TELEDYNE LECROY
Everywhereyoulook™

Summit™ Z5 PCI Express® 5.0 Protocol Exerciser/Analyzer

User Manual



PCIe Protocol Analysis Version 13.20

Generated: October 14, 2025, 08:52

Teledyne LeCroy Protocol Solutions Group

Trademarks and Servicemarks

Teledyne LeCroy, *CATC Trace, PETracer, PCIe Protocol Suite, PCIe Protocol Analysis, Summit Z516, Summit Z58, Summit T416, Summit T48, Summit T3-16, Summit T3-8, Summit T34, Summit T28, Summit T24, Summit Z3-16, Summit Z4-16, Summit T54, Summit M5x, PXP500 Test Platform,* are trademarks of Teledyne LeCroy.

Microsoft and Windows are registered trademarks of Microsoft Corporation.

Intel and Pentium are registered trademarks of Intel Corporation.

All other trademarks and registered trademarks are property of their respective owners.

THE SPECIFICATIONS AND INFORMATION REGARDING THE PRODUCTS IN THIS MANUAL ARE SUBJECT TO CHANGE WITHOUT NOTICE. ALL INFORMATION, EXAMPLES AND RECOMMENDATIONS IN THIS MANUAL ARE BELIEVED TO BE ACCURATE BUT ARE REPRESENTED WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED. USERS ARE FULLY RESPONSIBLE FOR THEIR APPLICATION OF ANY PRODUCTS.

THE SOFTWARE LICENSE AND LIMITED WARRANTY FOR THE ACCOMPANYING PRODUCT ARE SET FORTH IN INFORMATION THAT SHIPPED WITH THE PRODUCT AND ARE INCORPORATED HEREIN BY THIS REFERENCE. IF YOU ARE UNABLE TO LOCATE THE SOFTWARE LICENSE OR LIMITED WARRANTY, CONTACT Teledyne LeCroy FOR A COPY.

© 2024 Teledyne LeCroy, Inc. All rights reserved.
This document may be printed and reproduced without additional permission, but all copies should contain this copyright notice.

WEEE Program



Teledyne LeCroy
teledynelecroy.com

Contents

Chapter 1: Introduction 17

1.1 Summit Z5 PCIe Protocol Exerciser Overview. 17

1.2 Receiving Your Summit Z5 Protocol Exerciser 17

1.3 Unpacking the Summit Z5 PCIe Protocol Exerciser 18

1.4 Summit Z5 PCIe Protocol Exerciser: Overview 18

1.4.1 Summit Z516 PCIe Protocol Exerciser Features 18

1.4.1.1 Summit Z58 PCIe Protocol Exerciser/Analyzer Features 20

1.5 Related Reference Documents 22

1.6 Related Components 23

1.6.1 PXP500 PCI Express Test Platform: Overview 23

Chapter 2: Hardware Description 25

2.1 Summit Z516 PCIe Protocol Exerciser System Components. 25

2.2 Summit Z58 PCIe Protocol Exerciser System Components. 25

2.3 Host Machine Requirements 25

2.4 Environmental Conditions 26

2.5 Summit Z516 PCIe Protocol Exerciser 26

2.5.1 Controller Board: Power and Data Ports 28

2.5.1.1 Controller Board: Power and Data Ports 28

2.5.1.2 Controller Board: Display Screen and LEDs 28

2.5.1.3 Controller Board: Interface Connector to Main Board 29

2.5.2 Main Board: Interfaces to Controller Board and PCIe Slot. 30

2.5.3 User Interface on the Summit Z516 PCIe Protocol Exerciser. 30

2.5.4 Connectors 31

2.5.4.1 USB 3.1 Type-C Host Machine (Controller Board) 31

2.5.4.2 Ethernet Port (Controller Board). 32

2.5.4.3 Sync/Data (Controller Board) 32

2.5.4.4 Controller to Exerciser Interface (Controller Board). 32

2.5.4.5 x16 PCIe Edge Connector (Main Board) 32
2.5.4.6 Exerciser To Controller Interface (Main Board) 32
2.5.5 Protocol Exerciser Display and LEDs 33
2.5.5.1 Dot Matrix Display 33
2.5.5.2 Power LED 33
2.5.5.3 Status LED 33
2.5.5.4 Trigger LED 33
2.5.5.5 Training LED 33
2.5.5.6 Transmitter and Receiver Signal Activity LEDs 33
2.5.5.7 Speed LEDs 33
2.6 Summit Z58 PCIe Protocol Exerciser 34
2.6.1 Controller Board: Power and Data Ports 36
2.6.1.1 Controller Board: Power and Data Ports 36
2.6.1.2 Controller Board: Display Screen and LEDs 36
2.6.1.3 Controller Board: Interface Connector to Main Board 37
2.6.2 Main Board: Interfaces to Controller Board and PCIe Slot 38
2.6.3 User Interface on the Summit Z58 PCIe Protocol Exerciser 38
2.6.4 Connectors 38
2.6.4.1 USB 3.1 Type-C Host Machine (Controller Board) 38
2.6.4.2 Ethernet Port (Controller Board) 39
2.6.4.3 Sync/Data (Controller Board) 39
2.6.4.4 Controller to Exerciser Interface (Controller Board) 39
2.6.4.5 x16 PCIe Edge Connector (Main Board) 39
2.6.4.6 Exerciser To Controller Interface (Main Board) 39
2.6.5 Protocol Exerciser Display and LEDs 39
2.6.5.1 Dot Matrix Display 39
2.6.5.2 Power LED 39
2.6.5.3 Status LED 39
2.6.5.4 Trigger LED 39
2.6.5.5 Training LED 40
2.6.5.6 Transmitter and Receiver Signal Activity LEDs 40
2.6.5.7 Speed LEDs 40
2.7 PXP500 PCI Express Test Platform: Overview 41
2.7.1 PXP500 PCI Express Test Platform Features 41
2.8 PXP500 PCIe™ Test Platform: x16 Lane Width/Up to 32.0 GT/s 42
2.8.1 PXP500: Connectors and Switches 44

Chapter 3: Installation 47
3.1 Installing the PCIe Protocol Analysis software 47
3.1.1 Downloading the PCIe Protocol Analysis software 47
3.1.2 Windows Server 2016/2019 47

3.1.3 Launching the PCIe Protocol Analysis 56
3.2 Setting Up the Summit Z5 PCIe Protocol Exerciser using a USB Connection 57
3.3 Setting Up the Summit Z5 PCIe Protocol Exerciser using an Ethernet Connection . . . 58
3.4 Connecting to Summit Z5 in the Software 58
3.5 Adding Devices Manually 60
3.6 Setting Up the Summit Z5 PCIe Protocol Exerciser 64
3.6.1 Connecting the Summit Z5 PCIe Protocol Exerciser Directly to a Host Machine 64
3.6.2 Connecting the Summit Z5 PCIe Protocol Exerciser to the PXP500 PCI Express Test Platform . 65

Chapter 4: Traffic Generation 67
4.1 Theory of Operation 67
4.1.1 Overview 67
4.1.2 Starting Point 68
4.1.3 Link Speed Control 68
4.1.3.1 Speed Change to Gen3 68
4.1.3.2 Speed Change to Gen4 68
4.2 Summit Z5 PCIe Protocol Exerciser Control Bar 69
4.2.1 LTSSM Control Icon 71
4.2.1.1 LTSSM: Link Speed Control 71
4.2.1.2 LTSSM: Link Width Control 72
4.2.1.3 LTSSM Arc Tests 73
4.2.1.4 LTSSM Log 73
4.2.2 Link Dashboard Icon 74
4.3 Generating Traffic 76
4.3.1 High Performance Mode 78
4.4 Script Execution 79
4.5 Creating a Traffic Generation File 79
4.5.1 Export: To Generator File Format 80
4.5.1.1 Exporting a CATC Trace to a Traffic Generation File 80
4.5.2 Saving a Script to a New File 82
4.5.3 Select File > New PETrainer Script 83
4.5.3.1 Lane Margining Script: Using Packet = TLP 86
4.5.3.2 Lane Margining Script: Using Configuration Command 88
4.5.4 Generate Lightweight Notification Protocol 93
4.5.5 Generate Trigger Out 94
4.5.6 Creating a New Empty Generation File 98
4.6 Generation Options Dialogs Overview 98
4.6.1 Opening the Dialog 98
4.6.1.1 Z5 General Options Dialog Layout 99
4.6.1.2 General Generation Options 101

4.6.2 Link Generation Options 107
4.6.2.1 Enhanced Link Behavior Control Settings 112
4.6.2.2 Precode Settings 114
4.6.2.3 Alternate Protocol Vendor ID 115
4.6.3 Phy Parameters 117
4.6.3.1 5.0 GT/s Options 117
4.6.3.2 8.0 GT/s Options 119
4.6.3.3 16.0 GT/s Options 121
4.6.3.4 32.0 GT/s Option 123
4.6.3.5 General Receiver Settings Options 126
4.6.3.6 Preset Sweep Settings Options 128
4.6.4 Low Power 129
4.6.5 Integrity 136
4.6.5.1 Integrity for PCIe traffic 137
4.6.5.2 Integrity for CXL traffic 138
4.6.6 Flow Control 141
4.6.6.1 Enable Data Link Feature Exchange 142
4.6.6.2 Flow Control for CXL traffic 144
4.6.7 Transactions 146
4.6.7.1 Transactions: Device Emulation 146
4.6.7.2 Transactions: Device Emulation -> High Performance Real Memory Option 149
4.6.7.3 Transactions: Host Emulation 150
4.6.7.4 Transactions: Fast Memory Completer 151
4.6.7.5 Enable Precision Time Management (PTM) -> Host Emulation 154
4.6.7.6 Transactions: Host Emulation -> High Performance Real Memory Mode 156
4.6.7.7 Transactions for CXL traffic: Host Emulation 157
4.6.7.8 Transactions for CXL traffic: Device Emulation 162
4.6.8 Error Injection Definitions 165
4.6.8.1 Error Injection Definition: GUI 165
4.6.8.2 Error Injection Definition: Script 167
4.6.9 Generating Traffic: Set Generation Options 168
4.6.10 Saving a Generation Options File 168
4.6.11 Generating Traffic: Set Generation Options 169
4.6.11.1 Generation Options XML File 169
4.6.12 Generation Options XML Files 171
4.6.12.1 General Tab 171
4.6.12.2 LINK TAB 173
4.6.12.3 PHY PARAMETERS TAB 175
4.6.12.4 TRANSACTIONS TAB 180
4.6.12.5 Device Emulation Role 184
4.6.12.6 ERROR INJECTION TAB 186
4.6.12.7 Open Generation Options File 186

4.7 Generating Traffic: Prepare Traffic Generation 188
4.8 Generating Traffic: Begin Traffic Generation. 190
4.8.1 Script Command: Config = General 192
4.9 Autotuning. 194
4.9.1 Prerequisites. 194
4.9.1.1 General Tab. 195
4.9.1.2 Phy Parameters Tab 195
4.9.2 Exerciser Autotuning Dialog 197
4.9.3 Autotuning with Linux 199
4.10 Editing Generation Files with the Script Editor 200
4.10.1 Script Editor Toolbar 200
4.10.2 Script Edit Window. 201
4.10.2.1 Syntax Highlighting 201
4.10.2.2 Tooltips 202
4.10.2.3 Outlining 202
4.10.2.4 Text Editing Commands 202
4.10.2.5 Synchronized Scrolling with the CATC Trace Window. 202
4.10.3 Command Properties Window 203
4.10.4 Script Editor File Tabs 204
4.10.5 Script Editor Error Log. 205
4.10.6 View Options Menu 205
4.11 Example: Multi-Packet MCTP Message to the DUT 206

Chapter 5: Macros 207
5.1 Macros 207
5.1.1 Default Macros: Connect and Disconnect 207
5.1.2 Generate Menu 208
5.1.3 Connect Macro 208
5.1.4 Disconnect Macro. 208
5.1.5 Adding New Script Macros 208
5.1.5.1 Using the Generation Macros Dialog 209
5.1.5.2 Adding Script Files to the GenScriptMacros Directory 211
5.1.6 Modifying Script Macros 212
5.1.7 Changing the Order of Macro Icons on the Status Bar. 212
5.1.8 Deleting User-Defined Script Macros 212
5.1.9 Restoring the Default Appearance of the Connect and Disconnect Icons 213

Chapter 6: Summit Z58 Analyzer Capabilities 215
6.1 PCIe Protocol Analysis 215
6.1.1 Application Layout 216

6.1.2 Using the Toolbar 217
6.1.3 Multi-Segment Toolbar 220
6.1.3.1 Toolbar Hide Buttons 220
6.1.4 Using the Menus 223
6.1.5 File Menu 223
6.1.5.1 File Dialog 224
6.1.5.2 Clean Up Decoder Temp Files 224
6.1.5.3 Setup Menu 228
6.1.5.4 Record Menu 228
6.1.5.5 Generate Menu (used in conjunction with Teledyne LeCroy Trainer products 228
6.1.5.6 Report Menu 229
6.1.5.7 Search Menu 229
6.1.5.8 Quick Search Feature 232
6.1.5.9 View Menu 234
6.1.5.10 Tools Menu 236
6.1.5.11 Window Menu (helps display the loaded traces) 236
6.1.5.12 Help Menu 238
6.1.6 Dashboard View 238
6.1.6.1 Launching and Setting Recording Option from Dashboard View 240
6.1.7 Tool Tips 240
6.1.8 Keyboard Shortcuts 240
6.1.9 Status Bar 241
6.1.9.1 Recording Progress Bar 241
6.1.9.2 Recording Status 241
6.1.9.3 Recording Activity 242
6.1.9.4 Search Direction Indicator 242
6.1.10 Making a PCI Express Recording 242
6.1.10.1 Start a Recording 244
6.1.10.2 Stopping a Recording 244
6.1.10.3 Saving a Recording 245
6.1.11 PCIe Protocol Analysis Files 245
6.1.11.1 CATC Trace Files 246
6.1.11.2 Recording Options Files 246
6.1.11.3 Display Options Files 246
6.1.12 Saving CATC Trace Files 246
6.1.12.1 Using the Save As Function 246
6.1.13 Saving a Portion of a CATC Trace 248
6.1.14 Save Copy As Function 248
6.1.14.1 Trace File Structure 250
6.1.15 Exporting a CATC Trace File 251
6.1.16 Export: To Text 252
6.1.17 Export: Packets to CSV Text 254
6.1.17.1 Export: To Generator File Format 255

6.1.17.2 Export From Data Flow View 258
6.1.17.3 Data Flow CSV File: Legacy Format 259
6.1.17.4 Data Flow CSV File: New Format 259
6.1.18 Printing Data Files 261
6.1.19 Analyzer Chat Window 261
6.1.19.1 CrossSync Control Panel 262
6.2 Recording Options 264
6.2.1 Recording Overview 264
6.2.2 General Dialog Box 264
6.2.3 Recording Options-General dialog box 265
6.2.3.1 Recording Options: Simple Mode, Snapshot 265
6.2.4 Simple/Advanced Mode 266
6.2.5 Trace Filename and Path 266
6.2.6 Advanced Trace File Settings 266
6.2.7 Saving and Loading Previously Saved Recording Options 267
6.2.7.1 Setting Default Recording Options 267
6.2.7.2 Loading Recording Options 268
6.2.7.3 Saving Recording Options 268
6.2.8 Recording Type 269
6.2.8.1 Target Analyzer Options 269
6.2.9 Recording Mode 270
6.2.9.1 Protocol Recording 271
6.2.9.2 SMBus Recording 271
6.2.9.3 Recording the CCIX Protocol (Simple and Advanced Mode) 271
6.2.10 Snapshot 274
6.2.11 Buffer Size 274
6.2.12 Viewing Legacy Multi-Segmented CATC Traces 274
6.2.13 Link Settings 275
6.2.14 Link Speed and Link Width Limitations 275
6.2.15 Recording Options: Trigger on Events 276
6.2.15.1 Simple Mode: Z58 Triggers 276
6.2.15.2 Trigger Position 276
6.2.15.3 Advanced Mode: Z58 Trigger On 277
6.2.15.4 Z58 Trigger On Tab 278
6.2.15.5 Advanced Recording Options 278
6.2.15.6 Trigger / Filter on Events 281
6.2.16 Save 287
6.2.17 Load 287
6.3 Reading CATC Traces 288
6.3.1 Viewing PCI Express CATC Traces 288
6.3.2 Expand and Collapse Data Fields 288
6.3.3 Resizing Cells 289

6.3.4 Pop-up Menus 289
6.3.5 View Data Block 289
6.3.5.1 Save Data Block 290
6.3.6 Show Raw 10b Codes 291
6.3.7 Show Header Fields 292
6.3.8 Packet Cell Popup Menus 293
6.3.8.1 Show/Hide Link Tracker 293
6.3.8.2 Show Raw 10b Codes 294
6.3.8.3 Time From Trigger 295
6.3.8.4 Time From Marker 296
6.3.8.5 Copy for PETrainer ‘packet’ command 297
6.3.8.6 Set Start Quick Timing Marker 298
6.3.8.7 Set End Quick Timing Marker 298
6.3.8.8 Tag Pop Up Menu 299
6.3.8.9 Delete All Quick Timing Markers 301
6.3.8.10 Set Marker 301
6.3.8.11 Edit or Clear Marker 302
6.3.8.12 Format 303
6.3.8.13 Color 304
6.3.8.14 Other Packet Cell Popup Menus 305
6.3.9 Compressed CATC Trace View 305
6.3.10 Spreadsheet View 306
6.3.10.1 Columns 307
6.3.11 Detail View and Spreadsheet View 311
6.3.12 Decoding Traffic 312
6.3.12.1 Packet 312
6.3.12.2 Link 314
6.3.12.3 Split 314
6.3.12.4 Lane Margining Decoding 314
6.3.12.5 NVMe Decoding 318
6.3.12.6 NVMe 1.2 Specification Decoding 343
6.3.12.7 Support for Physical Region Page (PRP) and Scatter Gather List (SGL) in Controller Memory Buffer (CMB) 347
6.3.12.8 NVMe Decoding for Host Memory Buffer FID 349
6.3.12.9 AHCI 350
6.3.12.10 ATA 350
6.3.12.11 PQI 353
6.3.12.12 SOP 354
6.3.12.13 SCSI 354
6.3.12.14 Decoding MCTP (Management Component Transport Protocol) 354
6.3.12.15 Decoding MCTP Traffic with SMBus Traffic 370
6.3.12.16 Traffic Summary Report: SMBus Errors 375

6.3.12.17 Decoding SMBus with Address Resolution Protocol (ARP) 377
6.3.12.18 Decoding MCTP Traffic with Vendor Defined Messages (VDM) 378
6.3.12.19 Decoding Data Link Features 379
6.3.12.20 PMUX Channel ID Found and PMUX Packet Error Decoded in Trace 380
6.3.12.21 Decoding Traces with Different Class Codes 381
6.3.12.22 Data Link Features 383
6.3.12.23 Decoding PCI-SIG Vendor Defined Messages (VDMs) 383
6.3.12.24 Decode for NVMe 1.3c Specification 385
6.3.12.25 NVMe Warning Messages 389
6.3.12.26 Warning Messages in Split Traces 398
6.3.12.27 Decoding Lightweight Notification (LN) Protocol 400
6.3.12.28 Decoding CCIX Protocol 406
6.3.12.29 Decoding TCG Support of Pyrite 407
6.3.12.30 MCTP: Simple Hiding 408
6.3.12.31 Decoding NVME-MI Version 1.1 411
6.3.12.32 Decoding NVME-MI Version 1.1 with BMC 411
6.3.12.33 Decoding Traces Exported from USB4 Traces with Tunneled PCIe Traffic 416
6.4 Searching CATC Traces 419
6.4.1 CATC Trace Search Overview 419
6.4.2 Go to Trigger 419
6.4.3 Go to Selected Packet 419
6.4.4 Go to Packet 419
6.4.5 Go to Time 420
6.4.6 Go To Marker 420
6.4.6.1 Markers 421
6.4.6.2 Attaching Markers 423
6.4.6.3 Adding an Attachment 423
6.4.6.4 Recording an Audio File 424
6.4.6.5 Video Files Supported 424
6.4.6.6 Attachment Types and Visualization 424
6.4.6.7 Embedded Attachments to a Marker 425
6.4.6.8 Viewing Attachments of a Marker 425
6.4.6.9 URL Link 428
6.4.6.10 Edit Marker 431
6.4.6.11 All Markers Dialog 431
6.4.6.12 CATC Walk Playlist 433
6.4.6.13 Playlist Functionality 434
6.4.6.14 Playback Window 435
6.5 Go to NVMe Transactions and Commands 437
6.5.1 NVMe Transaction 437
6.5.2 NVMe Command 438
6.5.3 Go To SCSI Menu 439

6.5.4 Go To Menu 439
6.5.4.1 Example: Search → Go to → Link Event → Link Up/Link Down 440
6.5.5 Find 442
6.5.5.1 Event Groups for Packets 444
6.5.5.2 Example: Search for PMUX Channel ID 446
6.5.5.3 Event Groups for Link Transactions: 447
6.5.5.4 Event Groups for Split Transactions: 447
6.5.6 Event Groups for LM Commands 448
6.5.6.1 Event Groups for NVMe transactions: 449
6.5.6.2 Event Groups for PQI Transactions: 449
6.5.6.3 Event Groups for AHCI Transactions: 449
6.5.6.4 Event Groups for ATA transactions: 449
6.5.6.5 Event Groups for SOP Transactions: 449
6.5.6.6 Event Groups for SCSI Transactions: 450
6.5.6.7 Event Groups for NVMe Commands: 450
6.5.6.8 Example: Search for NVMe Command 450
6.5.6.9 Example: Search for NVMe Command: NVM Payload Portion 452
6.5.6.10 Event Groups for MCTP Messages: 453
6.5.6.11 MCTP Messages to Search For 453
6.5.6.12 Example: Searching for PLDM Message Types within MCTP Messages 454
6.5.6.13 Example: Searching for NC-SI Message Types within MCTP Messages 455
6.5.6.14 Example: Search for DLLP Header → Flow Control Feature 456
6.5.7 Find Next Packet Type 459
6.5.7.1 Quick Search Feature 459
6.5.7.2 Quick Search for MCTP Transactions 461
6.5.8 Toggle Search Direction 463
6.6 Display Options 464
6.6.1 Setting Display Options 464
6.6.2 Specifying General Display Options 465
6.6.2.1 Collapsing Data Fields 465
6.6.2.2 Fonts 466
6.6.2.3 Configuration Name 466
6.6.2.4 Color, Format, and Hiding Options 466
6.6.2.5 Setting Field Colors 467
6.6.2.6 Changing Field Formats 469
6.6.2.7 Hiding Fields 470
6.6.2.8 Hiding Levels 470
6.6.3 Error Hiding 475
6.6.3.1 Transaction Types 475
6.6.4 Warning Hiding 478
6.0.0.1 Transaction Types 480
6.6.5 Load a Previously Saved Display Options File 480

6.6.6 Saving Display Options 480
6.7 Reports and Tools 480
6.7.1 Trace Information 482
6.7.2 Error Summary 484
6.7.2.1 Error Summary for Storage Protocols 484
6.7.2.2 Error Summary for Storage Protocols -- NVMe 486
6.7.2.3 NVMe Queue Errors 487
6.7.2.4 NVMe CMD Errors 488
6.7.3 Traffic Summary 492
6.7.3.1 Traffic Summary for Storage Protocols 492
6.7.4 Using the Traffic Summary Window to Search the CATC Trace 493
6.7.5 NVMe Queue Time Metrics 493
6.7.5.1 Traffic Summary Buttons 495
6.7.6 Traffic Summary for MCTP 496
6.7.7 Traffic Summary for Flow Control 500
6.7.8 Bus Utilization 501
6.7.8.1 Bus Utilization Pop-up Menu 501
6.7.8.2 Bus Utilization Buttons 503
6.7.9 Link Tracker 508
6.7.9.1 Using the Link Tracker Window 509
6.7.9.2 Zooming In and Out 509
6.7.9.3 Collapsing Idle Time, Enabling Tool tips, and Resetting Column Widths 510
6.7.9.4 Docking and Undocking the Window 511
6.7.9.5 Setting Markers 511
6.7.9.6 Calculating Time between DWORDs 511
6.7.9.7 Hiding Traffic 512
6.7.9.8 Link Tracker Buttons 512
6.7.10 Data Flow Window 514
6.7.11 Flow Control Tracking 515
6.7.12 Using the CATC Trace Navigator 516
6.7.12.1 Displaying the Navigator 516
6.7.12.2 Navigator Toolbar 517
6.7.12.3 Navigator Ranges 517
6.7.12.4 To Determine Current Position 518
6.7.12.5 To Reset Navigator Range 518
6.7.12.6 Navigator Panes 519
6.7.12.7 To Show/Hide Navigator Panes 519
6.7.12.8 Navigator Slider 519
6.7.12.9 CATC Trace Navigator Legend 520
6.7.12.10 Using the Legend to Show/Hide Navigator Panes 520
6.7.12.11 Using the Legend to Set the Priority of Information Display 521
6.7.13 Detail View 521

6.7.14 LTSSM Flow Graph 521
6.7.15 LTSSM Dynamic Equalization 523
6.8 Lane Margining: Eye Diagram 526
6.8.1 Packet Header Bar 529
6.8.2 Packet Data Window 529
6.9 Configuration Space View 530
6.9.1 Tools → Import Configuration Space File 535
6.9.2 Configuration Space Editor 536
6.9.2.1 Metrics Defined for Split Transactions 537
6.9.3 Show Metrics in the CATC Trace Display 538
6.9.3.1 Collapsed Metrics Header Display 538
6.9.3.2 Metrics Tool Tip Display 538
6.9.3.3 Expanded Metrics Header Display 538
6.9.4 Show Metrics in the Traffic Summary Window 539
6.9.4.1 Reports at Split Transaction Level 539
6.9.4.2 Reports at the Link Transaction Level 540
6.9.5 Show Metrics in the Bus Utilization Window 541
6.9.5.1 Unit-Based Averaging 541
6.9.5.2 Bus Utilization Window Features 542
6.9.5.3 Split Transaction Level Graphs 542
6.9.5.4 Link Transaction Level Graphs 543
6.9.6 Real-Time Statistics Window 543
6.9.6.1 Real-Time Statistics Buttons 544
6.9.6.2 Real-Time Statistical Monitor Pop-up Menu 546
6.9.6.3 Real-Time Statistics Graph Areas 547
6.9.7 Memory I/O Space Editor 548
6.9.8 TC to VC Mapping 549
6.9.9 Timing and Bus Usage Calculations 549
6.9.9.1 Timing Calculator 549
6.9.9.2 Details of Timing Calculations 555
6.9.10 PCIe SSD Base Address Mapping 561
6.9.11 Base Address Not Record in Trace 561
6.9.12 Base Address Recorded in Trace 562
6.9.12.1 NVMe PCIe SSD Device Configuration 563
6.9.12.2 AHCI PCIe SSD Device Configuration 567
6.9.12.3 PQI PCIe SSD Device Configuration 568
6.9.13 SCSI PCIe SSD Device Configuration 570
6.9.14 Running Verification Scripts 571
6.9.14.1 NVMe Performance: Doorbell Timing 573
6.9.14.2 MCTP Transaction Verification Script Generation 574
6.9.15 Trace Expert 576
6.9.16 Performance Analysis 579

6.9.17 Trace Analysis Statistics 580
6.9.18 Error Reports 581
6.9.19 Trace Information 582

Chapter 7: Updates and Licensing 583
7.1 Updating the Exerciser. 583
7.2 License Keys. 583
7.3 License Information 584

Appendix A: How to Contact Teledyne LeCroy. 587

Appendix B: China Restriction of Hazardous Substances Table 589

Appendix C: Quick Search Feature 591
C.1 Quick Search Feature: Pre-Defined Terms 591

Appendix D: NVMe Drive Emulation. 595
D.1 NVME Drive Emulation in Windows 10 595
D.2 NVME Drive Emulation in Ubuntu Linux 14.10 and Linuxv3.1-rc4 599
D.2.1 Hardware Setup for Test Equipment 600

Appendix E: Example of XML File Format for SSD Decodes. 609

Appendix F: LTSSM Arc Tests 611
F.1 List of Arc Tests and Brief Description 611

Appendix G: Configuration Space Decoding 615
G.1 Mandatory Definitions 615
G.2 Mandatory Module Functions. 615
G.2.1 DecodeRegister(offset) 615
G.2.2 GetSize() 616
G.3 Configuration Register Types. 616
G.4 Primitives 616
G.4.1 GetRegisterField 616
G.4.2 AddField 616
G.4.3 AddSubField. 617

G.5 Helper File. 617

Appendix H: CXL Device Emulation 619

H.1 CXL Device Emulation in Windows or Linux. 619

H.2 Setup Requirements 619

H.3 Initial Setup. 619

H.4 Find the Root Port 625

H.4.1 Capture the Hexadecimal dump of the Host whole PCI Configuration Space 625

Index:..... 627

Chapter 1

Introduction

NOTE: The Summit Z58 is both an exerciser and analyzer. The Summit Z516 is an exerciser only. In the following chapters of the this manual Summit "Z5" describes capabilities of both the Summit Z58 and Summit Z516 Exercisers.

The Teledyne LeCroy Summit Z516 Protocol Exerciser is an advanced Gen5 PCI Express verification system capable of generating traffic up to 16 lanes (depending on configuration) at up to 32 GT/s rates. It blends sophisticated functionality with practical features to speed the development of PCI Express IP cores, bridges, switches, add-in boards, and systems.

This user manual describes the installation and operation of the Summit Z5 PCIe Protocol Exerciser. It includes a description and examples of the application.

1.1 Summit Z5 PCIe Protocol Exerciser Overview

The Summit Z5 is Teledyne LeCroy's fifth generation Protocol Exerciser (traffic generator), a critical test and verification tool to assist engineers in developing and improving the reliability of their systems. It adds support for PCI Express at the Gen5 data rate of 32GT/s.

For system testing, the Summit Z5 can be used in a device emulation mode, where the Summit Z5 is directly plugged in to a System Under Test. Hence, the setup is quick and easy. The Summit Z5 is both an exerciser and analyzer, so it provides a complete solution for testing and analyzing the functionality of a device under test (DUT).

For device testing, the Summit Z5 is used in combination with a test platform such as the PXP500 PCI Express Test Platform, which provides a convenient way of using the Summit Z5 for host emulation. The PXP500 Test Platform has two slots, one for the Summit Z5 PCIe Protocol Exerciser card and the other for the DUT (Device Under Test).

The Summit Z5 builds on the extensive programming and verification test libraries established for Teledyne LeCroy's PE*Trainer*™ and PCIExpress Exercisers, and provides the user a complete suite of test capability, including the ability to test products to the PCI Express 5.0 specification. The Summit Z5 PCIe Protocol Exerciser, provides engineers with a complete test and development environment for PCI Express Gen5 related work.

1.2 Receiving Your Summit Z5 Protocol Exerciser

The Summit Z5 PCIe Protocol Exerciser can be ordered either with or without the PXP500 PCI Express Test Platform. You can use the Summit Z5 PCIe Protocol Exerciser card directly in a system

using the DC adapter to power the Controller Board. If you purchased the PXP500 PCI Express Test Platform, you can use the Summit Z5 PCIe Protocol Exerciser in the provided slot. In this case the PXP500 PCI Express Test Platform supplies power to the Summit Z5 PCIe Protocol Exerciser.

The Summit Z5 PCIe Protocol Exerciser package includes the following components:

- Summit Z516/Z58 Main Board identified in the packing list
- Summit Z5 Controller Board identified in the packing list
- 12 inch ribbon cable
- Two (2) TX SSC CLK Cables
- USB 3.1 Type-C cable, 1 meter
- Ethernet cable, 10 feet
- AC Power Adapter (Output: 24 VDC, 9.2 A, 220 Watts)
- Summit Z516/Z58 PCIe Protocol Exerciser Quick Start Guide

1.3 Unpacking the Summit Z5 PCIe Protocol Exerciser

Inspect the received shipping container for any damage. Unpack the container and account for each of the system components listed on the accompanying packing list. Visually inspect each component for absence of damage. In the event of damage, notify the shipper and Teledyne LeCroy Corporation. Retain all shipping materials for shipper's inspection.

1.4 Summit Z5 PCIe Protocol Exerciser: Overview

The Teledyne LeCroy Summit Z5 PCIe Protocol Exerciser is a critical PCIe® test and verification tool intended to assist engineers in improving the reliability of their systems. It is a Gen5 PCI Express 8-lane advanced Protocol Exerciser system that can emulate PCI Express root complexes or device endpoints. You can test PCI Express IP cores, semiconductors, bridges, switches, and systems.

1.4.1 Summit Z516 PCIe Protocol Exerciser Features

The Summit Z516 PCIe Protocol Exerciser has the following features:

- Support for accurate generation of bidirectional PCI Express bus traffic for the following data rates and link widths: 2.5/5.0/8.0/16.0/32.0 GT/s up to x16 lanes
- Host/Device Emulation Support for allowing design and stress testing.
- Link Training and Status State Machine (LTSSM) Testing to exercise LTSSM state transitions for verification.
- Review the Quick Start Guide for your product to learn how to properly configure the platform.
- The latest Summit Z516 Trainer supports CLKREQ# signal that allows for L1 Substrate testing.

TABLE 1.1: Summit Z516 PCIe Protocol Exerciser Features and Benefits

Feature	Benefit
Script Level Traffic Generation	Programmability to test PCI Express components with more precision and control
Host/End-Point Emulation Support	End-point emulation (and optional host emulation) allow for designed stress and pre-testing of end-point and host devices for product verification
Point and Click Script Editor	Complex scripts can be created quickly and easily
Link Training & Status State Machine (LTSSM) Testing	Exercise LTSSM state transitions for verification
Supports existing PCIe Protocol Analysis API	Preserve investment in API Programs

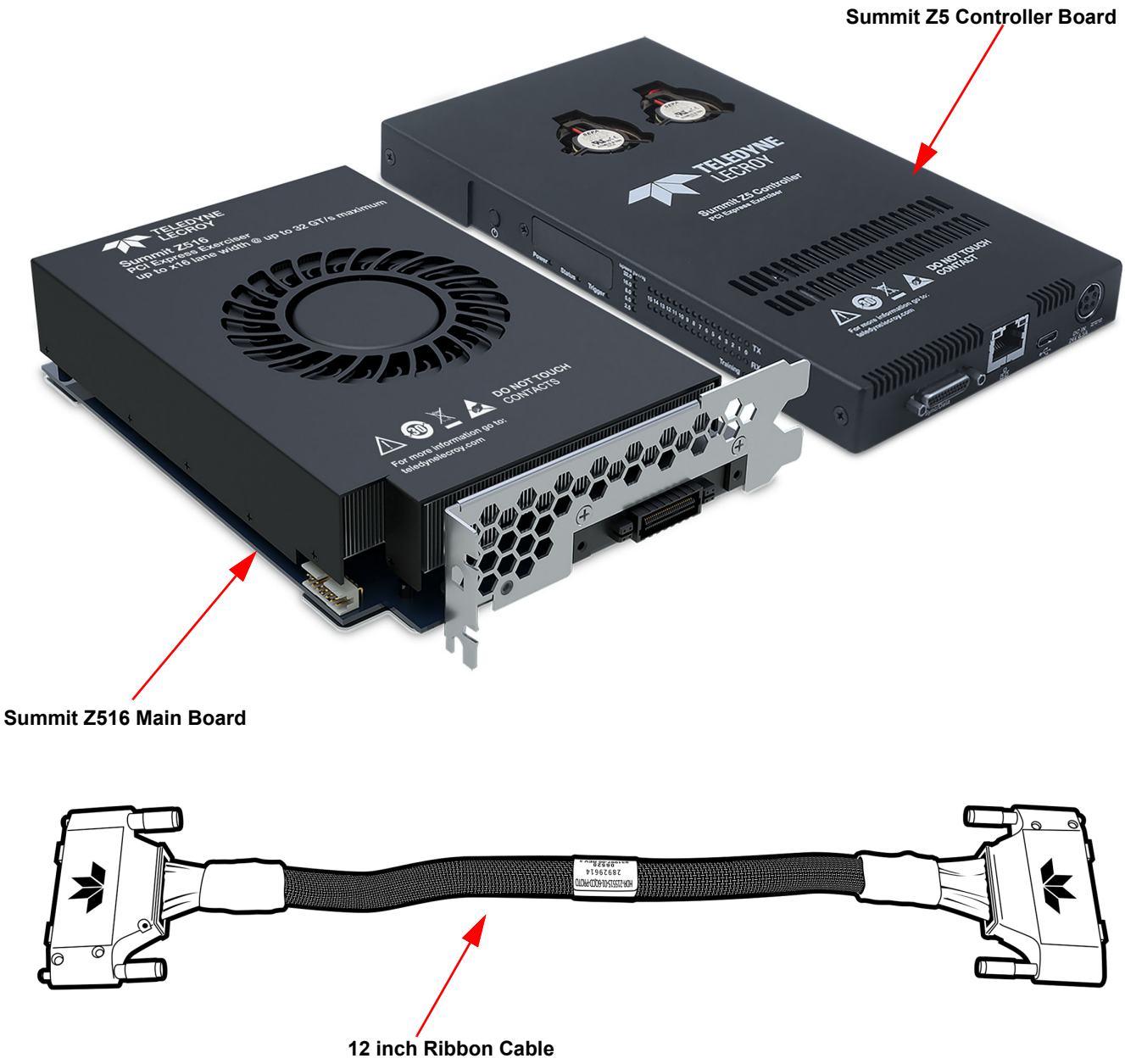


Figure 1.1: Summit Z516 PCIe Protocol Exerciser (Main Board and Controller Board) with Interface Cable

1.4.1.1 Summit Z58 PCIe Protocol Exerciser/Analyzer Features

The Summit Z58 PCIe Protocol Exerciser has the following features:

- Support for accurate generation of bidirectional PCI Express bus traffic for the following data rates and link widths:
  - 2.5/5.0 GT/s up to x8 lanes
  - 8.0 GT/s up to x8 lanes
  - 16.0 GT/s up to x8 lanes
  - 32.0 GT/s up to x8 lanes
- Host/Device Emulation Support for allowing design and stress testing.

- Link Training and Status State Machine (LTSSM) Testing to exercise LTSSM state transitions for verification.
- Review the Quick Start Guide for your product to learn how to properly configure the platform.
- The latest Summit Z58 Trainer supports CLKREQ# signal that allows for L1 Sub-strate testing.
- 8 GB Recording memory size

TABLE 1.2: Summit Z58 PCIe Protocol Exerciser Features and Benefits

Feature	Benefit
Protocol Recording, Triggering, Decoding, and Analysis	One tool does both PCIe 5.0 traffic generation and protocol analysis
Script Level Traffic Generation	Programmability to test PCI Express components with more precision and control
Convert Trace files into generation scripts	Recreate failure scenarios by replaying recorded traffic
Host/End-Point Emulation Support	End-point emulation (and optional host emulation) allow for designed stress and pre-testing of end-point and host devices for product verification
Point and Click Script Editor	Complex scripts can be created quickly and easily
Link Training & Status State Machine (LTSSM) Testing	Exercise LTSSM state transitions for verification
Supports existing PCIe Protocol Analysis API	Preserve investment in API Programs

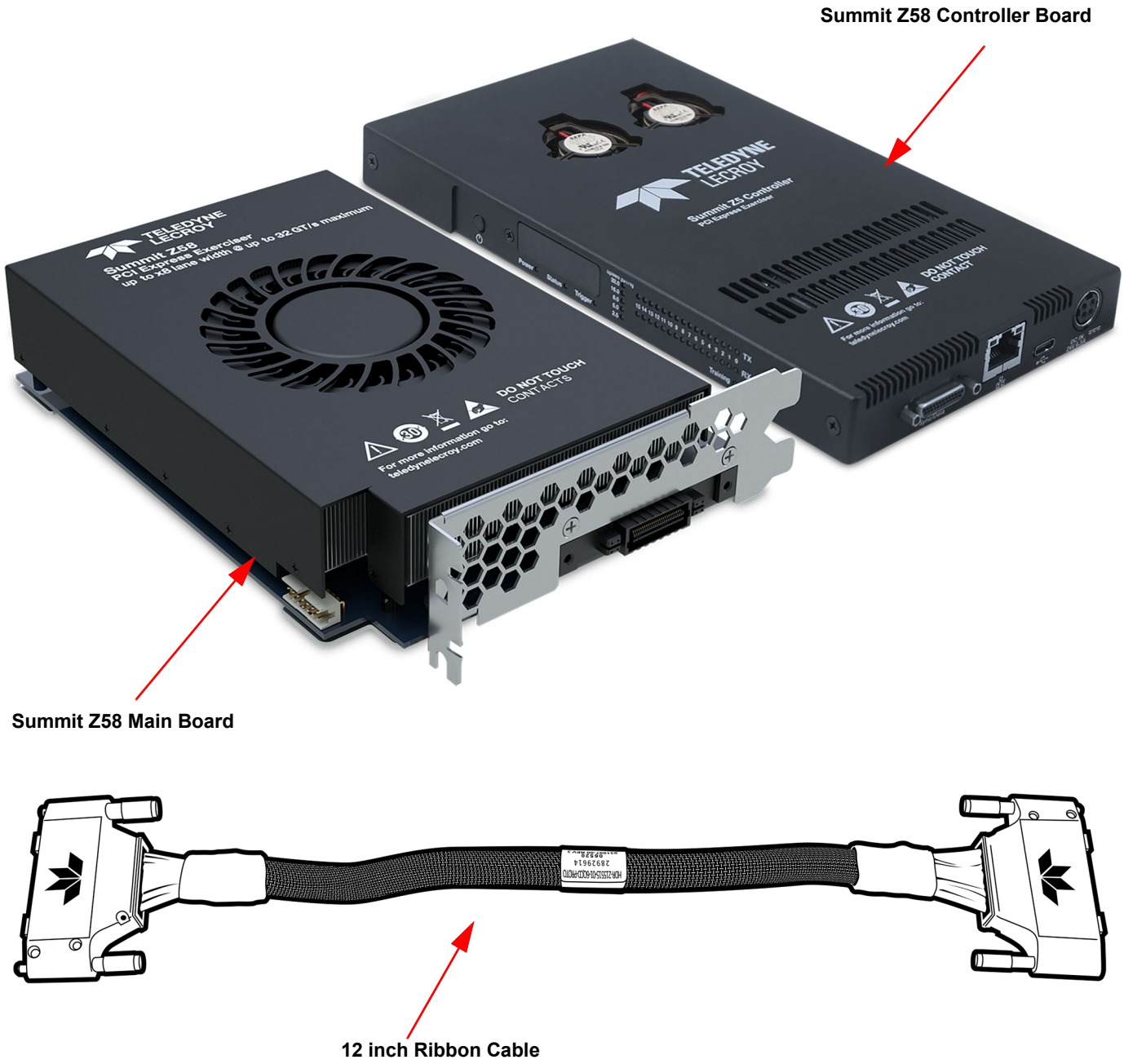


Figure 1.2: Summit Z5 PCIe Protocol Exerciser (Main Board and Controller Board) with Interface Cable

1.5 Related Reference Documents

For additional information refer to the following documents:

1. PCIe Protocol Suite/Trainer Automation Manual
2. PETrainer Scripting Language Reference Manual
3. Quick Start Guides: Summit Z58 PCI Express 5.0 Protocol Exerciser/Analyzer

1.6 Related Components

1.6.1 PXP500 PCI Express Test Platform: Overview

To create a complete DUT environment, the PXP500 PCI Express Test Platform can be used in conjunction with the Summit Z5. This combination of devices provides a convenient, powerful and flexible test platform for PCI Express devices at data rates up to 32.0 GT/s and link widths up to x16. See Figure 1.3

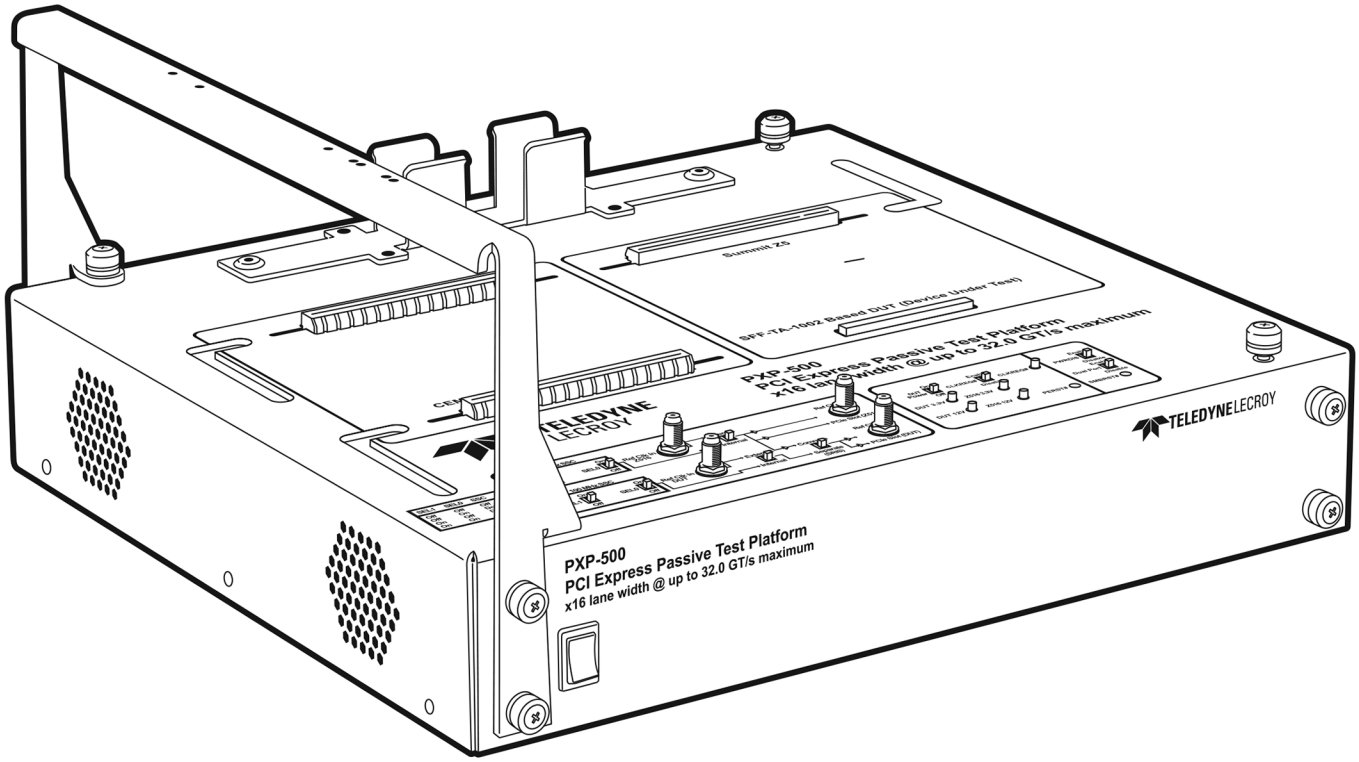


Figure 1.3: PXP500 PCI Express Test Platform x16 Lane Width @ Up To 32.0 GT/s

Chapter 2

Hardware Description

This chapter describes the hardware for the Summit Z516/Z58 PCIe Protocol Exerciser and the PXP500 PCI Express Test Platform.

2.1 Summit Z516 PCIe Protocol Exerciser System Components

The Summit Z516 PCIe Protocol Exerciser has the following components:

- Summit Z516™ Main plug in board
- Summit Z5 Controller Board
- Power Adapter (Output: 24 VDC, 9.2 A, 220 Watts)
- 12 inch Ribbon Cable
- Two (2) TX SSC CLK Cables
- USB 3.1 Type-C cable
- Ethernet Cable
- Summit Z516 PCIe Protocol Exerciser Quick Start Guide

2.2 Summit Z58 PCIe Protocol Exerciser System Components

NOTE: This is the Exerciser/Analyzer all across the document where the full name for Z58 is referenced.

The Summit Z58 PCIe Protocol Exerciser/Analyzer has the following components:

- Summit Z58™ Main plug in board
- Summit Z5 Controller Board
- Power Adapter (Output: 24 VDC, 9.2 A, 220 Watts)
- 12 inch Ribbon Cable
- Two (2) TX SSC CLK Cables
- USB 3.1 Type-C cable
- Ethernet Cable
- Summit Z58 PCIe Protocol Exerciser Quick Start Guide

2.3 Host Machine Requirements

The Summit Z58 PCIe Protocol Exerciser connects to a host machine. Please refer installation on the website for the latest host machine requirements.

2.4 Environmental Conditions

The environmental condition specifications are:

- Operating 41° F to 104° F (5° C to 40° C)
- Storage range from -4° F to 140° F (-20° C to 60° C)
- Humidity: Operating 5% to 80% RH (non-condensing) @ <= 86° F or <= 30° C

WARNING: Since the electrical components on the Summit Z58 card are exposed, please use standard ESD practices when handling the board; otherwise, it could be damaged.

2.5 Summit Z516 PCIe Protocol Exerciser

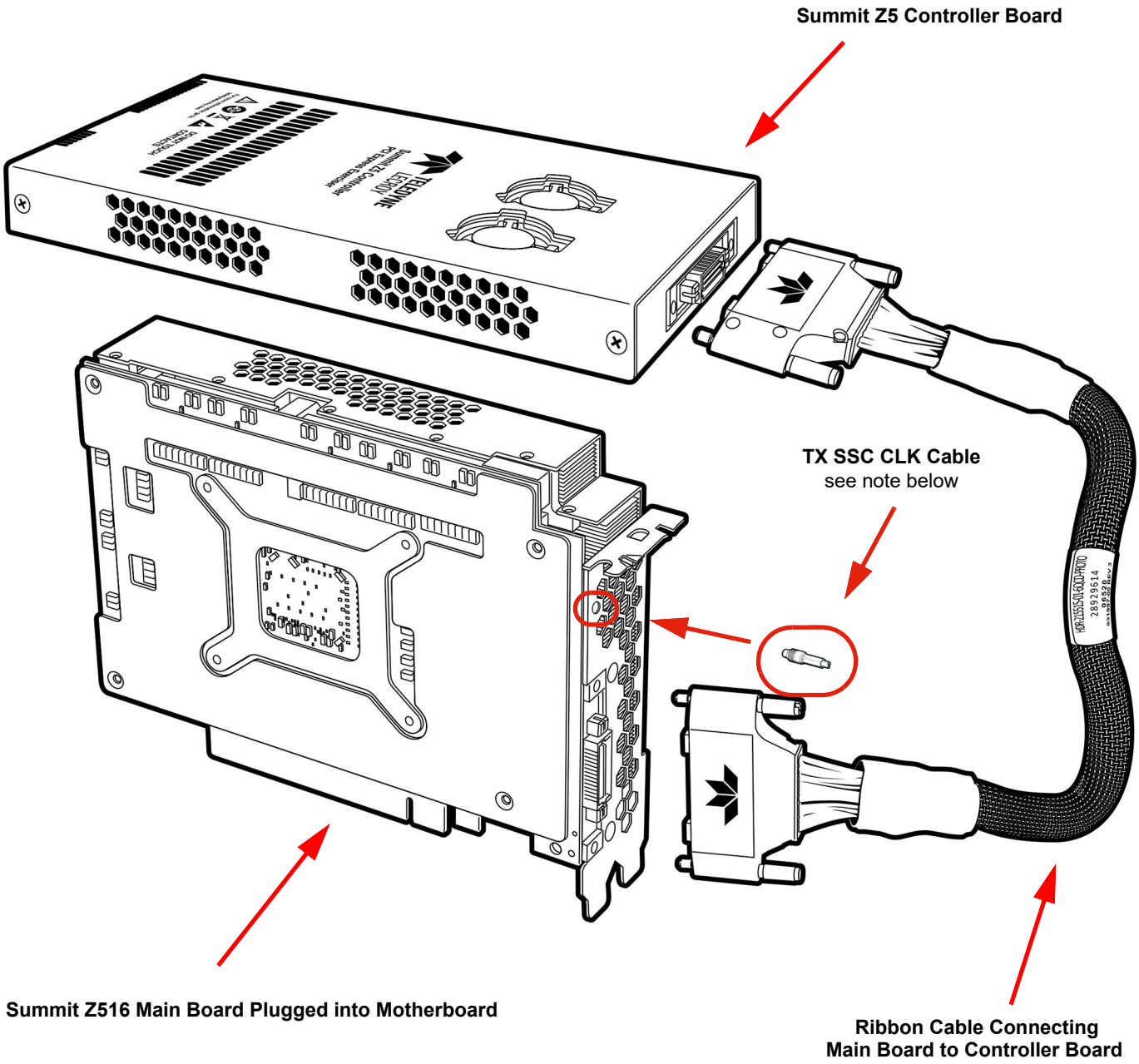
The Summit Z516 PCIe Protocol Exerciser is a multi-lane PCI Express Protocol Exerciser (see Figure 2.1 on page 27) designed to assist engineers in improving reliability of their solutions and providing advanced capabilities for stress and compliance testing.

All models operate as standalone Protocol Exercisers capable of generating and responding to all types of PCI Express transactions. Protocol Exercisers also have the ability to create protocol variations and anomalies. Users may create corner case and stress test scenarios to evaluate the robustness of their solutions. By utilizing the error injection feature, engineers can create worst-case PCI Express traffic scenarios allowing them to validate the error handling capabilities of their solutions.

The Summit Z516 PCIe Protocol Exerciser is a complete expert test system. This solution delivers traffic generation to assist developers with early validation of designs compliance test preparation with error injection and stress testing.

Device Emulation is a standard feature and host emulation is available through the optional PXP500 PCI Express Test Platform.

WARNING: There are no user serviceable parts. For servicing please contact Customer Support at Teledyne LeCroy.



Note: Depending on the cable used, the other end of the cable connects to the SMA input from the analyzer or the clock connector on the interposer. When the Summit Z5 is used in SRIS mode this clock output will allow an external analyzer to use the same clock being used by the Summit Z5 transmitter.

Figure 2.1: Summit Z516 PCIe Protocol Exerciser

The Summit Z516 can establish the link from x1 through x16 lane system and change speed from 2.5, 5.0, 8.0, 16.0 and 32.0 GT/s to exercise LTSSM State Transitions for verification.

2.5.1 Controller Board: Power and Data Ports

The Controller Board has the following power and data ports:

- 24V DC Power Input
- USB interface
- Ethernet Interface
- Sync/Data Interface
- Power On Display
- Status Display
- Trigger Display
- Speed (GT/s) Display
- Training Display
- Signal Activity DisplayTx[15:0] and Rx[15:0]
- Interface with Main Board

2.5.1.1 Controller Board: Power and Data Ports

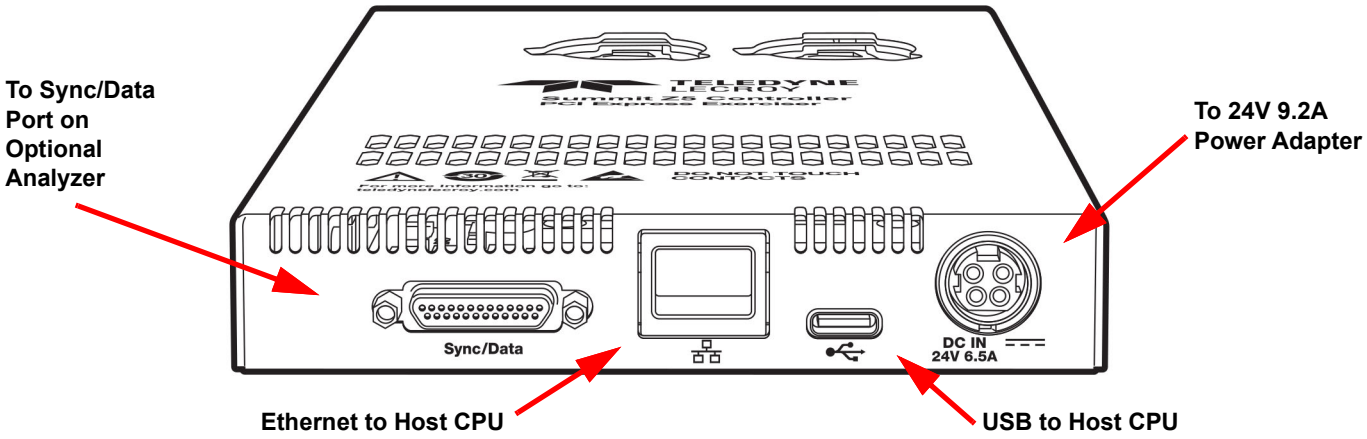


Figure 2.2: Controller Board: Power and Data Ports

2.5.1.2 Controller Board: Display Screen and LEDs

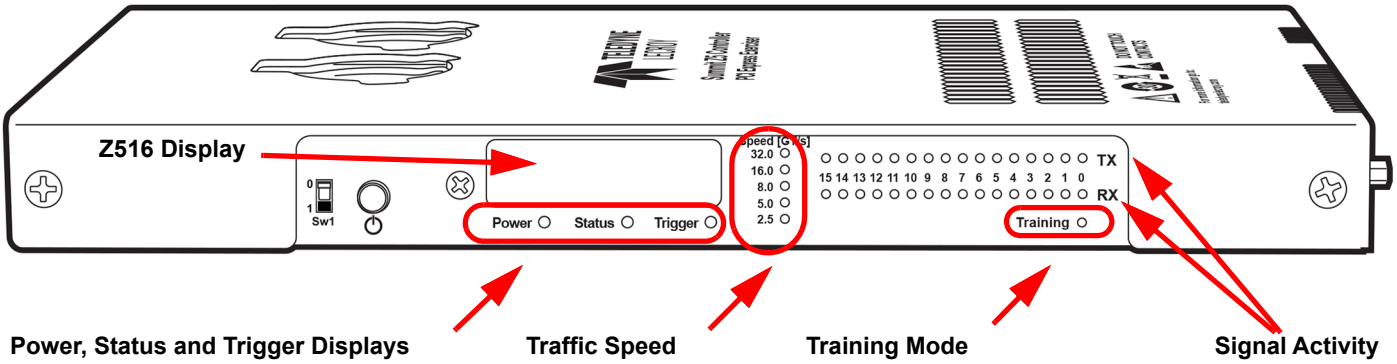


Figure 2.3: Controller Board: Display Screen and LEDs

2.5.1.3 Controller Board: Interface Connector to Main Board

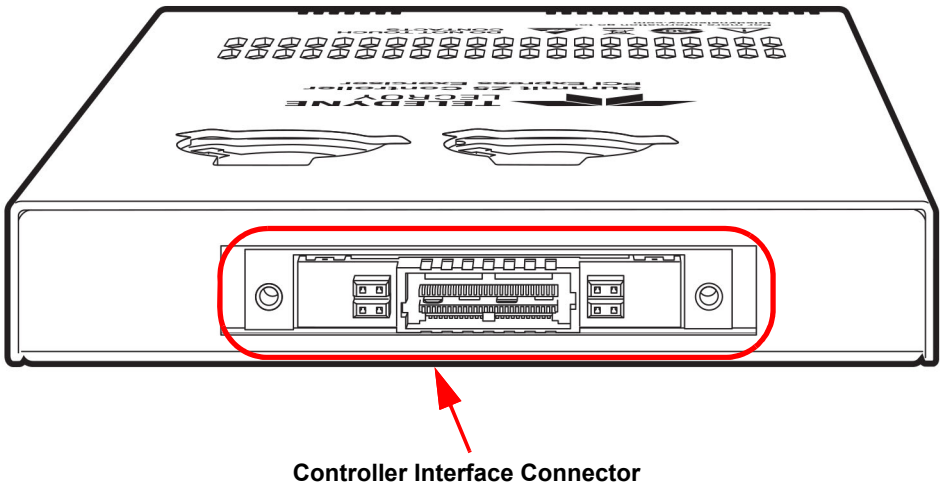


Figure 2.4: Controller Board: Interface Connector

2.5.2 Main Board: Interfaces to Controller Board and PCIe Slot

The Main Board has the following interfaces:

- Interface with Controller Board
- PCIe Edge Connector

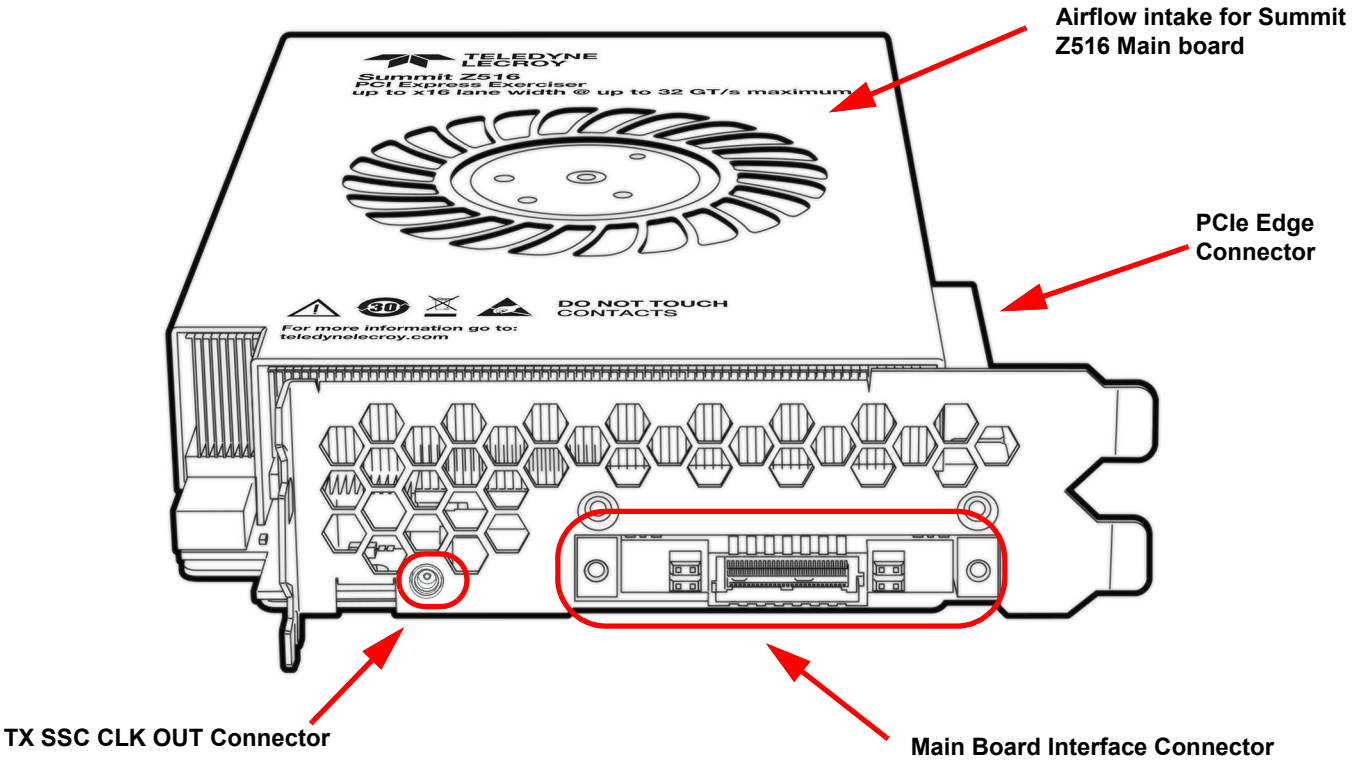


Figure 2.5: Z516 Main Board: Interface to Controller Board

2.5.3 User Interface on the Summit Z516 PCIe Protocol Exerciser

The Summit Z516 PCIe Protocol Exerciser contains the following interface components:

- Power On/Off LED
- Power socket for the 24V DC Power Connector
- Power requirement is 100-240 VAC, 47-63 Hz universal input for AC Adapter, which is included
- USB 3.1 Type-C Host Machine Connector
- Ethernet port

2.5.4 Connectors

Use a CACT SYNC cable to allow multiple Teledyne LeCroy analyzers to send synchronization and control messages to one another.

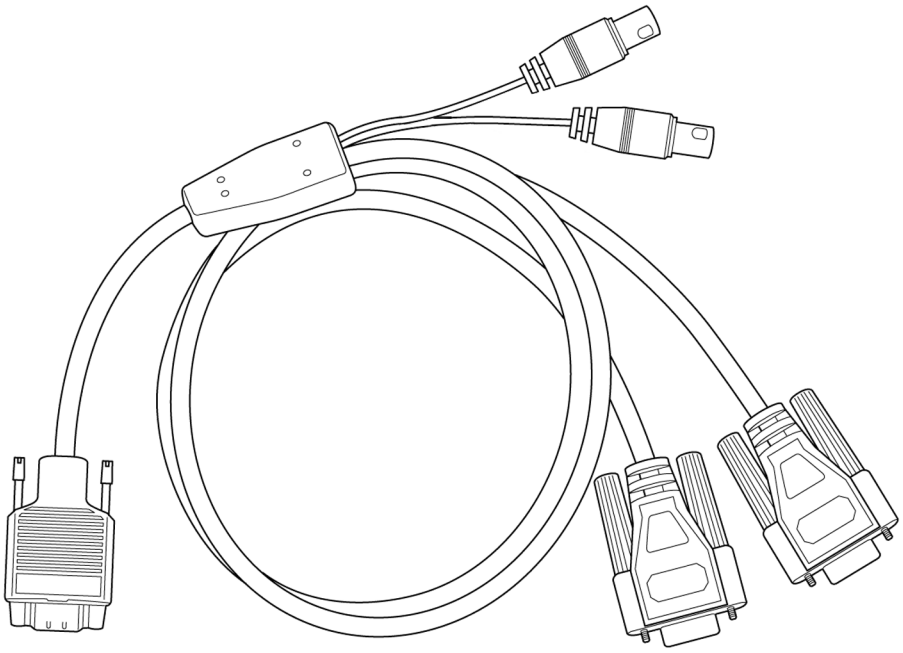


Figure 2.6: CACT SYNC cable for Summit Z416 Exerciser (AC030XXA-X)

Micro DB-25 “Octopus” interface cable for supporting Daisy-Chaining CATC Sync, and Cross Sync functions. Octopus side has DB-9 Male and Female connectors for supporting the Sync functions, and 2 bayonet connectors which support External Trigger In and External Trigger Out signals. (Sold separately, Part # AC030XXA-X)

Sync/External Trigger In/Out

Bayonet connector external trigger output.

Trigger In

Bayonet connector external trigger input. Note: Edge detected (Rising or Falling) Voltage required. Signal needs to be > 800mV to see a logic “1”, Signal needs to be < 400mV to see a logic “0”. Maximum value of the external input signal which can be input is 5 V. Minimum value is 0 V.

Trigger Out

Pulse Width = 280 ns. Pulse Voltage = 3.3 Volts into 1 MegOhms. Pulse Voltage = 2.7 Volts into 50 Ohms. Pulse is positive going.

2.5.4.1 USB 3.1 Type-C Host Machine (Controller Board)

This connector links the Summit Z516 PCIe Protocol Exerciser to the host machine for the purpose of downloading generation scripts and controlling the behavior of the Protocol Exerciser.

NOTE: Use either USB or Ethernet, not both.

2.5.4.2 Ethernet Port (Controller Board)

A 10/100/1000baseT Ethernet connector to the host machine is provided. GIGE Connectivity allows connection to an Ethernet network. This connector links a Protocol Exerciser to the host machine for the purpose of downloading generation scripts and controlling the behavior of the Protocol Exerciser.

NOTE: Use either USB or Ethernet, not both.

2.5.4.3 Sync/Data (Controller Board)

Use a CACT SYNC cable to allow multiple Teledyne LeCroy analyzers to send synchronization and control messages to one another.

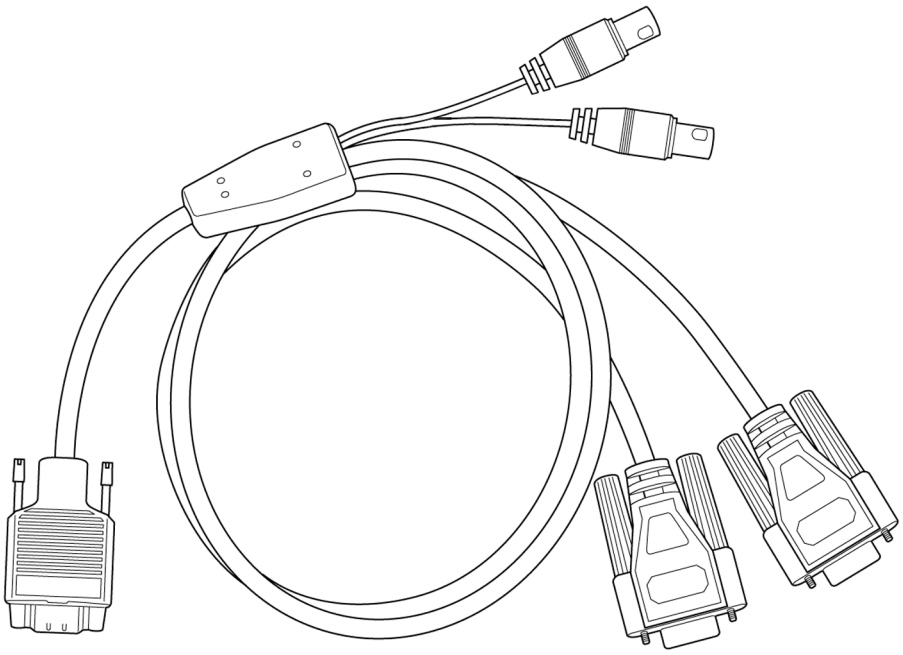


Figure 2.7: CACT SYNC cable for Summit Z416 Exerciser (AC030XXA-X)

2.5.4.4 Controller to Exerciser Interface (Controller Board)

Interface to Main Board.

2.5.4.5 x16 PCIe Edge Connector (Main Board)

The x16 PCIe Edge connector can be adapted to x16, x8, x4 or x1 slots through the use of a Card Reducer Edge Adapter.

2.5.4.6 Exerciser To Controller Interface (Main Board)

Interface to Controller Board.

2.5.5 Protocol Exerciser Display and LEDs

2.5.5.1 Dot Matrix Display

When powered on, the Summit Z516 PCIe Protocol Exerciser activates the dot matrix display, which displays “Summit Z516”. It will also display the IP address if the Z516 is connected to an Ethernet network.

2.5.5.2 Power LED

Lights when the power is ON.

2.5.5.3 Status LED

Red: Error condition. Try using the PCIe Protocol Analysis application to clear the error. Please contact the factory if the error persists.

Green: Configuring system.

Blue: Unit ready and connected.

2.5.5.4 Trigger LED

Lights when the Summit Z516 triggers on an event.

2.5.5.5 Training LED

There is a Training LED indicating whether the link is in Training mode or not.

2.5.5.6 Transmitter and Receiver Signal Activity LEDs

There are 32 LEDs, 16 for Transmitting and 16 for Receiving. These LEDs light up in two colors displaying transmitting or receiving activity.

- Green - no errors on the lane
- Yellow - the Summit Z516 PCIe Protocol Exerciser detects errors on this lane

2.5.5.7 Speed LEDs

There are 4 LEDs indicating the operating speed of 2.5, 5.0, 8.0, 16.0 and 32.0 GT/s.

2.6 Summit Z58 PCIe Protocol Exerciser

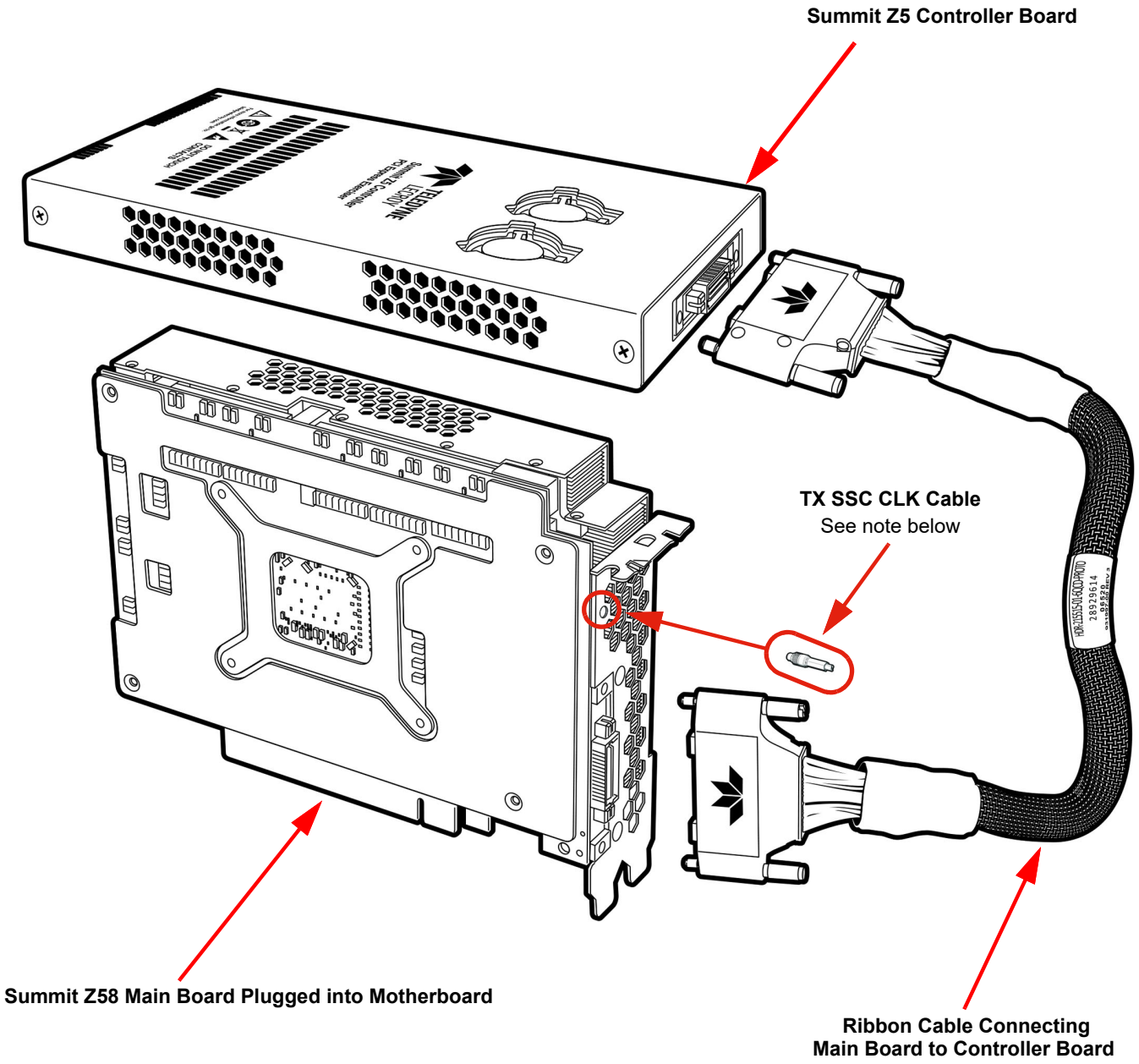
The Summit Z58 PCIe Protocol Exerciser is a multi-lane PCI Express Protocol Exerciser (see Figure 2.13 on page 42) designed to assist engineers in improving reliability of their solutions and providing advanced capabilities for stress and compliance testing.

All models operate as standalone Protocol Exercisers capable of generating and responding to all types of PCI Express transactions. Protocol Exercisers also have the ability to create protocol variations and anomalies. Users may create corner case and stress test scenarios to evaluate the robustness of their solutions. By utilizing the error injection feature, engineers can create worst-case PCI Express traffic scenarios allowing them to validate the error handling capabilities of their solutions.

The Summit Z58 PCIe Protocol Exerciser is a complete expert test and analysis system. This integrated solution delivers traffic generation and protocol analysis to assist developers with early validation of designs compliance test preparation with error injection and stress testing.

Device Emulation is a standard feature and host emulation is available through the optional PXP500 PCI Express Test Platform.

WARNING: There are no user serviceable parts. For servicing please contact Customer Support at Teledyne LeCroy.



Note: Depending on the cable used, the other end of the cable connects to the SMA input from the analyzer or the clock connector on the interposer. When the Summit Z5 is used in SRIS mode this clock output will allow an external analyzer to use the same clock being used by the Summit Z5 transmitter.

Figure 2.8: Summit Z58 PCIe Protocol Exerciser

The Summit Z58 can establish the link from x1 through x8 lane system and change speed from 2.5, 5.0, 8.0, 16.0 and 32.0 GT/s to exercise LTSSM State Transitions for verification.

