



# **Agilent Protocol Exerciser for PCI Express**

## **User's Guide**



**Agilent Technologies**

# Notices

© Agilent Technologies, Inc. 2010

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 Agilent Technologies, Inc. as governed by United States and international copyright laws.

## Trademarks

Windows 2000<sup>®</sup>, Windows XP<sup>®</sup>, and Microsoft .NET Framework 1.1<sup>®</sup> are U.S. registered trademarks of Microsoft Corporation.

## Installation Guides

You can find the installation guides for different components of the product on the product CD. Agilent recommends you to do not switch on the instrument before you have understood all the applicable installation instructions and have met all the installation prerequisites.

## Where to find more information

You can find more information about Protocol Analyzer from the following link:

<http://www.agilent.com/find/spt>

For further assistance, you can search for a local contact on the following link:

<http://www.agilent.com/find/assist>

## 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, Agilent 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. Agilent shall not be liable for errors or for incidental or consequential damages in connection with the furnishing, use, or performance of this document or of any information contained herein. Should Agilent 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 shall control.**

## 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.

## Restricted Rights Legend

If software is for use in the performance of a U.S. Government prime contract or subcontract, Software is delivered and licensed as “Commercial computer software” as defined in DFAR 252.227-7014 (June 1995), or as a “commercial item” as defined in FAR 2.101(a) or as “Restricted computer software” as defined in FAR 52.227-19 (June 1987) or any equivalent agency regulation or contract clause. Use, duplication or disclosure of Software is subject to Agilent Technologies’ standard commercial license terms, and non-DOD Departments and Agencies of the U.S. Government will receive no greater than Restricted Rights as defined in FAR 52.227-19(c)(1-2) (June 1987). U.S. Government users will receive no greater than Limited Rights as defined in FAR 52.227-14

(June 1987) or DFAR 252.227-7015 (b)(2) (November 1995), as applicable in any technical data.

## 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.

---

## Safety Symbols on Instruments



Indicates warning or caution. If you see this symbol on a product, you must refer to the manuals for specific Warning or Caution information to avoid personal injury or damage to the product.



Frame or chassis ground terminal. Typically connects to the equipment's metal frame.



Indicates hazardous voltages and potential for electrical shock.



Indicates that antistatic precautions should be taken.



Indicates hot surface. Please do not touch.



Indicates laser radiation turned on.



CSA is the Canadian certification mark to demonstrate compliance with the Safety requirements.



CE compliance marking to the EU Safety and EMC Directives.

ISM GRP-1A classification according to the international EMC standard.

ICES/NMB-001 compliance marking to the Canadian EMC standard.

# Safety Summary

## General Safety Precautions

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument.

Agilent Technologies Inc. assumes no liability for the customer's failure to comply with these requirements.

Before operation, review the instrument and manual for safety markings and instructions. You must follow these to ensure safe operation and to maintain the instrument in safe condition.

## General

This product is a Safety Class 1 instrument (provided with a protective earth terminal). The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

All Light Emitting Diodes (LEDs) used in this product are Class 1 LEDs as per IEC 60825-1.

## Environment Conditions

This instrument is intended for indoor use in an installation category II, pollution degree 2 environment. It is designed to operate at a maximum relative humidity of 95% and at altitudes of up to 2000 meters.

Refer to the specifications tables for the ac mains voltage requirements and ambient operating temperature range.

## Before Applying Power

Verify that all safety precautions are taken. The power cable inlet of the instrument serves as a device to disconnect from the mains in case of hazard. The instrument must be positioned so that the operator can easily access the power cable inlet. When the instrument is rack mounted the rack must be provided with an easily accessible mains switch.

## Ground the Instrument

To minimize shock hazard, the instrument chassis and cover must be connected to an electrical protective earth ground. The instrument must be connected to the ac power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

## Do Not Operate in an Explosive Atmosphere


Do not operate the instrument in the presence of flammable gases or fumes.

## Do Not Remove the Instrument Cover

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified personnel.

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

## Environmental Information

	<p>This product complies with the WEEE Directive (2002/96/EC) marking requirements. The affixed label indicates that you must not discard this electrical/ electronic product in domestic household waste.</p> <p><i>Product Category: With reference to the equipment types in the WEEE Directive Annex I, this product is classed as a "Monitoring and Control instrumentation" product.</i></p> <p><b><i>Do not dispose in domestic household waste.</i></b></p> <p><b><i>To return unwanted products, contact your local Agilent office, or see <a href="http://www.agilent.com/environment/product/">www.agilent.com/environment/product/</a> for more information.</i></b></p>
---	--

## Printing History

Agilent Technologies, Inc. can issue revisions between the product releases to reflect the latest and correct information in the guide. Agilent Technologies, Inc. also reserves its right to not issue a new edition of the guide for every system release.

The name of the guide and its part number are:

**Manual Name:** Agilent Protocol Exerciser for PCI Express - User's Guide

**Manual Part Number:** N5308A-91010

The edition number of the guide, publishing time of the guide, and applicable release number of the product are given in the following table.

<b>Edition</b>	<b>Published</b>	<b>Applicable Release</b>
1	June, 2010	8.1

# Contents

## What's New in this Release

### 1 Agilent Protocol Exerciser for PCI Express - Introduction

What is Protocol Exerciser for PCI Express	14
Features of Protocol Exerciser	15
Emulation Modes	15
Protocol Exerciser for PCI Express Modes (As Exerciser and as LTSSM)	17
When to use Protocol Exerciser for PCI Express	18
Protocol Exerciser for PCI Express Components	19
Hardware Components	19
Software Components	20

### 2 Getting Started with Protocol Exerciser

Creating a Protocol Exerciser Session	22
Protocol Exerciser Online mode	22
Protocol Exerciser Offline mode	23
Creating/Using a Protocol Exerciser Session	23
Starting and Exiting the Protocol Exerciser GUI	26
Protocol Exerciser GUI Components	28
Viewing and Updating the Protocol Exerciser Hardware Status	30
Managing Floating Windows	32

### 3 Configuring Protocol Exerciser

Creating and Managing Protocol Exerciser Setup Files	36
Configuring a PCIe Link Settings	37
Configuring Lane Settings	39
Configuring Equalization Procedure Settings	41
Transmitter Based Equalization (De-emphasis) for 5.0 GT/s speed	41
Equalization for 8.0 GT/s speed	42
Autonomous equalization	42
Software based equalization	43
Configuring Equalization settings	44
Configuring Transceiver Settings	46
Configuring External Triggers Settings	47

## 4 Initializing and Managing a PCIe Link

Initializing and training a PCIe Link between Protocol Exerciser and DUT	50
Training a PCIe Link	50
Verifying PCIe Link Training	51
Retraining a PCIe Link between Protocol Exerciser and DUT	53
Initiating Link Speed Change on a Configured Link	54

## 5 Testing DUT's LTSSM Functions

LTSSM	56
LTSSM Functions	56
LTSSM States	56
LTSSM Tester - Introduction	58
Protocol Exerciser as a USC and a DSC in context of LTSSM testing	58
LTSSM Tester Features	59
When to Use LTSSM Tester	60
LTSSM Supported States	60
How LTSSM Tester Works	62
Getting Started with LTSSM Tester	65
Accessing LTSSM Tester	65
Prerequisites for LTSSM Testing	67
Testing Link Initialization, Training, and Management	68
LTSSM Tests	68
Testing Link Training	69
Testing Link Speed Changes	74
Testing Link Retraining and Recovery	80
Testing LTSSM State Transitions	81

## 6 Protocol Exerciser GUI Reference

Dialog Boxes	84
Open dialog box	84
Port Selection dialog box	84
Save dialog box	85
Select type of connection dialog box	85
Menus	87
Action Menu	87
Edit Menu	87
File Menu	87
Help Menu	88
View Menu	88



Windows	90
General Function Equalization Settings tab	90
General Function Lane Settings tab	91
General Function Link Settings tab	92
General Function Symbol Settings tab	93
General Function Transceiver Settings tab	94
General function - Trigger Out tab	94
LTSSM Tests	95
Protocol Checker function	97

## **7 Performing Protocol Checks**

Using Protocol Checker	100
Supported Protocol Checks	101

## **A Updating the Firmware**

Using the Firmware Update Tool	104
--------------------------------	-----

## **Index**





## What's New in this Release

This is the first release of Agilent Protocol Exerciser for PCI Express for Gen3 PCIe devices. The LTSSM Tester tool is the focus of this release for effective and thorough link testing. The following are the new/key features of this release of the product.

- Testing link negotiation, initialization and training according to the PCIe specifications for Gen1, Gen2, and Gen3 PCIe devices.
- Support for training sequences exchange at 8.0 GT/s, 5 GT/s or 2.5 GT/s speeds on all lanes for link width up to x16.
- Gen3 LTSSM state transitions available while performing LTSSM functions.
- Support for training the link to Gen3 (8.0 GT/s) with options to test with 1st phase or all phases of Equalization or without Equalization.
- Link speed upgrade and downgrade across the Gen1, Gen2, and Gen3 speeds on a configured link.



## **0** What's New in this Release



# 1 Agilent Protocol Exerciser for PCI Express - Introduction

**What is Protocol Exerciser for PCI Express 14**

**Protocol Exerciser for PCI Express Modes (As Exerciser and as  
LTSSM) 17**

**When to use Protocol Exerciser for PCI Express 18**

**Protocol Exerciser for PCI Express Components 19**

This chapter introduces you to Protocol Exerciser for PCI Express and provides information on its emulation modes, features, uses, and its hardware and software components.

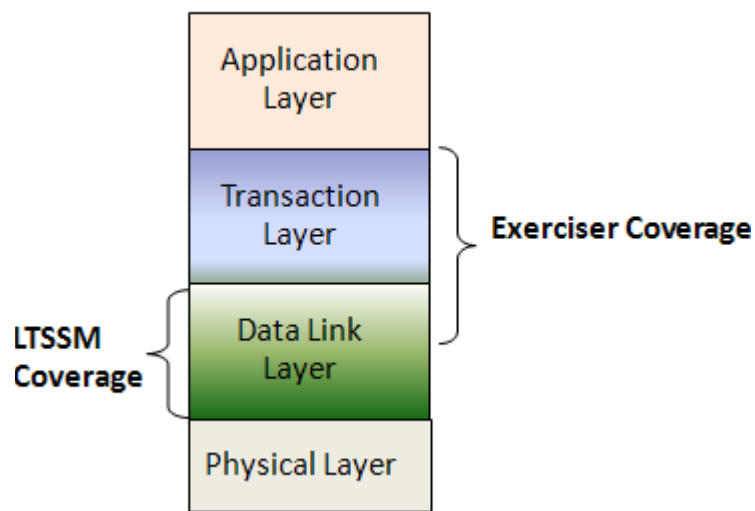


## What is Protocol Exerciser for PCI Express

Agilent Protocol Exerciser for PCI Express (PCIe) provides a test and debug solution for PCI Express, helping the industry to test the next generation of PCI Express technology. It can emulate any PCIe device and topology and can provide test conditions to test components on system boards and cards.

Protocol Exerciser can function as an Exerciser and a Link Training and Status State Machine (LTSSM) with a PCIe system or a PCIe device under test. This release of Protocol Exerciser focuses on its LTSSM mode and supports all the necessary LTSSM functions to test a DUT's LTSSM under various scenarios. The subsequent releases of Protocol Exerciser will increment its features as an Exerciser as well.

The following figure illustrates its coverage in terms of the OSI standard model.



**Figure 1** Protocol Exerciser coverage

Refer to the topic [Protocol Exerciser for PCI Express Modes \(As Exerciser and as LTSSM\)](#) on page 17 to know more about its functions as an Exerciser and an LTSSM.

## Features of Protocol Exerciser

A brief list of the features of Protocol Exerciser is given below:

- Performs link negotiation, initialization and training, data link layer functions, and handles incoming requests according to the Gen3 specifications.
- Addresses the industry's need for LTSSM testing by providing the LTSSM Tester tool for effective link negotiation testing:
  - Thorough link testing with LTSSM Tester.
  - Exercising DUT with the x16 Protocol Exerciser.
- Generates training sequences at 8.0 GT/s, 5 GT/s, and 2.5 GT/s speed on all lanes for link width up to x16, which allows effective link negotiation testing.
- Enables root complex emulation, Endpoint emulation, and add-in card testing at link widths x1 to x16.
- Enables you to perform protocol checks by selecting the PCIe protocol rules that you want to observe for violation.

## Emulation Modes

The Agilent Protocol Exerciser for PCI-Express can emulate a PCI Express end point (as a DSC) to exercise the System Under Test (SUT) acting as a root complex. It can also act as a root complex (USC) to test a PCI Express end point. In both cases, a controlling system is needed that hosts the Protocol Exerciser software to manage and control the Exerciser card.

### As an endpoint

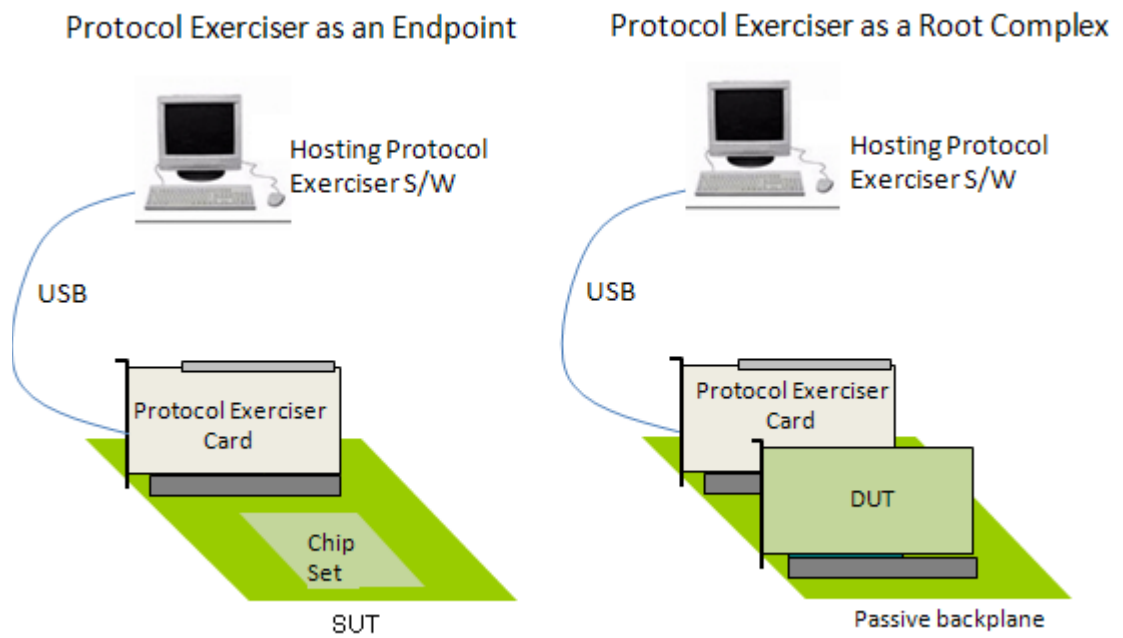
In this mode, the Agilent Gen3 exerciser card is plugged into the motherboard, as a normal PCIe device. You can use multiple exerciser cards to load and stress a server system under test. You can connect up to four Exerciser cards to one system controller through USB.

### As a root complex

In this case, the exerciser communicates to the DUT through the backplane board. When you use the backplane, Protocol Exerciser communicates to the DUT through the bottom connectors.

Another way is to connect the DUT through the top connector daughter board. In this mode, the link width would be limited. However, this would be the preferred test method of compliance test, in order to limit the link width.

The following figure demonstrates a sample setup of a Protocol Exerciser card emulating an endpoint and a root complex.



**Figure 2** Protocol Exerciser Card Sample Setups

**NOTE**

Refer to the Installation guide for the Protocol Exerciser for PCIe Express to know how to set up the Protocol Exerciser hardware to emulate as a root complex or as a PCIe endpoint.



## Protocol Exerciser for PCI Express Modes (As Exerciser and as LTSSM)

Protocol Exerciser can function as an Exerciser as well as an LTSSM.

As an LTSSM, you can use it for thorough link testing with DUT and exchanging training sequences to test and validate LTSSM state transitions.

As an Exerciser, it exercises DUT with appropriate PCIe traffic.

This release of Protocol Exerciser focuses on its LTSSM mode and supports all the necessary LTSSM functions to test a DUT's LTSSM under various scenarios. The subsequent releases of Protocol Exerciser will increment its features as an Exerciser as well.

To know more about its LTSSM mode and how to use it for LTSSM testing, refer to the chapter [Testing Link Initialization, Training, and Management](#) on page 68.

## When to use Protocol Exerciser for PCI Express

### Usage as a Protocol Exerciser

By emulating a PCIe endpoint or a root complex, Protocol Exerciser acts as an ideal link partner by sending appropriate I/O traffic to stimulate the DUT. This way, it can help you test DUT under various conditions and scenarios without influencing the performance parameters of DUT.

### Usage as an LTSSM

One of the key challenges with PCI Express is the validation testing for the LTSSM functions and thorough link testing supporting the Gen3 high speed. Protocol Exerciser in its mode as an LTSSM provides you LTSSM functions to test DUT's LTSSM. You can use various LTSSM tests that it provides to force DUT into various LTSSM states and verify the state transitions and timeout implementations.

In this release, Protocol Exerciser is used primarily for LTSSM testing.

To know more about its usage as an LTSSM, refer to the topic [When to Use LTSSM Tester](#) on page 60.

## Protocol Exerciser for PCI Express Components

This topic describes the hardware and software components of Protocol Exerciser.

### Hardware Components

#### U4305A Exerciser Card

The U4305A Exerciser card acts as both a Protocol Exerciser as well as an LTSSM for upto x16 link widths. This card supports simultaneously use of LTSSM and Protocol Exerciser functions, without requiring any configuration. For this release, you can use this card to perform LTSSM testing.

The following figure shows the U4305A exerciser card.



**Figure 3** U4305A Exerciser Card

#### NOTE

Refer to the Hardware guide for the Protocol Exerciser for PCIe Express to know more about the U4305A Exerciser card.

While setting up the hardware for Protocol Exerciser, you can mount this card on the System under Test (SUT) to stimulate SUT with PCIe testing scenarios. You can also set up this card as a root complex by mounting it on the backplane board and communicating with the DUT through this passive backplane.

