordered sets must be inserted at even shorter intervals.

Changing the "SKP Ordered Set Insertion" option (Figure 20) defines how often SKP ordered sets are inserted. Note that the gap between two SKP ordered sets might be shorter than required by the specification, in order to fit the pattern into the J-BERT's pattern memory.

Note that when a custom loopback pattern is used, there are no SKP ordered sets inserted into the custom pattern.

Error Detector

By default, the J-BERT error detector compares all bits from the DUT with the loopback pattern. With the option "Filter SKP OS", SKP ordered sets can be excluded from bit comparison.

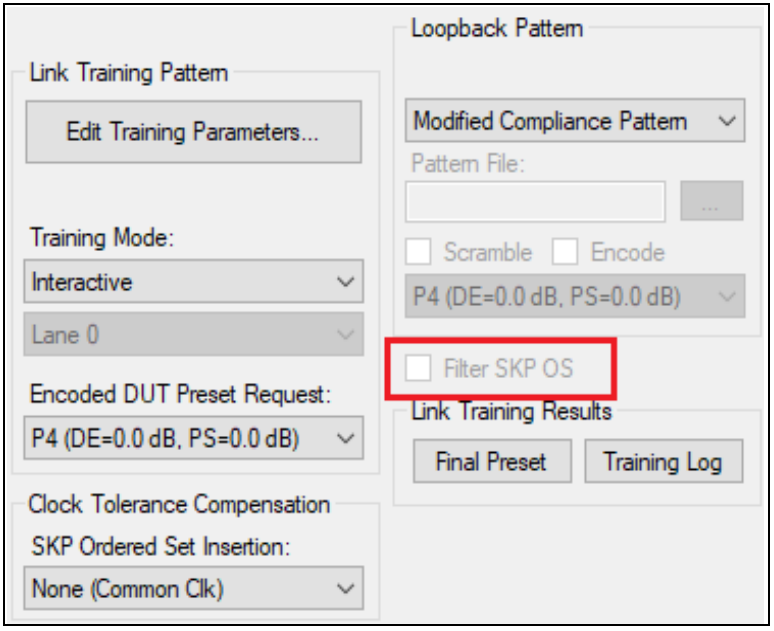

Figure 21 Error Detector Settings

This option (Figure 21) is usually required when the DUT uses its own reference clock.

Link Training Result

This section contains the result of the Interactive training mode (Figure 22).

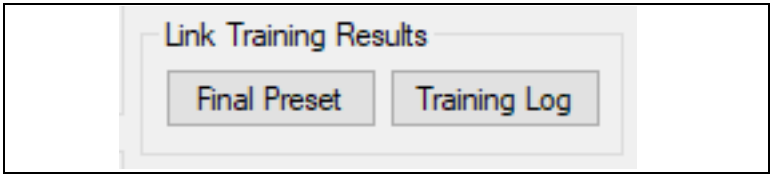

Figure 22 Link Training Suite Settings

If you click on the "Final Preset" button a dialog (Figure 23) shows the final pre-shoot, de-emphasis and preset after the training.

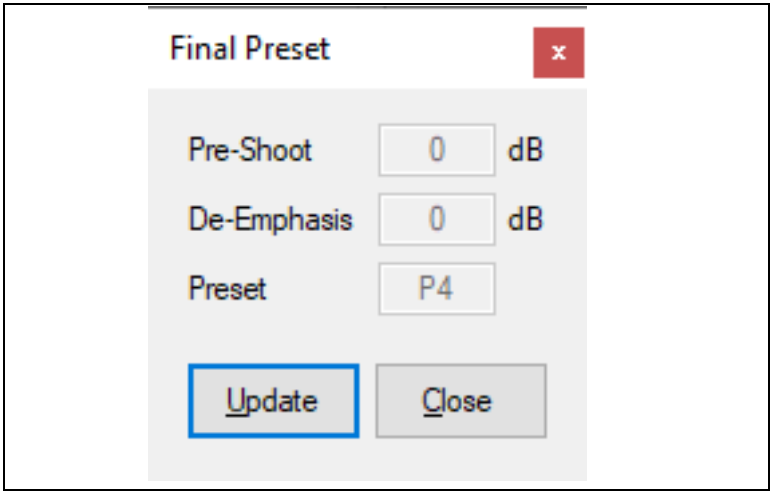

Figure 23 Final Preset dialog

Clicking on the "Training Log" button opens a window that presents a detailed log of the whole training process (Figure 24).