2.6.1 Controller Board: Power and Data Ports

The Controller Board has the following power and data ports:

- 24V DC Power Input
- USB interface
- Ethernet Interface
- Sync/Data Interface
- Power On Display
- Status Display
- Trigger Display
- Speed (GT/s) Display
- Training Display
- Signal Activity DisplayTx[15:0] and Rx[15:0]
- Interface with Main Board

2.6.1.1 Controller Board: Power and Data Ports

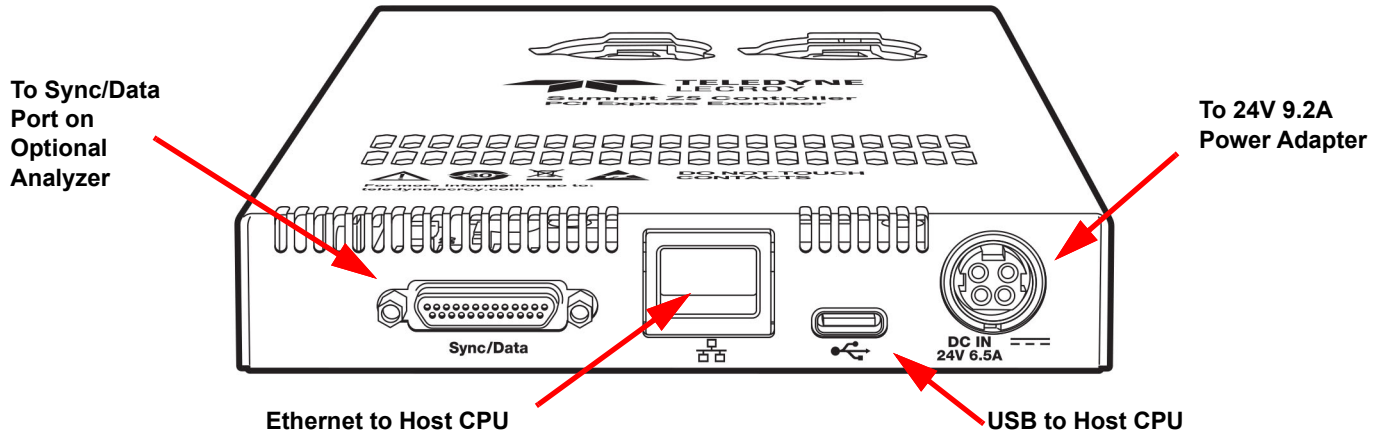


Figure 2.9: Controller Board: Power and Data Ports

2.6.1.2 Controller Board: Display Screen and LEDs

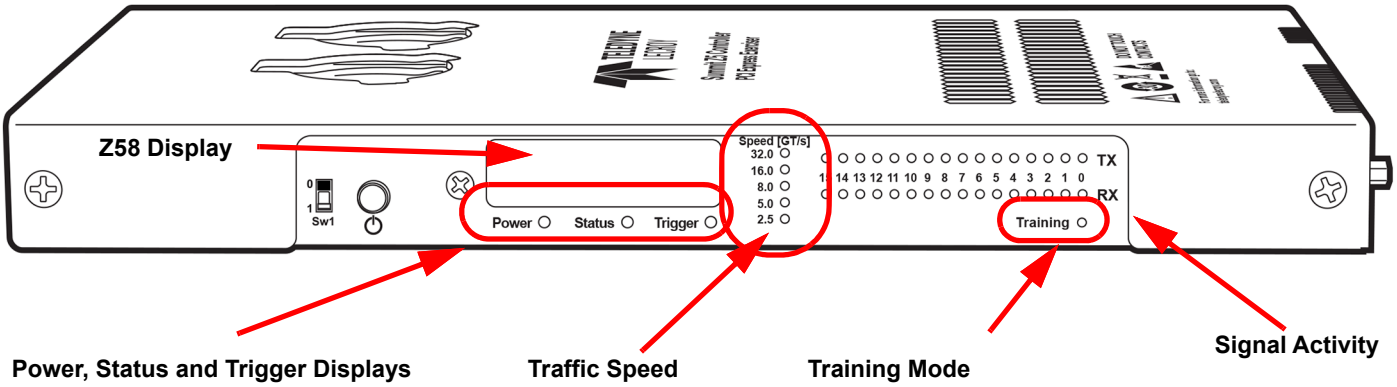


Figure 2.10: Controller Board: Display Screen and LEDs

2.6.1.3 Controller Board: Interface Connector to Main Board

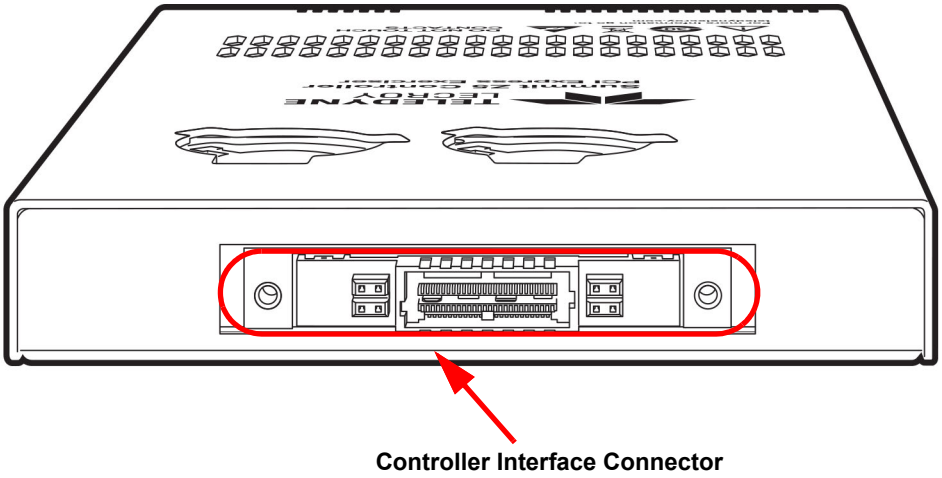


Figure 2.11: Controller Board: Interface Connector

2.6.2 Main Board: Interfaces to Controller Board and PCIe Slot

The Main Board has the following interfaces:

- Interface with Controller Board
- PCIe Edge Connector

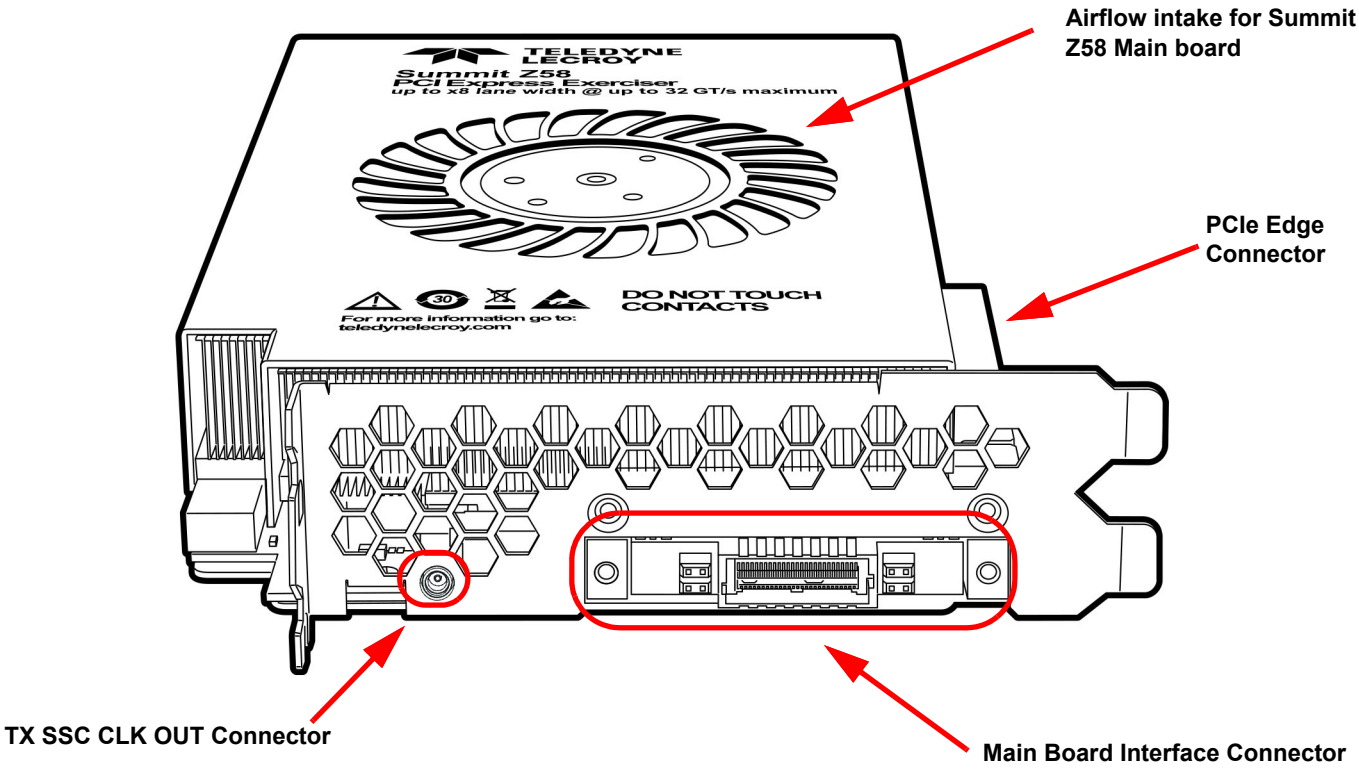


Figure 2.12: Z58 Main Board: Interface to Controller Board

2.6.3 User Interface on the Summit Z58 PCIe Protocol Exerciser

The Summit Z58 PCIe Protocol Exerciser contains the following interface components:

- Power On/Off LED
- Power socket for the 24V DC Power Connector
- Power requirement is 100-240 VAC, 47-63 Hz universal input for AC Adapter, which is included
- USB 3.1 Type-C Host Machine Connector
- Ethernet port

2.6.4 Connectors

2.6.4.1 USB 3.1 Type-C Host Machine (Controller Board)

This connector links the Summit Z58 PCIe Protocol Exerciser to the host machine for the purpose of downloading generation scripts and controlling the behavior of the Protocol Exerciser.

Note: Use either USB or Ethernet, not both.

2.6.4.2 Ethernet Port (Controller Board)

A 10/100/1000baseT Ethernet connector to the host machine is provided. GIGE Connectivity allows connection to an Ethernet network. This connector links a Protocol Exerciser to the host machine for the purpose of downloading generation scripts and controlling the behavior of the Protocol Exerciser.

Note: Use either USB or Ethernet, not both.

2.6.4.3 Sync/Data (Controller Board)

Use a special cable to allow multiple Teledyne LeCroy analyzers to send synchronization and control messages to one another.

2.6.4.4 Controller to Exerciser Interface (Controller Board)

Interface to Main Board.

2.6.4.5 x16 PCIe Edge Connector (Main Board)

The x16 PCIe Edge connector can be adapted to x8, x4 or x1 slots through the use of a Card Reducer Edge Adapter.

2.6.4.6 Exerciser To Controller Interface (Main Board)

Interface to Controller Board.

2.6.5 Protocol Exerciser Display and LEDs

2.6.5.1 Dot Matrix Display

When powered on, the Summit Z58 PCIe Protocol Exerciser activates the dot matrix display, which displays “Summit Z58”. It will also display the IP address if the Z58 is connected to an Ethernet network.

2.6.5.2 Power LED

Lights when the power is ON.

2.6.5.3 Status LED

Red: Error condition. Try using the PCIe Protocol Analysis application to clear the error. Please contact the factory if the error persists.

Green: Configuring system.

Blue: Unit ready and connected.

2.6.5.4 Trigger LED

Lights when the Summit Z58 triggers on an event.

2.6.5.5 Training LED

There is a Training LED indicating whether the link is in Training mode or not.

2.6.5.6 Transmitter and Receiver Signal Activity LEDs

There are 32 LEDs, 16 for Transmitting and 16 for Receiving. These LEDs light up in two colors displaying transmitting or receiving activity.

- Green - no errors on the lane
- Yellow - the Summit Z58 PCIe Protocol Exerciser detects errors on this lane

2.6.5.7 Speed LEDs

There are 4 LEDs indicating the operating speed of 2.5, 5.0, 8.0, 16.0 and 32.0 GT/s.

Summit Z58 PCIe Protocol Exerciser

The Summit Z58 PCIe Protocol Exerciser is a multi-lane PCI Express Protocol Exerciser (see Figure 2.8 on page 35) designed to assist engineers in improving reliability of their solutions and providing advanced capabilities for stress and compliance testing.

All models operate as standalone Protocol Exercisers capable of generating and responding to all types of PCI Express transactions. Protocol Exercisers also have the ability to create protocol variations and anomalies. Users may create corner case and stress test scenarios to evaluate the robustness of their solutions. By utilizing the error injection feature, engineers can create worst-case PCI Express traffic scenarios allowing them to validate the error handling capabilities of their solutions.

The Summit Z58 PCIe Protocol Exerciser is a complete expert test and analysis system. This integrated solution delivers traffic generation and protocol analysis to assist developers with early validation of designs compliance test preparation with error injection and stress testing.

Device Emulation is a standard feature and host emulation is available through the optional PXP500 PCI Express Test Platform.

WARNING: There are no user serviceable parts. For servicing please contact Customer Support at Teledyne LeCroy.

2.7 PXP500 PCI Express Test Platform: Overview

The PXP500 PCI Express Test Platform x16 Lane Width / Up to 32.0 GT/s provides a convenient, powerful and flexible test platform for PCI Express devices at data rates up to 32.0 GT/s and link widths up to x16. It can be used in conjunction with the Summit Z516/Z58 to create a DUT environment.

2.7.1 PXP500 PCI Express Test Platform Features

The PXP500 PCI Express Test Platform has the following features:

- The PXP500 PCI Express Test Platform accessory to the Summit Z5 PCIe Protocol Exerciser allows testing and debugging of the PCI Express cards by providing host emulation.
- The PXP500 PCI Express Test Platform supports PCIe rates up to 32 GT/s.
- Lane widths of x1, x2, x4, x8 and x16 are supported.
- Mechanical support and power is provided for both the Summit Z5 PCIe Protocol Exerciser and the device under test (DUT).
- Flexible Clock options.
  - External RefClk Input to Host Slot
  - Host Slot RefClk Out
  - Host Slot RefClk Source Selection
  - Host Slot Spread Spectrum Clock
  - L1 Substates (CLKREQ#) Support
  - Host/DUT RefClk Sharing
  - DUT Slot Spread Spectrum Clock
  - DUT Slot Clock Source Selection
  - External RefClk Input to DUT Slot
  - DUT Slot RefClk Out
- PERST# Toggle Switch
- Review the Quick Start Guide for your product to learn how to properly configure the platform.

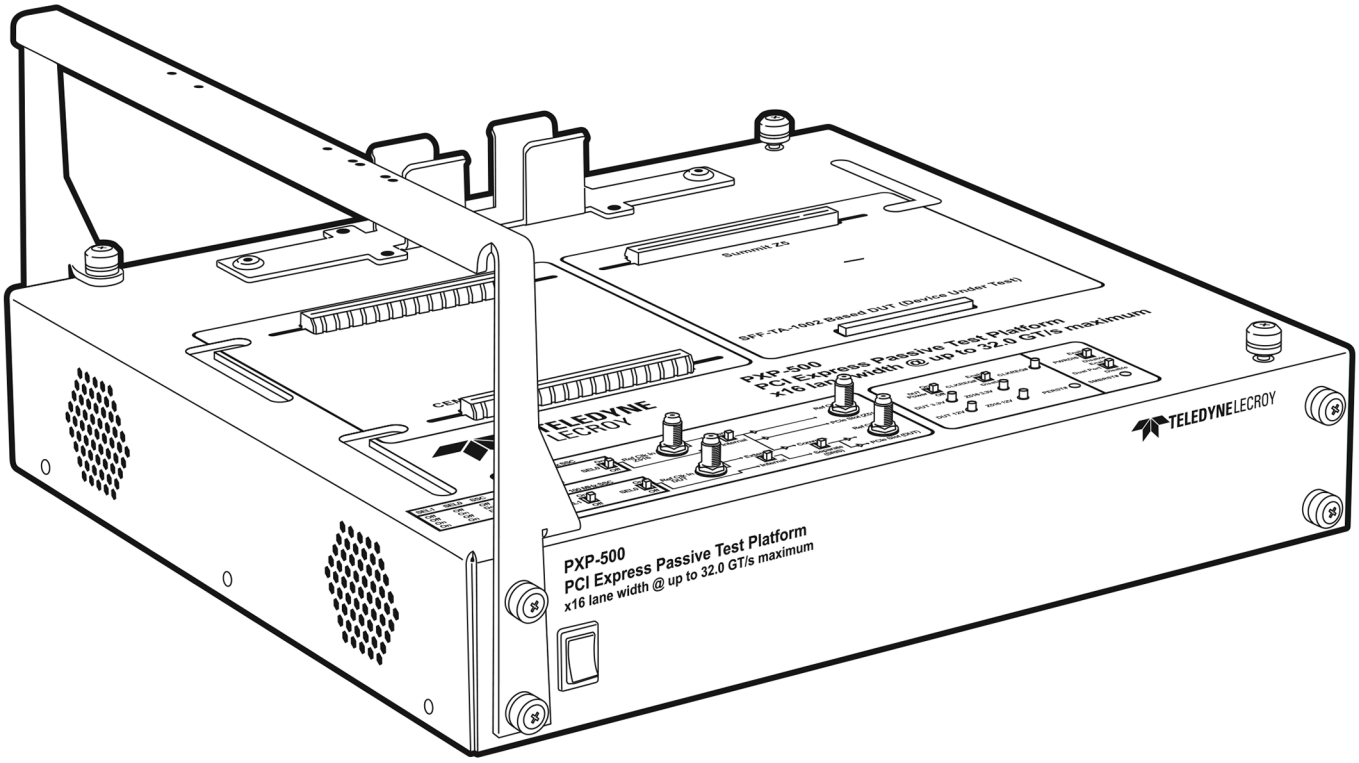


Figure 2.13: PXP500 PCI Express Test Platform x16 Lane Width @ Up To 32.0 GT/s

2.8 PXP500 PCIe™ Test Platform: x16 Lane Width/Up to 32.0 GT/s

The PXP500 PCI Express Test Platform: x16 Lane Width / Up to 32.0 GT/s (see Figure 2.14) for the Summit Z516/Z58 PCIe Protocol Exerciser can be purchased optionally to allow the Summit Z516 Protocol Exerciser to act as a host machine, enabling extensive protocol level testing of PCIe devices. It provides a convenient, powerful and flexible PCI Express Test Platform for PCI Express devices at data rates up to 32 GT/s and lane widths up to x16. It has two PCIe slots, one dedicated to the Summit Z5 PCIe Protocol Exerciser and another for the Device Under Test. The PCI Express Test Platform has a DUT PCIe x16 slot to capture protocol traffic between systems.

When the PCI Express Test Platform is powered on it provides power to the DUT. When using the PCI Express Test Platform you can choose a generic internal reference clock or external reference clocking from an external source.

Warning:
If the DUT blocks the air intake of the Summit Z5 main card we recommend the Summit Z5 main card be installed in the DUT slot instead.

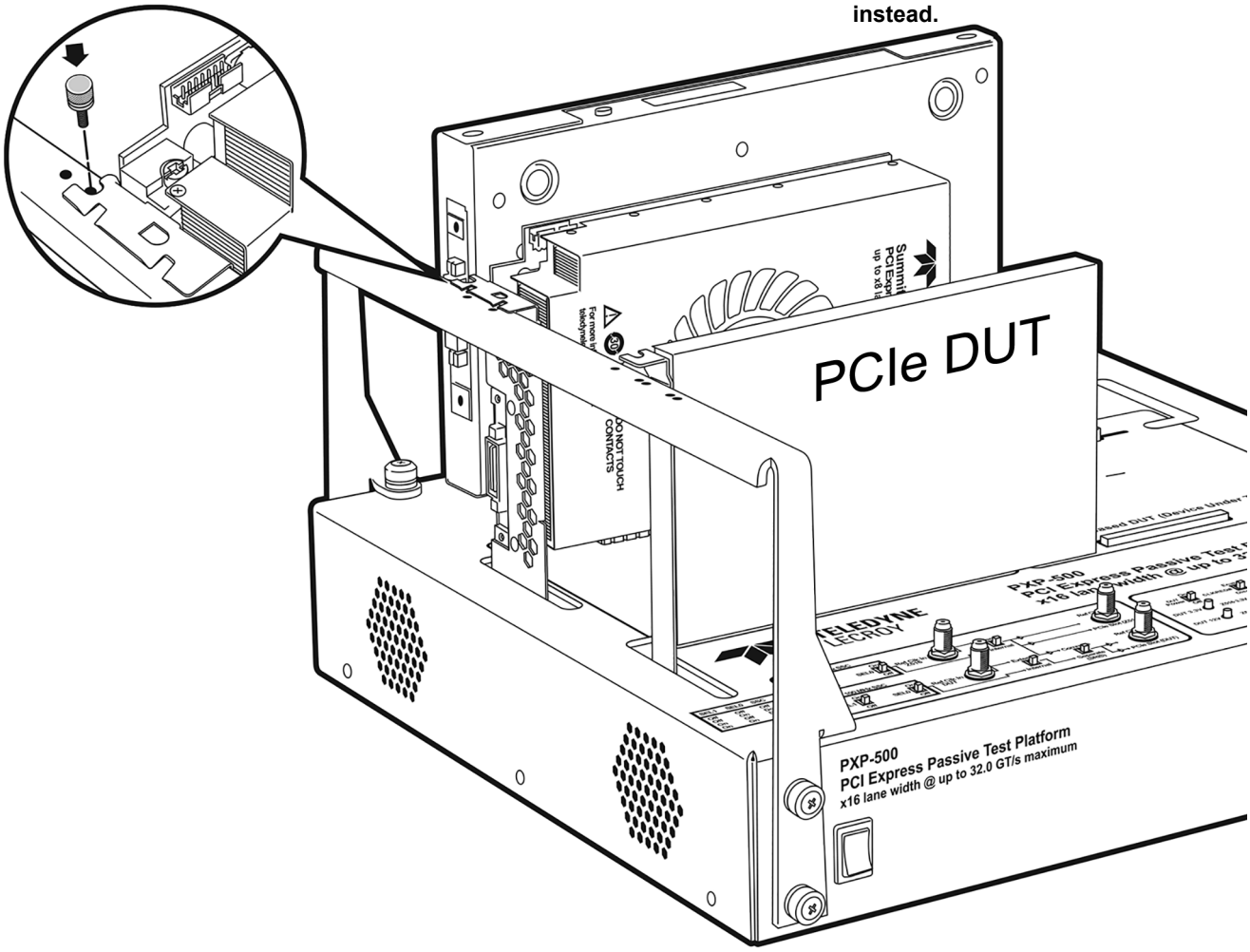


Figure 2.14: PXP500 PCI Express Test Platform: x16 Lane Width / Up to 32.0 GT/s

2.8.1 PXP500: Connectors and Switches

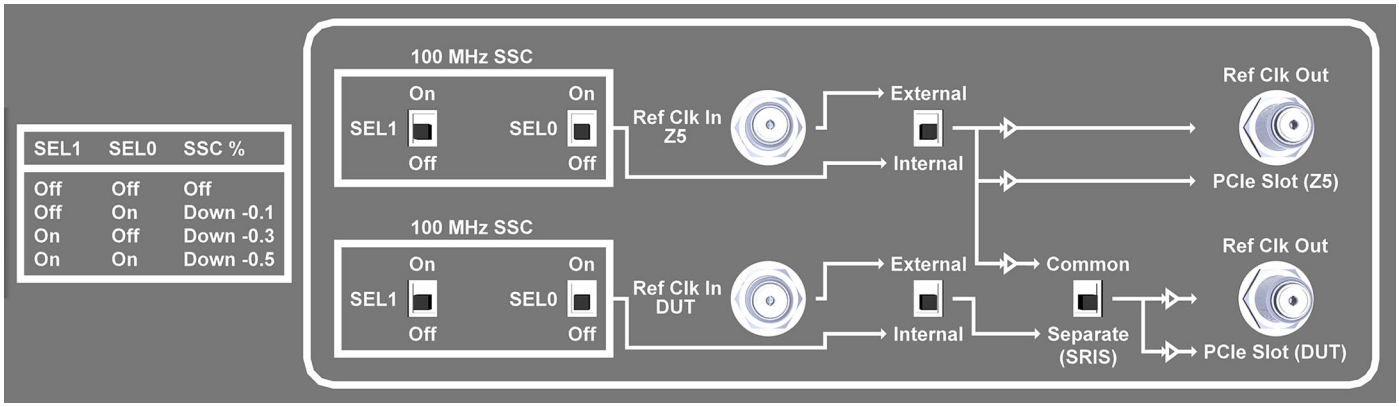


Figure 2.15: Clock Source Diagram

TABLE 2.3: 100MHz SSC Internal Clock Configuration

SEL1	SEL0	Clock downspread amount (%)
Off	Off	No SSC (Default setting)
Off	On	-0.1 (1000 ppm)
On	Off	-0.3 (3000 ppm)
On	On	-0.5 (5000 ppm)

TABLE 2.4: Z5 Slot / DUT Slot Clock Source

Z5 Slot	External	Clock for Z5 Slot comes from Ref Clk In connector
	Internal	Clock for Z5 Slot comes from Internal Clock (default setting)
DUT Slot	External	Clock for DUT Slot comes from Ref Clk In connector
	Internal	Clock for DUT Slot comes from Internal Clock (default setting)

TABLE 2.5: Z5 Slot / DUT Slot Clock Mode Configuration

Common	Clock for Z5 Slot and DUT Slot are the **same** (default setting)
Separate (SRIS)	Clock for Z5 Slot and the DUT Slot are **separate** and per source switch (see Table 2)

TABLE 2.6: Clock Input Specification

Parameter	Specification
Peak to peak voltage level	300mV (Min), 500mV (Max)
Input interface level accepted	To drive the 100MHz clock input the following sources can be used: CML, HCSL, LVPECL and LVDS. You should feed only one of the differential pair signals to the input or they should convert the differential to single ended.
Nominal frequency	100 MHz

TABLE 2.6: Clock Input Specification (Continued)

Parameter	Specification
Peak to peak voltage level	400mV
Interface level	LVDS
Nominal frequency	100 MHz

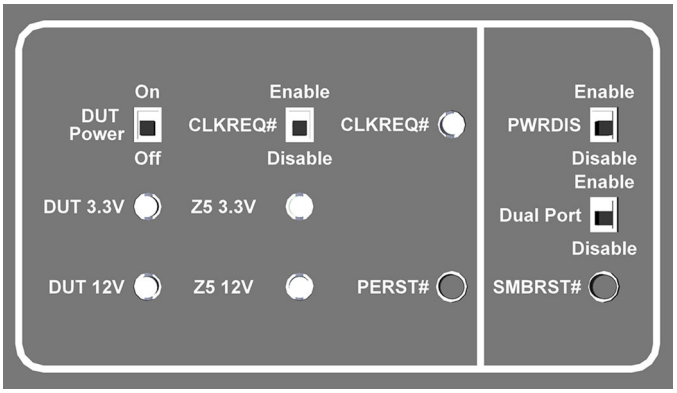


TABLE 2.7: Other Switches

DUT Power	On	Turn ON power to the DUT slot.
	Off	Turn OFF power to the DUT slot. Default setting.
CLKREQ#	Enable	Allows CLKREQ# to control (turn on or off) the reference clock. If the switch is enabled, the CLKREQ# signal must be asserted to have the clock turned on. If the switch is enabled and the CLKREQ# signal is deasserted the clock is turned off (low power mode).
	Disable	When the switch is in Disable position, the RefClk is always ON regardless of the state of CLKREQ# signal on the bus.Default setting.
PWRDIS	Enable	Power Disable signal: Active high. When set to Enable the signal notifies the device to turn off all systems connected to 12V power.
	Disable	When set to Disable, the PWRDIS signal has no effect on the system. Default setting.
Dual Port	Enable	Dual Port Enable signal: Active low. This signal indicates if dual port mode is supported by the host.
	Disable	When set to Disable, the Dual Port signal has no effect on the system. Default setting.
PERST#	Momentary switch: When pressed causes PERST# signal to go low, resetting the system.	
SMBRST#	Momentary switch: When pressed causes SMBRST# signal to go low, resetting the SMBus	

Chapter 3

Installation

This chapter provides instructions to install the PCIe Protocol Analysis, the Summit Z5 PCIe Protocol Exerciser and a PCI Express Test Platform.

3.1 Installing the PCIe Protocol Analysis software

PCIe Protocol Analysis software operates all of Teledyne LeCroy's PCI Express protocol Analyzer and Exerciser products:

The PCIe Protocol Analysis software is supported on systems using a Microsoft® Windows®-based host machine running Windows Server 2016, Windows Server 2019 and Windows 10 64-bit operating systems and serves as the interface for the Exerciser and/or Analyzer.

3.1.1 Downloading the PCIe Protocol Analysis software

You can download the latest version of the PCIe Protocol Analysis software from the following site:

https://teledynelecroy.com/sw/pciexpress/

Note: First-time user registration is required.

3.1.2 Windows Server 2016/2019

If you are using Windows Server 2016/2019, the Teledyne LeCroy PCIe Protocol Suite needs to be added to the firewall exceptions to ensure that the application can find the analyzers over your Ethernet network.

To add the PCIe Protocol Suite application to the firewall exceptions perform the following steps.

1. Open the Control Panel. See Figure 3.1.

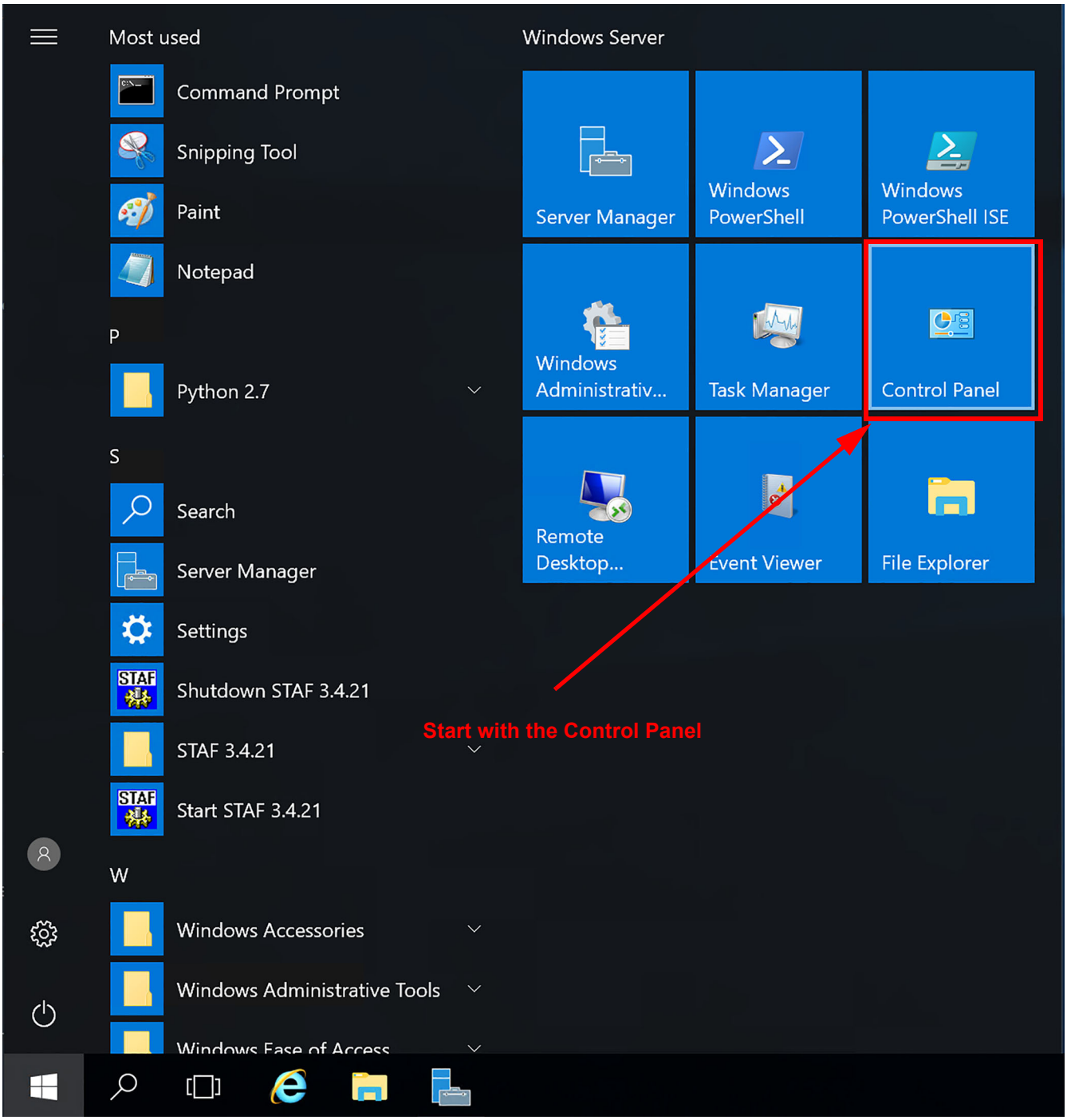


Figure 3.1: Windows Server 2016/2019: Start Menu → Control Panel

2. From the Control Panel. select the “Systems and Security” screen. See Figure 3.2.

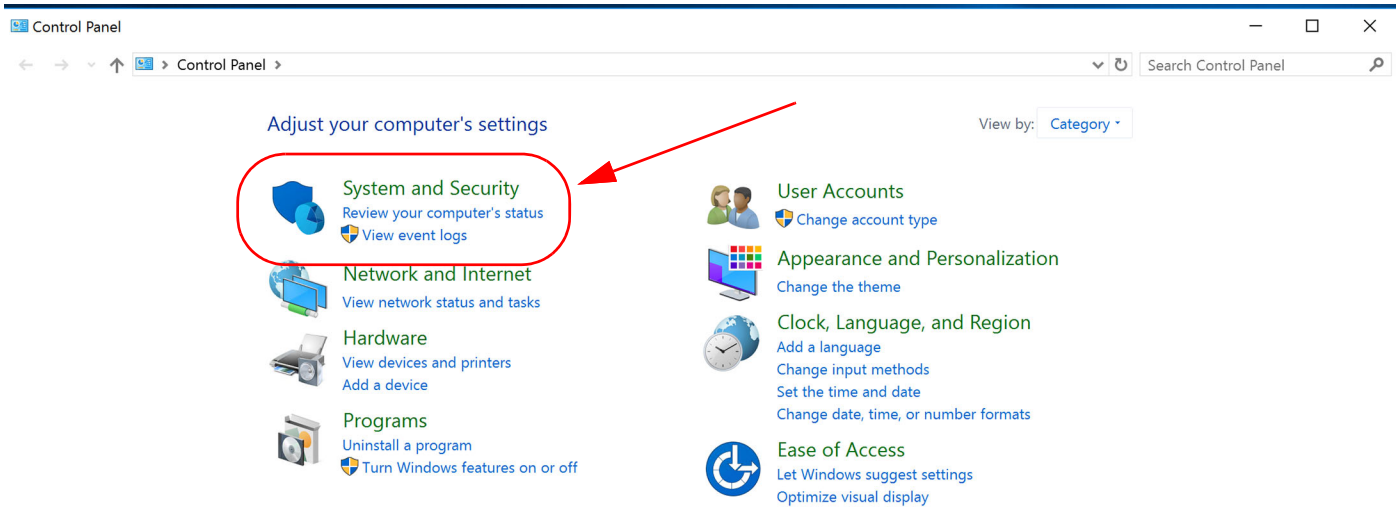


Figure 3.2: Windows Server 2016/2019: Control Panel → System and Security Screen

3. From the Control Panel → System and Security Screen, select “Allow an App through Windows Firewall”. See Figure 3.3.

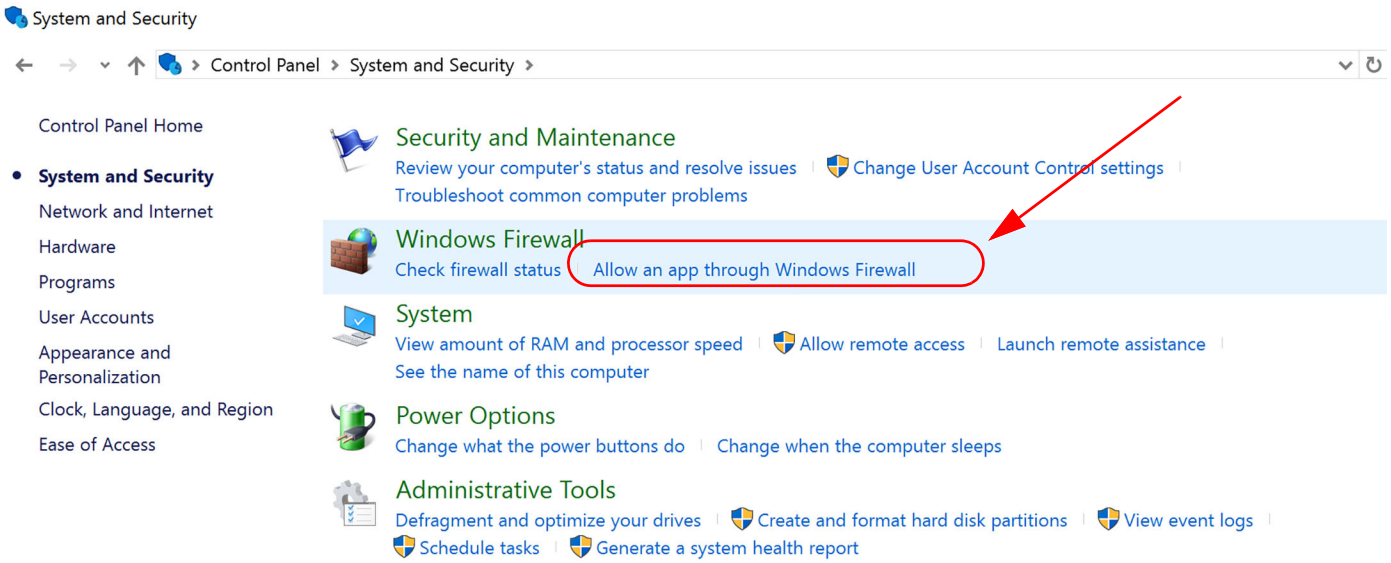


Figure 3.3: Windows Server 2016/2019: Allow an App Through Windows Firewall

4. From the Windows Firewall screen → Allow apps to communicate through Windows Firewall, select “Change settings”, then select “Allow another program”. See Figure 3.4.

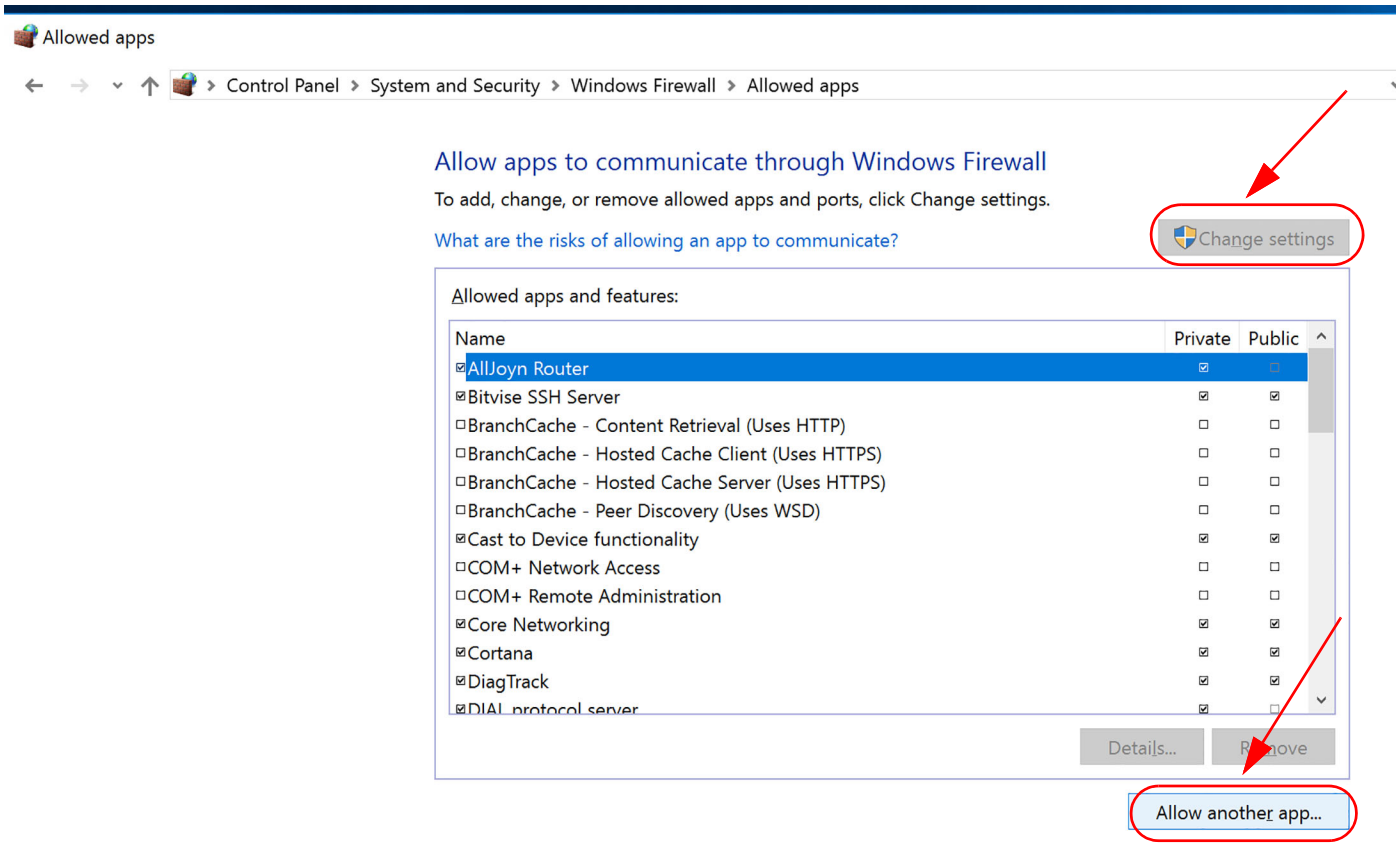


Figure 3.4: Windows Server 2016/2019: Change Settings → Allowed Another app

5. From the User Account Control screen, select “Yes”. Figure 3.5.

Note: This screen may be optional if you have already allowed Microsoft Windows to make changes to your computer.

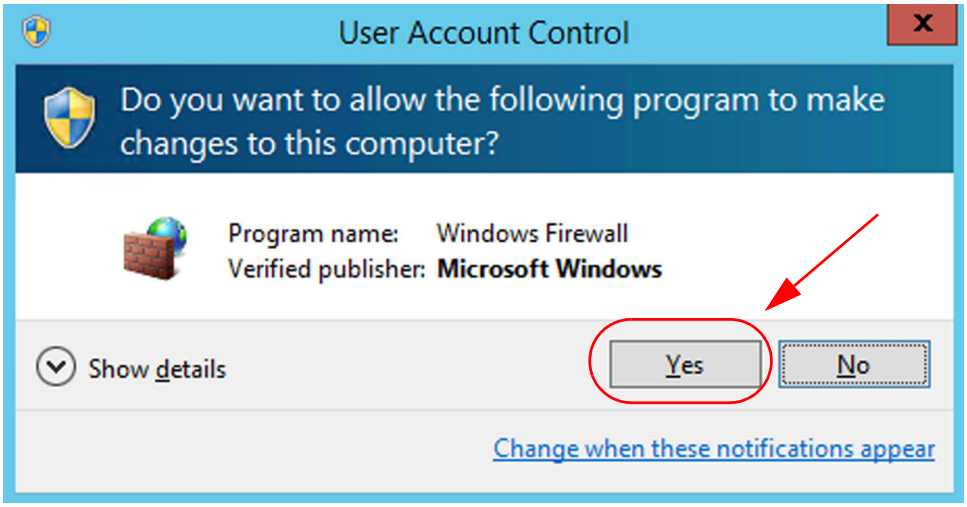


Figure 3.5: Windows Server 2016/2019: User Account Control

6. From the “Add an app” screen, select the Browse button. See Figure 3.6.

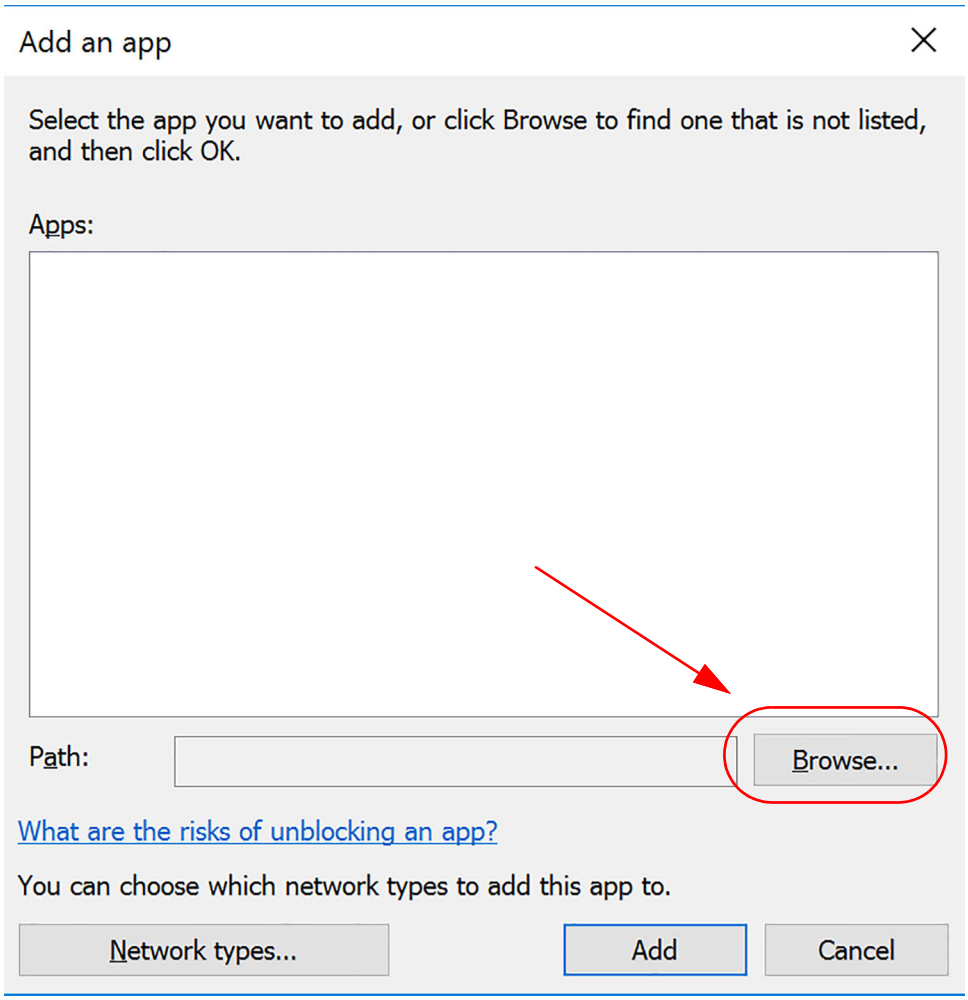


Figure 3.6: Windows Server 2016/2019: Add an App

7. In the Browse window navigate to the location of the installation directory for the PCIe Protocol Suite you are installing. The Teledyne LeCroy PCIe Protocol Suite is typically installed on your machine in the C:\Program Files\LeCroy\PCIe Protocol Suite directory. See Figure 3.7.

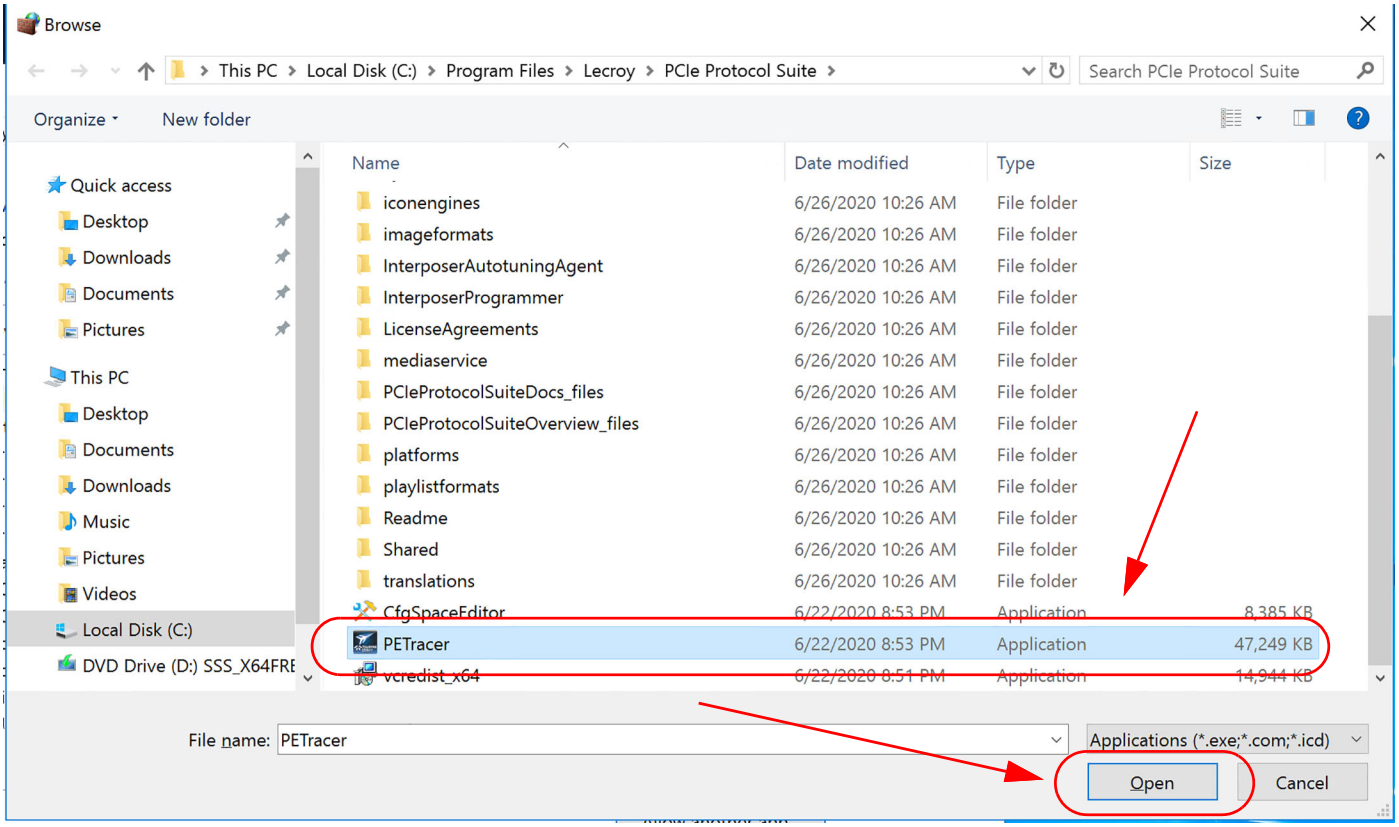


Figure 3.7: Windows Server 2016/2019: Browse to Find Application → PCIe Protocol Analysis Application

8. Select the PCIe Protocol Analysis executable file (with the .exe extension) and click on “Open”.

9. If necessary, select the Teledyne LeCroy PCIe Protocol Suite you want to add. Then click on “ADD”, this will add the Teledyne LeCroy PCIe Protocol Suite to the Apps allowed through the Firewall. See Figure 3.8.

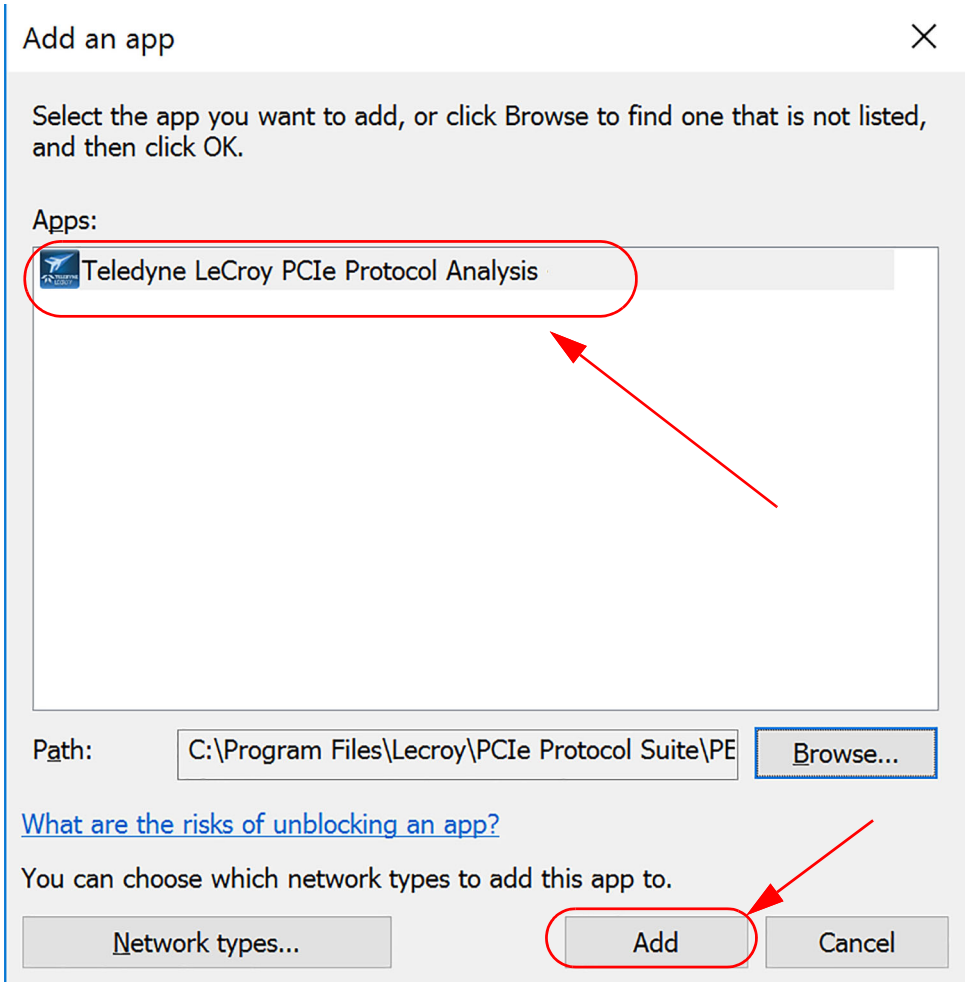


Figure 3.8: Windows Server 2016/2019: Add an Application to the Firewall Exceptions

10. After the Application has been added, you can see it in the "Allow apps to communicate through Windows Firewall" screen. See Figure 3.9.

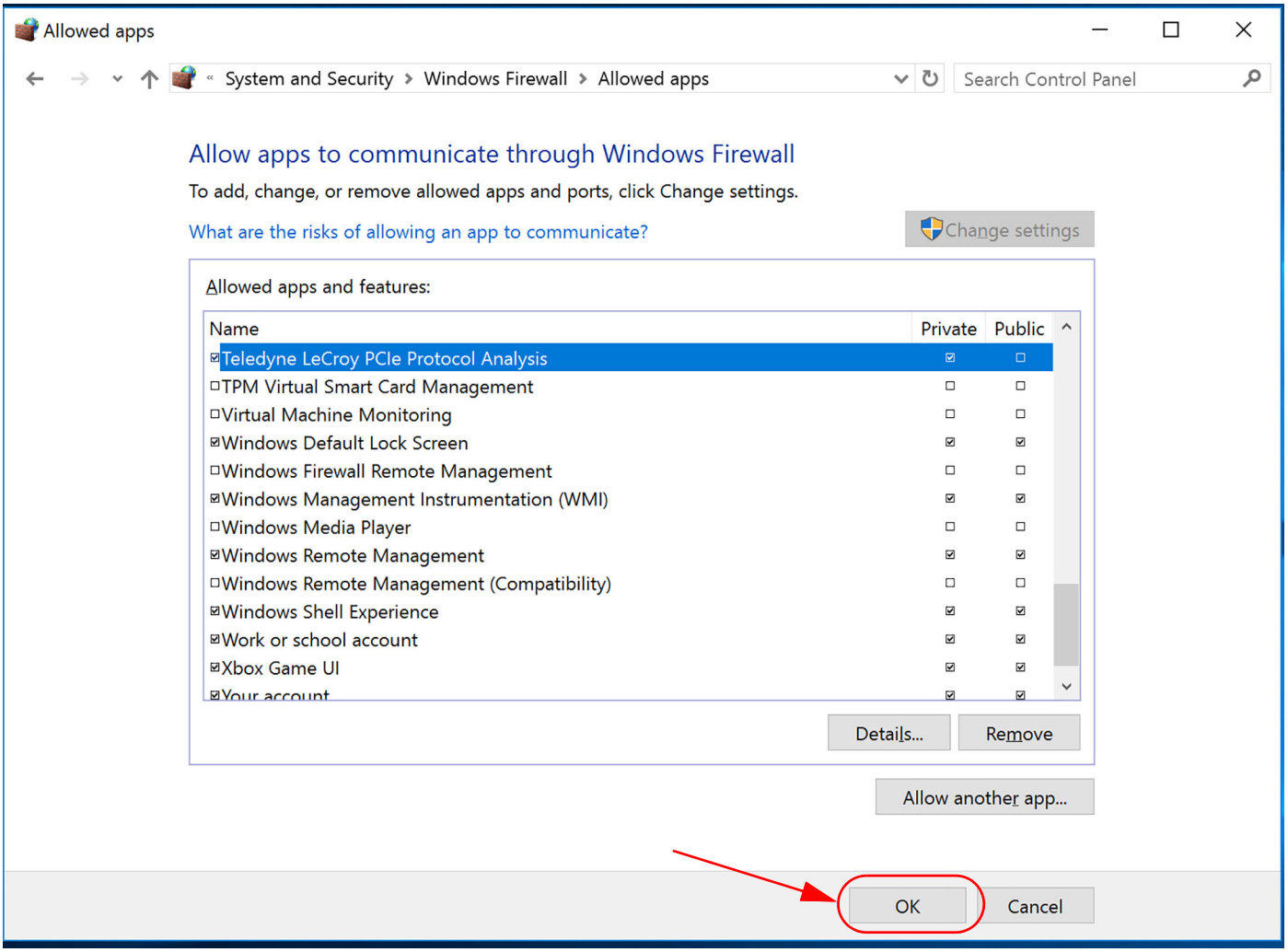


Figure 3.9: Windows Server 2016/2019: Add Teledyne LeCroy PCIe Protocol Suite to Allowed Applications

Click "**OK**" and you're done with updating the Firewall.

3.1.3 Launching the PCIe Protocol Analysis

To start the application, launch the PCIe Protocol Analysis program from the Start menu:
Start > All Apps > LeCroy > PCIe Protocol Suite

Note: The above path is for Windows 10, the path may be different for other versions of Windows.

Note: You can also download the software from the Teledyne LeCroy website and install it following steps 2 through 6 above.

The PCIe Protocol Analysis program opens as shown below (see Figure 3.10).

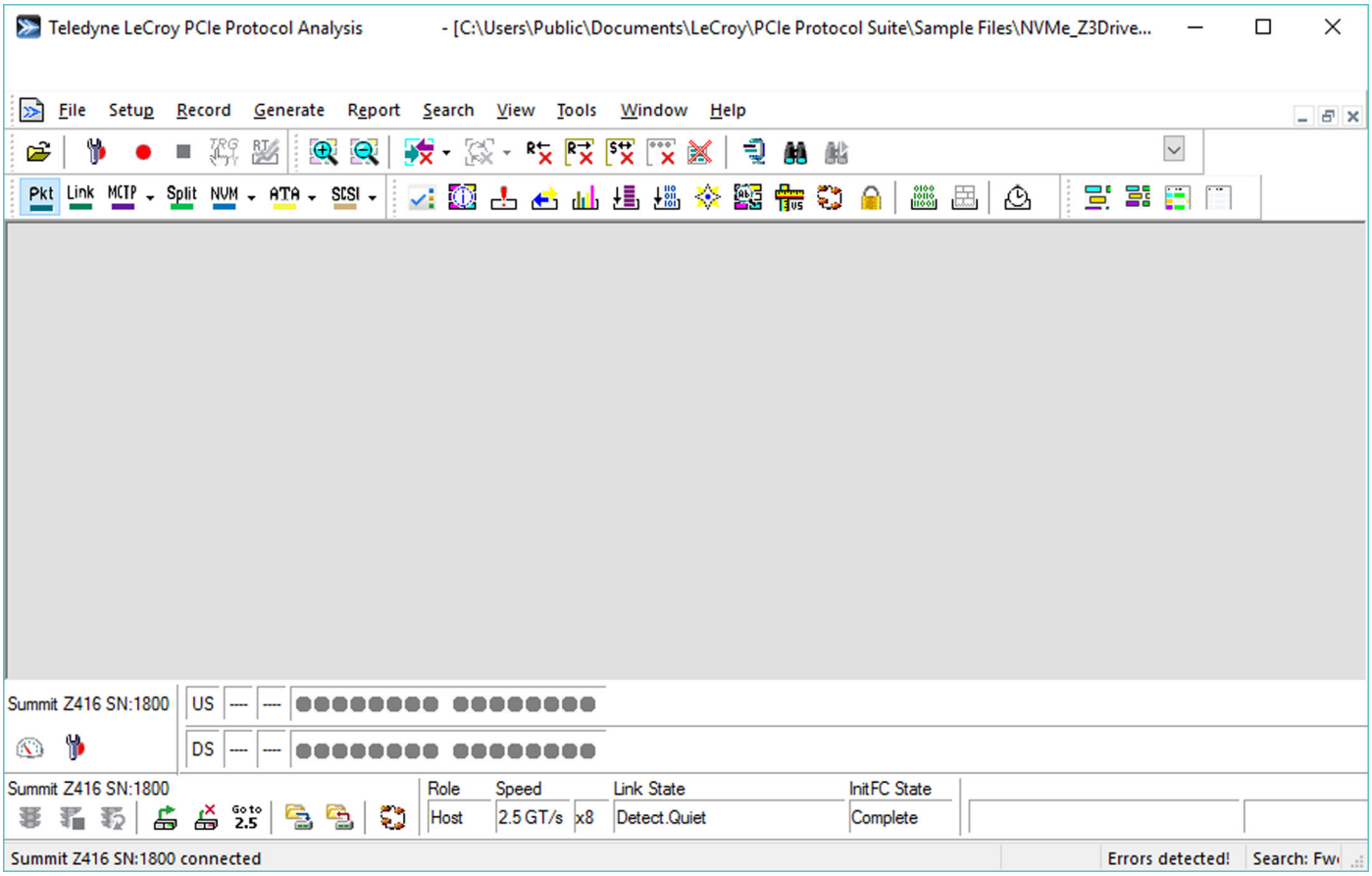


Figure 3.10: Teledyne LeCroy PCIe Protocol Analysis

Note: The software may be used with or without the Protocol Protocol Exerciser or Analyzer. When used without an Protocol Protocol Exerciser or Analyzer attached to the computer, the program functions as a CATC Trace Viewer to view and analyze captured traffic.

Note: In the following sections the steps to set up the Z58 or Z516 PCIe Protocol Exerciser are very similar. Some images may show the Z58 but the Z516 is set up in a very similar manner.

3.2 Setting Up the Summit Z5 PCIe Protocol Exerciser using a USB Connection

To set up the Protocol Exerciser using a USB connection:

1. Install PCIe Protocol Analysis on the host machine.
2. Connect the Power Adapter to a 100-volt to 240-volt, 50 Hz to 60 Hz, 160 W power outlet using the provided power cord.
3. Connect the USB port to a USB port on the host machine using a USB cable.

4. Power on the Protocol Exerciser by plugging the 24-V DC power cable into the Controller Card.

Note: At power-on, the Exerciser initializes and performs a self-diagnostic.

3.3 Setting Up the Summit Z5 PCIe Protocol Exerciser using an Ethernet Connection

Note: If your PC and the analyzer are both on the same subnet you should have no problem making a DHCP connection. If they are not, you may have to set appropriate subnet and gateway settings. Also, it is best if TCP ports 4000 to 4003 and UDP ports 4015 to 4017 are available on the network, but even if they are not you may be able to force a connection by checking the "Force add/connect attempt" box.

To set up the Protocol Exerciser using an Ethernet connection:

1. Install PCIe® Protocol Suite software on the host machine.
2. Connect the Power Adapter to a 100-volt to 240-volt, 50 Hz to 60 Hz, 160 W power outlet using the provided power cord.
3. Connect the Ethernet cable between the Ethernet port on the Protocol Exerciser and a Ethernet port in the local network.
4. Power on the Protocol Exerciser by plugging the 24-V DC power cable into the Controller Card.

Note: No driver installation is needed for Summit Z5 to operate over a network.

Note: At power-on, the Exerciser initializes and performs a self-diagnostic.

Note: Summit Z5 is configured at the factory to use dynamic IP setting and will get all required network parameters from the DHCP server on your network. If the DHCP server is not available, or to connect Summit Z5 directly to the host machine, you can reconfigure the network settings through the PCIe Protocol Analysis (see *Summit Z5 User Manual*).

3.4 Connecting to Summit Z5 in the Software

Start the PCIe Protocol Analysis and perform the following procedure to connect to a Summit Z5 analyzer over the network.

1. Select the **Setup > All connected devices…** menu in the PCIe Protocol Analysis application to display the Analyzer Devices dialog.

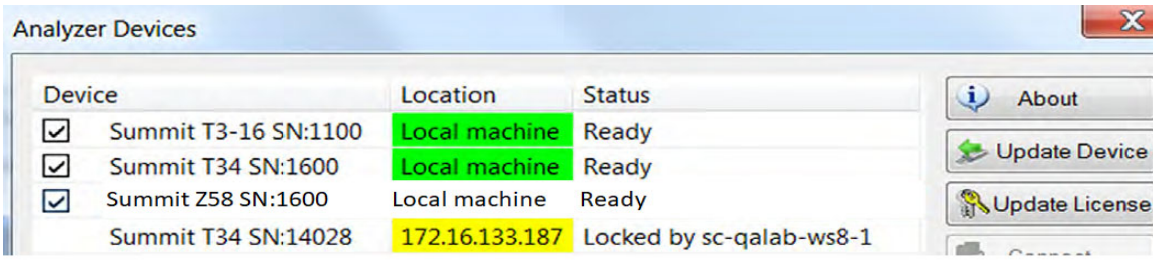


Figure 3.11: Analyzer Devices Dialog

The Summit devices in the list are marked:

Locked: Some other client on the network is already connected to that device

Ready to connect: Available for connection

2. Select your Summit Z5 device in the list and press the **Connect** button to execute the connection procedure. After the connection is established, the application displays the Connection Properties dialog.
3. Select an option:

Automatically connect to the device: When the application is started or when the named device appears on the network while the PCIe Protocol Analysis application is running on this computer, the PCIe Protocol Analysis application will try to connect to the named device.

Ask if I want to connect to the device: When the application is started or when the named device appears on the network while the PCIe Protocol Analysis application is running on this computer, the PCIe Protocol Analysis application will display a message box allowing you to connect to the named device.

Take no action: When you start the application or when the named device appears on the network while the PCIe Protocol Analysis application is running on this computer, you must connect manually to use the named device.

When you close the application on this computer (or you perform manual disconnect), the application disconnects from the device.

4. Press **OK** in the Connection Properties dialog. After you finish the connect procedure, the Summit Z5 to which you have connected is marked as **Ready** and you can use it for recording.

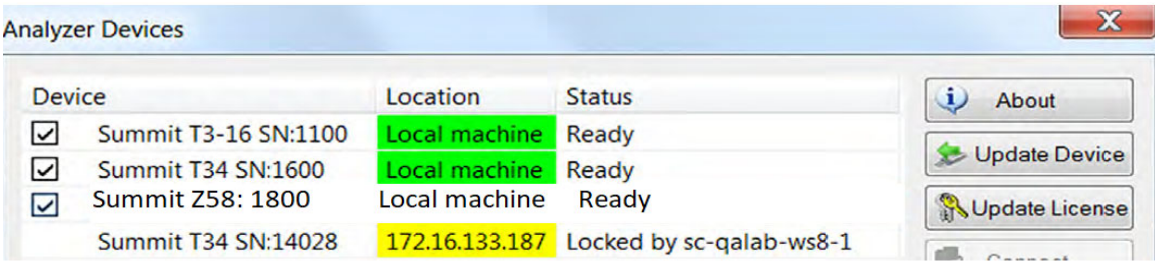


Figure 3.12: Analyzer Devices Dialog: Device Selected

Note: To disconnect from a device, display this dialog, select the device, and click the **Disconnect** button.

Note: Summit Z5 will not appear in the Analyzer Device dialog if it is connected on a different Subnet on your local network. You can connect to it on the Subnet by specifying its IP address in the Add Device dialog.

3.5 Adding Devices Manually

You can locate and add a Summit Z5 located in a Ethernet subnet using the Add Device button. Perform the following steps:

Click **Setup** → **All Connected Devices** → **Add Device** → to display the Add Ethernet Attached Device dialog.

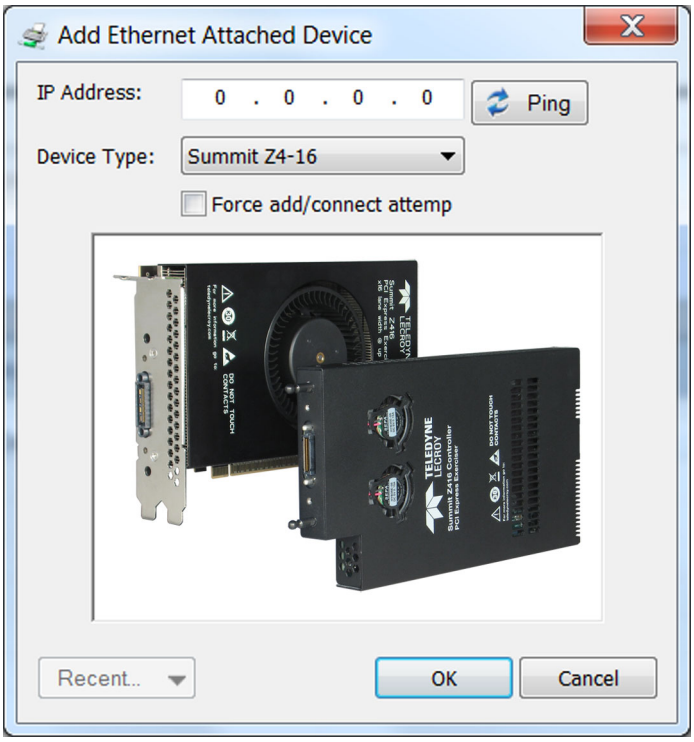


Figure 3.13: Add Ethernet Attached Devices Dialog

Click the **Recent** button to display a list of recently added devices (up to 15) and quickly add a recently used device.

Click the **Ping** button to ping a device as a network node (prompting an error message if no response). Ping also allows PCIe Protocol Analysis application to detect a device type before actually connecting to the device.

If the "Ping" feature discovers that the device is already connected and "locked" then it will inform the user and provide information about who locked the device.

Click **Setup** → **All Connected Devices** to display the Protocol Exerciser Devices dialog .

If the software fails to connect to a manually added device, a message displays notifying the user about the connection failure. The user is given the option to keep the failed device in the device list, in this case the PCIe Protocol Analysis application displays a "Failed to connect" status message in grey.

Square brackets for IP addresses are used for manually added devices to easily distinguish them from auto-discovered devices.

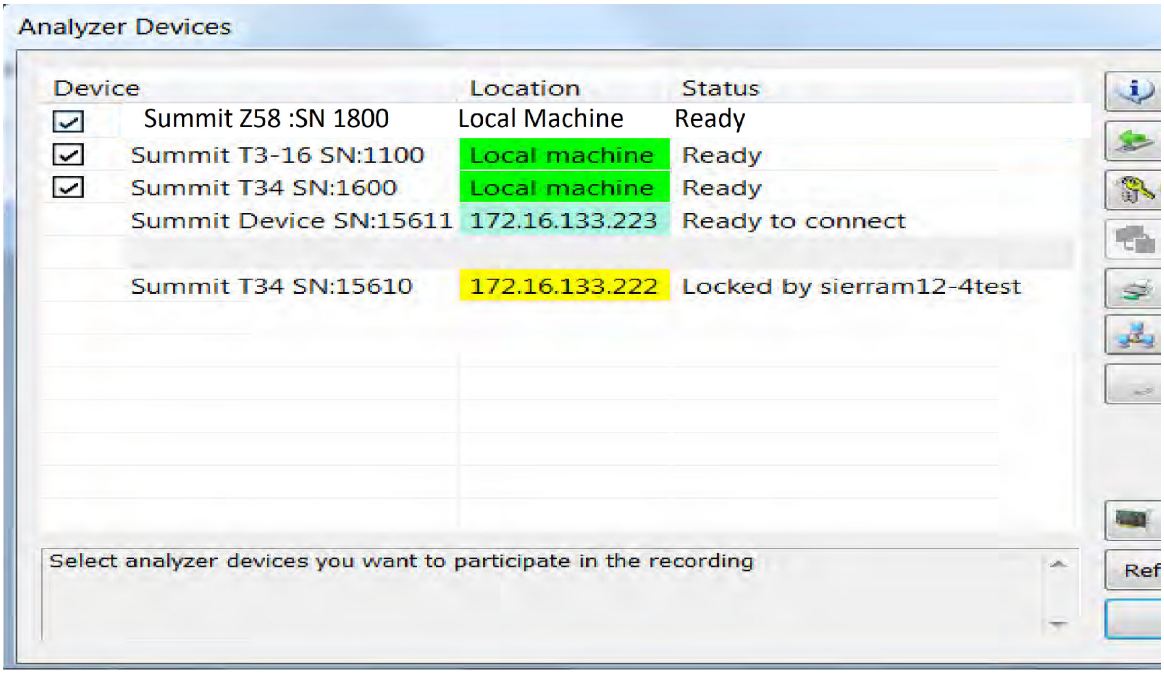


Figure 3.14: Add Ethernet Attached Devices Dialog

To discover the IP address of the local Summit Z5 (attached via the USB cable to your Summit Z5), select the IP Settings tab. This will popup the Device Settings dialog box. See Figure 3.15.

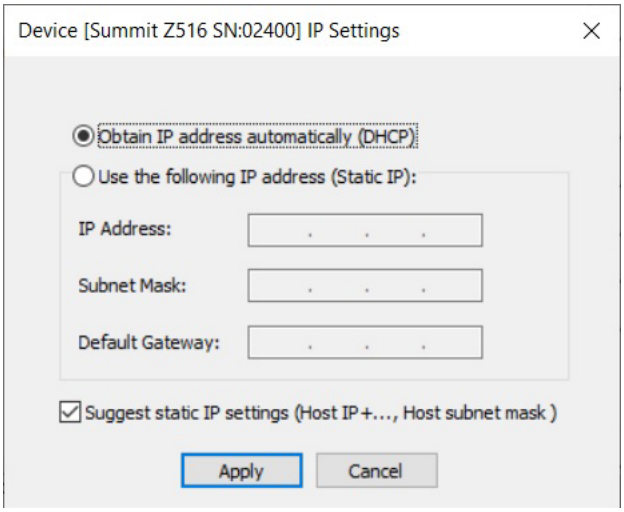


Figure 3.15: Device IP Settings (Z5)

From this dialog box you can either:

- Obtain an IP address automatically (DCHP)

- Use the following IP address (Static IP)
- Suggest Static IP Settings

If you choose the DCHP option the following dialog box will popup (see Figure 3.16).

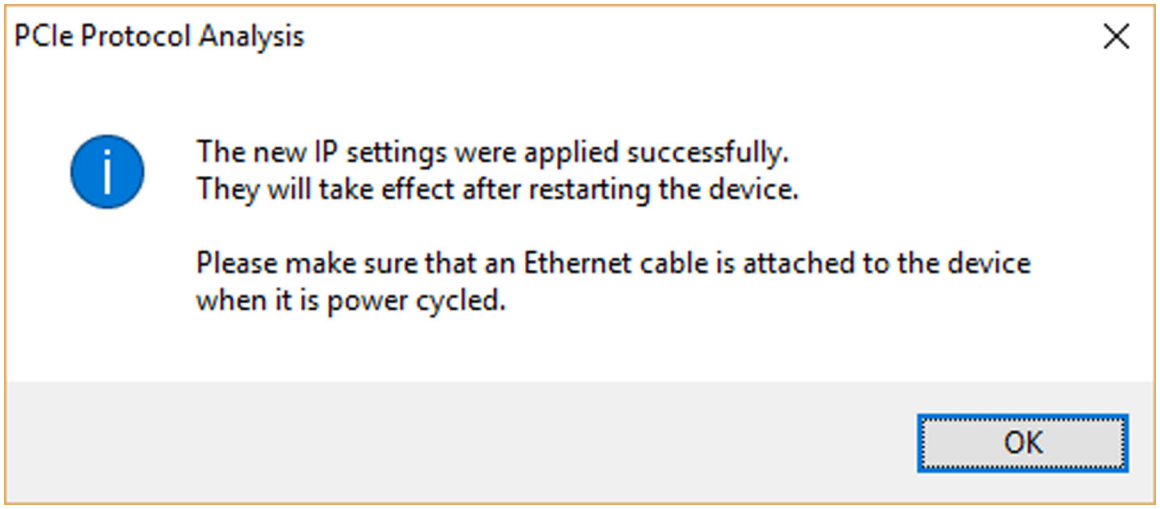


Figure 3.16: Use DCHP to Set IP Address

If you had chosen to use the Static IP address the following Dialog Box would popup (see Figure 3.17. You can either

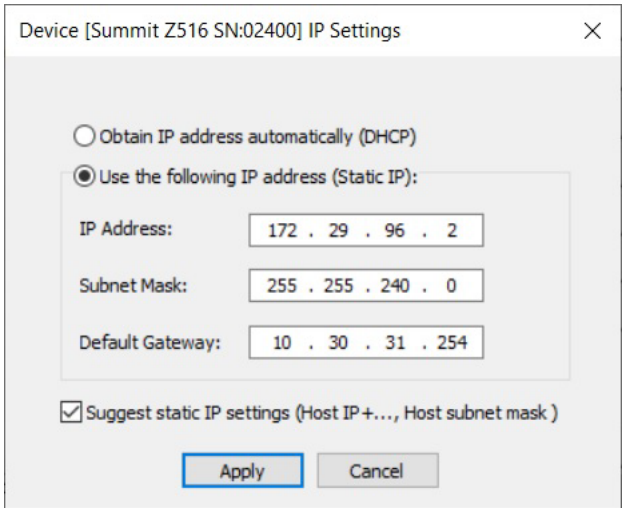


Figure 3.17: Use Static IP Address (Z5)

If you had chosen the Suggest static IP settings the following dialog box would popup (see Figure 3.18).

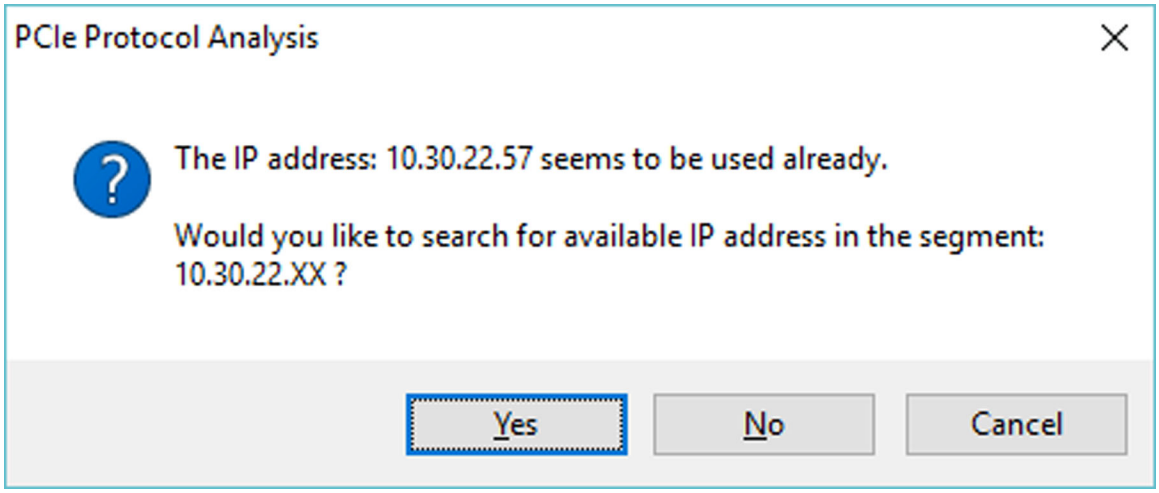


Figure 3.18: Suggest Static IP Settings

Select “Yes” and the system will select an unused IP address.

The the following dialog box will popup. See Figure 3.19.

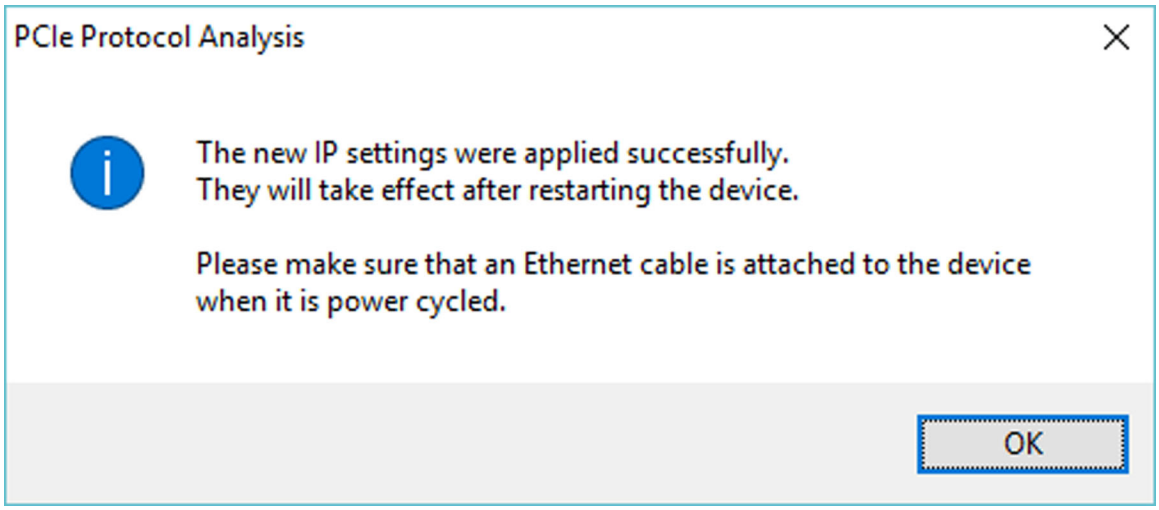


Figure 3.19: New IP Settings Applied

Now you should attach the Ethernet cable, disconnect the USB cable and cycle the power on the Summit Z5.

After the Summit Z5 re-initializes and the LCD display on the Z416 Controller board starts displaying a rolling "Available" message along with the IP address that was just assigned, restart the PCIe Protocol Analysis and select **Setup > All Connected Devices.**

Now the Summit Z5 has an IP address and is Ready to Connect.

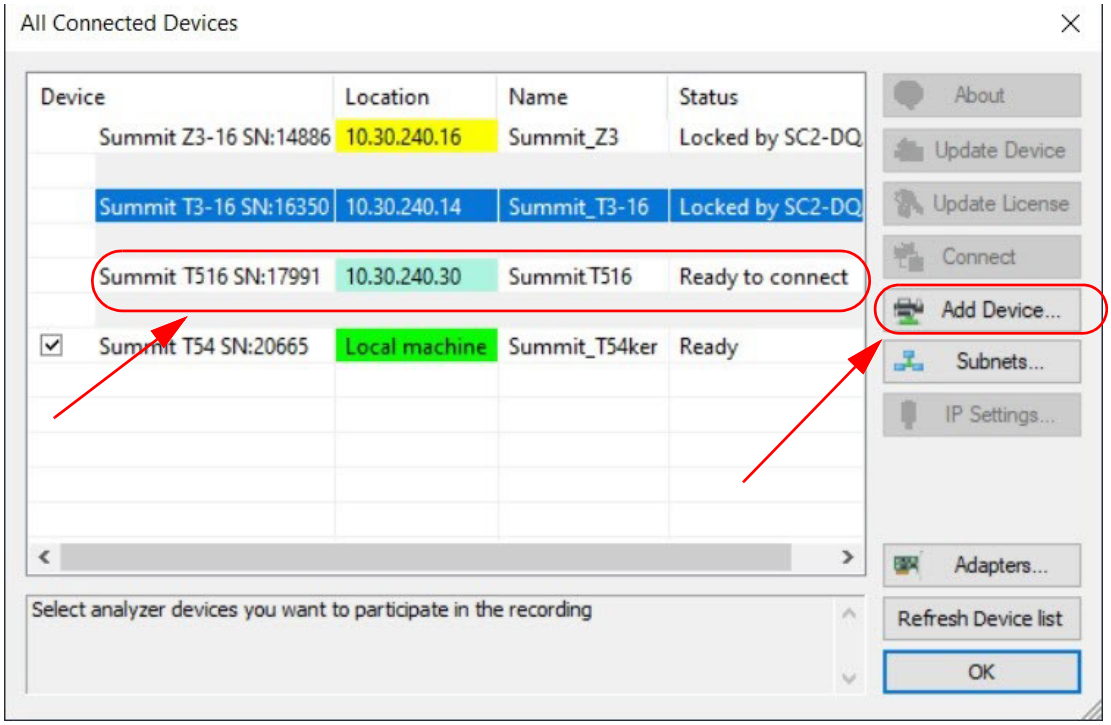


Figure 3.20: Analyzer Devices: Summit Z5 Showing IP Address

Select the Connect tab and you are ready to start capturing data traffic with the Summit Z5.