### NOTE

Refer to the Installation guide for the Protocol Exerciser for PCIe Express to know how to set up the Protocol Exerciser hardware to emulate as a root complex or as a PCIe endpoint.

---

## Software Components

When you install Protocol Exerciser, the following software components are installed.

- **Protocol Exerciser GUI** - You can use the Protocol Exerciser GUI to control, manage, and use the Protocol Exerciser card. Following are the primary functions of the Protocol Exerciser GUI.
  - Create and manage setup files for Protocol Exerciser
  - Create a link between DUT and Protocol Exerciser
  - Run LTSSM tests provided to test DUT's LTSSM functions
  - View and update the link and Exerciser hardware status

To know about the Protocol Exerciser GUI components, refer to the topic [Protocol Exerciser GUI Components](#) on page 28.

- **Protocol Exerciser API** - Protocol Exerciser provides a set of APIs to allow you to control, manage, and use Protocol Exerciser programmatically through these APIs. Refer to the API Reference guide to know about the usage of these APIs.
- **Firmware Update tool** - You use this tool to update the Firmware version for an Exerciser card. To know more, refer to the topic, [Using the Firmware Update Tool](#) on page 104.

### NOTE

This guide covers only the GUI aspect of Protocol Exerciser. For information on API, please refer to the API Reference guide.

---



## 2 Getting Started with Protocol Exerciser

<b>Creating a Protocol Exerciser Session</b>	<b>22</b>
<b>Starting and Exiting the Protocol Exerciser GUI</b>	<b>26</b>
<b>Protocol Exerciser GUI Components</b>	<b>28</b>
<b>Viewing and Updating the Protocol Exerciser Hardware Status</b>	<b>30</b>
<b>Managing Floating Windows</b>	<b>32</b>

This chapter describes the tasks that you should perform before you get started with using Protocol Exerciser to test a DUT. This chapter also introduces you to the main screen components of the Protocol Exerciser application and how to access it.



## Creating a Protocol Exerciser Session

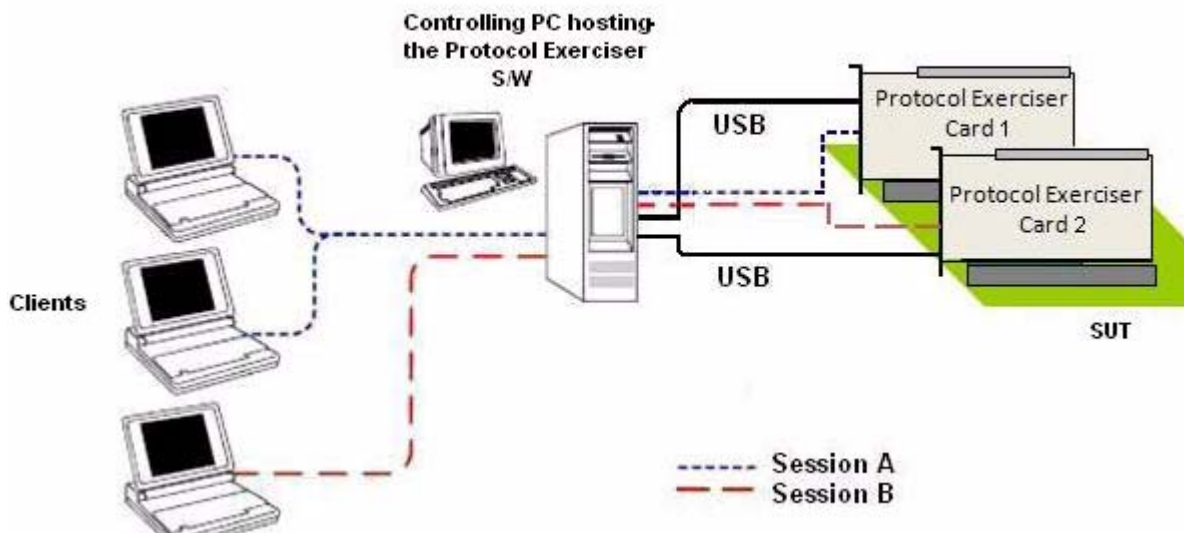
You can access Protocol Exerciser in either Offline or Online mode. This topic describes the Offline and Online modes of using the Protocol Exerciser GUI.

### Protocol Exerciser Online mode

When you want to use Protocol Exerciser in an online mode, you either create a new Protocol Exerciser session with the controller PC or use an existing session on the controller PC. A controller PC hosts the Protocol Exerciser software and hardware support services and connects to the Exerciser card(s) through a USB. A Protocol Exerciser session forms the basis of communication between the controller PC and exerciser cards, and also initializes the necessary firmware. Once a session is created, you can control and manage the installed exerciser card(s) using the Protocol Exerciser GUI.

Multiple clients can remotely connect to a single Protocol Exerciser session on the controller PC.

The following figure displays a Protocol Exerciser session scenario in which Session A and Session B have been created on the controller PC with two Protocol Exerciser cards connected to the controller PC through USB. Two clients are accessing Session A and one client is accessing Session B.



**Figure 4** Protocol Exerciser Sessions

In an online session, you generate real-time PCIe traffic to exercise a DUT. Therefore, before you start an online session, ensure that at least one exerciser card is connected with the Controller PC. Ending an online session releases the hardware resources of Protocol Exerciser, thereby enabling these to be used for a new session.

## Protocol Exerciser Offline mode

When you want to use Protocol Exerciser in an offline mode, you do not need to create a session between the Controller PC and an Exerciser card. You generally use an offline mode when you do not have an established connection with any external hardware device. However, you want to create configuration specifications to be used later when an online session is established.

Some options in offline mode are disabled due to their dependency on the connected hardware. For instance, the Hardware status is not displayed in the offline mode.

Protocol Exerciser does not enable you to lock a session (online or offline). Therefore, it is possible for multiple Protocol Exerciser instances to concurrently access a single session.

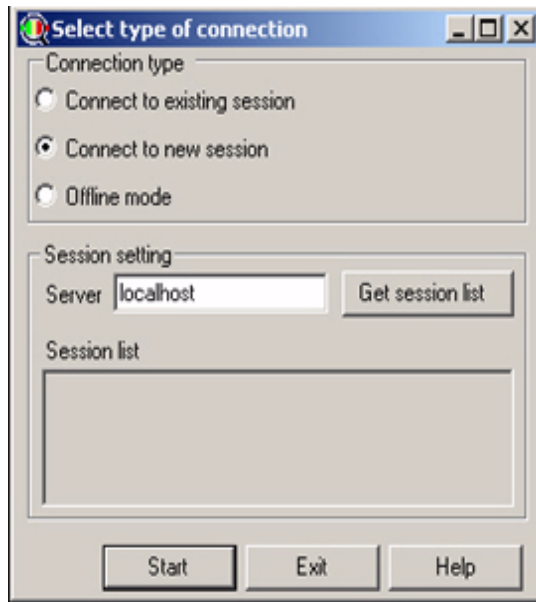
### NOTE

The controller PC does not protect against meaningless, or even conflicting requests. Therefore, it is recommended that only one user should own a particular session at a time.

## Creating/Using a Protocol Exerciser Session

While accessing the Protocol Exerciser GUI, you need to select whether you want to connect to a new or an existing Protocol Exerciser session or you want to use the GUI in an offline mode.

The **Select type of connection** dialog box helps you specify the mode of accessing Protocol Exerciser and the session related information if an online mode is needed. This dialog box is displayed when you try to access the Protocol Exerciser GUI.



**Figure 5** Select type of connection dialog box

### Working in an offline mode

In the Select type of connection dialog box, select the **Offline mode** radio button and click **Start**.

### Using an existing Protocol Exerciser session

- 1 Select the **Connect to existing session** radio button.
- 2 In the **Server** text box, specify the name or IP address of the controlling server that hosts the Protocol Exerciser software and on which you want to use an existing session.

The **Session list** listbox displays the list of Protocol Exerciser sessions existing on the specified server.

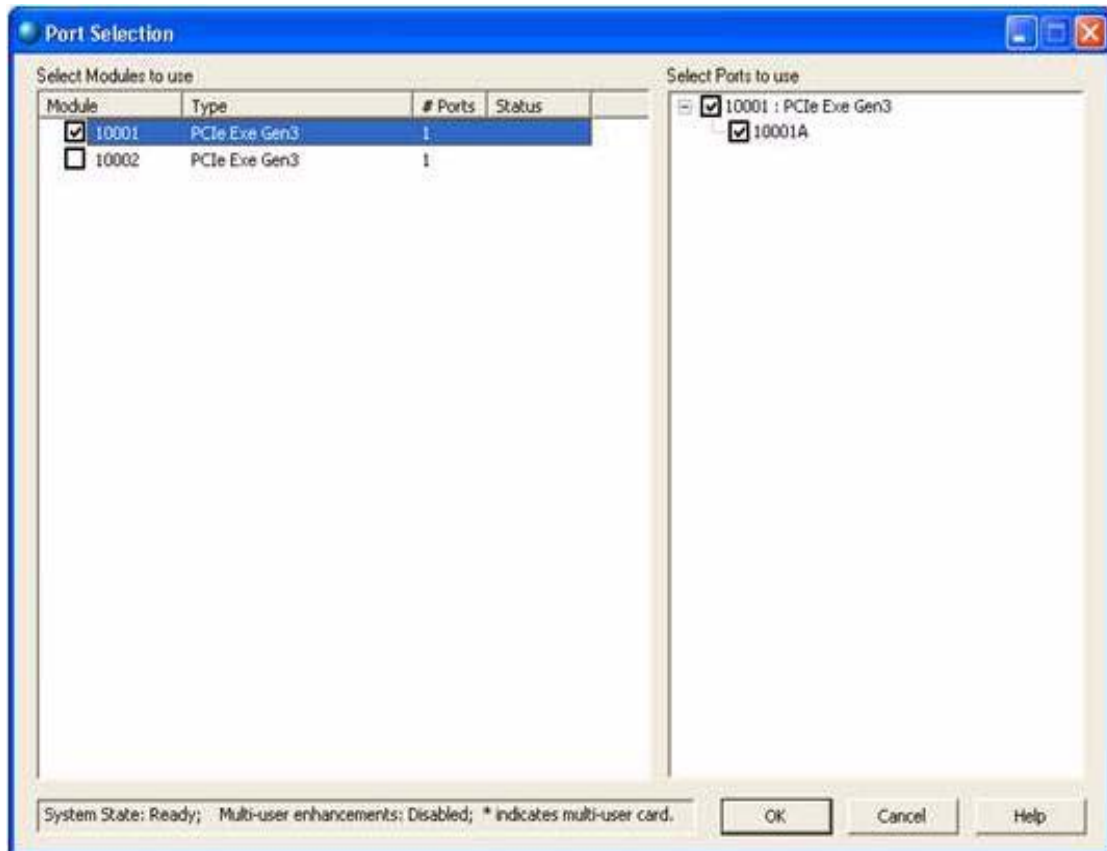
- 3 Select a session from the **Session list** listbox.
- 4 Click **Start**.

### Creating a new Protocol Exerciser session

- 1 Select the **Connect to new session** radio button.
- 2 In the **Server** text box, specify the name or IP address of the controlling server that hosts the Protocol Exerciser software and on which you want to create a new session.
- 3 Click **Start**.



The **Port Selection** dialog box is displayed. It displays a list of ready to use as well as already in use serial I/O exerciser modules along with their type in terms of link speed supported, and the available number of ports. Here, you can only select an exerciser module, which is not in use.



**Figure 6** Port Selection dialog box

- 4 Select the appropriate Exerciser module and then select the available port of the selected Exerciser module from the **Select Port to use** listbox.
- 5 Click **OK**.

At any time, you can access the session information by clicking the **Help** -> **Session** Information menu option in the Protocol Exerciser GUI.

## Starting and Exiting the Protocol Exerciser GUI

To access Protocol Exerciser GUI

- 1 On the Windows task bar, click **Start > Programs > Agilent SPT > PCIe Exerciser 8.1 Release > Exerciser GUI**.

The **Select type of connection** dialog box appears.

- 2 Select the Protocol Exerciser mode in which you want to use the GUI (Online or offline). If you want to use the GUI in an online mode, then either create a new session or join an existing session on the controller PC that hosts the Protocol Exerciser software and is connected the exerciser card hardware. Refer to the topic [Creating a Protocol Exerciser Session](#) on page 22 to know more about sessions.

The main **Protocol Exerciser** window is displayed.

Depending on the selected mode of usage (online or offline), some GUI features are enabled/disabled.

### Exiting Protocol Exerciser GUI

To exit from the Protocol Exerciser GUI:

- 1 Click **File > Exit**.

The Changes not applied message appears if you had not applied all the changes made to Protocol Exerciser.

- 2 Do one of the following:
  - Click **Yes** to apply all the unapplied changes before closing the Protocol Exerciser window.
  - Click **No** to close the Protocol Exerciser window without applying the unapplied changes.
  - Click **Cancel** to quit the message box and return to Protocol Exerciser.

Clicking **Yes** or **No** displays a message box that prompts to save the settings of the current session in a file.

- 3 Do one of the following:
  - Click **Yes** to save the underlying Protocol Exerciser settings before exiting.
  - Click **No** to close the Protocol Exerciser window without saving the underlying Protocol Exerciser settings.

- Click **Cancel** to quit the message box and return to Protocol Exerciser.

Completing this message box displays the Closing Session dialog box.

**4** Do one of the following:

- Click **Yes** to remove the associated session before closing the Protocol Exerciser window.
- Click **No** to close the Protocol Exerciser window without removing its associated session.

**NOTE**

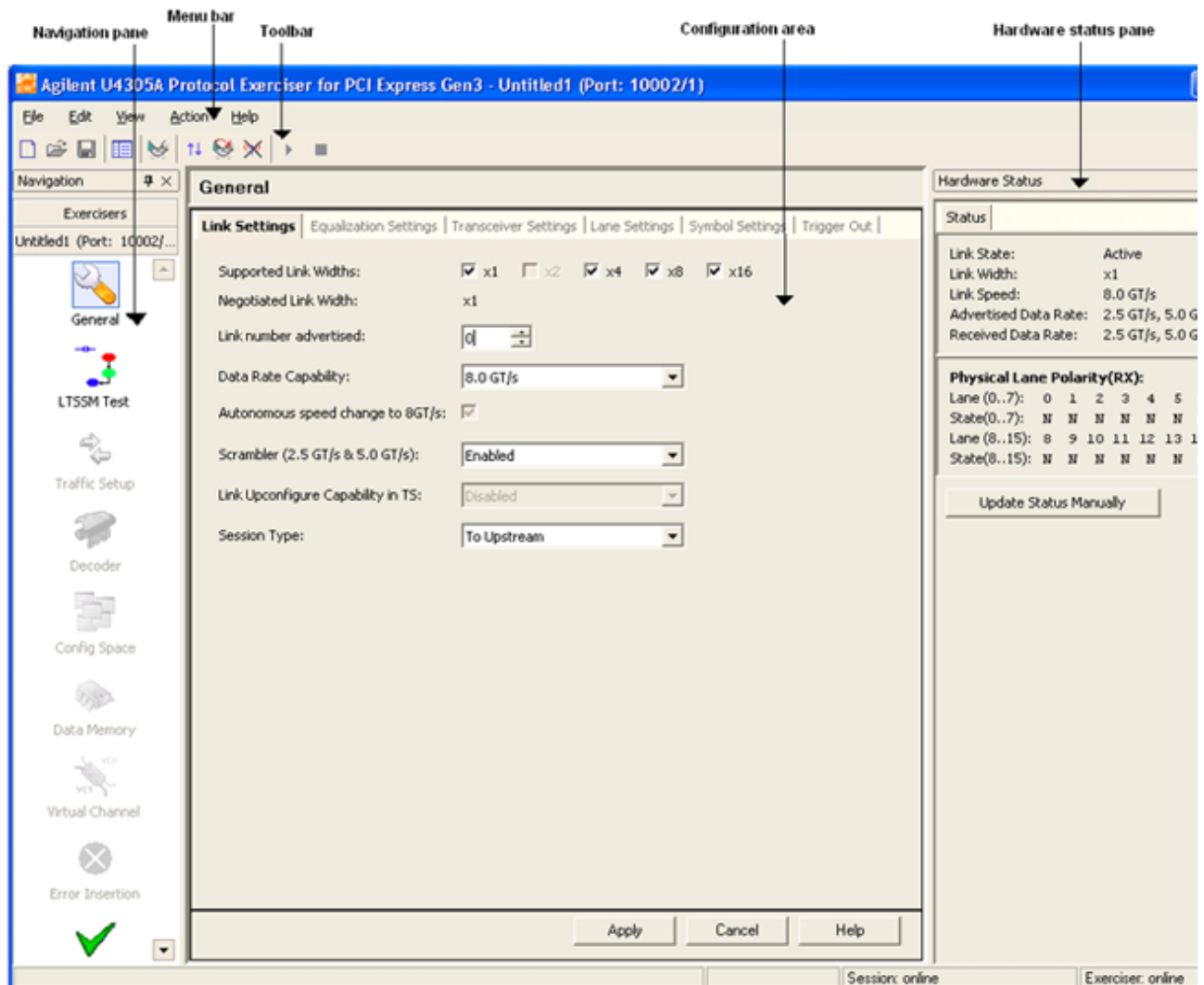
Closing a session automatically makes all the GUI interfaces that are connected to it, inaccessible.

---

## Protocol Exerciser GUI Components

This topic describes various components of the Protocol Exerciser GUI to help you understand how it is organized in various pane, the purpose of each pane, and how to access these panes.

The following figure displays the Protocol Exerciser application main window with its main components.



**Figure 7** Protocol Exerciser window

The main components of the Protocol Exerciser window are briefly described below:

- **Menu Bar and Toolbar:** These provide easy and quick access to the features of the Protocol Exerciser application.
- **Navigation Pane:** Displays the features of Protocol Exerciser as various icons. Using this pane, you can access and navigate through various features of Protocol Exerciser.
- **Configuration Area:** Displays the existing settings and allows you to specify the new settings for the Protocol Exerciser feature currently selected in the Navigation pane.
- **Status Bar:** Displays the current status of the various Protocol Exerciser activities, such as user level (User or Expert), session status (offline or online), and exerciser status (offline or online).
- **Hardware Status pane:** Displays the Protocol Exerciser hardware status and the link status. The information in this pane is updated automatically when you perform any function or run a test that impacts the hardware and link status.