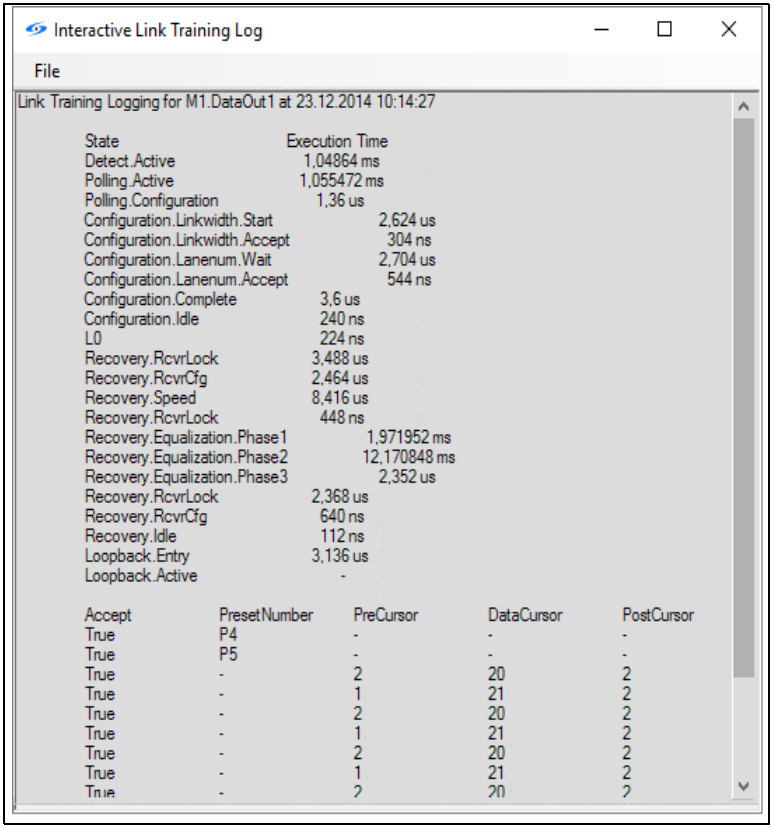

Figure 24 Training Log dialog

Power Switch

If the Power Switch is selected in the "Instrument Connection" dialog, this section will be visible in the main windows (Figure 25). Here you can turn the power off and on. This can be used to power-cycle the DUT

Figure 25 Power Switch Settings

Timing

Click on the "Timing Setup" button (Figure 26) to open the Timing Setup window as shown in Figure 27.

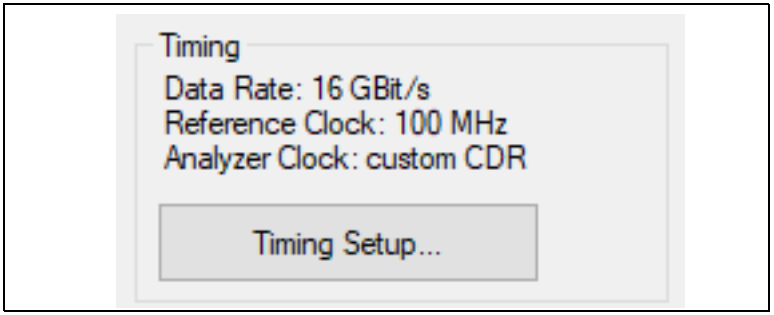

Figure 26 Timing Settings

Here you can define the data rate and add some deviation to it. The reference clock can also be modified, but keep in mind that the valid range and granularity is restricted by the J-BERT hardware.