3.6 Setting Up the Summit Z5 PCIe Protocol Exerciser

The Summit Z5 PCIe Protocol Exerciser can test both the host and device sides of a PCI Express link through the use of two types of adapters:

- **Motherboards and host controllers**: When using the Summit Z5 PCIe Protocol Exerciser as a device emulator, the Summit Z5 PCIe Protocol Exerciser is an adapter card that fits into motherboards and other slotted PCI Express devices.
- **PCI Express add-on cards**: **Using a Summit Z5 PCI Express 5.0 Protocol Exerciser.** A PCI Express Test Platform is a box-like adapter with a slot for testing PCI Express cards.

Both of these test devices can be purchased from Teledyne LeCroy.

There are two ways the Summit Z5 PCIe Protocol Exerciser can be connected:

- Directly inserted into a slot in the host machine
- Connected via the PXP500 PCI Express Test Platform

3.6.1 Connecting the Summit Z5 PCIe Protocol Exerciser Directly to a Host Machine

The Summit Z5 PCIe Protocol Exerciser is inserted into a slot in the host machine.

Connect the AC adapter to the Protocol Exerciser (rear of Controller Board). The Summit Z5 PCIe Protocol Exerciser powers on. Do not turn the host machine on until the Protocol Exerciser initializes, which could take a few minutes.

3.6.2 Connecting the Summit Z5 PCIe Protocol Exerciser to the PXP500 PCI Express Test Platform

The PXP500 PCI Express Test Platform allows the Summit Z5 PCIe Protocol Exerciser to act as a host emulation system. The PXP500 PCI Express Test Platform enclosure has two slots to accommodate the Summit Z5 PCIe Protocol Exerciser and a DUT (Device Under Test). See Figure 3.21 on page 65.

Warning:
If the DUT blocks the air intake of the Summit Z5 main card we recommend the Summit Z5 main card be installed in the DUT slot instead.

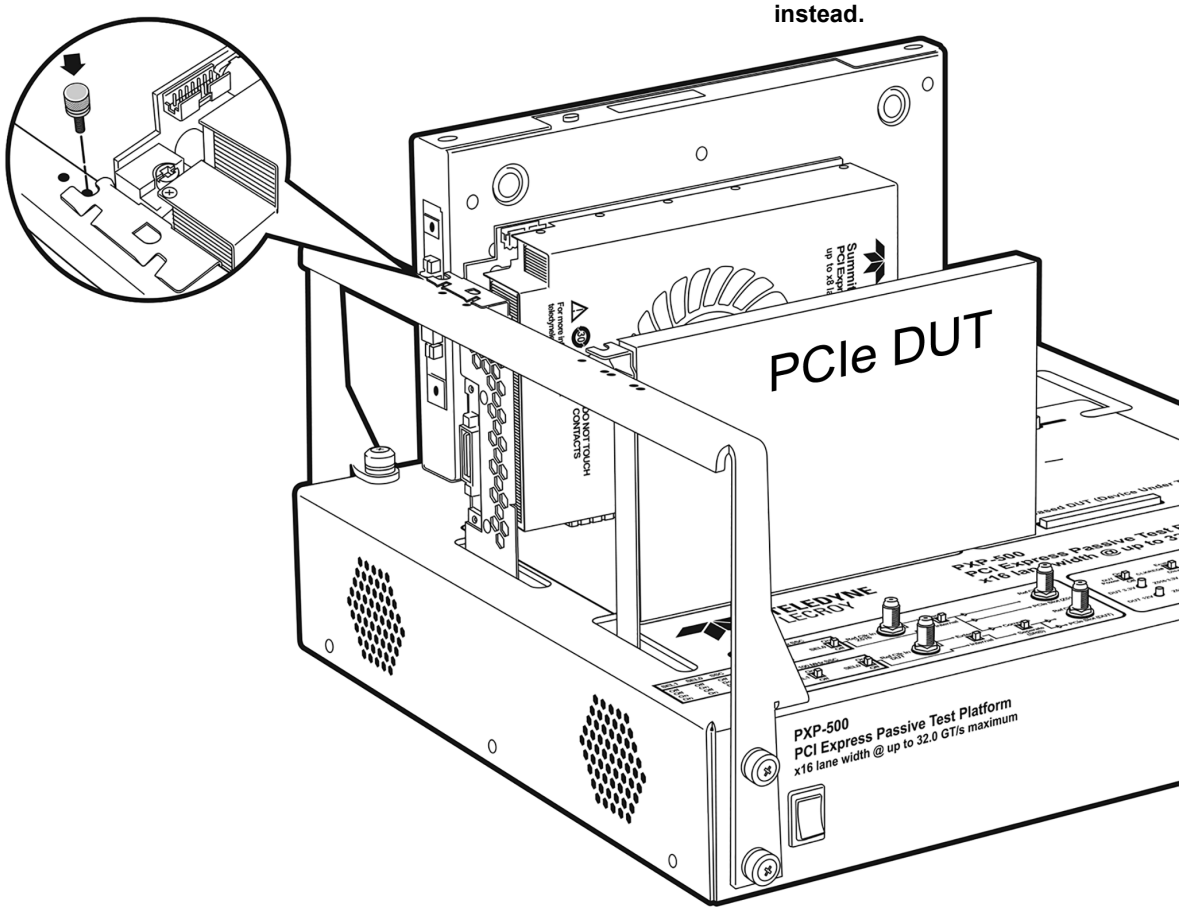


Figure 3.21: PXP500 PCI Express Test Platform: x16 Lane Width / Up to 32.0 GT/s

Reset button

Reset asserts PERST# for → 250 ms.

Clock Select

Select from the following clocking options:

- **Host Ext RefClk Input:** a user supplied reference via the **Host External RefCLK** SMA connector.
- **DUT Ext RefClk Input:** a user supplied reference via the **DUT External RefCLK** SMA connector.
- **Int**: an internal supplied 100MHz reference clock.
- **Int SSC**: an internal supplied 100MHz Spread Spectrum Clock.

Power LED

Lights when the PCI Express Test Platform is powered on.

Perform the following steps to connect the Protocol Exerciser to the PCI Express Test Platform:

1. Insert the Summit Z5 Protocol Main Board in the Summit Z5 slot on the PXP500 PCI Express Test Platform.
2. Connect the 24V DC power cable to the Summit Z5 PCIe Protocol Exerciser (in the Controller Board).
3. Insert a DUT in the DUT slot.



Make sure airflow is not blocked to the intake for the Summit Z5. This may happen when installing a large DUT card on the slot next to the Summit Z5 Main board.



4. Select correct reference clock source using clock selection switches.
5. Connect the AC power cable to the PXP-400 PCI Express Test Platform. Turn the PXP-400 PCI Express Test Platform switch on to power Test Platform. The Protocol Exerciser's green power LED lights turns on for approximately one minute while the Protocol Exerciser performs self-diagnostics.
6. Using the Ethernet or USB cables connect the Summit Z5 Protocol Main Board to the host machine.
7. Open the PCIe Protocol Analysis application on the host machine. The Protocol Exerciser is now ready for traffic generation.

Chapter 4

Traffic Generation

A traffic generator can emulate PCI Express™ root complexes and endpoint devices. Traffic generation can be used to transmit known errors, allowing you to observe how your device handles faulty link conditions.

After the Summit Z5 PCIe Protocol Exerciser and DUT have been cabled and powered on, you can test the setup by generating some traffic. The following steps show how to configure the Protocol Exerciser to generate a Link Training sequence.

NOTE: This chapter describes the traffic generation capabilities for both the Summit Z516 and Summit Z58 PCIe Protocol Exercisers. In the following chapters of this manual Summit "Z5" describes capabilities of both the Summit Z58 and Summit Z516 Exercisers except where noted.

4.1 Theory of Operation

4.1.1 Overview

The Summit Z5 PCIe Protocol Exerciser offers two mechanisms for implementing traffic generation: scripts, in which any type of traffic can be defined and executed, and the Generation Options dialog box, which offers a collection of PCI Express specific **behaviors** that can be enabled for automatic generation of traffic.

Using scripts, packets can be transmitted consecutively, with specific timing, or with event-based pauses between them. This allows the Protocol Exerciser to act as a pattern generator with PCI Express-specific formatting and transmission rates. However, creating traffic that emulates real devices with relatively complex protocol behaviors using a simple pattern generator is quite complicated. Certain behaviors such as ACK policies, and flow control require concurrent processing. This is where the automated features become useful.

The Protocol Exerciser includes a collection of automated traffic generation circuits that commonly exist in other PCI Express devices. These circuits include ACK/NAK generation, flow control management, replay buffers, and transaction timers. What makes the Protocol Exerciser unique and so useful is that each of these behaviors can be individually modified or disabled. This allows the user to perform operations that might not otherwise be possible using an off the shelf PCI Express device. This can be particularly useful when doing compliance or fault recovery testing.

NOTE: Summit Z5 does not support loopback as slave device.

4.1.2 Starting Point

When the Protocol Exerciser first powers up, it is at electrical idle on all lanes. To begin communication with a PCI Express device, Link training must occur, but first the generation settings must be set. This involves setting the Link parameters such as link width, polarity inversion, and lane reversal, through the Generation Options dialog.

NOTE: Setting the options in the Generation Options dialog has no effect on the Protocol Exerciser behavior until the first script is executed. In fact, each time a script is executed, these behaviors are reprogrammed to the Protocol Exerciser and the behaviors are modified accordingly.

4.1.3 Link Speed Control

The Summit Z5 PCIe Protocol Exerciser supports traffic generation at four speeds: 2.5, 5.0, 8.0, 16.0 and 32.0 GT/s. The link speed control shows the current link speed and has “Go to” buttons (see Figure 4.1 on page 69) to initiate speed switches to corresponding speeds.

When you press a speed control button, the Summit Z5 PCIe Protocol Exerciser initiates a speed switch for the speed indicated on that button. The link may not change speed if the speed switch operation is unsuccessful.

The speed switch buttons may be enabled/disabled based on the speed configuration settings in the Protocol Exerciser’s Generation Options settings. For example, if you set up the Summit Z5 PCIe Protocol Exerciser as a Gen2 capable device (Data Rate 5.0 & 2.5 GT/s) in the Generation Options (see “Z5 General Options Dialog Layout” on page 99), the “Go to 8.0” and “Go to 16.0” speed switch buttons will be disabled.

4.1.3.1 Speed Change to Gen3

If you set up the the Z5 as a Gen5 capable device (Data Rate 32.0, 16.0, 8.0, 5.0, 2.5 GT/s) in the Generation Options (see Figure 4.33 on page 99), and then select the “Go to 8.0” button, the Z5 will first attempt equalization at 8.0 GT/s. If equalization is successful, the Z5 will then change speeds to 8.0 GT/s.

4.1.3.2 Speed Change to Gen4

If you select the “Go to 16.0” button, the Z5 will first attempt equalization at 8.0 GT/s. If equalization is successful, the Z5 will then change speeds to 8.0 GT/s. Selecting the “Go to 16.0” button a second time will cause the Z5 to attempt equalization at 16.0 GT/s. If equalization is successful, the Z5 will then change speeds to 16.0 GT/s.

4.2 Summit Z5 PCIe Protocol Exerciser Control Bar

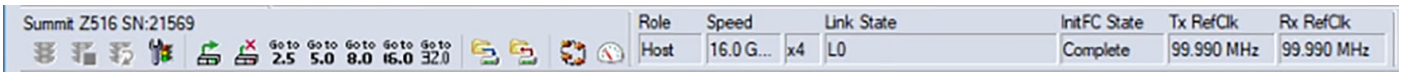
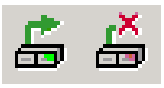


Figure 4.1: Exerciser Control Bar

The following icons are displayed in the Exerciser Control Bar.

Icon	Description
	The Start Traffic Generation button starts traffic generation of a currently loaded generation script. Before starting the generation it saves all the changes to the script file. If you start a new script that does not yet have a name, the Save As dialog opens to save the .peg file (see “Generating Traffic: Begin Traffic Generation” on page 190).
	The **Stop Traffic Generation** button stops generation script execution.
	The **Resume Traffic Generation** button resumes generation script execution if it was stopped.
	**Connect** and **Disconnect** buttons. When you click the **Connect** button it executes a connect script. It uses the device parameters, such as supported speed and link width, from the Generation Options Click on the **Disconnect** button to disconnect. It directs the Summit Z5 into Detect state.
	You can switch to a different speed by clicking on the **Go to 2.5, 5.0, 8.0, 16.0, 32.0** buttons. Pressing these buttons will initiate a speed switch. The link may not change speed if the speed switch operation is unsuccessful. The **GoTo**... buttons will attempt to initiate a speed change while advertising all of the data rates up to and including the speed on the button. The resulting speed change should be to the greatest common speed advertised by both sides. However, if **Go To 32.0** button is pressed and equalization has not been successfully executed at 16.0 GT/s, then the link will advertise 16.0 GT/s in order to perform equalization at that rate per the PCIE specification. Under this circumstance, a second pressing of the **Go To 32.0** will be needed to initiate a speed change to 32.0 GT/s. Selecting a Link Speed in this GUI will override the Data Rate selected in the Generation Options GUI (see “Z5 General Options Dialog Layout” on page 99)
	The **Write** and **Read Address Space** buttons. The Summit Z5 is capable of emulating device memory spaces. Using these buttons you can load data into the different memory spaces and read data from each of the memory spaces.You can also access these by clicking **Generate → Write Address Space** and **Generate → Read Address Space**. See Figure 4.2 on page 70 and Figure 4.3 on page 70.

Icon	Description
	The **LTSSM Control** button on the Summit Z5 Exerciser status toolbar can be pressed to open the LTSSM Control dialog. In this dialog, you can initiate speed switches, initiate link width changes, initiate select link state changes, apply error injection (as defined in "Error Injection Definitions" on page 165) and run tests on the different arcs of the LTSSM. See Figure 4.4.
	The **Link Dashboard button** on the Summit Z5 Exerciser status toolbar can be pressed to open the Exerciser Error Dashboard dialog. In this dialog, you can read error counters from the device.

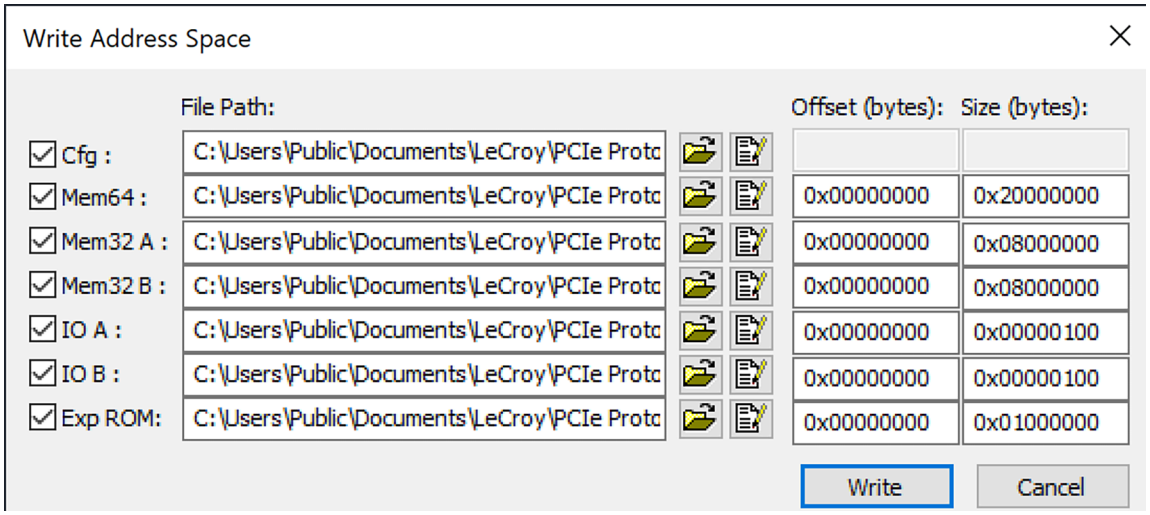


Figure 4.2: Write Address Space

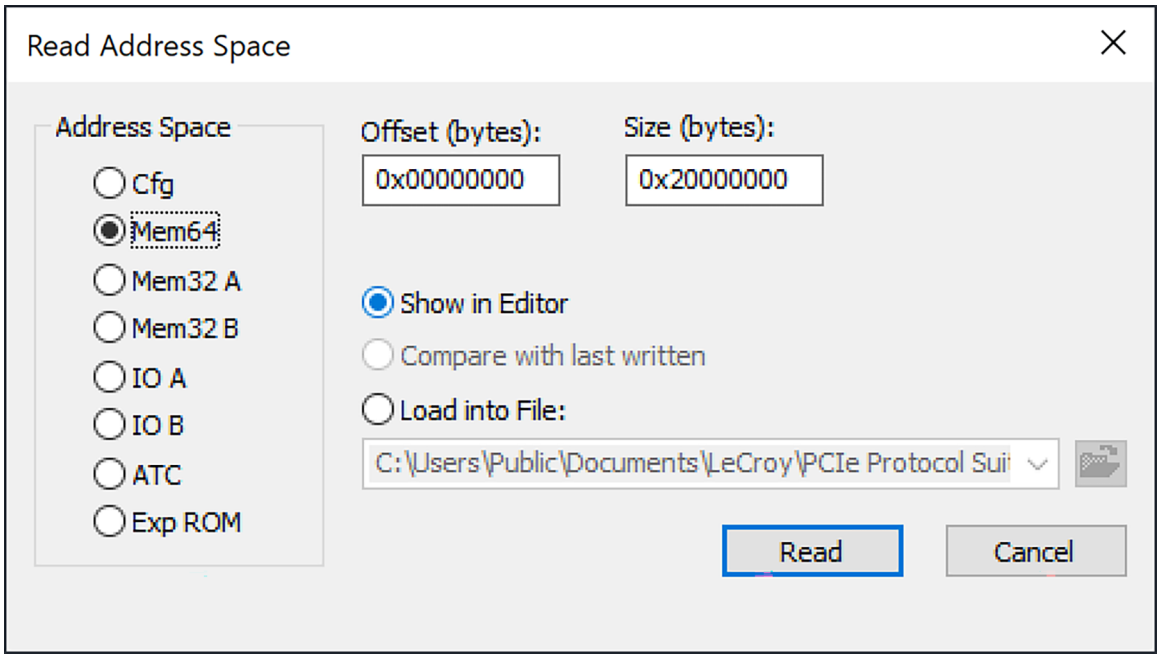


Figure 4.3: Read Address Space.

4.2.1 LTSSM Control Icon

This section describes the Link Training and Status State Machine (LTSSM) control icon. Click the LTSSM icon and the LTSSM Control Menu displays. See Figure 4.4.

NOTE: Errors can be injected into data traffic only after a link has been established and the LTSSM has reached the L0 state.

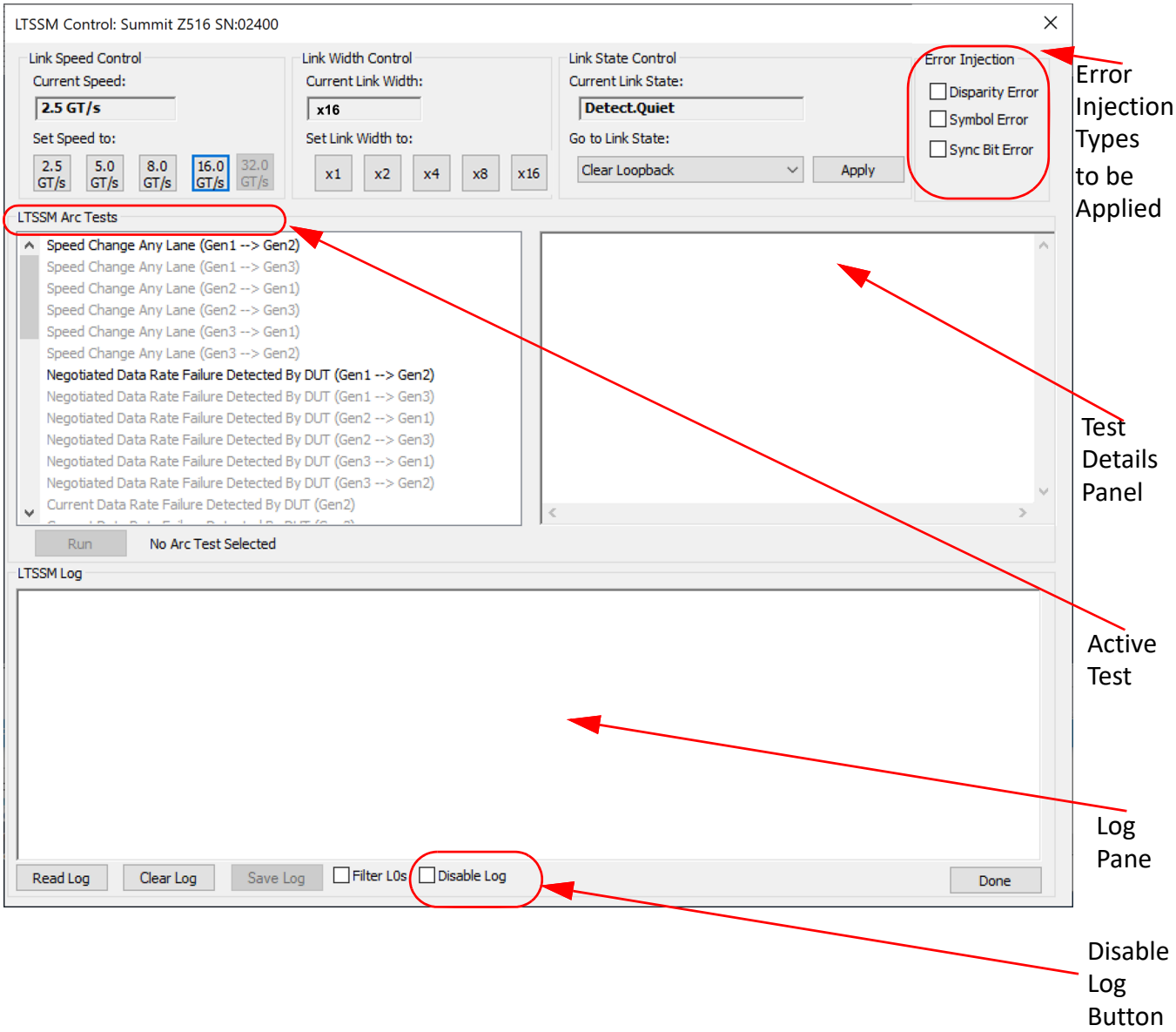


Figure 4.4: Z5: LTSSM Control Menu

4.2.1.1 LTSSM: Link Speed Control

You can set the Link Speed (2.5 GT/s, 5.0 GT/s, 8.0 GT/s, 16.0GT/s or 32.0 GT/s) by selecting the appropriate button in the LTSSM Menu. See Figure 4.5.

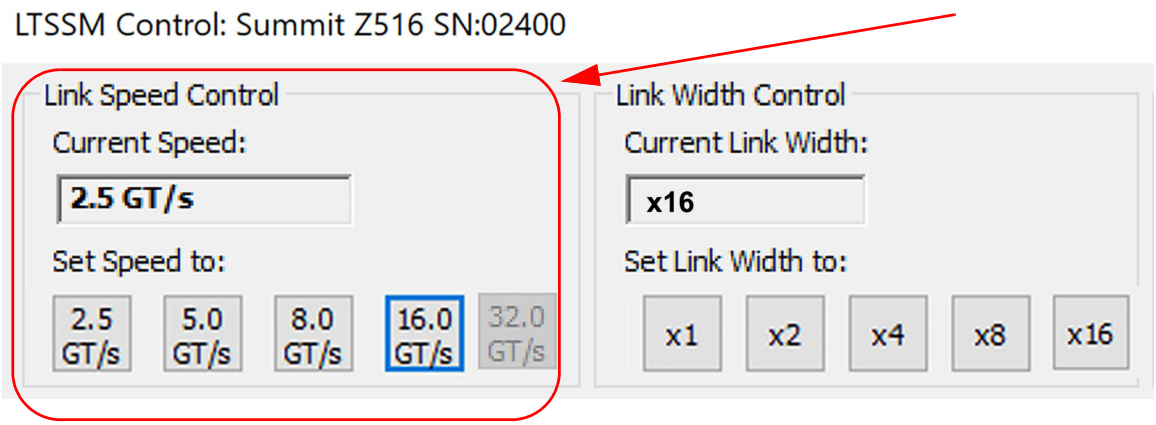


Figure 4.5: LTSSM: Link Speed Control GUI

NOTE: Selecting a Link Speed in this GUI will override the Data Rate selected in the Generation Options GUI (see "Z5 General Options Dialog Layout" on page 99)

4.2.1.2 LTSSM: Link Width Control

You can set the Link Width (x1, x2, x4, x8 or x16) by selecting the appropriate button in the in the LTSSM Menu. See Figure 4.6.

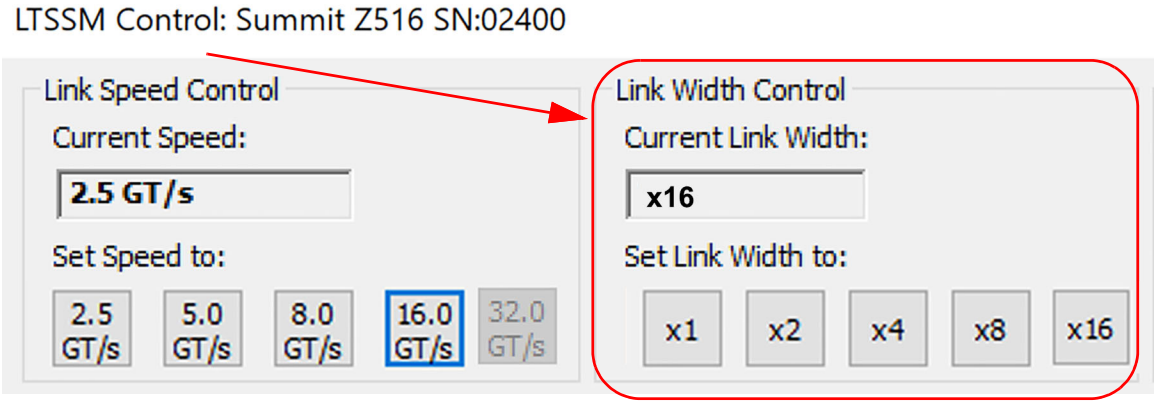


Figure 4.6: LTSSM: Width Control GUI

NOTE: Selecting a Link Width in this GUI will override the Link Width selected in the Generation Options GUI (see "Z5 General Options Dialog Layout" on page 99)

4.2.1.3 LTSSM Arc Tests

NOTE: The Change Speed Tests will override the Data Rate selected in the Generation Options GUI (see "Z5 General Options Dialog Layout" on page 99)

The Summit Z5 Exerciser has been developed to allow for testing of the different arcs of the LTSSM. This list of tests (described in detail in Appendix F, "LTSSM Arc Tests," on page 611) is displayed in the LTSSM Arc Tests in the left pane. When you select a test from the test list, its information is displayed in the adjacent right panel. The information is in the form as follows:

- Test: The name of the test.
- Test Description: A brief description of the test.
- PreRequisites: The expected state that this test is starting from.
- Test Scenario: Explains the details of what the test will perform.
- Expected DUT State Transitions: The LTSSM states that the Device Under Test is going through.
- Expected Exerciser State Transitions: The LTSSM states that the Z5 (Host) is going through.

These tests have different prerequisites that need to be met in order to be run. Tests that have their prerequisites met and that are ready to be run are displayed in black. Tests that do not have their prerequisites met will be grayed out in the list of tests and you will not be able to run them if you select them. In order to run tests that do not have their prerequisites met, you can view the prerequisites and/or the description of the test by clicking on that specific test. From there, you can manipulate the link speed/width/state of the exerciser to match the prerequisites so that the test is enabled to run.

For example, as shown in the LTSSM Control Dialog, the Summit Z5 is linked up at 2.5GT/s (Gen1) so the first test is ready to be run but the second and third tests are grayed out since they require 5.0GT/s (Gen2), 8.0GT/s (Gen3), 16.0GT/s (Gen4) and 32.0GT/s (Gen5) speeds.

To run a test, select the test and click **Run**. The LTSSM state transitions from the test will be displayed in the LTSSM Log (the bottom pane).

4.2.1.4 LTSSM Log

After issuing a speed change, link width change, link state transition, and/or running any LTSSM arc test, the LTSSM state transitions that occurred will be displayed in the LTSSM Log. This log will accumulate the state transitions from different run tests and the results from commands issued from the controls. You can clear this log by clicking the Clear Log button and you can also save the log as a text file for future reference by clicking on the Save Log button. Clicking the Save Log button will prompt open the save file dialog. Clicking on the Disable Log button will turn off the logging of data.

Running an LTSSM arc test will clear the logged transitions in the Summit Z58 before the test runs to ensure that all the test transitions are recorded. Clearing the log will also clear any logged transitions in the Summit Z58.

Reading the entire log takes time and may be unnecessary in some cases. Disable Log option will prevent the application from reading the trainer log.

4.2.2 Link Dashboard Icon

When you press the Link Dashboard button on the Summit Z5 Exerciser status toolbar, it opens. the Exerciser Error Dashboard dialog. In this dialog, you can read error counters from the device. See Figure 4.7.

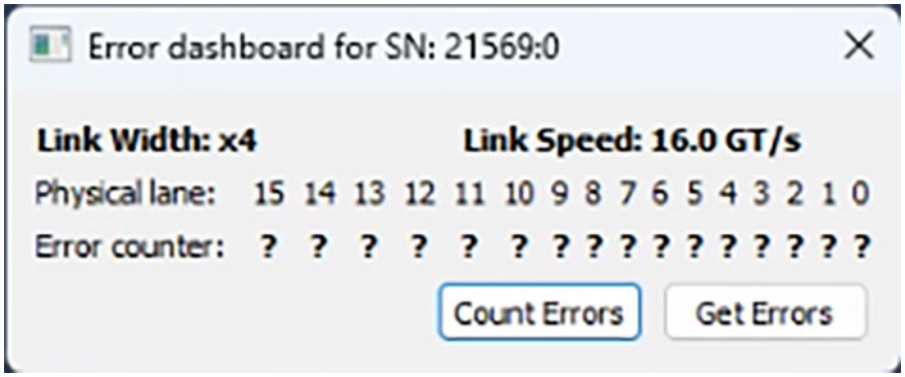


Figure 4.7: LInk Dashboard Dialog

Serial number as well as current Link Width and Speed are displayed at the top of the dialog. Number of Physical lanes will be 16 for Z516 and 8 for Z58.

By default, all error counters are not read, indicated by the "?" symbol.

Two buttons are available:

1. Count Errors: Measures errors for 20 milliseconds.
2. Get Errors: Gets the number of errors since last read.

After either button is clicked, error counters are read and displayed, as shown in Figure 4.8.

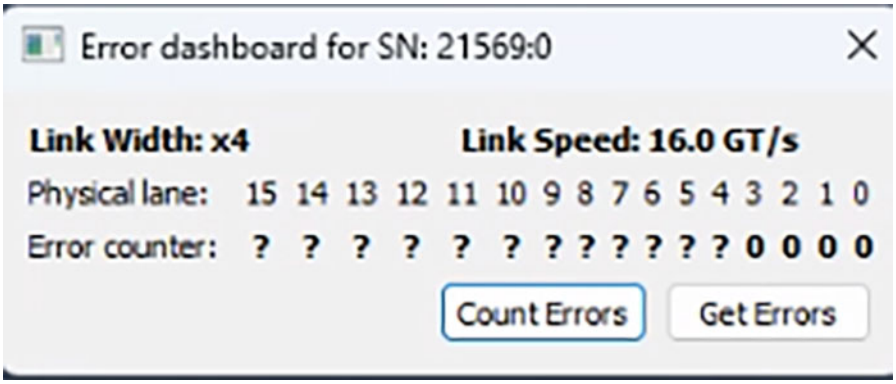


Figure 4.8: Link Dashboard Dialog after Read

NOTE: Only active lanes are read, so in case Link Width is 4 then only lanes 0 - 3 will be read.

Error counters are available only for 8.0/16.0/32.0 GT/s Link Speeds. It is not possible to read errors if the speed is invalid.

4.3 Generating Traffic

To generate traffic, open or create a traffic generation file (***.peg**) and then run it.

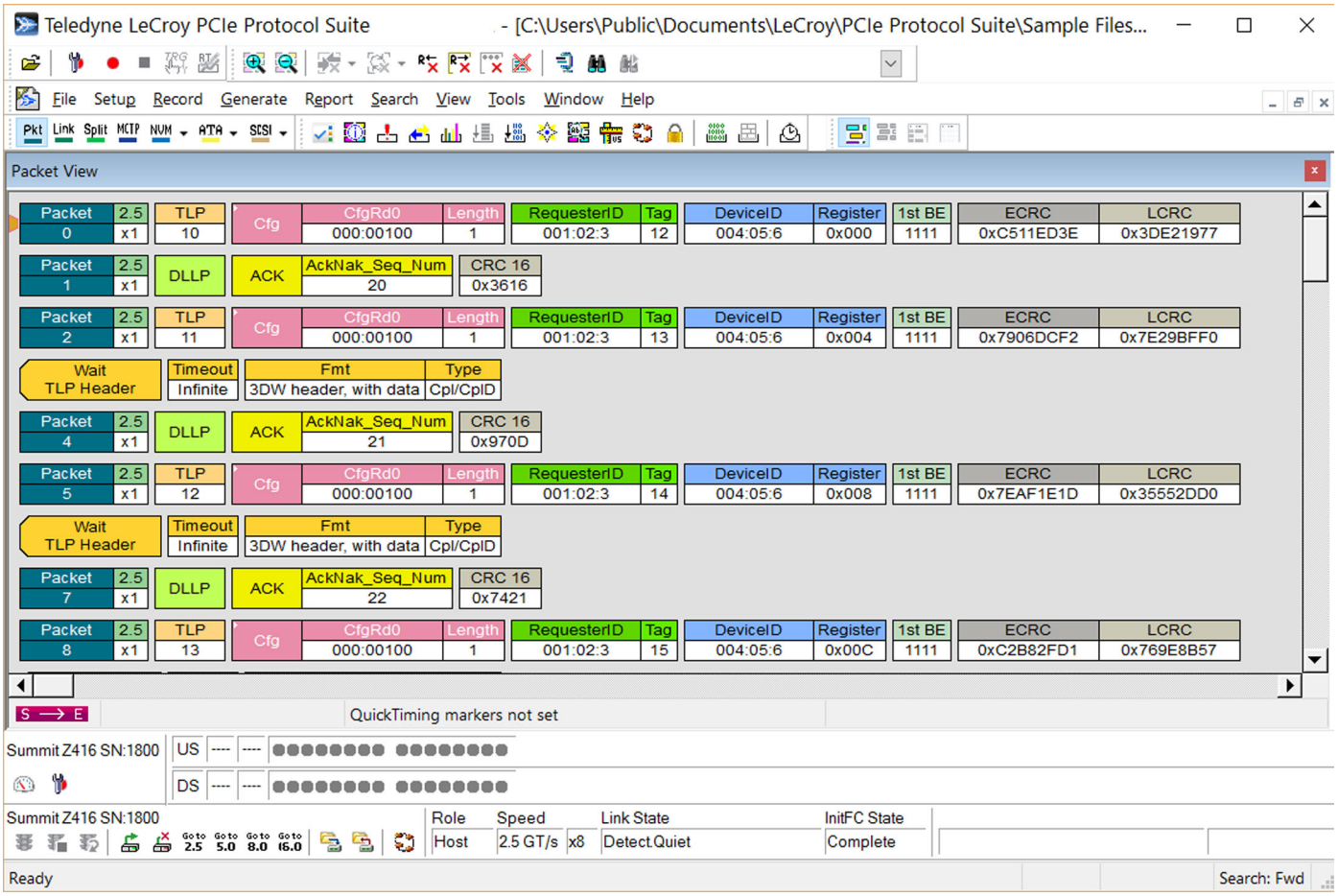


Figure 4.9: Open Trace File

When the file is opened, it appears in the CATC Trace window looking like a CATC Trace file.

To run the file, click the **Start Generating Traffic** button.

To create or edit a **.peg** file, use the Script Editor.

The Script Editor is a text-editing tool that can be opened by performing a right click in the Packet View as shown in Figure 4.10 (below) and Figure 4.11 on page 78 or selecting **File > New PETrainer Script** from the menu bar.

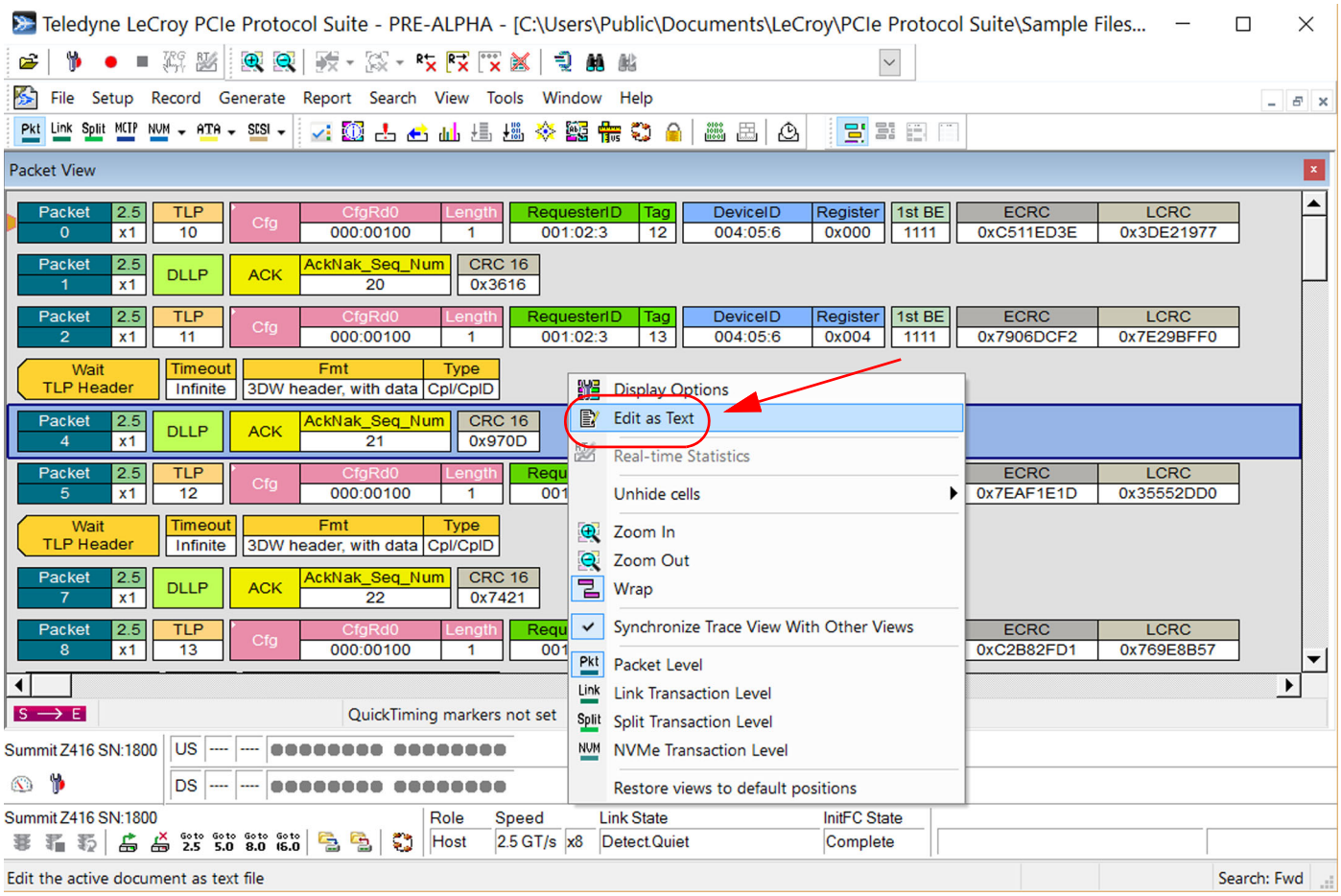


Figure 4.10: Script Editor

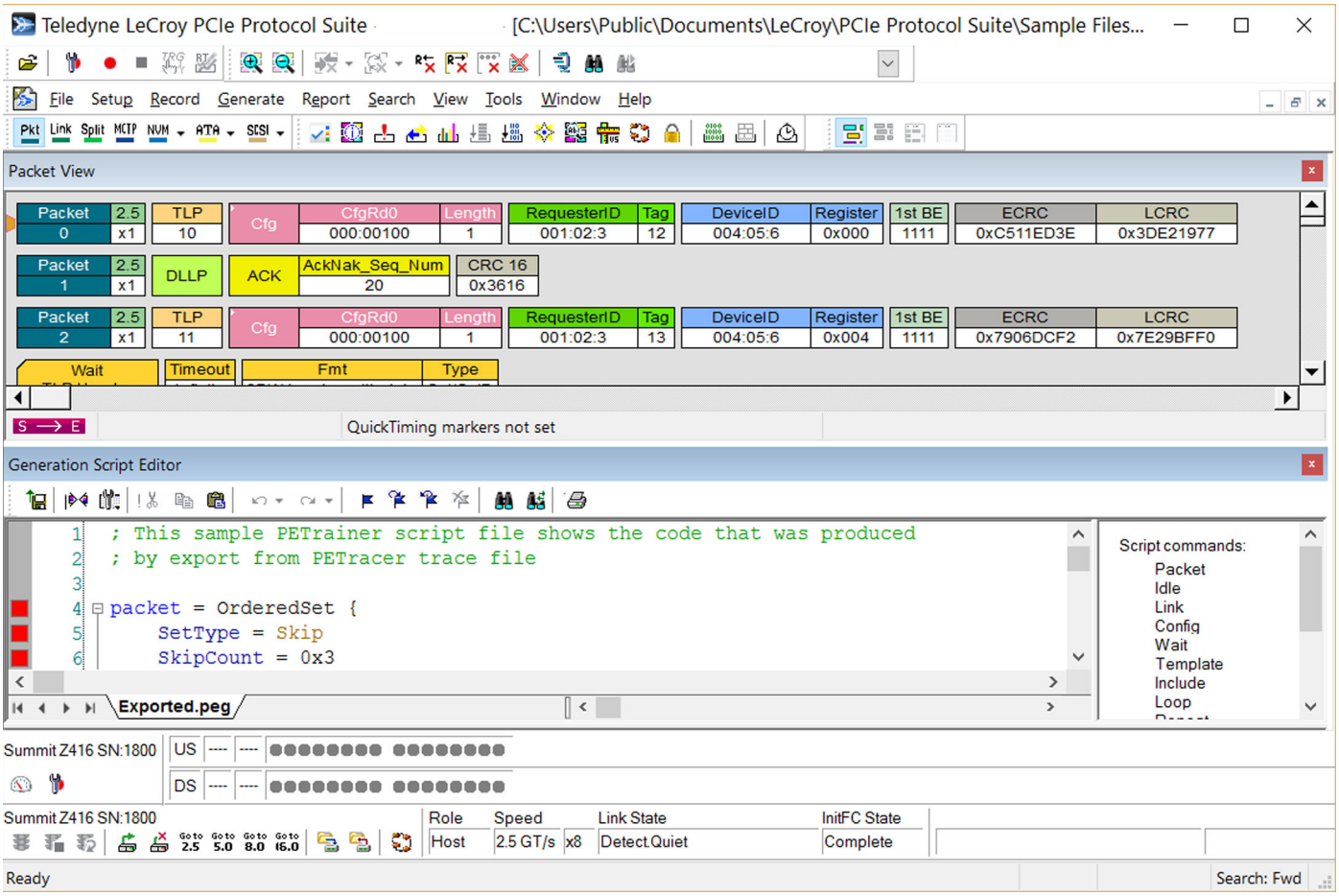


Figure 4.11: Script Editor Opened

Alternatively, the traffic generation file can be created by exporting the data from a CATC Trace into a traffic generator file.

4.3.1 High Performance Mode

NOTE: High Performance Mode applies to both the Summit Z58 and the Summit Z516 Exercisers. Z5 references both Z58 and Z516 except where noted.

High Performance Mode refers to faster TLP generation as compared to Firmware generated requests which is the normal way of generating TLPs in the exerciser. This does not generally mean that the exerciser will send TLPs faster than other devices. In some cases depending on generation option settings, particular script and flow control very high throughput can be achieved. See “Generation Options Dialogs Overview” on page 98 for more details on GUI options.

High Performance mode in the Summit Z5 refers to three features:

- Fast Transmit Mode

  Accessible and configured through scripts (*Summit Trainer™ Scripting Language Reference Manual*), this feature enables the exerciser to send Memory Writes and Memory Reads as fast as allowed by hardware on the Summit Z5.

- Fast Memory Completer Mode

  Configured in generation options (see "Transactions: Fast Memory Completer" on page 151), this feature enables the exerciser to respond to Memory request with completion packets as fast as allowed by the hardware Summit Z5. The payload used for the write requests or the completions is algorithmic and pre-configured through script or generation options.
- High Performance Memory (Real Memory) Mode

  Configured through generation options (see "Z5 General Options Dialog Layout" on page 99), with this feature the Summit Z5 Exerciser will respond to requests as fast as allowed by the exerciser, flow control and write or read data from actual 4GB memory. In this mode there is no analysis capabilities in the Summit Z5.

These features are enabled for use by a single special license.

4.4 Script Execution

As mentioned above, each time a script is executed, the configuration settings for the Summit Z5 PCIe Protocol Exerciser are reprogrammed. When the **Start generation** button is pressed, the script is uploaded to the Exerciser hardware and executed immediately. The progress of the script can be tracked in the Exerciser Control Bar at the bottom of the screen. Subsequent executions of the same script do not require upload of the script to the Summit Z5 PCIe Protocol Exerciser, however, as mentioned above, the generation options are still reprogrammed.

Script execution can be throttled using **Wait** commands inserted directly into the script. Waits can be time based, require receipt of certain packet types, or can even require **User** input from the GUI.

After the script is complete, any enabled PCI Express **behaviors,** such as SKIP insertion, Flow control, and ACK generation, continue. This allows you to run multiple scripts, one after another, without interrupting the Link state.

4.5 Creating a Traffic Generation File

There are four ways to create a traffic generation script file:

- **Export an existing trace** to a script file
- **Save an existing script** to a new file
- **Select File > New** to create a new and empty script file that contains no text.
- **Create an empty file** using an OS shell (with **.peg** extension) and open it with PCIe Protocol Analysis.

NOTE: Please refer to the *PETrainer Scripting Language Reference Manual* for a comprehensive list of available commands and structures for PCIe and storage protocols.

4.5.1 Export: To Generator File Format

To export a Trace File to Generator File format, choose that option. See Figure 4.12

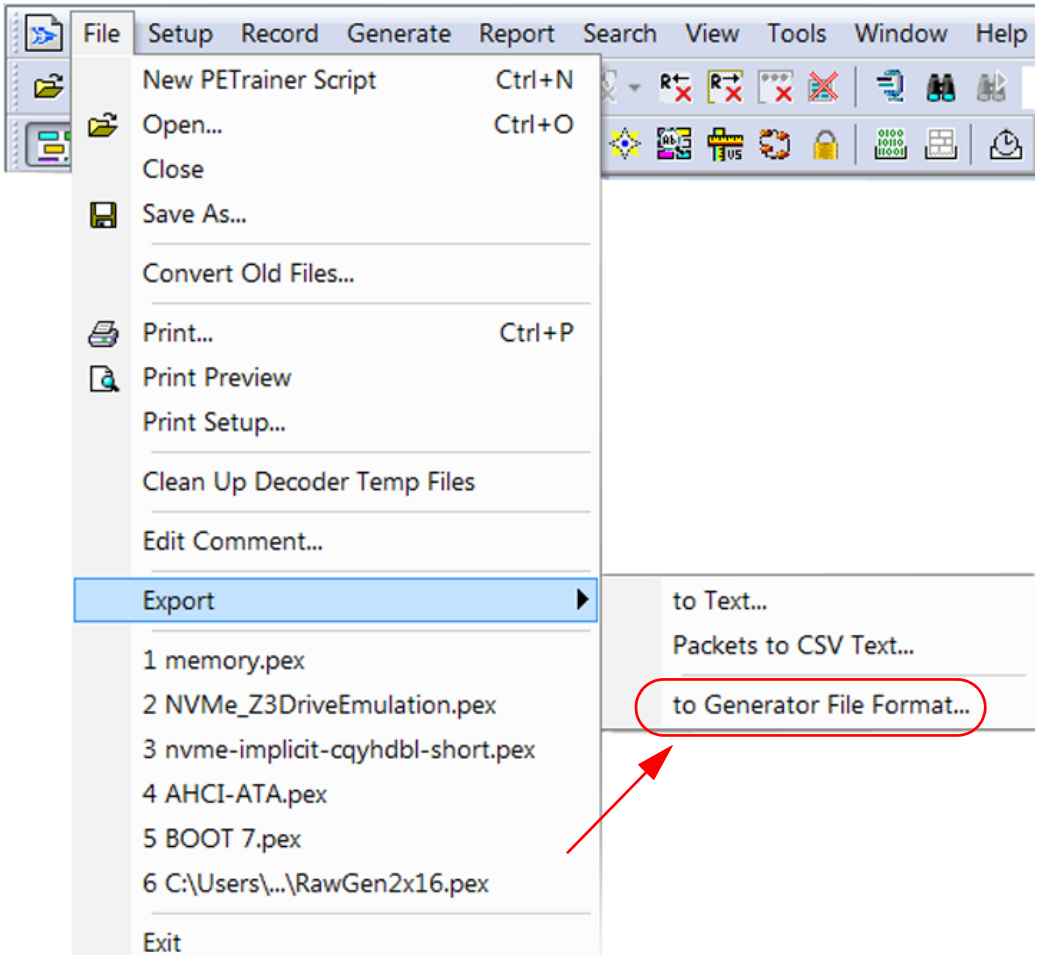


Figure 4.12: Export to Generator File Format

The purpose of Exporting a Trace file to Generator File Format is so that you can load that Generator file into a Teledyne LeCroy Exerciser (i.e. Z5) to generate data traffic to test a device.

4.5.1.1 Exporting a CATC Trace to a Traffic Generation File

A simple way to create a script file is to open a CATC Trace and then to export the CATC Trace data to a generation file:

1. Open a CATC Trace file.
2. Select **File > Export > to Generator File Format**.
3. Select the desired options from the File Export dialog box as shown below. See Figure 4.13.

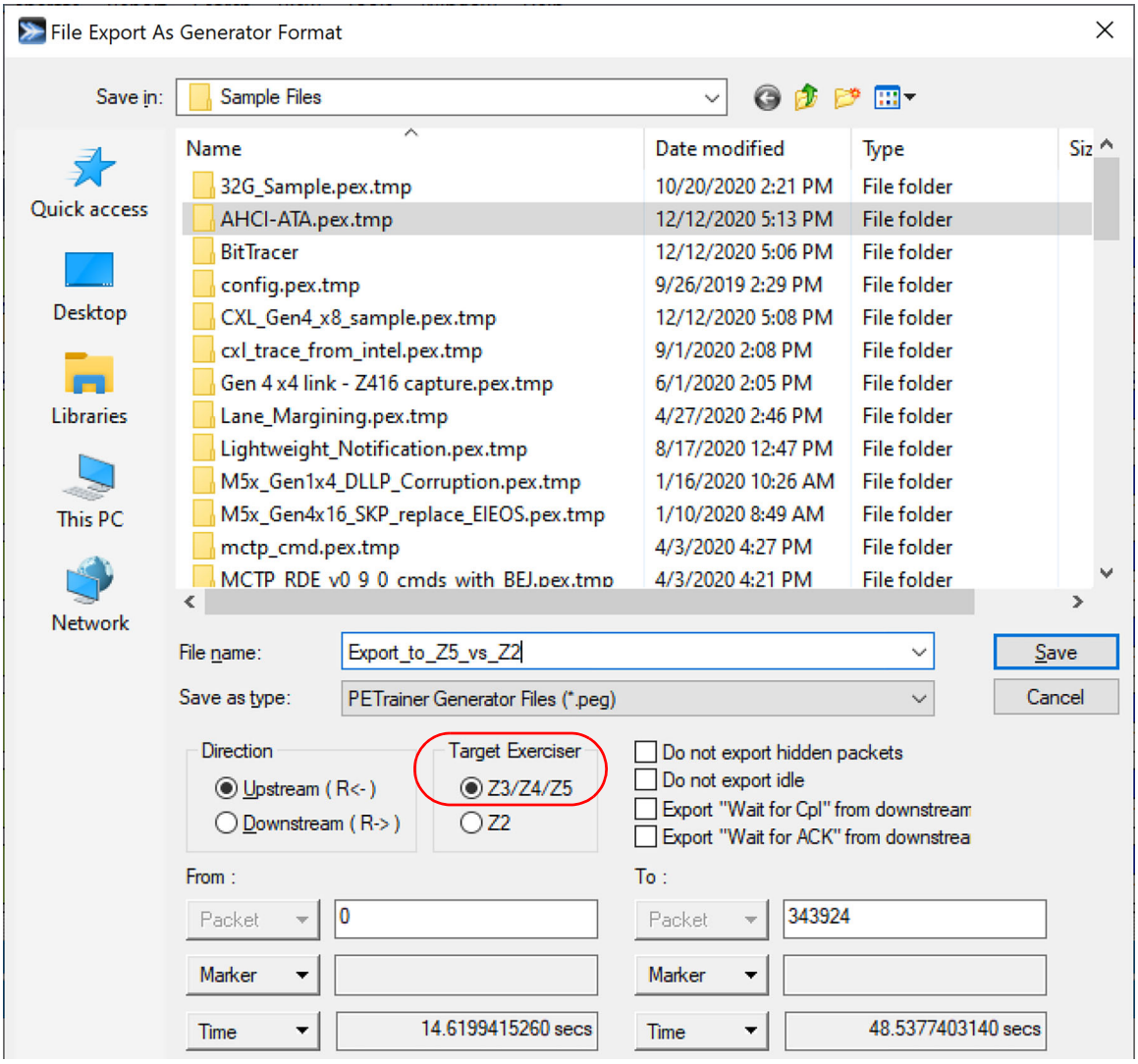


Figure 4.13: File Export As Generator Format Dialog (Z3/Z4/Z5)

Direction

Selects the direction of the traffic to be exported (Upstream or Downstream). In this case we chose Upstream. This will affect the Export “Wait for Cpl” and “Wait for ACK” options.

Target Exerciser

Select the type of Exerciser you plan to use (Z3/Z4/Z5 or Z2).

From and To

Selects a range for exporting. You can export all or part of the CATC Trace. You can select a range of Packets, Markers or Time.

Do not export hidden packets

Ignores any packets hidden through the various hide options.

Do not export Idle packets

Excludes Idles from the export.

Export “Wait for Cpl” from downstream

Exports all **Wait for Completions** from the opposite direction. **Wait = TLP** is a script command.

Export “Wait for ACK” from downstream

Exports all **Wait for ACK DLLPs** from the opposite direction.

4.5.2 Saving a Script to a New File

To save a script file as a generation file:

1. Open an existing script file.
2. Select **File > Save As**... or click the **Save As** button on the toolbar.

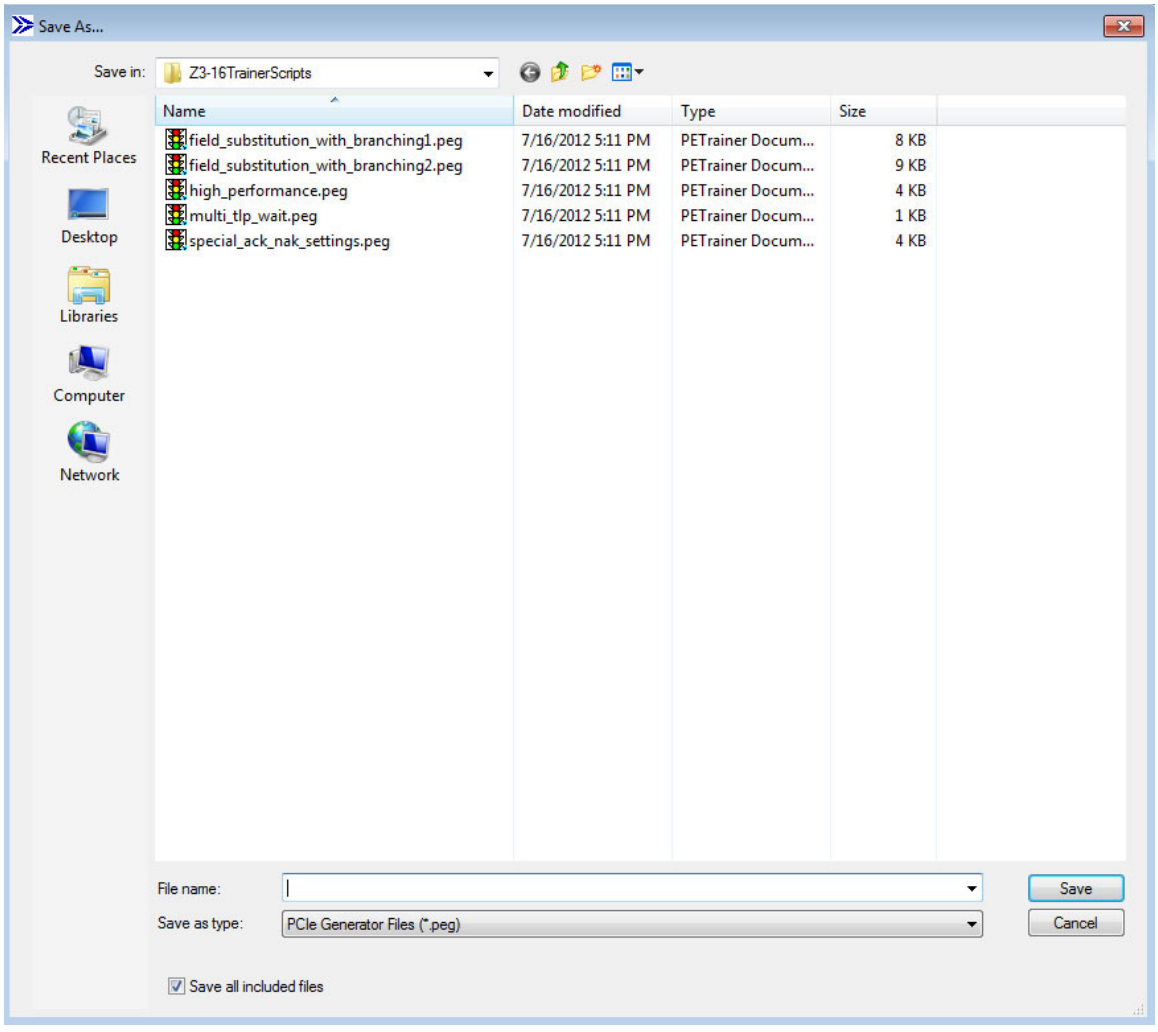


Figure 4.14: Save As Dialog

3. Navigate to the desired folder and type a new file name where you want to save the current script, then click the **Save** button:

When the Save As command completes, the newly created script is displayed.

NOTE: The Save As dialog box includes the option **Save all included files**. This option causes the software to save any **Include** files that have been included in the script. The Included files are saved to the same directory as the traffic generation file.

4.5.3 Select File > New PETrainer Script

To create a new script select **File -> New PETrainer Script** (see Figure 4.15).

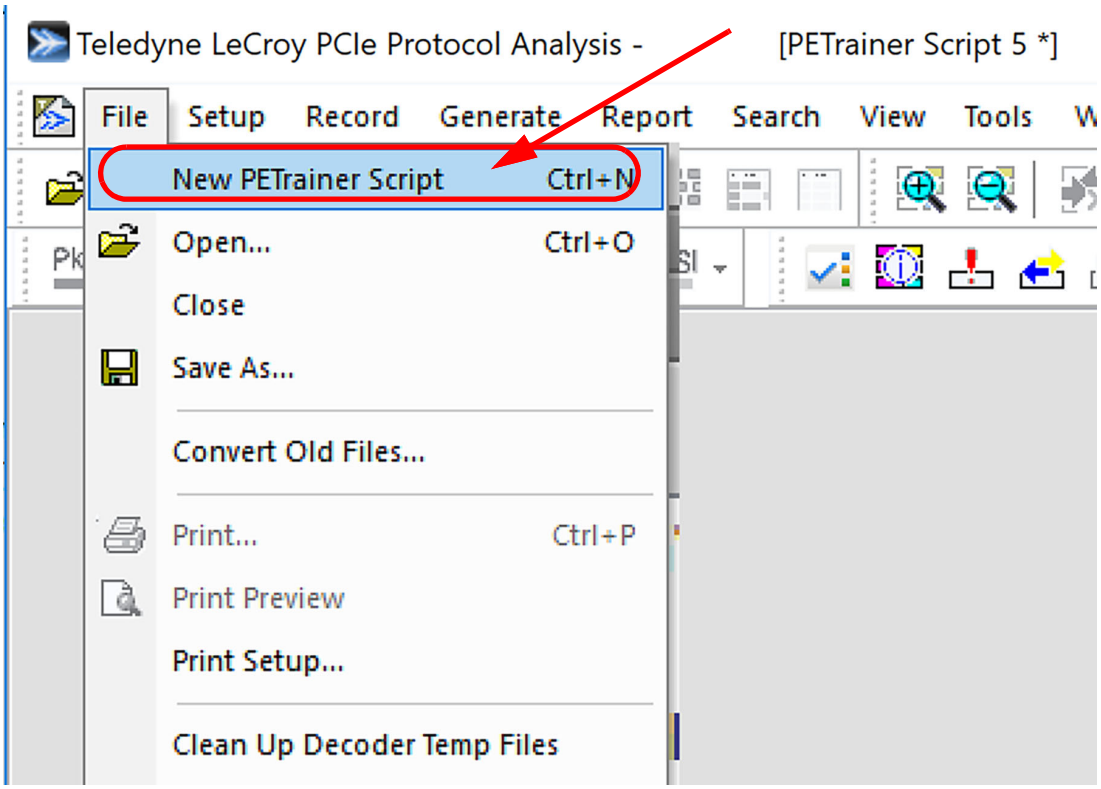


Figure 4.15: Generating a New PETrainer Script

This will pop up the Packet View see Figure 4.16 on page 84.

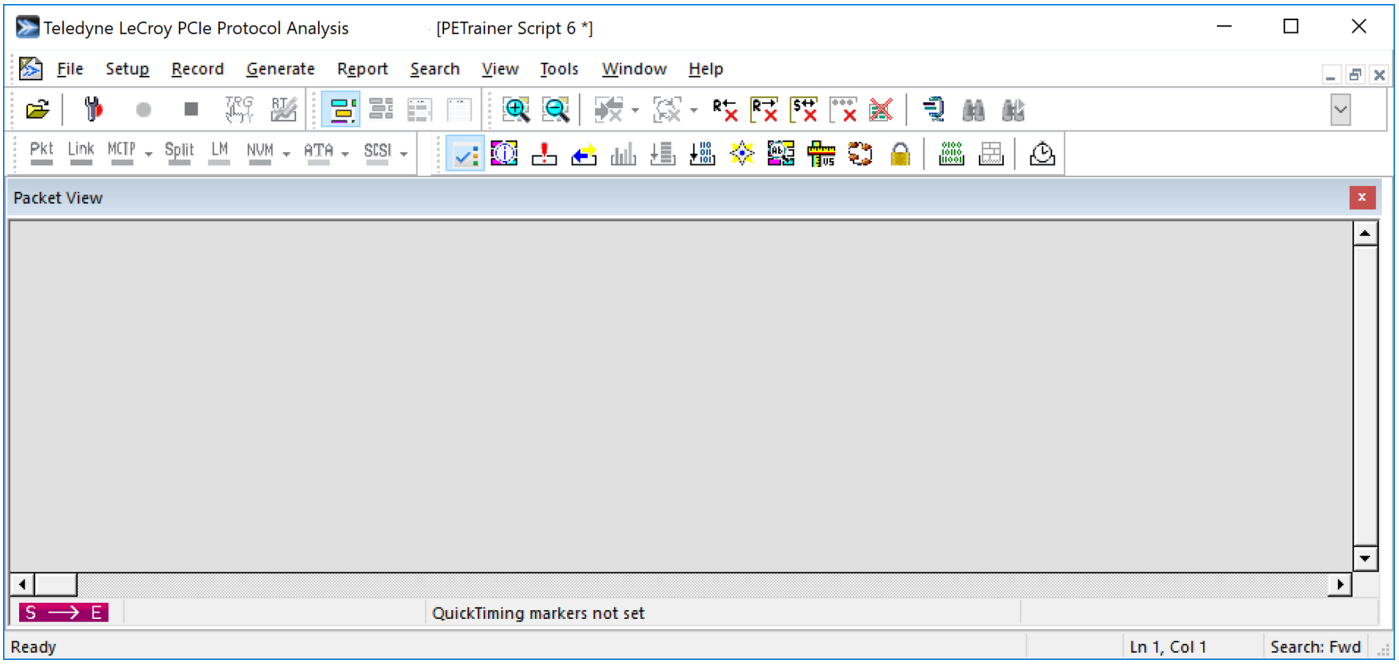


Figure 4.16: New PETrainer Script: Packet View

Now move your cursor into the blank Packet View area and click the right mouse button. A context menu will pop up. See Figure 4.17.

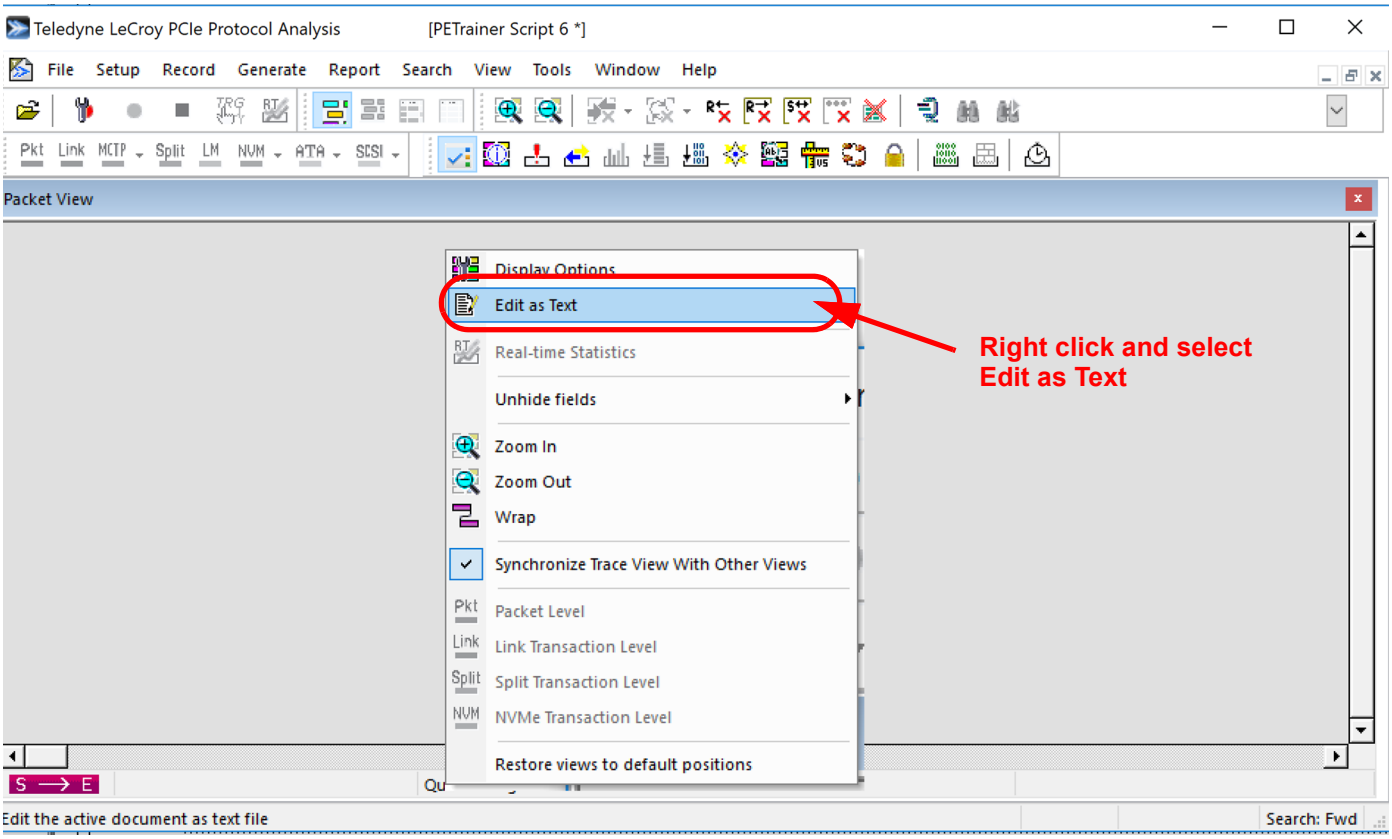


Figure 4.17: New PETrainer Script: Packet View → Edit as Text

Select **Edit as Text** from the context menu.

Now a script editing window will pop up. You can generate a script by selecting Script commands from the right side of the editor (see Figure 4.18).

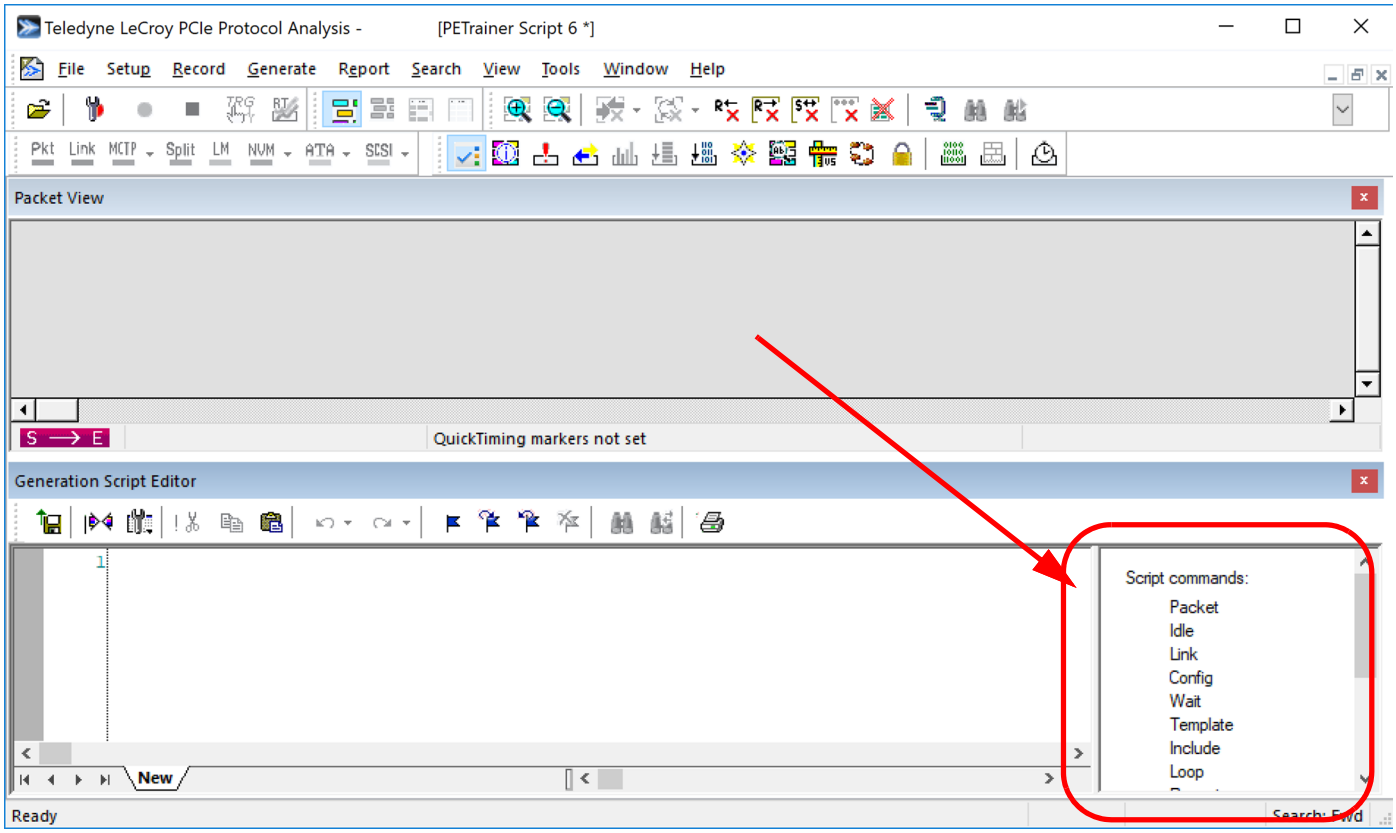


Figure 4.18: Generation Script Editor

In the example below we show a script using the Lane Margining commands and options. See Figure 4.19 on page 86.

4.5.3.1 Lane Margining Script: Using Packet = TLP

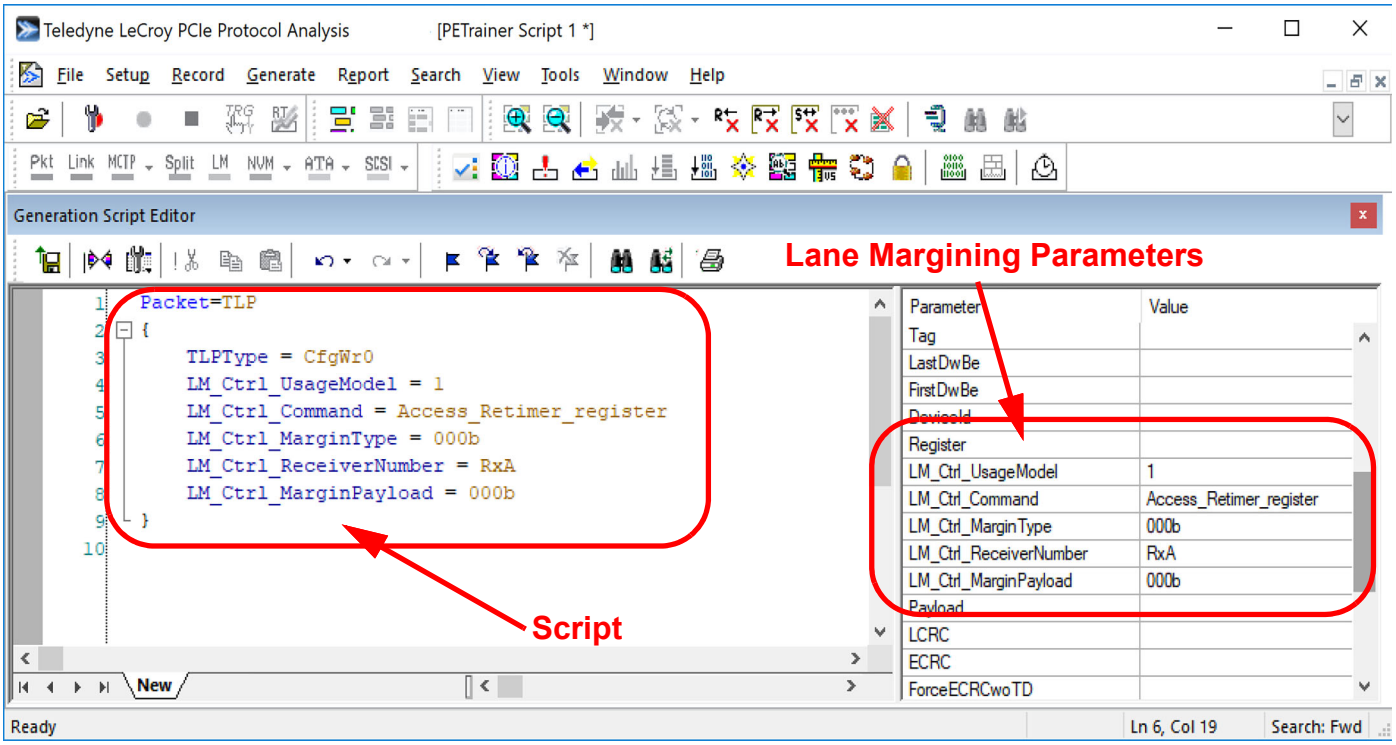


Figure 4.19: Lane Margining Script

When you have completed your script you can Save it by clicking on the Save Button in the toolbar. See Figure 4.20.



Figure 4.20: Saving a Script File

This will bring up the path to the PCIe Protocol Suite Sample Files (see Figure 4.21 on page 87).

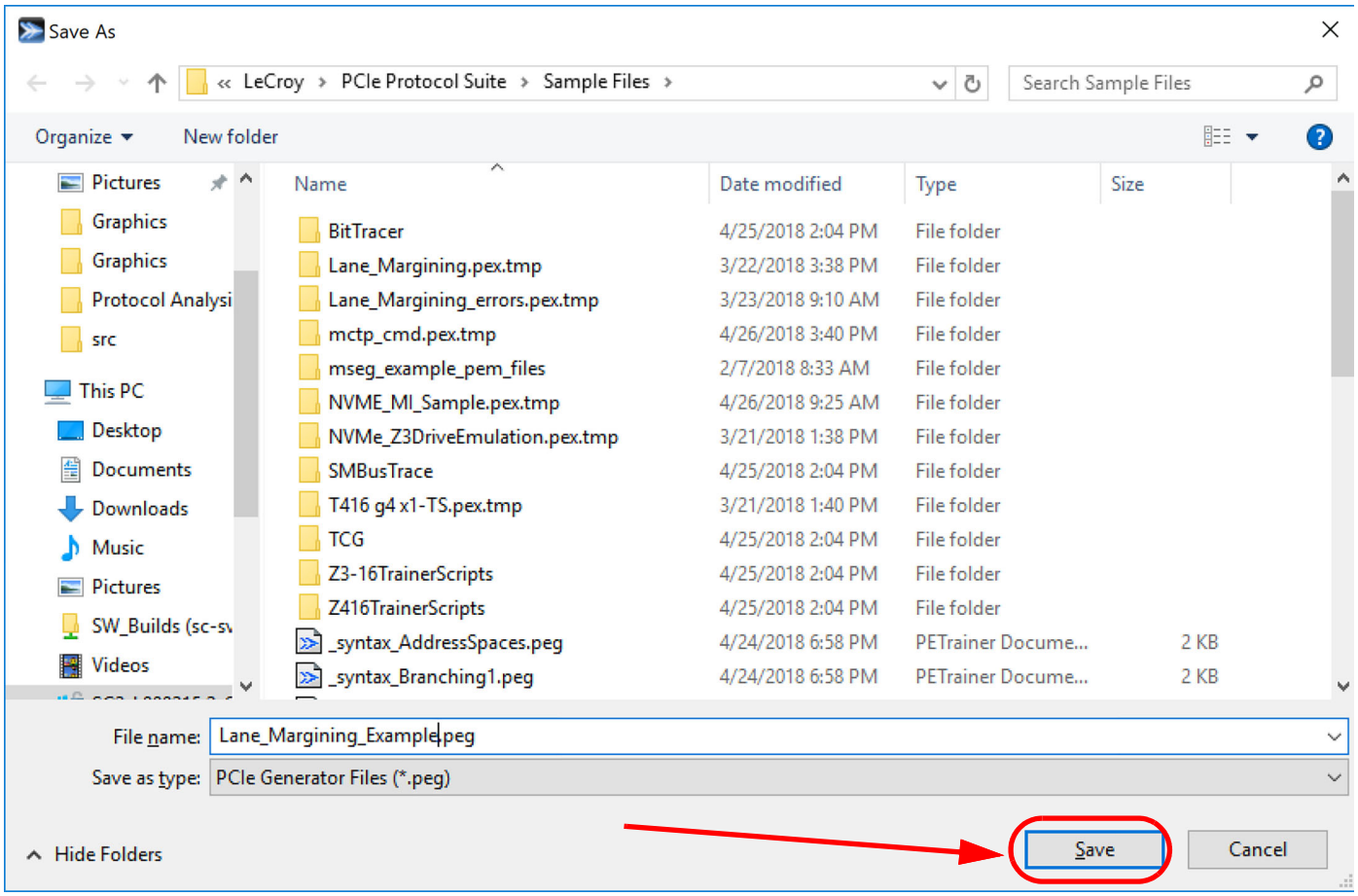


Figure 4.21: Saving a Script File

Click on Save to save the script.

4.5.3.2 Lane Margining Script: Using Configuration Command

Another way to create a script with Lane Margining is to use **File -> New PETrainer Script** but select **Config** in the right side pane. See Figure 4.22

Lane Margining and Control SKPs

NOTE: When using the script command "Config = LaneMargining" parameters and values will be embedded in control SKPs.