You can view/hide a pane using the **View** menu.

## Viewing and Updating the Protocol Exerciser Hardware Status

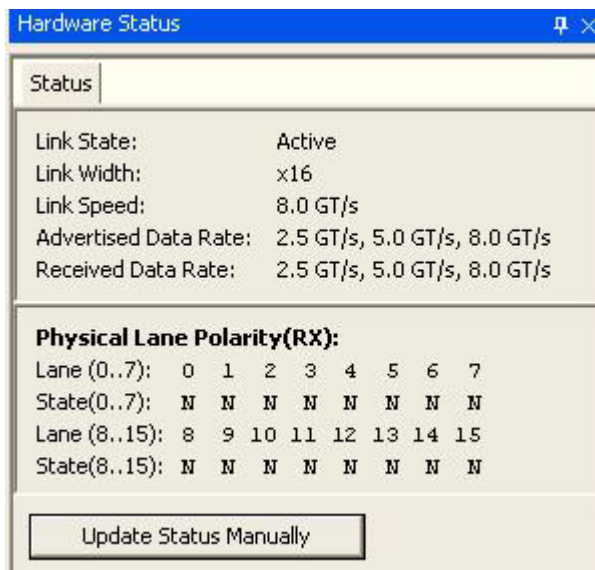
You can get information about the Protocol Exerciser hardware status and the link status using the Hardware Status pane of the Protocol Exerciser GUI.

The information in this pane is updated when you perform any function or run a test that impacts the link partners and link status. For instance, when the link between the DUT and Protocol Exerciser is not up, the link status is displayed as **No Link**. When you perform the steps to initialize this link, the link status is updated to Active if the procedure is completed successfully. If needed, you can also manually update the status on this pane using the **Update Status Manually** button after performing a specific action and to see its impact on the status. Consider a situation when you changed the link width to x4 from x16 in the Link settings page and then initialized the link with this new lane width setting. You can check if the link width is changed to x4 using the Hardware status window.

To access the Hardware Status pane:

- Click **View > Hardware Status**.

The **Hardware Status** pane appears. A sample screen is displayed.



**Figure 8** Hardware Status pane

This pane has the following information:

- Status - The status tab provides you the following information:
  - The current state of the PCIe Link between DUT and Exerciser.
  - The link width at which the link is presently active.
  - The current speed of the underlying link.
  - The advertised data rate capabilities of the Protocol Exerciser.
  - The received data rate, that is the data rate capabilities of the DUT.
  - The received state of polarity for each lane.
  - **Update Status Manually:** Click to refresh the data displayed in the Status tab.

## Managing Floating Windows

The main Protocol Exerciser window contains many floating windows. These windows can float anywhere on the desktop, or you can dock them together with other windows on the main Protocol Exerciser window. In the default window arrangement, all windows are properly docked on the main Protocol Exerciser window.

In this section, you will learn:

- [To Display a Floating Window](#)
- [To Hide a Floating Window](#)
- [To Auto-Hide a Floating Window](#)
- [To Change a Docked Window to a Floating Window](#)
- [To Dock a Floating Window](#)

### To Display a Floating Window

- Click **View** > *menu\_command\_for\_floating\_window*.

Here, *menu\_command\_for\_floating\_window* represents the name of the menu command to access the floating window. For example, Hardware Status is a floating window. To display it, click the **View** > **Hardware Status** menu command.


### To Hide a Floating Window

- Click the  icon on the title bar of the floating window.

You can also hide a floating window by clicking its menu command in the View menu.

### To Auto-Hide a Floating Window

- Click the  icon on the title bar of the floating window.

This automatically hides the floating window when you are not using it. This also displays a new  icon on the title bar of the floating window.

To display the window again, place the cursor over the tab displayed for the hidden window, or click its menu command in the View menu.

### To Change a Docked Window to a Floating Window

- Double-click the title bar of the docked window.



### **To Dock a Floating Window**

- Double-click the title bar of the floating window.

## 2 Getting Started with Protocol Exerciser



## 3 Configuring Protocol Exerciser

**Creating and Managing Protocol Exerciser Setup Files 36**

**Configuring a PCIe Link Settings 37**

**Configuring Lane Settings 39**

**Configuring Equalization Procedure Settings 41**

**Configuring Transceiver Settings 46**

**Configuring External Triggers Settings 47**

This chapter provides information on the various settings that you can configure in the General tab of the Protocol Exerciser GUI to customize its functions according to your specific requirements. The help book also describes how to create and manage a Protocol Exerciser setup file.



## Creating and Managing Protocol Exerciser Setup Files

Protocol Exerciser performs its functions as an Exerciser and an LTSSM based on the settings that you configure in the Protocol Exerciser GUI. These settings are used by Protocol Exerciser to configure a session with DUT for functions such as link and lane negotiations, exchanging training sequences, performing equalization, and link speed changes.

Protocol Exerciser saves these settings in the Protocol Exerciser setup file. You can create multiple versions of this file for multiple Exerciser cards with different link, lane, and other settings to use these versions in different testing scenarios with DUTs. For instance, you can create different setup files for an Upstream and a Downstream session with DUT and use these files based on whether Protocol Exerciser is emulating a root complex (as USC) or a PCIe endpoint (as DSC). You may also want to have different setup files for a session type with different link speed or lane width settings to test link negotiations with different link settings scenarios.

Ensure that you have created the Protocol Exerciser setup file with the required settings before starting link up between the DUT and Protocol Exerciser.

To create a Protocol Exerciser setup file, click the **General** icon in the Navigation window of the Protocol Exerciser GUI and then click the relevant tabs on the screen to configure various settings. Save the file with an appropriate name. The Protocol Exerciser setup files are saved with an .exs extension.

Using the File menu options, you can open, close, or save a Protocol Exerciser setup file.

#### NOTE

Some fields in the General tab pages are disabled if you are using Protocol Exerciser in an offline mode. Also, if the Protocol Exerciser is used as a DSC (based on the configured session type), some fields which are not applicable for Protocol Exerciser as a DSC are disabled.

Refer to the Protocol Exerciser GUI Reference help topics in this online help to get a detailed description of each field in the tab pages. Alternatively, click the Help button displayed in the tab page to get a context-sensitive help page.

## Configuring a PCIe Link Settings

Before you can create/initialize a PCIe link between Protocol Exerciser and DUT for normal exchange of data packets, you need to configure the settings for this link. This ensures that Protocol Exerciser initializes the link as per your specific link settings.

### NOTE

Protocol Exerciser saves the link settings in an Exerciser setup file. You can create multiple versions of this file with different link, lane, and other settings to use these versions in different testing scenarios with DUTs. To know more, refer to [Creating and Managing Protocol Exerciser Setup Files](#) on page 36.

To configure the link settings, click the **General** icon in the Navigation window of the Protocol Exerciser GUI and then click the **Link settings** tab.

### NOTE

Refer to the Protocol Exerciser GUI Reference help topics in this online help to get a detailed description of each field in this tab page. Alternatively, click the Help button displayed in the tab page to get a context-sensitive help page.

Some fields in this tab page are disabled if you are using Protocol Exerciser in an offline mode. Also, if the Protocol Exerciser is used as a DSC (based on the configured session type), some fields which are not applicable for Protocol Exerciser as a DSC are disabled.

The following are some of the points to be considered when configuring link settings.

- You select the session type based on whether you want the Protocol Exerciser to act as a USC or a DSC for the session. When Protocol Exerciser is emulating a root complex and acting as a USC, the session type should be **To Downstream**. The DUT is at the end point in this case. When Protocol Exerciser is emulating a PCIe end point and acting as a DSC, the session type should be **To Upstream**. The DUT is at root-complex in the hierarchy in this case.
- Select the data rate capabilities of the Protocol Exerciser based on the link speed scenarios that you want to test. The data rate capabilities options are disabled in the offline mode of Protocol Exerciser.

- Protocol Exerciser performs data scrambling as per the PCIe specifications. At Gen1 and Gen2 speeds, you can enable or disable scrambling using the Link settings page. If you disable scrambling, Protocol Exerciser generates and responds to training sequences with the “disable scrambling” bit set, which causes the link to operate without scrambling. The disabling takes effect the next time Protocol Exerciser exchanges Training sequences after you select the Disable Scrambling option. At the Gen3 speed, scrambling is always enabled to follow the new Gen3 Scrambling Rules as listed in the PCIe specifications. Therefore, the Enable/Disable Scrambling option is not provided for the Gen3 speed.
- If the data rate capabilities of both the link partners is 8.0 GT/s and you want to initialize the link to 8.0 GT/s, then ensure that the **Autonomous speed change to 8 GT/s** option in the **Link Settings** tab is selected. Selecting this check box autonomously moves the link speed to 8.0 GT/s during link training.

## Configuring Lane Settings

Before you can create/initialize a PCIe link between Protocol Exerciser and DUT for normal exchange of data packets, you need to configure the lane settings for this link. This ensures that the lanes of a port are associated and configured into a link through link width and lane negotiation as per the specified lane settings.

### NOTE

Protocol Exerciser saves the lane settings in an Exerciser setup file. You can create multiple versions of this file with different link, lane, and other settings to use these versions in different testing scenarios with DUTs. To know more, refer to [Creating and Managing Protocol Exerciser Setup Files](#) on page 36.

To configure the lane settings, click the **General** icon in the Navigation window of the Protocol Exerciser GUI and then click the **Lane settings** tab.

The screenshot displays the 'Lane Settings' tab in the Protocol Exerciser GUI. At the top, there are navigation tabs: Link Settings, Equalization Settings, Transceiver Settings, Lane Settings (selected), Symbol Settings, and Trigger Out. Below the tabs, the following settings are visible:

- Reverse Lanes:**  Yes  No
- Automatic Lane Reversal:**  Enabled  Disabled
- Tx** (Transmitter section):
  - Physical Lane Polarity:**

Lane	Normal	Inverted
Lane 0:	<input checked="" type="radio"/>	<input type="radio"/>
Lane 1:	<input checked="" type="radio"/>	<input type="radio"/>
Lane 2:	<input checked="" type="radio"/>	<input type="radio"/>
Lane 3:	<input checked="" type="radio"/>	<input type="radio"/>
Lane 4:	<input checked="" type="radio"/>	<input type="radio"/>
Lane 5:	<input checked="" type="radio"/>	<input type="radio"/>
Lane 6:	<input checked="" type="radio"/>	<input type="radio"/>
Lane 7:	<input checked="" type="radio"/>	<input type="radio"/>
Lane 8:	<input checked="" type="radio"/>	<input type="radio"/>
Lane 9:	<input checked="" type="radio"/>	<input type="radio"/>
Lane 10:	<input checked="" type="radio"/>	<input type="radio"/>
Lane 11:	<input checked="" type="radio"/>	<input type="radio"/>
Lane 12:	<input checked="" type="radio"/>	<input type="radio"/>
Lane 13:	<input checked="" type="radio"/>	<input type="radio"/>
Lane 14:	<input checked="" type="radio"/>	<input type="radio"/>
Lane 15:	<input checked="" type="radio"/>	<input type="radio"/>

#### NOTE

Refer to the Protocol Exerciser GUI Reference help topics in this online help to get a detailed description of each field in this tab page. Alternatively, click the Help button displayed in the tab page to get a context-sensitive help page.

---

The number of lanes displayed in the **Lane settings** page depend on the Link Width that you selected in the **Link settings** page.

#### **Lane Reversal**

You can enable or disable the lane reversal feature for the Transmitter. Protocol Exerciser can reverse its lanes before starting the link negotiation. Enabling the lane reversal can help you test the DUT's capability to perform lane ordering during link training.

#### **Lane Polarity Inversion**

You can set the Lane Polarity inversion for each lane of the link independently. If you select the Polarity inversion for a lane, then at the time of link training, the receiver gets an indication of the lane polarity inversion setting through the transmitted TS1 and TS2 ordered sets. Subsequently, it indicates that the receiver must invert the received data. Setting the Tx lane polarity inversion can help you assess DUT's capabilities to understand and implement polarity inversion during the link training.



## Configuring Equalization Procedure Settings

You use the Equalization Settings tab in the General pane to configure the Equalization settings for the Protocol Exerciser Transmitter (Tx). The settings are configured separately for 5.0 and 8.0 link speeds. This topic describes how to enable/disable and configure the equalization settings.

The screenshot shows the 'Equalization Settings' tab with the following configuration:

- 5.0 GT/s:** De-emphasis shown in TS: [Dropdown]
- 8.0 GT/s:**
  - Request to DUT:** Tx Preset value: [Dropdown], Tx pre cursor coefficients: 0, Tx data cursor coefficients: 0, Tx post cursor coefficients: 0, Rx preset hints: [Dropdown]
  - Exerciser:** FS: 12, LF: 0, Tx Preset value: [Dropdown], Tx pre cursor coefficients: 0, Tx data cursor coefficients: 0, Tx post cursor coefficients: 0, Ignore Coefficient Rule check  $|C-1| \leq \text{Floor}(FS/4)$ : , Ignore Coefficient Rule check  $|C-1|+C_0+|C+1| = FS$ : , Ignore Coefficient Rule check  $C_0 - |C-1| - |C+1| \geq LF$ :
- Bottom Section:** Perform Equalization in Recovery @8GT/s: , Request for Equalization in Recovery @8GT/s: , Perform Phase 2/ Phase 3:

**Figure 9** Equalization settings tab

### Transmitter Based Equalization (De-emphasis) for 5.0 GT/s speed

For 5.0 GT/s link speed, you can select the Tx de-emphasis option on a per-link basis. You can enable and set the Tx de-emphasis level that the Protocol Exerciser will use for transmission using the De-emphasis shown in TS listbox in the 5.0 groupbox. Typically, the -3.5dB option is used when Protocol Exerciser is acting as a DSC and the -6dB option is used when Protocol Exerciser is acting as a USC.

## Equalization for 8.0 GT/s speed

For 8.0 GT/s, all the operational and associated lanes of a link need to participate in the equalization procedure to adjust their transmitter and receiver setups to improve signal quality when moving to 8.0 GT/s. Each combination of Tx, channel, and Rx will have a unique set of coefficients yielding an optimum signal-to-noise ratio. The training sequences exchanged during the link training to 8.0 GT/s consists of negotiating the equalization coefficients to be used, to ensure reliable transfer of data.

For any link training or link speed upgrade to 8.0 GT/s, the link partners have to go through the phases of the Equalization procedure as per the PCIe specifications. The USC and DSC use the following phases to adjust the Transmitter and Receiver setup of each lane to improve the signal quality.

- Phase 1 - Both USC and DSC transmit with the specified preset values. The specified FS and LF values are advertised in phase 1.
- Phase 2 - DSC tunes the USC by requesting a change in the coefficients at the transmitter of the USC.
- Phase 3 - USC tunes the DSC by requesting a change in the coefficients at the transmitter of the DSC.

Protocol Exerciser supports two types of equalization when moving to 8.0 GT/s. These are described in the following sections.

### Autonomous equalization

The Autonomous equalization feature is applicable if the link partners are 8.0 GT/s capable during the initial link negotiations and they are moving to 8.0 GT/s from the Detect state. To perform autonomous equalization, Protocol Exerciser acting as a USC autonomously transitions from L0 to Recovery before transmitting any DLLPs. To accomplish the autonomous equalization, the **Autonomous speed change to 8 GT/s** option in the **Link Settings** tab should be selected. If this option is not selected, the link is not moved to 8.0 GT/s after it gets trained to 2.5 GT/s.

If **Autonomous speed change to 8 GT/s** option is selected, Protocol Exerciser acting as a USC will always perform equalization at the first entry to 8GT/s after exit from the Detect State. If Protocol Exerciser is acting as a DSC, it will respond to the Equalization state transitions of USC.

## Software based equalization

The software based equalization feature is applicable if the link is configured at 2.5 or 5.0 GT/s and a link partner requests to move to 8.0 GT/s with both link partners capable of 8.0 GT/s data rate. You can configure Protocol Exerciser to enable/disable software based equalization while moving to 8.0 GT/s from 2.5 or 5.0 GT/s.

### Enabling Equalization at 8.0 GT/s

If Protocol Exerciser is acting as USC and you want Protocol Exerciser to perform software based equalization while moving to 8.0 GT/s, ensure that:

- the **Perform Equalization in Recovery @8 GT/s** option is selected in the **Equalization settings** tab. Protocol Exerciser (acting as a USC) then must perform Equalization when upgrading the link speed to 8.0 GT/s. If this option is not selected, then the link speed upgrade to 8.0 GT/s happens without performing equalization.

If Protocol Exerciser acting as a USC is configured to perform equalization and you want to ensure that it performs all the three phases of equalization, then select the **Perform Phase 2/Phase 3** option in the **Equalization settings** tab. Protocol Exerciser (acting as a USC) then must perform Phase 2 and 3 of Equalization when upgrading the link speed to 8.0 GT/s. If this option is not selected, then Protocol Exerciser exits the Recovery.Equalization sub-state after phase 1 and transitions to the Recovery.RcvrLock substate to proceed towards making the link operational at the 8.0 GT/s speed.

If you want to ensure that Protocol Exerciser (acting as a DSC) should request the USC to redo the equalization, then select the **Request Equalization in Recovery @8GT/s** option in the **Equalization settings** tab.

### Disabling Equalization at 8.0 GT/s

If you do not want Protocol Exerciser to perform software based equalization while moving to 8.0 GT/s, ensure that:

- the **Perform Equalization in Recovery @8 GT/s** option is deselected in the **Equalization settings** tab. This is applicable if Exerciser is used as a USC.
- the **Perform Phase 2/Phase 3** option is deselected in the **Equalization settings** tab. This is applicable if Exerciser is used as a USC.

If you do not want Protocol Exerciser acting as a DSC to request USC to redo equalization while moving to 8.0 GT/s, then deselect the **Request Equalization in Recovery @8 GT/s** option in the **Equalization settings** tab.