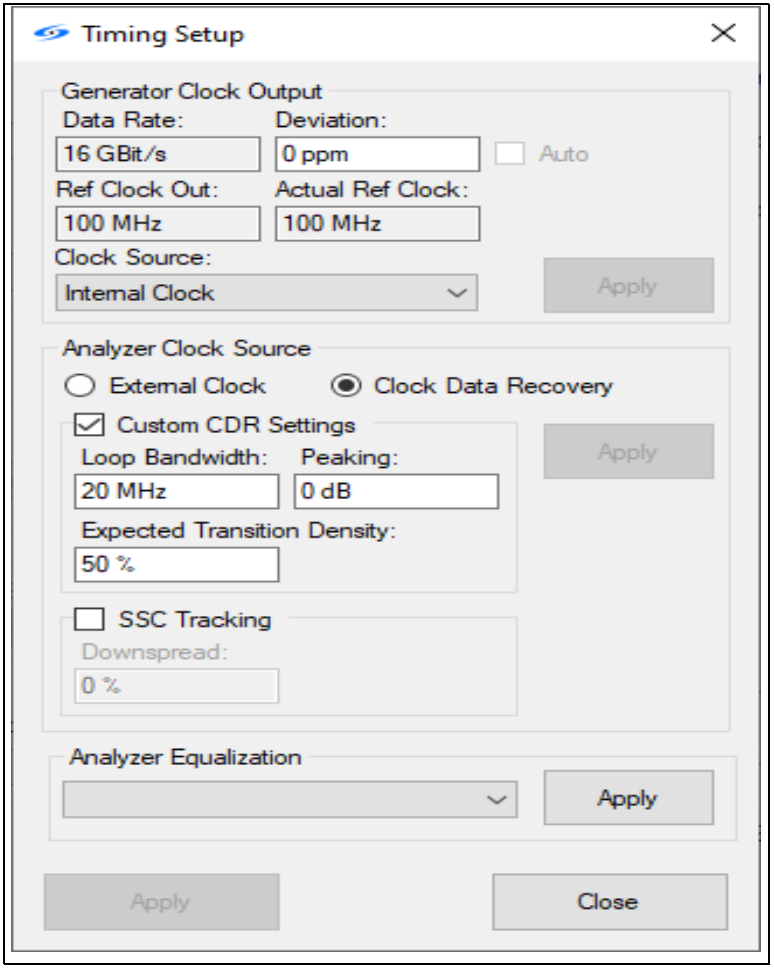

Figure 27 Timing Setup dialog

By default, the generator uses an internal clock source, or an external clock multiplier (N4880A) for system board tests. Note that the N4880A must be connected to the J-BERT and configured in order to be used.

You can configure the analyzer's clock to external clock or internal CDR. If internal CDR is selected, parameters such as Loop Bandwidth, Peaking, and Expected Transition Density can be modified

Jitter/SSC

Click "Jitter/SSC..." (see Figure 28) to open the Jitter Setup window (Figure 29).

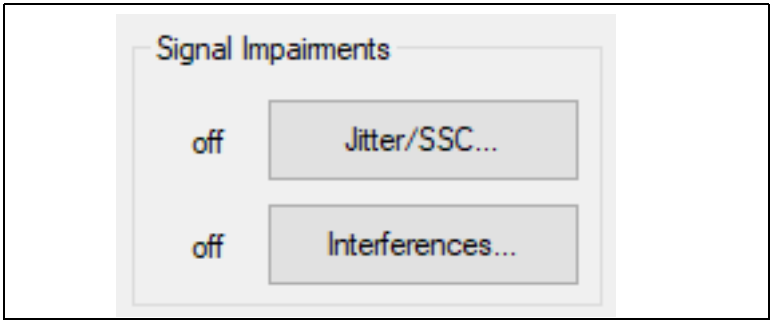

Figure 28 Signal Impairment settings

The dialog allows different types of jitter to be defined when the hardware jitter sources are available:

- Spread Spectrum Clocking
- Sinusoidal Clock Jitter
- Periodic Jitter
- Compliance Spectral RJ