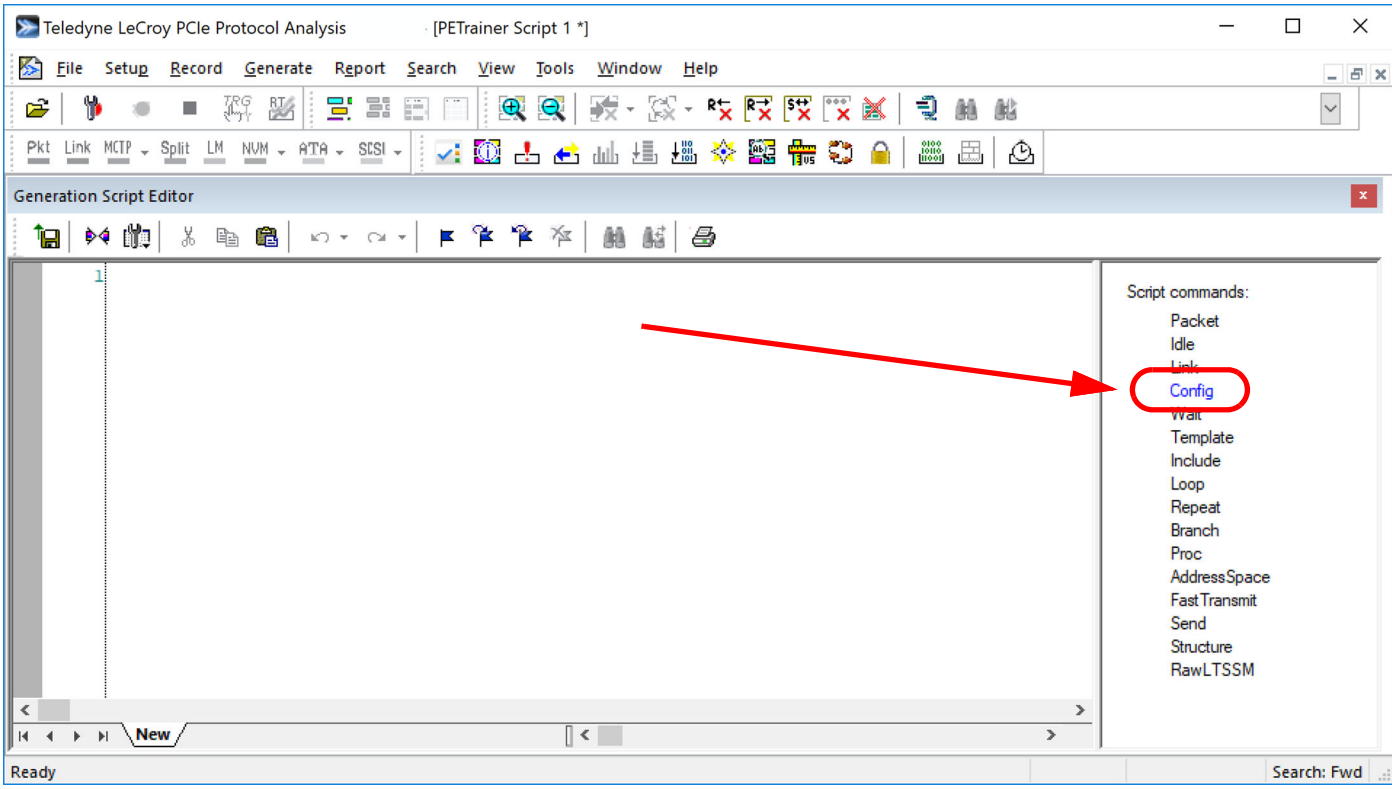


Figure 4.22: Script Editor: Select Config

Selecting "Config" will pop up a menu with the Lane Margining option. See Figure 4.23 on page 89.

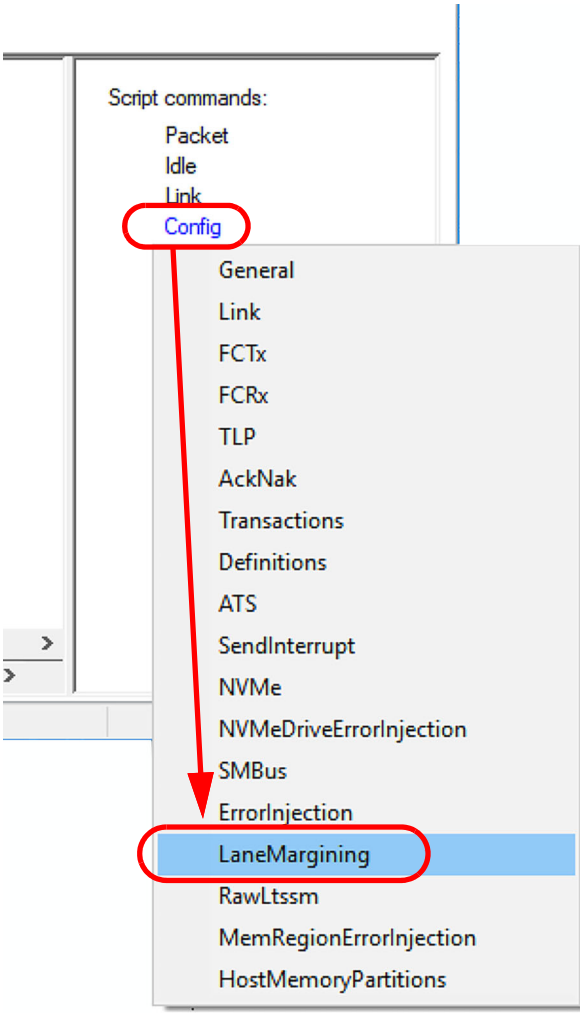


Figure 4.23: Script Editor: Config = Lane Margining

Select LaneMargining and all the options for Lane Margining will pop up. See Figure 4.24 on page 90.

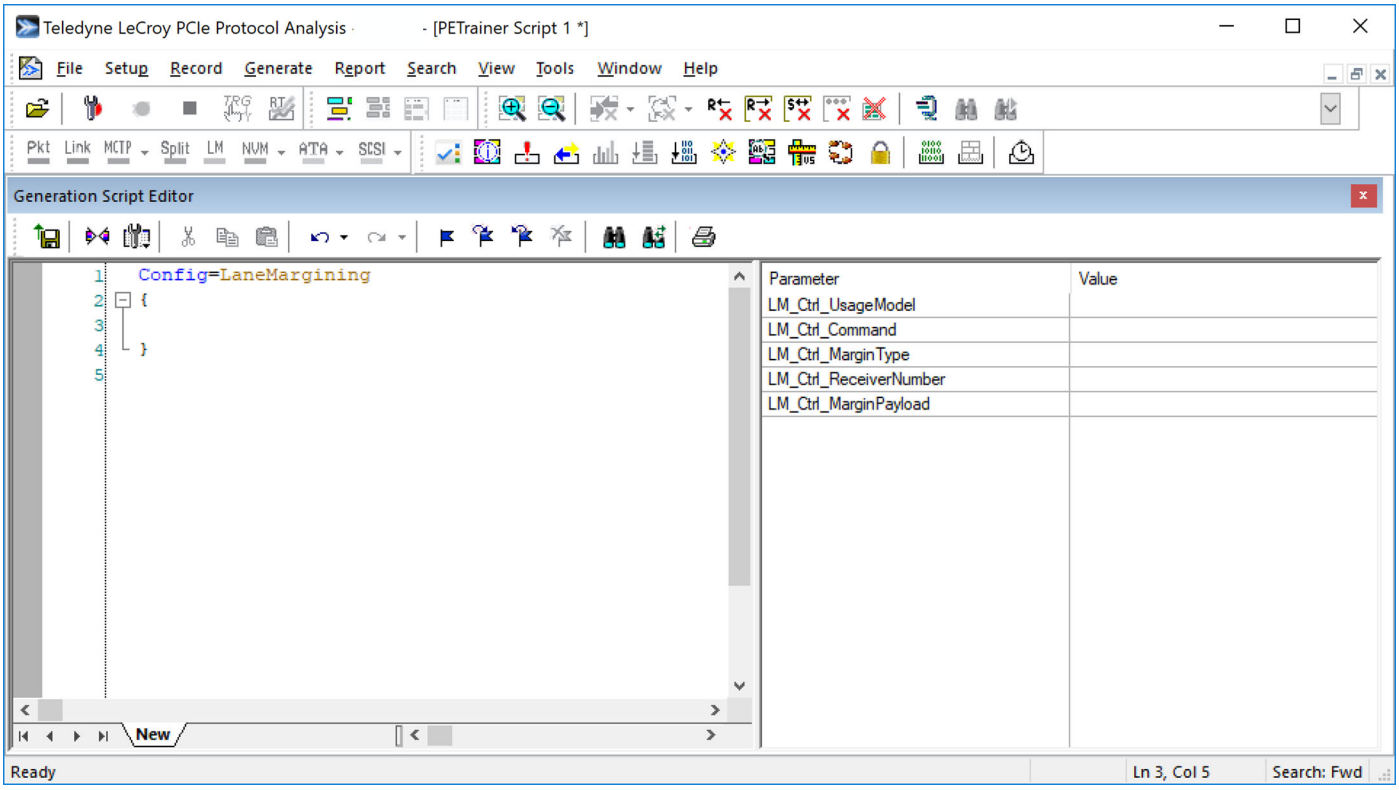


Figure 4.24: Lane Margining Options

Now you can start adding Lane Margining parameters to your script. See Figure 4.25

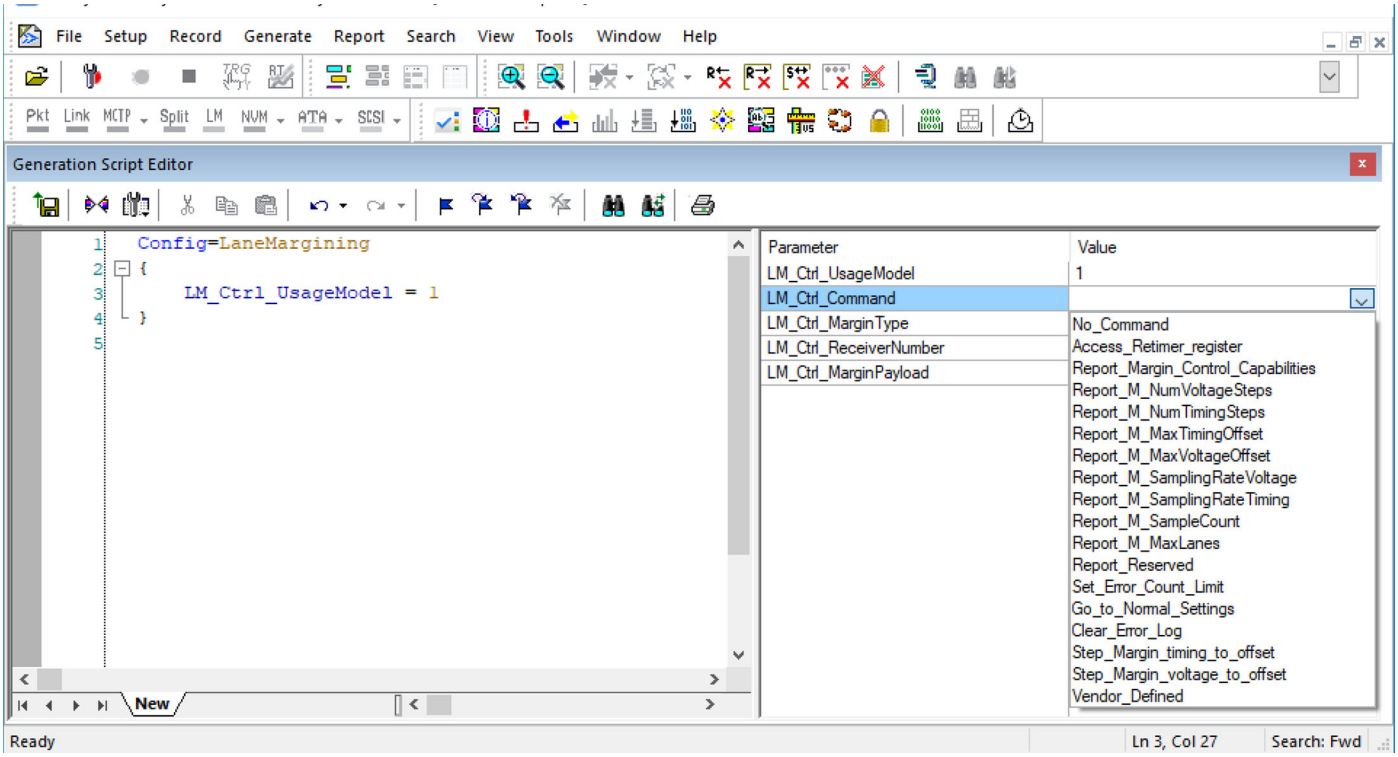


Figure 4.25: Lane Margining: Parameters: Commands

A full set of parameters and values can be seen in Figure 4.26

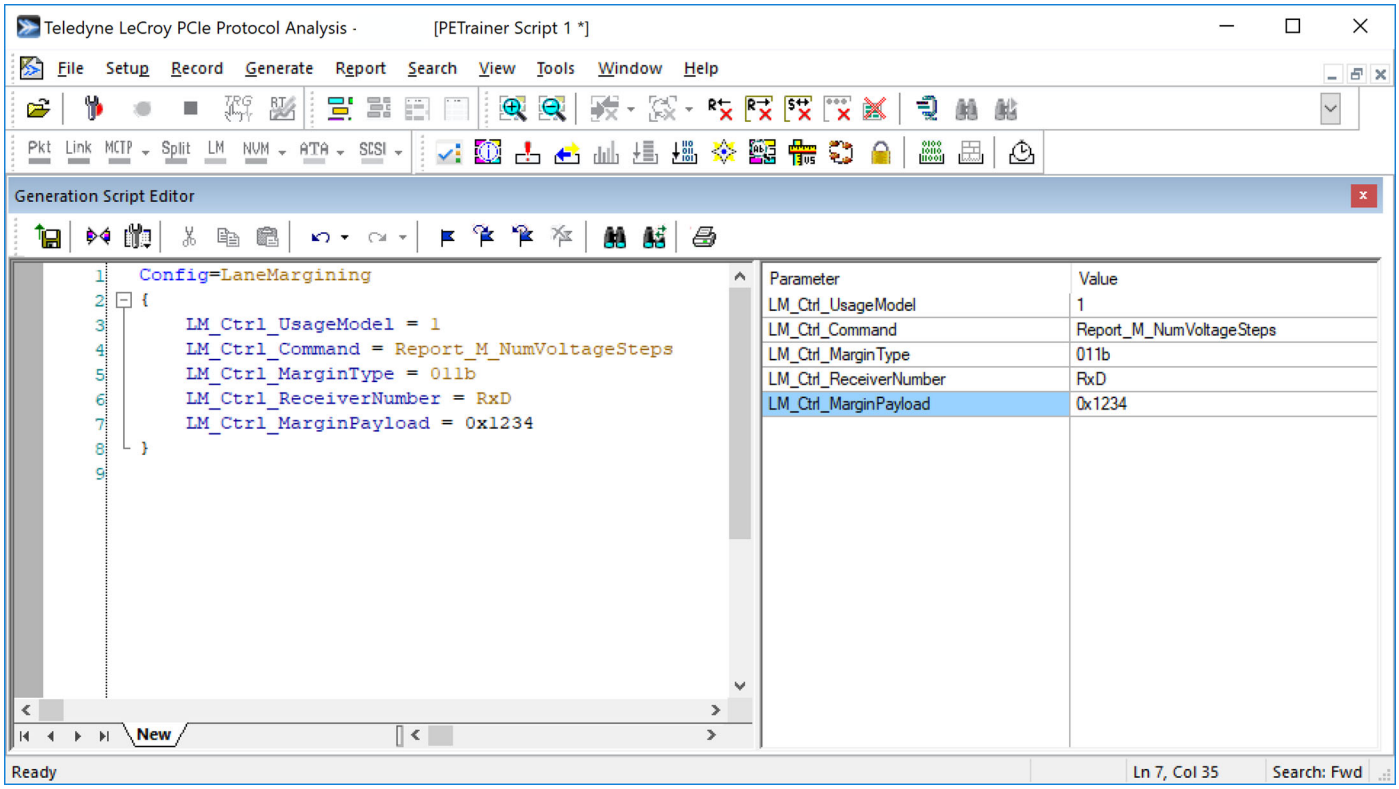


Figure 4.26: Lane Margining Parameters and Values

NOTE: Using the GUI in the Script Editor allows you to enter all of the defined parameters and values. If you want to test your DUT with parameters outside of the defined parameters and values you can manually type those values into the left pane of the script editor. See Figure 4.27 on page 92.

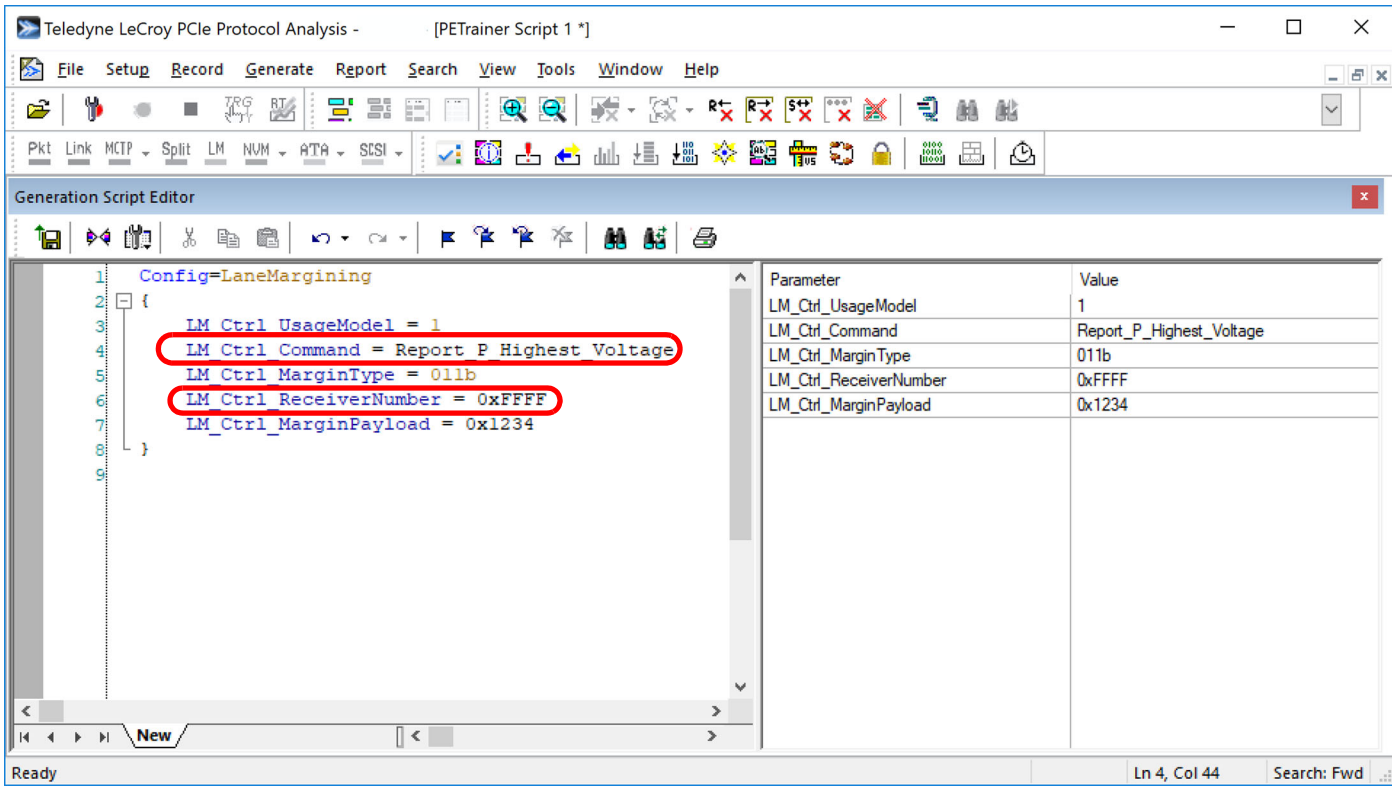


Figure 4.27: Lane Margining Script with Out of Bounds Values

4.5.4 Generate Lightweight Notification Protocol

You can use the Script Editor to generate the Lightweight Notification Protocol. The example script below shows both a Memory Read and a Vendor Specific ID. See Figure 4.28.

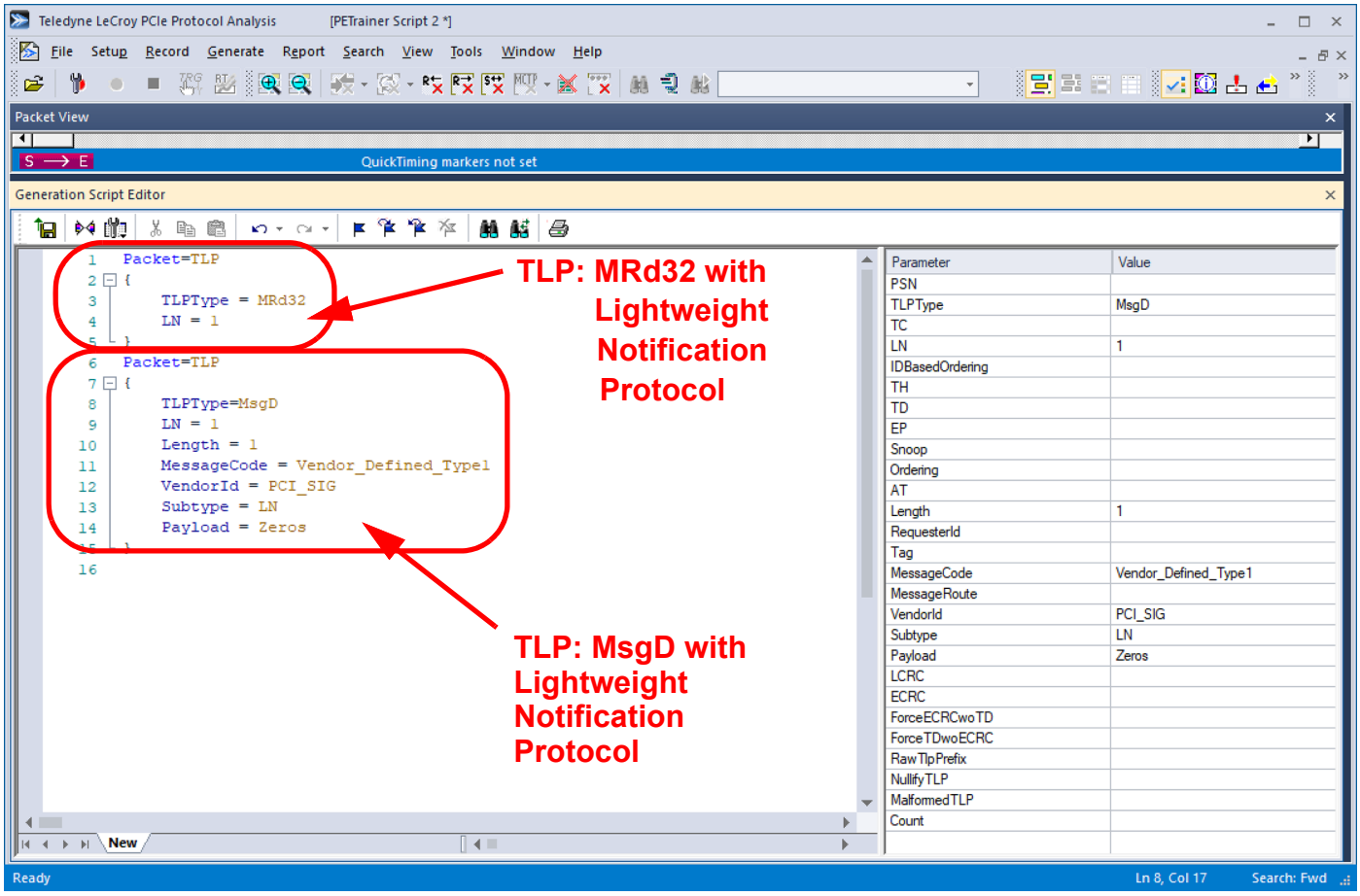


Figure 4.28: Script Editor: Lightweight Notification Protocol

4.5.5 Generate Trigger Out

For information on trigger out requirements see “Sync/Data (Controller Board)” on page 32.

To generate a script to perform a Trigger Out select File -> New PETrainer Script (see Figure 4.29).

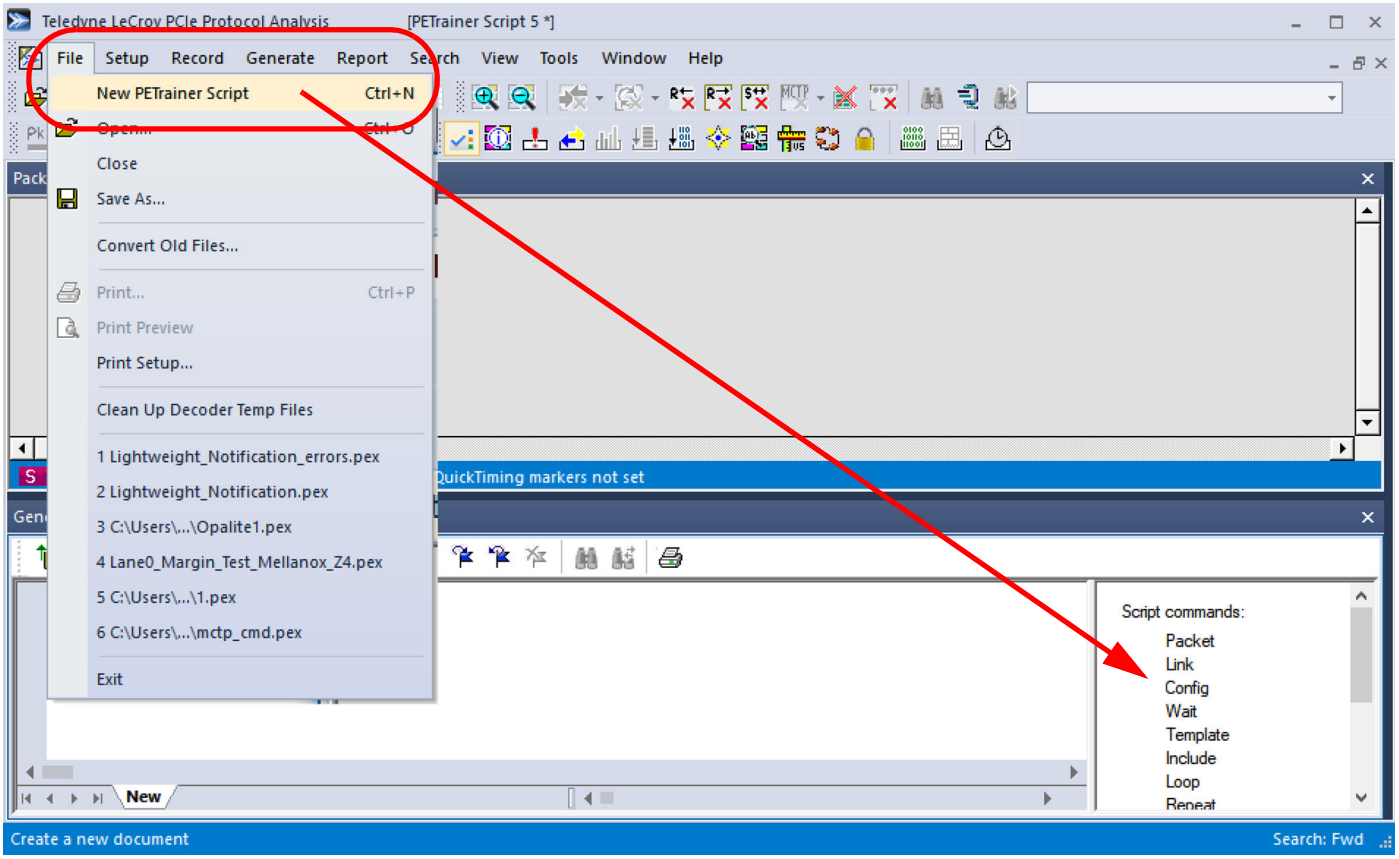


Figure 4.29: Generate New Script

Select Configuration. See Figure 4.30 on page 95.

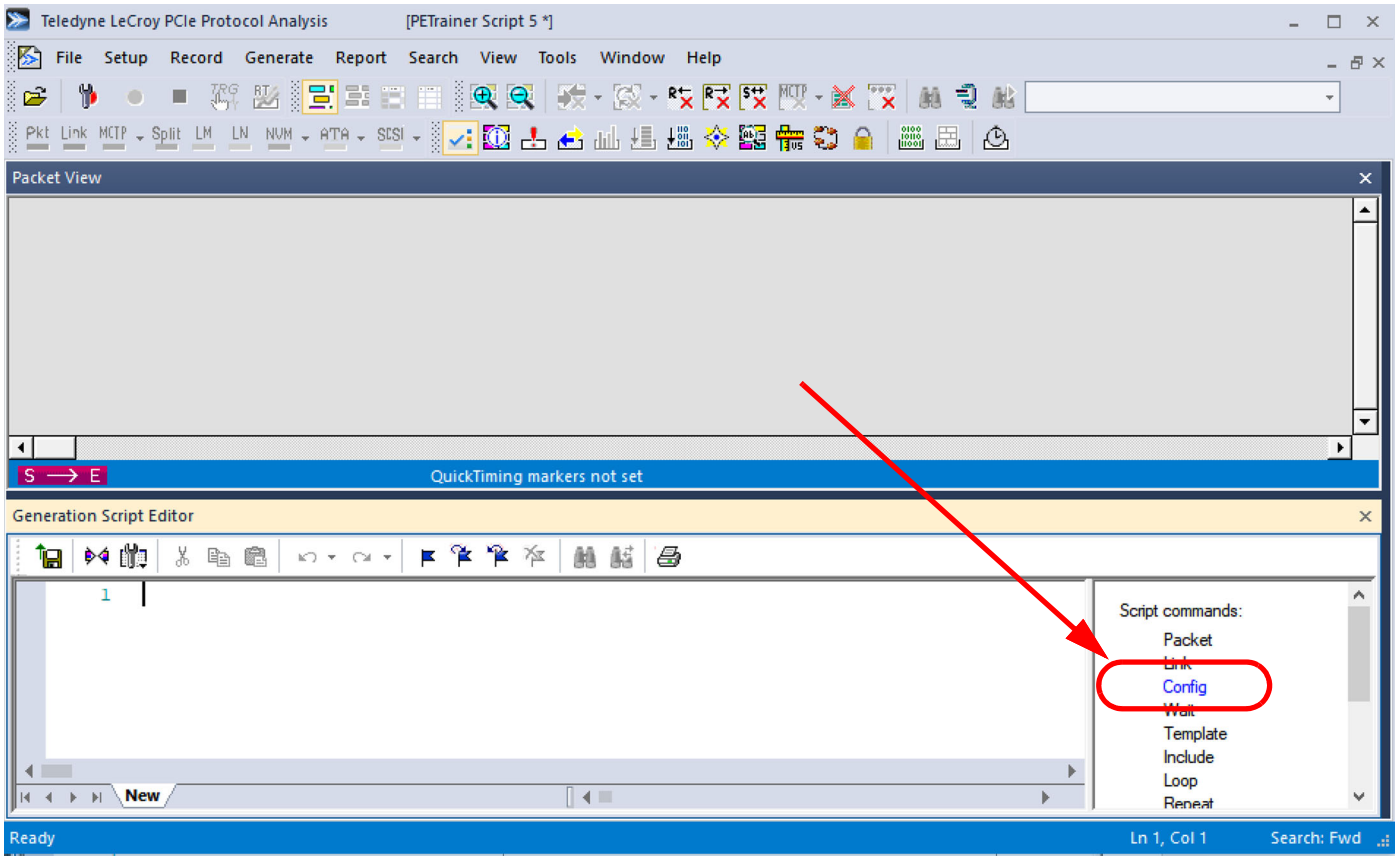


Figure 4.30: Select Configuration

Select the Trigger Out option from the popup menu. See Figure 4.31 on page 96.

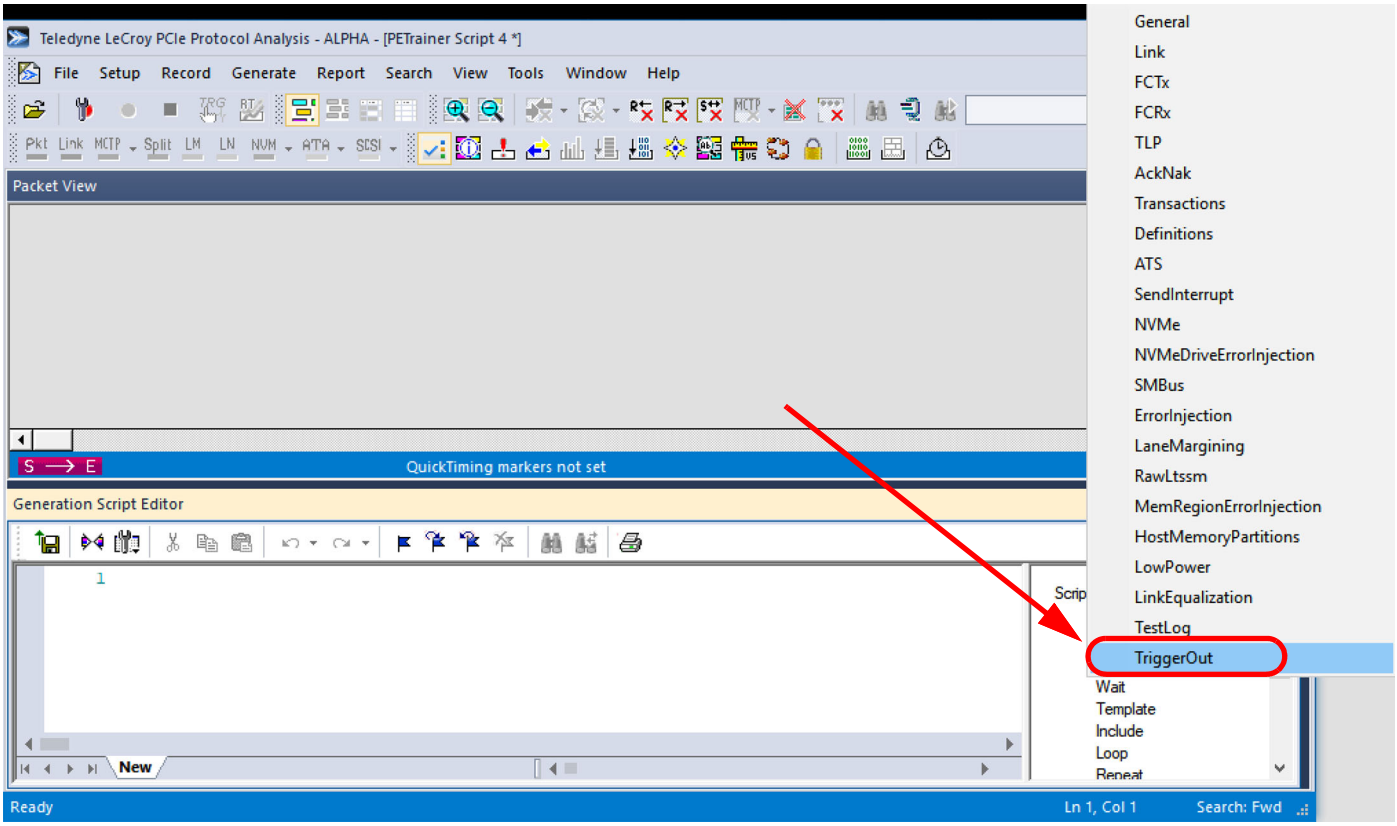


Figure 4.31: Configuration = TriggerOut

Select TriggerOut and your script will have the Trigger Out command set. See Figure 4.32 on page 97.

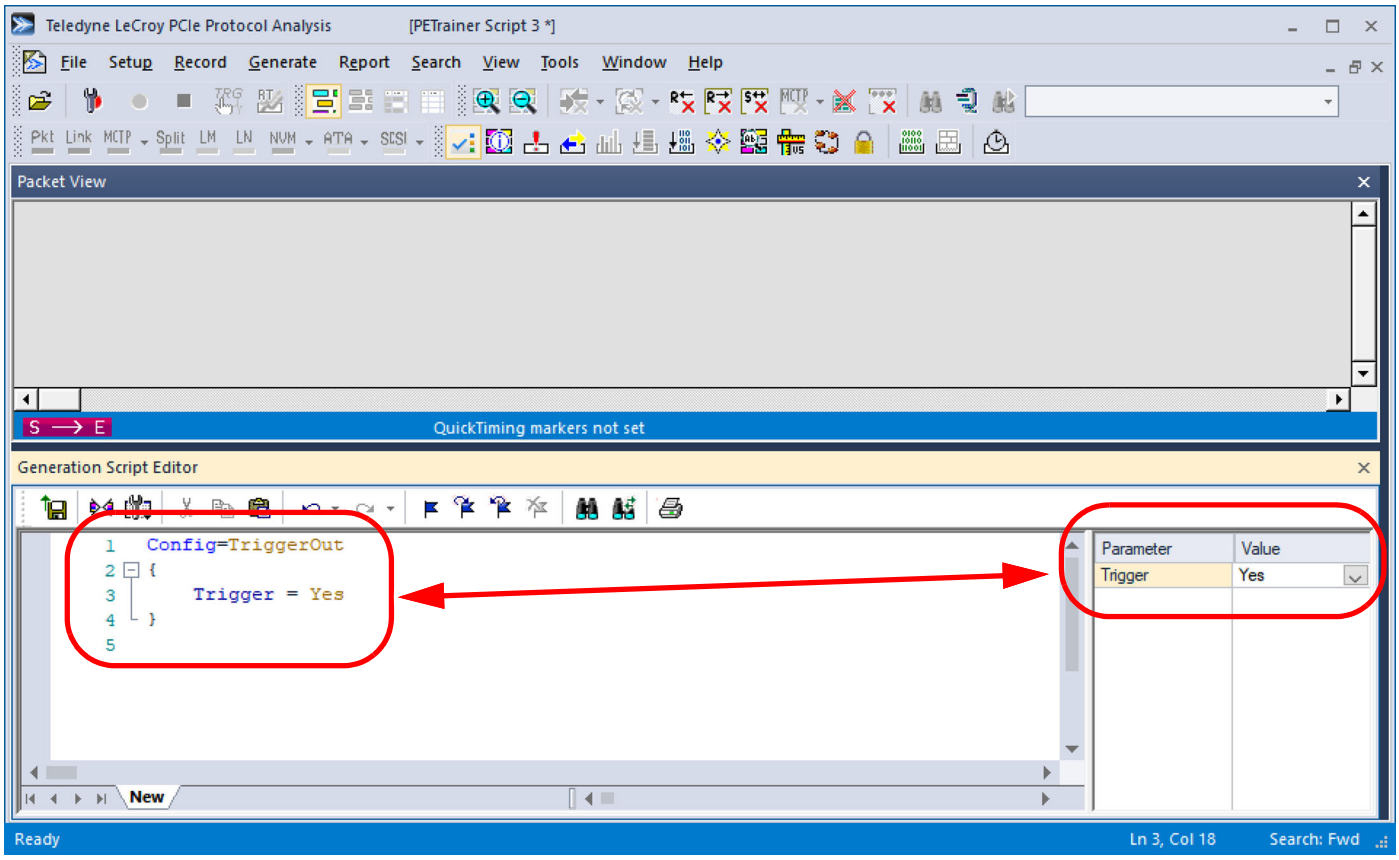


Figure 4.32: Configuration Added to Script with Trigger Out Command Set to Yes

NOTE: The trigger latency for the Z4 Trigger Output is 240ns +/-10ns measured from the time the triggering pattern happens on the bus until the trigger output shows up on the Summit Z5 Trigger Out connector.

4.5.6 Creating a New Empty Generation File

To create a generation file from scratch see the next section.

4.6 Generation Options Dialogs Overview

The Generation Options dialog box is used to configure settings of the device. If there are additional devices, you can control the settings separately of each device. Once the settings are changed you can save them as a default. When the application is launched the next time, the default settings are loaded.

These options are also used in a traffic generation script (for example, **Config = General** or **Config = Link**). This dialog duplicates the **Config** script command and is provided as a convenient alternative means of setting this command in the script.

NOTE: Generation Options together with Config Script commands define the Summit Z5 behavior as a device. Some configuration changes may require a link reset to ensure correct system operation. For example, changing lane reversal settings or changing available flow control values after the link has been established will cause problems with the link.

The Generation Options dialog is subordinate to the script itself, so script commands override options selected in this dialog box.

4.6.1 Opening the Dialog

To open the Generation Options dialog (see Figure 4.33 on page 99) select **Setup > Generation Options** or click

the **Generation Options** button  .

4.6.1.1 Z5 General Options Dialog Layout

NOTE: High Performance Mode applies to both the Summit Z58 and the Summit Z516 Exercisers. Z5 references both Z58 and Z516 except where noted.

The Generation Options dialog is organized into seven tabs: **General**, **Link**, **Phy** (Physical) **Parameters, Low Power, Integrity, Flow Control, Transactions** and **Error Injection**.

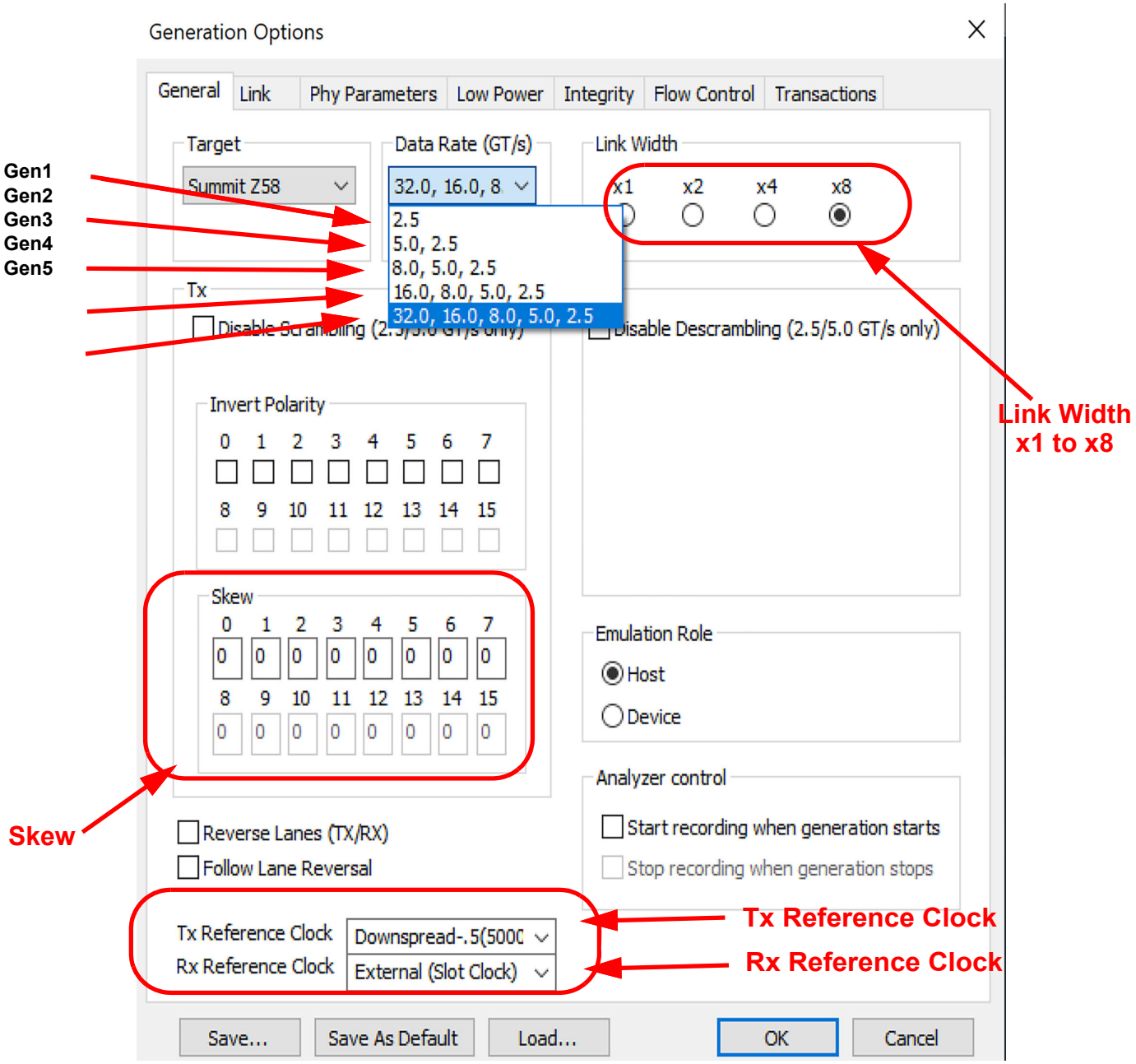


Figure 4.33: Generations Options Dialog - Z516 PCIe

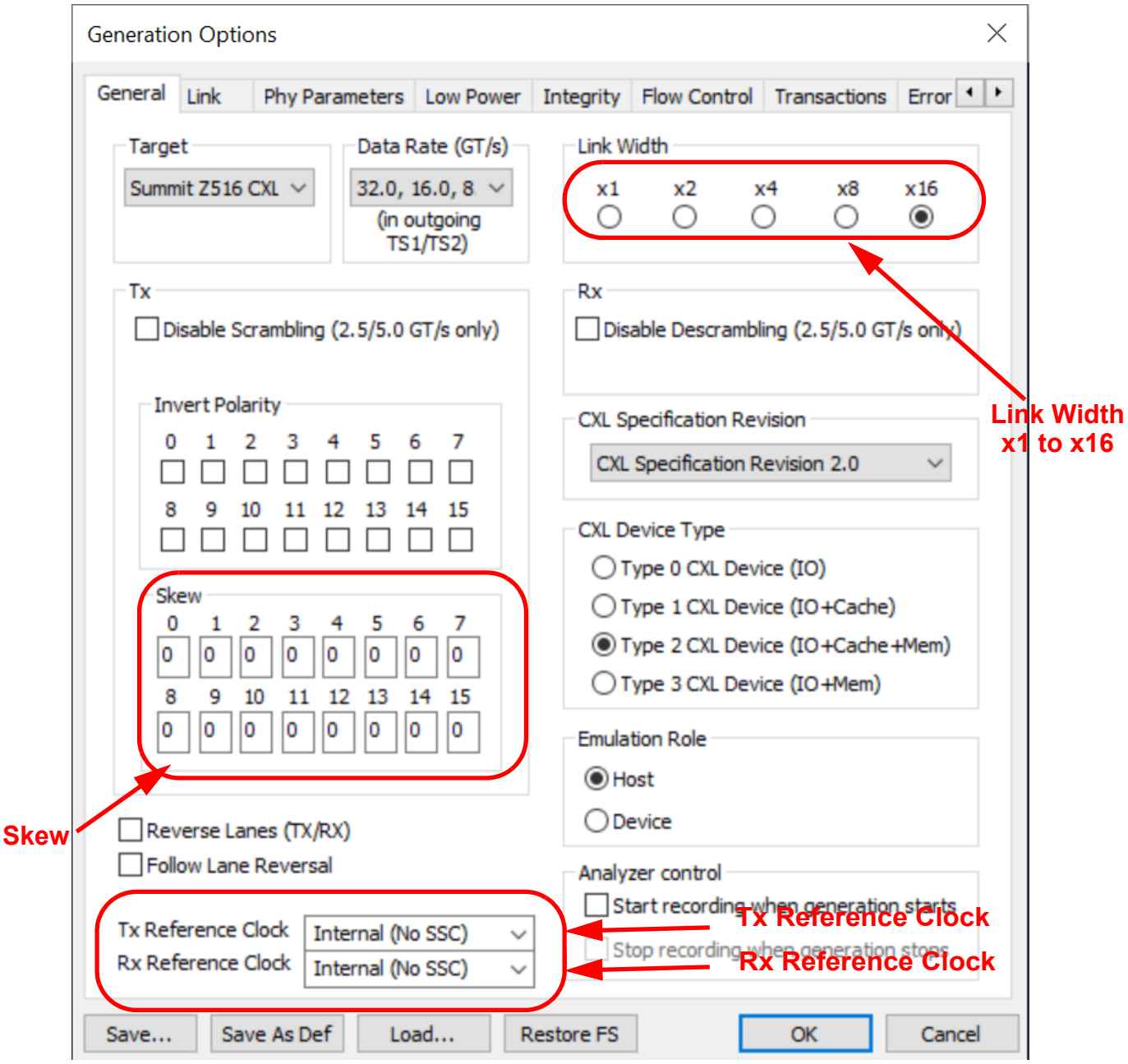


Figure 4.34: Generations Options Dialog - Z516 CXL

NOTE: The Data Rate and Link Width set in this GUI can be overridden by making different selections in the LTSSM GUI (see "LTSSM: Link Speed Control" on page 71 or "LTSSM Arc Tests" on page 73). The Data Rate can also be overridden by making different selections in the Exerciser Control Bar "Go to" buttons, see "Summit Z5 PCIe Protocol Exerciser Control Bar" on page 69.

4.6.1.2 General Generation Options

The general generation options can be selected on this dialog. The parameter values, defaults and description are given in the table below.

TABLE 4.1: Values for Generation Options

Parameter	Values	Default	Description
Target	Summit Z58, Summit Z516, Summit Z516 CXL.	Summit Z58 or Summit Z516 depending on the device.	This control allows switching CXL and PCIe mode for Z516. After a switch, the corresponding BE is automatically applied.
Data Rate 2.5 GT/s Data Rate 5.0 & 2.5 GT/s Data Rate 8.0, 5.0, 2.5 GT/s Data Rate 16.0, 8.0, 5.0, 2.5 GT/s Date Rate 32.0, 16.0, 8.0,5.0,2.5GT/s	Selection	2.5 GT/s	Specifies advertised data rate. The Data Rate selected can be overridden by the Link Speed selected in the LTSSM GUI (see "LTSSM: Link Speed Control" on page 71) or the Exerciser Control Bar (see "Summit Z5 PCIe Protocol Exerciser Control Bar" on page 69).
Link Width	x1, x2, x4, x8, x16	1	Specifies the link width. Based on the **Link Width** you choose by selecting the radio button the settings on the **Invert Polarity** is enabled. The Link Width selected can be overridden by the Link Width selected in the LTSSM GUI (see "LTSSM: Link Width Control" on page 72). Note: Summit Z58 maximum capability is x8 and Summit Z516 maximum capability is x16.
Disable Scrambling Tx	Yes No	No	Select to disable scrambling of the data that the Summit Z5 is transmitting (applies only to Gen1 and Gen2 data rates).
Invert Polarity Tx	From 0 to 15		Inverts the polarity of the selected lanes that the Summit Z5 is transmitting.

TABLE 4.1: Values for Generation Options

Parameter	Values	Default	Description
Invert Polarity Rx			Disabled for Summit Z5 as it automatically detects polarity of incoming data.
Skew	From 0 to 15	0	Skews data from 0 to 15 symbol times.
Emulation Role	Host or Device and High Performance Memory	Host	For Host or Device Emulation the High Performance Memory option can be enabled (See Figure 4.33 on page 99). See the description for the Transactions tab on how to associate the High Performance Memory with a memory space or memory region. See "Transactions: Device Emulation -> High Performance Real Memory Option" on page 149 and "Transactions: Host Emulation -> High Performance Real Memory Mode" on page 156. Note: For CXL mode emulation role is important because the role in generation options should correspond to the packet types in the generation script for CXL.Cache / CXL.Mem.
Reverse Lanes (TX/RX)	Yes No	No	Select this option to emulate a host/device with reversed lanes. This option will reverse both RX and TX lanes to emulate a reversed link and test the DUT tolerance. If the link is actually reversed this option will cause the Z5 to not train properly.
Follow Lane Reversal	Yes No	No	When set, the Summit Z5 responds to lane reversal requests from the DUT. When cleared, the Summit Z5 Trainer does not follow the lane reversal protocol. **Note:** In this case the link may not be able to train.

TABLE 4.1: Values for Generation Options

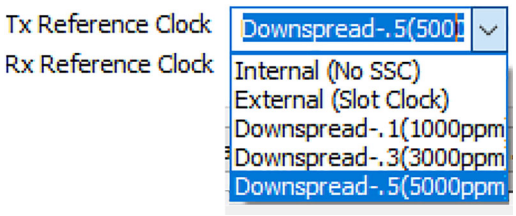
Parameter	Values	Default	Description
Tx Reference Clock	Tx	Internal (No SSC)	 *For the Tx clock: When Internal (No SSC) is selected, the Summit Z516/Z58 uses an on board clock (no SSC) that allows operation when there is no reference clock provided.* *When External (Slot Clock) is selected, the Z516/Z58 External Clock uses the Tx clock supplied at the PCIe bus (from the PCIe slot connector). This allows for independent clocking operation when using the Summit PXP500 Test Platform.* When Downspread -.1 (1000ppm) is selected the Z516/Z58 uses a local oscillator on the Z516/Z58 with a Downspread of -0.1 (1000ppm). When Downspread -.3 (3000ppm) is selected the Z516/Z58 uses a local oscillator on the Z516/Z58 with a Downspread of -0.3 (3000ppm). When Downspread -.5 (5000ppm) is selected the Z516/Z58 uses a local oscillator on the Z516/Z58 with a Downspread of -0.5 (5000ppm).

TABLE 4.1: Values for Generation Options

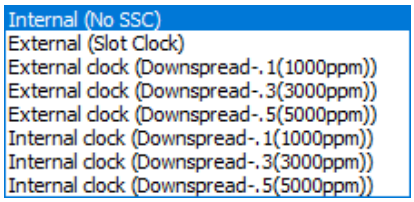
Parameter	Values	Default	Description
Rx Reference Clock	Rx	Internal (No SSC)	 For the Rx clock: Internal (No SSC) is selected, the Summit Z516/Z58 uses an on board clock (no SSC) that allows operation when there is no reference clock provided. When External (Slot Clock) is selected, the Z516/Z58 External Clock uses the Rx clock supplied at the PCIe bus (from the PCIe slot connector). This allows for independent clocking operation when using the Summit PXP500 Test Platform. This options assumed there is no SSC in the PCIe reference clock supplied. External Clock (Downspread -.1 (1000ppm)) is selected the Z516/Z58 uses a local oscillator on the Z516/Z58 with a Downspread of -0.1 (1000ppm). This option assumes there is SSC in the reference clock supplied up to 1000ppm. External Clock (Downspread -.3 (3000ppm)) is selected the Z516/Z58 uses a local oscillator on the Z516/Z58 with a Downspread of -0.3 (3000ppm). This option assumes there is SSC in the reference clock supplied up to 3000ppm. External Clock (When Downspread -.5 (5000ppm)) is selected the Z516/Z58 uses a local oscillator on the Z516/Z58 with a Downspread of -0.5 (5000ppm). This option assumes there is SSC in the reference clock supplied up to 5000ppm.

TABLE 4.1: Values for Generation Options

Parameter	Values	Default	Description
			Internal Clock (Downspread -.1 (1000ppm)) is selected the Z516/Z58 uses a local oscillator on the Z516/Z58 with a Downspread of -0.1 (1000ppm). This option assumes the date received is clocked with SSC up to 1000ppm. Internal Clock (Downspread -.3 (3000ppm)) is selected the Z516/Z58 uses a local oscillator on the Z516/Z58 with a Downspread of -0.3 (3000ppm). This option assumes the date received is clocked with SSC up to 3000ppm. Internal Clock (When Downspread -.5 (5000ppm)) is selected the Z516/Z58 uses a local oscillator on the Z516/Z58 with a Downspread of -0.5 (5000ppm). This option assumes the date received is clocked with SSC up to 5000ppm.
Analyzer Control	Yes No	No No	Gives you the option to: Start recording when generation starts. Stop recording when generation stops.
CXL Device Type	Type 1 CXL Device (Only Cache), Type 2 CXL Device (Cache+ Mem), Type 3 CXL Device (Only Mem)	Type 2 CXL Device (Cache+ Mem)	This option is available only in CXL mode (Target = Summit Z516 CXL). Defines capabilities that are supported for CXL traffic.

TABLE 4.1: Values for Generation Options

Parameter	Values	Default	Description
CXL Specification Revision	CXL Specification Revision 1.1 CXL Specificaiton Revision 2.0	CXL Specification Revision 1.1	This option is available only in CXL mode (Target = Summit Z516 CXL). Defines CXL specification revision that is supported for CXL traffic

4.6.2 Link Generation Options

The **Link** Generation Options dialog allows you to set up the link options.

The parameters, values, defaults and descriptions are given in Table , “” on page 110 below.

The dialog has different settings depending on target device and mode.

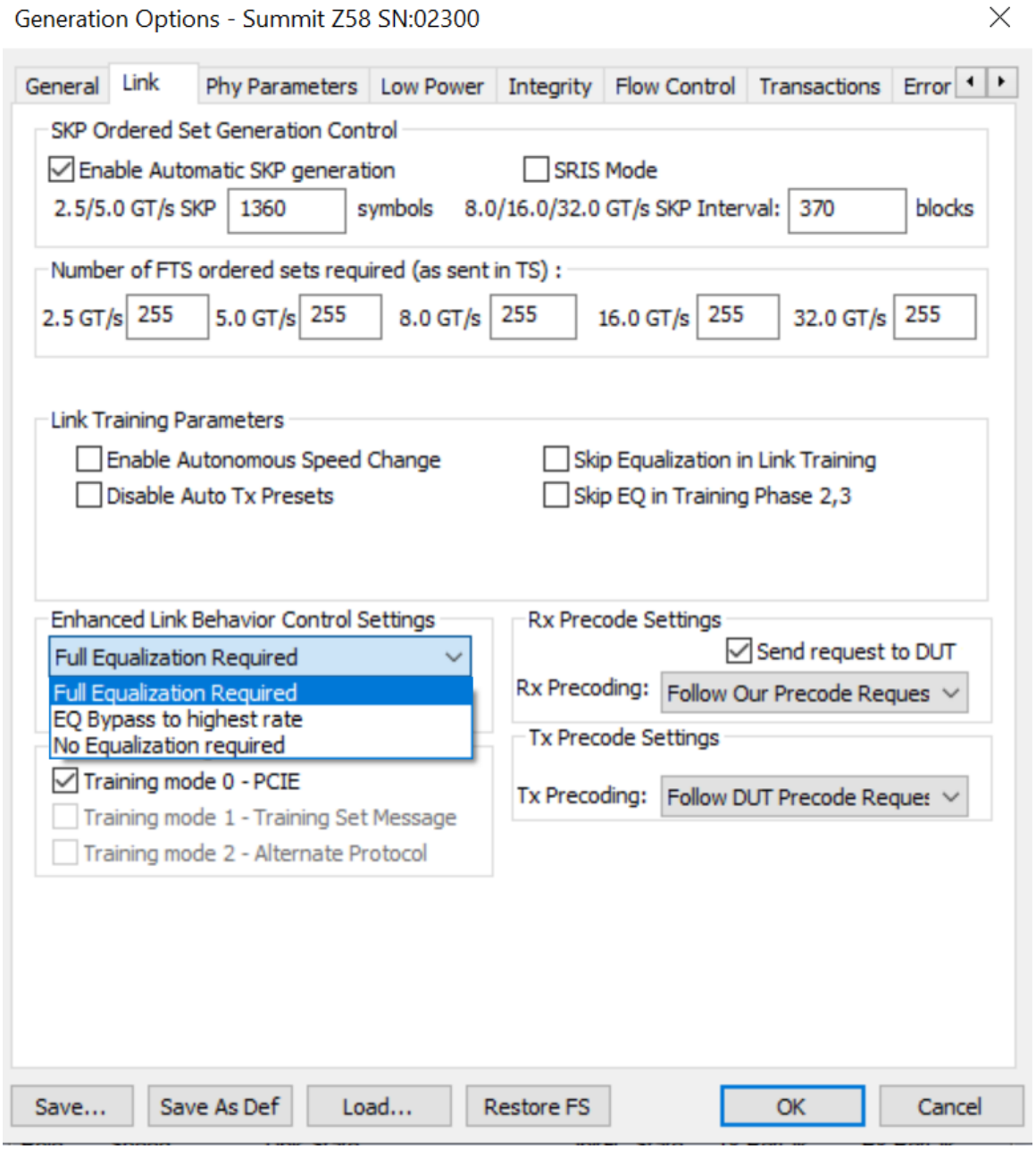


Figure 4.35: Generations Options Link Dialog for Summit Z58.

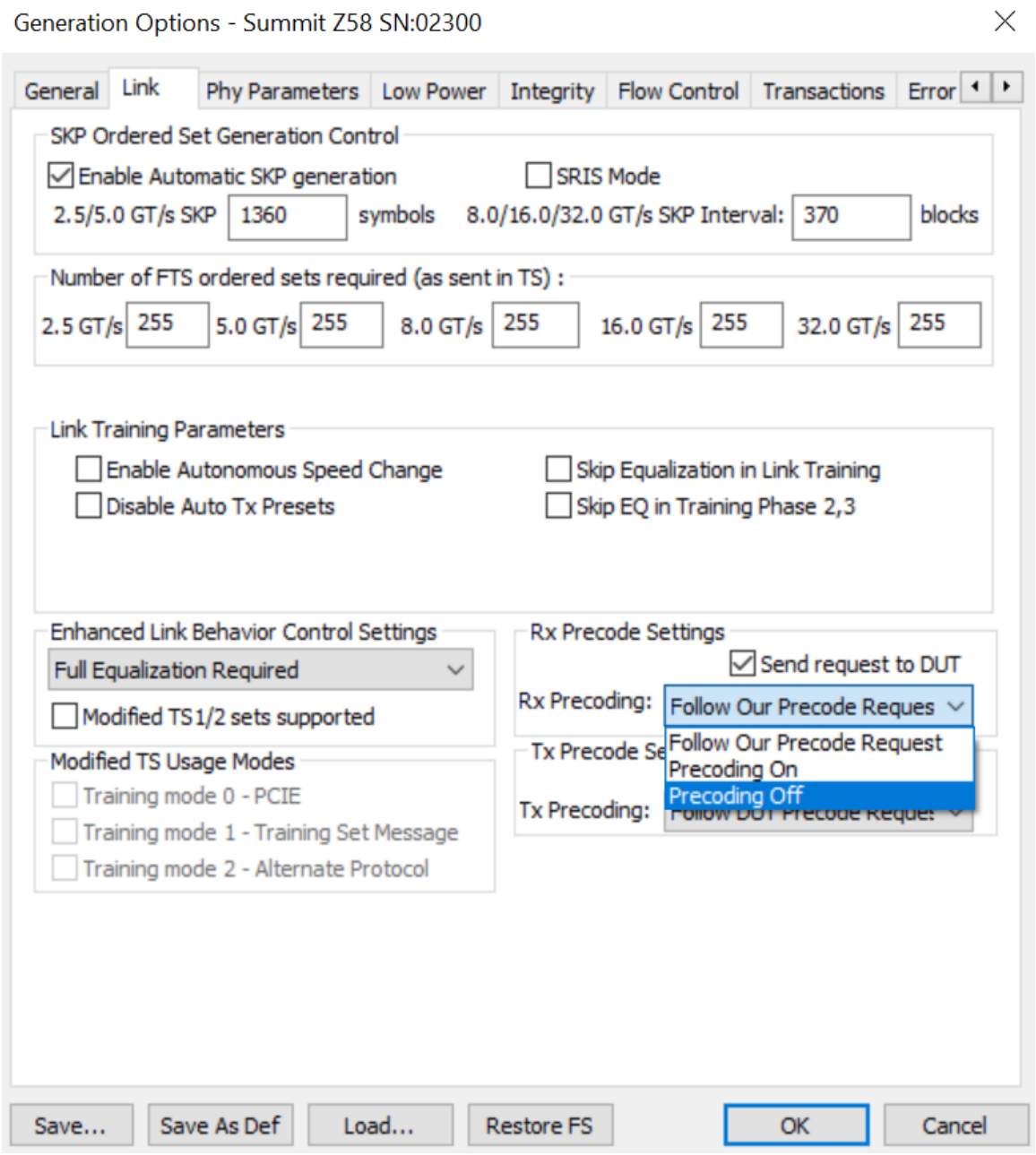


Figure 4.36: Generations Options Link Dialog for Summit Z516.

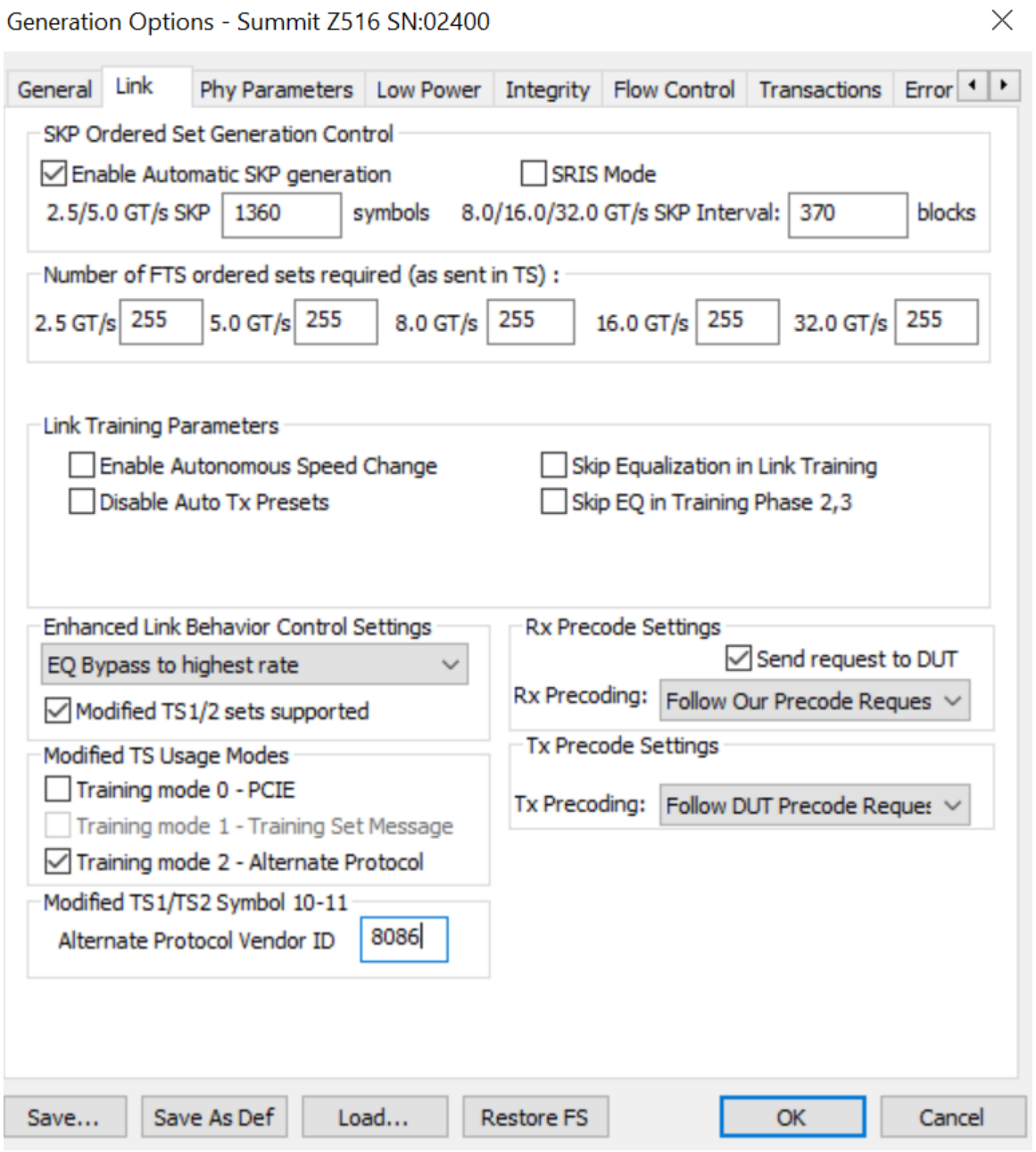


Figure 4.37: Generations Options Link Dialog for Summit Z516 CXL.

NOTE: Once the PCIe Specification Compatibility has been set in the **Generation Options -> Link** tab above, the Recording options for the Z5 will be set to the same option: **Revision 4.0 Version 0.5 or Revision 4.0 Version 0.7 and above**. See “Recording Options” on page 264.

TABLE 4.8: Generation Options Link Dialog Parameters

Parameter	Values	Default	Description
SKP Ordered Set Generation Control			
Enable Automatic SKP Generation		Enabled	Generates SKP ordered set automatically.
SRIS Mode		Disabled	Sets defaults for SKP Interval used by a timer that controls the SKP generation in the exerciser. The timer value is measured in number of symbols for Gen1/Gen2 and in 130 bit blocks for Gen3. These timer defaults are selected as required for SRIS operation by the PCIe specification.
2.5/5.0 GT/s SKP Interval	1180 to 1538	1360 symbols	Number of symbols to skip
8.0/16.0/32.0 GT/s SKP Interval	370 to 375	370 blocks	Number of blocks between SKPs
Number of FTS ordered sets required (as sent in TS)			
2.5 GT/s	1 to 255	255	Number of Fast Training Sequences (FTS) ordered sets
5.0 GT/s	1 to 255	255	Number of Fast Training Sequences (FTS) ordered sets
8.0 GT/s	1 to 255	255	Number of Fast Training Sequences (FTS) ordered sets
16.0 GT/s	1 to 255	255	Number of Fast Training Sequences (FTS) ordered sets
32.0 GT/s	1 to 255	255	Number of Fast Training Sequences (FTS) ordered sets
Link Training Parameters			
PCIe Specification Compatibility	Revision 4.0 Version 0.5 or Revision 4.0 Version 0.7 and above	Revision 4.0 Version 0.5	Both Revision 4.0 Version 0.5 and Revision 4.0 Version 0.7 and above are supported.

TABLE 4.8: Generation Options Link Dialog Parameters

Parameter	Values	Default	Description
Skip Equalization in Link Training	Enabled Disabled	Disabled	The Summit Z5 will skip all equalization stages during Gen5 training.
Skip EQ in Training Phase 2, 3	Enabled Disabled	Enabled	The Summit Z5 will skip phase 2 and 3 equalization stages during Gen5 training.
Enable Autonomous Speed Change	Enabled Disabled	Disabled for Summit Z58 and Summit Z516. Enabled for Summit Z516 CXL.	Enables Autonomous Speed change support. When enabled, upon the initial linkup to L0 at 2.5 GT/s, the link will initiate all of the speed switches necessary to attempt to link up at the greatest common speed initially advertised by both sides. For 16.0 GT/s, this includes first initiating a switch to 8.0 GT/s to perform equalization, prior to initiating another speed switch to 16.0 GT/s. If disabled, the Speed Changes can be performed as outlined in “Link Speed Control” on page 68.
Disable Auto Tx Presets	Enabled Disabled	Disabled	Used to prevent exerciser from applying the presets the other side is sending in the TS EQS while in Gen1 or Gen2 or Gen3 prior to the first speed change to Gen4/Gen5, and tells the Z5 to use its own defined values.

4.6.2.1 Enhanced Link Behavior Control Settings

For Summit Z58 and Z516 in PCIe mode the following rules are applied to Enhanced Link Behavior Control Settings:

When Z5 is a host, select one of four settings that it advertises to the DUT.

When Z5 is a device, select one or more settings to be accepted in negotiation. See Figure 4.38.

For Summit Z516 in CXL mode the following rules are applied to Enhanced Link Behavior Control Settings:

Modified TS1/2 sets supported options is always turned on because it is always used for CXL protocol.

For both host and device, it is possible to choose from the following options:

- Full Equalization Required + Modified TS1/2 sets supported
- EQ Bypass to highest rate + Modified TS1/2 sets supported (is used by default, please find the combination in Figure 4.35)
- EQ Bypass to highest rate + No Equalization Required + Modified TS1/2 sets supported

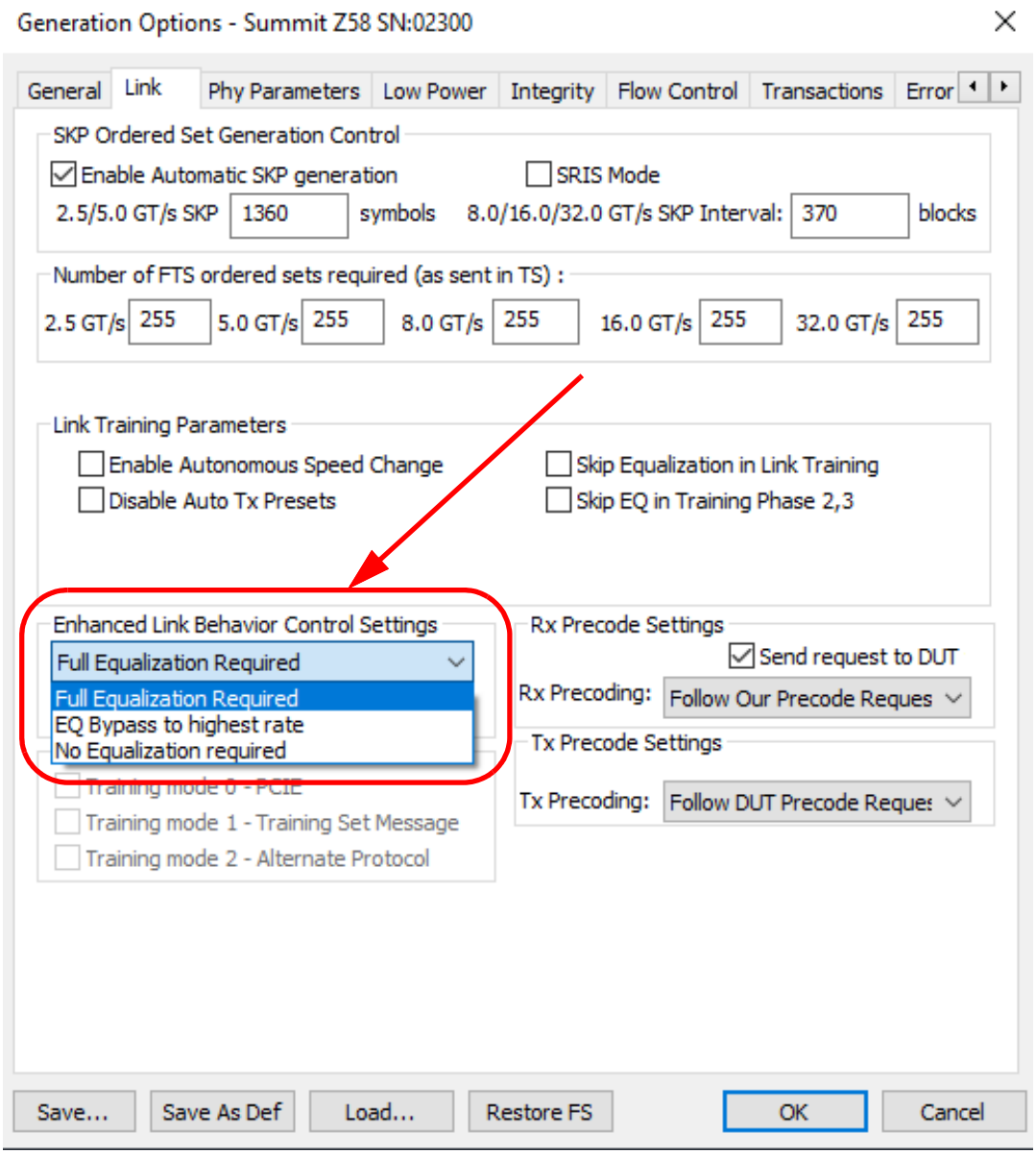


Figure 4.38: Link Options: Enhanced Link Behavior Control Settings

NOTE: The actual setting that is used is subject to the host and device negotiating the setting.

Enhanced Control Settings

- Full Equalization Required: Recovery equalization phases are required to be performed for all data rates from 8.0 GT/s and above.
- EQ Bypass to highest rate: Equalization for data rates may be skipped for all but the highest data rate assuming the highest data rate is 32 GT/s or above.
- No Equalization Required: Equalization may be skipped for all data rates. Also infers EQ Bypass data rate is supported. The link will use stored values (applied Tx Presets).

- Modified TS1/2 sets supported: Link will use modified TS1/2 sets allowing for negotiation to alternate protocols, training set messages, etc.

Modified TS Usage modes:

These define which protocol will be advertised in the modified TS1/2 sets. When the Z5 is the host, it will define the one setting it will advertise to the DUT. When the Z5 is a device, the user will select one or more settings it will accept in response to the host advertisement in modified TS1/2 sets.

- Training Mode 0 - PCIE - selects standard PCIE as the protocol.
- Training Mode 1 - reserved for Training Set Messages
- Training Mode 2 - Alternate Protocol.

4.6.2.2 Precode Settings

These control the precoder usage at 32 GT/s and above, and defines if the precoders will follow the protocol or will be overridden. See Figure 4.39.

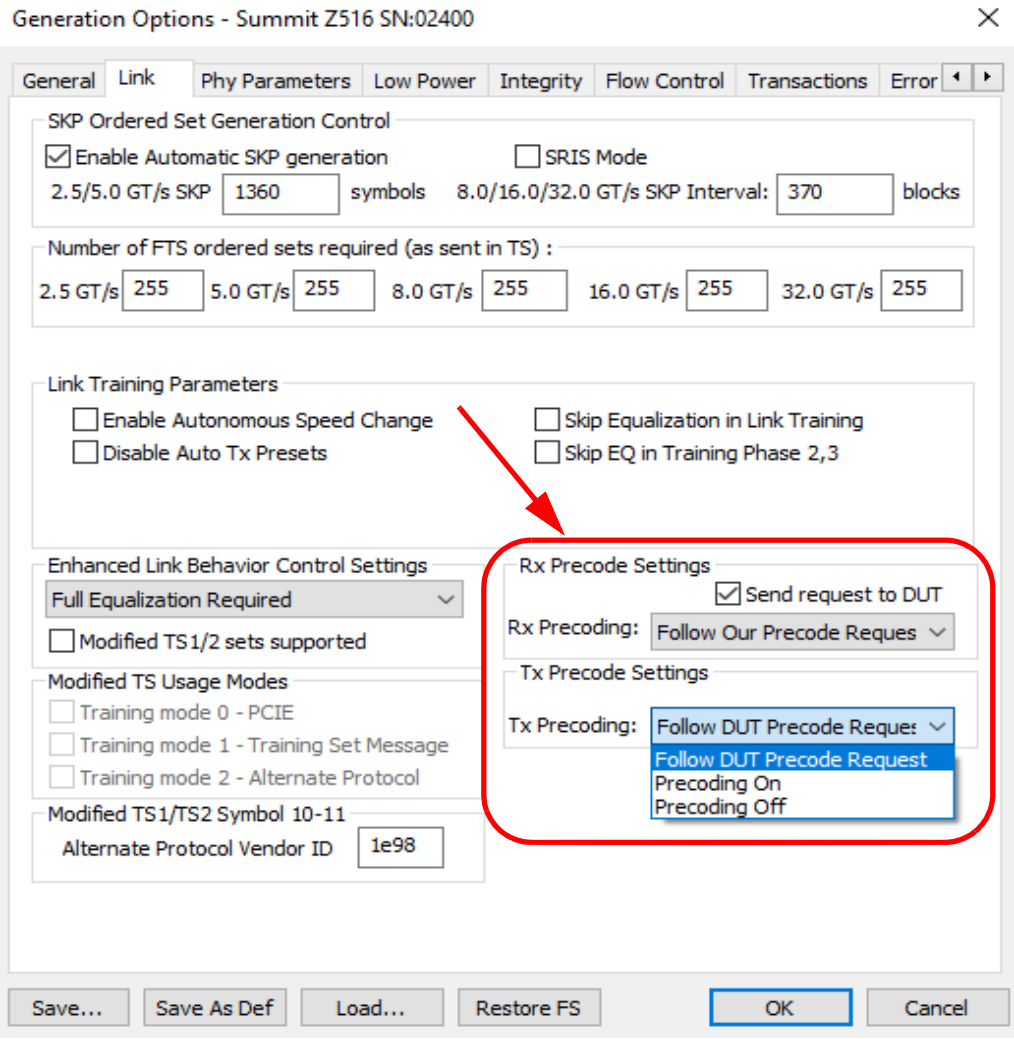


Figure 4.39: Precode Settings

RxPrecode Request checkbox

When unchecked, the Z5 receiver will not apply precoding unless overridden by the RxPrecode drop down menu below it.

When checked, the Z5 receiver will apply precoding unless overridden by the RxPrecode drop down menu below it.

RxPrecode drop down menu

Follow Rx Precode - The Rx precoder will honor the RxPrecode request setting checkbox. This is the normal default setting and follows Protocol.

Precode On - The Rx Precoder will override the RxPrecode Request setting checkbox and force the rx precoding to be on.