#### NOTE

Protocol Exerciser needs to perform or respond to the Equalization phases while running some LTSSM tests used to test DUT's LTSSM functions. For these tests, the Equalization settings that you configured in this tab are over-ridden by the equalization settings relevant for the test when the test is running. The configured equalization settings are reverted back when the test execution is over.

For instance, you have not enabled software based equalization and executed the LTSSM test to upgrade the link speed to 8.0 GT/s with equalization. In this situation, the test overrides the disabled equalization setting and performs equalization while upgrading to 8.0 GT/s.

## Configuring Equalization settings

You configure the equalization co-efficients, presets, and FS and LF voltage swings for the Protocol Exerciser transmitter using the **Equalization Settings** tab in the **General** navigation pane of the Protocol Exerciser GUI. Protocol Exerciser uses these settings to perform or respond to the Equalization steps while training/retraining, or upgrading the link to the 8.0 GT/s link speed.

#### NOTE

Refer to the Protocol Exerciser GUI Reference help topics in this online help to get a detailed description of each field in this tab page. Alternatively, click the Help button displayed in the tab page to get a context-sensitive help page.

### Setting Equalization values

You can set the:

- FS and LF values that the Protocol Exerciser advertises during the link training for its Tx capabilities using the Exerciser group box.
- Tx De-emphasis preset and co-efficient values that the Protocol Exerciser advertises during the link training for its Tx capabilities using the Exerciser group box.
- Tx De-emphasis preset and co-efficient values that the Protocol Exerciser will send to DUT in the training sequences to request DUT to use the specified presets and co-efficient values using the Request to DUT group box.

**NOTE**

Protocol Exerciser ignores all the Tx De-emphasis value requests from DUT. To yield an optimum combination of Tx/Rx equalization, it uses the Protocol Exerciser Tx and Rx equalization settings that you set in the Transceiver settings tab.

---

**NOTE**

In comparison to a standard PCIe device, Protocol Exerciser can also control the electrical de-emphasis settings that are independent of the settings in the training sequences. This allows you to test the de-emphasis level negotiation protocol without changing the electrical behavior of Protocol Exerciser.

---

## Configuring Transceiver Settings

You can set the Protocol Exerciser Transmitter and Receiver equalization settings using the Transceiver Settings tab. These settings impact the overall signal quality. You should change the default settings in this page if you are facing problems specific to signal quality or you want to test how the changes in these settings impact the overall signal quality.

You can adjust the transceiver settings to yield an optimum combination of Tx/Rx equalization.

Using the Transceiver Settings tab, you can adjust the output voltage, pre tap, first post tap, and second post tap for the Protocol Exerciser transmitter and the AC and DC Gain settings for the Protocol Exerciser Receiver.

The following figure displays the default Transceiver settings.

The screenshot shows the 'Transceiver Settings' tab with the following configuration:

- Tx Output Voltage:** 900 mV (dropdown menu)
- Tx Pre-emphasis Pre Tap:** -1 (input box) with a slider ranging from -15 to 15.
- Tx Pre-emphasis First Post Tap:** 0 (input box) with a slider ranging from 0 to 31.
- Tx Pre-emphasis Second Post Tap:** 0 (input box) with a slider ranging from -15 to 15.
- Rx Equalizer DC Gain:** 3 dB (dropdown menu)
- Rx Equalizer AC Gain:** 5 dB (dropdown menu)

**Figure 10** Transceiver Settings tab

### NOTE

Refer to the Protocol Exerciser GUI Reference help topics in this online help to get a detailed description of each field in this tab page. Alternatively, click the Help button displayed in the tab page to get a context-sensitive help page.

## Configuring External Triggers Settings

Protocol Exerciser can generate events or trigger other test equipments such as logic analyzers or protocol analyzers when a specified trigger condition is met. You can set the trigger conditions using the Trigger Out tab. Once you enable the trigger out conditions, Protocol Exerciser records and displays a corresponding event generating a trigger out pulse when any of these conditions are met. The external trigger out pulse is generated at 125 ns. The list of accumulated events is displayed in the **Trigger Out** tab.

The following trigger out conditions are available:

- **Protocol Error** - An event is generated on encountering any protocol related error.
- **Going Out of L0** - When the LTSSM state transitions out of L0 indicating that the link is not operational, Protocol Exerciser alerts you by generating an event.

The U4305A exerciser card has a component, namely *Trigger Out Connector*, located on the front bracket of the card. This component is used to generate a trigger out pulse from Protocol Exerciser to other test equipment.

### NOTE

Refer to the Protocol Exerciser GUI Reference help topics in this online help to get a detailed description of each field in this tab page. Alternatively, click the Help button displayed in the tab page to get a context-sensitive help page.

---

### **3 Configuring Protocol Exerciser**





## 4 Initializing and Managing a PCIe Link

**Initializing and training a PCIe Link between Protocol Exerciser and DUT 50**

**Retraining a PCIe Link between Protocol Exerciser and DUT 53**

**Initiating Link Speed Change on a Configured Link 54**

This chapter describes how to initialize and train a PCIe link and how to manage it in terms of retraining it and upgrading or downgrading the link speed.



# Initializing and training a PCIe Link between Protocol Exerciser and DUT


Before you can start using Protocol Exerciser to stimulate DUT with PCIe traffic or to test DUT's LTSSM functions like speed changes, you need to initialize the PCIe link between Protocol Exerciser and DUT.

The Hardware Status pane in the Protocol Exerciser GUI displays the current status of the link. Before initializing the link, the status is reflected as **No Link** indicating that the link is not operational.

### Before you start:

- Make sure you have configured the link, lane, and other settings relevant for link training in a Protocol Exerciser Setup file. You use the General navigation window of the Protocol Exerciser GUI to configure these settings. Refer to the chapter Configuring Protocol Exerciser to know more.
- If you want Protocol Exerciser to initialize and train the link to 8.0 GT/s autonomously, then ensure that the data rate capability of both the link partners is 8.0 GT/s and you have selected the **Autonomous speed change to 8 GT/s** check box in the Link Settings page. If this check box is not selected, Protocol Exerciser does not autonomously move the link to the 8 GT/s speed and trains it to 2.5 GT/s. You can then later upgrade the speed to 8.0 GT/s through the **Initiate Speed Change** menu option.

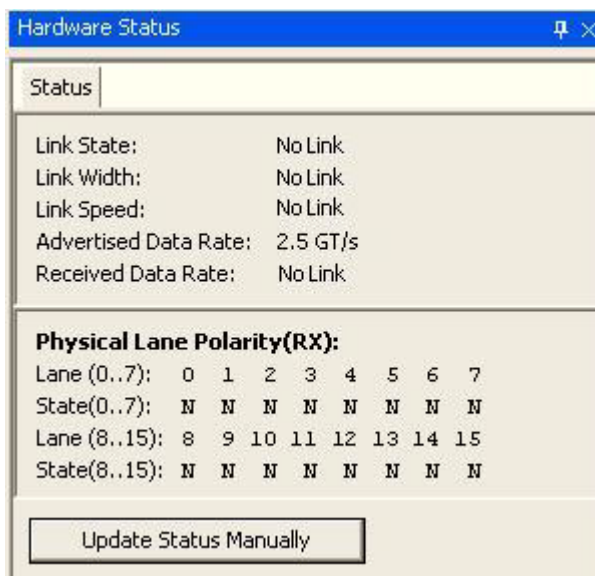
## Training a PCIe Link

To create/initialize a PCIe link, click the  icon on the toolbar. Alternatively, you can also select the **Action > Link Up** menu command. This creates a link between the current Protocol Exerciser session and DUT. The link is trained to 2.5 GT/s even if the link partners advertise a higher data rate capability during link training. However, if the data rate capability of both the link partners is 8.0 GT/s and you have selected the **Autonomous Speed change to 8 GT/s** check box in the **Link Settings** page, the link is trained to 8 GT/s.

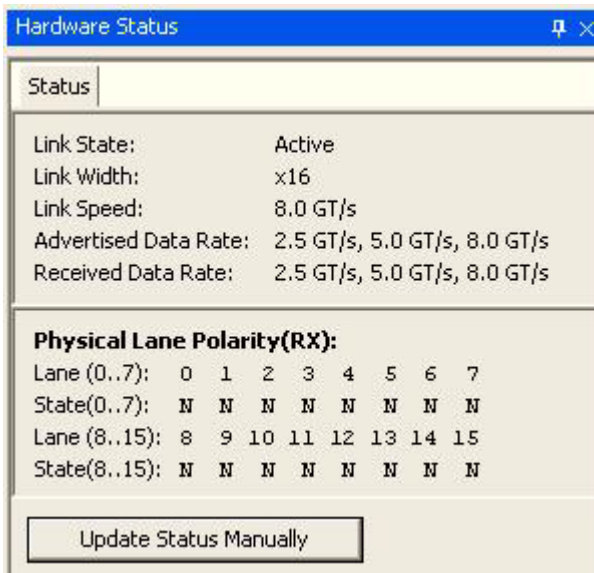
## Verifying PCIe Link Training

You can check the status of the link training action using the Hardware Status pane of the Protocol Exerciser GUI. The following screens displays the status of the link before and after the link up.

You can check the status of the link training action using the Hardware Status pane of the Protocol Exerciser GUI. The following screens displays the status of the link before and after the link up.



**Figure 11** Protocol Exerciser - Hardware Status Before Link Up



**Figure 12** Protocol Exerciser - Hardware Status After Link Up

### NOTE

If you are trying to configure an exerciser card of higher link width (such as x8) to a lower link width (such as x1), then you may face the following issue:


As the receivers of the exerciser card have the 50 OHm termination resistance, the receiver detect logic of the system detects 8 receivers. If during linkup, the system does not get a valid signal on all the lanes where it detected a receiver, the system according to the specification goes into the compliance mode.

This issue can only be worked around by taping off unused lanes, or by using a passive slot-interposer with a smaller edge connector according to the desired link width.

## Retraining a PCIe Link between Protocol Exerciser and DUT

Once you have initialized the PCIe link between Protocol Exerciser and DUT, you can start using Protocol Exerciser. As you progress with the DUT testing, you may need to retrain this link between DUT and Protocol Exerciser, for instance, in case of link errors or if during an LTSSM test execution, the advertised or received data rate do not match the data rate capabilities.

Consider a situation when you have changed the speed of a configured link from 5.0 GT/s to 2.5 GT/s. Consequently, the advertised data rate is also reflected as 2.5 GT/s. You can then retrain the link to ensure that the advertised and received data rate are restored back to the set 2.5 and 5.0 GT/s capabilities.


To retrain a PCIe link, click the  icon on the toolbar. Alternatively, you can also select the **Action > Initiate Retrain Link** menu command.

Protocol Exerciser then retrains the link by moving it to recovery and then back to the Operational state. The link is retrained/recovered as per the link and lane settings negotiated during the initial link training sequence. For example, the link is trained to 2.5 GT/s and the data rate capabilities of DUT and Protocol Exerciser are 5.0 GT/s. By initiating the link retraining, the initial data rate – 2.5 GT/s is used to retrain the link. The Advertised and Received data rate capabilities are updated based on the current data rate capabilities of the link partners.

You can verify if the link is retrained successfully by viewing the status of the link in the Hardware Status pane of the Protocol Exerciser GUI. On the successful retraining, the link status should be Active and the link speed, link width, advertised and received data rate and lane polarity reversal are as per the initial link and lane negotiations.

### Initiating Link Speed Change on a Configured Link

As you progress with the DUT testing on a configured link, you may need to change the link speed to test the DUT's capabilities in a higher/lower speed scenarios.

To change the link speed on a configured link, click the  icon on the toolbar. Alternatively, you can also select the **Action > Initiate Speed Change** menu command.

Protocol Exerciser then initiates link speed change to the highest data rate advertised by both the link partners during link training.

If the link is already at the highest data rate supported by both the link partners and you want to downgrade the link speed, then you first need to downgrade the data rate capabilities of a link partner before starting speed change. In such a situation, the link speed is downgraded based on the changed data rate capability.

You can verify if the link speed has been changed successfully by viewing the status of the link speed in the Hardware Status pane of the Protocol Exerciser GUI.



## 5 Testing DUT's LTSSM Functions

<b>LTSSM</b>	<b>56</b>
<b>LTSSM Tester - Introduction</b>	<b>58</b>
<b>When to Use LTSSM Tester</b>	<b>60</b>
<b>How LTSSM Tester Works</b>	<b>62</b>
<b>Getting Started with LTSSM Tester</b>	<b>65</b>
<b>Testing Link Initialization, Training, and Management</b>	<b>68</b>

This chapter provides detailed information on Protocol Exerciser's use as an LTSSM to test a DUT's LTSSM functions. This chapter describes Protocol Exerciser's test tool - LTSSM Tester and how to use it to perform LTSSM testing.



## LTSSM

Link Training and Status State Machine (LTSSM) is the sub-block that drives and controls the link initialization, and training process for a PCIe device to enable the normal data exchange between the two devices over the link. LTSSM operates at the physical layer level and exchanges physical layer packets (Ordered sets such as TS1 and TS2) to initialize, train, and manage the link.

### LTSSM Functions

The following are some of the key functions of LTSSM that are referred to later in this chapter in the context of LTSSM testing.

- Link initialization and configuration to bring the link to an operational state when TLP and DLLPs can be transmitted over it.
- Link recovery or retraining in situations such as speed changes, power management, or recovering from a link error.
- Performing link bandwidth management by downgrading or upgrading the link speed in response to a link speed change request.
- For PCIe Gen3 devices, performing the Equalization procedure before reaching the Gen3 (8.0 GT/s) speed during the link training or retraining.

### LTSSM States

LTSSM transits through various states and substates during link initialization, training, and management. The entry and exit of each of these states and the exchange of packets (Ordered sets) between the two devices during each state is as per the PCIe specifications.

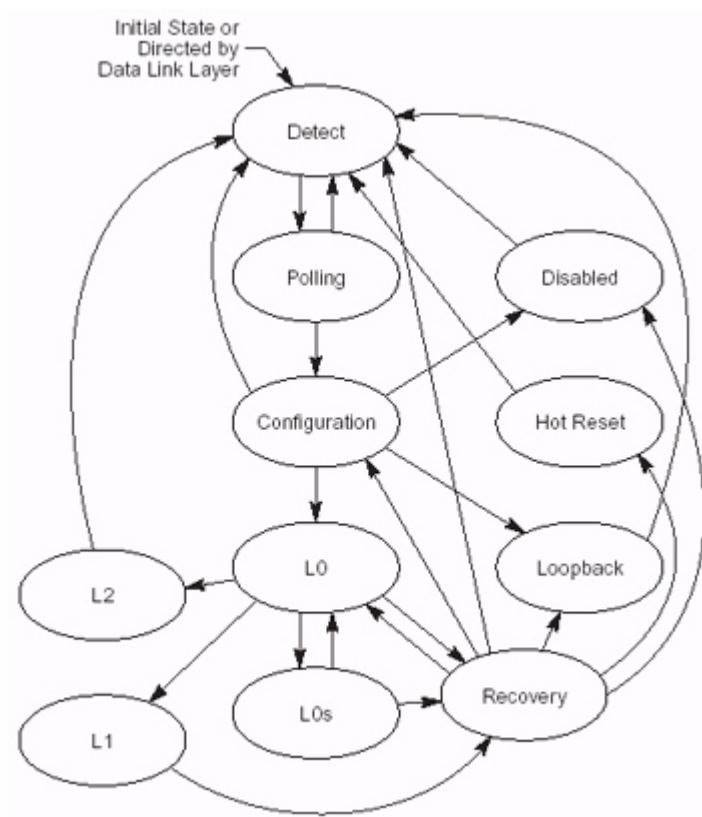
As per the PCIe specifications, LTSSM has 11 states and further substates. These states are referred to frequently in this chapter to describe LTSSM testing using the Agilent LTSSM Tester tool. Following is a list of these states followed by a diagram to illustrate the sequence of these states as per the PCIe specifications.

- Detect
- Quiet



- Polling
- Configuration
- L0
- Recovery
- L0s
- L1
- L2
- Hot Reset
- Disabled
- Loopback

The following figure displays the top-level states of LTSSM.



**Figure 13** LTSSM States

**NOTE**

For information on different LTSSM states and sub-states, refer to *PCI Express specification*.

## LTSSM Tester - Introduction

LTSSM is one of the key challenges when moving from PCI Express Gen2 to Gen3 with link testing for Gen3 as one of the biggest validation challenges.

Agilent LTSSM Tester is a tool that helps you perform link negotiations testing effectively and thoroughly to test a DUT's LTSSM functions. Using this tool, you can verify all the LTSSM state transitions of DUT and check if all the state timeouts are correctly implemented. This tool provides you a set of predefined LTSSM tests to help you assess if the DUT's LTSSM capabilities are as per the LTSSM rules specified in the PCIe specifications.

The LTSSM Tester tool is integrated with Protocol Exerciser and is available as a tab in the Protocol Exerciser GUI. When you install and configure the Agilent's Protocol Exerciser card, the card emulates a PCIe device and provide the LTSSM functionality as well to stimulate the DUT's LTSSM functions.

Protocol Exerciser exchanges appropriate physical layer packets (ordered sets) with the DUT as per the PCIe specifications to test DUT's LTSSM capabilities. You can access the LTSSM functions provided by Protocol Exerciser by running the appropriate LTSSM tests using the LTSSM Tester tool. The test results help you assess the DUT's capabilities in the context of a particular LTSSM function.

### Protocol Exerciser as a USC and a DSC in context of LTSSM testing

Protocol Exerciser can act as an Upstream Component (USC) or a Downstream Component (DSC) with DUT for LTSSM testing. Protocol Exerciser functions as a USC or a DSC depending on the session type that you selected based on the Exerciser card setup. You use the Link Settings page of the General tab of the Protocol Exerciser GUI to select the session type.

As a USC, Protocol Exerciser emulates a root complex and controls the link initialization, training, and management sequences for self-initiated or DUT initiated requests. DUT, in this case, acts as a DSC and responds to the sequences.

As a DSC, Protocol Exerciser emulates an end point and only responds to the LTSSM function sequences performed by the DUT acting as a USC in this case.

## LTSSM Tester Features

The LTSSM Tester tool provides various features that make it a useful tool to perform the DUT's LTSSM testing. Some of the key features of LTSSM Tester are listed below.