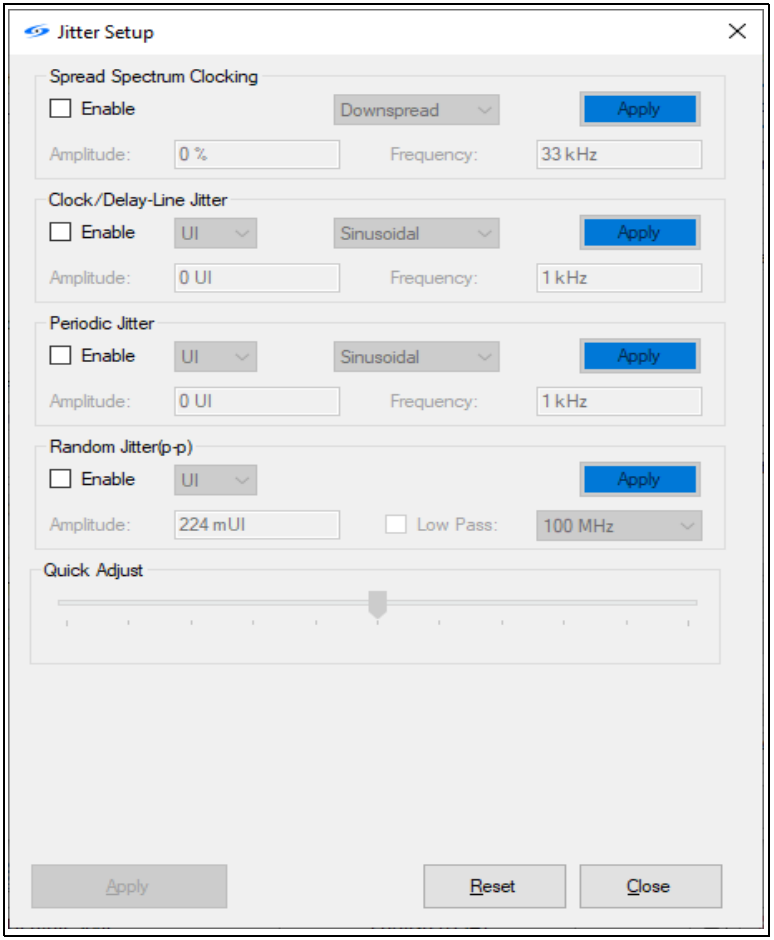

Figure 29 Jitter Setup dialog

Note that the composition of available jitter sources is different for every spec version and DUT type (which is selected in the main window in the "PCIe Physical Parameters" box).

Note that when any slider is moved, the corresponding parameter will be written to the hardware immediately. Otherwise, you will have to click the "Apply" button. When you change any parameter, e.?g. enter a new value into a text-box, the corresponding "Apply" button is highlighted. This means that you have to click "Apply" in order to activate your changes.

If you use calibration data, the compliance jitter values will use calibrated levels. However, jitter parameters that are not covered by the specification will not be calibrated.

Note that some jitter/SSC parameters will reset the sequencer when modified. This means that the current sequencer state is left and the link training is restarted. With the default settings, this means you will have to click the "Manual Trigger" button again to start link training. The PCIe Link Training Suite tries to minimize the sequencer resets as much as possible, but it is recommended that you keep an eye on the sequencer state when changing jitter or SSC parameters.

Interferences

Click the "Interferences..." button (Figure 28) to open the interferences window (Figure 30). You can modify the common-mode and differential-mode sinusoidal interferences.

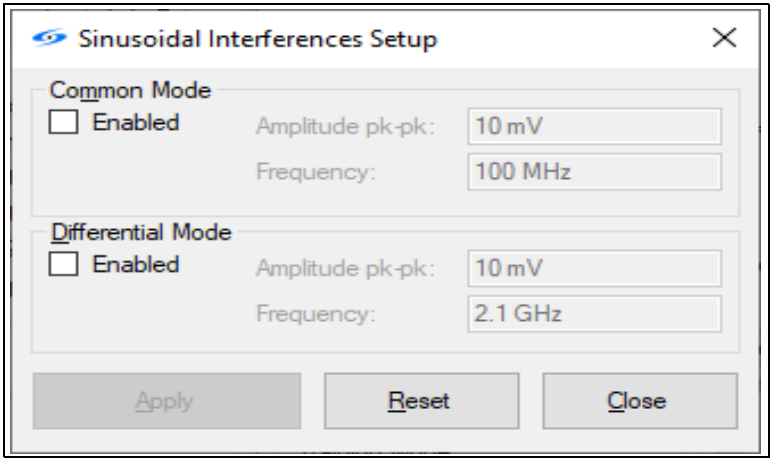

Figure 30 Interferences Setup dialog

If no AWG connected, common-mode interference is generated with the J-BERT J20 module. Using the J20 is less accurate and cannot be combined with differential-mode interference. Be sure to have the AWG/J20 connected properly.