Precode Off - The Rx Precoder will override the RxPrecode Request setting checkbox and force the rx precoding to be off.

TxPrecode drop down menu

Follow Tx Precode - The Tx precoder will honor the Tx Precode setting sent in the training sequences sent from the DUT. This is the normal default setting and follows protocol.

Precode On - The Tx Precoder will override the Precode setting sent by the DUT and force the tx precoding to be on.

Precode Off - The Tx Precoder will override the Precode setting sent by the DUT and force the tx precoding to be off.

4.6.2.3 Alternate Protocol Vendor ID

This control is used for setting the Vendor ID field in Modified TS1/TS2. Alternate Protocol Vendor ID field is specified in hex format. This field is supported for Summit Z516 and Summit Z516 CXL. The list of commonly used IDs:

- 8086 for CXL specification version 1.1 (default)
- 1E98 for CXL specification version 2.0

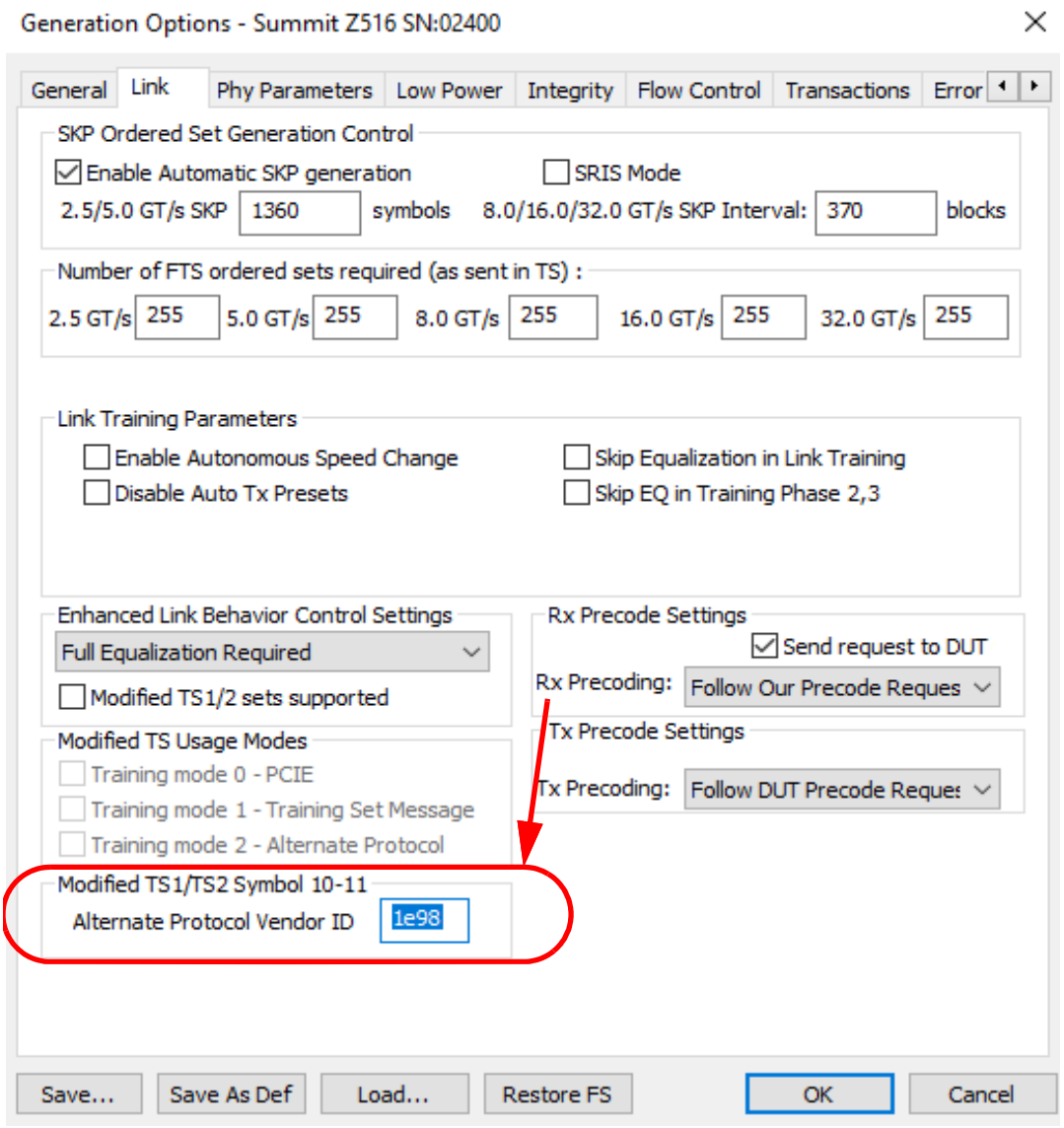


Figure 4.40: Alternate Protocol Vendor ID for Summit Z516 and Summit Z516 CXL

4.6.3 Phy Parameters

This tab displays the physical parameters of transmission and receiving. It allows you to select equalization parameters for transmitting and receiving lanes.

You can control lane parameters individually, or set them together by selecting the **Set All Lanes** check box available on each of the tabs. See Figure 4.41.

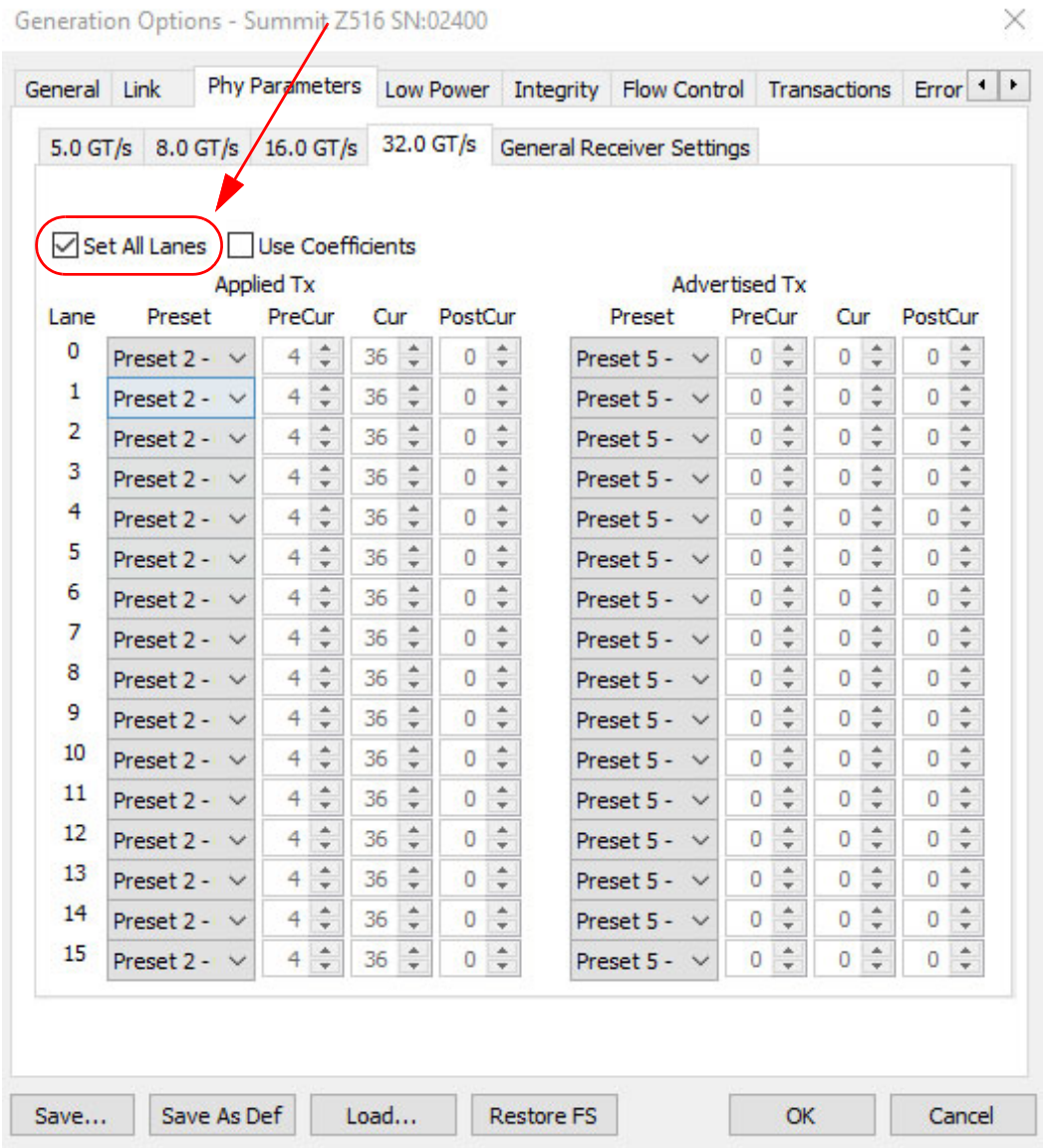


Figure 4.41: Generations Options Phy Parameters Applying Same Settings to All Lanes.

4.6.3.1 5.0 GT/s Options

This tab displays configuration for transmission parameters for the exerciser when the link is training to 5.0 GT/s. **De-emphasis** selects one of two value for de-emphasis that is advertised to the DUT.

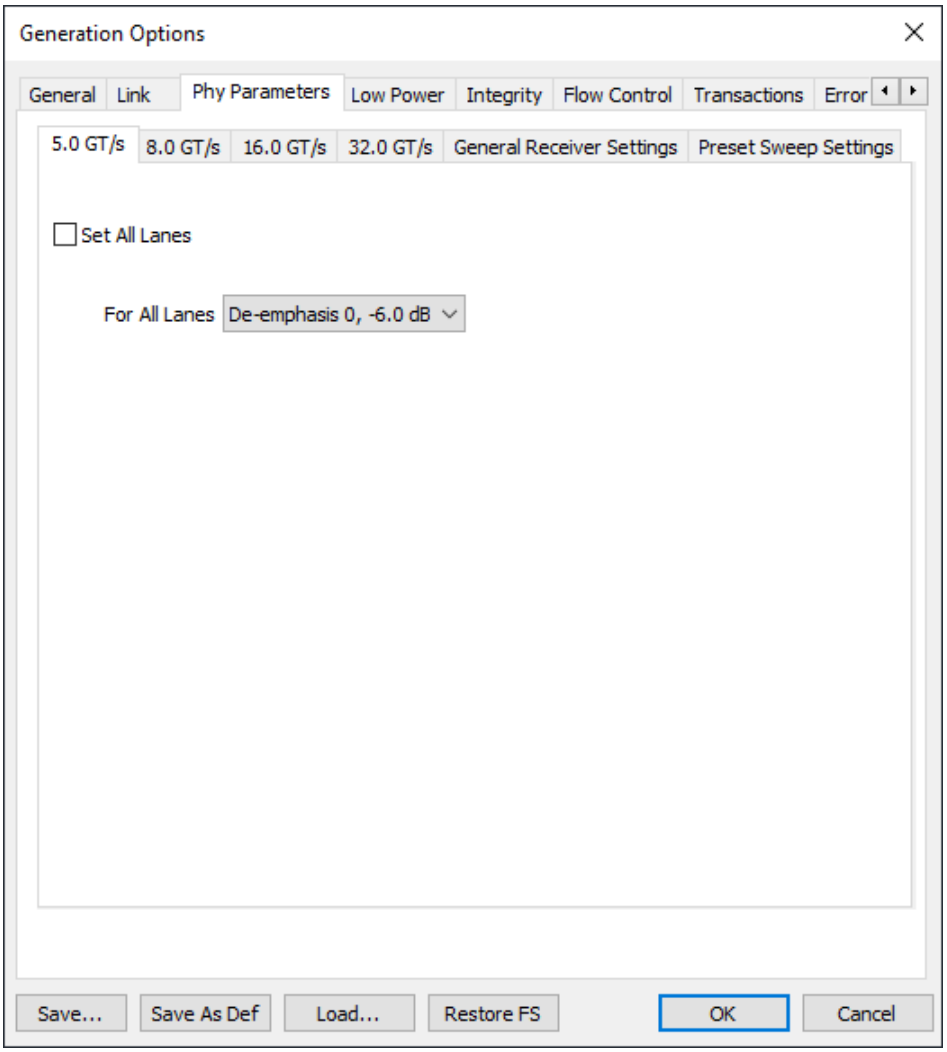


Figure 4.42: Generations Options Phy Parameters 5.0 GT/s Settings.

4.6.3.2 8.0 GT/s Options

This tab displays configuration for transmission parameters for the exerciser when the link is training to 8.0 GT/s.

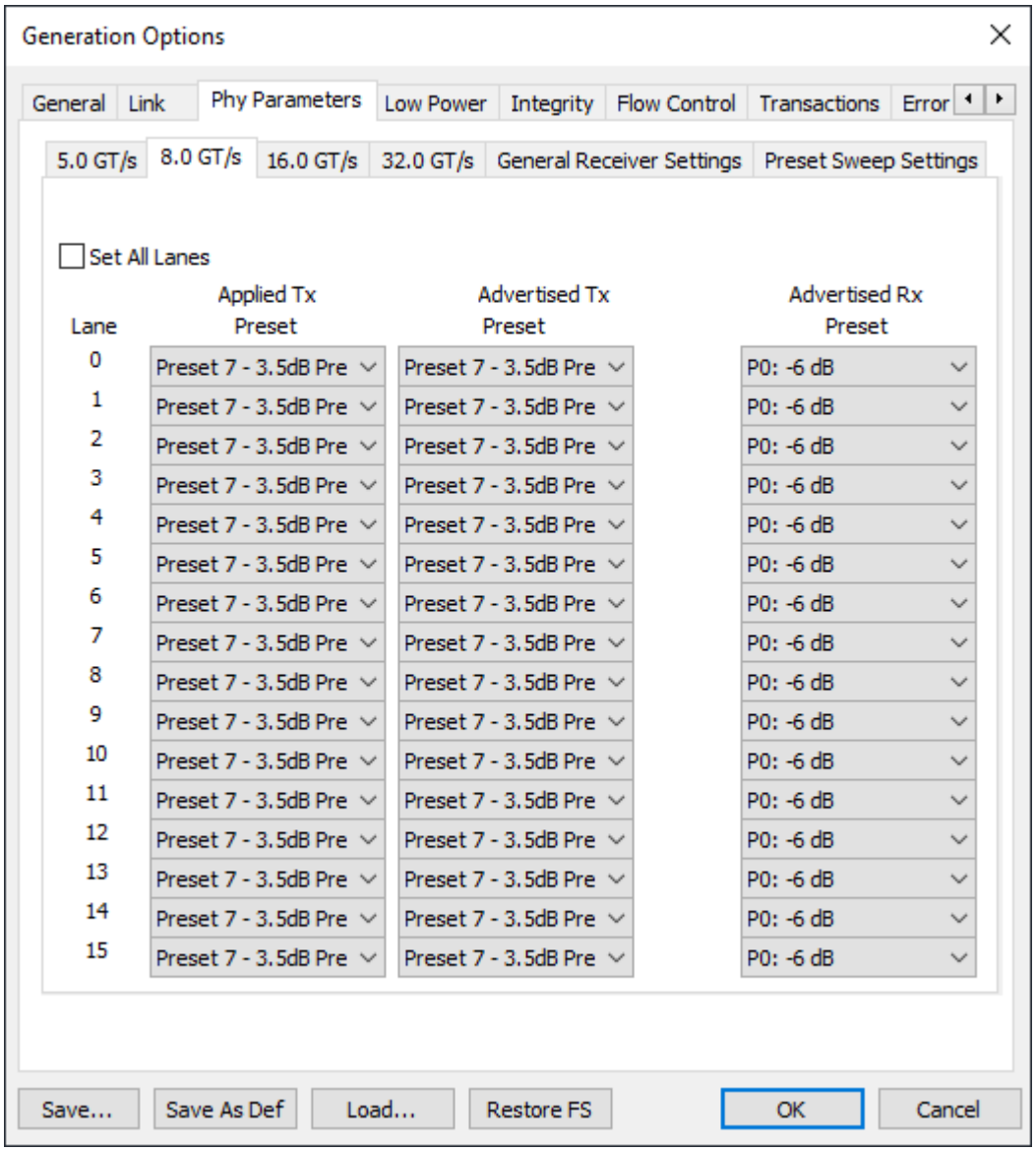


Figure 4.43: Generations Options Phy Parameters 8.0 GT/s settings

Applied Tx Preset

Selects the value of the Tx Preset to apply to the exerciser transmitters when either an illegal preset request is received from the DUT or if the **Disable Auto Tx Presets** checkbox on the link tab is checked. You can select a value from the drop down menu.

Advertised Tx Preset

The Advertised Tx Preset value is the preset value that the exerciser requests the DUT to use to transmit. This value is advertised in the training sequences sent by the exerciser. You can select a value from the drop down menu.

Advertised Rx Preset

The Advertised Preset Hint as requested by the exerciser and advertised in the training sequences sent to the DUT. The value may be selected from a drop down menu.

4.6.3.3 16.0 GT/s Options

This tab displays configuration for transmission parameters for the exerciser when the link is training to 16.0 GT/s. See Figure 4.44.

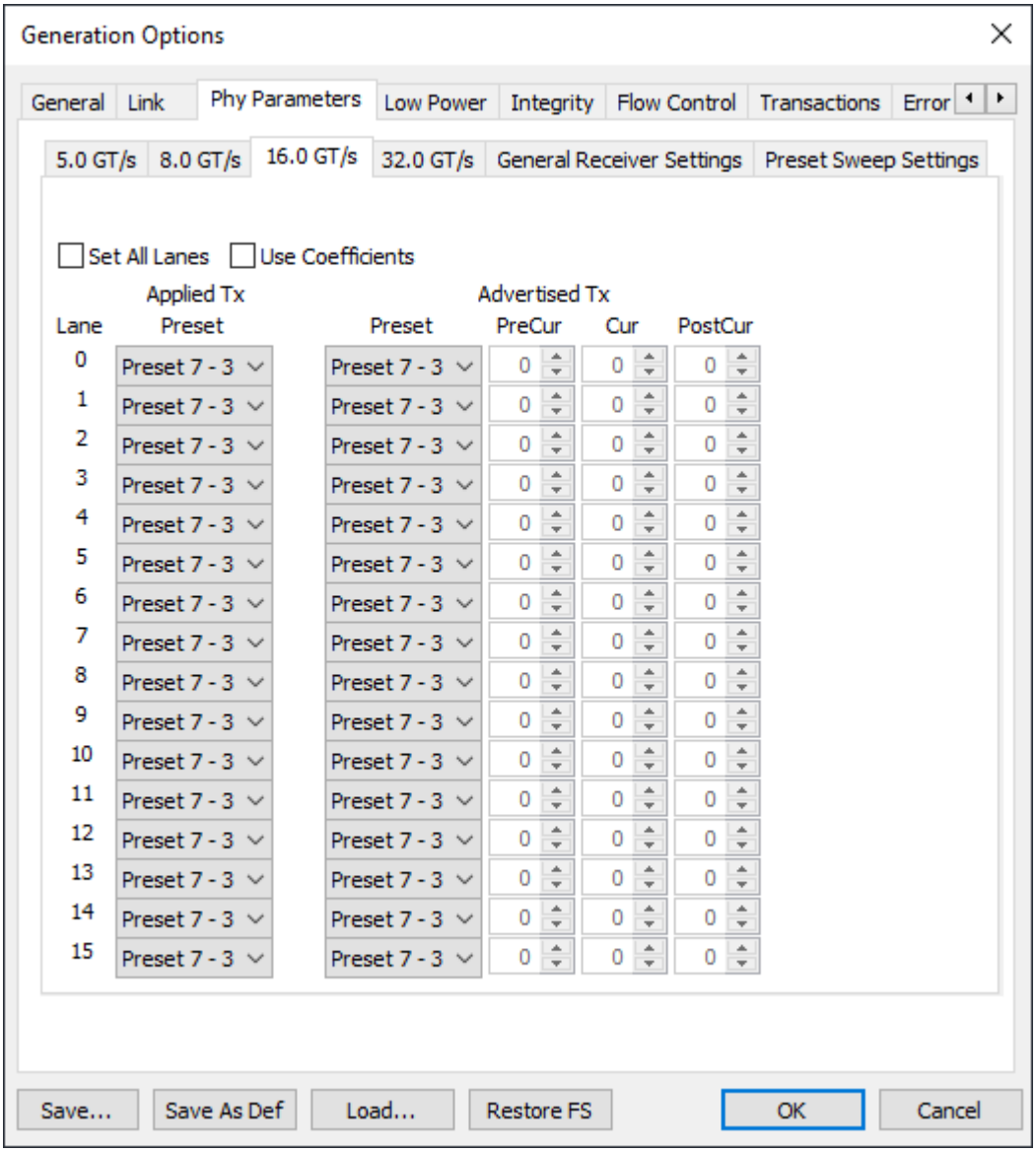


Figure 4.44: Generations Options Phy Parameters 16.0 GT/s Settings.

Use Coefficients

When checked, indicates that the exerciser will request the DUT to use the Advertised Tx Precusor (**Advertised Tx PreCur)**, Advertised Tx Cursor (**Advertised Tx Cur**), and Advertised Tx PostCursor (**Advertised Tx PostCur**) values by advertising these values in the training sequences during either phase 2 or phase 3 of equalization as appropriate for the emulation role setting of the exerciser. If the box is unchecked, it will repeat the advertised preset setting with the **Use Preset** bit checked during equalization phase 2 or 3.

NOTE: The values for the PreCursor, Cursor, and PostCursor are selected from a drop down menu and should adhere to the requirements for coefficeint values in regards to the specific values of LF and FS of the DUT. Failure to do so results in the DUT rejecting the values.

Applied Tx Preset

Selects the value of the Tx Preset to apply to the exerciser transmitters when either an illegal preset request is received from the DUT or if the **Disable Auto Tx Presets** checkbox on the link tab is checked. You can select a value from the drop down menu.

Advertised Tx Preset

The Advertised Tx Preset value is the preset value that the exerciser requests the DUT to use to transmit. This value is advertised in the training sequences sent by the exerciser. You can select a value from the drop down menu.

4.6.3.4 32.0 GT/s Option

This tab displays configuration for transmission parameters for the exerciser when the link is training to 32.0 GT/s. The settings are sent prior to changing to 32 GT/s, or during the equalization prior to linking up at 32 GT/s.

Applied Tx Preset

Select the Preset, Preshoot and the De-emphasis Applied Tx values from the drop-down menu. The options are shown below. See Figure 4.45.

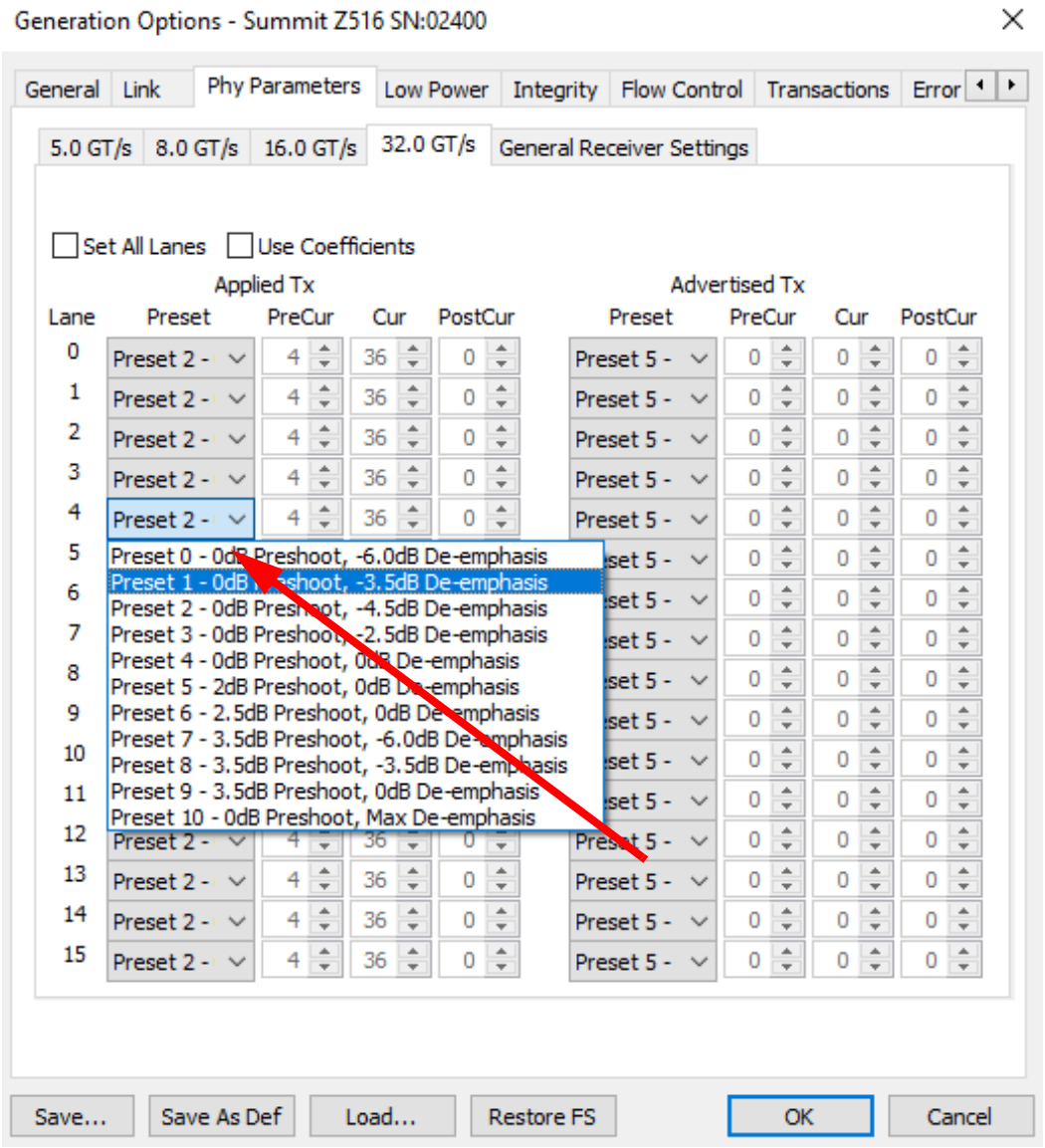


Figure 4.45: Phy Parameters Displaying Tx Emphasis Values.

Advertised Tx Preset

The Advertised Tx Preset value is the preset value that the exerciser requests the DUT to use to transmit. This value is advertised in the training sequences sent by the exerciser as shown in Figure 4.46.

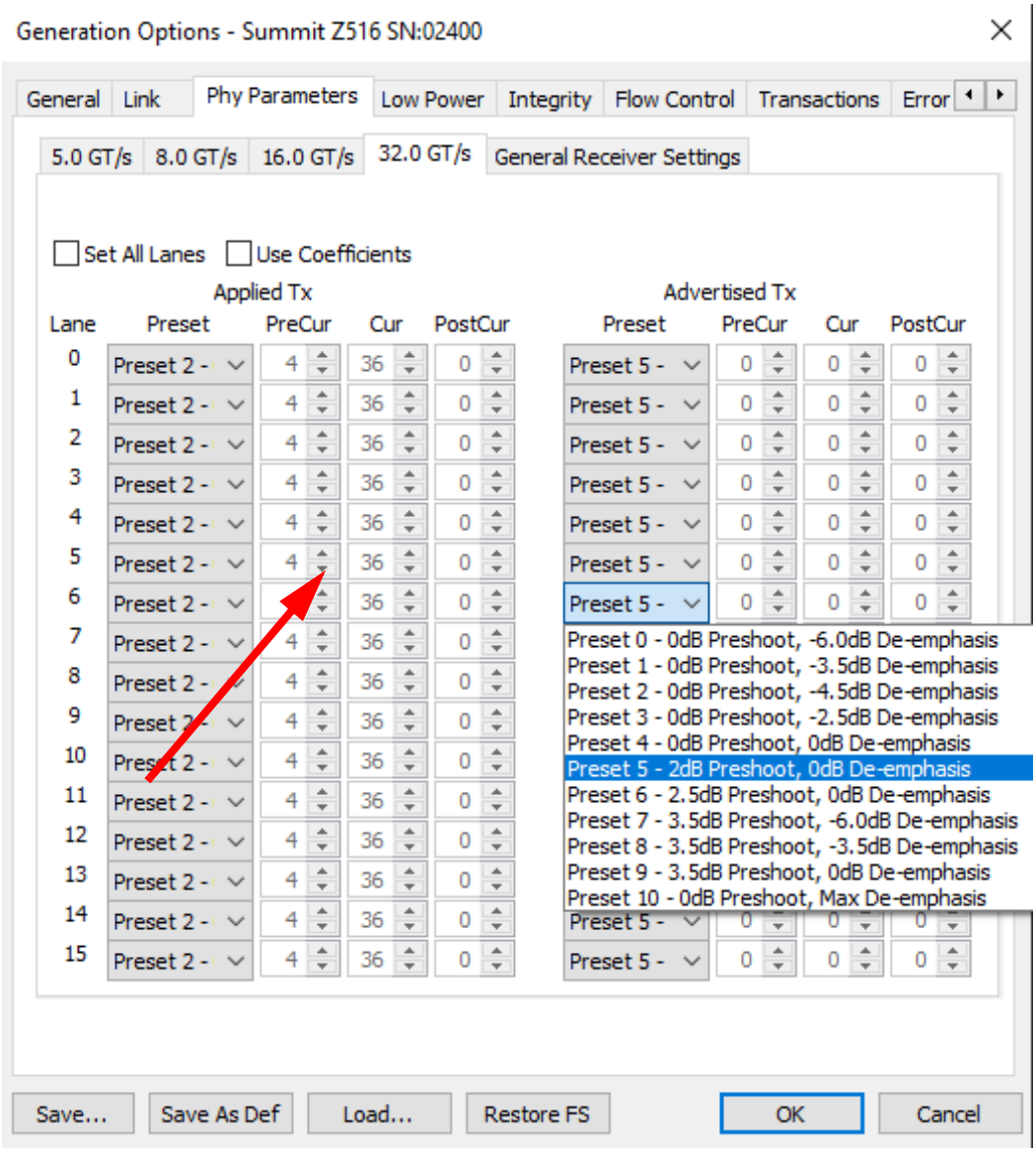


Figure 4.46: Phy Parameters Displaying Advertised Tx Values.

Use Coefficients

When checked, indicates that the exerciser will request the DUT to use the Advertised Tx Precusor (**Advertised Tx PreCur)**, Advertised Tx Cursor (**Advertised Tx Cur**), and Advertised Tx PostCursor (**Advertised Tx PostCur**) values by advertising these values in the training sequences during either phase 2 or phase 3 of equalization as appropriate for the emulation role setting of the exerciser. If the box is unchecked, it will repeat the advertised preset setting with the **Use Preset** bit checked during equalization phase 2 or 3.

NOTE: The values for the PreCursor, Cursor, and PostCursor are selected from a drop down menu and should adhere to the requirements for coefficeint values in regards to the specific values of LF and FS of the DUT. Failure to do so results in the DUT rejecting the values.

4.6.3.5 General Receiver Settings Options

When you select the General Receiver Settings Options tab (Figure 4.47), you can set the DC Gain and the Continuous Time Linear Equalizers (CTLE). The values range from 0.0 dB to 6.2 dB for both DC Gain and CTLE. You can set the DC Gain and CTLE values on a per lane basis or check **Set All Lanes** and all the lanes will have the same values. The DC Gain and CTLE setting are also applied to all frequencies: 5.0 GT/s, 8.0 GT/s, 16.0 GT/s, and 32.0 GT/sec.

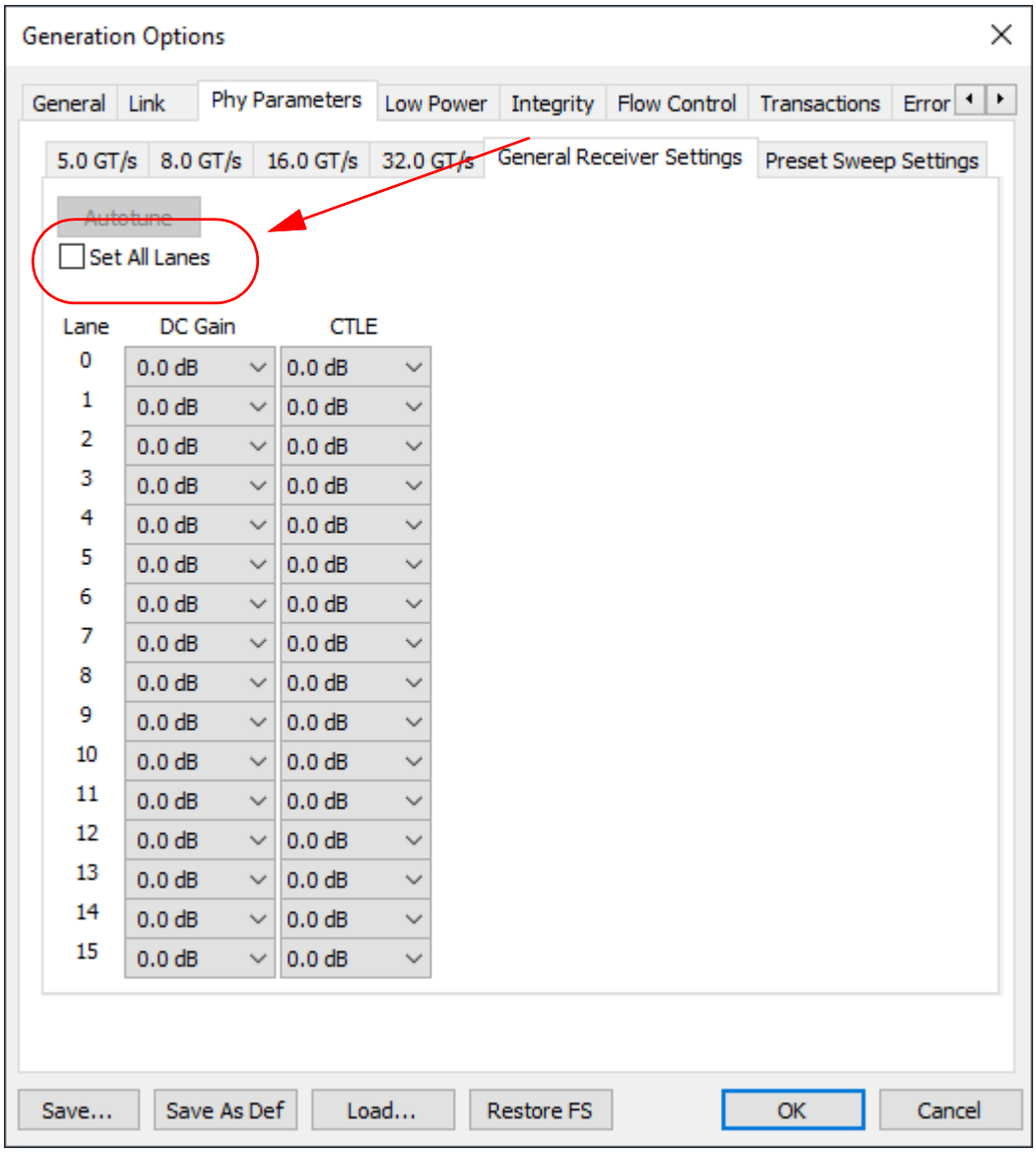


Figure 4.47: Phy Parameters: General Receiver Settings

Rx DC Gain

Select the decibels from the drop-down menu.

Rx Continuous Time Linear Equalizers (CTLE) Gain

Select values from 0 to 31 by clicking on the up/down arrows.

Rx VGA

Select values from 0 to 7 by clicking on the up/down arrows.

Rx Advertised

The Advertised value is the broadcasted value. You can also select a value from the drop-down menu.

4.6.3.6 Preset Sweep Settings Options

This Preset Sweep Settings tab (Figure 4.48) is used to configure the Z5 to send a set of preset requests during equalization. When the Z5 is configured as the host, the system sends these presets on all lanes during equalization phase 3. When the Z5 is configured as the device, the system sends these presets on all lanes during equalization phase 2.

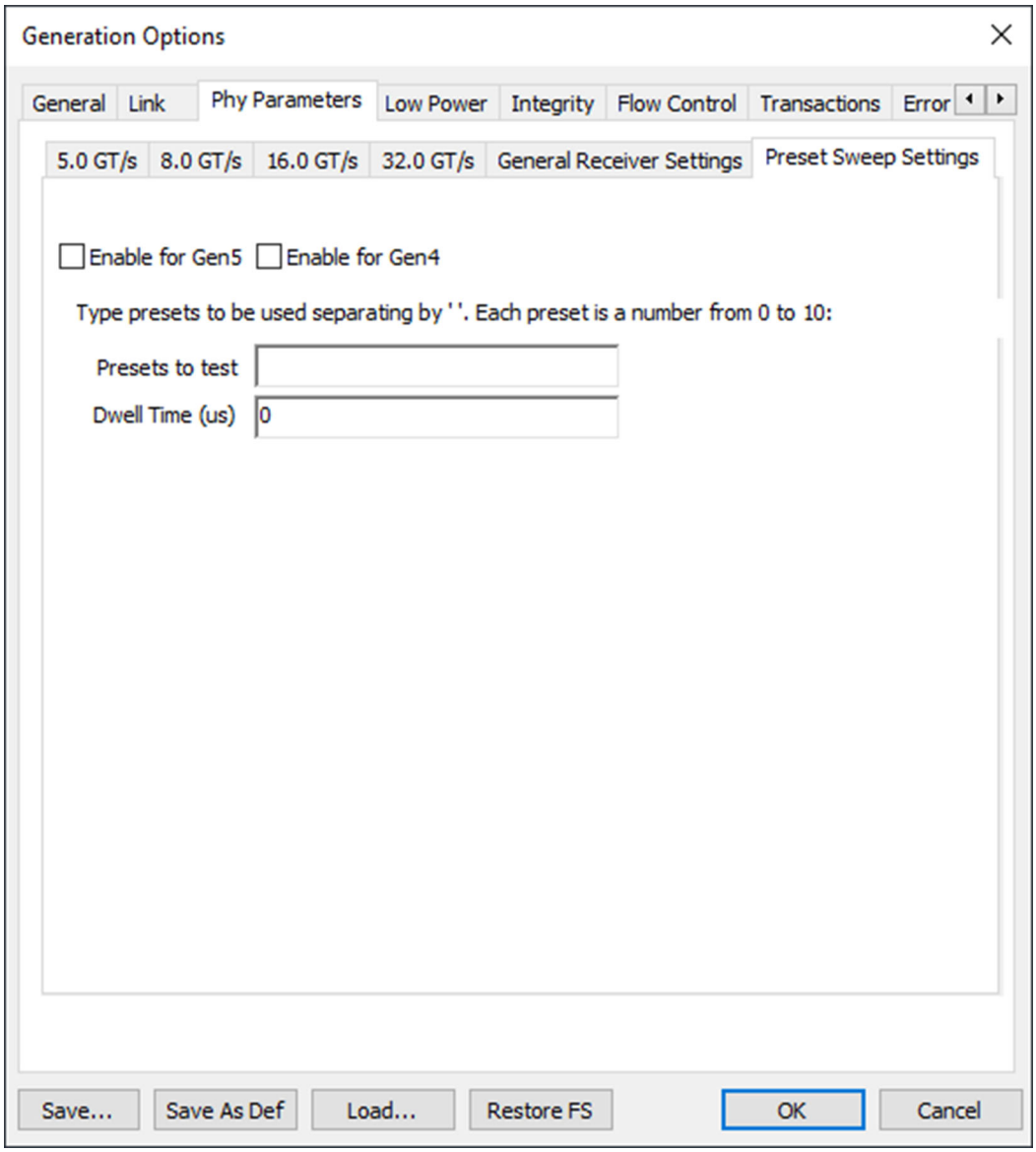


Figure 4.48: Phy Parameters: Preset Sweep Settings

NOTE: The system sends each preset after the configured **Dwell Time**.

Two check boxes are available:

- Enable for Gen5: Select this option to send the presets during Gen5 equalization.
- Enable for Gen4: Select this option to send the presets during Gen4 equalization.

When equalization includes both Gen4 and Gen5, check both options.

If neither option is selected, the Z5 will proceed using the presets selected in the **Advertised Tx Preset** fields of the 16.0 GT/s and 32.0 GT/s tabs.

Presets to Test

Valid values are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. Any number of these preset settings may be used as long as the number of presets multiplied by the **Dwell Time** (in us) is less than 33454.

Dwell Time (us)

The number of microseconds that each preset will be sent from the Z5. This value applies to each of the presets specified in the **Presets to Test** field with a minimum value of 0 and a maximum value of 536871.

NOTE: The number of **Presets to Test** multiplied by the **Dwell Time** must be less than 33454. Therefore, The practical maximum value for **Dwell Time** is 33454.

4.6.4 Low Power

Active State Power Management (ASPM) is a power management protocol used to manage PCI Express-based (PCIe) serial link devices as links become less active over time.

While ASPM brings a reduction in power consumption, it can also result in increased latency as the serial bus needs to be 'woken up' from low-power mode, possibly reconfigured and the host-to-device link re-established. This is known as ASPM exit latency and takes up valuable time.

You can utilize the L1 state to reduce power consumption. The traditional L1 state allows the reference clock to be disabled on entry to L1. L1 sub-states add two “pseudo sub-states,” called L1.1 and L1.2, to the LTSSM, which can be used to turn off additional analog circuits in the PHY. L1.1 allows the common-mode voltage to be maintained, while L1.2 allows all high-speed circuits to be turned off.

NOTE: Due to long exit latency from low power sub states some loss of traffic has been observed when analyzer latency exceeds DUT latency using the common reference clock. Teledyne recommends the use of the internal reference clock setting for low power sub-states testing.

With the Z5 you have the following options in the L1 Low Power State: (See Figure 4.51 on page 134)

- Modes
  - ASPM (Active State Power Management)
    - Send PM ACK in response to every L1 ASPM request
    - PM Ack/Nak Count: 0 to 255 (see Figure 4.50 on page 132): This allows you to vary the number of PM Acks/Naks received before either a PM Ack is sent to the host or prior to transitioning to the L1 state.
  - PCIPM (PCIe Power Management): In this mode a PM Ack is always sent in response to a PM Nak.
- L1 Sub States
  - Enable L1-1:
    - The link common mode voltages are maintained
    - You can use a bidirectional open-drain clock request (CLKREQ#) signal for

entry to and exit from this state
- Upstream and Downstream Port are not required to be enabled to detect electrical idle (EI)

- Enable L1-2
  - The link common mode voltages are not required to be maintained
  - You can use a bidirectional open-drain clock request (CLKREQ#) signal for entry to and exit from this state
  - Upstream and Downstream Port are not required to be enabled to detect electrical idle (EI)

While in L1 Sub States (L1-1 or L1-2) you can set the following parameters:

- TPowerOn: Port T POWER ON Value -- 1250000 nsec (Default value). This parameter sets the time (in usec) that this Port requires the port on the opposite side of the link to wait in L1.2 EXIT after sampling CLKREQ# is asserted before actively driving the interface.
- TCommonMode: Common Mode Restore Time -- 10000 nsec (Default value). This parameter sets the value of $T_{COMMONMODE}$ (in usec), which must be used by the Downstream Port for timing the re-establishment of common mode.

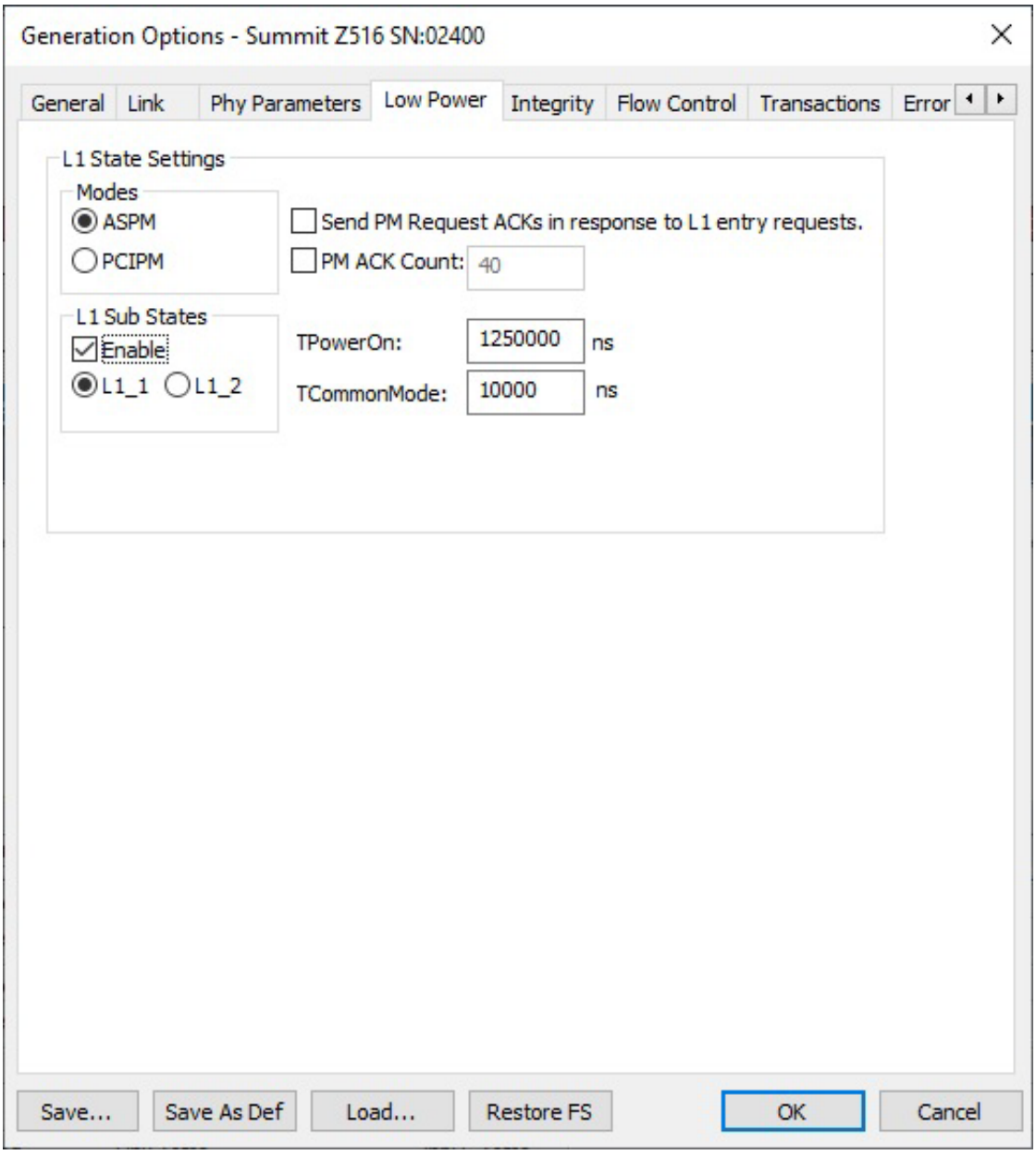


Figure 4.49: Low Power Options in L1 State

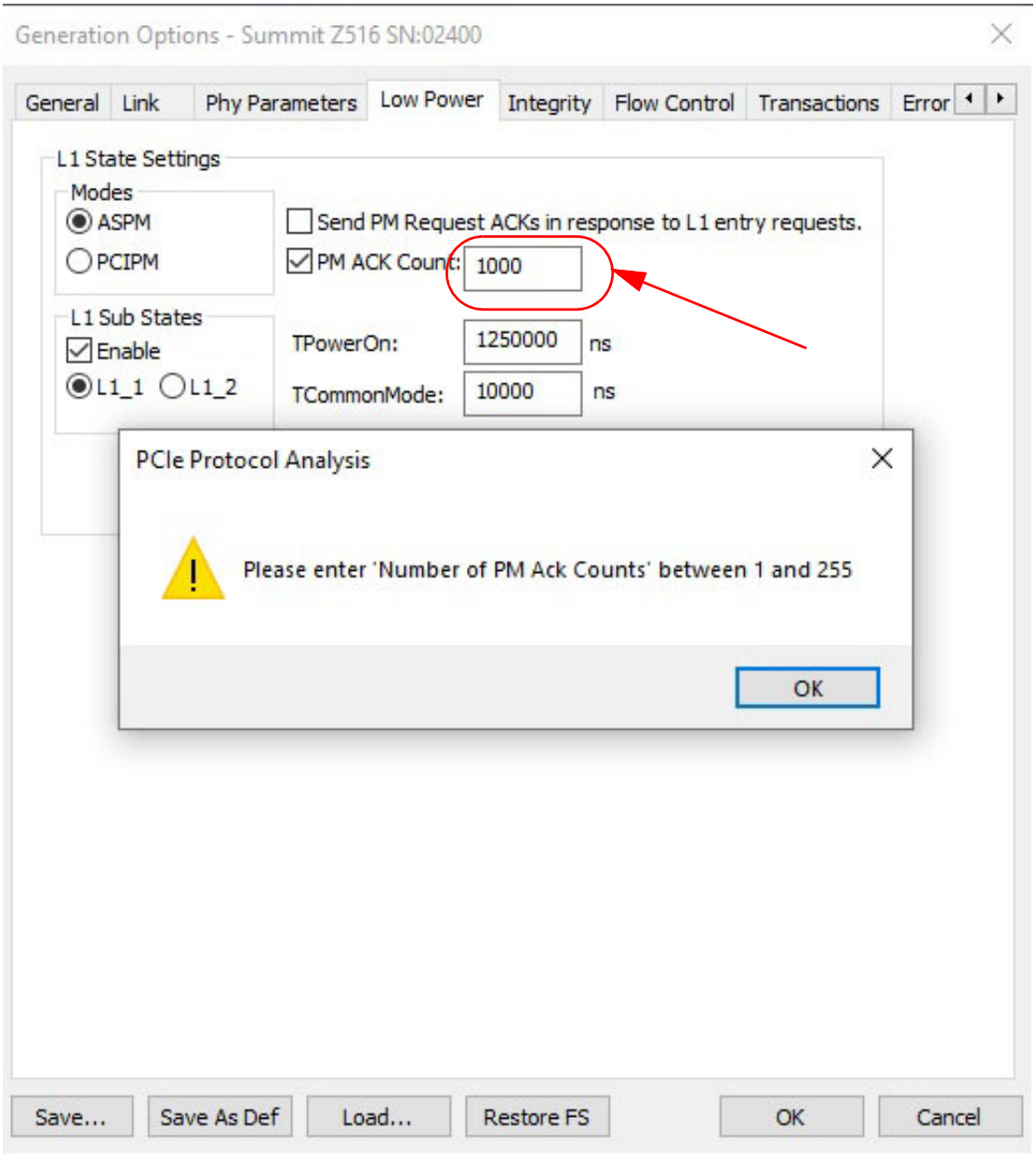


Figure 4.50: Low Power Option: PM Ack/Nak Count

- LTSSM Exit Time
  - None
  - TxL0s
  - L1

The programmable LTSSM timer allows the Exerciser to automatically exit a chosen low power state after a programmable time, and then return to L0.

- None - timer is disabled. This is the default and the normal use of the low power states.
- TxL0s - the programmable timer will be active while in TxL0s.Idle. When the

timer expires, the link will automatically be directed to L0, and then return to TxL0s

- L1 - The programmable Timer will be active in L1.Idle, L1.1.Idle or L1.2.Idle. When the timer expires, the link will be directed out of L1 and back to L0, and will return to L1 when requested by the DS device.
- Timer value: this will be the time in ns that the Z4 LTSSM will spend in the chosen state before exiting that state. The time spent will be +- 8 ns from the chosen value.

NOTE: The uncertainty in exiting TxL0s and L1 while utilizing the programmable L0s and L1 timing will be in the low 10s of ns, typically under 16 ns, and is dependent upon the clock rate and the state and timing of the arbiters.

See Figure 4.51 on page 134.

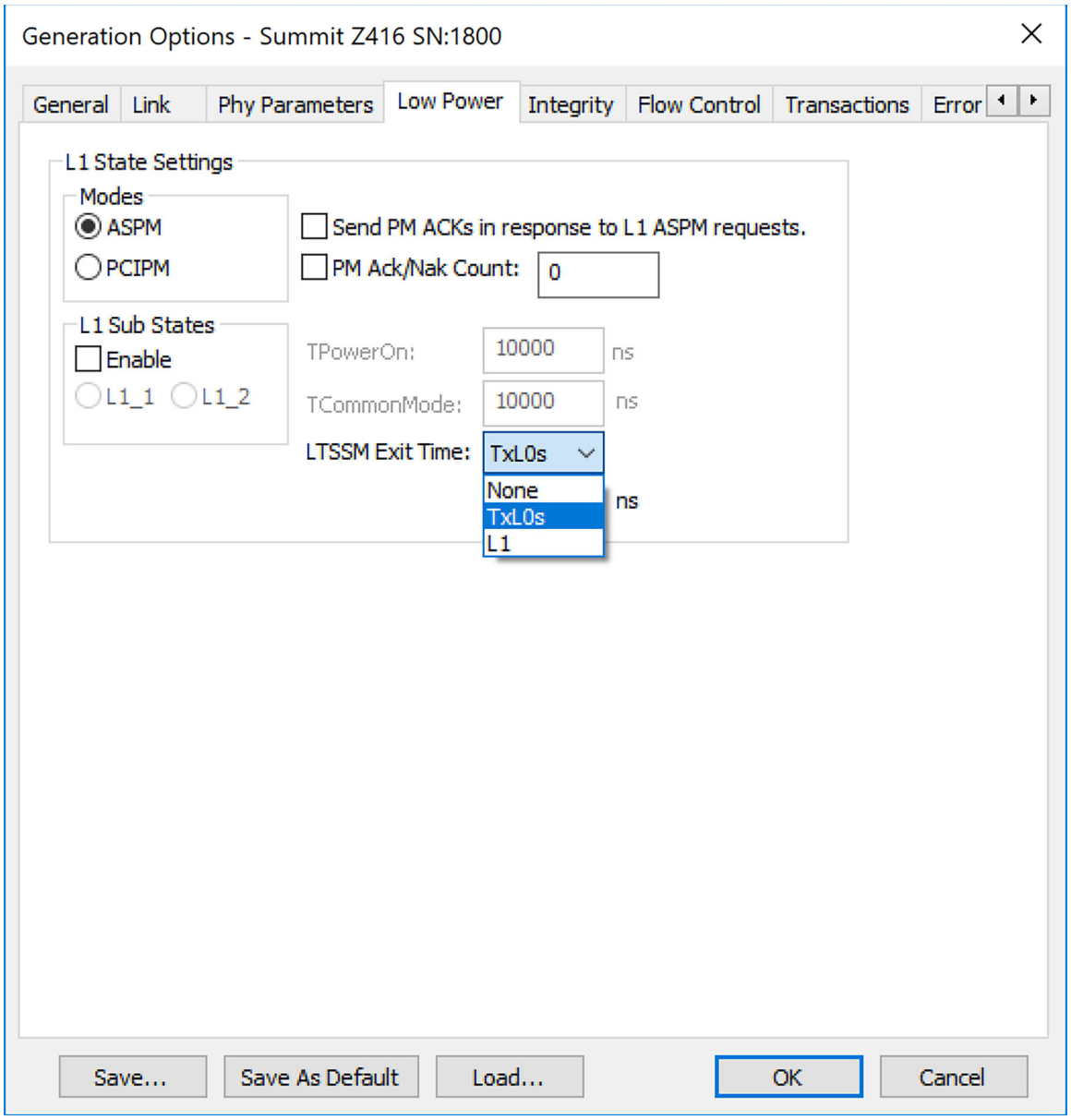


Figure 4.51: L1 State Settings: L1 Sub States

The valid inputs for LTSSM Exit Time are shown in Figure 4.52 on page 135.

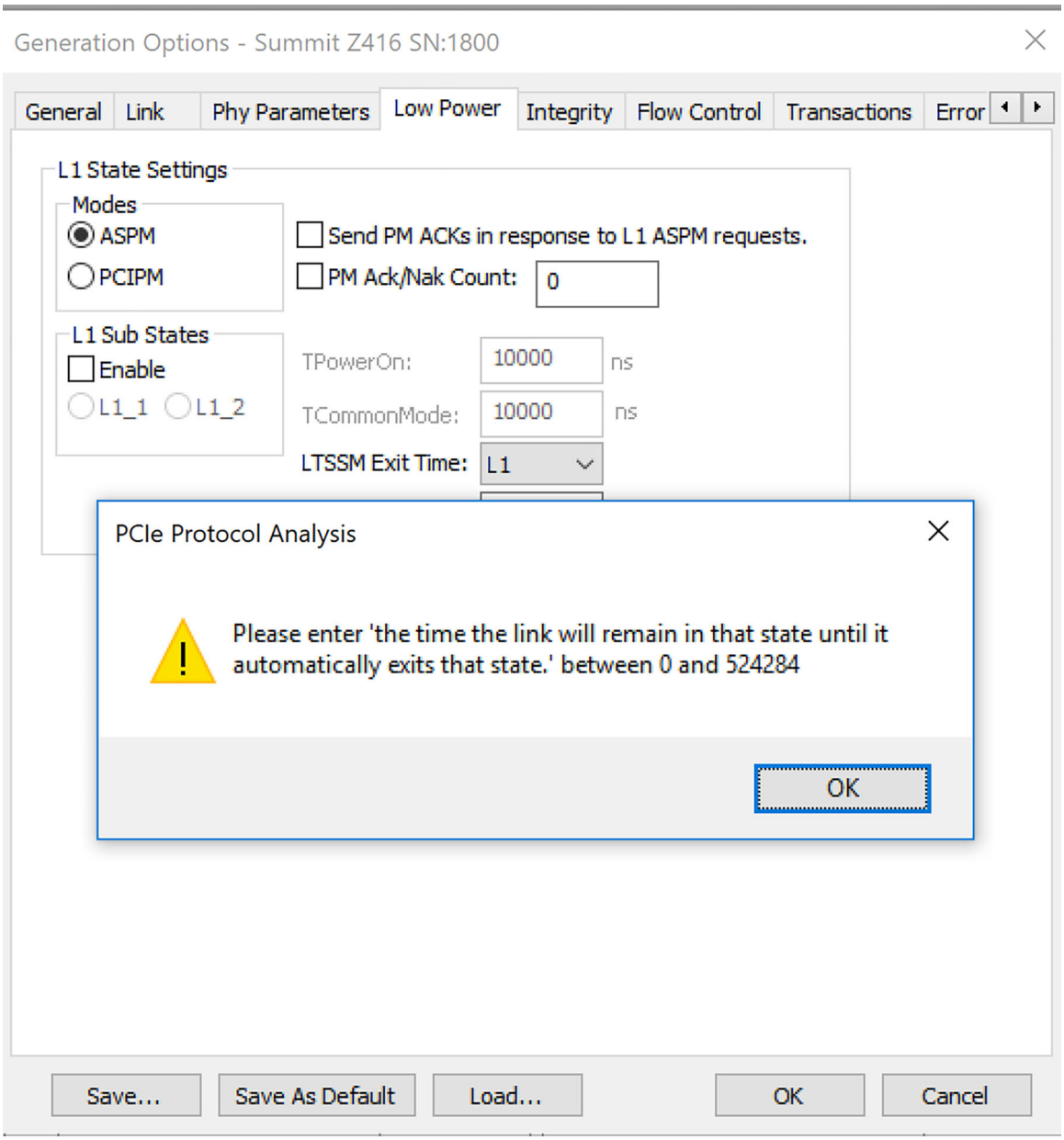


Figure 4.52: Valid Inputs for LTSSM Exit Time

4.6.5 Integrity

The parameters, values, defaults and descriptions are given in Table on page 137.

NOTE: The Integrity page sets the parameters for two Config commands: **Config = TLP** and **Config = AckNak**

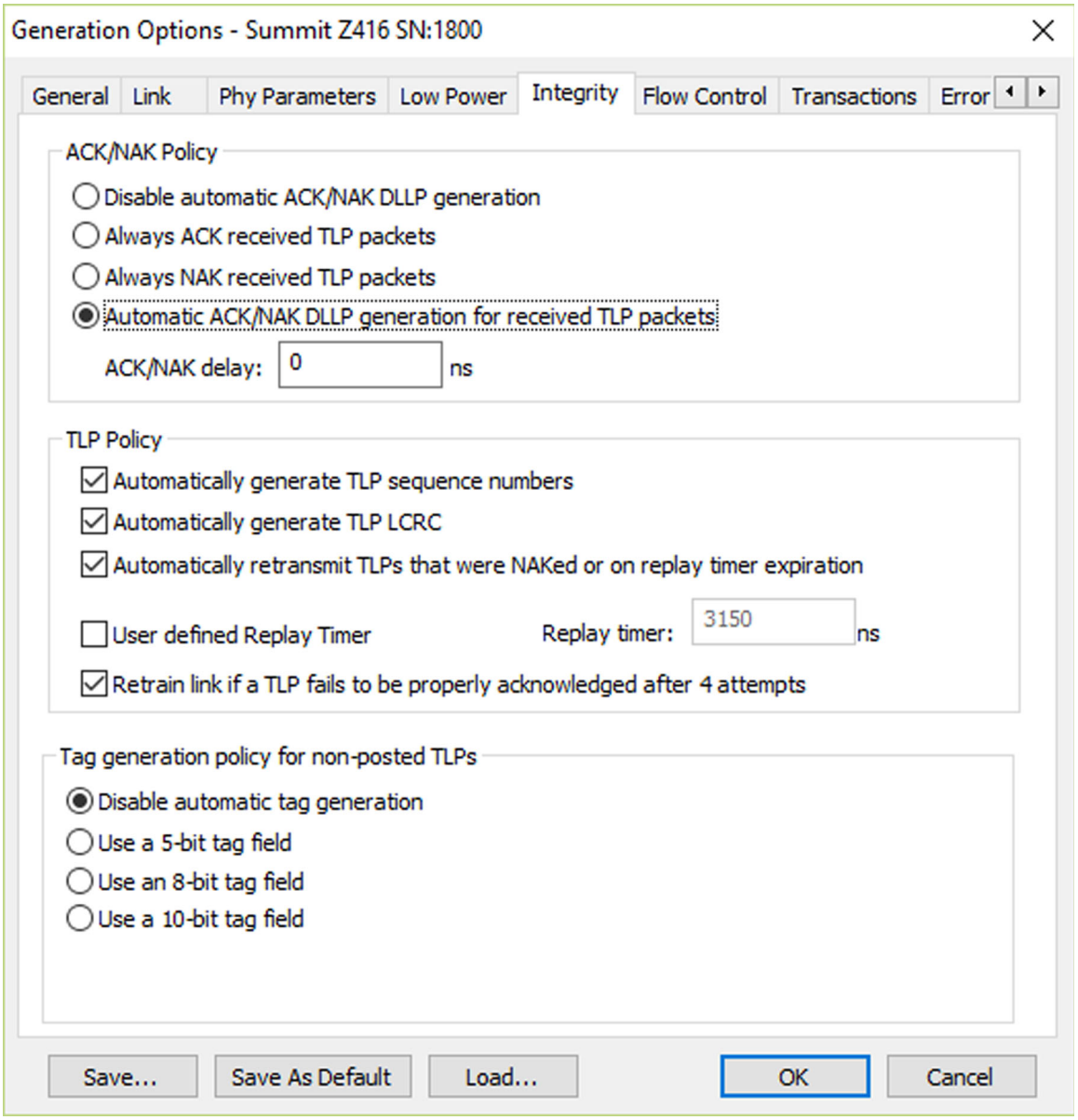


Figure 4.53: Generations Options Integrity Dialog.

4.6.5.1 Integrity for PCIe traffic

TABLE 4.9: PCIe Traffic Integrity Parameters

Parameter	Values	Default	Comment
ACK/NAK Policy			
Disable automatic ACK/NAK DLLP generation Always ACK received TLP packets Always NAK received TLP packets Automatic ACK/NAK DLLP generation for received TLP packets (default)	Auto Ack Nak Disable	Auto	Auto - The Summit Z5 will send Ack or NAK according to the PCIe specification within the guidelines of the relaxed timing ECN Ack- The Summit Z5 will Ack all incoming TLP packets. Using this option will improve ACK latency of the Summit Z3-16, but does not guarantee reliable data transmission. NAK - The Summit Z5 will NAK all incoming TLP. Disable. The Summit Z5 will not send any Ack or NAK packets automatically. Ack and NAK packets can still be generated using a script.
TLP Policy			
Automatically generate TLP sequence numbers	Yes No	Yes	If not set, overrides automatic generation of the TLP sequence number and uses user-defined value of the field in the **Packet=TLP** commands. This option overrides any sequence numbers specified in the script.
Automatically generate TLP LCRC	Yes No	Yes	If not set, overrides automatic generation of LCRC and uses user-defined value of the field in the **Packet=TLP** commands. This option overrides any LCRC specified in the script.

TABLE 4.9: PCIe Traffic Integrity Parameters

Parameter	Values	Default	Comment
Automatically retransmit TLPs that were NAKed or on replay timer expiration	In symbols Off	3150	Timeout in TLP transmitter path that counts time since last Ack or Nak DLLP is received. If set, automatically retransmit TLPs that were NAKed or on replay timer expiration.
User defined Replay Timer	In symbols Off	3150	If set, enable the user to define the Replay Timer.
Automatically retrain the link when number of retransmitted TLPs is 4	Yes No	Yes	If set, enable automatic retraining of the link in case the number of retransmitted TLP is 4. Valid only when AutoRetransmission is set.
Tag generation policy for non-posted TLPs			
Disable automatic tag generation	Yes No	Yes	Prevents the Exerciser from automatically inserting a tag. Tags are a sub-field of the transaction ID field. When auto tag insertion is enabled, the tag field is only modified for non-posted transactions such as **CfgRd, CfgWr**, and **MemRd**.
Use lower 5-bit of Tag field. Zero out higher 3 bits	Yes No	No	The Summit Z5 will automatically generate 5-bit TLP tags.
Use 8-bit of Tag field	Yes No	No	The Summit Z5 will automatically generate 8-bit TLP tags.
Use 10-bit of Tag Field	Yes No	No	The Summit Z5 will automatically generate 10-bit TLP tags.

4.6.5.2 Integrity for CXL traffic

For Summit Z516 CXL all the PCIe settings described in “Integrity for PCIe traffic” on page 137 are applicable for “CXL.io” traffic in the corresponding tab. The CXL-specific settings can be found under the “CXL.cache/mem” tab.

NOTE: These parameters correspond to Config commands: **config=CXL_Link**

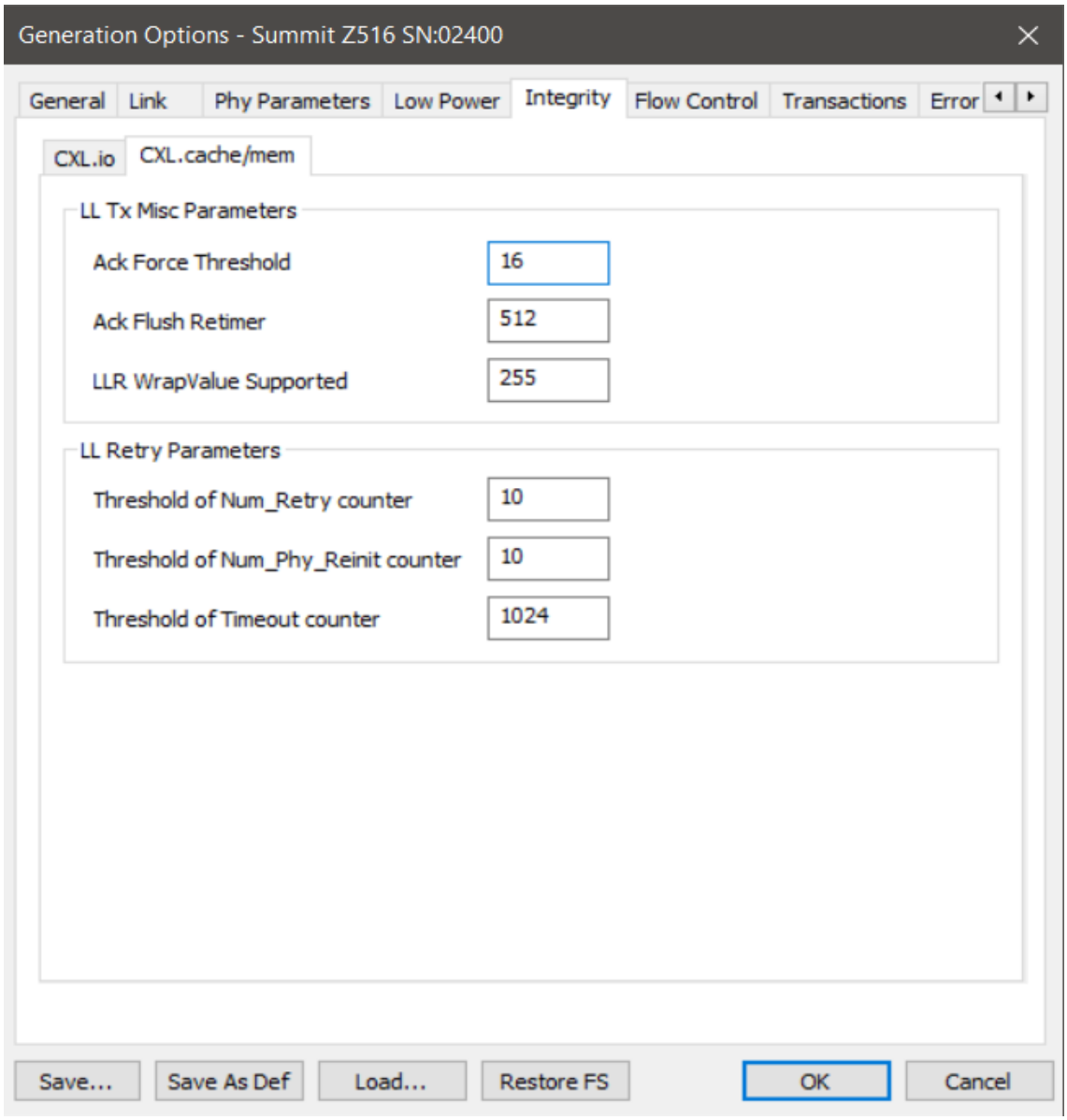


Figure 4.54: Generations Options Integrity Dialog for “CXL.cache/mem”.

TABLE 4.10: CXL Generations Options

Parameter	Values	Default	Description
CXL Link Layer Ack Timer Control Register			
Ack Force Threshold	0 to 255	Auto	This specifies how many Flit Acks the Link Layer should accumulate before injecting a LLCRD.

TABLE 4.10: CXL Generations Options

Parameter	Values	Default	Description
Ack Flush Retimer	0 to 1023	512	This specifies how many link layer clock cycles the entity should wait in case of idle, before flushing accumulated Acks using a LLCRD.
LLR WrapValue			
LLR WrapValue Supported	0 to 255	255	Value after which LLR sequence counter should wrap to zero.
LLR State Machines parameters.			See details on this mechanism in the CXL specification under the "4.2.8.5 LLR State Machines" section.
Threshold of Num_Retry counter	0 to 31	10	This counter is used to count the number of RETRY.Req requests sent to retry the same flit.
Threshold of Num_Phy_Reinit counter	0 to 31	10	This counter is used to count the number of physical layer reinitializations generated during a LLR sequence.
Threshold of Timeout counter0 to 16383 1024This counter is enabled whenever a RETRY.Req request is sent from an entity and the LRSM state becomes RETRY_LOCAL_IDLE. The TIMEOUT counter is disabled and the counting stops when the LRSM state changes to some state other than RETRY_LOCAL_IDLE.			

4.6.6 Flow Control

The parameters, values, defaults and descriptions are given in Table 4.11 on page 143.

NOTE: The Flow Control page sets parameters for **Config = FCTx** and **Config = FCRx.**

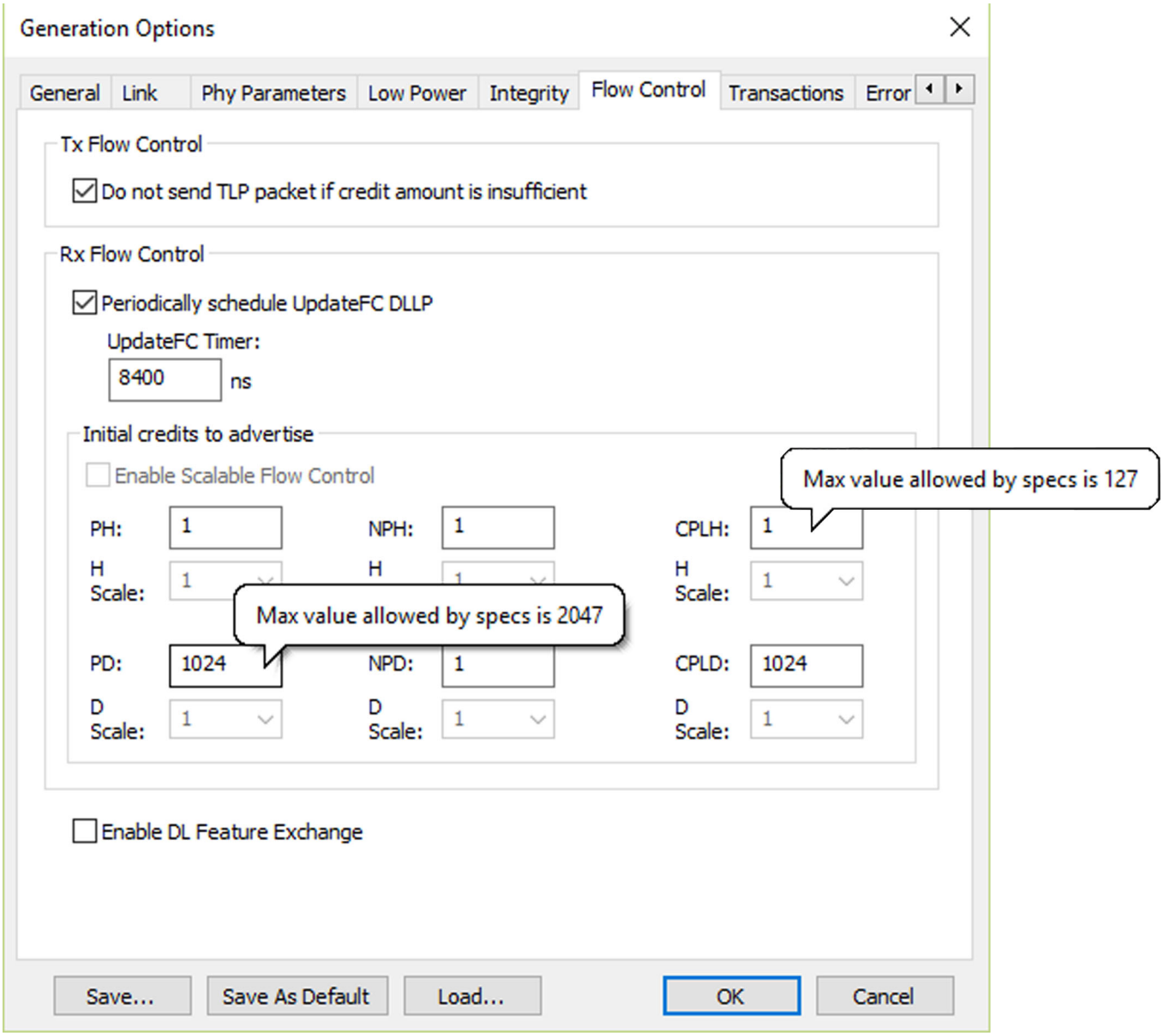


Figure 4.55: Generations Options Flow Control Dialog

4.6.6.1 Enable Data Link Feature Exchange

If you select the **Enable Data Link (DL) Feature Exchange** checkbox you can then select the **Enable Scalable Flow Control** checkbox and change both the Header Scale values and the Data Scale values. See Figure 4.56 on page 142.

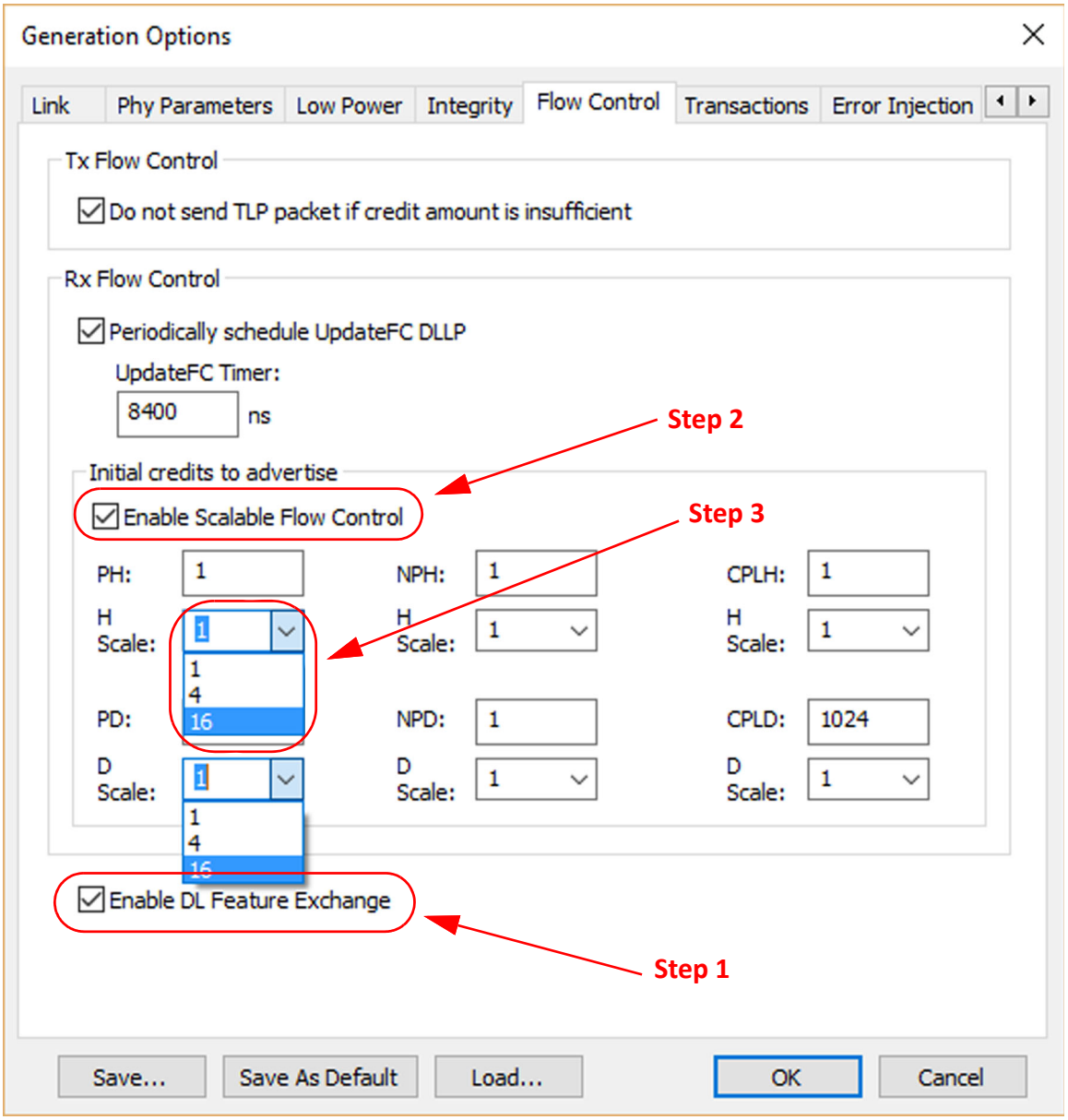


Figure 4.56: Enable Data Link (DL) Feature Exchange and Enable Scalable Flow Control

TABLE 4.11: Generations Options Flow Control

FCRx Parameter	Values	Default	Comment
Tx Flow Control			
Do not send TLP packet if credit amount is insufficient	Yes No	Yes	When not set, the TLPs are being sent without the regard of how many credits are available. This option prevents TLP transmission if insufficient credits are available.
Rx Flow Control			
Periodically schedule UpdateFC DLLP	In ns (rounded to nearest 8) Off	8400	When enabled, allows automatic updating of these DLLPs. This option enables a periodic timer that controls sending of UpdateFC DLLPs. You should leave timer and credit values to defaults for correct behavior.
Initial Credits to Advertise			
PH	0 to 127	1	Posted Request Headers
H Scale	1, 4 or 16	1	Header Scale factor
NPH	0 to 127	1	Non-Posted Request Headers
H Scale	1, 4 or 16	1	Header Scale factor
CPLH	0 to 127	1	Completion Headers
H Scale	1, 4 or 16	1	Header Scale factor
PD	0 to 2047	1024	Posted Request Data Payload
D Scale	1, 4 or 16	1	Data Scale factor
NPD	0 to 2047	1	Non-Posted Request Data Payload
D Scale	1, 4 or 16	1	Data Scale factor
CPLD	0 to 2047	1024	Completion Data Payload
D Scale	1, 4 or 16	1	Data Scale factor

NOTE: Currently the Summit Z5 does not support processing for nullified TLPs in the receiver path. This test scenario should be avoided.