- Can explicitly test or force LTSSM state transitions.
- Can monitor state transitions and follow timeout controlled process to ensure protocol compliance.
- Supports scalable speed transitions varying from 2.5 GT/s to 8.0 GT/s.
- Supports LTSSM testing for Gen1, Gen2, and Gen3 PCIe devices.
- Supports lane polarity inversion setting for all the lanes independently.
- Supports link widths ranging from x1, x4, x8 to x16 (any combinations allowed). X2 is not supported.
- Supports automatic or manual enabling /disabling of the lane reversal feature to help you test the DUT's lane reversal feature.
- Supports data scrambling settings.
- Can test link initialization and retraining with or without performing the Equalization procedure.
- Captures and displays the LTSSM state transitions along with the timestamps for:
  - fast and easy debug and
  - verification to ensure that DUT's LTSSM state transitions and timeouts are as per the PCIe specifications.
- Can initiate link transition to recovery.
- Can create corner conditions to test DUT's error responses.
- Supports Equalization Settings to improve signal quality for DUT and Exerciser.
- Supports Transceiver Settings for hardware connected for variable voltages.
- Supports displaying the protocol errors violated while linking, retraining, recovering or speed change.

## When to Use LTSSM Tester

LTSSM Tester provides a set of LTSSM tests to help you test various aspects of DUT's LTSSM. The following list provides you pointers to the broad areas/situations when these tests can help you in LTSSM testing.

To test and assess if:

- The DUT is able to perform or respond to the link initialization and training process at the negotiated link speed and width.
- The DUT's LTSSM state transitions are as per the LTSSM rules specified in the PCIe specifications.
- The DUT's LTSSM transits to recovery and back to the operational state for a link retraining request (for instance, link errors or link speed changes).
- The DUT can successfully transit from Gen2 to Gen3 in terms of higher link speeds, new training sequences for the equalization procedure, and other PCIe specifications which are new for Gen3.
- The DUT autonomously changes the link speed to 8.0 GT/s after initiating the link to 2.5 GT/s while performing the Equalization procedure.
- The DUT can perform a downgrade or an upgrade link speed in response to a self initiated or a link partner initiated speed change request on a configured link. This can help you assess how well the DUT handles link bandwidth management.
- The DUT can handle link and lane settings negotiated during the link training process and can successfully train the link with these negotiated or discovered settings. For instance, lane polarity inversion is selected and advertised during the link training. You can test if the DUT's LTSSM initializes the link with lane polarity inversion.

### LTSSM Supported States

LTSSM has 11 states with further substates. LTSSM transits through these states while performing the link initialization, training, and management.

In this release, LTSSM Tester supports the LTSSM states transitions except the following states or a state feature:

- Multi-link configuration

- Polling compliance testing
- Link power management states
- Direct to Hot Reset or Disabled state
- Loopback

## How LTSSM Tester Works

This topic describes the overall working of the LTSSM Tester.

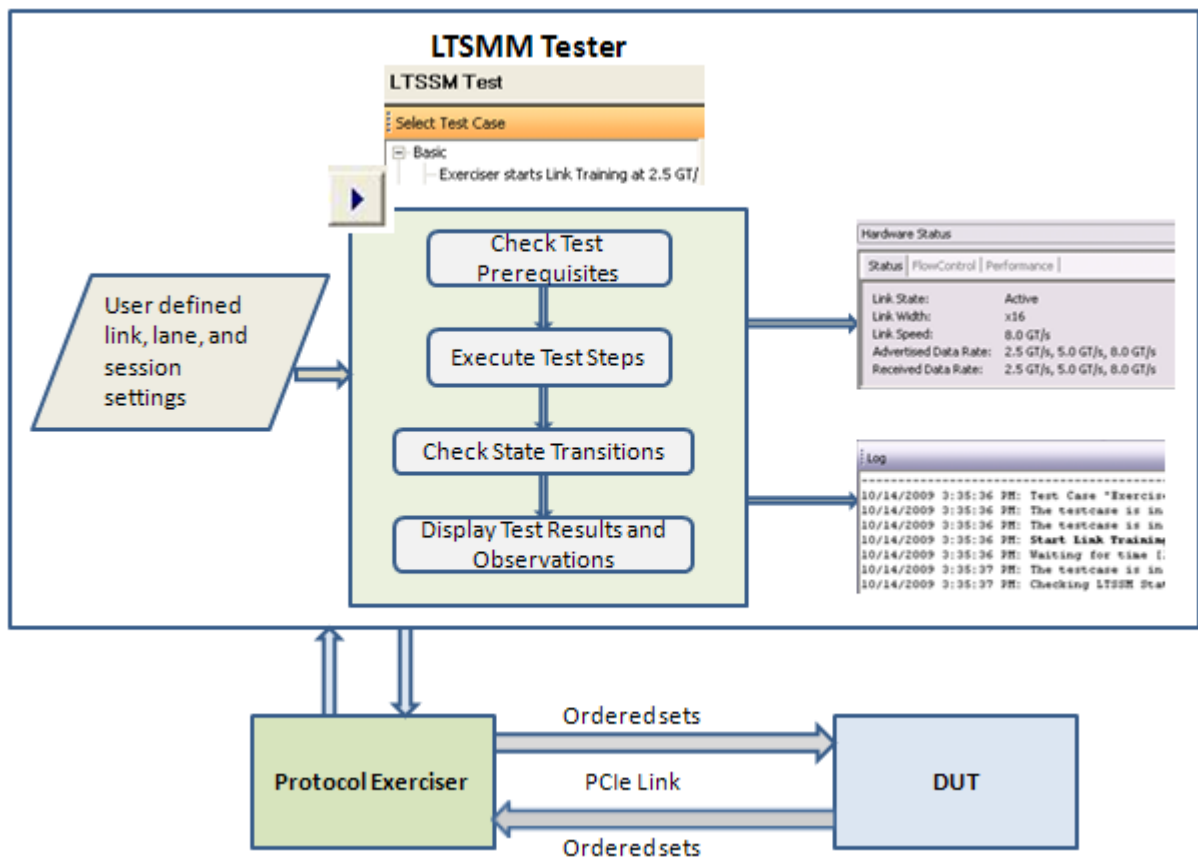
All the LTSSM tests are available in the LTSSM Tests tab of the Protocol Exerciser GUI. When a user runs an LTSSM test, the LTSSM Tester tool executes that test's steps taking all the required link, lane, equalization, and other settings as inputs. The test execution and observations depend on whether the Protocol Exerciser is acting as a USC or a DSC (based on the user-configured session type). Most of the tests have some prerequisites that need to be fulfilled. LTSSM Tester checks if the test prerequisites are met without which the test execution fails.

When LTSSM Tester starts executing the test, appropriate ordered sets are exchanged between the Protocol Exerciser and DUT as per the PCIe specifications. During the test execution, Protocol Exerciser transits through various applicable LTSSM states and forces the DUT to make the changes to its LTSSM states so that you can verify the state transitions. By looking at the responses from the DUT, Protocol Exerciser checks if the DUT has taken the correct arcs in the state-machine and made the correct transitions or not. LTSSM Tester captures and displays the state transitions in a test log to help you identify the source of problem (if any) and debug when the test stops.

As a USC, Protocol Exerciser performs all the necessary steps of the LTSSM function for which the test is executed. As a DSC, it responds to the steps of the LTSSM functions that DUT performs for that test.

When the test execution completes, LTSSM Tester updates the status of the link, lane, and other relevant settings that are impacted by the test execution. These updates are displayed in the Hardware Status window of the Protocol Exerciser GUI. The test result and the applicable LTSSM state transitions (expected and actual) are displayed in the test log pane of the GUI. If an actual state transition is different from the expected state transition, the test fails notifying the user about the state at which it failed. LTSSM Tester also displays the timestamp for each state transition to indicate the time taken to transit from one state to another.

The following diagram illustrates the working of LTSSM Tester.



**Figure 14** How LTSSM Tester Works

Consider an example of an LTSSM test to initialize and train the link to 2.5 GT/s with Protocol Exerciser acting as a USC and DUT as a DSC.

When you execute the Link training test, LTSSM Tester checks the data rate capability of the Protocol Exerciser, selected link width, lane settings, and other relevant settings. Protocol Exerciser then starts performing the link training sequence. It exchanges training sequences with DUT to negotiate link parameters such as link speed, link width, lane polarity, link number, and scrambler enabled or disabled. Protocol Exerciser trains the link initially to 2.5 GT/s even if the link partners (Protocol Exerciser and DUT) are capable of transmitting at higher data rates. When the test execution completes, the link status (No link or Active), negotiated link speed and advertised and received data rate capabilities of Protocol Exerciser and DUT respectively are displayed in the Hardware Status window of the Protocol Exerciser GUI. Once the link is trained to 2.5 GT/s, the

LTSSM state transitions to L0 indicating that the link is operational. After this, Protocol Exerciser handles any upgrade to speed by retraining the link as a response to a self-initiated or DUT initiated speed change request. The following screen displays a sample test log generated for such a test with all the LTSSM state transitions while initiating the link to 2.5 GT/s.

```

Log
6/15/2010 9:23:51 PM: Check Prerequisites: Checking prerequisites succeeded.
6/15/2010 9:23:51 PM: The testcase is in progress...
6/15/2010 9:23:51 PM: The testcase is in progress...
6/15/2010 9:23:51 PM: Start Link Training: Link training started.
6/15/2010 9:23:51 PM: Waiting for time [1 seconds]...
6/15/2010 9:23:52 PM: The testcase is in progress...
6/15/2010 9:23:52 PM: Checking LTSSM State Transitions...
6/15/2010 9:23:52 PM: Actual: Electrical Idle          Timestamp: 0 ns
6/15/2010 9:23:52 PM: Actual: Detect.Quiet          Timestamp: 112 ns
6/15/2010 9:23:52 PM: Actual: Detect.Active        Timestamp: 12,000,176 ns
6/15/2010 9:23:52 PM: Actual: Polling.Active       Timestamp: 13,048,816 ns
6/15/2010 9:23:52 PM: Actual: Polling.Configuration Timestamp: 37,048,880 ns
6/15/2010 9:23:52 PM: Actual: Configuration.Linkwidth.Start Timestamp: 37,050,208 ns
6/15/2010 9:23:52 PM: Actual: Configuration.Linkwidth.Accept Timestamp: 37,052,160 ns
6/15/2010 9:23:52 PM: Actual: Configuration.Lanenum.Wait Timestamp: 37,052,400 ns
6/15/2010 9:23:52 PM: Actual: Configuration.Lanenum.Accept Timestamp: 37,054,304 ns
6/15/2010 9:23:52 PM: Actual: Configuration.Complete Timestamp: 37,054,784 ns
6/15/2010 9:23:52 PM: Actual: Configuration.Idle   Timestamp: 37,058,096 ns
6/15/2010 9:23:52 PM: Actual: L0                   Timestamp: 37,058,448 ns
6/15/2010 9:23:52 PM: Check test case result: Link is up.
6/15/2010 9:23:52 PM: Check test case result: Current link speed is 2.5 GT/s.
6/15/2010 9:23:52 PM: Check test case result: Current link width is x8.
6/15/2010 9:23:52 PM: Test Case Result: Success.
6/15/2010 9:23:52 PM: Test Case stopped.
    
```

Figure 15 Sample LTSSM test log



## Getting Started with LTSSM Tester

LTSSM Tester is integrated with Protocol Exerciser and all LTSSM functions are available as a tab in the Protocol Exerciser GUI.

### Accessing LTSSM Tester

You can access LTSSM Tester from the Navigation window of the Protocol Exerciser GUI.

#### To access LTSSM Tester

- 1 Start the Protocol Exerciser GUI. For information on starting the Protocol Exerciser GUI, refer to [Starting and Exiting the Protocol Exerciser GUI](#) on page 26.
- 2 Click the **LTSSM Test** icon in the Navigation window.

The **LTSSM Test** screen is displayed in the main Protocol Exerciser window.

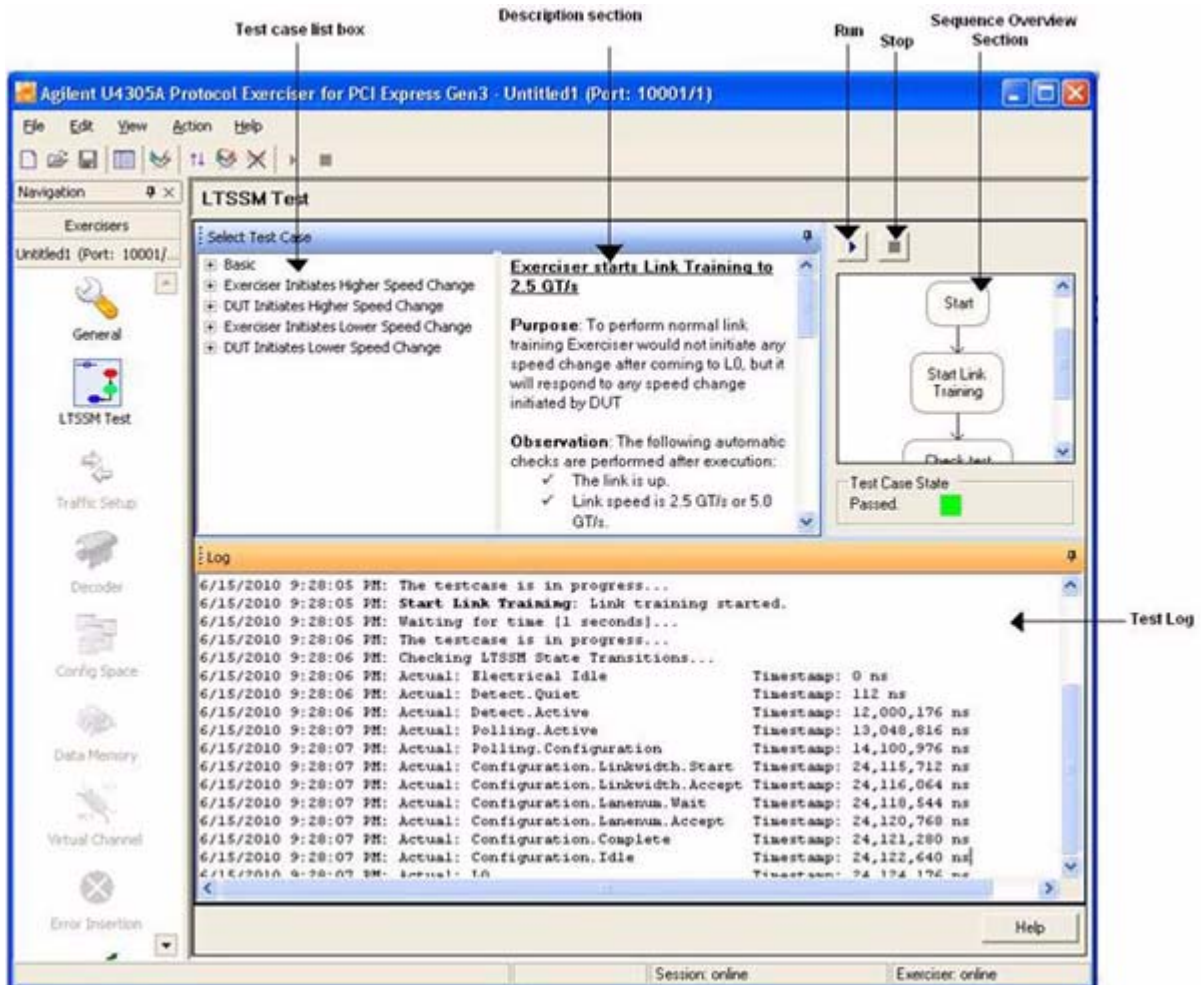


Figure 16 LTSSM Test screen

**NOTE**

In this release, except for the following icons, all other icons are disabled in the Navigation window of the Protocol Exerciser GUI:

- General
- LTSSM Test
- Protocol Checker

All the supported LTSSM tests are grouped under the LTSSM Tests listbox. On clicking a test, its description and sequence of execution steps are displayed in the Description and Sequence panes respectively.

The Log pane provides you details of the steps that the LTSSM Tester is performing during the test execution. It displays the prerequisites that are checked, the steps that are performed, and the LTSSM states that the LTSSM Exerciser transits during the test execution. Based on whether all the test prerequisites are met and whether all the LTSSM state transitions are as expected, the Log pane displays test result as Success or Failure.

**NOTE**

Refer to the Protocol Exerciser GUI Reference help topics in this user guide to get a detailed description of each field in the LTSSM Test page. Alternatively, click the Help button displayed in the tab page to get a context-sensitive help page.

## Prerequisites for LTSSM Testing


- Ensure that all the test specific prerequisites are met before executing the test. Each test has some prerequisites which are listed in the LTSSM Tests pane.
- Ensure that all the link and lane settings are configured using the General tab of the Protocol Exerciser GUI. Protocol Exerciser uses these settings for link negotiations during the link training sequence.
- Ensure that the Equalization and Transceiver settings (coefficients and presets) are appropriately configured for tests that perform or respond to the equalization procedure.
- Ensure that the DUT is connected to the Protocol Exerciser.

## Testing Link Initialization, Training, and Management

### LTSSM Tests

LTSSM Tester provides a set of predefined LTSSM tests that you can run from the **LTSSM Test** tab of the Protocol Exerciser GUI.



To run a test, click the  icon. Before running a test, check if all the test prerequisites stated in the Prerequisites section of the test are met.

#### Sequence of Steps in LTSSM Tests

- 1 For an LTSSM test, LTSSM Tester first checks the test prerequisites.
- 2 If all prerequisites are met, the training sequence is started and LTSSM state transitions are captured, checked and displayed.
- 3 If an LTSSM state transition is not as per the PCIe specifications, the test stops and fails.
- 4 The test result is displayed along with the reason for the test failure if the test failed.

#### Understanding the Test Results

The test results are displayed in the Log pane of the LTSSM Tests window. A test Log helps to identify the root cause of a problem. For instance, the test log shows test failure due to an unexpected LTSSM state change (RecRvcfg was expected but RecSpeed transition happened). This pane displays the following information with the date and time stamp:

- Name of the executed test.
- The list of prerequisites that are being checked for the test execution.
- The status of the "Check prerequisites" step. It displays Success if all the prerequisites are met and displays Failed if one or more prerequisites are not met causing the test to fail.
- The LTSSM states through which Protocol Exerciser transits during the test execution. If any of the LTSSM state transitions is missing or is not the expected state transition specified in the PCIe specifications, the test fails stating the LTSSM state which caused the test to fail.