If you use calibration data, the compliance interference values will use calibrated levels.

Voltage Levels

You can set the voltage levels for every output independently. Note that when any slider is moved, the corresponding parameter will be written to the hardware immediately. Otherwise, you will have to click the "Apply Levels" button. Note that the "Apply Levels" button also applies the de-emphasis levels (if available).

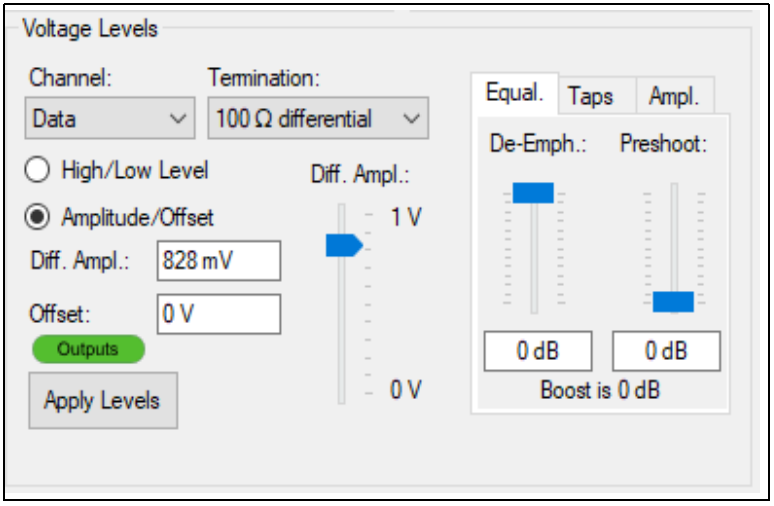

Figure 31 Voltage Levels and De-Emphasis Settings

You can also use the "Apply" button in the lower left corner of the window to apply all parameters at once. Alternatively, you can click the "Apply" command under the "Instruments" menu, or press F6 on your keyboard.

Clicking on the "Outputs" button will turn on/off the J-BERT outputs. If the button is in green color means that the outputs of the J-BERT are turn on and if is in red color means that the outputs are turn off.

DeEmphasis

You can control the de-emphasis and preshoot levels as shown in Figure 31.

The tabs let you select between three different views:

- de-emphasis and pre-shoot in dB
- FIR tap coefficients
- emphasized and de-emphasized voltage levels

Note that when any slider is moved, the corresponding parameter will be written to the hardware immediately. Otherwise, you will have to click the "Apply" or "Apply Levels" button

Bit Error Rate Measurement

You can click the "Start BER Measurement" (Figure 32) in the right part of the window to automatically poll the J-BERT's bit and error counters. By default, the displayed BER (Bit Error Rate) is calculated from the total number of bits and total number of errors. You can click the button on the left side of the BER display to toggle to the current BER, which is the calculated BER of the last error counter reading. Note that neither of these number is necessarily always equal to the BER displayed in the J-BERT, since the measurement intervals might be different.

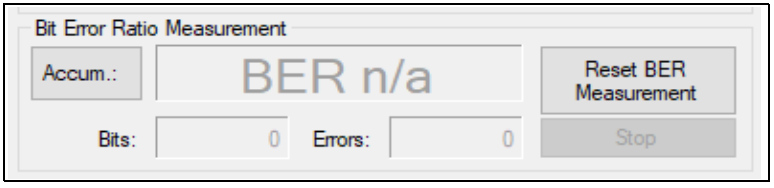

Figure 32 Bit Error Ratio Measurement Settings

You can click "Reset BER Measurement" to reset the bit and error counters.