4.6.6.2 Flow Control for CXL traffic

For Summit Z516 CXL all the PCIe settings described in “Flow Control” on page 141 and “Enable Data Link Feature Exchange” on page 142 are applicable for "CXL.io" traffic in the corresponding tab. The CXL-specific settings can be found under the "CXL.cache/mem" tab.

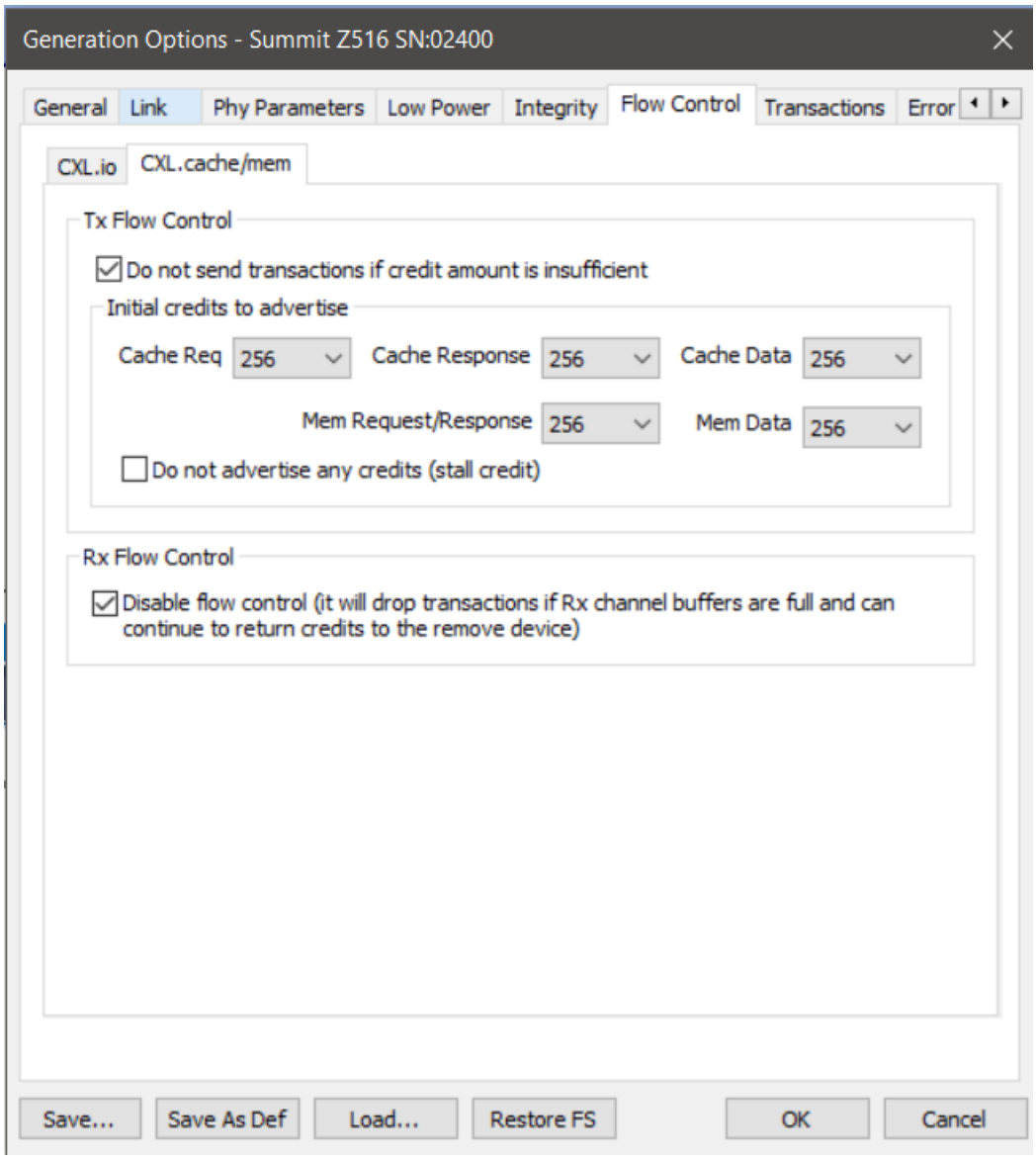


Figure 4.57: Generations Options Flow Control Dialog for "CXL.cache/mem".

TABLE 4.12: CXL Traffic Flow Control

Parameter	Values	Default	Description
Tx Flow Control			
Do not send transactions if credit amount is insufficient	Yes No	Yes	Do not send transactions if credit amount is insufficient
Do not advertise any credits (stall credit)	Yes No	No	Do not advertise any credits (stall credit)
Initial Credits to Advertise			
Cache Req	0, 1, 2, 4, 8, 16, 32, 64, 128, 256	256	Credits to advertise for Cache Request channel at init.
Cache Response	0, 1, 2, 4, 8, 16, 32, 64, 128, 256	256	Credits to advertise for Cache Response at init.
Cache Data	0, 1, 2, 4, 8, 16, 32, 64, 128, 256	256	Credits to advertise for Cache Data channel at init.
Mem Request/ Response	0, 1, 2, 4, 8, 16, 32, 64, 128, 256	256	Credits to advertise for Mem Request or Response channel at init
Mem Data	0, 1, 2, 4, 8, 16, 32, 64, 128, 256	256	Credits to advertise for Mem Data channel at init.
RX Flow Control			
Disable flow control	Yes No	Yes	It will drop transactions if Rx channel buffers are full and can continue to return credits to the remove device.

4.6.7 Transactions

4.6.7.1 Transactions: Device Emulation

NOTE: High Performance Mode applies to both the Summit Z58 and the Summit Z516 Exercisers. Z5 references both Z58 and Z516 except where noted.

Select **Device** in the General dialog box (see Figure 4.33 on page 99) to display the Host Memory Regions pane in the Transactions tab (see Figure 4.58 on page 147). When in Device Emulation mode, the Summit Z58 and Summit Z516 can automatically process incoming Configuration, Memory and IO read and write requests. This tab allows you to configure these options, which are described in more detail in Table on page 148.

This dialog allows you to select to "Enable Fast Memory Completer". See "Transactions: Fast Memory Completer" on page 151.

This dialog also allows you to enable "Precision Time Management". See "Enable Precision Time Management (PTM) -> Host Emulation" on page 154.

For more details about NVMe Drive Host and Device Emulation see Appendix , "NVMe Drive Emulation," on page 595.

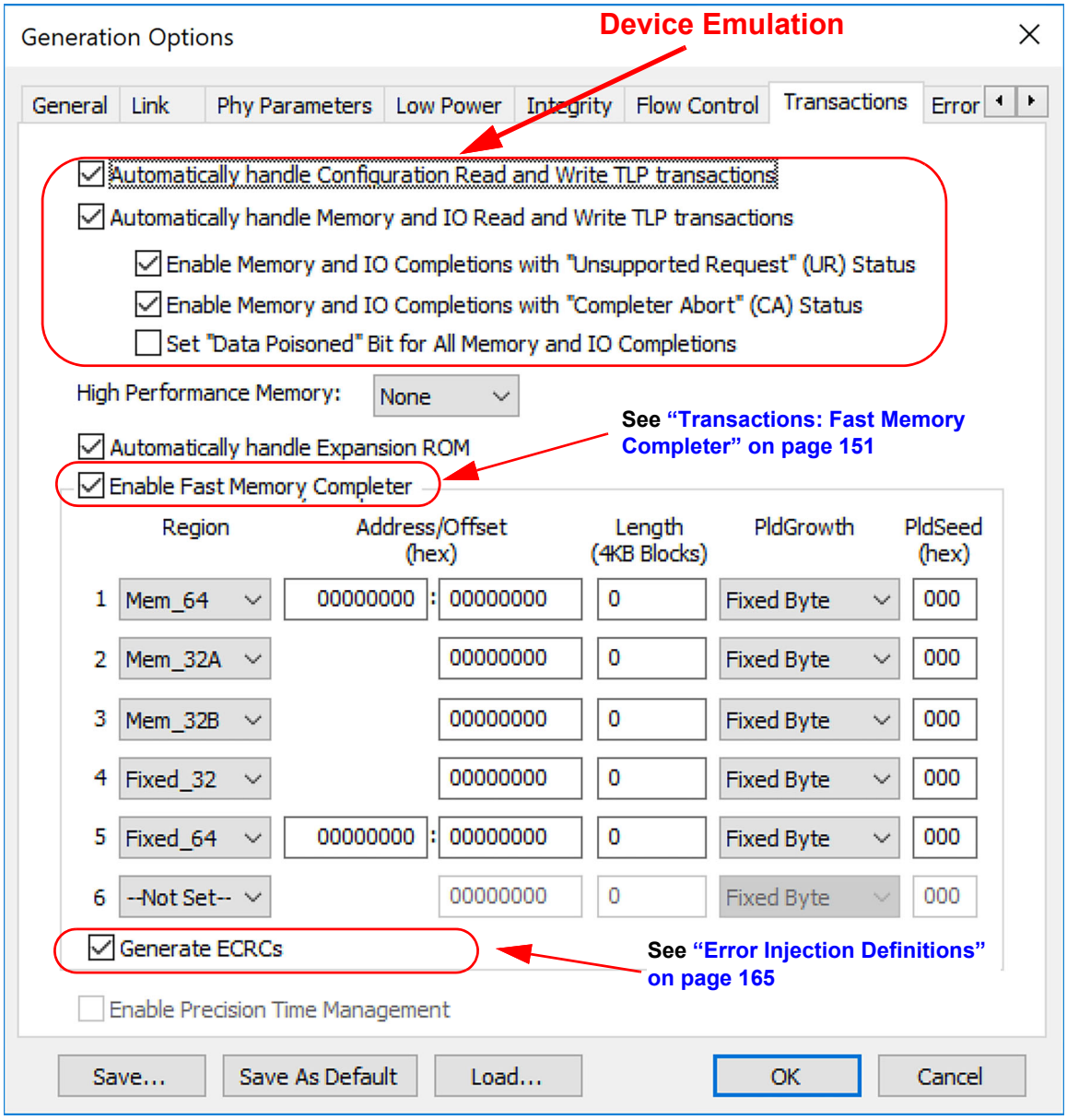


Figure 4.58: Generations Options Transactions Dialog - Device Emulation.

TABLE 4.13: Generations Options Transactions Dialog - Device Emulation

Parameter	Values	Default	Comment
Automatically handle Configuration Read and Write TLP transactions	Yes No	No	If set, automatically handles Configuration Read and Write TLP transactions. For Configuration Read transactions, **Completion TLP** contains the data read from the internal Configuration Space according to the specified register address. For Configuration Write transactions, the internal Configuration Space is updated at the address with the data from Configuration Write TLP, and Configuration Write Completion is returned. This option enables Read and Write access to 4-KB configuration space.
Automatically handle Memory and IO Read and Write TLP transactions	Yes No	No	If set, automatically handles Memory and IO Read and Write TLP transactions. For Memory and IO Read transactions, **Completion TLP** contains the data read from the internal Memory/IO Address Space according to the specified address. For Memory and IO Write transactions, internal Memory/IO Address Space is updated at the address with the data from TLP.
Automatically handle Expansion ROM	Yes No	No	If set, automatically handles system Reads from Expansion ROM, using the base address programmed by the system in the Expansion ROM Base Address register in the configuration space of Device Emulation. The driver data could be programmed in the Expansion ROM address space using the Address Space Write functionality.

4.6.7.2 Transactions: Device Emulation -> High Performance Real Memory Option

NOTE: High Performance Mode applies to both the Summit Z58 and the Summit Z516 Exercisers. Z5 references both Z58 and Z516 except where noted.

For Device Emulation there is now a High Performance Memory drop list above the Expansion ROM checkbox. When "High Performance Memory" is not checked in the General dialog (see Figure 4.33 on page 99), this list is disabled. When "High Performance Memory" is checked in the General dialog box, this list is enabled and is associated with Mem64 or Mem32A (or none) address space with the High Performance Memory. When the base address is assigned to the selected memory space in the Device Emulator's Configuration space, it will start using the High performance Memory using the assigned address. Everything written to this memory space over the PCIe link (or from the PCIe Suite application using Address Space Write functionality) will be placed into the High Performance Memory on Z5. Everything read from this memory space over the PCIe link (or from the PCIe Suite application using Adress Space Read functionality) will be taken from the High Performance Memory. When data is written to / read from the region over the PCIe link, it is handled with a much better performance then the regular Firmware based handling. See Figure 4.59.

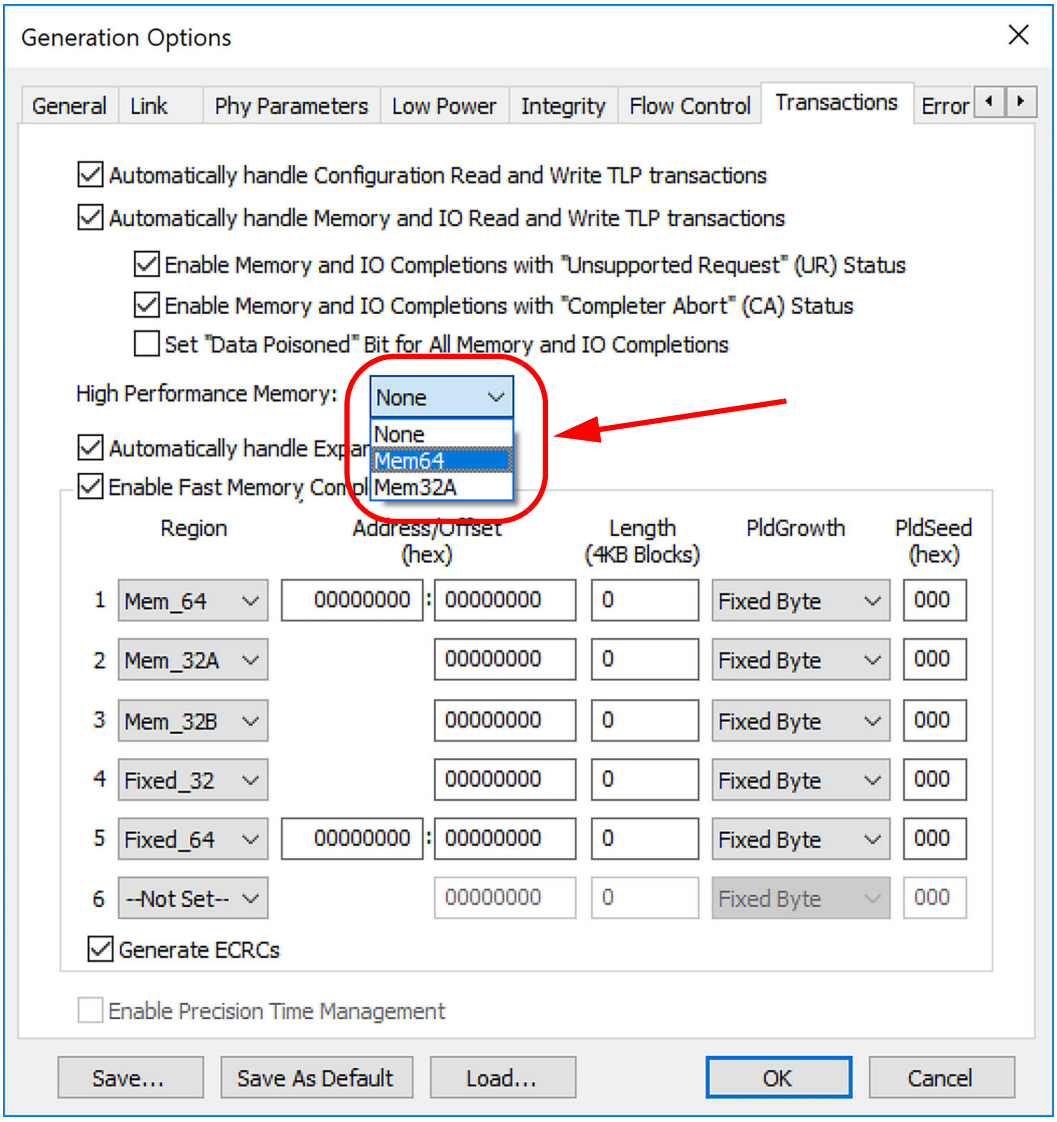


Figure 4.59: Device Emulation Selected: High Performance Memory

4.6.7.3 Transactions: Host Emulation

Select **Host** in the General dialog box (see Figure 4.33 on page 99) to display the Host Memory Regions pane in the Transactions tab.

One 64-bit and two 32-bit regions can be specified. If a region is selected, the Physical Address for the start of the region has to be provided as well as the length in 4 KB blocks.

Read Completion Boundary for the Host (Root Complex) emulation can be specified as 128 or 64 bytes, as defined by the PCI Express specification.

Maximum Payload Size in bytes can be specified as 128, 256, 512, 1024, 2048, 4096.

When Host Memory Regions are selected, they are accessible for reading and writing by Write and Read Address Space buttons (see Exerciser Control Bar) as well as by AddressSpace = Write and AddressSpace = Read script commands. When the Device Under Test reads memory locations

in the physical address range defined by one of the enabled regions, the data written there prior to that (from the application/script or by the device itself over PCI Express) is going to be returned.

Examples of using Host Memory Regions can be found in the SampleFiles\Z5TrainerScripts\NVMe_HostEmulation folder of the PCIe Analysis Software.

4.6.7.4 Transactions: Fast Memory Completer

NOTE: High Performance Mode applies to both the Summit Z58 and the Summit Z516 Exercisers. Z5 references both Z58 and Z516 except where noted.

The Fast Memory Completer options are shown below (see Figure 4.60 on page 152), and explained in more detail in Table 4.14 on page 152.

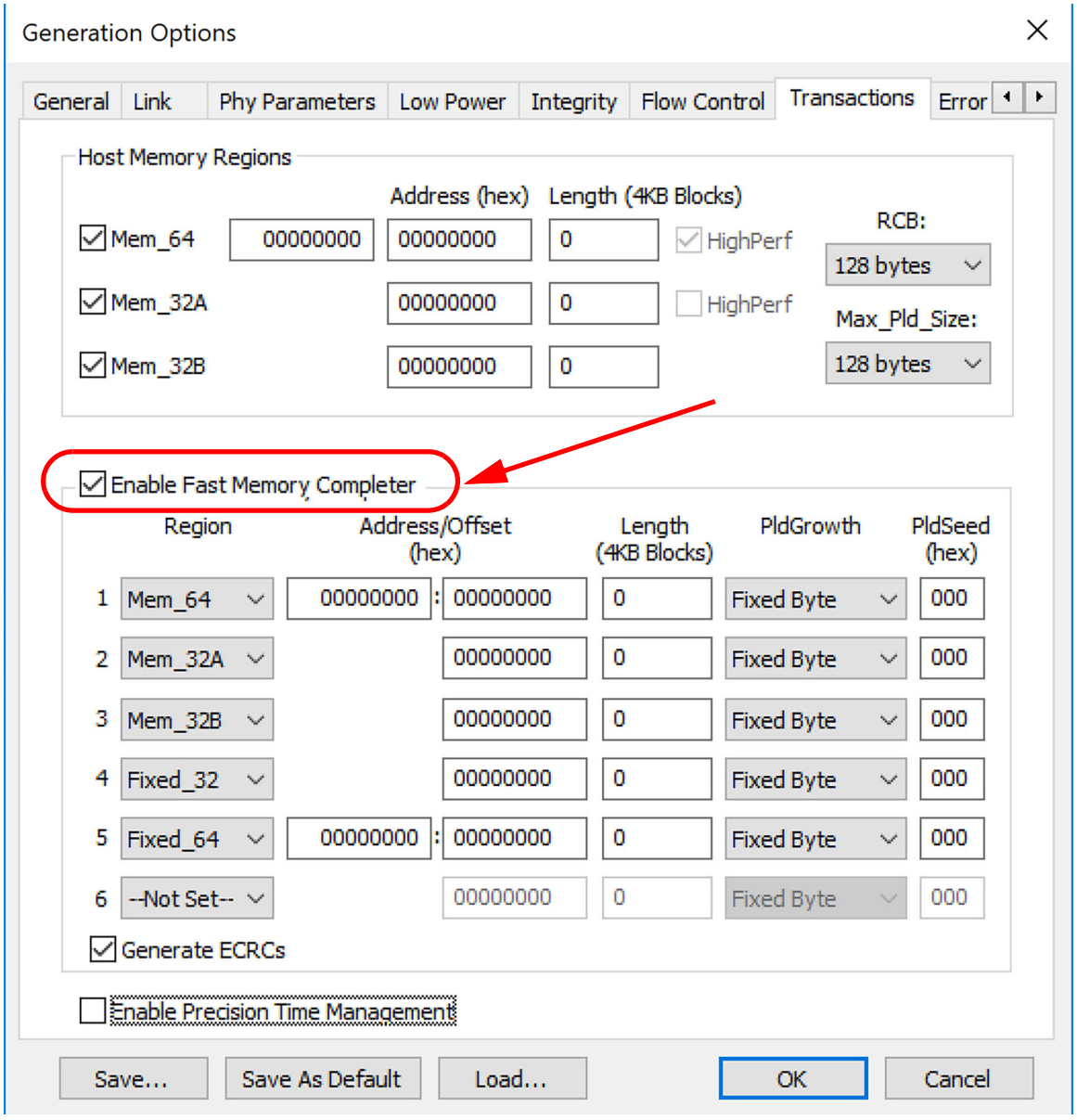


Figure 4.60: Selecting Options to Enable Fast Memory Completer.

TABLE 4.14: Generation Options for Fast Memory Completer

Parameter	Values	Default	Comment
Enable Fast Memory Completer	Yes No	No	If set, enables the high-performance memory completer functionality.
Region	--Not Set-- Mem_64 Mem_32A Mem_32B Fixed_64 Fixed_32	--Not Set--	A **Region** is a range of addresses in PCI Express memory space, which the high-performance memory completer handles using a defined policy. There are two region types: • The first type is defined by the fixed address location, such as Fixed_32 and Fixed_64, and can be used for both Device and Host Emulation. • The second type is defined by the specific device memory space, such as Mem_64, Mem_32A, and Mem_32B, specified in the BAR setup in the Configuration Space Editor, and can be used only for Device Emulation. The supplied Address is really the Offset from the beginning of the corresponding memory space. The actual address is calculated by the Summit Z5 Exerciser when the BARs are configured. When a region is enabled, all Write data to the address range is consumed at high speed and discarded. All completion data for read requests is filled according to the rules specified by the **PldGrowth** and **PldSeed** parameters. Six regions are currently available for the fast memory completer. **FastMemoryCompleter** must be set to enable the **Region**.
Address/ Offset (hex)	32-bit Address/ Offset 64-bit Address/ Offset	32-bit 0x00000000	If the corresponding **Region** is set, based on the region type, this field is a 32-bit Offset for Mem_32A and Mem_32B, 64-bit Offset for Mem_64, 32-bit Address for Fixed_32, and 64-bit Address for Fixed_64. The corresponding **Region** must be set to enable the **Address/Offset**.

TABLE 4.14: Generation Options for Fast Memory Completer

Parameter	Values	Default	Comment
Length (in 4-KB blocks)	0 to 1,048,576	0	If the corresponding **Region** is set, this field specifies the length of the address range in 4-kilobyte blocks, starting from the address/offset, in the **Address/Offset** field, to which the fast memory completer responds. The corresponding **Region** must be set to enable **Length**.
PldGrowth	Fixed Byte Fixed DWord Incr Byte Incr DWord	Fixed Byte	If the corresponding **Region** is set, this field specifies the expected payload format. Fixed Byte and Fixed DWord specify a payload of a byte or dword pattern consisting of **PldSeed**. Incr Byte and Incr DWord specify a payload of incrementing bytes or dwords starting from zero. The corresponding **Region** must be set to enable **PldGrowth**.
PldSeed (hex)	8-bit value 10-bit value	0	If the corresponding **Region** is set and **PldGrowth** is set to Fixed Byte or Fixed DWord, this field species the byte value repeated for **PldGrowth** of Fixed Byte or the 10-bit dword value for **PldGrowth** of Fixed DWord. For other types of **PldGrowth,** this field is set to zero. The corresponding **Region** and **PldGrowth** must be set to enable **Pldseed**.
Generate ECRCs	Yes No	No	Enable if memory completions need to have ECRC appended. The TD bit will be asserted for the completions generated by the fast memory completer.

NOTE: In Device emulation mode, the current MaxPayload size set in configuration space will be used by completions from both firmware memory space and FastCompleter.

In Host emulation mode, the RCB set in generation options will be used by completions. Z5 will follow the rules for aligning completion boundaries based on MaxPacket size (and RCB).

4.6.7.5 Enable Precision Time Management (PTM) -> Host Emulation

NOTE: Precision Time Management applies to both the Summit Z58 and the Summit Z516 Exercisers. Z5 references both Z58 and Z516 except where noted.

When enabled during Host emulation, PCIe Analysis Software directs the Z5 to respond to Precision Time Management (PTM) Request TLPs with PTM Response and PTM ResponseD messages as required. PTM Response will be sent for the first PTM Request received, and a PTM ResponseD for each PTM Request received thereafter (see Figure 4.61 on page 155).

The Z5 maintains the Master Time in 4ns increments, and will generate the Propagation Delay and Master Time fields required for the PTM ResponseD message.

If the Enable PTM option is unchecked, all PTM Request messages will be ignored and no response will be generated.

In device emulation, the Enable PTM selection has no effect. In device emulation PTM Request messages may be generated via scripting.

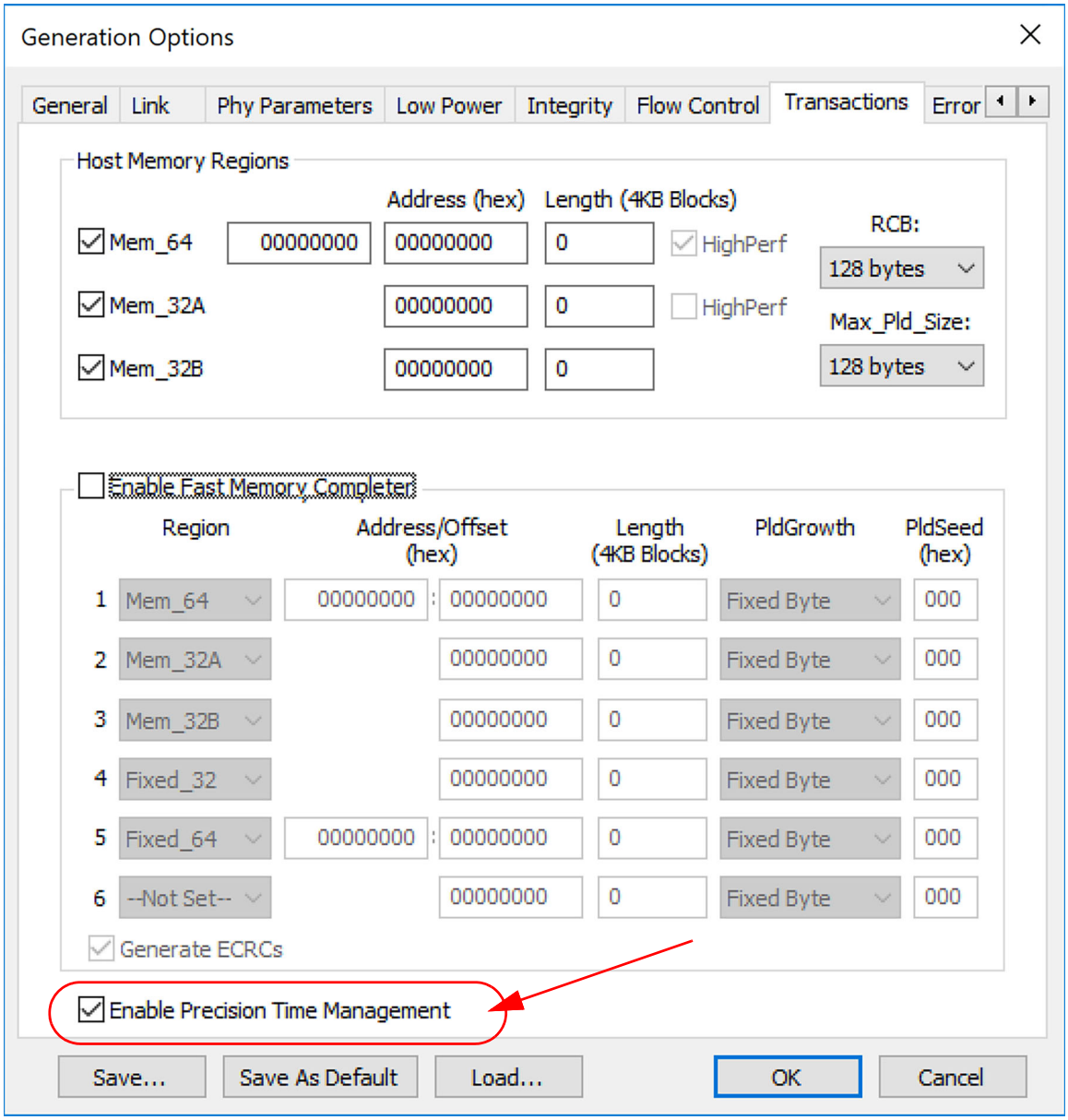


Figure 4.61: Generations Options Transactions Dialog - Host Emulation.

4.6.7.6 Transactions: Host Emulation -> High Performance Real Memory Mode

NOTE: High Performance Mode applies to both the Summit Z58 and the Summit Z516 Exercisers. Z5 references both Z58 and Z516 except where noted.

When in Host Emulation mode, up to three physical memory regions can be defined to be automatically handled by the Summit Z5.

For Host Emulation the Host Memory Regions now have "High Perf" checkboxes next to the Mem_64 and Mem32A regions. When "High Performance Memory" is not checked in the General dialog box, those checkboxes are disabled. When "High Performance Memory" is checked in the General dialog box, those checkboxes are enabled and mutually exclusive (you can only check the checkbox for one of the regions).

When the "High Perf" checkbox is checked for Mem_64 or Mem32A region, it enables the High Performance Memory to be associated with that region at the specified base physical address and length. Everything written to this region over the PCIe link (or from the PCIe Suite application using Address Space Write functionality) will be placed into the High Performance Memory on the Summit Z5. Everything read from this region over the PCIe link (or from the PCIe Suite application using Address Space Read functionality) will be taken from the High Performance Memory. When data is written to / read from the region over the PCIe link, it is handled with a much better performance then the regular Firmware based handling. See Figure 4.62 on page 157.

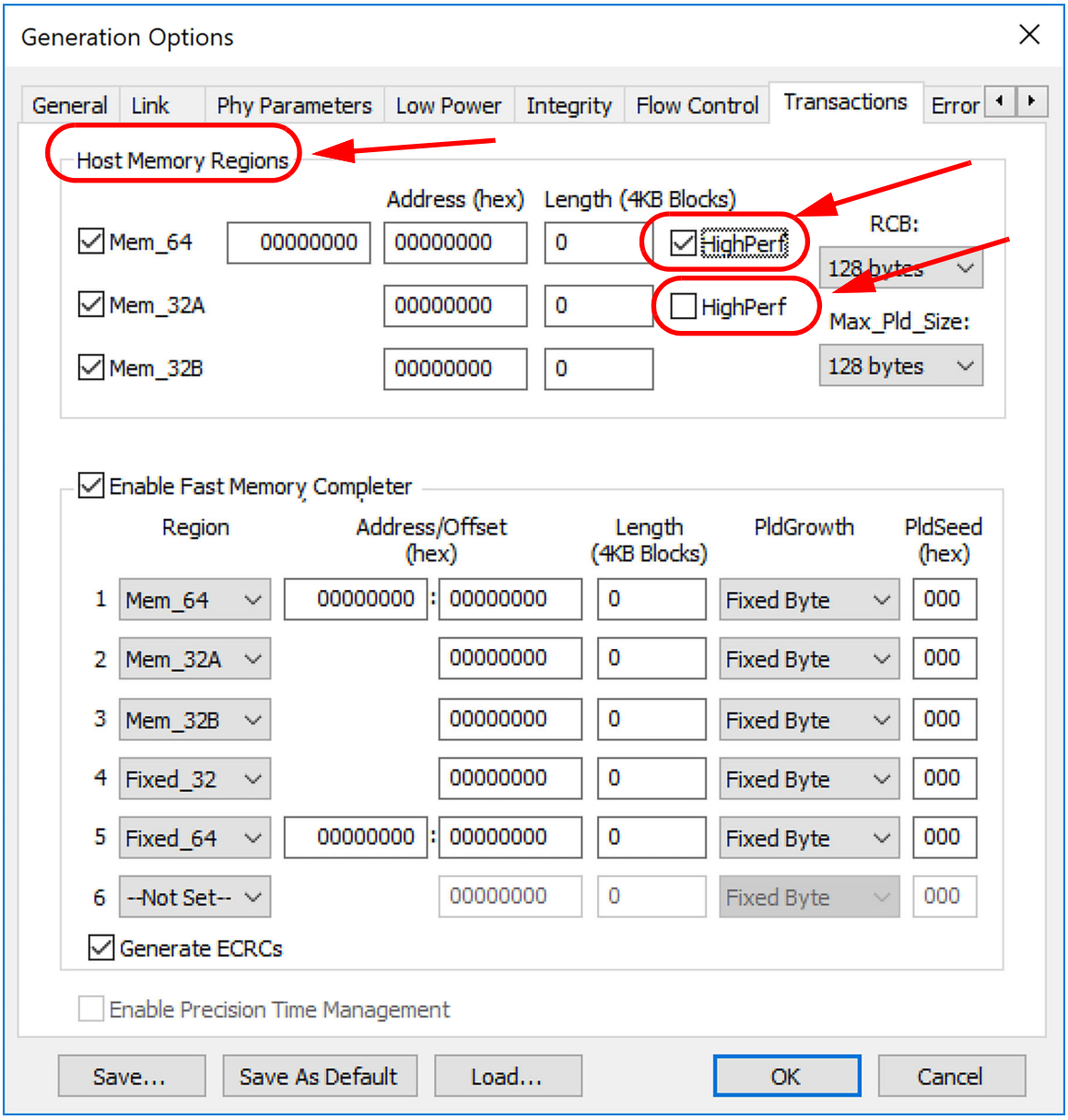


Figure 4.62: Transactions Dialog – Host Emulation → High Performance Real Memory

4.6.7.7 Transactions for CXL traffic: Host Emulation

For Summit Z516 CXL all the PCIe settings are described in “Transactions” on page 146. All these settings are applicable for "CXL.io" traffic in the corresponding tab. The CXL-specific settings can be found under the "CXL.cache/mem" tab.

The only parameter in this tab is "Multi Data Header (MDH) Enabled". It's used to control the way data packets are generated. It's enabled by default.

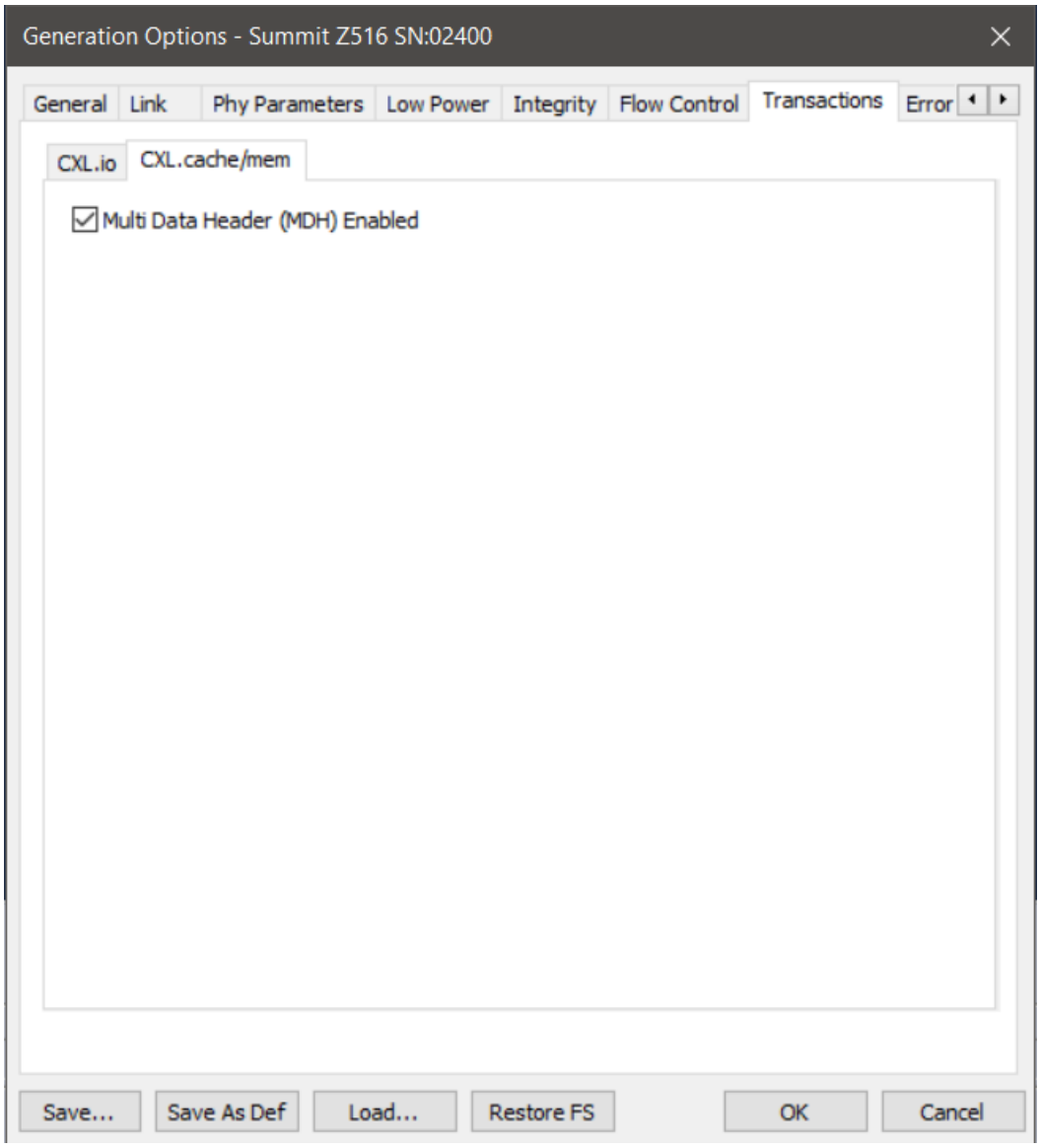


Figure 4.63: Generations Options Transactions Dialog for "CXL.cache/mem".

There are a few common options for Host Emulation and Device Emulation:

The first parameter in this tab is "Multi Data Header (MDH) Enabled". It is used to control the way Data packets are generated. You can find more details on the MDH mechanism in the CXL specification. It's turned on by default.

All other settings on the "CXL.cache/mem" tab are related to **CXL High Performance Mode**. It allows creating fast responses for all the received requests. The responses are generated by the device internally with a few choices between predefined packets available.

For some opcodes, the responses are strictly defined and can't be changed. For others, the responses can be chosen on this tab. You cannot change the content of the packet except the opcode and a few other fields.

The first field is “Address for CXL.cache protocol.” This setting specifies the address limit for the cache request over which the error response is generated. This is common to both Device and Host Emulation.

Settings for particular packet responses differ for Device and Host modes because it is necessary to send different packets. See Figure 4.64 on page 160.

Table 4.15 shows predefined requests/response pairs. No customization is allowed.

TABLE 4.15: CXL Predefined Requests/Response Pairs

CXL.cache D2H Request	Response
CacheFlushed	GO-I
CleanEvictNoData	GO-I
CXL.mem M2S Request	**Response**
MemWr	S2M NDR - CMP
MemWrPtl	S2M NDR - CMP

The GUI allows you to customize other requests/response pairs. The details are described below.

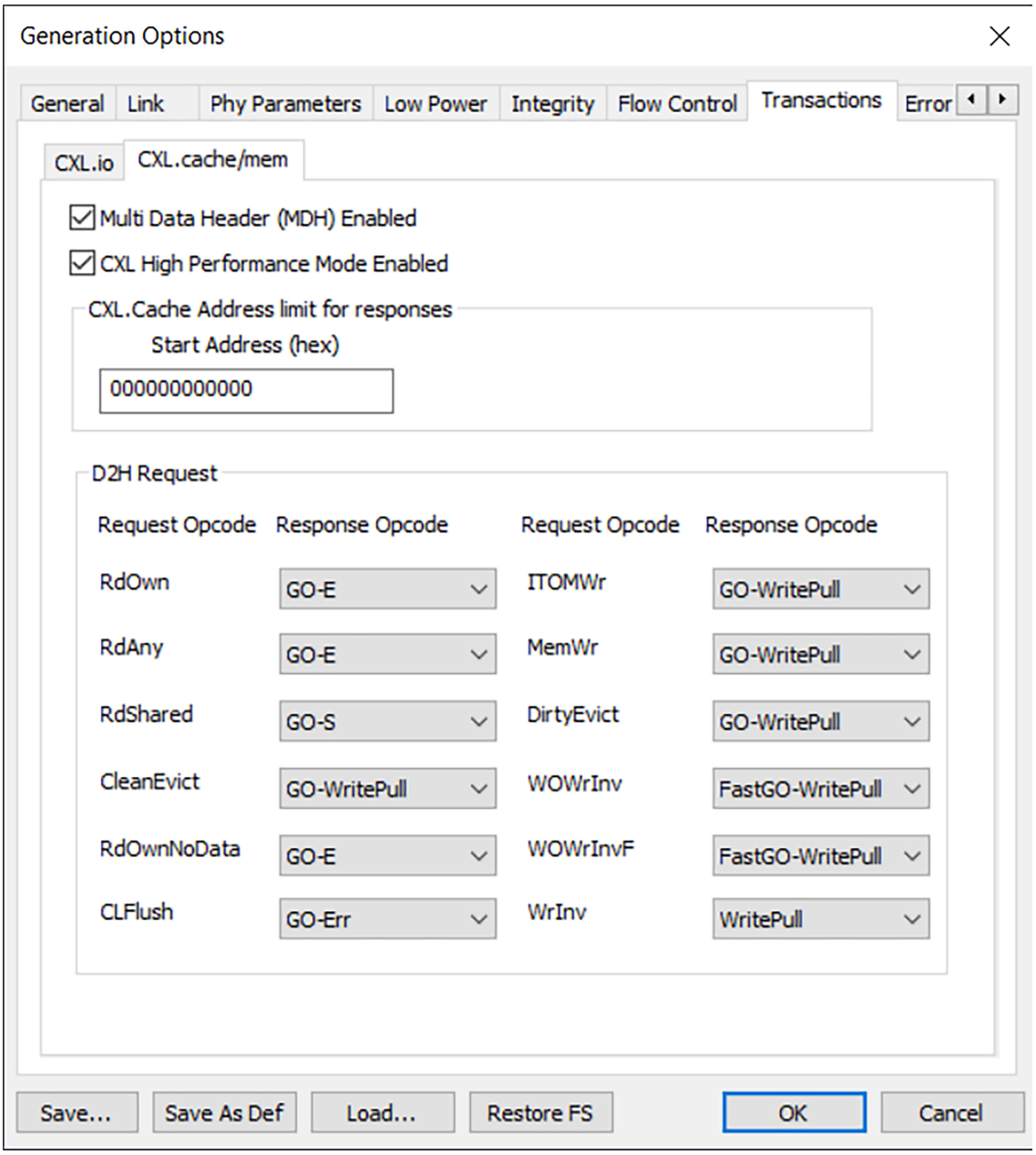


Figure 4.64: Generations Options Transactions Dialog for “CXL.cache/mem” in Host Mode

TABLE 4.16: Generations Options Transactions Options for "CXL.cache/mem" in Host Mode

Parameter	Values	Default	Description
RdOwn response	GO-E GO-M GO-Err GO-I	GO-E	The opcode of the generated response for RdOwn request
RdAny response	GO-E GO-M GO-S GO-Err GO-I	GO-E	The opcode of the generated response for RdAny request
RdShared response	GO-S GO-Err GO-I	GO-S	The opcode of the generated response for RdSharedrequest
CleanEvict response	GO-WritePull GO-WritePullDrop	GO-WritePull	The opcode of the generated response for CleanEvict request
RdOwnNoData response	GO-E GO-Err	GO-E	The opcode of the generated response for RdOwnNoData request
CLFlush response	GO-Err GO-I	GO-Err	The opcode of the generated response for CLFlush request
ITOMWr response	GO-WritePull GO-Err-WritePull	GO-WritePull	The opcode of the generated response for ITOMWr request
MemWr response	GO-WritePull GO-Err-WritePull	GO-WritePull	The opcode of the generated response for MemWr request
DirtyEvict response	GO-WritePull GO-Err-WritePull	GO-WritePull	The opcode of the generated response for DirtyEvict request
WOWrInv response	FastGO-WritePull ExtCmp GO-Err-WritePull	FastGO-WritePull	The opcode of the generated response for WOWrInv request

TABLE 4.16: Generations Options Transactions Options for "CXL.cache/mem" in Host Mode

Parameter	Values	Default	Description
WOWrInvF response	FastGO-WritePull ExtCmp GO-Err-WritePull	FastGO-WritePull	The opcode of the generated response for WOWrInvF request
WrInv response	WritePull GO-Err GO-I	WritePull	The opcode of the generated response for WrInv request

4.6.7.8 Transactions for CXL traffic: Device Emulation

For CXL.cache/mem Transaction tab for Device Emulation, some options are common. The different types of requests and responses are listed in Table 4.17 on page 164.

Configure responses for M2S Requests in device mode. To modify **Meta Field** and **Meta Value** for CXL.mem traffic, There are two options:

- Predefined values of these fields (check-boxes enabled) and exact values chosen in the combo-boxes.
- The values from the requests are used (check-boxes disabled).

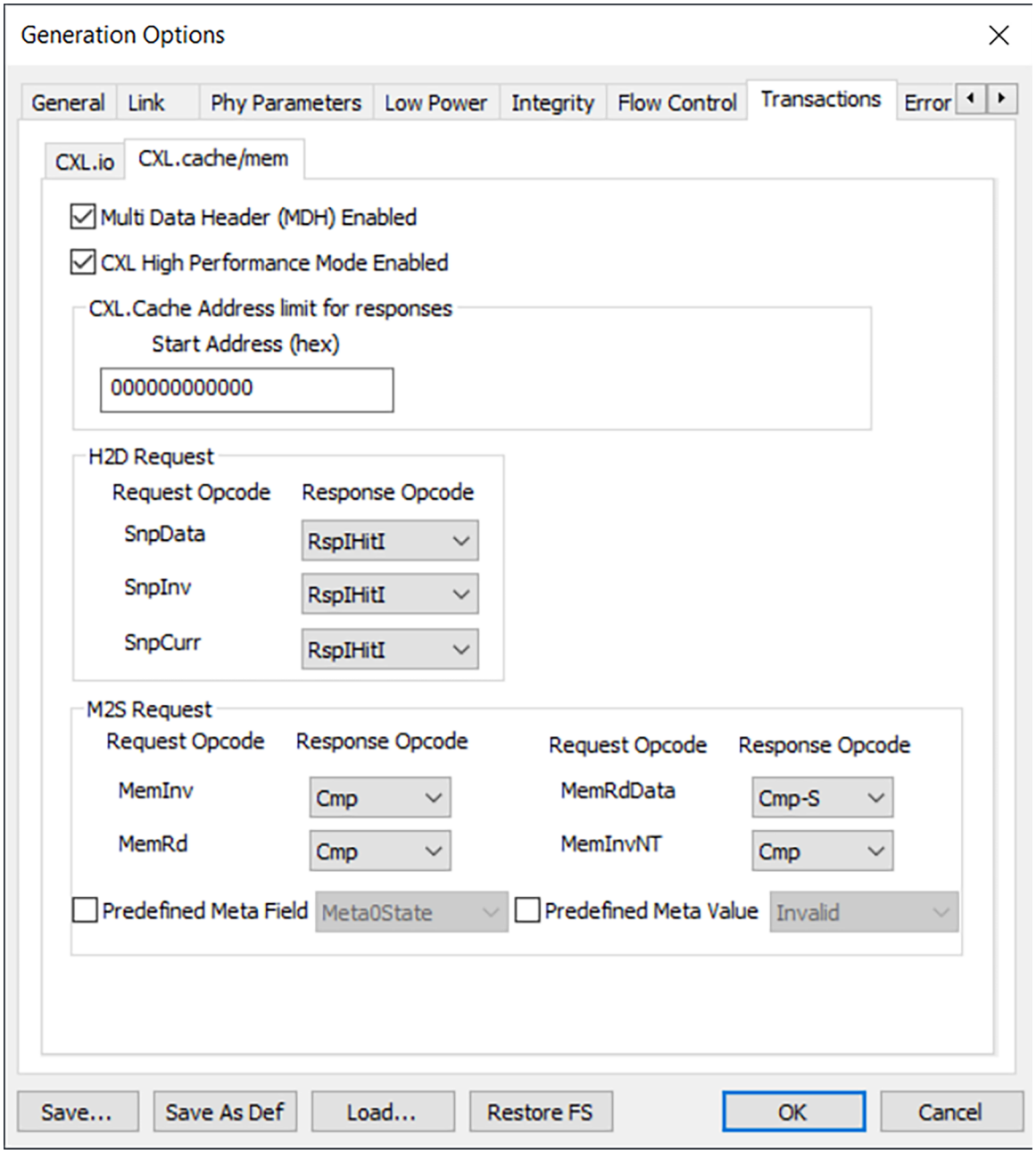


Figure 4.65: Generations Options Transactions Dialog for "CXL.cache/mem" in Device mode

Generations Options Transactions Dialog for "CXL.cache/mem" in Device mode

TABLE 4.17: Generations Options Transactions Options for "CXL.cache/mem" in Device mode

Parameter	Values	Default	Description
SnpData response	RspIHitI RspSHitSE RspSFwdM RspIFwdM	RspIHitI	The opcode of the generated response for SnpData request
SnpInv response	RspIHitI RspIHitSE RspIFwdM	RspIHitI	The opcode of the generated response for SnpInv request
SnpCurr response	RspIHitI RspSHitSE RspSFwdM RspIFwdM RspVFwdV RspVHitV	RspIHitI	The opcode of the generated response for SnpCurr request
MemInv response	CMP CMP-S CMP-E	CMP	The opcode of the generated response for MemInv request
MemRd response	CMP CMP-S CMP-E	CMP	The opcode of the generated response for MemRd request
MemRdData response	CMP-S CMP-E	CMP-S	The opcode of the generated response for MemRdData request
MemInvNT response	CMP CMP-S CMP-E	CMP	The opcode of the generated response for MemInvNT request

NOTE: The CXL HPM is only available in CXL mode and it's enabled for use by the "Z516 Exerciser: High Performance Mode" license feature.

4.6.8 Error Injection Definitions

NOTE: Error Injection applies to both the Summit Z58 and the Summit Z516 Exercisers.
Z5 references both Z58 and Z516 except where noted.

Several types of errors can be defined to be injected into the data traffic after a link has been established. These error type can be defined using this GUI (see Figure 4.66) or by defining them in a script (see Figure 4.67 on page 167):

- Disparity
- Symbol
- Sync Bit

4.6.8.1 Error Injection Definition: GUI

The Error rate can be set from 1 to 65535 and errors can be injected on any active lane chosen (from Lane 0 through Lane 7).

NOTE: The Generation Options: Error Injection GUI sets the speed (GT/s), Error Type, Error rate and Lane where the errors will occur, but you must enable the Error Type in the LTSSM (see "Errors can be injected into data traffic only after a link has been established and the LTSSM has reached the L0 state." on page 71) to generate the errors in the data traffic.

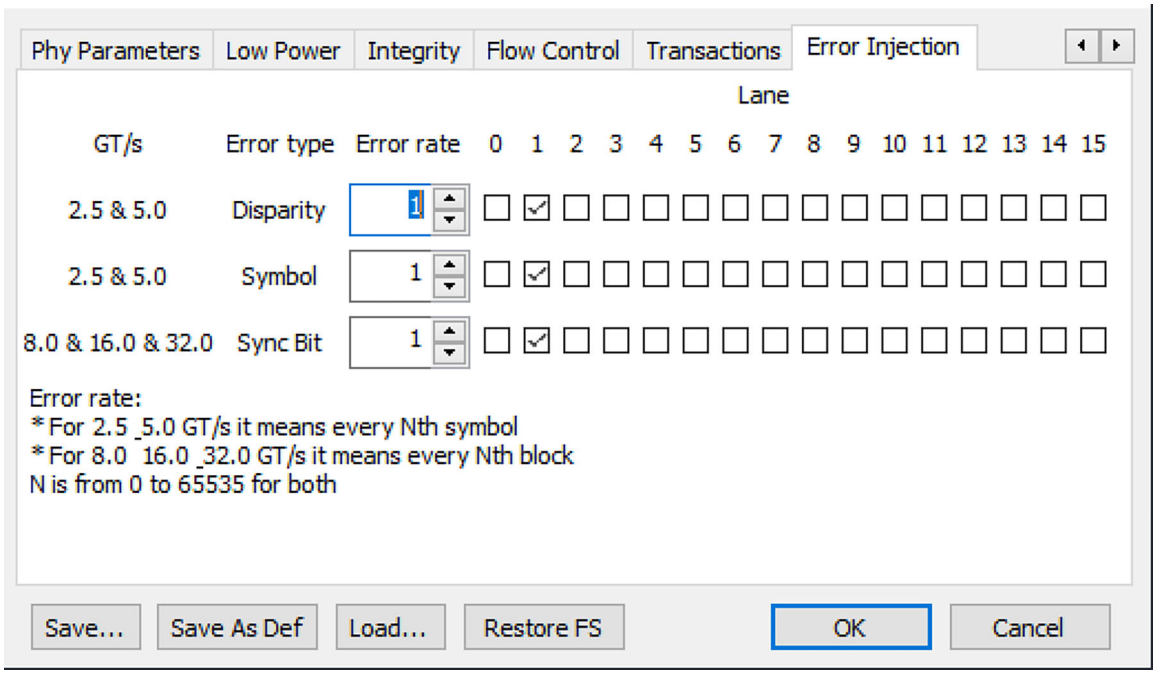


Figure 4.66: Generation Options: Error Injection Definitions

WARNING: The injection of even a single error into 2.5 GT/s & 5.0 GT/s or 8.0 GT/s & 16.0 GT/s & 32.0 GT/s data traffic may cause large numbers of corrupted packets to be decoded in the trace.

TABLE 4.18: Generation Options: Error Injection Options

Speed (GT/s)	Error Type	Error Rate	Lanes
2.5 and 5.0	Disparity	1 – 65535 (Error occurs every Nth symbol)	0 - 15 (Lane selected by checking checkbox)
2.5 and 5.0	Symbol	1 – 65535 (Error occurs every Nth symbol)	0 - 15 (Lane selected by checking checkbox)
8.0 and 16.0 and 32.0	Sync Bit	1 – 65535 (Error occurs every Nth block)	0 - 15 (Lane selected by checking checkbox)

NOTE: To generate errors in the data traffic you must perform two separate steps.

Step 1:

This GUI only allows you to select the speed, type, rate and lanes of the errors.

Step 2:

To have the errors generated in the data traffic you must select:

- ❑ Disparity
- ❑ Symbol
- ❑ Sync Bit

In the LTSSM GUI see “Errors can be injected into data traffic only after a link has been established and the LTSSM has reached the L0 state.” on page 71.

4.6.8.2 Error Injection Definition: Script

Error Injection can also be defined in a script. See Figure 4.67.

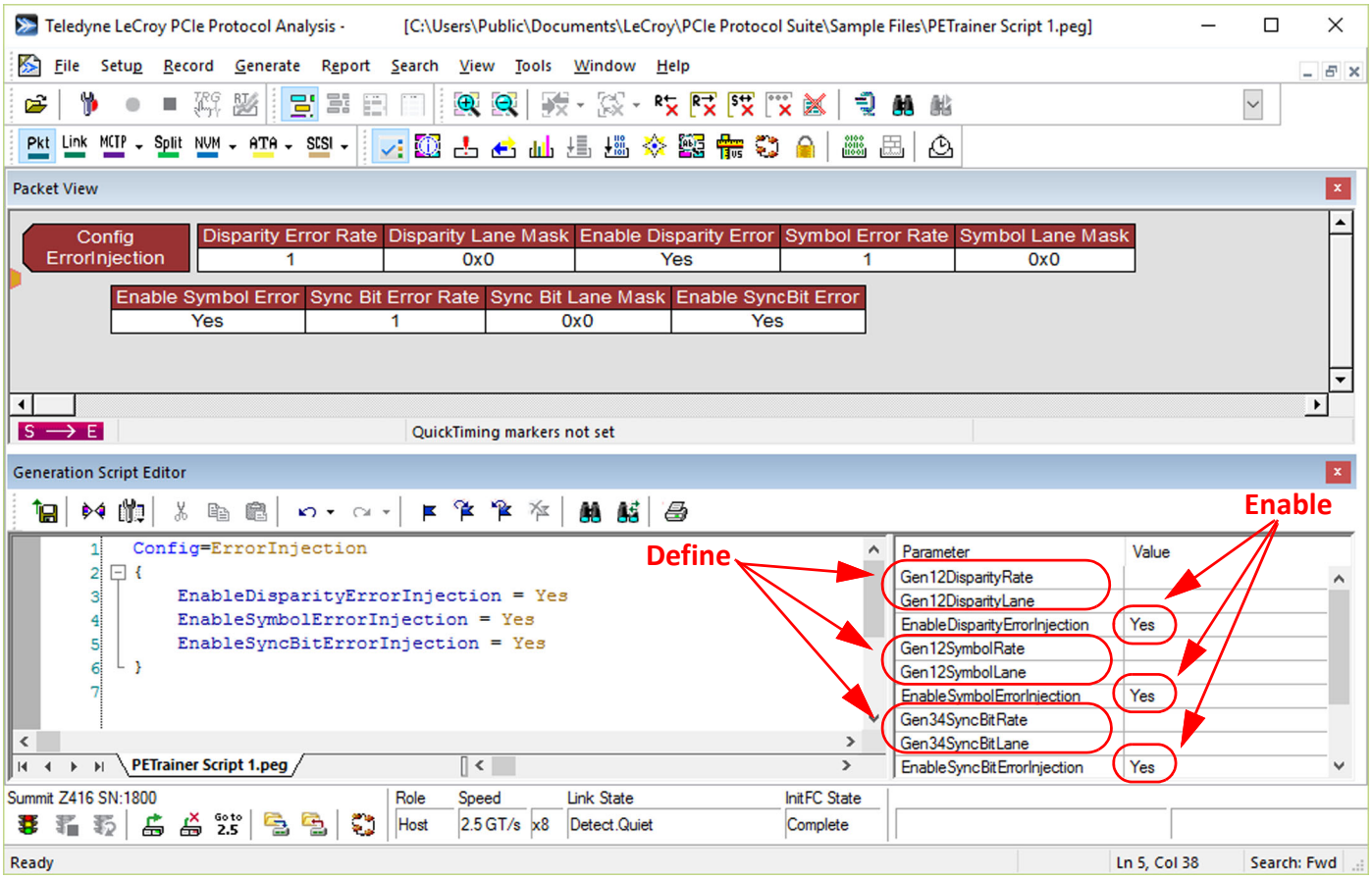


Figure 4.67: Error Injection Definition and Enable in a Script

4.6.9 Generating Traffic: Set Generation Options

Before beginning generation, set options in the Generation Options dialog box. The steps below describe how to change the most common settings in order for the Z5 Trainer to operate with any device.

Change other options only if you need a different behavior from the default or if you are experiencing problems during operation.

1. Open the Generation Options dialog box by selecting **Setup** > **Generation Options** from the menu. The Generation Options dialog opens.

   By default the General page displays.
2. Set the generation direction based on type of device you are emulating.
   - ❑ Host Emulation: Select Host
   - ❑ Device Emulation: Select Device
3. Set the maximum speed to be advertised by the trainer in the TS Data Rate options.
4. Set the maximum link width to attempt by the trainer in the Link Width options.
5. Click **OK** to apply all changes and close the Generation Options dialog.

4.6.10 Saving a Generation Options File

4.6.11 Generating Traffic: Set Generation Options

Before beginning generation, set options in the Generation Options dialog box. The steps below describe how to change the most common settings in order for the Z516 Trainer to operate with any device.

Change other options only if you need a different behavior from the default or if you are experiencing problems during operation.

1. Open the Generation Options dialog box by selecting **Setup** > **Generation Options** from the menu. The Generation Options dialog opens.

   By default the General page displays.
2. Set the generation direction based on type of device you are emulating.
   - Host Emulation: Select Host
   - Device Emulation: Select Device
3. Set the maximum speed to be advertised by the trainer in the TS Data Rate options.
4. Set the maximum link width to attempt by the trainer in the Link Width options.
5. Click **OK** to apply all changes and close the Generation Options dialog.

4.6.11.1 Generation Options XML File

To make it easier to read and edit your Generation Options, you can save it as an XML file with a .xgen file extension. Changes to Generation Options serialization and usage across different software versions are also made easier.

Note: Legacy .gen file types are still compatible with current software, though the .xgen file extension is not backward compatible with versions prior to 11.63.

For example, see the following values highlighted in the image below:

- "LinkWidth=2"
- "DisableScrambleTx=1"
- DisableDescrableTx=1"
- "InvertPolarityTx=1"

```
!DOCTYPE GenerationOptions><GenerationOptions>
<struct name="CCoreGenOptions">
 <field name="CoreVersion">1</field>
</struct>
<struct name="SPEGenOptions">
 <field name="PhyFileName">C:\Users\Public\Documents\LeCroy\PCIe Pro
uite\Z58.__phy.pp</field>
 <struct name="SPEGenOptionsSingleFile">
  <field name="Size">1905</field>
  <field name="Version">40</field>
  <struct name="SGenGeneralCfg">
   <field name="AutoConfig">0</field>
   <field name="LinkWidth">2</field>
   <field name="DisableScrambleTx">1</field>
   <field name="DisableDescrambleRx">1</field>
   <collection name="InvertPolarityTx">
    <collectionelement>
     <key>0</key>
     <value>1</value>
    </collectionelement>
```

Figure 4.68: .xgen Values Example

Refer to the next section for a full listing of the .xgen fields and corresponding generation parameters.

4.6.12 Generation Options XML Files

Generation options parameters are saved in an XML file (.xgen data type) for ease of use. The following list shows how the file parameters correspond to the dialog box options.

Z58

(also valid for Z516, Z516 CXL)

4.6.12.1 General Tab

Data Rate Parameters

`<field name="DataRate">0</field>` corresponds to Data Rate drop-down list 2.5

`<field name="DataRate">1</field>` corresponds to Data Rate drop-down list 5.0, 2.5

`<field name="DataRate">2</field>` corresponds to Data Rate drop-down list 8.0, 5.0, 2.5

`<field name="DataRate">3</field>` corresponds to Data rate 16.0, 8.0, 5.0, 2.5 Gt/s

`<field name="DataRate">4</field>` corresponds to Data rate 32.0, 16.0, 8.0, 5.0, 2.5 Gt/s

Linkwidth parameters

`<field name="LinkWidth">1</field>` corresponds to linkwidth x1

`<field name="LinkWidth">from 2 to 16</field>` corresponds to linkwidth from x2 to x16

Tx

`<field name="DisableScrambleTx">1</field>` corresponds to checked checkbox "Disable scrambling (2.5/5.0 Gt/s only)

(also valid for Z516, Z516 CXL)

`<field name="UseExtRefClock">0</field>` corresponds to Internal (No SSC) ref clock

`<field name="UseExtRefClock">1</field>` corresponds to Tx Internal (No SSC) and Rx External (Slot Clock)

`<field name="UseExtRefClock”>2</field>` corresponds to Tx External (Slot Clock) and Rx Internal (No SSC)

`<field name="UseExtRefClock">3</field>` corresponds to External (Slot Clock)

`<field name="UseExtRefClock">4</field>` corresponds to Tx Downspread-.1(1000ppm) and Rx Internal (No SSC)

`<field name="UseExtRefClock">5</field>` corresponds to Tx Downspread-.1(1000ppm) and Rx External (Slot Clock)

<field name="UseExtRefClock">8</field> corresponds to Tx Downspread-.3(3000ppm) and Rx Internal (No SSC)

<field name="UseExtRefClock">9</field> corresponds to Tx Downspread-.3(3000ppm) and Rx External (Slot Clock)

<field name="UseExtRefClock">12</field> corresponds to Tx Downspread-.5(5000ppm) and Rx Internal (No SSC)

<field name="UseExtRefClock">12</field> corresponds to Tx Downspread-.5(5000ppm) and Rx Internal (No SSC)

Z516 CXL

<field name="CacheMemSupport">0</field> corresponds to Type 2 CXL Device (Cache+Mem)

<field name="CacheMemSupport">1</field> corresponds to Type 1 CXL Device (Only Cache)

<field name="CacheMemSupport">2</field> corresponds to Type 2 CXL Device (Only Mem)

Invert polarity

<collection name="InvertPolarityTx"> corresponds to Invert Polarity

<key>from 0 to 15</key> corresponds to lanes from 0 to 15

<value> 0</value> corresponds to unchecked lane

<value>1</value> corresponds to checked lane

Skew

<collection name="SkewTx"> corresponds to Skew

<key>from 0 to 15</key> corresponds to lane from 0 to 15

<value>0</value> corresponds to default parameters

<value>from 0 to 15</value> corresponds to written lanes from 0 to 15

<field name="ReverseLanes">1</field> corresponds to checked checkbox "Reverse Lanes"

<field name="FollowLaneReversal">1</field> corresponds to checked checkbox "Follow Lane Reversal"

<field name="UseExtRefClock">3</field> corresponds to checked checkbox "Use External Ref. Clock"

Analyzer control

<field name="AutoStartRecording">0</field> Corresponds to unchecked checkbox "Start recording when generation starts"

<field name="AutoStartRecording">1</field> Corresponds to checked checkbox "Start recording when generation starts"

<field name="AutoStopRecording">1</field> Corresponds to checked checkbox "Stop recording when generation stops"

Emulation Role

<field name="IsRootComplex">0</field> Corresponds to Device Emulation Role

<field name="IsRootComplex">1</field> Corresponds to Host Emulation Role

<field name="IsHPM">1</field> corresponds to checked checkbox “High Performance Memory”

<field name="IsHPM">0</field> corresponds to unchecked checkbox “High Performance Memory”

4.6.12.2 LINK TAB

SKP Ordered Set Generation Control

<field name="AutoSkipGenerate">1</field> Corresponds to checked checkbox "Enable Automatic SKP Generation"

<field name="SkipTimerSymbols">1360</field> Corresponds to 1360 SKP symbols

<field name="SkipTimerBlocks">370</field> Corresponds to 370 Skip Interval blocks

<field name="EnableSRIS">1</field> Corresponds to checked checkbox "SRIS Mode"

<field name="SkipTimerSymbols">154</field> Corresponds to SKP 154 symbols

<field name="SkipTimerBlocks">38</field> Corresponds to 38 Skip Interval blocks

Number of FTS ordered sets required

<field name="N_FTS">255</field> Corresponds to Number of FTS ordered sets required 2.5 Gt/s

<field name="GEN2_N_FTS">255</field> Corresponds to Number of FTS ordered sets required 5.0 Gt/s

<field name="GEN3_N_FTS">255</field> Corresponds to Number of FTS ordered sets required 8.0 Gt/s

Link Training Parameters

<field name="EnableAutonomSpChange">1</field> Corresponds to checked checkbox "Enable Autonomous Speed Change"

<field name="DisableAutoTxPresets">1</field> Corresponds to checked checkbox "Disable Auto Tx Presets"

<field name="EnableEq">0</field> Corresponds to checked checkbox Skip Equalization Link Training

<field name="EnableEq23">0</field> Corresponds to checked checkbox Skip EQ in Training Phase 2,3

<field name="Gen3SpecVersion">1</field> corresponds to Revision 3.0 Version 1.0

<field name="Gen4SpecVersion">1</field> corresponds to Revision 4.0 Version 1.0

<field name="Gen4SpecVersion">1</field> corresponds to spec revision 4.0 version 0.7 and above

Z58

Enhanced Link Behavior Control Settings

<struct name="SConfigLinkGen5"> corresponds to Enhanced Link Behavior Settings

<field name="FullEqRequired">1</field> corresponds to “Full Equalization Required” selected option

<field name="EqBypassSupported">1</field> corresponds to “EQ Bypass” selected option

<field name="NoEqSupported">1</field> corresponds to “No Equalization required” selected option

<field name="ModTS12Supported">1</field> corresponds to checked checkbox “Modified TS1/2 sets”

Modified TS Usage Modes

<field name="ModTSUsageMode0Supported">1</field> corresponds to checked checkbox “Training mode 0 – PCIE”

Rx/Tx Precode Settings

(also valid for Z516, Z516CXL)

Modified TS Usage Modes

<field name="ModTSUsageMode0Supported">1</field> corresponds to checked checkbox “Training mode 0 – PCIE”

<field name="RxPrecodeOverride">0</field> and <field name="RxPrecodeOverrideValue">0</field> correspond to “Follow our Precode Request” Rx Precoding

<field name="TxPrecodeOverride">0</field> and <field name="TxPrecodeOverrideValue">0</field> correspond to “Follow our Precode Request” Tx Precoding

<field name="TxPrecodeOverride">1</field> and <field name="TxPrecodeOverrideValue">1</field> correspond to “Precoding On” Tx Precoding

<field name="RxPrecodeOverride">1</field> and <field name="RxPrecodeOverrideValue">1</field> correspond to “Precoding On” Rx Precoding

<field name="TxPrecodeOverrideValue">0</field> corresponds to “Precoding Off” Tx Precoding

<field name="RxPrecodeOverrideValue">0</field> corresponds to “Precoding Off” Rx Precoding

Z516

<field name="AlternateProtocolVendorID">7832</field> corresponds to Alternate Protocol Vendor ID 1e98

<field name="ModTSUsageMode2Supported">1</field> corresponds to checked checkbox Training Mode 2 – Alternate Protocol

Z516 CXL

<field name="CXLForcedMode">1</field> corresponds to checked checkbox “CXL Force Mode”

<field name="SyncHeaderBypass">1</field> corresponds to checked checkbox "CXL Sync Header Bypass Enabled"

<field name="AllowUserControlledLLCTRL">1</field> corresponds to checked checkbox "CXL Allow User Controlled LLCTRL"

4.6.12.3 PHY PARAMETERS TAB

<struct name="SConfigEqualization"> corresponds to Emphasis column

<collection name="PresetsTx">

<key>from 0 to 15</key> Corresponds to lanes from 0 to 15

<value>from 0 to 10</value> Corresponds to Presets from 0 to 10

<struct name="SConfigEQAdvertizement"> corresponds to Tx Advertised column

<collection name="PresetsTx">

<key>from 0 to 15</key> Corresponds to lanes from 0 to 15

<value>from 0 to 10</value> Corresponds to Presets from 0 to 10

<field name="PresetTxGen2">0</field> corresponds to Gen2 (all lanes) De-Emphasis 0, -6.0dB

<field name="PresetTxGen2">1</field> corresponds to Gen2 (all lanes) De-Emphasis 1, -3.5dB

<struct name="SConfigEqualization"> corresponds to DC Gain and CTLE

<collection name="PresetsRx"> corresponds to Rx column

<value>0</value> corresponds to DC Gain 0 and CTLE 0

<value>16</value> corresponds to DC Gain 0 and CTLE 1

<value>32</value> corresponds to DC Gain 0 and CTLE 2

<value>48</value> corresponds to DC Gain 0 and CTLE 3

<value>64</value> corresponds to DC Gain 0 and CTLE 4

<value>80</value> corresponds to DC Gain 0 and CTLE 5

<value>96</value> corresponds to DC Gain 0 and CTLE 6

<value>112</value> corresponds to DC Gain 0 and CTLE 7

<value>128</value> corresponds to DC Gain 0 and CTLE 8

<value>144</value> corresponds to DC Gain 0 and CTLE 9

<value>160</value> corresponds to DC Gain 0 and CTLE 10

<value>176</value> corresponds to DC Gain 0 and CTLE 11

<value>192</value> corresponds to DC Gain 0 and CTLE 12

<value>208</value> corresponds to DC Gain 0 and CTLE 13

<value>224</value> corresponds to DC Gain 0 and CTLE 14

<value>240</value> corresponds to DC Gain 0 and CTLE 15

<value>1</value> corresponds to DC Gain 3 and CTLE 0

<value>2</value> corresponds to DC Gain 6 and CTLE 0

<value>3</value> corresponds to DC Gain 9 and CTLE 0

<value>4</value> corresponds to DC Gain 12 and CTLE 0

<field name="PresetTxGen2">1</field> corresponds to De-emphasis 1, -3.5dB for all lanes on 5.0 Gt/s

<field name="PresetTxGen2">0</field> corresponds to De-emphasis 0, -6.50B for all lanes on 5.0 Gt/s

<struct name="SConfigEqualizationZ4"> corresponds to Tx Applied

`<collection name="PresetsTxGen4">` corresponds to 16.0Gt/s

`<value>from 0 to 10</value>` corresponds to Presets from 0 to 10

`<struct name="SConfigEQAdvertizementGen4">` corresponds to Tx Advertised

`<collection name="PresetsTx">` corresponds to Presets Tx

`<value>from 0 to 10</value>` corresponds to Presets from 0 to 10

General Receiver Settings

`<key>from 0 to 15</key>` corresponds to lanes from 0 to 15

`<key>from 0 to 15</key>` corresponds to lanes from 0 to 15

`<field name="DCGain">0</field>` corresponds to DCGain 0.0dB

`<field name="CTLE">from 1 to 31</field>` corresponds to CTLE from 0.2dB to 6.2 dB (step is 0.2)

`<field name="DCGain">from 1 to 31</field>` corresponds to DCGain 0.2dB to 6.2 dB (step is 0.2)

32. Gt/s

`<struct name="SConfigEQAdvertizementGen5">` corresponds to Advertised column on speed 32.0 Gt/s

`<collection name="PresetsTx">` corresponds to Tx Presets

Lanes

`<key>from 0 to 7</key>` corresponds to lanes from 0 to 7

`<value>from 0 to 10</value>` corresponds to Preset 0 – 0dB Preshoot, -6.0dB De-emphasis

`<collection name="PresetsRx">`

`<struct name="SConfigEQAdvertizementGen5">`

CTLE

`<field name="CTLE">from 0 to 60</field>` corresponds to CTLE from 0.0dB to 12.0 dB (step is 0.2)

DC Gain

`<field name="DCGain">from 0 to 39</field>` corresponds to DC Gain from -3.0dB to +4.8 dB (step is 0.2)

LOW POWER TAB

<struct name="SConfigLowPower">

<field name="L1_SubState">0</field> corresponds to disabled checkbox L1

<field name="SendPMAck">1</field> corresponds to checked checkbox Send PM Request ACK

<field name="PMAckNakCount">40</field> corresponds to checked checkbox PM ACK Count 40

<field name="PMAckNakCount">0</field> corresponds to unchecked checkbox PM ACK Count

<field name="Mode">1</field> corresponds to ASPM mode

<field name="Mode">2</field> corresponds to PCIPM mode

<field name="ProgrammableTimerState">0</field> corresponds to LTSSM Exit Time “None”

<field name="ProgrammableTimer">262142</field> corresponds to LTSSM Exit Time 262142 ns

<field name="ProgrammableTimerState">1</field> corresponds to LTSSM Exit Time “Tx L0s”

<field name="ProgrammableTimerState">2</field> corresponds to LTSSM Exit Time “L1”

INTEGRITY TAB

ACK/NAK Policy

<struct name="SConfigAckNak">

<field name="AckNak">0</field> corresponds to Disable automatic ACK/NAK

<field name="AckNak">1</field> corresponds to Always ACK received TLP packets

<field name="AckNak">2</field> corresponds to Always NAK received TLP packets

<field name="AckNak">3</field> corresponds to ACK/NAK DLLP

<field name="Delay">0</field> corresponds to ACK/NAK delay (0 ns)

TLP Policy

<struct name="SConfigTLP">

<field name="AutoSeqNumber">1</field> corresponds to checked checkbox "Automatically generate TLP sequence number"

<field name="AutoLCRC">1</field> corresponds to checked checkbox "Automatically generate TLP CRC"

<field name="AutoRetransmission">1</field> corresponds to checked checkbox "Automatically retransmit TLPs"

<field name="ReplayTimerSymbols">3150</field> corresponds to Replay timer 3150ns

<field name="UseUserDefinedReplayTimer">1</field> corresponds to checked checkbox "User defined Replay Timer"

Z516 CXL

LL Tx Misc Parameters

<field name="DCGain">from 0 to 39</field> corresponds to DC Gain from -3.0dB to +4.8 dB (step is 0.2)

<field name="AckForceThreshold">16</field> corresponds to Ack Force Threshold 16

<field name="AckFlushRetimer">512</field> corresponds to Ack Flush Retimer 512

<field name="LlrWrapValue">255</field> corresponds to LLR WrapValue Supported 255

LL Retry Parameters

<field name="MaxNumRetry">10</field> corresponds to Threshold of Num_Retry counter 10

<field name="MaxNumPhyReinit">10</field> corresponds to Threshold of Num_Phy_Reinit counter 10

<field name="TimeoutThreshold">1024</field> corresponds to Threshold of Timeout counter 1024

FLOW CONTROL TAB

<field name="EnableScalableFlowControl">1</field> corresponds to checked checkbox "Enable Scalable Flow ControlTAB

<field name="ScPH">2</field> corresponds to PH H Scale 4

<field name="ScNPH">2</field> corresponds to NPH H Scale 4

<field name="ScCPLH">3</field> corresponds to CPLH H Scale 16

<field name="ScPD">3</field> corresponds to PD D Scale 16

<field name="ScNPD">2</field> corresponds to NPD D Scale 4

<field name="ScCPLD">1</field> corresponds to CPLD D Scale 1

<field name="ScCPLD">1</field> corresponds to CPLD D Scale 1

Z516 CXL

<field name="TxEnableFC">1</field> corresponds to checked checkbox “Do not send transactions…”

<field name="CacheReqCredits">from 0 to 9</field> corresponds to Cache Req from 0 to 256

<field name="CacheRspCredits">from 0 to 9</field> corresponds to Cache Response from 0 to 256

<field name="CacheDataCredits"> from 0 to 9</field> corresponds to Cache Data from 0 to 256

<field name="MemReqCredits"> from 0 to 9</field> corresponds to Mem Request/Response from 0 to 256

<field name="MemRspCredits"> from 0 to 9</field> corresponds to Mem Request/Response from 0 to 256

<field name="MemDataCredits"> from 0 to 9</field> corresponds to Mem Data from 0 to 256

<field name="StallCreditReturn">1</field> corresponds to checked checkbox “Do not advertise any credits”

<field name="RxEnableFC">0</field> corresponds to checked checkbox “Disable flow control…”

4.6.12.4 TRANSACTIONS TAB

<struct name="SConfigHostMemRegions"> corresponds to Host Memory Regions

<field name="EnableMem64">1</field> corresponds to checked checkbox "Mem_64"

<field name="EnableMem32A">1</field> corresponds to checked checkbox "Mem_32A"

<field name="EnableMem32B">1</field> corresponds to checked checkbox "Mem_32B"

<field name="RCB">from 0 to 1</field> corresponds to RCB: from 128 bytes to 64 bytes

<field name="MaxPayloadSize">from 0 to 5</field> corresponds to Max_Pld_Size: from 128 bytes to 4096 bytes

Device Emulation Role

<field name="AutoCfgCompletion">1</field> corresponds to checked checkbox "Automatically handle Configuration …" when the Summit Exerciser is in Device Emulation Role

<field name="AutoMemIoCompletion">1</field> corresponds to checked checkbox "Automatically handle Memory..." when the Summit Exerciser is in Device Emulation Role

<field name="EnableUR">1</field> corresponds to checked checkbox "Enable Memory...with Unsupported Status" when the Summit Exerciser is in Device Emulation Role

<field name="EnableCA">1</field> corresponds to checked checkbox "Enable Memory...with Completer Abort Status" when the Summit Exerciser is in Device Emulation Role

<field name="Poisoned">1</field> corresponds to checked checkbox "Set "Data Poisened" Bit..." when the Summit Exerciser is in Device Emulation Role

<field name="AutoExpROM">1</field> corresponds to checked checkbox "Automatically handle Expansion ROM" when the Summit Exerciser is in Device Emulation Role

<struct name="SConfigTra">

<field name="FastMemCompleter">1</field> corresponds to checked checkbox "Enable Fast Memory Completer"

<struct name="SConfigFMCRegion">

<key>from 0 to 5</key> corresponds to the rows from 1 to 6

<field name="RegionType">from 0 to5</field> corresponds to Region from -Not Set-to Fixed_64

<field name="AddressLo">0</field> and <field name="AddressHi">0</field> correspond to Address/Offset 00000000

<field name="Length">0</field> corresponds to Length 0

<field name="PayloadGrowth">from 0 to 3</field> corresponds to PldGrowth from Fixed Byte to Incr DWord

<field name="PayloadSeed">0</field> corresponds to PldSeed 000

<field name="SendECRCforFastMC">1</field> corresponds to checked checkbox "Generate ECRCs"

<field name="EnablePTM">1</field> corresponds to checked checkbox "Enable Precision Time Management"

<field name="Mem64HighPerf">1</field> corresponds to checked checkbox “High Perf” for Host Memory Regions Mem_64 if “High Performance Memory” is checked in Emulation Role

<field name="Mem32AHighPerf">1</field> corresponds to checked checkbox “High Perf” for Host Memory Regions Mem_32A if “High Performance Memory” is checked in Emulation Role

<field name="AddrSpaceForHighPerf">0</field> corresponds to “None” High Performance Memory drop-down list if the Summit Exerciser is in Device Emulation and with High Performance Memory checkbox checked

<field name="AddrSpaceForHighPerf">1</field> corresponds to Mem64 High Performance Memory drop-down list if the Summit Exerciser is in Device Emulation and with High Performance Memory checkbox checked

<field name="AddrSpaceForHighPerf">2</field> corresponds to Mem_32 A High Performance Memory drop-down list if the Summit Exerciser is in Device Emulation and with High Performance Memory checkbox checked

Device Emulation Role

H2D Request

<field name="SnpDataResponses">4</field> corresponds to SnpData RspIFwdM

<field name="SnpInvResponses">3</field> corresponds to SnpInv RspIFwdM

<field name="SnpCurrResponses">4</field> corresponds to SnpCurr RspIFwdM

<field name="SnpDataResponses">1</field> corresponds to SnpData RspIHitI

<field name="SnpInvResponses">1</field> corresponds to SnpInv RspIHitI

<field name="SnpCurrResponses">1</field> corresponds to SnpCurr RspIHitI

<field name="SnpDataResponses">3</field> corresponds to SnpData RspSFwdM

<field name="SnpInvResponses">2</field> corresponds to SnpInv RspIHitSE

<field name="SnpCurrResponses">3</field> corresponds to SnpCurr RspSFwdM

<field name="SnpDataResponses">2</field> corresponds to SnpData RspSHitSE

<field name="SnpInvResponses">2</field> corresponds to SnpInv RspIHitSE

<field name="SnpCurrResponses">2</field> corresponds to SnpCurr RspSHitSE

<field name="SnpCurrResponses">5</field> corresponds to SnpCurr RspVFwdV

M2S Request

<field name="MemInvResponses"> from 1 to 3</field> corresponds to MemInv from Cmp to Cmp-E

<field name="MemRdResponses">from 1 to 3</field> corresponds to MemRd from Cmp to Cmp-E

<field name="MemRdDataResponses">from 1 to 3</field> corresponds to MemRdData from Cmp to Cmp-E

<field name="MemRdFwdResponses">from 1 to 3</field> corresponds to MemRdFwd from Cmp to Cmp-E

<field name="MemWrFwdResponses">from 1 to 3</field> corresponds to MemWrFwd from Cmp to Cmp-E

<field name="MemInvNTResponses">from 1 to 3</field> corresponds to MemInvNT from Cmp to Cmp-E

<field name="UseMetaFieldFromRequest">0</field> corresponds to checked checkbox Predefined Meta Field

<field name="MetaField">3</field> corresponds to Meta Field NoOp

<field name="MetaField">0</field> corresponds to Meta Field Meta0State

<field name="MetaField">1</field> corresponds to Meta Field Reserved 0b01

<field name="MetaField">2</field> corresponds to Meta Field Reserved 0b10

<field name="UseMetaFieldFromRequest">1</field> corresponds to unchecked checkbox Predefined Meta Field

<field name="UseMetaValueFromRequest">0</field> corresponds to checked checkbox Predefined Meta Value

<field name="MetaValue">0</field> corresponds to Meta Value Invalid

<field name="MetaValue">2</field> corresponds to Meta Value Any

<field name="MetaValue">1</field> corresponds to Meta Value Reserved 0b01

<field name="MetaValue">3</field> corresponds to Meta Value Shared

Z516 CXL

<field name="MDHSupport">1</field> corresponds to checked checkbox “Multi Data Header Enabled”

<field name="CXLHPMEnabled">1</field> corresponds to checked checkbox “CXL High Performance Mode Enabled”

Host Emulation Role

<field name="RdOwnResponses">1</field> corresponds to RdOwn GO-E

<field name="RdOwnResponses">2</field> corresponds to RdOwn GO-M

<field name="RdOwnResponses">3</field> corresponds to RdOwn GO-Err

<field name="RdOwnResponses">4</field> corresponds to RdOwn GO-I

<field name="RdAnyResponses">1</field> corresponds to RdAny GO-E

<field name="RdAnyResponses">2</field> corresponds to RdAny GO-M

<field name="RdAnyResponses">3</field> corresponds to RdAny GO-S

<field name="RdAnyResponses">4</field> corresponds to RdAny GO-Err

<field name="RdAnyResponses">5</field> corresponds to RdAny GO-I

<field name="RdSharedResponses">from 1 to 3</field> corresponds to RdShared from GO-S to GO-I

<field name="CleanEvictResponses">1 or 2</field> corresponds to CleanEvict GO-WritePull or GO-WritePullDrop respectively

<field name="RdOwnNoDataResponses">1 or 2</field> corresponds to RdOwnNoData GO-E or GO-Err respectively

<field name="CLFlushResponses">1 or 2</field> corresponds to CLFlushResponses GO-Err or GO-I respectively

<field name="ITOMWrResponses">1 or 2</field> corresponds to ITOMWr GO-WritePull or GO-Err-WritePull respectively

<field name="MemWrResponses">1 or 2</field> corresponds to MemWr GO-WritePull or GO-Err-WritePull respectively

<field name="DirtyEvictResponses">1 or 2</field> corresponds to DirtyEvict GO-WritePull or GO-Err-WritePull respectively

<field name="WOWrInvResponses">from 1 to 3</field> corresponds to WOWrInv from FastGO-WritePull to GO-Err-WritePull

<field name="WOWrInvFResponses">from 1 to 3</field> corresponds to WOWrInvF from FastGO-WritePull to GO-Err-WritePull

<field name="WrInvResponses">from 1 to 3</field> corresponds to WrInv from WritePull to GO-I

4.6.12.5 Device Emulation Role

H2D Request

<field name="SnpDataResponses">1</field> corresponds to SnpData RspIHitI

<field name="SnpInvResponses">1</field> corresponds to SnpInv RspIHitI

<field name="SnpCurrResponses">1</field> corresponds to SnpCurr RspIHitI

<field name="SnpDataResponses">2</field> corresponds to SnpData RspSHitSE

<field name="SnpInvResponses">2</field> corresponds to SnpInv RspIHitSE

<field name="SnpCurrResponses">2</field> corresponds to SnpCurr RspSHitSE

<field name="SnpDataResponses">3</field> corresponds to SnpData RspSFwdM

<field name="SnpInvResponses">3</field> corresponds to SnpInv RspIFwdM

<field name="SnpCurrResponses">3</field> corresponds to SnpCurr RspSFwdM

<field name="SnpDataResponses">4</field> corresponds to SnpData RspIFwdM

<field name="SnpCurrResponses">4</field> corresponds to SnpCurr RspIFwdM

<field name="SnpCurrResponses">5</field> corresponds to SnpCurr RspVFwdV

<field name="SnpCurrResponses">6</field> corresponds to SnpCurr RspVHitV

M2S Request

<field name="MemInvResponses"> from 1 to 3</field> corresponds to MemInv from Cmp to

Cmp-E

<field name="MemRdResponses">from 1 to 3</field> corresponds to MemRd from Cmp to Cmp-E

<field name="MemRdDataResponses">1 or 2</field> corresponds to MemRdData Cmp-S or Cmp-E respectively

<field name="MemInvNTResponses">from 1 to 3</field> corresponds to MemInvNT from Cmp to Cmp-E

<field name="UseMetaFieldFromRequest">0</field> corresponds to checked checkbox

Predefined Meta Field

<field name="MetaField">0</field> corresponds to Meta Field Meta0State

<field name="MetaField">1</field> corresponds to Meta Field Reserved 0b01

<field name="MetaField">2</field> corresponds to Meta Field Reserved 0b10

<field name="MetaField">3</field> corresponds to Meta Field NoOp

<field name="UseMetaFieldFromRequest">1</field> corresponds to unchecked checkbox

Predefined Meta Field

<field name="UseMetaValueFromRequest">0</field> corresponds to checked checkbox

Predefined Meta Value

<field name="MetaValue">0</field> corresponds to Meta Value Invalid

<field name="MetaValue">1</field> corresponds to Meta Value Reserved 0b01

<field name="MetaValue">2</field> corresponds to Meta Value Any

<field name="MetaValue">3</field> corresponds to Meta Value Shared

4.6.12.6 ERROR INJECTION TAB

<struct name="SErrorInjection"> corresponds to Error Injection tab

<field name="Gen12DisparityRate">1</field> corresponds to Disparity Error rate 1

<field name="Gen12DisparityLanes">0</field> corresponds to Disparity lane unchecked

<field name="Gen12SymbolRate">1</field> corresponds to Symbol Error rate 1

<field name="Gen12SymbolLanes">0</field> corresponds to Symbol lane unchecked

<field name="Gen34SyncBitRate">1</field> corresponds to Sync Bit Error rate 1

<field name="Gen34SyncBitLanes">0</field> corresponds to Sync Bit lane unchecked

<field name="Gen12DisparityRate">2</field> corresponds to Disparity Error rate 2

<field name="Gen12DisparityLanes">1</field> corresponds to Disparity lane checked

<field name="Gen12SymbolRate">2</field> corresponds to Disparity Error rate 2

<field name="Gen12SymbolLanes">1</field> corresponds to Symbol lane checked

<field name="Gen34SyncBitRate">2</field> corresponds to Disparity Error rate 2

<field name="Gen34SyncBitLanes">1</field> corresponds to Sync Bit lane checked

4.6.12.7 Open Generation Options File

Click Load in Generation Options to open the Open file dialog. This dialog provides options to load .xgen and .gen files (by default .xgen is selected) under PCIe Generator Options.