- The test case result based on whether or not all prerequisites are met and all the LTSSM state transitions are as per the expected state transitions in PCIe specifications. It displays Success, Failure, or Cancelled by user. It also displays the outcome of the test in terms of the current link speed, link width and link status.

You can save the test results as an RTF or a TXT file by right-clicking anywhere inside the Log pane and clicking Save as...

In this release, the following LTSSM tests are provided. Click a test to get a detailed description of its usage, flow, and test results.

#### **Basic Tests**

- [Exerciser starts Link Training to 2.5 GT/s](#) on page 69
- [Exerciser starts Link Training to 2.5 GT/s](#) on page 69
- [Exerciser Initiates Transition to Recovery Test](#) on page 80
- [Exerciser starts Link Training to 2.5 GT/s](#) on page 69

#### **Link Speed Upgrade tests**

- [Exerciser starts Link Training to 2.5 GT/s](#) on page 69
- [Exerciser starts Link Training to 2.5 GT/s](#) on page 69

#### **Link Speed Downgrade Tests**

- [Exerciser starts Link Training to 2.5 GT/s](#) on page 69
- [Exerciser starts Link Training to 2.5 GT/s](#) on page 69

## **Testing Link Training**

### **Exerciser starts Link Training to 2.5 GT/s**

#### **Description**

This test initializes and trains the PCIe link between the Protocol Exerciser and DUT to 2.5 GT/s. Even if the data rate capabilities of both the link partners is higher, the test trains the link to 2.5 GT/s. However, the link speed can later be upgraded by running a link speed change LTSSM test.

In this test, Protocol Exerciser performs link training and exchanges training sequences with DUT to negotiate link parameters like:

- lane polarity
- link number

- set of lanes that belong to the link
- lane numbers
- scrambler enabled or disabled
- link speed
- number of fast training sequences required

### Usage

- You can use this test to check if the DUT's LTSSM can initialize the link to 2.5 GT/s. This is the basic test to test the linkup between Protocol Exerciser and DUT. You can use this test as the initial test to test other scenarios such as link transition to recovery and autonomous or manual speed changes after the link initializes to 2.5 GT/s.
- This test also lets you check whether DUT initializes the link with the user-configured link and lane settings such as lane polarity inversion or lane reversal negotiated during the training sequence. You can test if the DUT can understand and implement polarity inversion for lanes if you selected this option for lanes.

### Test Results

If the test passes, the LTSSM state is **L0** indicating that the link is up and operational. The link status is displayed as **Active** in the Hardware Status window to indicate the successful link up.

If the test fails, it indicates:

- Link is not up.
- Link or lane settings incompatibility on either of the two link partners side. For instance, Polarity inversion set for the Transmitter of the Protocol Exerciser but not implemented on DUT or data scrambling enabled at USC but not at DSC.
- Missing or unexpected LTSSM state transitions. For instance, the test log shows test failure when the LTSSM state does not transit to Configuration.Linkwidth.Start after Polling.Configuration while running the link training test.

### Exerciser starts Link Training to 8.0 GT/s with Equalization Tests

LTSSM Tester provides the following two tests to train the link to the 8.0 GT/s speed with the execution of the Equalization procedure.

- Link training to 8.0 GT/s with the execution of all the phases of Equalization
- Link training to 8.0 GT/s with only the first phase of Equalization

Both these tests are described below with a focus on the difference in their Equalization execution.

### **Link training to 8.0 GT/s with all the phases of Equalization test**

#### **Description**

This test initializes and trains the PCIe link between the LTSSM Exerciser and DUT to 2.5 GT/s initially. If the data rate capabilities of both the link partners is advertised as 8.0 GT/s, the test initiates the transition to the Recovery.Equalization sub state to perform all the phases of the Equalization procedure before moving the link to 8.0 GT/s. While performing equalization, Protocol Exerciser advertises the Equalization settings (presets, coefficients, and voltage swings) that you specified in the Equalization Settings page as its Tx capabilities for the transmission of training sequences. In phase 2 and 3, DUT and Exerciser tune the equalization settings by requesting a change in the coefficients at the transmitter of the link partner. Protocol Exerciser uses the equalization settings specified in the Equalization Settings page to perform or respond to these phases. If the Equalization phases are successfully done, then both Protocol Exerciser and DUT transition to the Recovery.RcvrLock sub state to proceed towards making the link operational at the 8.0 GT/s speed.

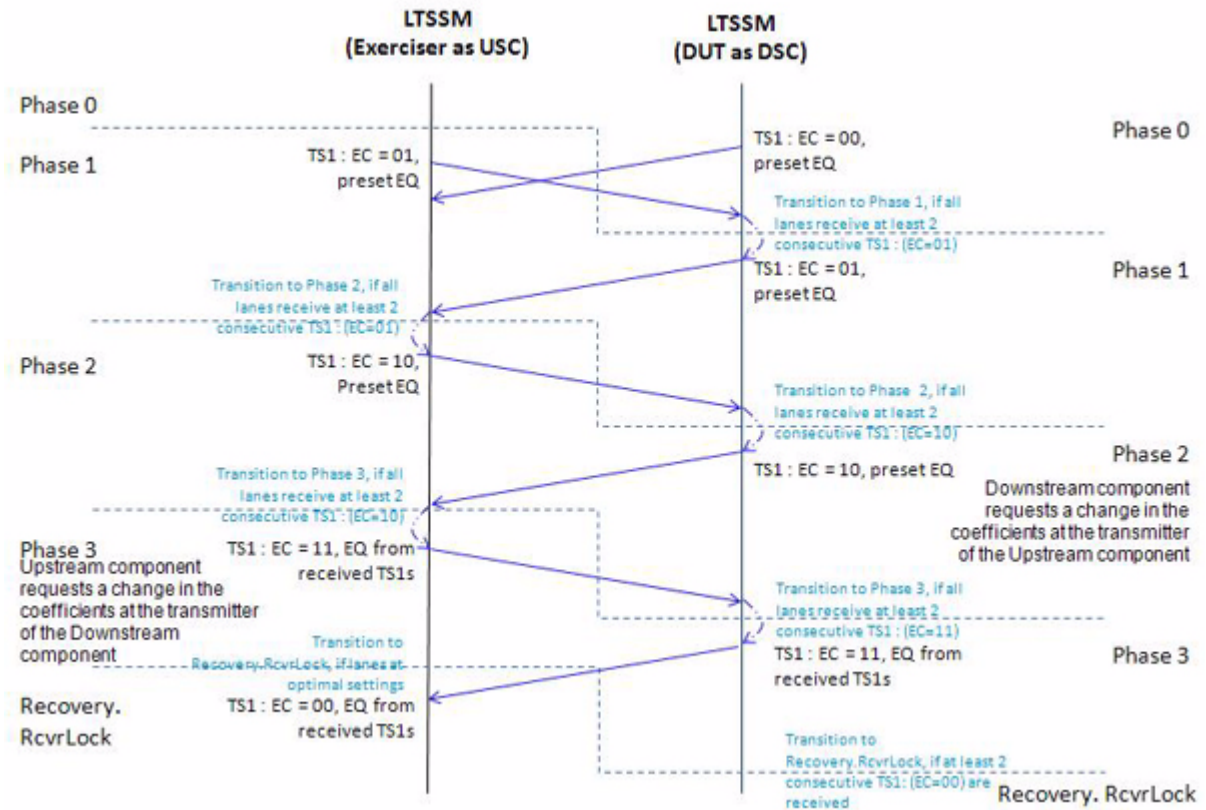
#### **Usage**

- You can use this test to check the full execution of the equalization procedure with DUT acting as a USC or a DSC.
- You can verify the Equalization substates entered after reaching to 2.5 GT/s and before achieving 8.0 GT/s.
- You can use this test to troubleshoot at which phase of equalization, the problem occurs.

#### **Test Flow**

This section displays the sequence of test execution in terms of the LTSSM state transitions and the steps performed by DUT and Protocol Exerciser during the test execution.

The following figure displays the test flow during the Equalization phases when Exerciser acting as a USC has trained the link to 2.5 GT/s and moved to the Recovery.Equalization substate to perform all the phases of equalization before moving the link to 8 GT/s.



### Test Results

If the test passes, the LTSSM state is L0 indicating that the link is up and operational at 8.0 GT/s. The link status is displayed as Active in the Hardware Status window to indicate successful link up.

If the test fails, it indicates:

- One or more of the test prerequisites are not met.
- Link or lane settings incompatibility on either of the two link partners side. For instance, Polarity inversion set for the Transmitter of the Protocol Exerciser but not implemented on DUT.
- Failure of transition to correct Equalization substates while performing Equalization.
- Inappropriate Equalization settings.



You can try fine tuning the Tx De-emphasis values for the Protocol Exerciser and the DUT using the Equalization Settings tab.

### **Link training to 8.0 GT/s with the first phase of Equalization test**

#### **Description**

This test initializes and trains the PCIe link between the Protocol Exerciser and DUT to 2.5 GT/s initially. If the data rate capabilities of both the link partners is advertised as 8.0 GT/s, the test initiates the transition to Recovery to perform the first phase of the Equalization procedure before achieving 8.0 GT/s. During link training, the first phase requires both USC and DSC to advertise the preset values. Protocol Exerciser advertises the Equalization settings (presets, co-efficients, and voltage swings) that you specified in the Equalization Settings page as its Tx capabilities for the transmission of training sequences. USC exits the Recovery.Equalization sub-state after phase 1 and transitions to the Recovery.RevrLock substate to proceed towards making the link operational at the 8.0 GT/s speed.

#### **Usage**

- You can use this test to check if the DUT's LTSSM can initialize the link to 8.0 GT/s with the execution of phase 1 of equalization.
- You can verify the Equalization substates entered after reaching to 2.5 GT/s and before achieving 8.0 GT/s.
- You can use this test to troubleshoot whether or not the device is capable of undergoing the first phase of equalization while achieving 8.0 GT/s.

#### **Test Results**

If the test passes, the LTSSM state is L0 and link speed is 8.0 GT/s indicating that the link is up and operational at 8.0 GT/s. The link status is displayed as Active in the Hardware Status window to indicate successful link up.

If the test fails, it indicates:

- One or more of the test prerequisites are not met.
- Link or lane settings incompatibility on either of the two link partners side. For instance, Polarity inversion set for the Transmitter of the Protocol Exerciser but not implemented on DUT.

- Failure of transition to correct LTSSM states while performing Equalization.
- Inappropriate Equalization settings.

You can try fine tuning the Tx De-emphasis values for the Protocol Exerciser and DUT using the Equalization Settings tab.

## Testing Link Speed Changes

### Link Speed Change Without Equalization Tests

This topic describes the LTSSM tests that you can use to test the DUT's LTSSM function of performing or responding to link speed changes on a configured link. In these tests, Equalization is not performed when moving to the 8.0 GT/s speed from 2.5 GT/s or 5.0 GT/s. The tests transitions the LTSSM of link partners to Recovery and then back to the operation state at the new speed.

Before executing a link speed change test:

- ensure that the Protocol Exerciser's data rate capabilities are appropriately set to support the desired link speed. You set data rate capabilities using the Link Settings page of the General icon in the Protocol Exerciser GUI. If one of the link partners does not support the desired link speed, then the test fails stating that the prerequisites is not met.

#### NOTE

For link speed change to 8.0 GT/s tests, the Equalization options that you enabled/disabled in the **Equalization Settings** tab are over-ridden by the equalization options relevant for the test when the test is running. However, the equalization options that you set are reverted back when the test execution is over.

For instance, you have not deselected the **Perform Equalization in recovery @ 8 GT/s** option in the **Equalization Settings** tab and executed the LTSSM test to upgrade the link speed to 8.0 GT/s without equalization. In this situation, the test overrides the enabled equalization setting and skips equalization while upgrading to 8.0 GT/s.

### Description

Once the link is up between the Protocol Exerciser and DUT, you can use various link speed change tests available in the LTSSM Tester to upgrade the link speed or later downgrade it for link bandwidth management testing.

These tests are categorized into:

- **Link upgrade speed tests** – The tests support the following speed upgrades:
  - 2.5 to 5.0
  - 5.0 to 8.0 without Equalization
  - 2.5 to 8.0 without Equalization
- **Link downgrade speed tests** – The tests support the following speed downgrades:
  - 8.0 to 5.0
  - 5.0 to 2.5
  - 8.0 to 2.5

These tests are further categorized on the basis of the link partner (Protocol Exerciser or DUT) from where you want to initiate the link speed change request. Once the request is initiated, based on whether the Protocol Exerciser is acting as a USC or a DSC for the session, it performs or responds to these link speed change requests during the test execution.

**NOTE**

If you want to test a link speed change request initiated by DUT, then you manually need to change the link speed at the DUT end on receiving instructions during the test execution.

Using these tests, you can also test the implementation of the autonomous speed change while changing the link speed to 8.0 GT/s on a configured link.

**Usage**

You can use the link speed change tests to assess:

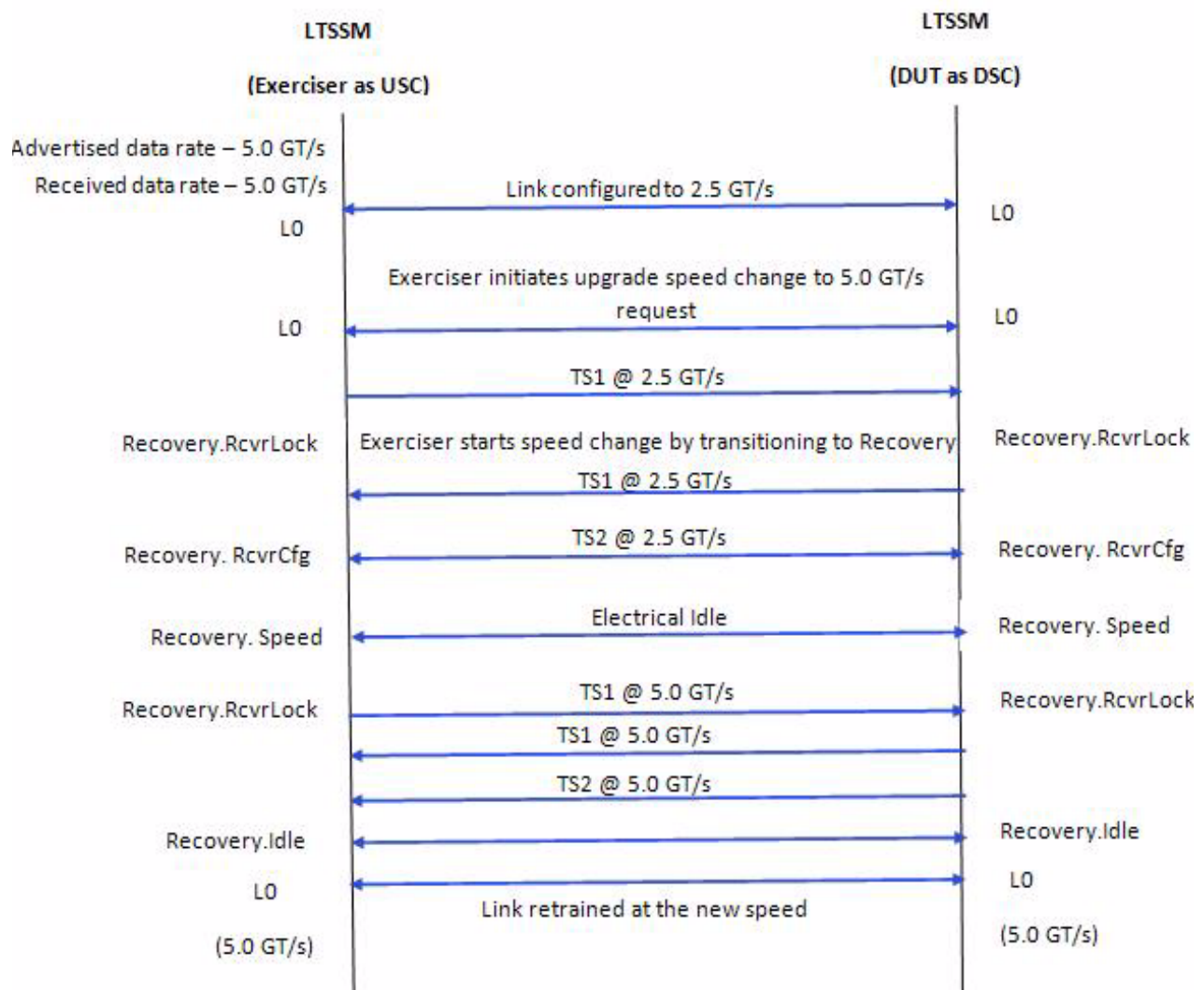
- DUT's capabilities to perform or respond to link bandwidth management requests.
- DUT's capabilities to upgrade to 8.0 GT/s without the equalization procedure on a configured link.
- The interconnect data rate as a result of the link speed changes and data rate capabilities of link partners.

- The LTSSM state transitions are as per the PCIe specifications. For instance, LTSSM state transitions to all the appropriate substates of Recovery before making the link operational at the desired speed change.
- Whether or not DUT enters the Equalization substates before moving the link speed to 8.0 GT/s.

### **Test Flow**

This section displays the sequence of the test execution in terms of the LTSSM state transitions and the steps performed by DUT and LTSSM Exerciser during the test execution.

The following figure displays the test flow when Exerciser initiates the request to upgrade the link speed from 2.5 to 5.0 GT/s with LTSSM Exerciser acting as a USC.



### Test Result

If the link speed change test passes, the link is operational and trained to the new (desired speed).

If the test fails, it indicates:

- One or more of the listed test prerequisites failed.
- Data rate incompatibility. Either of the two link partners does not support the desired link speed.
- Missing or unexpected LTSSM state transitions. For instance, the test log shows test failure for an upgrade speed test when the LTSSM state transits to **Rec.Speed** instead of the expected **Rec.RcvrCfg** after **Rec.RcvrLock**.
- Transition to Equalization substate(s) by a link partner for a speed upgrade to 8.0 GT/s.