The BER can be used to determine whether link training was successful or not. A very high BER and increasing error count could indicate that no link training was performed, because the error counter is always programmed to only compare the loopback pattern.

Sequencer

The group box in Figure 33 shows the sequencer control.

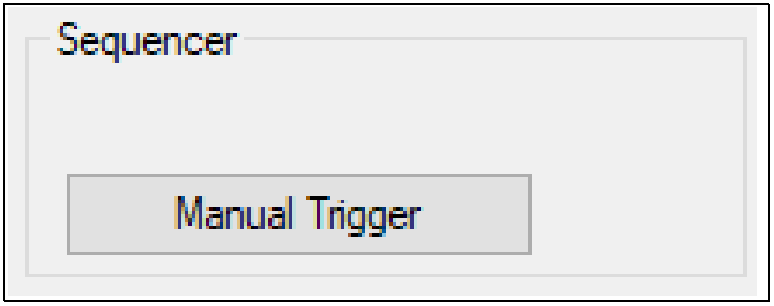

Figure 33 Sequencer Settings

When the "Poll Sequence State" option in the "Options" menu is enabled, the current state of the sequencer is shown.

When the sequence contains a loop with a manual break condition, that loop can be ended with the "Manual Trigger" button.

BERT Control

Figure 34 shows the BERT control. Here you can control the sequencer, the pattern generator, and the analyzer.

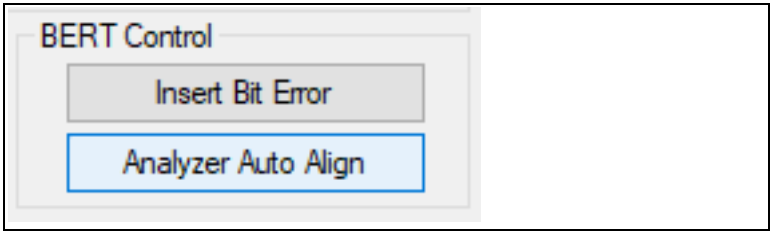

Figure 34 BERT Control Settings

The "Insert Bit Error" causes the J-BERT to insert a single bit error into the data stream. This can be useful to verify that the DUT is in loopback; when the DUT is not in loopback, inserting bit errors does not affect the bit error and BER counters.

You can use the "Auto Align" button to force the analyzer to auto-align to the incoming data. This is usually necessary after the pattern generator was restarted, e.g. when a new pattern was downloaded.

Saving and Loading Settings

You can store the current settings using the "Apply and Save..." button in the main window, or via the main menu. Note that before the settings are saved, they are applied to the hardware. Only if applying succeeds can the settings be saved. This guarantees that only those settings that are in a consistent state can be saved.

The settings can be restored at any time using the "Load and Apply..." button. The restored settings are then immediately applied to the hardware.

Expert Mode

In the "Options" menu, you can enable "Expert Mode". This mode is recommended for advanced users and offers some more parameters to modify. The main advantage of the Expert Mode is the possibility of editing the link training sequence and pattern using a special script.

Exporting the Scripts

Once you have found a link training sequence suitable for the DUT, you may want to export that sequence, either for later use or to the automated test solution software.

To export the current script, click "File", then "Export Script". This saves the currently used script for the training sequence to a file, regardless of whether you defined it via parameters or by editing the PCIe generic script. Please refer to the next section for details of the scripts.

Script Editing

The main advantage of the Expert Mode is the ability to edit the link training sequence and pattern using a script. This allows you to define virtually any kind of pattern, whereas the methods mentioned earlier in this document only allow those patterns to be generated that are in sync with the PCIe link training methodology.

In order to be able to edit the script, Expert Mode must be enabled, and the script must be defined as the source of the pattern. By default, the pattern that is downloaded to the J-BERT is defined via parameters, such as the ones contained in the "Link Training Pattern" box. However, in Expert Mode the group box "Pattern/Sequence Script" becomes available (Figure 35).