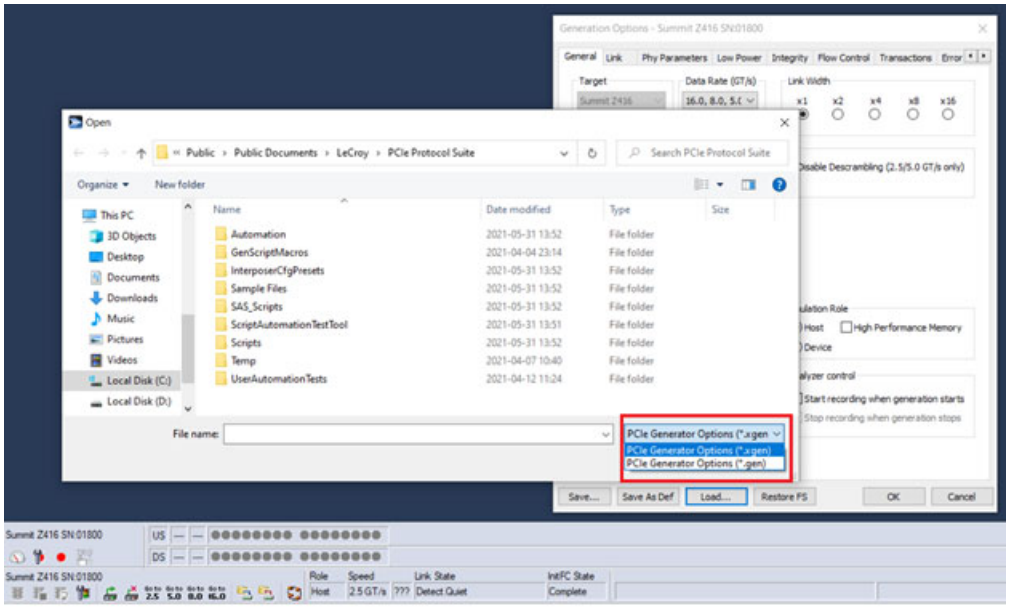


Figure 4.69: PCIe File Generator Options

From here you can chose the following actions:

- Choose PCIe Generator Options (*.gen) to make an old .gen file available for loading.
- Click the Save button to open the Save As dialog. The default and only file type allowed is .xgen

You can also load and save Generator Option files as n.xgen using the COM method. Use the COM methods SetGenerationOptionsFromXML and GetGenerationOptionsAsXML . For detailed steps refer to the *Automation API for Teledyne LeCroy PCIe Protocol Analysis* Reference Manual.

Running the COM method "GetGenerationOptionsAsXML" creates an XML file as shown below.

```
from win32com.client import Dispatch
import os
from time import sleep


analyzer = Dispatch("CATC.PETracer")
analyzer.GetGenerationOptionsAsXML("C:\Users\Public\Documents\LeCroy\PCIe Proto
Suite\Save_Generation_Options.xml")
```

Figure 4.70: Creating an XML File using a COM Method

Next, click Load in Generation Options and enter the file name with an .xml file extension then load the Generator Options from this file.

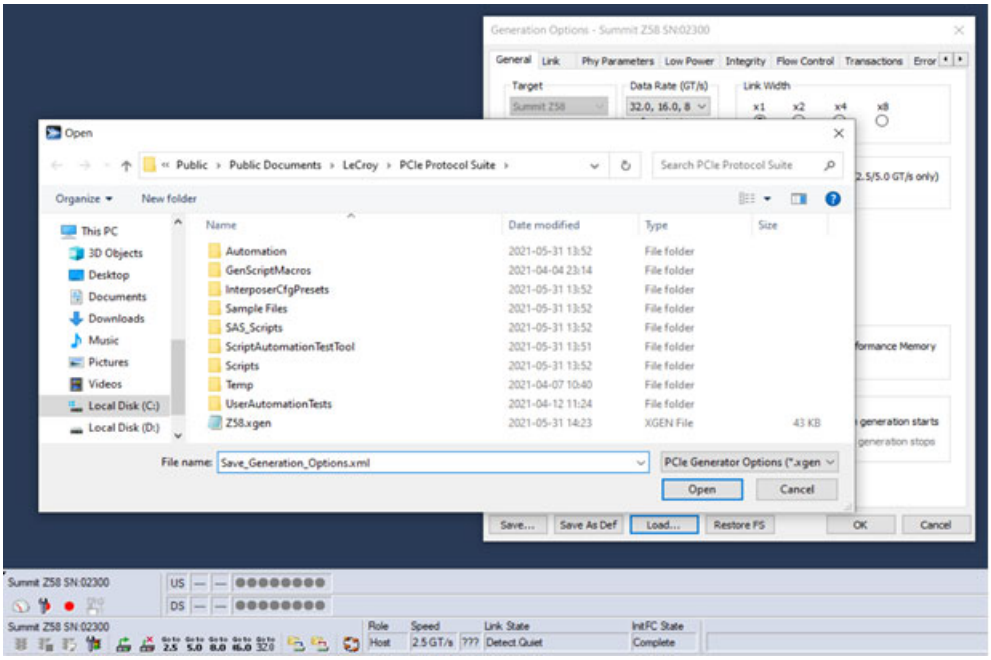


Figure 4.71: Open Generation Options File

4.7 Generating Traffic: Prepare Traffic Generation

To prepare for traffic generation, follow these steps:

1. If it is not running, start the PCIe Protocol Analysis™.
2. Open an existing script file or create a new script. For example, open the traffic generation file Exported.peg by selecting File > Open from the menu. The following packets display in the main window (see Figure 4.72 on page 189).

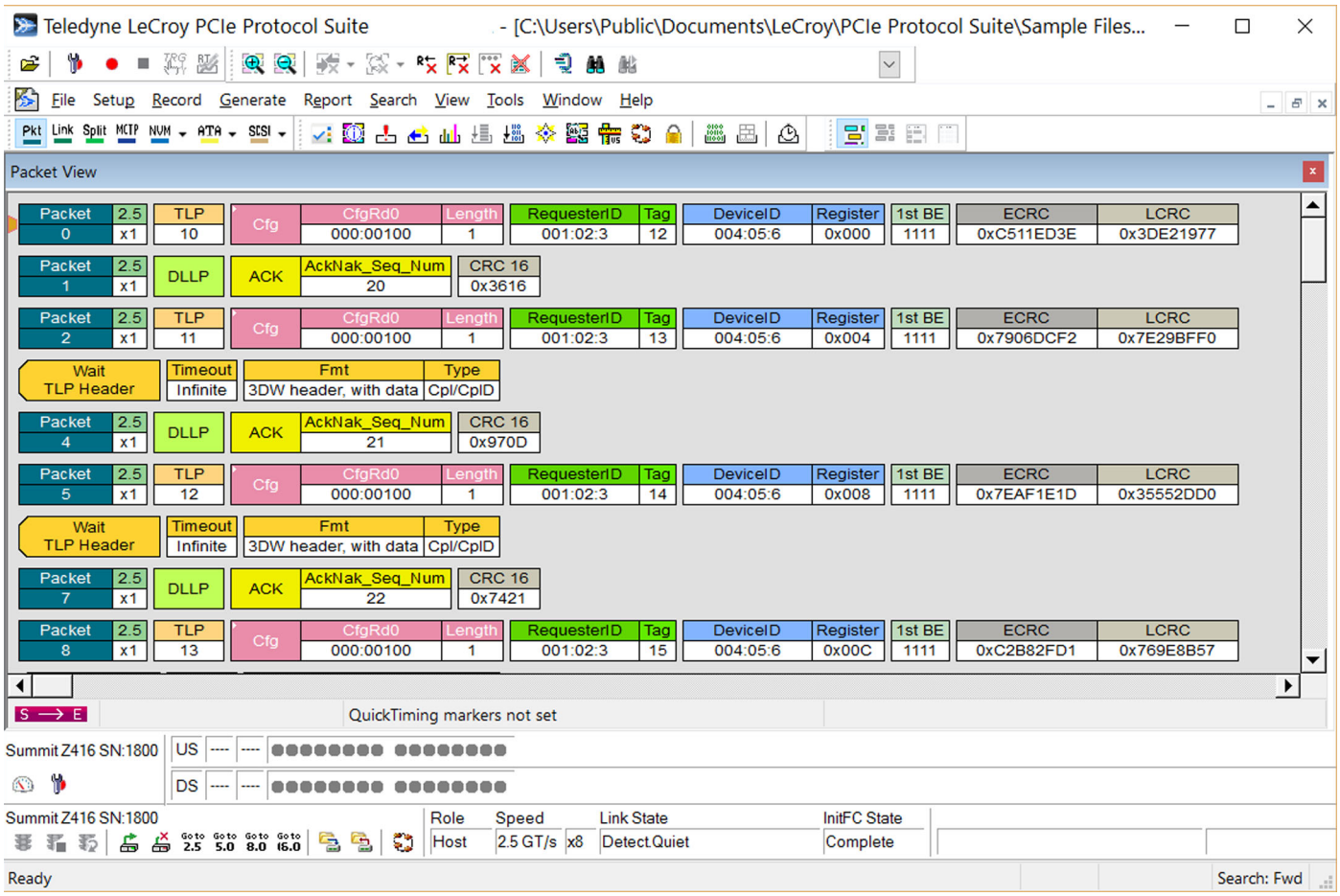


Figure 4.72: Opening an Existing Script File

The CATC Trace window shows the type of traffic that is to be generated in the current generation session.

3. If needed, make changes to the script file,

   then save the file by clicking the Save button  .

4.8 Generating Traffic: Begin Traffic Generation

Perform the following steps to begin traffic generation:

1. Start generation by clicking the Start Traffic Generation button on the Exerciser Control Bar.

   This action causes the software to download the script to the device. After the download completes, the device starts executing the script.

   As the script executes, the Exerciser Control Bar displays the script's progress. The **Current script position** field displays the command description and CATC Trace packet number currently being generated.

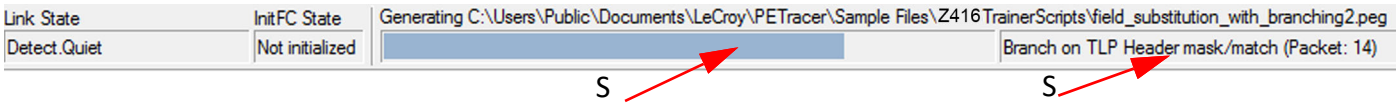


Figure 4.73: Exerciser Control Bar: Script Status

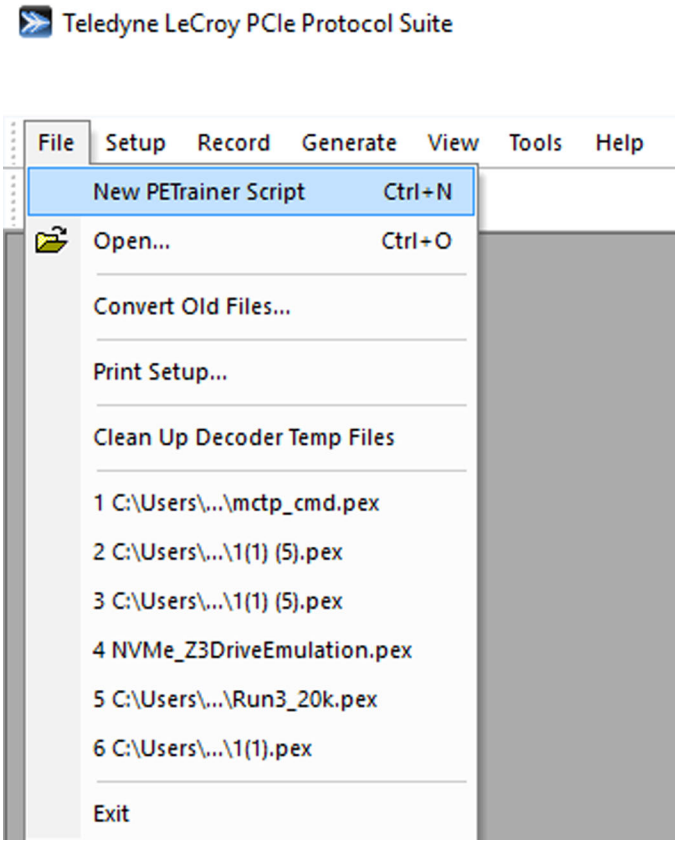
NOTE: Script execution can be terminated at any time by clicking the **Stop Generation** button on the toolbar.

If a Wait command is executed where the Display parameter is specified, the user-defined text is displayed.

If a **wait=user** script command is executed, the script pauses until you click the **Resume Generation** button on the toolbar.

To run a new traffic generation file, do the following:

1. Select File > New PETrainer Script or use the shortcut Ctrl+N.



2. An empty traffic generation file displays. You can also view the Script Editor (see Figure 4.74 on page 192).

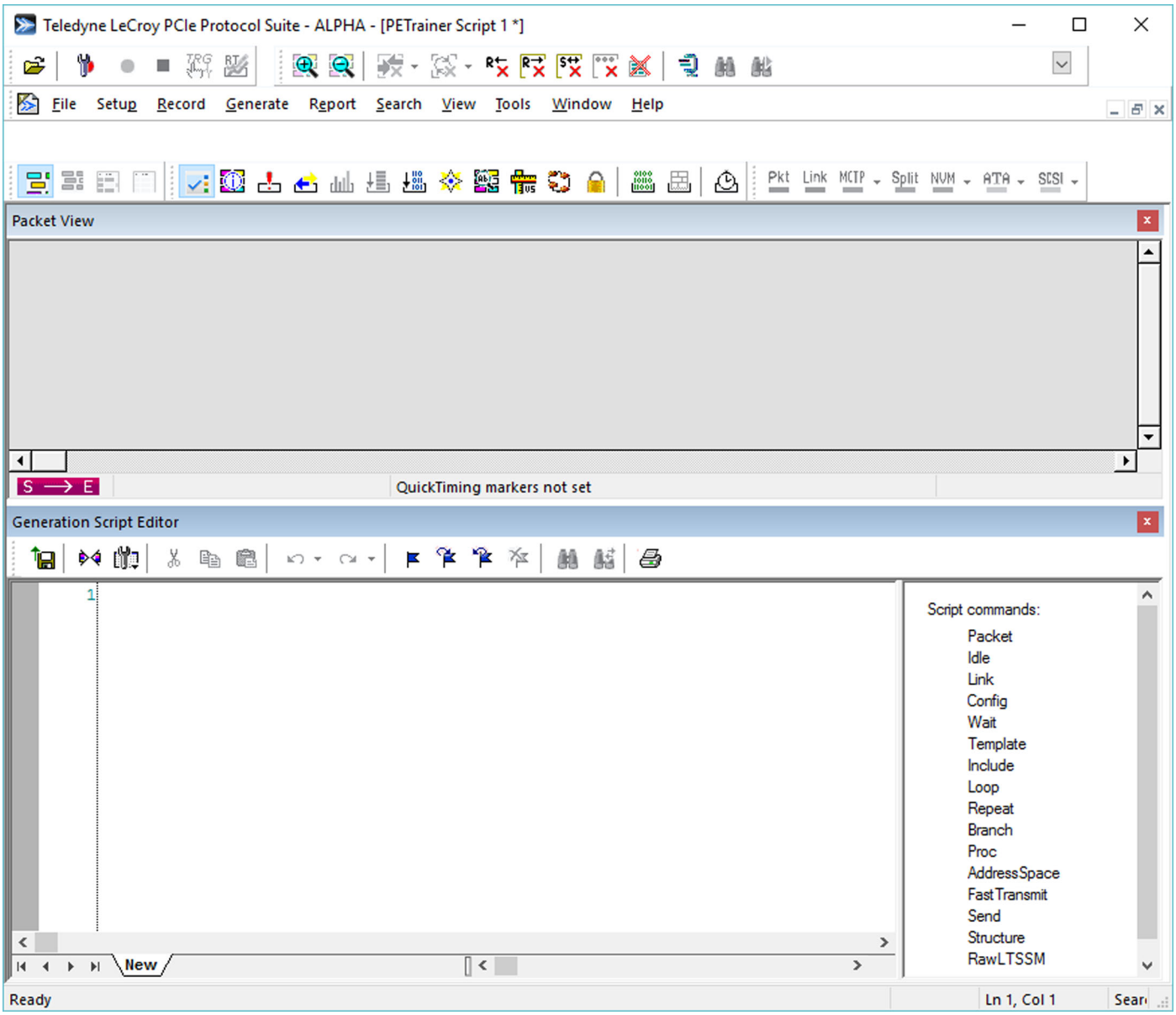


Figure 4.74: Empty Traffic Generation File

4.8.1 Script Command: Config = General

If you select the Script Command “Config = General” the following options are available to control the PHY Parameters:

- EmphasisTx
- AdvertisedTx
- DCGainRx
- CTLEGainRx
- AdvertisedRx
- DeEmphasis_Gen2

The figure below shows an example of how to generate a script from the **File -> New PETrainer Script** menu. See Figure 4.75.

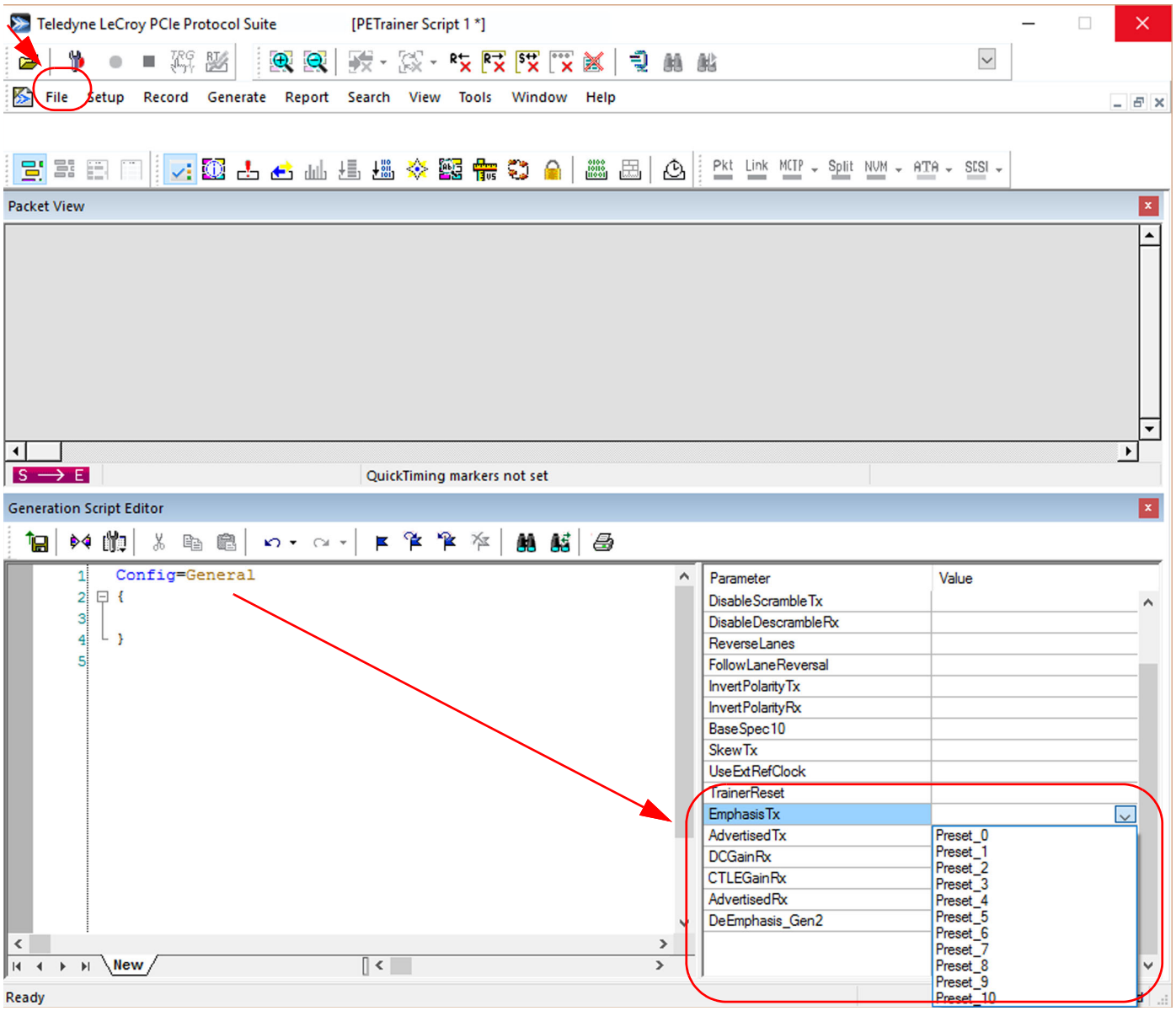


Figure 4.75: Generation Script Commands: Config = General

NOTE: The PHY Parameters are discussed in greater detail in the Summit Trainer Script Generation Reference Manual and the PCI Express Base Specification, Revision 3.0.

4.9 Autotuning

The autotuning feature for Summit Z5 optimizes the DC Gain and CTLE settings for the Z5 receiver and sweep through coefficients on the DUT transmitter in order to minimize bit error rate per lane.

Autotuning is performed from Device (add-in card) to Host if the Summit Z5 is configured as Host, and from Host (Root Complex) to Device if the Summit Z5 is configured as Device. Autotuning is only available for Gen5 rate.

If an interposer is present in the DUT <-> Host path the DC Gain and CTLE values of the interposer should be held constant at default settings for all lanes in both directions for the analyzer settings.

4.9.1 Prerequisites

Before running autotuning, make sure the exerciser options settings are configured as suggested below. Summit Z5 autotuning can only be performed using PCIe Protocol Analysis 11.75 and later.

4.9.1.1 General Tab

Configure the Summit Z5 for the desired linkwidth in the Generation options dialog box, along with any other link parameters not specific to the autotuning process.

The other device should be ready to link up (powered, out of reset, etc.).

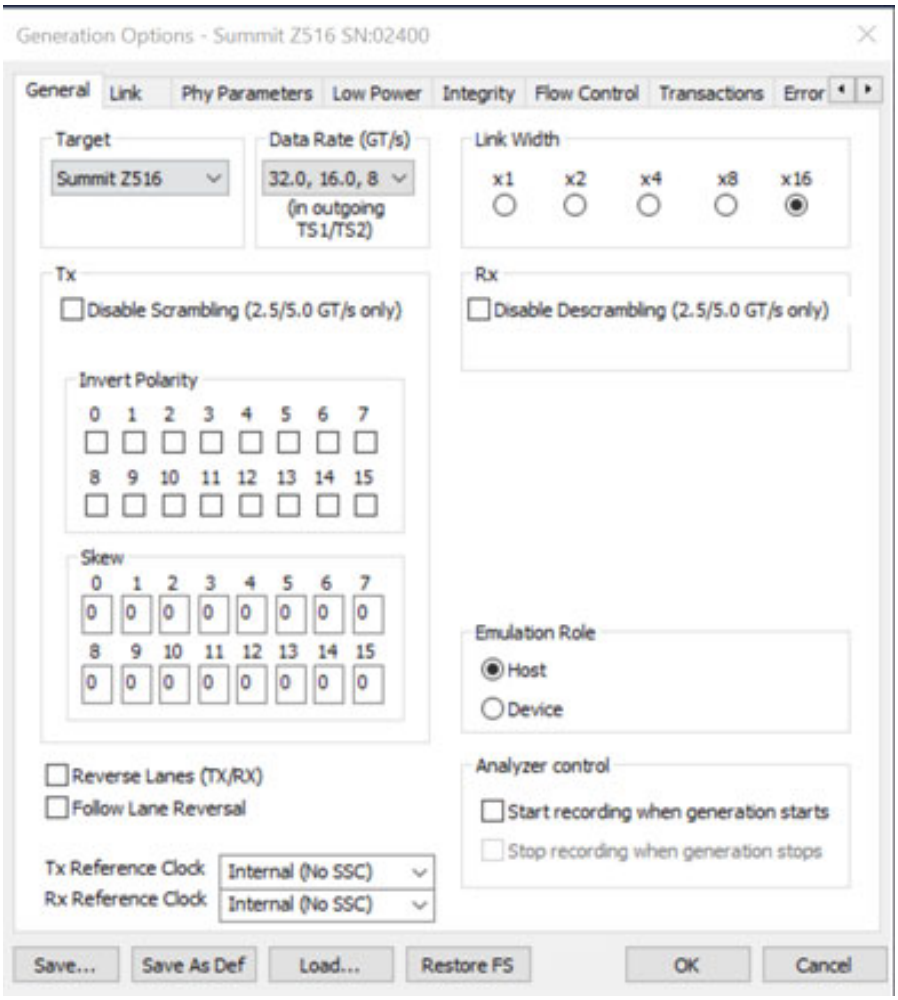


Figure 4.76: Generation Options General Tab

4.9.1.2 Phy Parameters Tab

In the “Phy Parameters” tab of the Generation Options dialog there are sub-tabs for 5.0 GT/s, 8.0 GT/s, and 16.0 GT/s which should be configured to allow linking up to L0 at those rates. The software defaults should allow this link training.

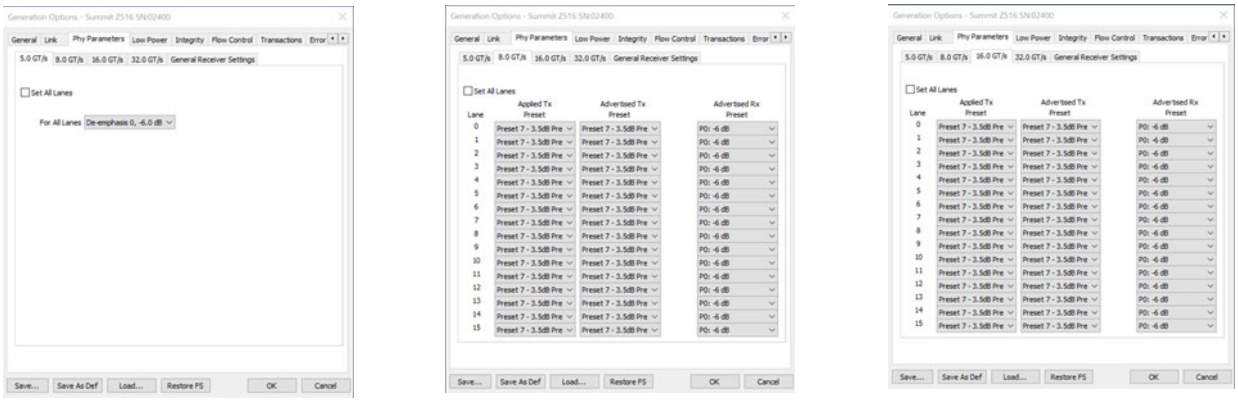


Figure 4.77: Phy Parameters Sub-Tabs

The 32.0 GT/s sub-tab needs to be configured with initial applied and advertised preset values that are good enough for the exchange of training sequences to reach equalization phase 3. The DC Gain and CTLE settings in the “General Receiver Settings” sub-tab should be 0.0dB/0.0dB for all lanes during this process. The LTSSM Log can be used to check if the exerciser has reached the required equalization phase. It may be necessary to experiment with different preset values until equalization phase 3 is achievable. For advertised preset use the same preset values for all lanes.

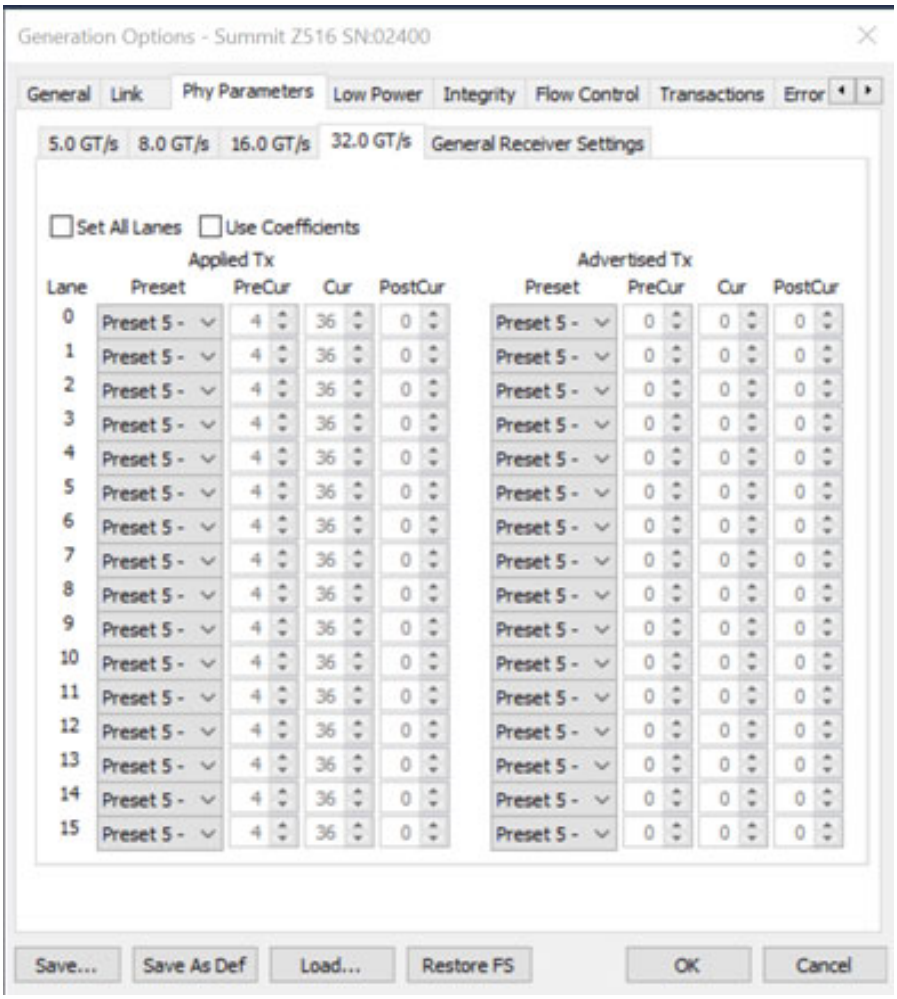


Figure 4.78: Phy Parameters 32.0 GT/s Sub-Tab

The “Use Coefficients” option is not necessary at this stage, as this parameter is among the ones being optimized by the autotuning process.

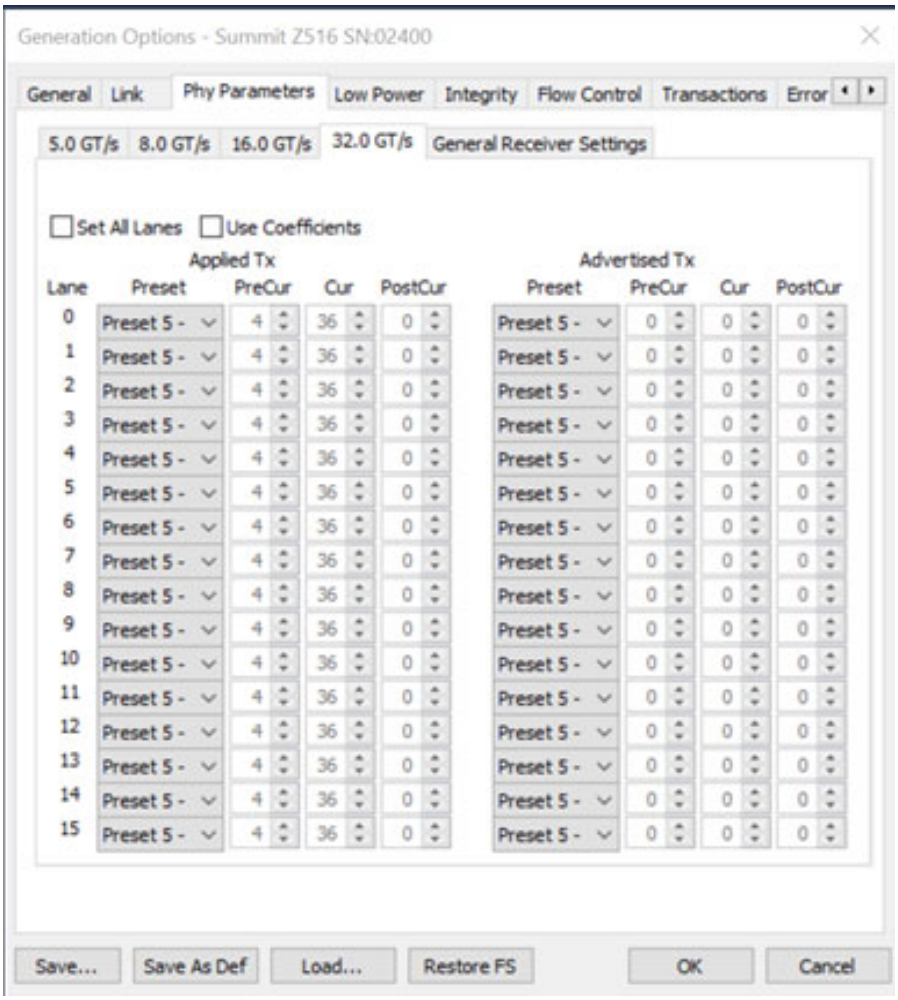


Figure 4.79: Phy Parameters 32.0 GT/s Sub-Tab Use Coeffecients

In the “General Receiver Settings” sub-tab the DC Gain and CTLE settings may be left at 0.0dB/ 0.0dB. These parameters are among the ones being optimized by the autotuning process.

4.9.2 Exerciser Autotuning Dialog

In the “General Receiver Settings” sub-tab click the Autotune check box. The “Exerciser Autotuning” dialog appears. In the “Initial Preset” box of the dialog, select the preset value that was used to achieve equalization phase 3 (this is the advertised preset value). The Pre-cursor, Cursor, and Post-cursor ranges are set to default (recommended) when the dialog appears. Using default coefficient ranges allows autotuning to evaluate all valid coefficients. The Z5 automatically calculates valid coefficients from the FS and LF parameters provided by the other device during equalization. If the Pre-cursor, Cursor, and Post-cursor ranges are set manually, only valid coefficients within the range are evaluated.

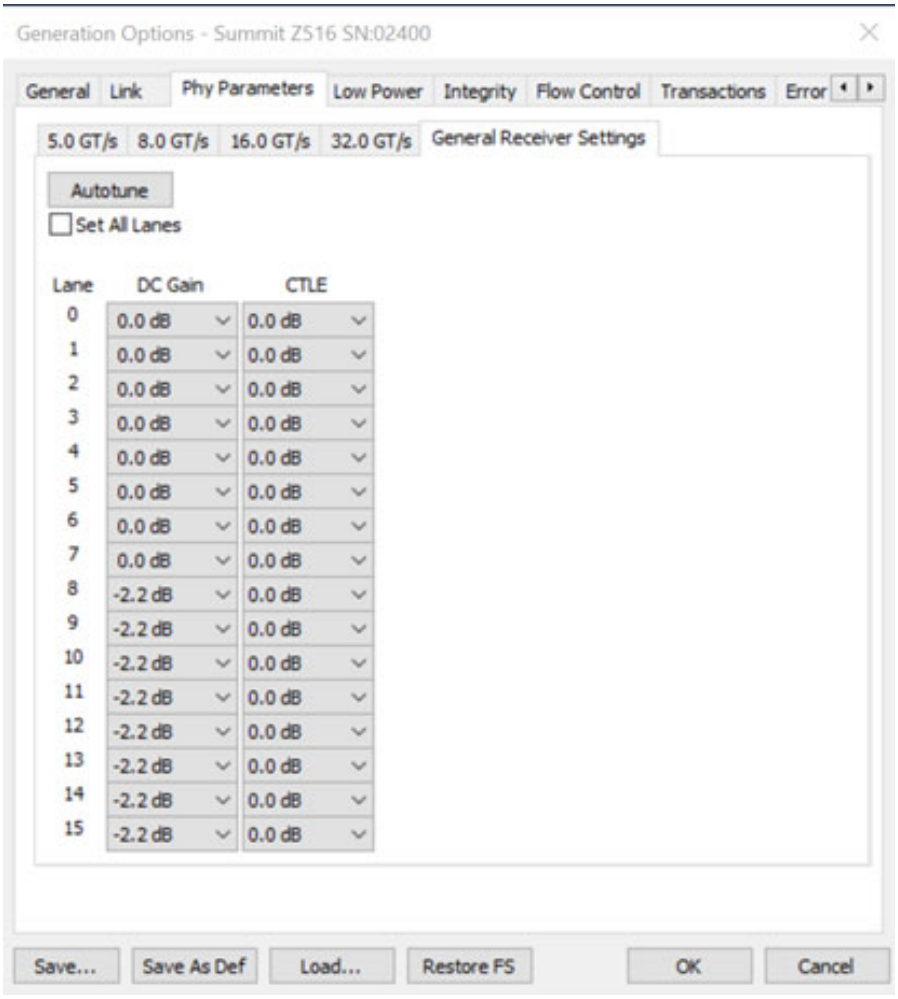
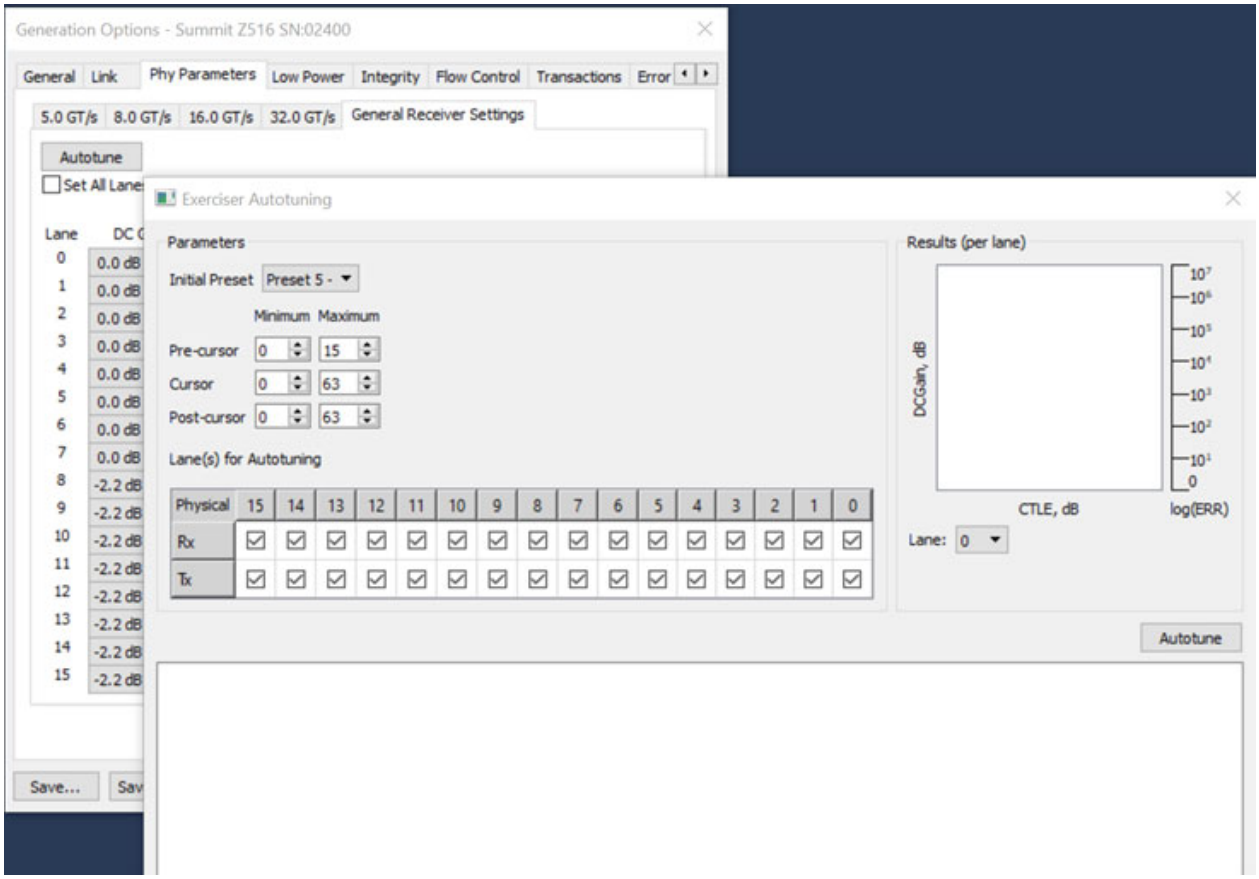


Figure 4.80: Phy Parameters General Receiver Settings Sub-Tab

When the ranges have been set, select the lanes to be tuned then click the “Autotune” box. It will run for some time (a few minutes). The best settings will be configured in the “General Receiver Settings” and 32.0 GT/s sub-tabs at the completion of the process.



4.9.3 Autotuning with Linux

In order to run Autotune on Linux systems, the Z58 or Z516 device should be discovered and configured in Linux. Use the following configuration file provided with the PCIe package:

1. Use `Write Address Space, Cfg` to write Configuration space from:

```
C:\Users\Public\Documents\LeCroy\PCIe Protocol
Suite\ScriptAutomationTestTool\TrainerScripts\RootComplex\
test_cfg_space_lecroy_final.dat
```

2. In Generation options select the Device, and in the Transactions tab select “Automatically handle Configuration Read and Write TLP Transactions”.
3. Click OK in Generation Options.
4. Click Connect.
5. Boot up the system.

4.10 Editing Generation Files with the Script Editor

The Script Editor is an editing tool for traffic generation files (**<filename>.peg**). The generation script is presented in the Script Edit window. Parameters are presented in menus and text boxes in the Command Properties window in the right-hand portion of the Script Editor.

To launch the Script Editor: click the **Script Editor** button  on the toolbar or right-click the CATC Trace window and choose **Edit as Text** from the pop-up menu.

The Script Editor window displays in the lower portion of the CATC Trace window.

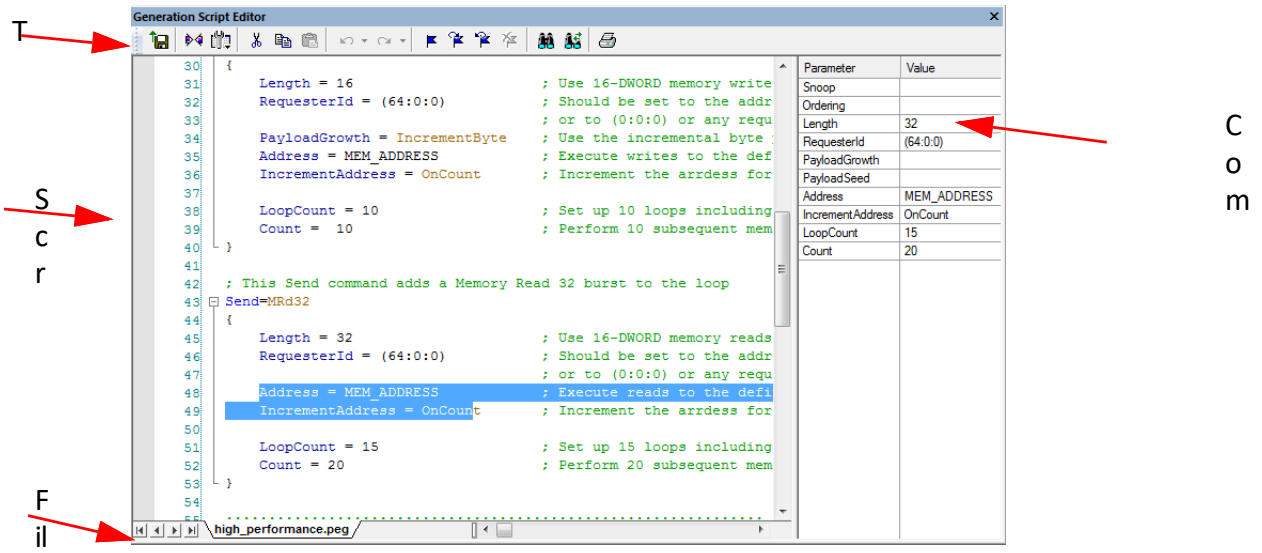


Figure 4.81: Script Editor Window

Layout: The Script Editor divides into four areas:

- **Script Editor toolbar**: Presents options for printing, saving, bookmarking, and other options.
- **Script Edit window**: Main window where the script is displayed and edited. Text in this window behaves as in most text editors. Text can be copied, pasted, and searched.
- **Command Properties window**: Presents editable parameters. Many parameters have menus. Click the parameter in the Command Properties window to see if a down-arrow appears.
- **File tabs**: Lists the name of the traffic generation file and any open **Include** files that are associated with the generation file. If the generation file has **Include** statements, the **Include** files automatically open and display as tabs in the File tabs section of the Editor window.

Error Log: An error log opens automatically at the bottom of the window any time a script error occurs. The window closes automatically whenever the error is corrected, after you save the script.

4.10.1 Script Editor Toolbar

The toolbar contains buttons for saving your edits, navigating, searching and other functions.



TABLE 4.19: Script Editor Toolbar Icons

Icon	Description	Icon	Description
	Save. Saves your edits and immediately updates the setting bars and Frames shown in the CATC Trace window.		
	Go to Trace View. Causes trace view to bring the currently selected script line to the top of the screen.		Toggle Bookmark. Allows markers to be set or removed to aid in navigation.
	View Options. Opens a menu with three options: Enable Outlining Toggle Outlining Line Numbers. See “View Options Menu” on page 205 for descriptions.		Next Bookmark.
	Cut.		Previous Bookmark.
	Copy.		Clear All Bookmarks.
	Paste.		Find.
	Undo.		Replace; Find and replace.
	Redo.		Print.

4.10.2 Script Edit Window

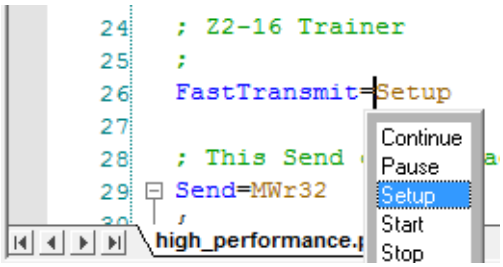
The Script Edit Window offers several features to simplify the process of editing.

4.10.2.1 Syntax Highlighting

All known commands and parameters are highlighted in **blue**.

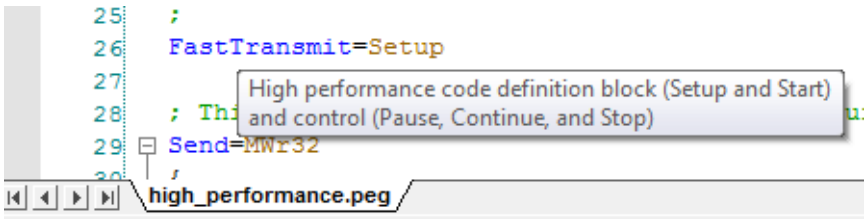
All predefined values and command modifiers are highlighted in **brown**.

Intellisense prompts for known predefined values/literals. This functionality is invoked when you type **=** after a known key or select **List values** from the Context menu.



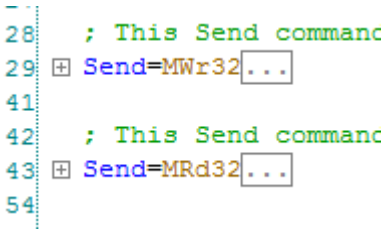
4.10.2.2 Tooltips

The Tooltips look like the following:



4.10.2.3 Outlining

When outlining is enabled the user has the option to **collapse/expand** code blocks:



4.10.2.4 Text Editing Commands

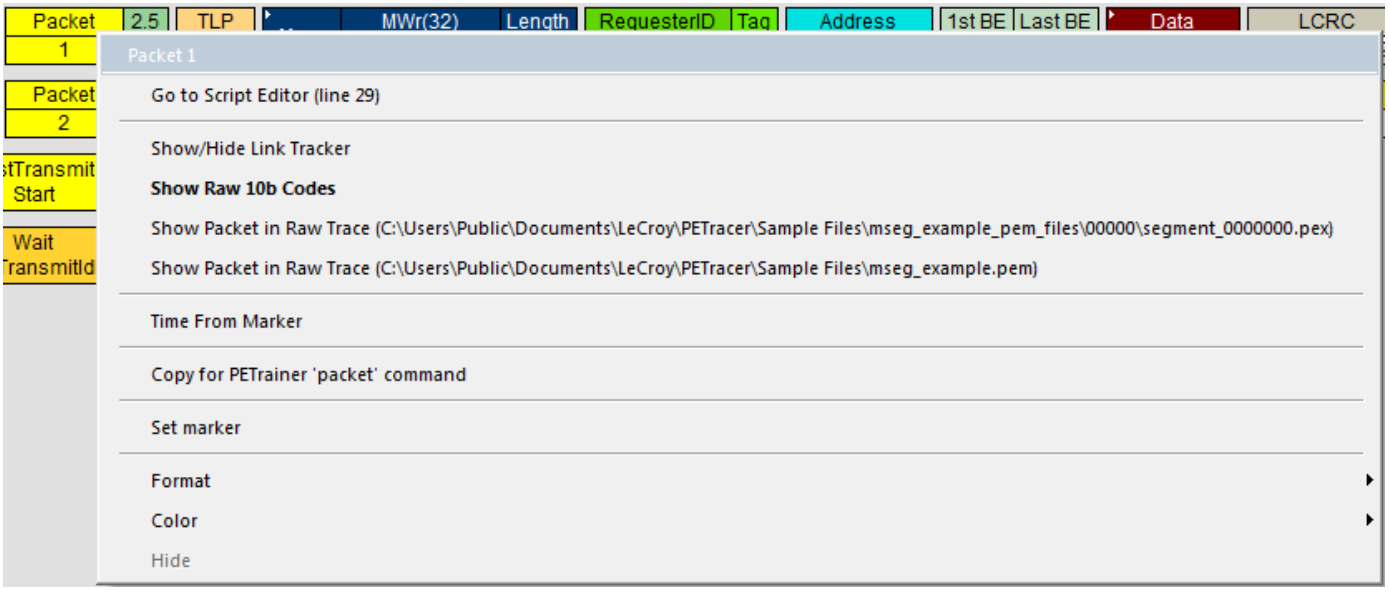
The Script Editor supports standard editor commands:

- Copy/Paste
- Undo/Redo
- Find/Replace
- Bookmarks

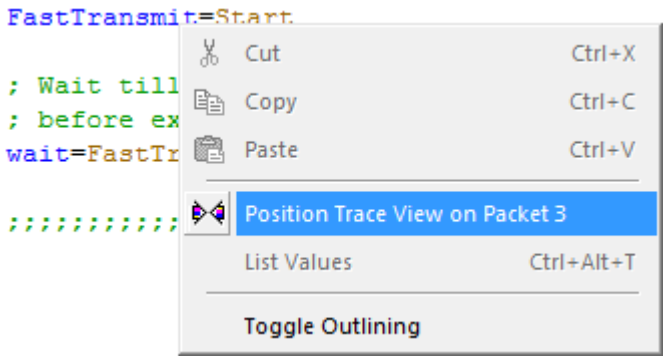
4.10.2.5 Synchronized Scrolling with the CATC Trace Window

You can navigate from the generation code window to the corresponding place in the CATC Trace representation, and vice versa.

From the CATC Trace window, right-click the **first cell in a packet** in the CATC Trace window and select **Go to Script Editor** from the pop-up menu. The Script Editor window then repositions to the corresponding code.



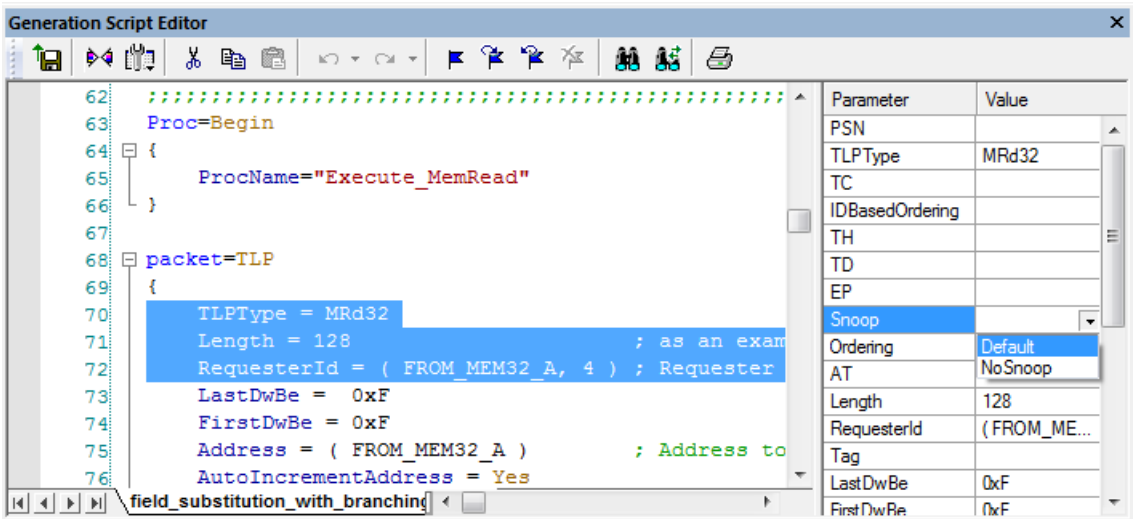
From the script editor, right-click some **code** within the Script Editor window and select **Position Trace view on packet x** from the pop-up menu (where **x** is a packet number). The CATC Trace window repositions to the corresponding packet number (see the following figure on the next page).



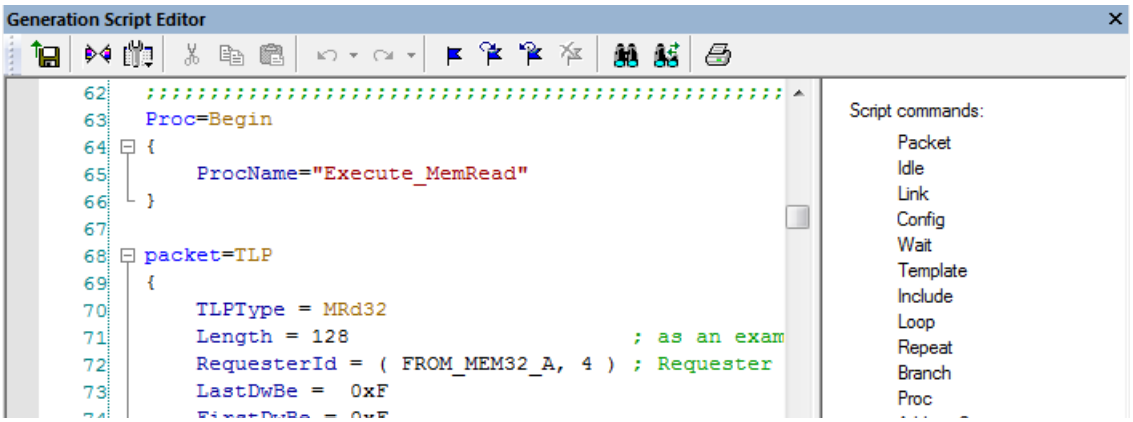
4.10.3 Command Properties Window

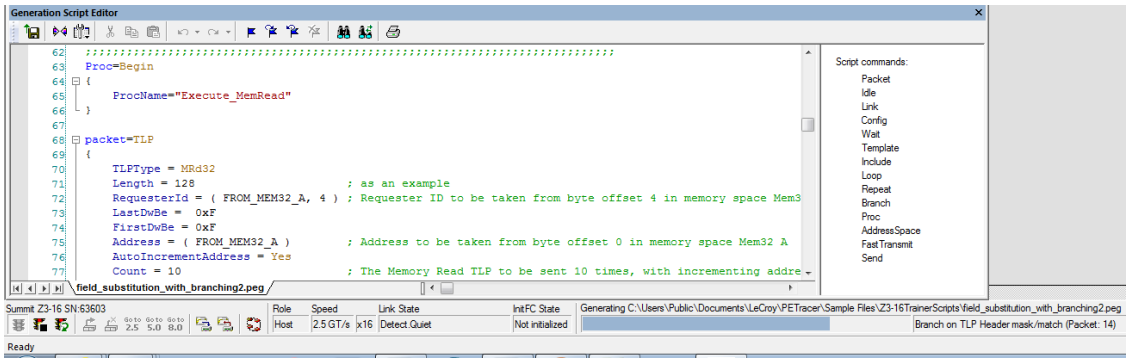
The Command Properties window lists all possible parameters for the current script command and all values for the parameters currently defined in this command. Entering parameters/values within the Edit window causes the Command Properties window to automatically update.

Parameters/values can be changed by entering text into the text boxes or by selecting items from pull-down menus as shown in the example below.



In this case, the edit window is updated automatically. If the current script command does not have parameters or the current cursor position is outside of any script command, then a generic prompt is displayed in the window:





4.10.4 Script Editor File Tabs

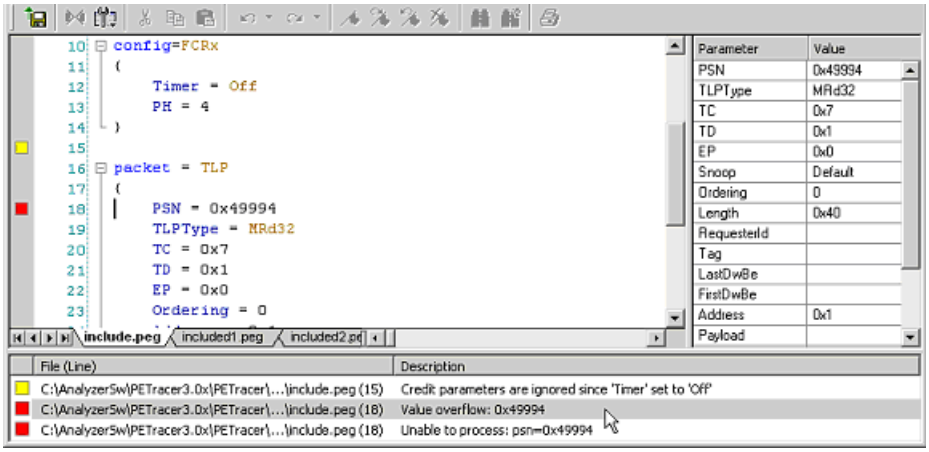
At the bottom of the Script Editor window is the name of the open generation file.

If there are **Include** statements in the generation file that link it to other generation files, these files automatically open and display as tabs at the bottom of the window. You can click the tabs to toggle between the open generation files.



4.10.5 Script Editor Error Log

Whenever you create a scripting error, a log opens at the bottom of the application window. When the error is corrected, the window automatically closes.



Errors: Marked by red squares.

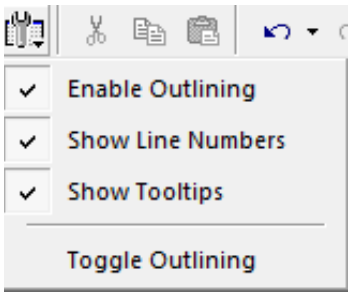
Warnings: Marked by yellow squares.

Double-clicking an error in the error log causes the cursor in the edit window to move to where the error was detected.

NOTE: You cannot run the script if it has syntax errors.

4.10.6 View Options Menu

The **View Options** button displays a menu with these options:



Enable Outlining: Adds an expandable/collapsible tree structure to the left side of the Script Editor showing the hierarchical relationships of the script lines.

Show Line Numbers: Adds line numbers to the left side of the Script Editor window.

Show Tooltips: Allows tooltip pop-ups, which provide descriptions of script keywords when cursor mouses over a keyword.

Toggle Outlining: Toggles the outline tree between collapsed and expanded states.

4.11 Example: Multi-Packet MCTP Message to the DUT

You can generate multi-packet MCTP messages to the DUT as shown in Figure 4.82.

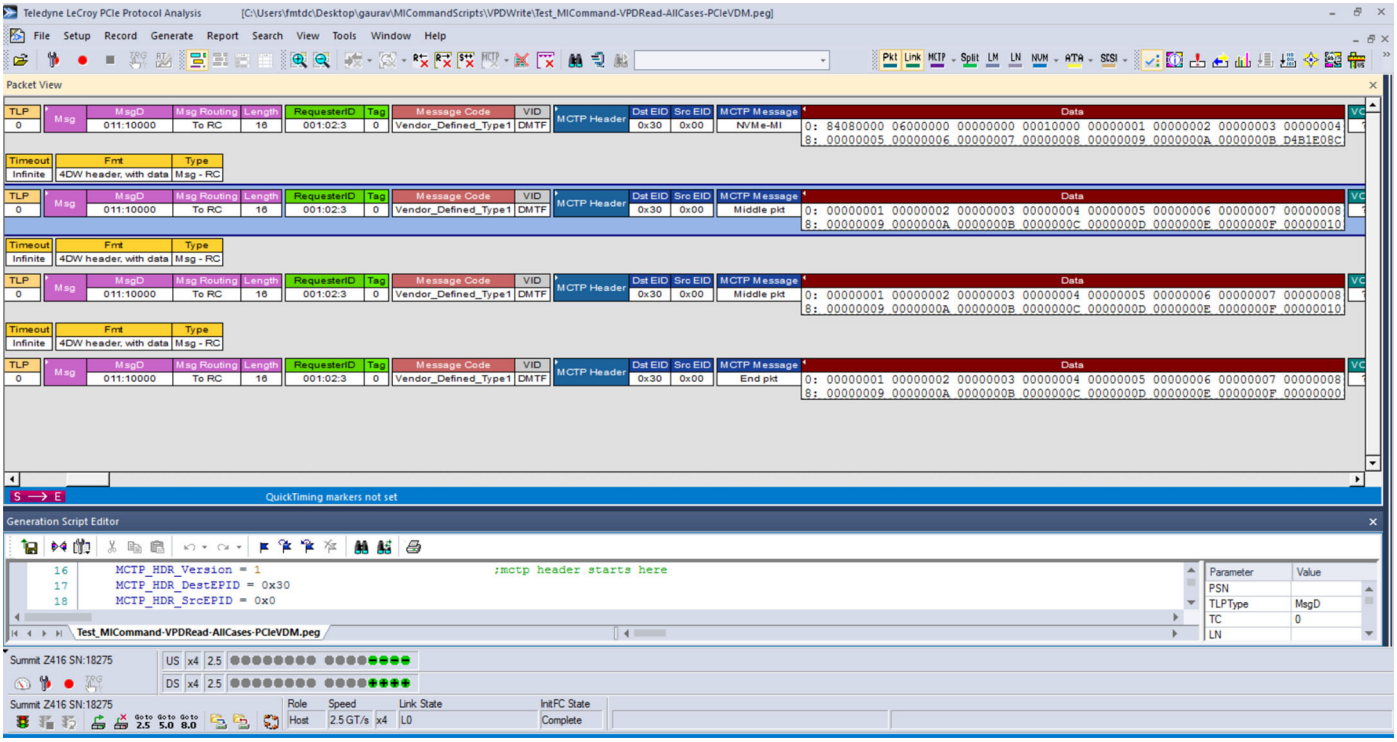


Figure 4.82: Multi-Packet MCTP Message to the DUT

Chapter 5

Macros

5.1 Macros

You can add buttons to the Status bar at the bottom of the window (and add commands to the Generate menu) to run traffic generation macros on the Exerciser.

After a macro script has been defined and assigned to a button the on the Status bar, the macro can be run by clicking the macro button with the mouse or selecting the macro name from the Generate menu.

5.1.1 Default Macros: Connect and Disconnect

By default, the PCIe Protocol Analysis™ includes two macros, Connect and Disconnect. These buttons execute macros for creating and breaking a connection between the Exerciser and a DUT.

The buttons are on the Status bar when Exerciser hardware is present. The commands are also on the Generate menu (see :

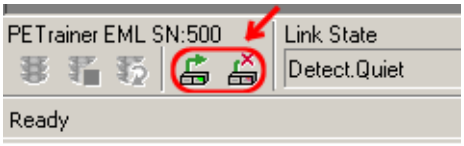


Figure 5.1: Generate Menu1

5.1.2 Generate Menu

Connect	Connects the Analyzer
Disconnect	Disconnects the Analyzer.
Switch to 2.5 GT/s	Switches to 2.5 GT/s speed.
Switch to 5.0 GT/s	Switches to 5.0 GT/s speed.
Switch to 8.0 GT/s	Switches to 8.0 GT/s speed.
Switch to 16.0GT/s	Switches to 16.0 GT/s speed.
Switch to 32.0 GT/s	Switches to 32.0 GT/s speed.
Write Address Space	Writes to the Address Space.
Read Address Space	Read from the Address Space.

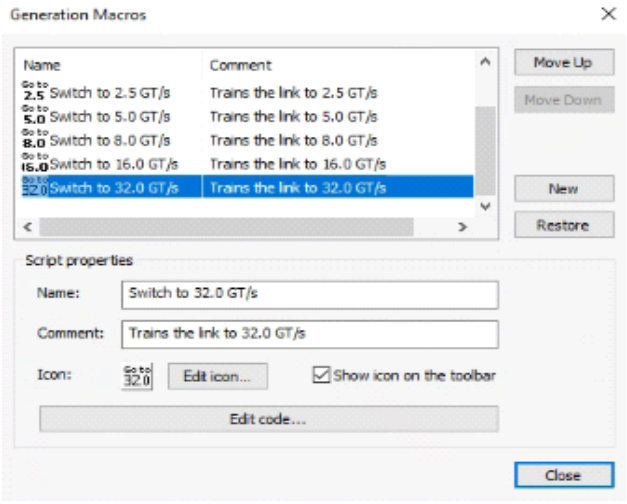


Figure 5.2: Summit Z5: Generate menu Option2

5.1.3 Connect Macro

The default code for this macro is the following:

```
Config = General {TrainerReset = 1}
Link = Detect
Wait = 500
Link = L0
```

5.1.4 Disconnect Macro

The default code for this macro is the following:

```
Config = General {TrainerReset = 1}
Link = Detect
```

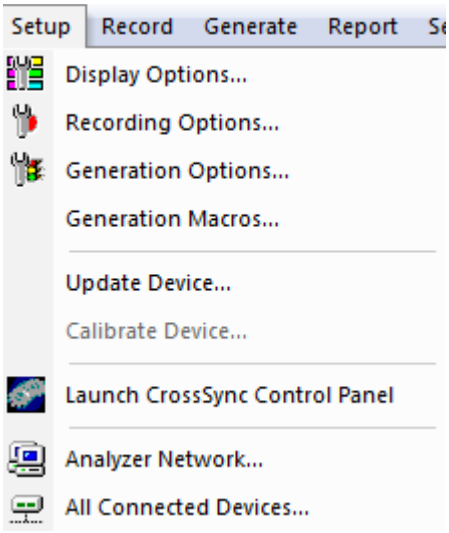
5.1.5 Adding New Script Macros

There are two ways to add script macros:

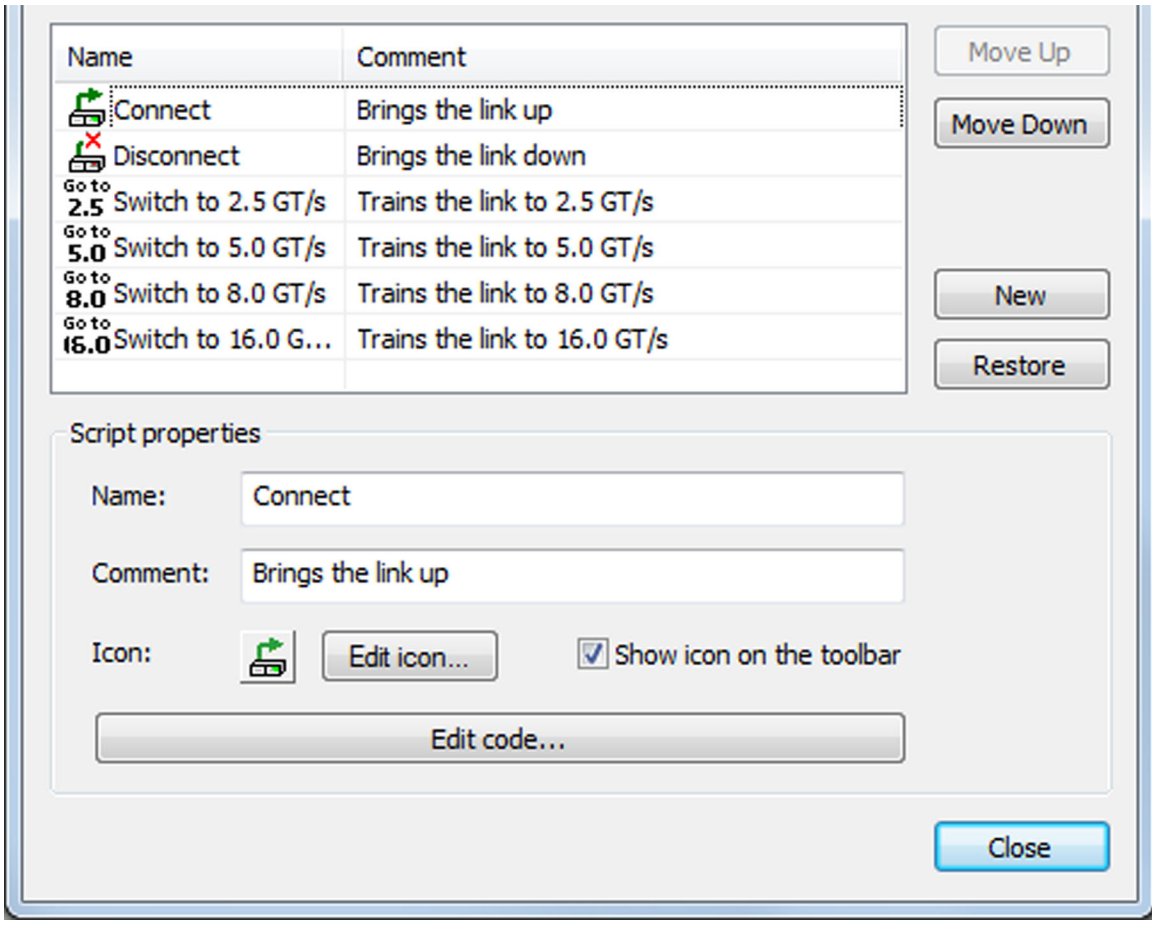
- Using the Generation Macros dialog
- Adding script files to the GenScriptMacros directory.

5.1.5.1 Using the Generation Macros Dialog

1. Open the Generation Macros dialog by selecting **Setup > Generation Macros** from the menu.



2. In the Generation Macros dialog box, click the **New** button.



3. Within Script properties area specify **script name**, **script comment**, **script icon**, and **whether or not to show script icon** on a toolbar.
4. Create a new icon for the script by clicking **Edit Icon**... button. The Edit Generation Macro Icon dialog displays.