## Link Speed Change With Equalization Tests

This topic describes the LTSSM tests that you can use to test the DUT's LTSSM function of performing or responding to link speed change to 8.0 GT/s on a configured link. In these tests, equalization is performed before moving to the 8.0 GT/s speed. You can choose a test based on whether you want the test to perform only phase 1 or all the phases of equalization.

In phase 1 of equalization, both DUT and Protocol Exerciser advertise their equalization preset values. In phase 2 and 3, DUT and Exerciser tune the equalization settings by requesting a change in the coefficients at the transmitter of the link partner. Protocol Exerciser uses the equalization settings specified in the Equalization Settings page to perform or respond to these phases.

Either DUT or Exerciser can initiate these tests for a link configured to 2.5 GT/s or 5.0 GT/s. Based on whether the Protocol Exerciser is acting as a USC or a DSC for the session, it performs or responds to these link speed change requests during the test execution.

Before executing a link speed change test:

- ensure that the Protocol Exerciser's data rate capabilities are set to support the desired link speed, 8.0 GT/s. You set data rate capabilities using the Link Settings page of the General icon in the Protocol Exerciser GUI. If one of the link partners does not support the 8.0 GT/s link speed, then the test fails stating that the prerequisites are not met.
- ensure that the preset, co-efficient, and minimum/maximum voltage swing values are set for the Protocol Exerciser transmitter part. Also, the equalization setting values that the Protocol exerciser sends to DUT as a request to use these settings to tune the equalization should be set. You use the Equalization settings page to configure these settings.

**NOTE**

For these tests, the Equalization options that you enabled/disabled in the Equalization tab are over-ridden by the equalization options relevant for the test when the test is running. However, the equalization options that you set are reverted back when the test execution is over.

For instance, you have not enabled the **Perform Equalization in recovery @ 8 GT/s** option in the **Equalization Settings** tab and executed the LTSSM test to upgrade the link speed to 8.0 GT/s with equalization. In this situation, the test overrides the disabled equalization setting and performs equalization while upgrading to 8.0 GT/s.

**Description**

Once the link is up between the Protocol Exerciser and DUT, you can use various link speed change tests available in the LTSSM Tester to upgrade the link speed to 8.0 GT/s to specifically test the Gen3 speed bandwidth management.

The tests support the following speed upgrades:

- 5.0 to 8.0 with phase 1 or all phases of equalization
- 2.5 to 8.0 with phase 1 or all phases of equalization

These tests are further categorized on the basis of the link partner (Protocol Exerciser or DUT) from where you want to initiate the link speed change request. Once the request is initiated, based on whether the Protocol Exerciser is acting as a USC or a DSC for the session, it performs or responds to these link speed change requests during the test execution.

**NOTE**

If you want to test a link speed change request initiated by DUT, then you manually need to change the link speed at the DUT end on receiving instructions during the test execution.

Using these tests, you can test the implementation of the Equalization procedure while changing the link speed to 8.0 GT/s on a configured link.

**Usage**

You can use the link speed change tests to assess:

- DUT's capabilities to perform or respond to link bandwidth management requests.
- DUT's capabilities to implement the Equalization procedure while upgrading to 8.0 GT/s.

- The interconnect data rate as a result of the link speed changes and data rate capabilities of link partners.
- The equalization related LTSSM state transitions are as per the PCIe specifications.

### Test Result

If the link speed change test passes, the link is operational and trained to the new (desired speed).

If the test fails, it indicates:

- One or more of the listed test prerequisites failed
- Either of the two link partners does not support the 8.0 GT/s link speed.
- Missing or unexpected LTSSM state transitions. For instance, absence of transition to Equalization substates while moving to the 8.0 GT/s speed.

## Testing Link Retraining and Recovery

### Exerciser Initiates Transition to Recovery Test

#### Description

This test allows you to direct the LTSSM Tester to initiate the link retraining or recovery by transiting to the Recovery LTSSM state and then back to the Operational state.

When the test initiates link retraining/recovery, the link is retrained/recovered as per the link and lane settings negotiated during the initial link training sequence. For example, the link is trained to 2.5 GT/s and the data rate capabilities of DUT and Protocol Exerciser are 5.0 GT/s. By initiating the transition to Recovery, the negotiated data rate – 2.5 GT/s is used to recover and retrain the link. The Advertised and Received data rate capabilities are updated based on the current data rate capabilities of the link partners.

#### Usage

You can use this test to check:

- DUT's capabilities to respond to the transition to the Recovery state, in situations such as link errors.
- If the link is retrained/recovered as per the link and lane negotiations in the initial training sequence in response to an initiation of the transition to recovery.



### Test Results

The test passes if the link transitions to recovery and then back to the Operational state and the data rate at which the link is retrained is the initial data rate at which the link was initially trained. On the successful execution of the test, the link status is displayed as Active in the Hardware Status window.

If the test fails, it indicates:

- Link is not up.
- Link width is not x1, x4, x8 or x16.
- Failure of transition to the correct Recovery substates.

## Testing LTSSM State Transitions

### Capture State Transitions Test

#### Description

Protocol Exerciser and DUT transits through various LTSSM states while performing LTSSM functions. This test can capture and display a maximum of 512 consecutive LTSSM state transitions of the Protocol Exerciser to check the sequence of LTSSM transitions and identify the state at which a problem occurred.

#### Usage

When the link between the Protocol Exerciser and DUT is configured and operational, the link status is displayed in the Hardware Status window of the Protocol Exerciser GUI. The current state of link is reflected through this status (either No Link or Active). There may be situations when you want to troubleshoot the No Link status of the link by checking the LTSSM state transitions. In such situations, this test can provide you a trail of LTSSM state transitions to help you identify the source of problem in the link between DUT and Protocol Exerciser.

You can also use this test to check if the sequence of DUT's LTSSM state transitions for an LTSSM function is as per the PCIe specifications.

#### Test Results

If the test passes, the LTSSM state transitions are displayed in the test log along with the current link width and link status.





## 6 Protocol Exerciser GUI Reference

**Dialog Boxes 84**

**Menus 87**

**Windows 90**

This chapter provides description of each field, menu option, and toolbar option available in various windows and dialog boxes of the Protocol Exerciser GUI.



## Dialog Boxes

### Open dialog box

To access this dialog: Select **File > Open**. Select the file to open. Then, click **Open**.

Component	Description
Load following items	The <b>Load following items</b> list box provides you an expandable/collapsible check box list of exerciser settings. Here, select only those settings that you want to load from the *.exs file.
Description of file	The <b>Description of file</b> text box displays a brief description of the setup file, if exists.

### Port Selection dialog box

Component	Description
Module	The Module column provides a list of modules in the form of check boxes. These check boxes are organized under the expandable list of chassis to which they belong. Here, select a module on which you want to start a new session. A module, which is already associated with a session, appears disabled.
Type	The Type column shows the link width along with the speed of the port, such as 5.0Gb/s or 2.5Gb/s, at which it operates.
# Ports	The # Ports column displays the number of ports available for each module.
License	The License column displays the license details of each module.

Component	Description
Status	The Status column displays the status of each module. This column displays the following messages: <ul style="list-style-type: none"> <li>• <b>Rebooting</b>: This message indicates that the serial I/O module is restarting.</li> <li>• <b>Ready</b>: This message indicates that you can now add port to the session.</li> <li>• <b>Session_Name</b>: Session_Name is the name of the session. This message indicates that the Session_Name session is now connected with the port.</li> </ul>
Select Ports to use	Select the port to use from the <b>Select Ports to use</b> list box.

## Save dialog box

To access this dialog: Select **File > Save**.

Component	Description
Save following items	The <b>Save following items</b> list box provides you an expandable/collapsible check box list of exerciser settings. Here, select only those settings that you want to save in the *.exs file for later use.
Description for Setup file	The <b>Description for Setup file</b> text box allows you to specify a brief description for the setup file.

## Select type of connection dialog box

To access this dialog: Click **Start > Programs > Agilent SPT > PCIe Exerciser 8.1 Release > Exerciser GUI**.

Component	Description
Connect to existing session	Select <b>Connect to existing session</b> if you want to use an existing session of Protocol Exerciser on a known server. The existing session can be either initiated by the API or by another GUI since multiple GUIs can share the same session.

Component	Description
Connect to new session	Select <b>Connect to new session</b> if you want to create a new Protocol Exerciser session on a known server.
Offline mode	Select <b>Offline</b> mode if you want to access the Protocol Exerciser GUI without connecting to the hardware.
Server	Specifies the name or IP address of the server, where you want to start a new or join an existing Protocol Exerciser session. Its default value is <b>localhost</b> .
Get session list	Click <b>Get session list</b> to retrieve a list of existing Protocol Exerciser sessions from the server you specified in the <b>Server</b> text box. This button works only if you have selected the <b>Connect to existing session</b> option.
Session list	Displays a list of sessions existing on the server you specified in the <b>Server</b> text field.
Start	Click <b>Start</b> to start a new Protocol Exerciser instance.
Exit	Click <b>Exit</b> to close the dialog box without starting the Protocol Exerciser application.

## Menus

### Action Menu

The following is a brief description of the Action menu commands. Some of the options which are not supported in this release are disabled in the GUI.

Menu command	Description
Link Up	Performs a Link-Up between Protocol Exerciser and DUT as per the configured link and lane settings.
Initiate Speed change	Initiates speed change to the highest data rate advertised by both the link partners during link training.
Initiate Retrain Link	Retrains the Link.
Disable Exerciser Transmitter	Disables the exerciser transmitter.
Reload Data Memory	Reloads Data Memory from Exerciser.
Initialize Data Memory	Opens a dialog to initialize the Exerciser Data Memory.

### Edit Menu

The following is a brief description of the Edit menu commands.

Menu command	Description
Find in Data Memory	Allows finding particular pattern in the Exerciser Data Memory.
Goto Data Memory Address	Moves the cursor to a particular memory address of the Exerciser Data Memory.

### File Menu

The following is a brief description of the File menu commands.

Menu command	Description
New	Opens the port selection dialog box.

Menu command	Description
Open	Displays the Open dialog box that enables you to open the saved session information.
Save	Displays the Save dialog box that enables you to save the session information. You can enter the location and a file name for the data to be saved. After confirming these entries an additional dialog pops up as seen in the figure below. You can define if all or a subset of the Exerciser setting should be saved. As default all possible data will be saved.
Save As	Displays the Save As dialog box that enables you to specify the desired location to save the session information.
Close	Closes the selected session.
Exit	Closes the Protocol Exerciser application.

## Help Menu

The Help menu provides access to:

Menu command	Description
Help Topics	Opens the main help menu.
Session Information	Provides an information dialog containing the IP address of the server the module is connected to, the session ID and the used module.
Version Information	Provides an information dialog containing the software version number of the Exerciser solution, outlining the different elements of the solution.
About	Displays the about dialog.

Please have the complete version information available in case you need to contact Agilent support.

## View Menu

The following is a brief description of the View menu commands.



Menu command	Description
Navigation Window	Displays the Navigation Window.
Hardware Status Window	Display the Hardware Status Window.

## Windows

### General Function Equalization Settings tab

To access this function: Click **General** in the Navigation pane. Then, click the **Equalization Settings** tab.

Refer to the topic Configuring Equalization Procedure Settings in the main online help of Protocol Exerciser to know more about the Equalization implementation in Protocol Exerciser.

The **Equalization Settings** tab is broadly divided into two groups - **5.0 GT/s** and **8 GT/s** allowing you to configure the Equalization settings separately for 5.0 GT/s and 8 GT/s speeds. The **8 GT/s** group is further organized into two groups - **Request to DUT** and **Exerciser**. The following table describes fields in all these groups and subgroups.

Field	Description
<b>5.0 GT/s</b>	
De-emphasis shown in TS	Provides options to specify the Tx De-emphasis settings in training sequences (TS1 and TS2). You can set the de-emphasis level that the Protocol Exerciser will use for the transmission of training sequences at 5.0 GT/s.
<b>8 GT/s</b>	
<b>Request to DUT</b>	This group box provides options to configure the Equalization settings that the Protocol Exerciser will send to DUT in the training sequences to request DUT to use the specified presets and co-efficient values.
Tx Preset Value	Options to set the Tx De-emphasis preset value that the Protocol Exerciser will send to DUT in the training sequences to request DUT to use the specified preset.
Tx pre cursor coefficients	Options to set the Tx coefficient –C1 value from the Tx Equalization Finite Impulse Response Filter.
Tx data cursor coefficients	Options to set the Tx coefficient C0 value from the Tx Equalization Finite Impulse Response Filter.
Tx post cursor coefficients	Options to set the Tx coefficient +C1 value from the Tx Equalization Finite Impulse Response Filter.
Rx preset hints	Options to set the preset value that the Protocol Exerciser will send to the DUT as a Hint for the Rx Equalization value based on the trace length of the DUT.
<b>Exerciser</b>	This group box provides options to configure Equalization settings that the Protocol Exerciser will use and advertise as its Tx capabilities during the link training.
FS	Options to set the value for Full Swing (FS) resolution for de-emphasis. Protocol Exerciser advertises this value in Phase 1 of Equalization.

Field	Description
LF	Options to set the value for Low Frequency (LF) resolution for de-emphasis.
Tx Preset Value	Options to set the Tx De-emphasis preset value that the Protocol Exerciser advertises as its Tx capabilities during the link training at 8.0 GT/s.
Tx pre cursor coefficients	Options to set the Tx coefficient -C1 value from the Tx Equalization Finite Impulse Response Filter. The three Tx co-efficient values set for the Exerciser should add up to the specified FS value.
Tx data cursor coefficients	Options to set the Tx coefficient C0 value from the Tx Equalization Finite Impulse Response Filter. The three Tx co-efficient values set for the Exerciser should add up to the specified FS value.
Tx post cursor coefficients	Options to set the Tx coefficient +C1 value from the Tx Equalization Finite Impulse Response Filter. The three Tx co-efficient values set for the Exerciser should add up to the specified FS value.
Ignore coefficient rule checks	Selecting these check boxes allow you to break the specified co-efficient rule(s) so that you can test how the DUT responds when a co-efficient rule is ignored.
Perform Equalization in Recovery @8 GT/s	The <b>Perform Equalization in Recovery @8 GT/s</b> option ensures that Protocol Exerciser (acting as a USC) must perform Equalization when upgrading the link speed to 8.0 GT/s. If this option is not selected, then the link speed is upgraded without performing equalization. A USC performs the phases of equalization. Therefore, this option is applicable only for a USC and is disabled when Protocol Exerciser acts as a DSC, that is when the Session type is configured as ToUpstream.
Request Equalization in Recovery @8 GT/s	The <b>Request Equalization in Recovery @8 GT/s</b> option ensures that Protocol Exerciser (acting as a DSC) should request the USC to redo equalization. This option is applicable only for a DSC. Therefore, this option is disabled when Protocol Exerciser acts as a USC, that is the Session type is configured as ToDownstream.
Perform Phase 2/Phase 3	Selecting the <b>Perform Phase 2/Phase 3</b> option instructs Protocol Exerciser to perform the phase 2 and phase 3 of the Equalization procedure before moving the link to 8 GT/s. If this option is not selected, then Protocol Exerciser exits the Recovery.Equalization sub-state after phase 1 and transitions to the Recovery.RcvrLock substate to proceed towards achieving the 8.0 GT/s speed. A USC performs the phases of equalization. Therefore, this option is applicable only for a USC and is disabled when Protocol Exerciser acts as a DSC, that is when the Session type is configured as ToUpstream.

## General Function Lane Settings tab

To access this function: Click **General** in the Navigation pane. Then, click the **Lane Settings** tab.

Field	Description
Reverse Lanes	Provides the following option buttons for transmitter (Tx): <ul style="list-style-type: none"> <li>• <b>Yes:</b> Select to enforce the lanes reversal manually on physical lanes by reversing the logical lane numbers.</li> <li>• <b>No:</b> Select to not enforce lane reversal.</li> </ul>
Lane Reversal Capability	Provides the following option buttons for transmitter (Tx): <ul style="list-style-type: none"> <li>• <b>Disabled:</b> Automatically deactivates the lane reversal capability.</li> <li>• <b>Enabled:</b> Automatically activates lane reversal capability when needed.</li> </ul>
Lane Polarity	Provides options to set the polarity of the individual lanes to <b>Normal</b> or <b>Inverted</b> for transmitter (Tx). Lane numbers available for lane polarity setting vary from 0 to 15 based on the advertised link width.

## General Function Link Settings tab

To access this function: Click **General** in the Navigation pane. Then, click the **Link Settings** tab.

Field	Description
Supported Link Widths	Enables you to specify the desired link width to use for data transfer. Here, only those link widths, which are supported by Protocol Exerciser, are available for selection. The link widths, which are not supported by Protocol Exerciser, are disabled. The <b>x1</b> check box is by default selected. This is because the support for <b>x1</b> is mandatory as per PCI Express specification.
Negotiated Link Width	Displays the link width that Protocol Exerciser and DUT have agreed upon after link up.
Link number advertised	Enables you to specify the link number that you want to advertise in training sequences. The link number specified here should be in the range of zero to 255.
Data Rate Capability	Enables you to select the data rate capability of Protocol Exerciser. This data rate is advertised during the link training sequence to perform link speed negotiations. You can select a data rate capability from the following options: <ul style="list-style-type: none"> <li>• 2.5 GT/s</li> <li>• 5.0 GT/s - Advertised data rate is then 2.5 and 5.0 GT/s</li> <li>• 8.0 GT/s - Advertised data rate is then 2.5, 5.0, and 8.0 GT/s</li> </ul>

Field	Description
Autonomous speed change to 8 GT/s	Select this check box to enable autonomous speed change to the 8 GT/s speed. This ensures that Protocol Exerciser autonomously moves the link to 8.0 GT/s during the link training if the data rate capability of both the link partners is 8.0 GT/s. If this option is selected, Protocol Exerciser must perform equalization at the first entry to 8GT/s after exit from the Detect State. This option is applicable only when you are using Protocol Exerciser as a USC that is, the Session Type is configured as ToDownstream.
Scrambler (2.5 GT/s and 5.0 GT/s)	<p>The <b>Scrambler</b> drop-down list provides the following options:</p> <ul style="list-style-type: none"> <li>• <b>Enabled:</b> Selecting this option enables or disables scrambling of data depending on the state of the Disable Scrambling bit of the link partner during link training.</li> <li>• <b>Disabled:</b> Selecting this option disables the scrambling of data and also sets the Disable Scrambling bit in the link control field of training sequences during link training.</li> </ul> <p>This option is not applicable for 8 GT/s link speed. At the Gen3 speed, scrambling is always enabled to follow the new Gen3 Scrambling Rules as listed in the PCIe specifications.</p>
Session Type	<p>The <b>Session Type</b> drop-down list provides the following options:</p> <ul style="list-style-type: none"> <li>• <b>To Downstream:</b> Select this option when Protocol Exerciser emulates a root complex and you are testing a PCIe device at end point. The Protocol Exerciser then acts as an Upstream Component (USC) and performs the training sequences during its use as an LTSSM.</li> <li>• <b>To Upstream:</b> Select this option when Protocol Exerciser emulates an end point and you are testing a PCIe device at root-complex. The Protocol Exerciser then acts as a Downstream Component (DSC) and responds to the training sequences during its use as an LTSSM.</li> </ul>

## General Function Symbol Settings tab

To access this function: Click **General** in the Navigation pane. Then, click the **Symbol Settings** tab.