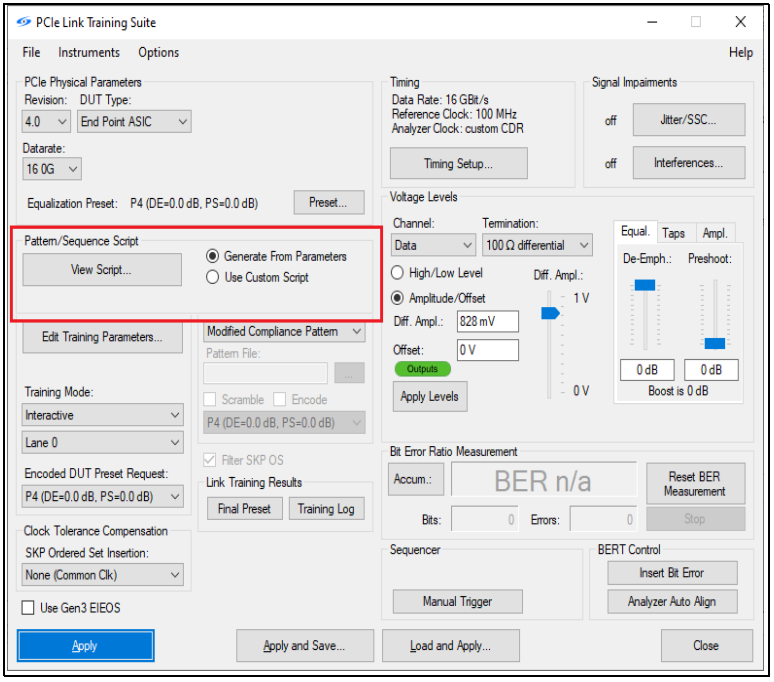

Figure 35 Expert Mode

When the radio button "Generate From Parameters" is checked, the pattern will be automatically generated, that is, in the same way as in non-Expert Mode. When the radio button "Use Custom Script" is checked (see Figure 36), a custom script will be used. The parameters for the automatically generated script are disabled then and have no influence.

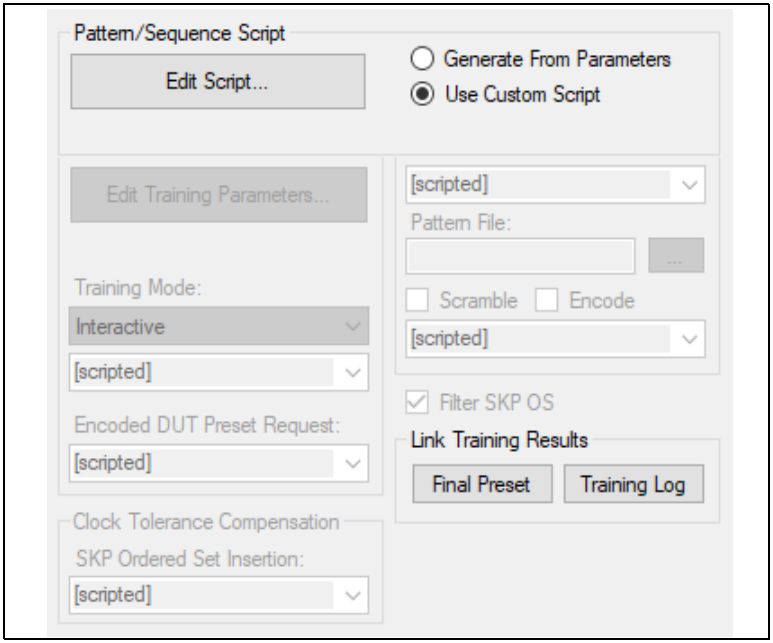

Figure 36 Expert Mode with Custom Script

To edit the script, click the "Edit Script" button. The script editor, as shown in Figure 37, will pop up. In the script editor, you can edit the sequence and pattern, with a unified syntax. It allows you to define the data using terms common to PCIe. For example, to generate a TS1 ordered set with the loopback flag set, you can use the macro "TS1(Loopback)". You can also use the menu to convert pattern data between different representations (binary, hexadecimal, 8b/10b).

Clicking the "Process PCIe Macros" button starts a script translation, where all PCIe specific macros and symbol names are converted into their binary, 8b/10b, or 128b/130b representation.

When the automatically generated script is used, the "Edit Script" button will change to "View Script". In that case, the script can only be changed by modifying the parameters in the main window

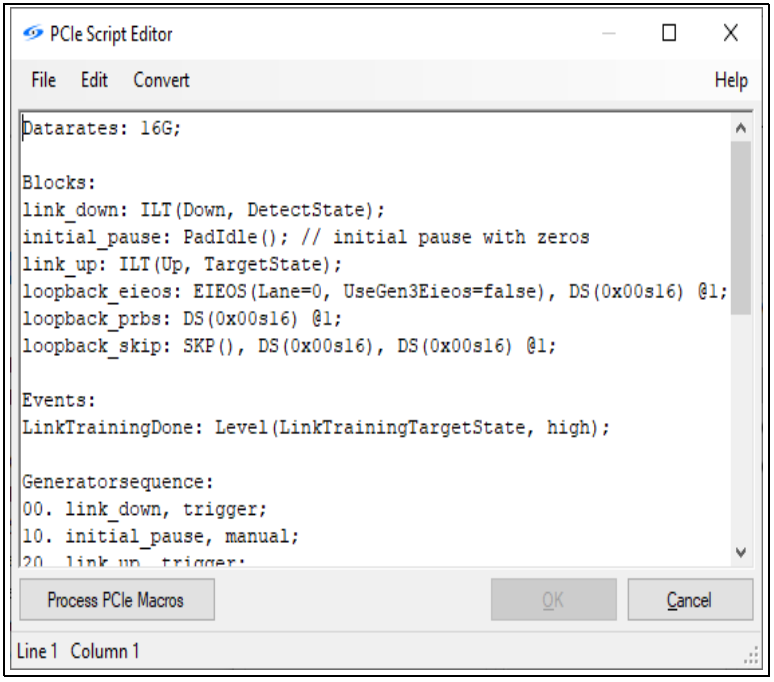

Figure 37 Script Editor

Limitations

When editing the script, the resulting pattern must meet the J-BERT"s granularity requirements (512 bits for M8040A J-BERT and 80 bits for M8020A J-BERT).

If the pattern you want to define does not fit this granularity, you could, for example, repeat the pattern until the granularity requirement is met (using the {} operator), or place a Pad0() macro somewhere to fill the pattern with zeros.

For more details, please refer to the "PCI Express Link Training Suite Language Guide".

5 Troubleshooting

Startup Fails / 56
Slow Response / 57
Loopback Training Fails / 58

Startup Fails

The anti-virus software Sophos Endpoint Security might mistakenly classify the PCIe Link Training Suite as a virus and prevent it from executing. Starting the Link Training Suite then leads to an error message such as

"Windows cannot access the specified device, path, or file". In this case, please check whether the anti-virus software has blocked the executable file of the PCIe Link Training Suite and add it to the exceptions if necessary. Note that you will probably have to repeat this procedure for some of the DLLs.

Slow Response

If you encounter a slow response of the PCIe Link Training Suite user interface, this might be a result of a poor remote connection. Probably the delay over Ethernet is too high.

In most cases, it helps if you disable the BER polling and the sequencer status polling. The BER polling can be disabled by simply clicking the "Stop" button in the "Bit Error Rate Measurement" group. The sequencer state polling can be disabled by un-checking the "Poll Sequence Status" item in the "Options" menu.

Loopback Training Fails

If link training fails, you might want to check the following points:

- Did you click **Apply** after connecting and adjusting all your parameters? Note that just connecting doesn't automatically download the pattern and settings!
- Is the injected jitter too high? Try reducing or disabling the injected jitter in the "Jitter/SSC" dialog.
- Are the timing, the voltage levels, and the de-emphasis correct?
- Is the selected link training sequence suitable for your DUT? Probably using a tweaked sequence will help your DUT to get into loopback. Try the "Preset..." button in the "Sequence to Loopback Mode" dialog. This dialog opens when you click "Edit Parameters..." in the "PCIe Training Parameters" group of the main window.

This information is subject to
change without notice.
© Keysight Technologies 2019
Edition 1.0, December 2019

www.keysight.com

KEYSIGHT
TECHNOLOGIES