Field	Description
<b>2.5 GT/s and 5.0 GT/s</b>	
SKP Interval (in number of symbols)	Enables you to specify the symbol time gap between two SKP ordered sets.
Number of SKP symbols in SKP ordered sets	Provides options to specify the number of SKP symbols, ranging between 1 to 5, to be included in an ordered set.
<b>8.0 GT/s</b>	
SKP Interval (in number of blocks)	Enables you to specify the block time gap between two SKP ordered sets.

Field	Description
Number of SKP symbols in SKP ordered sets	Provides options to specify the number of SKP symbols, ranging between 8 to 24, to be included in an ordered set.

## General Function Transceiver Settings tab

To access this function: Click **General** in the Navigation pane. Then, click the **Transceiver Settings** tab.

These settings control the Protocol Exerciser Tx and Rx equalization settings.

Field	Description
Tx output voltage	This setting controls the maximum Vout before any pre-emphasis or de-emphasis (Vd). The default value is 900 mV.
Tx Pre-emphasis Pre Tap	This setting controls the amount of pre-emphasis (Vc). As you move towards a more negative value, you get more Pre-emphasis.
Tx Pre-emphasis First Post Tap	Main De-emphasis value, which controls the amount of de-emphasis (Va). The higher the number, the higher is the de-emphasis.
Tx Pre-emphasis Second Post Tap	Second post-tap De-emphasis.
Rx Equalizer AC and DC Gain	These settings impact the Receiver equalization of the Protocol Exerciser. You can tune the Rx equalization by adjusting the AC and DC gain settings. Typically DC gain would be 0 or 3db gain.

Refer to the topic [Configuring Transceiver Settings](#) in the main online help of Protocol Exerciser to know more.

## General function - Trigger Out tab

To access this function: Click **General** in the Navigation pane. Then, click the **Trigger Out** tab.

Field	Description
Status	<p>The <b>Status</b> section shows the following messages:</p> <ul style="list-style-type: none"> <li>• <b>Accumulated events:</b> Shows a list of events that resulted in generating the trigger-out pulse since the last time you clicked Clear Status.</li> <li>• <b>First event:</b> Shows which first events, which occurred in the same timestamp, resulted in generating the trigger-out pulse since the last time you clicked Clear Status.</li> </ul>
Source Name	The <b>Source Name</b> column displays a list of events, such as Protocol Error and Going Out of L0, which you can use as a source to generate a trigger-out pulse.
Enabled	The <b>Enabled</b> column provides a check box for each event in the Source Name column. Here, select a the check box corresponding to a event that you want to use as a source to generate a trigger-out pulse.
Fired	<p>The <b>Fired</b> column shows the following messages for each event listed under the Source Name column:</p> <ul style="list-style-type: none"> <li>• <b>Fired:</b> This message appears when the corresponding event has occurred.</li> <li>• <b>Not fired:</b> This message appears when the corresponding event has not occurred.</li> </ul>
Mask All	Click <b>Mask All</b> to select all check boxes in the <b>Enabled</b> column. This, as a consequence, instructs Protocol Exerciser to trigger-out whenever one or more of the events listed under the <b>Source Name</b> column occur.
Unmask All	Click <b>Unmask All</b> to clear all check boxes in the Enabled column.
Clear Status	Click <b>Clear Status</b> to set the status of all events to Not fired.
Refresh Status	Click <b>Refresh Status</b> to refresh the status of all the events.

## LTSSM Tests

To access this page: Click the **LTSSM Test** icon in the Navigation window.

Field	Description
Select Test Case	<p>The <b>Select Test Case</b> pane has the following components:</p> <ul style="list-style-type: none"> <li>• <b>Test Case:</b> The Test Case list box provides a list of LTSSM test cases that you can select to run.</li> <li>• <b>Description:</b> The Description list box displays the description of the selected test case. A test case description is divided into the following heads: <ul style="list-style-type: none"> <li>• <b>Purpose:</b> This head states what the test case intends to do.</li> <li>• <b>Prerequisites:</b> This head states what should already be in place before you run the test case.</li> <li>• <b>Observation:</b> This head states the checks that are performed during the execution of a test case.</li> </ul> </li> </ul>
Sequence Overview	<p>The <b>Sequence Overview</b> section displays a flow-chart diagram to show the execution sequence of the selected test case.</p>
Run	<p>Click <b>Run</b> to start executing the selected test case.</p>
Stop	<p>Click <b>Stop</b> to halt the execution of the underlying test case.</p>
Test Case State	<p>The Test Case State section displays the following states that an executing test case goes through:</p> <ul style="list-style-type: none"> <li>• <b>Running:</b> Reflects that the test case is executing.</li> <li>• <b>Passed:</b> Reflects that the test case is successfully executed.</li> <li>• <b>Failed:</b> Reflects that executing test case is either cancelled by user or has met an unwarranted condition. You can cancel an executing test case by clicking the Stop button.</li> </ul>
Log	<p>The <b>Log</b> pane displays the data describing the various stages of the underlying test case. The Log pane has its own short-cut menu, which is displayed when you right-click anywhere inside it. This short-cut menu has the following commands:</p> <ul style="list-style-type: none"> <li>• <b>Clear Log:</b> Clears the Log pane.</li> <li>• <b>Copy to Clipboard:</b> Copies the data in the Log pane to clipboard.</li> <li>• <b>Save:</b> Displays the Save log file dialog box, which you can use to save the data shown in the Log pane to a file in RTF or TXT format.</li> </ul>

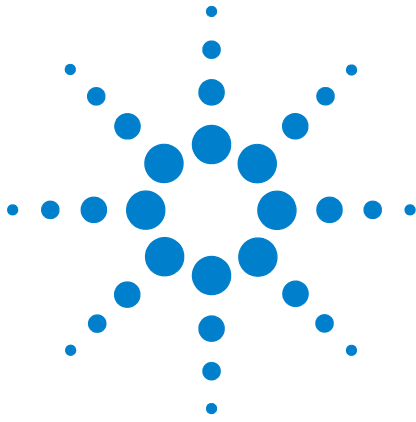


## Protocol Checker function

To access this function: Click **Protocol Checker** in the Navigation pane.

Field	Description
Status	<p>The Status section shows the following components:</p> <ul style="list-style-type: none"> <li>• <b>Violated Rules:</b> Shows a list of PCIe protocol rules that were violated since the last time you clicked <b>Clear Status</b>.</li> <li>• <b>First Violated:</b> Shows which first rules of the PCIe protocol were violated in the same timestamp since the last time you clicked <b>Clear Status</b>.</li> </ul>
Rule Name	The <b>Rule Name</b> column displays a list of PCIe protocol rules, which you can select to observe for violation.
Enabled	The <b>Enabled</b> column provides a check box for each rule in the Rule Name column. Here, select the check box corresponding to a rule that you want to observe for violation.
Violation	<p>The <b>Violation</b> column shows the following messages for each rule listed under the Rule Name column:</p> <ul style="list-style-type: none"> <li>• <b>Violated:</b> This message appears when the corresponding rule has been violated.</li> <li>• <b>Not Violated:</b> This message appears when the corresponding rule has not been violated.</li> </ul>
Mask All	Click <b>Mask All</b> to select all check boxes in the Enabled column. Use this command button when you want to enable all the rules listed under the Rule Name column.
Unmask All	Click <b>Unmask All</b> to clear all check boxes in the Enabled column.
Clear Status	Click <b>Clear Status</b> to set the status of all events to Not violated.
Refresh Status	Click <b>Refresh Status</b> to refresh the status of all the rules listed under the Rule Name column.





## 7 Performing Protocol Checks

**Using Protocol Checker 100**

This chapter provides information on the Protocol Checker function of the Protocol Exerciser application.



## Using Protocol Checker

Consider a situation in which you have linked up Protocol Exerciser with a DUT, and these two devices are transmitting data to each other. Now, you want to find out if the transmission between the two devices is adhering to the rules of the PCIe protocol. Or you want to test DUT by introducing a PCIe rule violation in the transmission, and want to see if that rule is actually violated. To help you in this situation, Protocol Exerciser provides you the Protocol Checker function.

The Protocol Checker function provides a list of PCIe protocol rules that you can select to observe them for violation. Once a protocol rule is enabled, Protocol Exerciser displays the name of rules in the Status pane of Protocol Checker when that rule is violated.

To access the Protocol Checker function:

- Click the **Protocol Checker** icon in the Navigation pane.

The following screen displays the Protocol Checker pane with two protocol rules displayed as violated out of the four enabled rules.

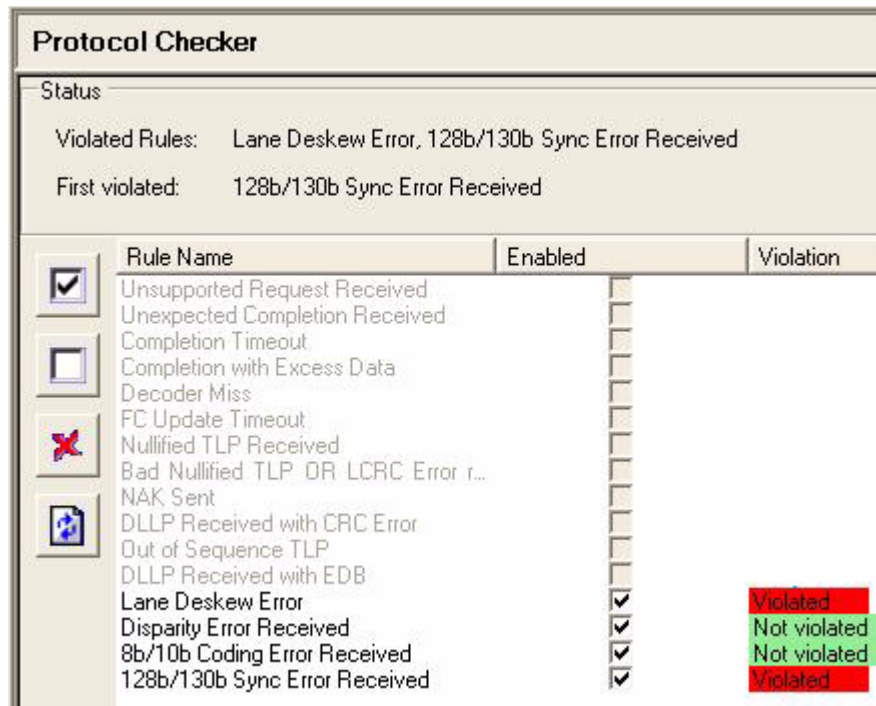


Figure 17 Protocol Checker

## Supported Protocol Checks

In this release, the following protocol checks are supported:

- Lane De-skew Error
- Disparity Error Received
- 8b/10b Coding Error Received
- 128b/130b sync error

## **7 Performing Protocol Checks**



## • A Updating the Firmware

**Using the Firmware Update Tool 104**

This appendix provides information on the Firmware Update tool.



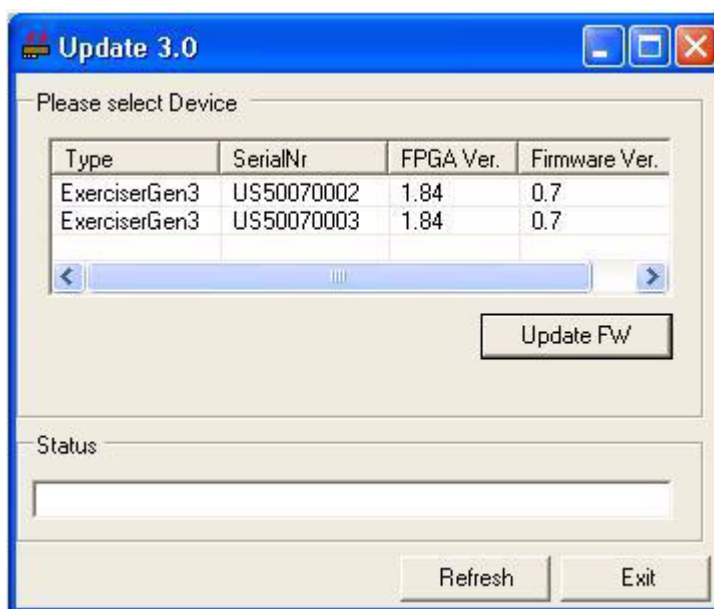
## Using the Firmware Update Tool

The Firmware Update tool is automatically installed during the Protocol Exerciser installation. You use this tool to update the Controller PC with the new firmware for the selected Exerciser card.

To access the Firmware Update tool:

Select **Start > Programs > Agilent SPT > PCIe Exerciser 8.1 Release -> Update GUI**.

The **Firmware Update** window appears.



**Figure 18** Firmware Update window

### NOTE

The cards shown with a grey background indicate that these are currently in use and cannot be updated. The cards displayed in red indicate that these cards need an update.

To Update the Firmware Version of the Exerciser Card

- 1 Select the Exerciser card, for which you want to update the Firmware, in the **Please Select Device** section.
- 2 Click **Update FW**.



This instructs the Controller PC to check for the new Firmware version for the selected exerciser card. If there is any new version, the Controller PC uses it to update its existing Firmware version.

Once the Controller PC is updated with the new firmware, the Status field in the Firmware Update tool shows Done.



# Index

## Symbols

.exs file, 36

## A

AC and DC Gain, 46  
 Auto-Hide a Floating Window, 32  
 Autonomous equalization, 42  
 Autonomous speed change to 8 GT/s, 38, 93

## B

backplane, 20

## C

Capture State Transitions Test, 81  
 Change a Docked Window to a Floating Window, 32  
 change the link speed, 54  
 co-efficient values, 44  
 components of the Protocol Exerciser GUI, 28  
 Configuring Equalization settings, 44  
 controller PC, 22  
 Creating a new Protocol Exerciser session, 24

## D

data scrambling, 38  
 Disabling Equalization, 43  
 Display a Floating Window, 32  
 Dock a Floating Window, 33  
 DSC, 15, 58

## E

Enabling Equalization, 43  
 endpoint, 15  
 equalization procedure, 42  
 Equalization Settings, 41  
 Equalization Settings tab, 90  
 exerciser emulation modes, 15  
 Exerciser starts Link Training to 2.5 GT/s, 69  
 Exerciser starts Link Training to 8.0 GT/s with Equalization Tests, 70

## F

FS, 44

## H

Hardware, 19  
 Hardware Status pane, 30  
 Hide a Floating Window, 32

## I

Ignore coefficient rule checks, 91  
 initialize a PCIe link, 37

## L

Lane Polarity Inversion, 40  
 Lane Reversal, 40  
 Lane Settings tab, 91  
 LF, 44  
 Link downgrade speed tests, 75  
 Link settings tab, 37  
 Link Speed Change With Equalization Tests, 78  
 Link Speed Change Without Equalization Tests, 74  
 link status, 30  
 Link Training and Status State Machine, 56  
 Link training to 8.0 GT/s with the first phase of Equalization test, 73  
 Link Up, 50  
 Link upgrade speed tests, 75  
 LTSSM, 56  
 LTSSM States, 56, 57  
 LTSSM states, 62  
 LTSSM test prerequisites, 62  
 LTSSM Test Results, 68  
 LTSSM Tester, 58  
 LTSSM tests, 62  
 LTSSM Tests Sequence, 68

## O

Offline, 22  
 Online, 22

## P

Perform Equalization in Recovery @8 GT/s, 91  
 Perform Phase 2/Phase 3 option, 43  
 phases of equalization, 42  
 Port Selection, 25, 84  
 Protocol Checker, 100  
 Protocol Exerciser API, 20  
 Protocol Exerciser GUI, 20  
 Protocol Exerciser hardware status, 30  
 Protocol Exerciser session, 22  
 Protocol Exerciser setup file, 36

## R

Recovery.Equalization sub state, 71  
 Request Equalization in Recovery @8 GT/s, 91  
 retrain link, 53  
 root complex, 15

## S

Scrambler (2.5 GT/s and 5.0 GT/s), 93  
 Select type of connection, 85  
 Select type of connection dialog box, 23  
 Session list, 24  
 session type, 37  
 Setting Equalization values, 44  
 setup files, 20  
 Software based equalization, 43  
 SUT, 15

## T

test log, 62  
 Testing Link Retraining and Recovery, 80  
 Testing Link Training, 69  
 Testing LTSSM State Transitions, 81  
 Training a PCIe Link, 50  
 transceiver settings, 46  
 Transceiver Settings tab, 94  
 trigger, 47  
 trigger out conditions, 47  
 Trigger Out Connector, 47  
 Tx de-emphasis, 41  
 Tx De-emphasis preset, 44  
 types of equalization, 42

## U

U4305A Exerciser Card, 19  
 USC, 15, 58  
 Using an existing Protocol Exerciser session, 24

## V

Verifying PCIe Link Training, 51

## W

working of LTSSM Tester, 62



## **Acknowledgements**

Protocol Exerciser GUI uses Outlook Bar, a Graphical library created by Tim Dawson (Refer <http://www.divil.co.uk/net/>).

Copyright Agilent Technologies 2010



N5308-91010