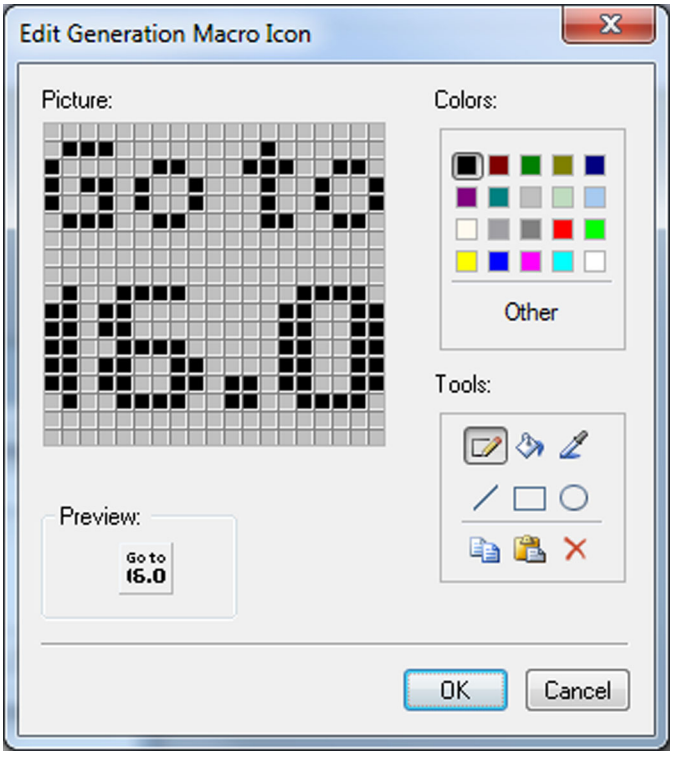


Figure 5.3: Edit Generation Macro Icon Menu

5. Using the tools provided, paint the icon for new script macro and then press **OK**.
6. Edit the script code by clicking the **Edit code**... button. The dialog closes and an empty script editing window appears (see "Autotuning" on page 194).
7. Type the script code and press the **Save** button. The script macro and icon are saved in the GenScriptMacros directory located under the PCIe Protocol Analysis directory (for example, Program Files\CATC\PCIe Protocol Suite\GenScriptMacros).
8. Close the script window. The new macro script button automatically appears on the Status bar at the bottom of the window. Clicking this button causes the Exerciser to execute the script.

5.1.5.2 Adding Script Files to the GenScriptMacros Directory

The second way to add a new script macro is to copy an existing script file in the GenScriptMacros directory.

1. Copy a script file into the GenScriptsMacros directory located under the PCIe Protocol Suite directory (for example, Program Files\CATC\PCIe Protocol Suite\GenScriptMacros).
2. Switch to the PCIe Protocol Analysis application. You see that a new icon has been automatically added for the script file to the Status bar at the bottom of the window. The default icon is assigned to the new script macro and the file name is used as a script name.

5.1.6 Modifying Script Macros

To modify a macro assigned to a button:

1. Select **Setup > Generation Macro** from the menu to open the Generation Macros dialog for modifying, creating, and deleting macros:
   - **Name**: Name of Macro
   - **Comment**: Descriptive comment so you can remember what the macro does
   - **Icon**: Currently assigned button for the macro.
   - **Show icon on the toolbar**: If checked, places the icon on the Status bar.
   - **Edit Code**: Opens a dialog for editing the macro script.
2. Select the macro to be modified.
3. Within the Script properties area, modify the script name, script comment, script icon, and whether or not to show script icon
4. To edit script code, press the Edit code... button. The Generation Macros dialog closes and the Script Editing window appears, showing current code for the selected script macro.

Note: If the Generation Script Editor pane does not appear, click  .

5. Modify the script code and press the Save button .
6. Close the script window. The macro has now been modified.

5.1.7 Changing the Order of Macro Icons on the Status Bar

To change the order of script macro icons on the Status bar:

1. Open Generation Macro Scripts dialog by selecting **Setup > Generation Macros**.
2. Click the Up and Down buttons to change the order of the script macros.
3. Close the dialog. The button order is changed.

5.1.8 Deleting User-Defined Script Macros

To delete a script macro:

1. Open the Generation Macro Scripts dialog by selecting **Setup > Generation Macros**.
2. Select the macro you want to delete and press the Delete button:

   All deleted scripts and icons are removed from GenScriptMacros directory. A backup copy is stored in the GenScriptMacros\Deleted directory.

Note: You cannot delete the Connect and Disconnect script macros.

5.1.9 Restoring the Default Appearance of the Connect and Disconnect Icons

You can restore the default appearance of the Connect and Disconnect icons by clicking the Restore button.

1. Open the Generation Macro Scripts dialog by selecting **Setup > Generation Macros**.
2. Select the macro you want to restore and press the Restore button.

Chapter 6

Summit Z58 Analyzer Capabilities

6.1 PCIe Protocol Analysis

Note: The Summit Z58 is both an exerciser and analyzer. The following sections about PCIe Protocol Analysis apply to the Summit Z58 only. The Summit Z516 is an exerciser only. If analysis capabilities are needed in conjunction with a Summit Z516, a PCIe interposer and Summit PCIe Protocol Analyzer are needed. See separate documentation for the analyzer and interposer to be used.

The PCIe Protocol Analysis™ administers Analyzer platforms and handles all CATC Trace analysis and display. The core software is thus the same for all of Teledyne LeCroy's PCI Express products.

The software runs on a Windows® based host machine that is attached to the Exerciser via an Ethernet or USB 3.1 connection. PCIe Protocol Analysis can be used without the Summit components as a CATC Trace viewer for viewing, analyzing and printing traces.

The PCIe Protocol Analysis operates on systems using Windows Server 2016/2019 (x64), Windows 10 (x64). The latest Service Pack available for the Windows OS in use is required. It is recommended that you use one of the supported 64-bit Windows versions listed above.

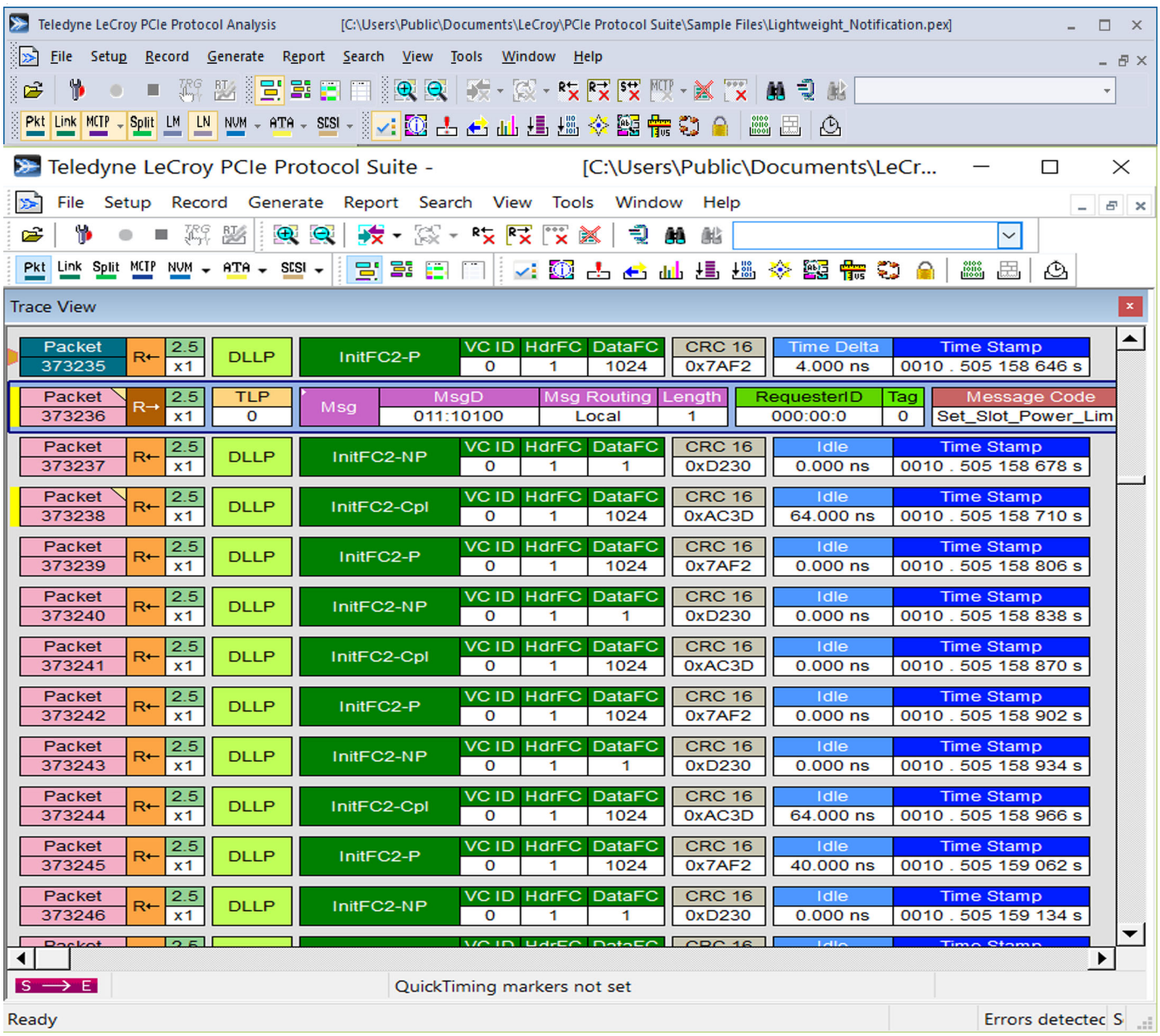


Figure 6.1: Sample of a CATC Trace

6.1.1 Application Layout

The PCIe Protocol Analysis application contains the following components:

Title bar: The title bar is at the top of the application window and displays the CATC Trace file name or generation script name.

Menu bar: The menu bar is located below the title bar, by default. The menu bar can be moved by clicking a blank area of the bar and then dragging the menu to a new position. It can be docked in another part of the application window or moved outside of the window to become a floating menu.

Toolbar: The toolbar is composed of buttons that represent the commonly used commands. The toolbar divides into smaller toolbars that can be moved and docked in a new position or made to float outside of the window.

Display area: The display area is the main part of the application window in which CATC Traces are displayed.

Status bar: The status bar is located at the bottom of the application window. The left end of the status bar displays descriptions of buttons and menu items when the mouse is positioned over them. The right end of the bar shows the search direction.

6.1.2 Using the Toolbar

You can use the PCIe Protocol Analysis application Toolbar as a shortcut to most of the operations supplied by the menus.

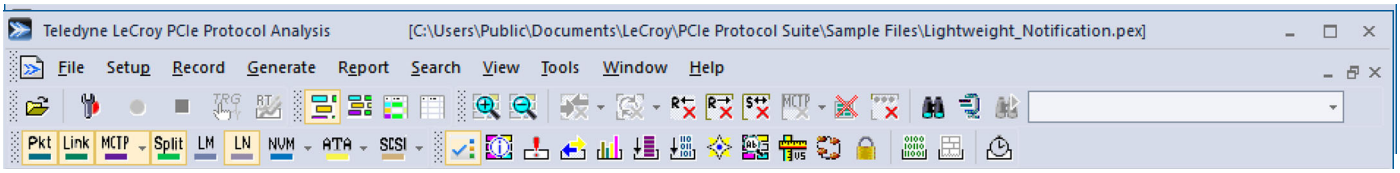
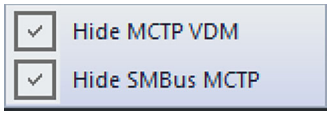


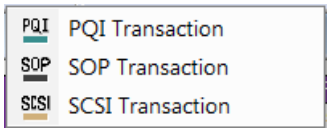
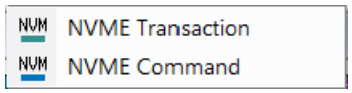
Figure 6.2: Summit Z58 Toolbar

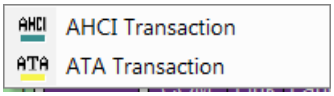
	Opens a previously recorded CATC Trace file.		Stop Recording.
	Setup Recording Options Opens the Recording Options dialog.		Real Time Statistics monitor Opens a window that displays real-time information.
	Start Recording.		

	Displays CATC Trace view.		Displays color spreadsheet view.
	Displays compressed CATC Trace view.		Displays black and white spreadsheet view.

	Zoom in display.		Advanced Hiding Options Opens a dialog box that allows you to select items to hide from view.
	Zoom out display.		Hide Unassociated Traffic Hides the lower-level transaction packets. Example: Link Transactions and Packets are considered “unassociated” when using Split Transaction Level view.

	Hide Training Sequence.		Compact View Toggles compacting of training sequences to analyze CATC Trace data faster, or no compacting to display more data.
	Hide SKIP and Update FC packets.		Find Opens a dialog box that allows you to select one or more items to find in the recording, then searches to that point.
	Hide Upstream recording/ traffic.		Find Next. Repeats last Find or Search action.
	Hide Downstream traffic/ recording.		
	Hide MCTP VDM and Hide SMBus MCTP		
			
			Quick Search window: Allows user to search for pre-defined terms or type in their own term to search for. See “Quick Search Feature” on page 232.

	View Packet Level data.		View Link Transaction Level data.
	View Split Transaction Level data		View PQI, SOP and SCSI Transaction Level data pull down menus.
	View NVME Transaction Level and Command data pull down menus		
			View MCTP Transaction Level data

ATA	View AHCI and ATA Transaction Level data pull down menus	LM	Lane Margining Commands/Respones
		LN	Lightweight Notification Transaction Level data
SCSI	SCSI level decode displays SCSI transactions.		

	Trace Expert Generates data on Performance Analysis, Trace Analysis Statistics, Error Reports and Trace Information.		Opens the Data Flow window. Shows recorded data in a compressed tabular format.
	Trace Information Lists the conditions under which the recording was made.		Navigator. Shows/hides the Navigator bar - a utility that lets you easily navigate the CATC Trace
	Error Report Opens a window that lists all errors identified in the recording.		Detail View Shows the Detail view of the selected packet.
	Traffic Summary Opens a window that lists all events that occurred during the recording		Running Verification Scripts Runs selected Verification Scripts
	Bus Utilization Opens a window that graphically represents various information about the recording.		LTSSM Flow Graph Shows a state diagram of the Link Training and Status State machine.
	Link Tracker Opens a window that displays symbol information per lane.		Opens view for TCG Security Codes. TCG decoding is performed using NVMe Command Level option.

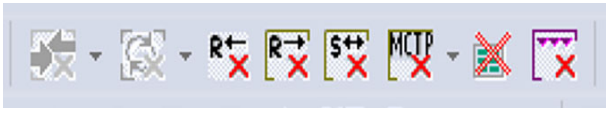
	Displays the Data/Payload window for the current packet.		Displays the Packet Header bar. Opens a window that displays the header information in the current packet, as it would be viewed in the specification.
	Opens the Timing and Bus Usage Calculations window.		

6.1.3 Multi-Segment Toolbar

	First Segment. Open first segment in the multisegment CATC Trace.		Index file. This button becomes active if a multisegment CATC Trace file is open and displays the index file for the recording.
	Previous segment. Open previous segment in the multisegment CATC Trace.		Next Segment. Open next segment in multisegment CATC Trace.
			Last segment. Open last segment in multisegment CATC Trace.

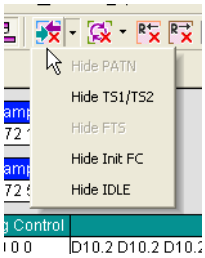
6.1.3.1 Toolbar Hide Buttons

The PCIe Protocol Analysis application toolbar has five buttons related to show/hide of CATC Trace file contents. The buttons allow you to quickly adjust the display to your needs.



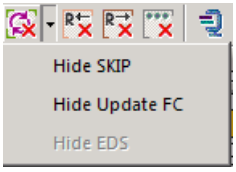


Hide Training: Brings up a drop-down menu that lets you to hide all or a portion of the packets in the training portion of the CATC Trace.





Hide SKIP, Update FC and Hide EDS: Brings up a drop-down menu that lets you hide SKIP, Update FC and hide EDS packets in a CATC Trace.



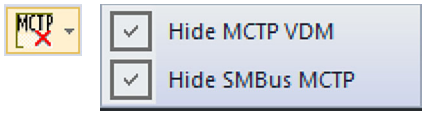
Hide Upstream: Hide all traffic from endpoint devices to the root complex.



Hide Downstream: Hide all traffic from the root complex to endpoint devices.



Hide MCTP: Hide MCTP VDM traffic (and/or) Hide SMBus MCTP traffic.



Advanced Hiding Options: Brings up the Level Hiding pane of the Display Options window. Use this pane to tune the show/hide options within the CATC Trace display.



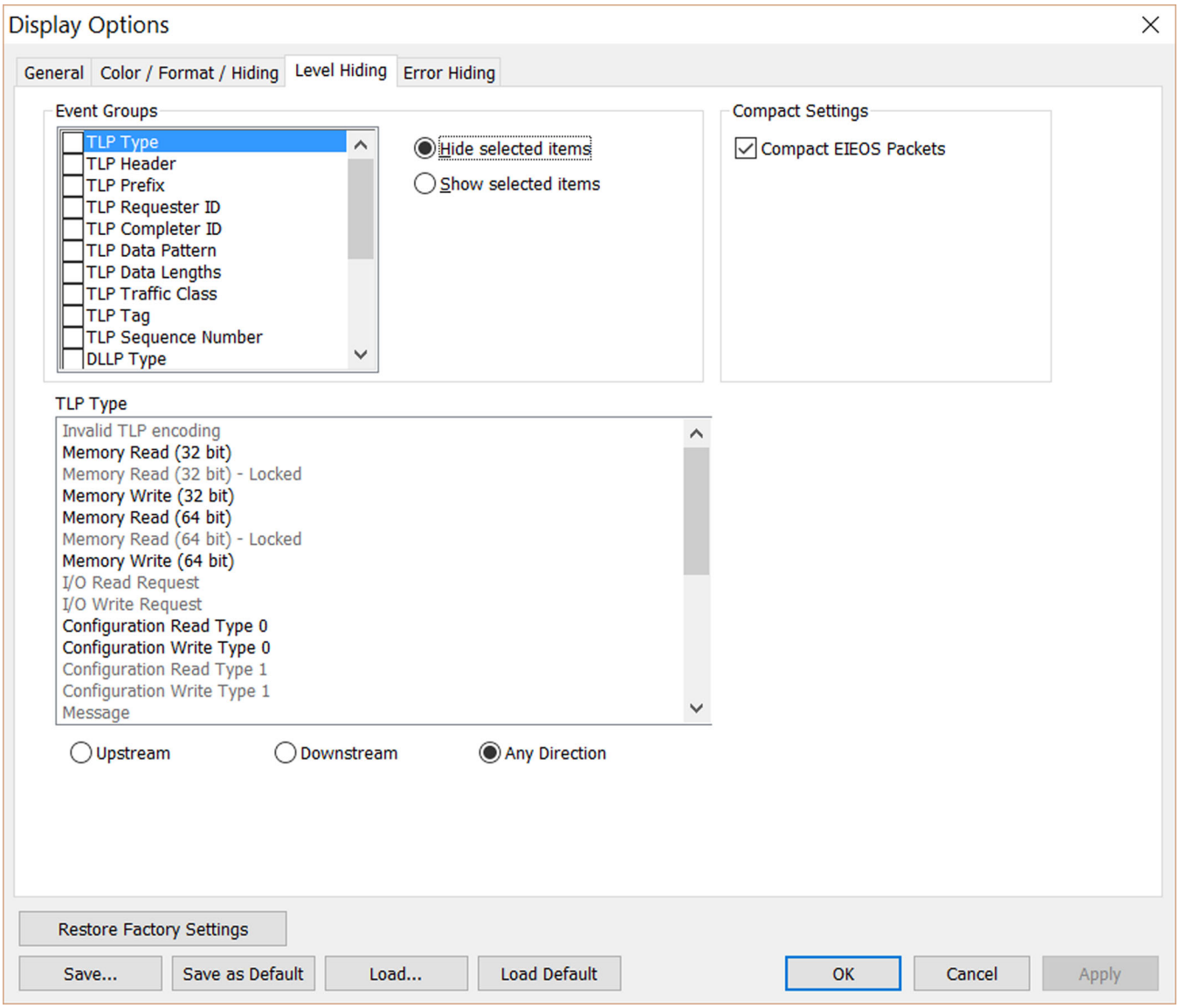


Figure 6.3: Display Options

Hide Unassociated Traffic: Hides the lower-level transaction packets. Example: Link Transactions and Packets are considered "unassociated" when using Split Transaction Level view.



6.1.4 Using the Menus

The PCIe Protocol Analysis application main display includes the following set of pull-down menus:



6.1.5 File Menu

New PETrainer Script	Creates a new Traffic Generation file.
Open	Opens a file.
Close	Closes the current file.
Save as	Saves all or a specified range of packets to a uniquely named file. Overwrites existing file name. See “Using the Save As Function” on page 246.
Save Copy As	Saves all or a specified range of packets to a uniquely named file. Original file remains the same and new file is created with the new file name. See “Trace File Structure” on page 250.
Convert Old Files	Convert CATC Trace files made in previous versions of PE*Tracer* to the new format for PE*Tracer* version 5.0 and higher.
Print	Prints part or all of the current traffic data file.
Print Preview	Produces an on-screen preview before printing.
Print Setup	Setup your current or new printer.
Clean Up Decoder Temp Files	Let’s you selectively delete decoder temp files (see “Clean Up Decoder Temp Files” on page 224).
Edit Comment	Create or edit the comment field in a CATC Trace file.
Export >> to Text >> Packets to CSV Text >> to Generator File Format	Saves all or part of a CATC Trace to a text file or traffic generation file. This text file summarizes the traffic in the CATC Trace. Saves the CATC Trace to a text file in Comma Separated Value (CSV) format. Saves the CATC Trace to a generation file, which can be used Summit Exerciser (Z58).
Exit	Exit the PCIe Protocol Analysis application.

6.1.5.1 File Dialog

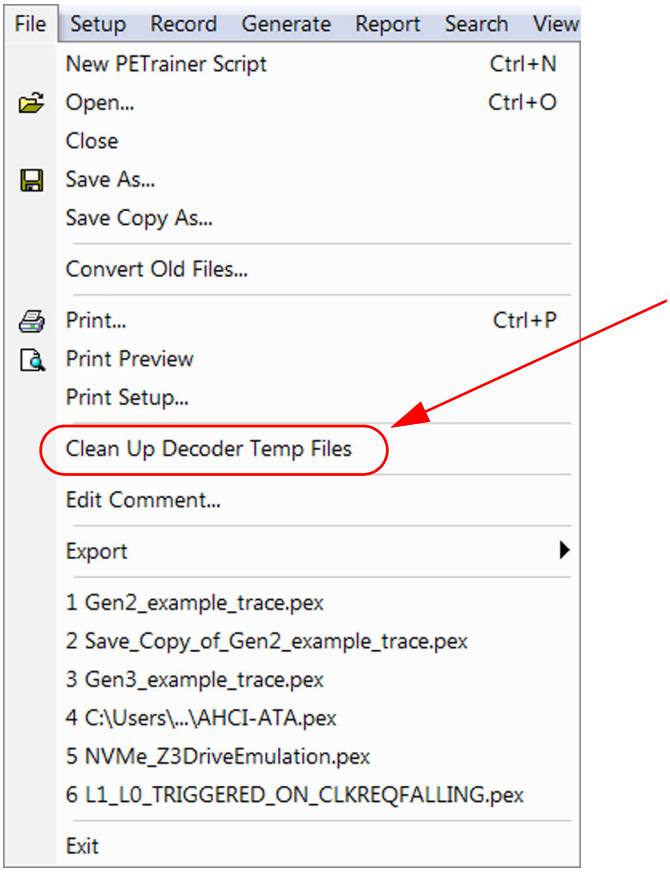


Figure 6.4: File Dialog

6.1.5.2 Clean Up Decoder Temp Files

This command deletes selected decoder temp files from the selected folder.

The file types effected by this command are:

- *.pem
- *.pex
- *.peraw
- *.mpex
- *.peg

To use this command follow the steps below:

1. The Sample File Folder has Temp files for every trace that has been opened: See Figure 6.5.

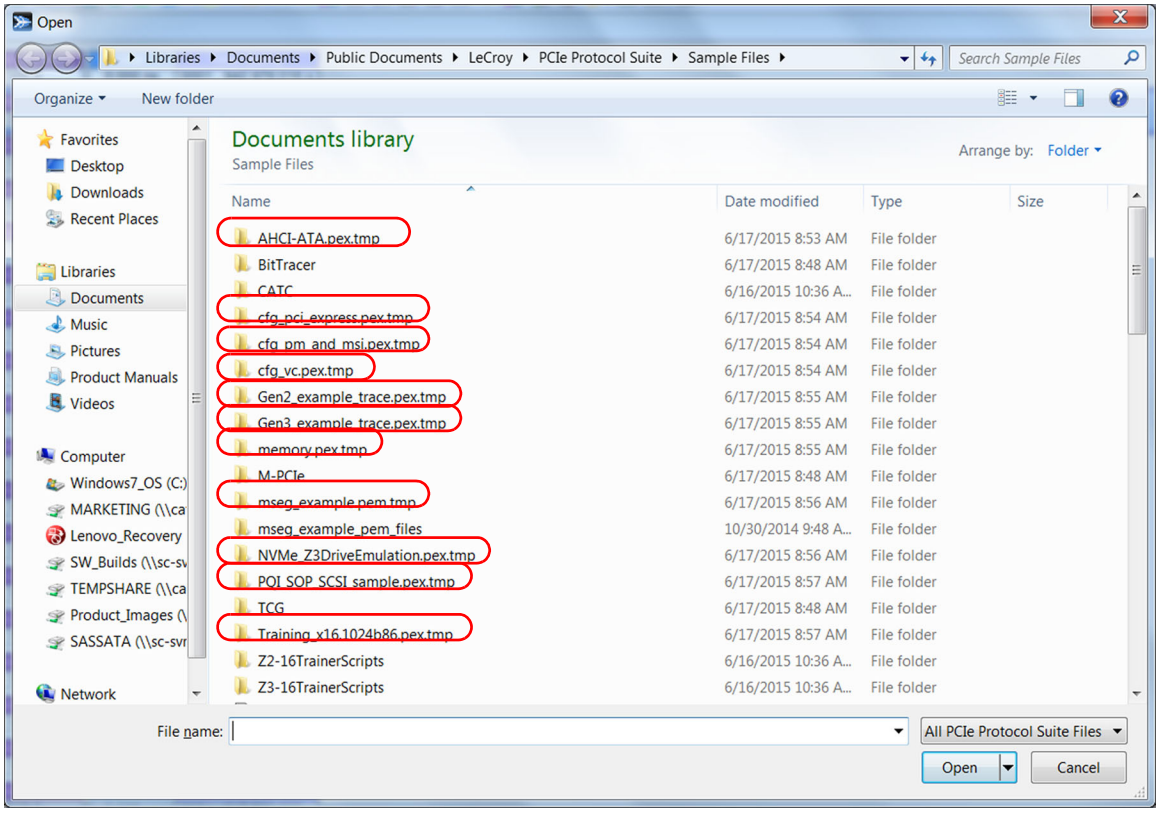


Figure 6.5: Sample Files Folder After Opening a Variety of Traces

2. Now select the File → Clean Up Decoder Temp Files (see Figure 6.4 on page 224).
3. The following Dialog will pop up: See Figure 6.6 on page 225.

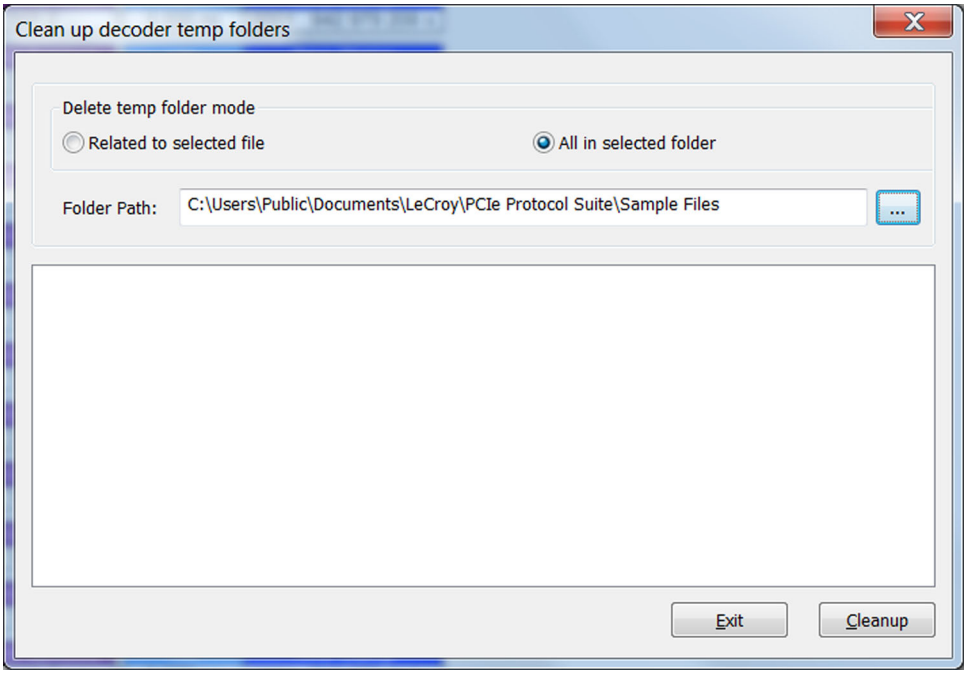


Figure 6.6: Clean Up Decoder Temp Files Dialog

4. Select C:\Users\Public\Documents\LeCroy\PCIe Protocol Site\Sample Files folder.
5. Select Cleanup and a Warning Dialog will pop up. See Figure 6.7.

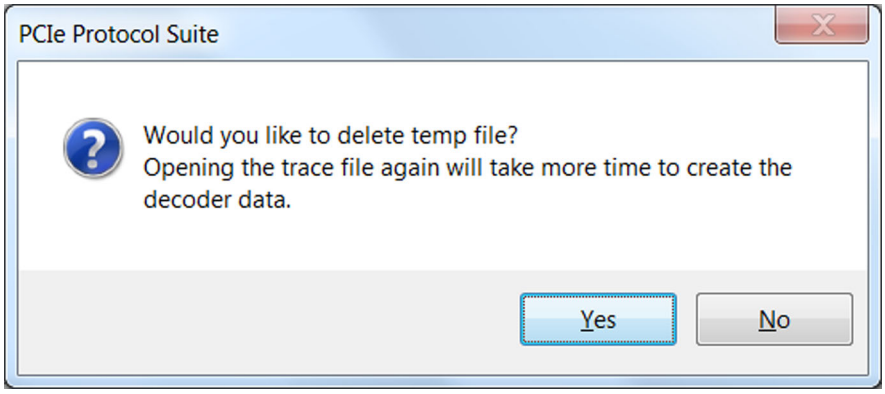


Figure 6.7: Clean Up Decoder Temp Files Warning Dialog

6. Click on Yes, (if files are still in use the Clean Up will Fail, see Figure 6.8 on page 226).

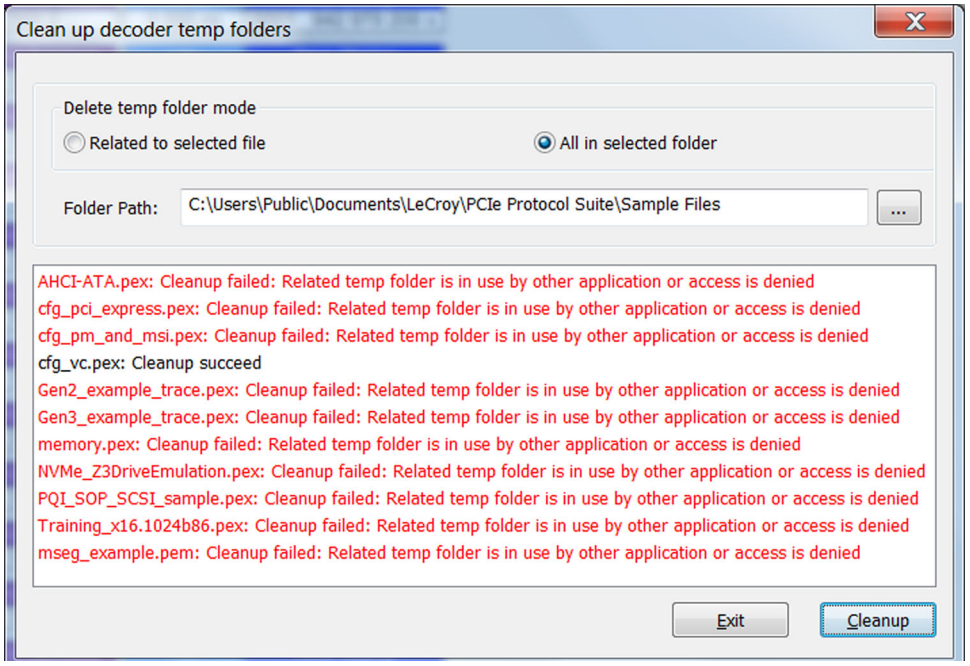


Figure 6.8: Clean Up Decoder Temp Files if Files are Still Open

7. Close Files you're not working with.
8. Select Clean Up Decoder Temp Files again.
9. Select Yes on the Warning Dialog.
10. With the files closed, the Clean Up Dialog will respond as shown below (see Figure 6.9).

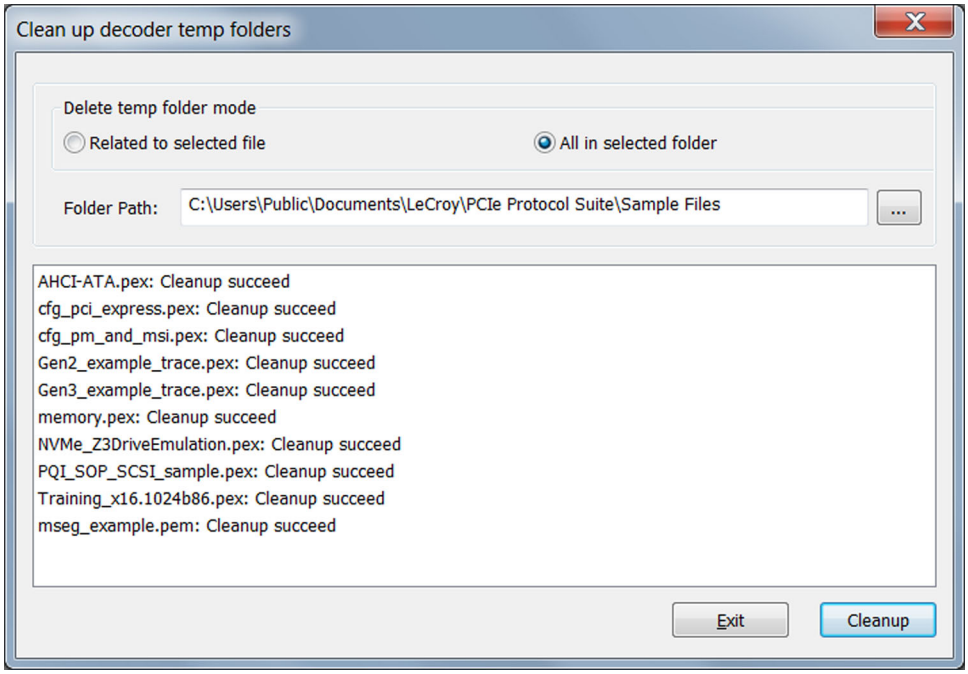


Figure 6.9: Results of Running Clean Up Command

11. Confirm that the Clean Up Command was successful by viewing the C:\Users\Public\Documents\LeCroy\PCIe Protocol Site\Sample Files folder contents, (see Figure 6.10).

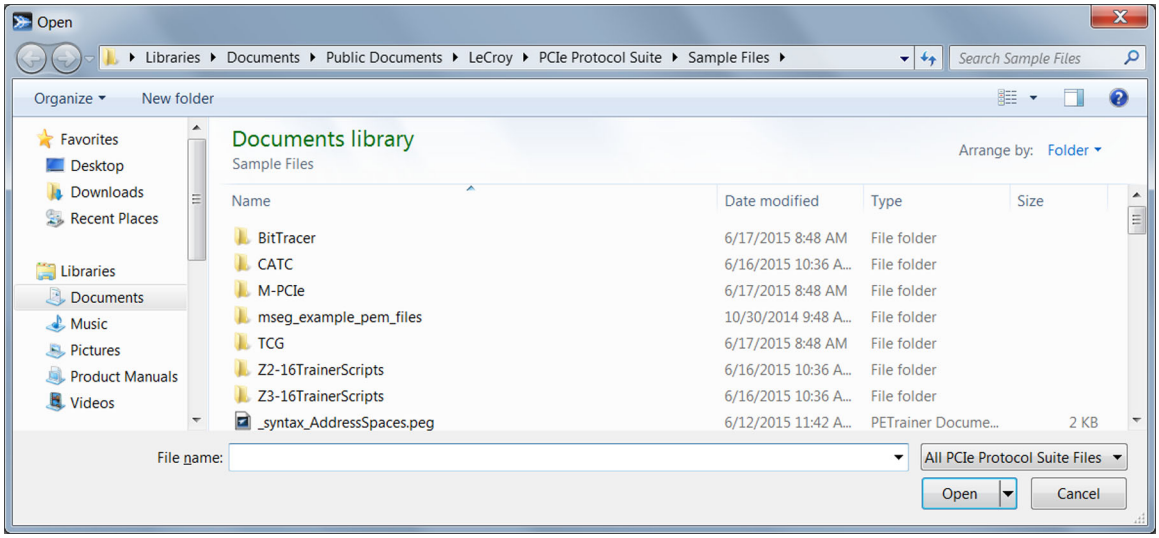


Figure 6.10: Sample File Folder After Temp File Clean Up

12. Compare Figure 6.5 on page 225 with Figure 6.10 to ensure that the .tmp files have been deleted.

6.1.5.3 Setup Menu

Display Options	Allows you to customize display options such as field colors, field formats and level hiding.
Recording Options	Allows you to customize control and setup features associated with recording, triggering, and filtering recorded events.
Generation Options	The Generation Options dialog is used to set configuration settings in a traffic generation script (*.peg). This dialog provides a convenient alternative means of editing a traffic generation file.
Generation Macros	Opens a dialog for creating buttons on the status bar that can be used to run traffic generation macros.
Update Device	Opens a dialog box that lets you update the BusEngine™ and Firmware.
Launch CrossSync Control Panel	Launches the CrossSync application. The CrossSync Control Panel allows you to select analyzers for synchronization and manage the recording process. See “CrossSync Control Panel” on page 262.
All Connected Devices	Opens a dialog box with a list of locally or remotely connected devices. Allows you to update the BusEngine, Firmware, and your licensing information.

6.1.5.4 Record Menu

Start	Causes the Analyzer to begin recording traffic.
Stop	Causes the Analyzer to stop recording traffic.
Reupload	Causes the Analyzer to re-send all, or selected portions, of the CATC Trace from the Analyzer buffer to the host machine.
Manual Trigger	Trigger command for Analyzer is generated upon clicking this button.

6.1.5.5 Generate Menu (used in conjunction with Teledyne LeCroy Trainer products

Connect	Connects the Analyzer.
Disconnect	Disconnects the Analyzer.
Switch to 2.5 GT/s	Switches to 2.5 GT/s speed.
Switch to 5.0 GT/s	Switches to 5.0 GT/s speed.
Switch to 8.0 GT/s	Switches to 8.0 GT/s speed.
Switch to 16.0 GT/s	Switches to 16.0 GT/s speed.
Switch to 32.0 GT/s	Switches to 32.0 GT/s speed.

Write Address Space	Writes to the Address Space.
Read Address Space	Read from the Address Space.

6.1.5.6 Report Menu

Report Menu operations are only available when you are working with a CATC Trace file.

Trace Expert Report	Generates Reports for the currently loaded trace: Performance Analysis, Trace Analysis, Errors, File Information.
Trace Information	Displays information about the file contents and describes the conditions of the file's recording (Recording Options, hardware information, and so on).
Error Summary	Displays an error summary of the current CATC Trace file and allows you to go to a specific packet, and save the error file to a uniquely named file.
Traffic Summary	Details the number and types of packets that were transferred during the recording. You can hide, save, send, text, print, and view.
Bus Utilization	Opens a window with graphs of bus usage for the open CATC Trace.
Link Tracker	Opens a window for displaying a detailed chronological view of traffic. The window provides view and navigation options.
Data Flow	Opens the Data Flow Window, providing a tabular view of transactions and their payload.
Trace Navigator	Shows the Navigator bar for navigating a CATC Trace. Shows a snapshot of the recording and allows you to adjust the memory area for the view.
LTSSM Flow Graph	Shows a state diagram of bus activity. Also allows you to navigate through the LTSSM, based on the current recording.
Packet Header	Opens the Packet Header bar, showing the Packet Header information as it would be viewed in the specification.
Packet Data	Opens the Data Window for the current packet or transaction, with the options: Hide, Save, Hexadecimal, ASCII, Decimal, Binary, MSB Format, LSB Format, Big Endian, and Little Endian. Format Line allows you to enter the number of bytes, words, or dwords per line.
Configuration Space	Presents a list of Configuration Spaces. Clicking an item displays the selected Configuration Space in a Configuration Table format.

6.1.5.7 Search Menu

Search Menu operations are only available when you are working with a CATC Trace file.

Go to Trigger	Repositions the display to show the first packet following the trigger event.
Go to Selected Packet	Repositions the display to a specific packet, Link or Split transaction of PCI Express protocol or NVME, PQI, AHCI, ATA, SOP and SCSI command transaction levels.
Go to Packet	Allows searching for specific link events packets or time.
Go to Time	Repositions the display to specific timestamp.
Go to Marker	Repositions the display to a previously marked packet, Link, Split, NVME, PQI, AHCI, ATA, SOP or SCSI command transactions.
Go to NVMe Transaction	Allows searching for Controller Registers, Other NVMe Entities, Doorbell Registers, Admin Submission Command Set, NVM Submission Command Set, Completion Queue Entry and NVMe Errors.
Go to NVMe Command	Allows searching for Admin Command Set NVM Command Set, Status, Errors, TCG Types, TCG Method, TCG Invoker, TCG Com ID and TCG Ext Com ID.
Go to SCSI	Allows searching for SCSI commands and sub-commands: SCSI Operation, Command Status, Task Management, Task Management Response, Error, SCSI Logical Unit Number.
Go to	Allows searching for specific link events: TLP Type, DLLP Type, Ordered Set, Link Event, OBFF Message, Traffic Class, DLLP Virtual Channel, TLP Virtual Channel, Direction, Speed, Link Width, Requester ID, Completer ID, Data Lengths, Errors.

Find	Displays the Find dialog to allow searching for various events within a CATC Trace. You can search by Display Level: Packets, Link or Split transaction of PCI Express protocol or NVME, PQI, AHCI, SATA, SOP and SCSI protocol Transaction. You can search packets by Event Group: TLP Type, TLP Header, TLP Requester ID, TLP Completer ID, TLP Data Pattern, TLP Data Lengths, TLP Tag, TLP Sequence Number, DLLP Type, DLLP Header, DLLP Virtual Channel, ACK/NAK Seq Number, Ordered Sets, Link Event, Direction, Errors, TS1 Data, TS2 Data. You can search link transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag. You can search for LM Commands: Event Groups → Margin Command, Margin Type, Receiver Number or Errors. You can search Link, Split, NVMe and PQI transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag, Address. You can search Link, Split, NVMe and PQI transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag, Address. You can search for LN transactions: Notification Reason, Cacheline Size, Cachelines, Completion Status, Read/Write, Directed/Broadcast and Errors. You can search NVMe transactions by the following Event Groups: Controller Registers, Queue IDs, Command IDs, Doorbell Registers, Admin Submission Command Set, NVMe Submission Command Set, Completion Queue Entry, and PRP. You can search PQI transactions by Event Group: PQI Register ID, PQI Admin Functions, PQI Errors. You can search AHCI transactions by Event Group: AHCI Register ID, AHCI Port Number, AHCI Slot Number, AHCI Port Multiplier Port, Raw Address, AHCI Direction, AHCI Errors. You can search ATA transactions by Event Group: ATA Register Type, ATA Port Number, ATA Slot Number, ATA Raw Address, ATA Port Multiplier, ATA Interruption Reason, ATA Error Type, ATA Input/ Output, ATA Payload Portion, ATA CFS Fields, ATA RFIS Device to Host Fields, ATA DSFIS Fields, ATA PSFIS Fields, ATA SDBFIS Fields. You can search SOP transactions by Event Group: SOP Information Unit ID, SOP Errors. You can search SCSI transactions by Event Group: SCSI Operation, Command Status, Task Management, Task Management Response, Errors, SCSI Logical Unit Numbers. You can search for the MCTP transactions: MCTP Packets, MCTP Source Endpoint ID, MCTP Destination Endpoint ID or MCTP Control Messages. Find allows you to create complex searches based on numerous criteria.

Find Next	Repeats the previous Find or Search operation.
Toggle Search Direction	Changes the current search direction from Forward to Backward or from Backward to Forward. Current search direction shown in lower right hand corner of main PCIe Protocol Analysis Menu.

6.1.5.8 Quick Search Feature

The Quick Search feature allows you to either search for a pre-defined term (see Figure 6.11) within a loaded Trace by clicking on the down arrow  or by typing your own term into the search window  and then moving the cursor into the window and hitting the Enter key. This feature will scroll through the entire Trace searching for the requested term and either stop at a highlighted Packet within the Trace or not move to a new position in the Trace if the term was not found. For more details see "Quick Search Feature" on page 459.

For a list of all possible terms, refer to "Quick Search Feature" on page 591.

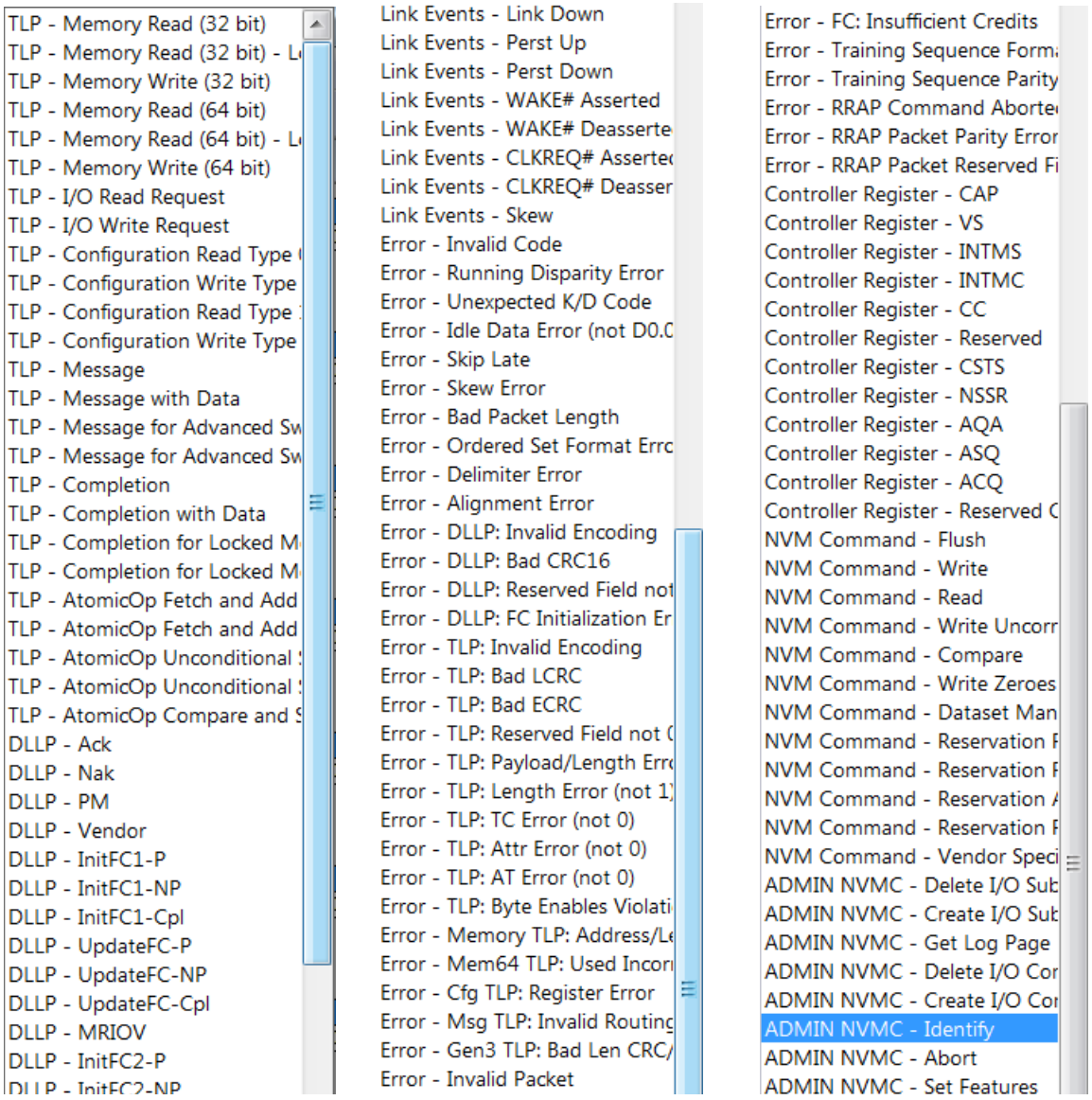


Figure 6.11: Quick Search: Pre-Defined Terms

6.1.5.9 View Menu

Toolbars>>	Displays available toolbars: Standard, View Type, Frequently Used, Analysis, and Transaction Level. Use Customize to display the Windows Customize window.
Analyzer Network Chat Bar	Opens a chat window for communicating with persons working with networked Analyzers. This command requires that your host machine be attached to a LAN. The Chat window broadcasts messages to whatever host machines have been connected.
Status Bar	Switches display of the Status Bar on or off.
QuickTiming Bar	Switches display of the QuickTiming Bar on or off.
CATC Walk	Lets you play a playlist or manage Playlists (see “CATC Walk Playlist” on page 433).
Real Time Statistics	Opens the Real Time Statistics monitor dialog and displays a real-time graph of link activity.
Unhide Cells	Unhides PQI Reserved, PQI SGL Reserved and SOP reserved cells. You can also select Unhide all.
Script Editor	Displays the Script Editor (only appears if a **.peg** file is open).
Zoom In	Zoom in increases the size of the displayed elements.
Zoom Out	Zoom out decreases the size of the displayed elements.
Wrap	Wraps displayed packets within the window.
Synchronize Trace View With Other Views	Synchronizes the Trace view with other views.
FC Credits	Toggles a display for tracking Flow Control Credit update and consumption on a PCI Express link.
FC Credits Setup	Allows you to customize the display for tracking Flow Control Credits.
Compact View	Toggles compacting of the Link Training sequence to analyze CATC Trace data faster or no compacting to display more data.
Packet Level	View the current recording at the Packet Level.
Link Transaction Level	View the current recording at the Link Transaction Level.
Split Transaction Level	View the current recording at the Split Transaction Level.

Lane Margining Commands/ Responses Level	View the current recording with Lane Margining Commands and Responses.
Lightweight Notification Commands and Responses	View the current recording of Lightweight Notification Commands and Responses.
MCTP Transaction Level	View the current recording at the MCTP Transaction Level.
NVM Transaction Level	View the current recording at the NVM Transaction Level.
AHCI Transaction Level	View the current recording at the AHCI Transaction Level.
ATA Transaction Level	View the current recording at the ATA Transaction Level.
PQI Transaction Level	View the current recording at the PQI Transaction Level.
SOP Transaction Level	View the current recording at the SOP Transaction Level.
SCSI Transaction Level	View the current recording at the SCSI Transaction Level.
NVM Command Level	View the current recording at the NVM Command Level.
Restore views to default positions	Restores views to the default positions after you click **Yes** on the prompt.

6.1.5.10 Tools Menu

Configuration Space Editor	Displays the Configuration Space Editor dialog which allows you to either create a new Configuration Space File or open an existing Configuration Space File.
Memory/IO Space Editor	Displays the Memory/IO Space Editor dialog which allows you to either create a new Address Space File or open an existing Address Space File. Select the memory size from the drop-down menu.
TC to VC Mapping	Allows Traffic Classes to be mapped to Virtual Channels for purposes of simplifying navigation (for example, Search > Go to > TLP Virtual Channel) and changing the way the CATC Trace is displayed (for example, in Split Transactions).
Timing Calculations	Starts the mode-less calculator dialog for calculating various timing and bandwidth parameters in the recording file.
PCIe SSD Base Address Mapping	Displays the PCIe SSD Base Address Mapping dialog.
Run Verification Scripts	Displays a list of verification scripts, from which you can run a verification script.

6.1.5.11 Window Menu (helps display the loaded traces)

New Window	Opens a copy of the current CATC Trace window.
Cascade	Displays all open CATC Trace windows in an overlapping arrangement.
Tile Horizontal	Displays all open CATC Trace windows as a series of strips across the display.
Tile Vertical	Displays all open CATC Trace windows as a series of strips vertically from top to bottom of the display.
Arrange Icons	Arranges minimized CATC Trace windows at the bottom of the display.
Synchronize Traces	Synchronizes the CATC Trace View windows so that a move in one window repositions the other window of the same recording.
Windows	Displays all open windows. Select to display. See Figure 6.12 on page 237 and Figure 6.13 on page 237 as well as “Trace Display Options” on page 237

For a more detailed explanation of the Window Menu options see Figure 6.12 and Figure 6.13 as well as “Trace Display Options” on page 237.

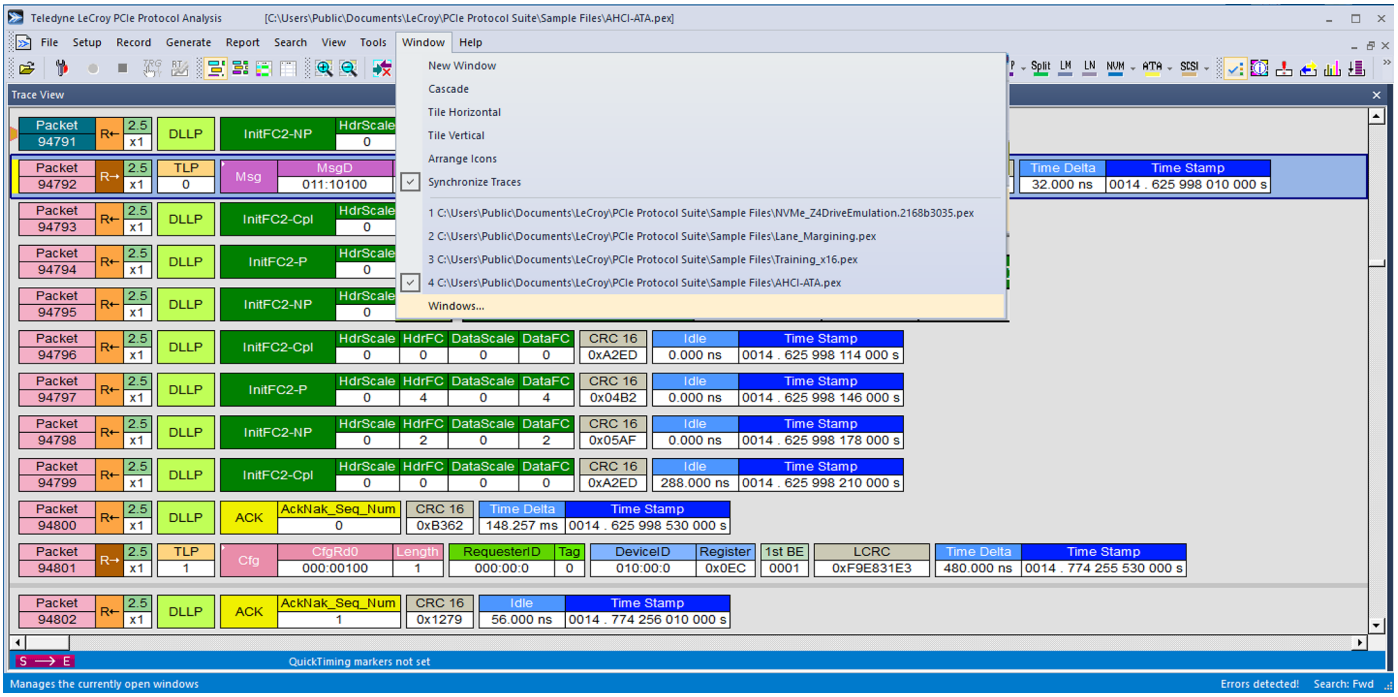


Figure 6.12: Window: Windows Menu with four traces loaded

If you select Windows from the options above a new menu will popup with the list of loaded traces. See Figure 6.13.

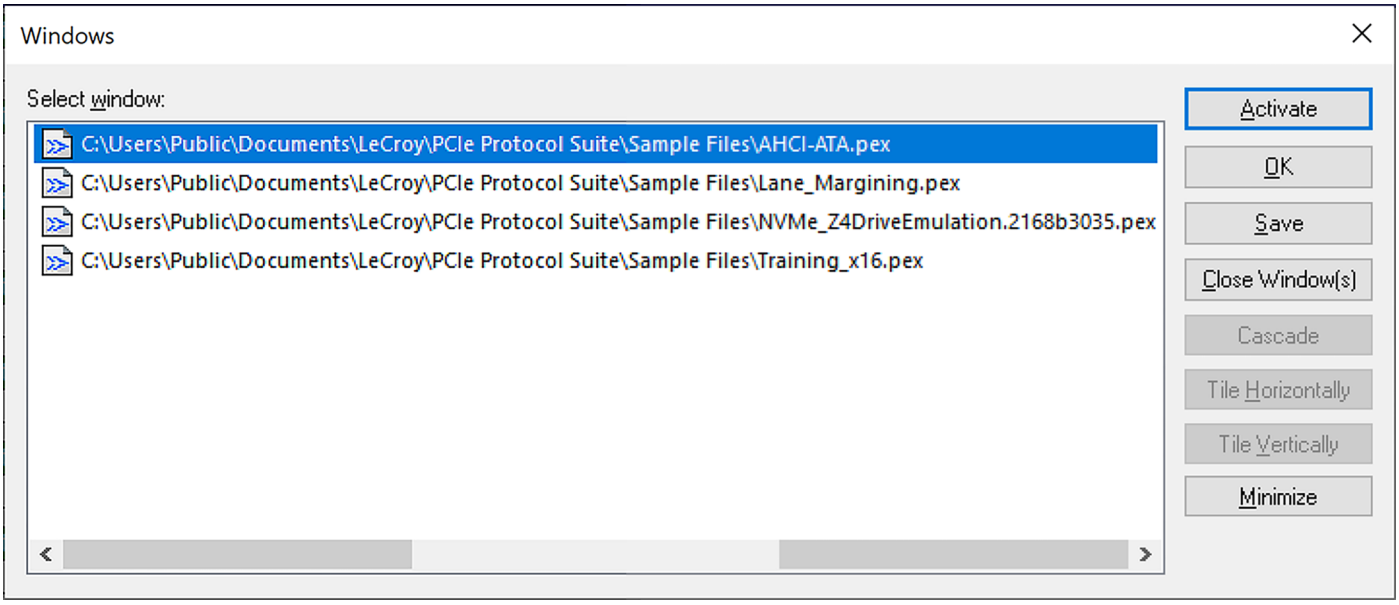


Figure 6.13: Window: Windows menu with four traces loaded

Trace Display Options

You have the following options on how the traces are displayed:

- Activate - makes selected trace active in a Trace View.

- OK - closes dialog.
- Save - This is useful for Generation Scripts, it brings up save dialog to save changes in generation script, for opened trace it does nothing.
- Close - closes selected window(s).
- Cascade, Tile Horizontally and Tile Vertically - enabled only when multiple windows are selected. Cascades or tiles selected windows.
- Minimize - minimizes selected window.

6.1.5.12 Help Menu

User Manuals F1	Click User Manuals or press F1 to access the documentation guide for all Teledyne LeCroy PCIe products.
Display License Information	Opens an information box describing the current license information.
Register Product Online	Register at the Teledyne LeCroy website registration page.
Check for Updates	Check whether a new software version is available. If so, you can download from the Teledyne LeCroy web site. You can select to **Check for updates at application startup**
Tell Teledyne LeCroy	Report a problem to Teledyne LeCroy Support via e-mail. This requires that an e-mail client be installed and configured on the computer.
Shortcut List	Displays a list of Keyboard shortcuts.
About PCIe Protocol Analysis	Displays version information about the attached Analyzer and its Firmware and BusEngine™.

6.1.6 Dashboard View

Dashboard View shows state of the link that analyzer is tracking. Click the Dashboard View icon to view the Dashboard View window for the selected device at the bottom left of the application.

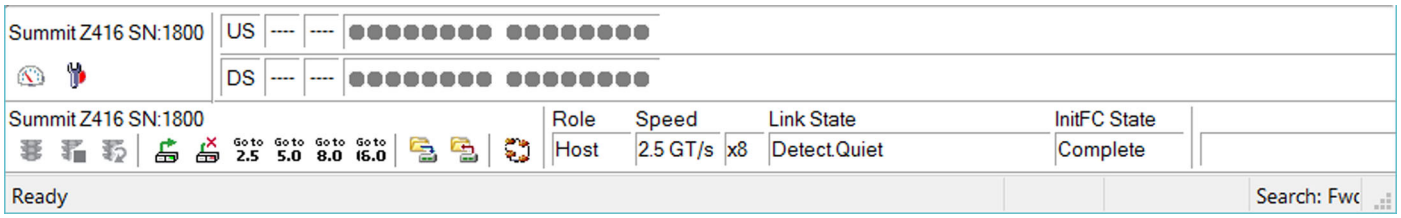


Figure 6.14: Dashboard View Icon Displaying Device

Dashboard (see Figure 6.15 on page 239) displays the following information for Upstream and Downstream:

- Link Width
- Link speed
- Per lane activity indication
  - Green - lane is active, analyzer does not detect any signal errors on this lane
  - Orange - lane is active, analyzer detects signal errors on this lane
  - Grey - lane is inactive
- Logical to physical lane mapping
- Lane polarity
- Link Number
- NFTS - The number of FTS advertised by the device for each speed

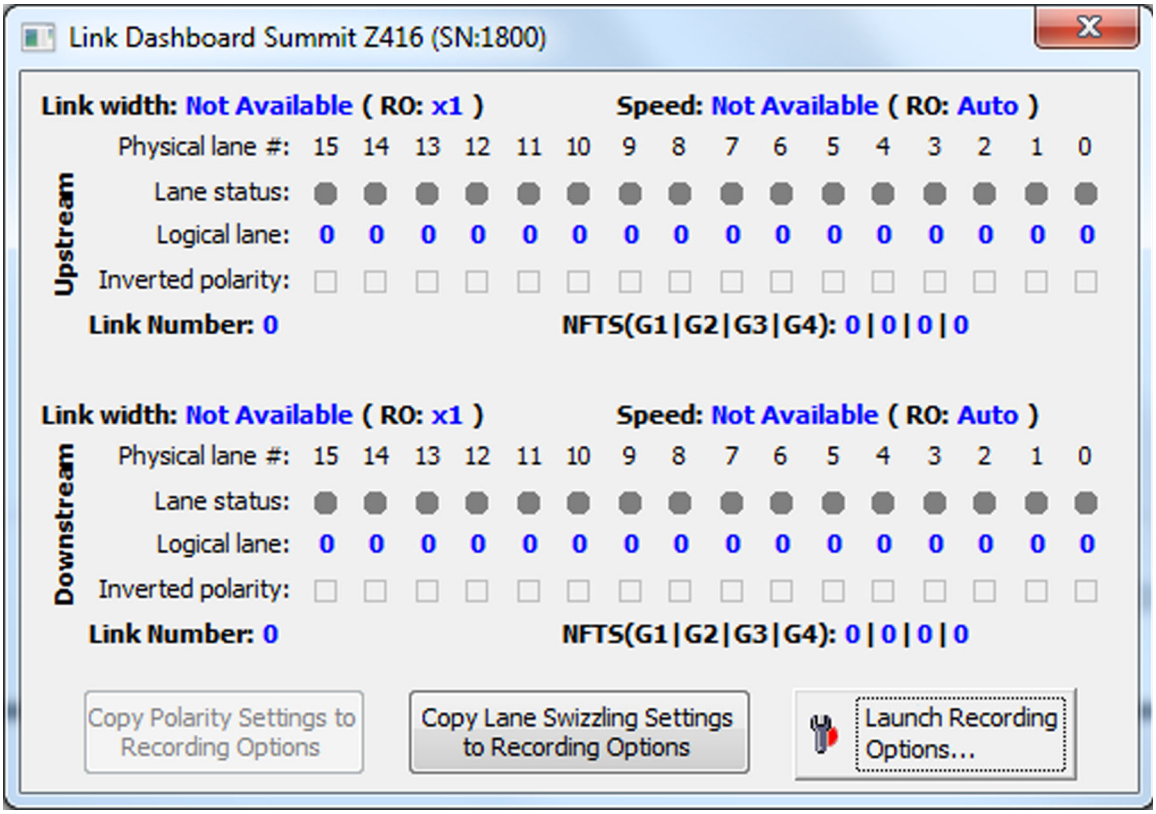


Figure 6.15: Dashboard View Dialog

You can launch Recording Options for the analyzer from the Dashboard View and adjust recording settings to match the current link configuration. The **Copy Polarity Settings to Recording Options** button allows you to copy the detected polarity into Recording Options. The **Copy Lane Swizzling Settings to Recording Options** button allows you to copy the detected Lane Swizzling Settings into Recording Options.

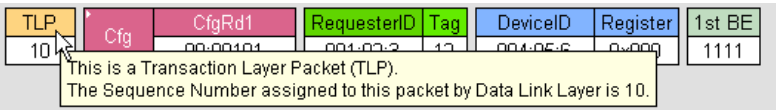
Note: Polarity auto detection and lane swizzling detection requires the link to go through link retraining at Gen1 or Gen2 speed. The analyzer has to be configured correctly to track this link retraining. For example, if the analyzer is configured to track only 8.0 GT/s speed, auto polarity detection will not work even if the link goes through the appropriate retrain.

6.1.6.1 Launching and Setting Recording Option from Dashboard View

You can select a device and click the **Launch Recording Options as shown in** Figure 6.15 button to go to **Recording Options**. In the Recording Options window the Upstream and Downstream channels can be set manually, refer to Figure 6.42 on page 265 (3C and 3D).

6.1.7 Tool Tips

Tool tips provide details about fields within the CATC Trace. To see a tool tip, position your mouse pointer over a field within the CATC Trace.



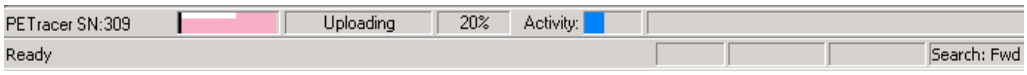
You can turn off this capability in the Display Options menu.

6.1.8 Keyboard Shortcuts

Keystrokes	Operation
Ctrl + N	New PCIe Protocol Analysis script
Ctrl+O	Open file
Ctrl+P	Print
Ctrl+S	Save file
Ctrl + R	Start Analyzer recording
Ctrl + T	Stop Analyzer recording
Ctrl+Home	Jump to first packet
Ctrl+End	Jump to last packet
Ctrl + G	Go to packet...
Ctrl + F	Search forward
Ctrl + 1	Access documentation
F3	Find next
F6	Next pane
Shift+F6	Previous pane
Ctrl+B	Search backward

6.1.9 Status Bar

The Status Bar is a gray bar that runs along the bottom of the application window.



From left to right:

PCIe Protocol Analysis SN:309: Analyzer Serial Number

Ready: Analyzer Status

Recording Progress Bar: The colored bar to the right of the serial number represents how much traffic has been recorded. The trigger point is indicated by the black line at the left side of the bar. In this example, the trigger occurred at the very beginning of the CATC Trace. If the trigger is set in the middle of the CATC Trace, the line is positioned in the middle of the bar. Additionally, the color of the bar is different on each side of the trigger point. For examples, see "Recording Progress Bar" on page 241. The white strip along the top edge of the color bar indicates how much traffic has been uploaded from the Analyzer buffer to the host machine.

Uploading and 20%: Indicates the Analyzer's recording status, what part of the recording process the Analyzer is now in. In this example, the Analyzer is in the upload stage and has completed 20% of the upload from the Analyzer to the host machine. See "Recording Status" on page 241 for details on other status messages.

Activity: The colored bar moves to indicate that the Analyzer is currently recording.

Search: Fwd: Indicates search direction. The direction can be toggled to **Search: Bwd** by double-clicking the search direction or by selecting **Search Direction** from the Search menu.

6.1.9.1 Recording Progress Bar

This indicator bar changes color to reflect the recording progress.

- Black vertical line is at the location of Trigger position.
- Black vertical line wiggles when Trigger Position is nearly reached.
- Field to right of Trigger Position changes color to indicate post-trigger activity.
- Upper half of progress indicator turns white when recording is complete.

6.1.9.2 Recording Status

The second segment from the left in the Status Bar indicates recording status.

During recording, the current Recording Status is in a segment. When you activate the **Record** function, this segment flashes a message depending on the selected Recording Options, such as **Waiting for Trigger**, **Uploading** or **Triggered**.

- The status bar displays **Waiting for Trigger** while waiting for trigger to occur based on the settings defined in the Recording Options.



Figure 6.16: Status Bar - Waiting For Trigger

The status bar displays **Uploading** when recording is complete and is being uploaded (see Figure 6.17 on page 242).

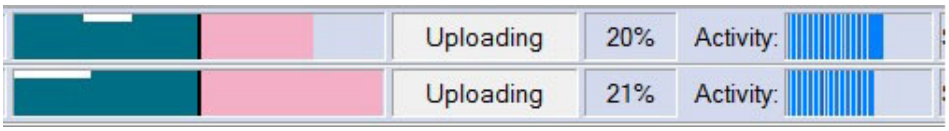


Figure 6.17: Status Bar - Uploading

The status bar displays **Triggered** when the trigger condition has occurred, but uploading has not commenced yet.

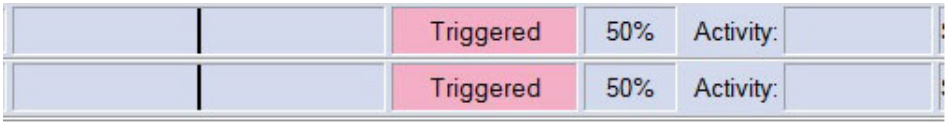


Figure 6.18: Status Bar - Triggered

As uploading progresses, the percent increases to 100. You can abort this upload if you wish by pressing the **ESC** button on your keyboard or

clicking  in the Tool Bar.

6.1.9.3 Recording Activity

The third segment displays recorded activity as a series of blue vertical bars. The more vertical bars that display, the greater the amount of activity recording. If there are no vertical bars, there is no recording activity.

During uploading, the percent of the completed upload displays.

6.1.9.4 Search Direction Indicator

The fourth segment in the status bar indicates search direction. The direction can be changed by selecting Search Direction from the Search menu.

6.1.10 Making a PCI Express Recording

Before making a recording the exerciser must be about to or already in communication with the DUT. Refer to the generation options section (see "General Generation Options" on page 101). Next Recording Options must be configured (see "Recording Options" on page 264). Then you can test the Analyzer by creating a 16-MB snapshot recording.

To make this recording, follow these steps:

1. From the **Setup** menu, select **Recording Options** and click the **Switch to Simple Mode** button.
2. Select the **Simple Mode** tab.

   The following window displays the factory default settings in **Simple Mode**, such as Snapshot and 32-MB buffer size. For your first recording, select the proper speed and link width. See Figure 6.19.

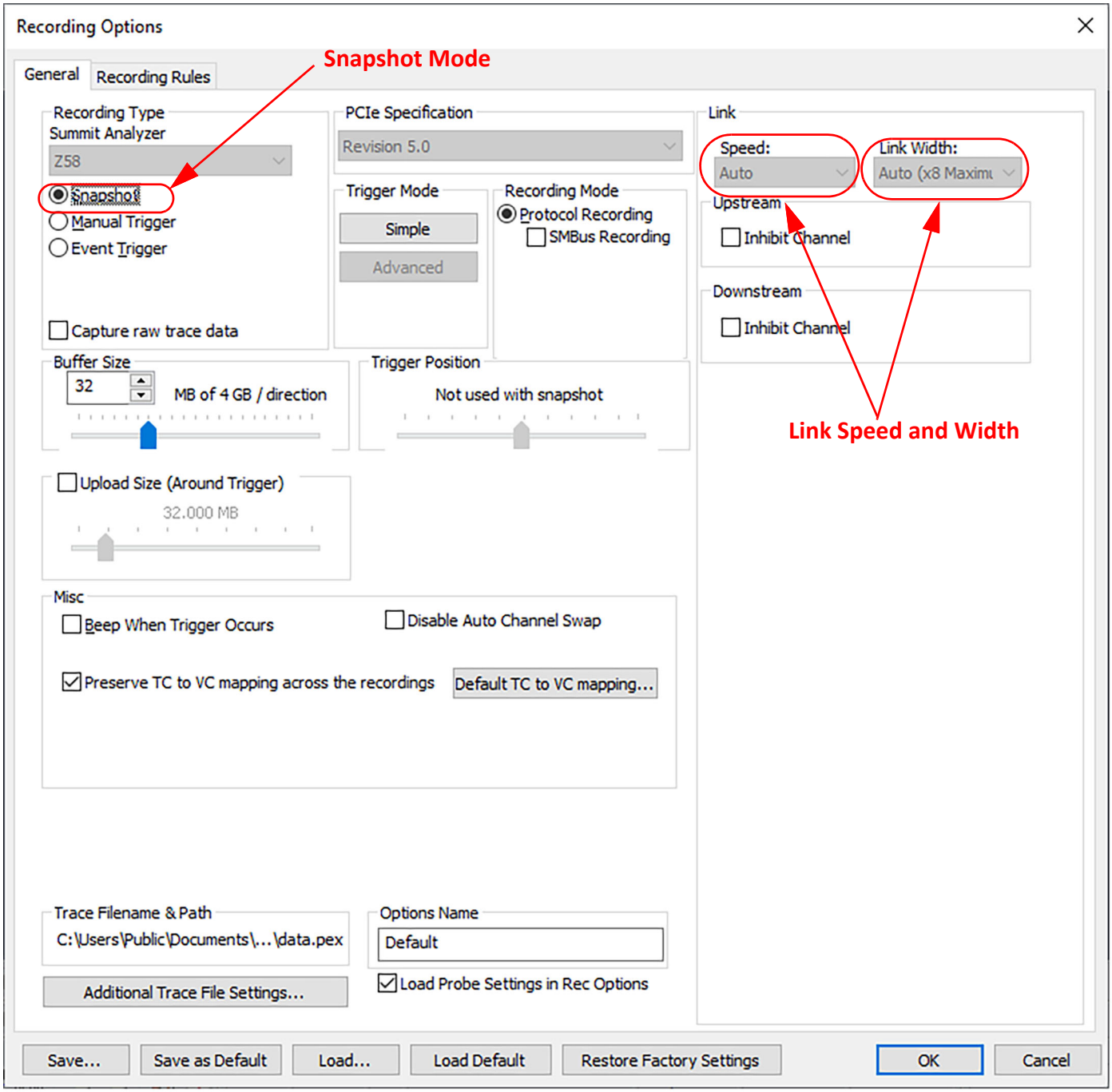


Figure 6.19: Summit Z58 in Advanced Mode: Snapshot

Note: The Link Speed and Link Width are set to Auto and Auto x8by default. There are certain limitations of Data Rate and Link Width, which are set by the Generation Options (see "Z5 General Options Dialog Layout" on page 99) and as outlined below (see Table 6.1).

TABLE 6.1: Data Rate vs. Link Width

Date Rate (GT/s)	Link Width
2.5/5.0	Up to x16
8.0	Up to x16
16.0	Up to x16
32.0	Up to x 16

3. In the **Link** section, specify the link width of the PCI Express link to be analyzed. The rest of the settings in this section can be left at the factory defaults for most PCI Express systems.
4. Speed option is determined by the current speed of the exerciser, the analyzer will track any speed changes.
5. Click **OK** at the bottom of the Recording Options dialog to apply the Analyzer recording settings specified.
6. Click the **Record**  button.

6.1.10.1 Start a Recording

6.1.10.2 Stopping a Recording

You can stop the recording process at any time by pressing the **Stop** button  . This causes the Analyzer to stop the recording and upload the CATC Trace to the host machine. If you press the **Stop** button again, the Analyzer temporarily halts the upload process and opens the following dialog box.

Note: If the uploading process is stopped manually, the resulting trace may have significant periods of time where the traffic from upstream and downstream will seem like they are not interleaved. Teledyne recommends to always let the analyzer complete the upload process.

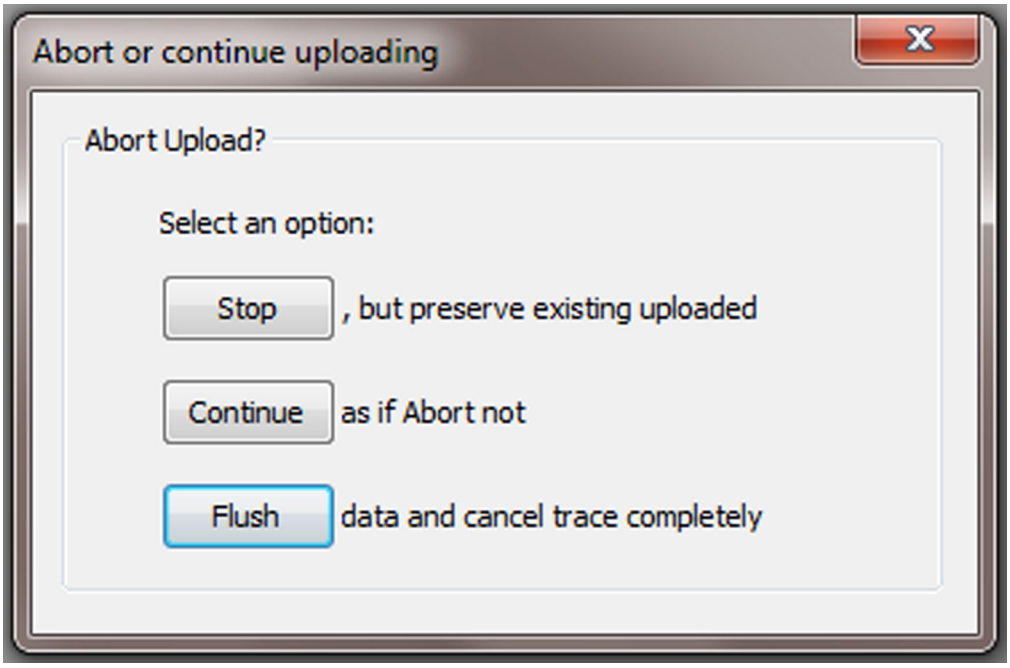


Figure 6.20: Abort Upload

This dialog presents options for stopping, continuing, or aborting the upload:

- **Stop**: Aborts further CATC Trace upload and displays whatever data that has already been uploaded.
- **Continue**: Resumes the upload. This command tells the Analyzer to finish uploading whatever CATC Trace data is still in its buffer.
- **Flush**: Flushes the CATC Trace without saving or displaying it.

If you allow the traffic data to be uploaded, it is automatically saved on the host machine's hard drive as a file named **data.pex** or the name you assign as the default filename in the recording options.

6.1.10.3 Saving a Recording

1. To save a current recording for future reference, select **Save As** from the File menu.
2. Give the recording a unique name, then save it to the appropriate directory.

6.1.11 PCIe Protocol Analysis Files

The PCIe Protocol Analysis creates and uses different kinds of files:

- **CATC Trace Files**: Recorded traffic
- **Recording Options Files**: Configuration file that contains the various options selected in the Recording Options dialog to configure the recording
- **Display Options Files**: Configuration file that contains the options selected in the Display Options dialog to configure how traffic is displayed

6.1.11.1 CATC Trace Files

PCIe Protocol Analysis records PCI Express traffic into a CATC Trace file with the default name **data.pex** or any other that you specified in the Recording Options. This file is overwritten with new data each time PCI Express traffic is recorded.

If you want to save a CATC Trace, use the **File > Save As** function. This option allows you to save the current CATC Trace to a unique file name, thereby ensuring that it is not overwritten. This option also allows you to save a range of packets in a CATC Trace file.

You can pre-define the name of the recorded CATC Trace file using the Trace Filename and Path option in Recording Options.

6.1.11.2 Recording Options Files

Recording Options files are created when you set recording options. These files use the **.rec** extension and contain recording option information.

6.1.11.3 Display Options Files

Display Options files are created when you set display options. These files use the **.opt** extension and contain the display options information.

6.1.12 Saving CATC Trace Files

6.1.12.1 Using the Save As Function

When you record a CATC Trace file, the Analyzer software provides a pre-defined name to the CATC Trace file (**data.pex** or any other that you specified in the Recording Options). If you do consecutive recordings, each time the previous recording is overwritten. If you see a recording you want to analyze later, you need to give a unique name to the CATC Trace file, so it is not overwritten with the next recording.

Also, when you analyze a recorded CATC Trace file, you might be interested in preserving just a part of the PCI Express traffic that was recorded. If you save a portion of a CATC Trace file, it can get significantly smaller, allowing you to attach it to an e-mail.

To save a portion of a CATC Trace file or the whole file to a unique name, select **Save As** from the File menu (see Figure 6.21 on page 247).

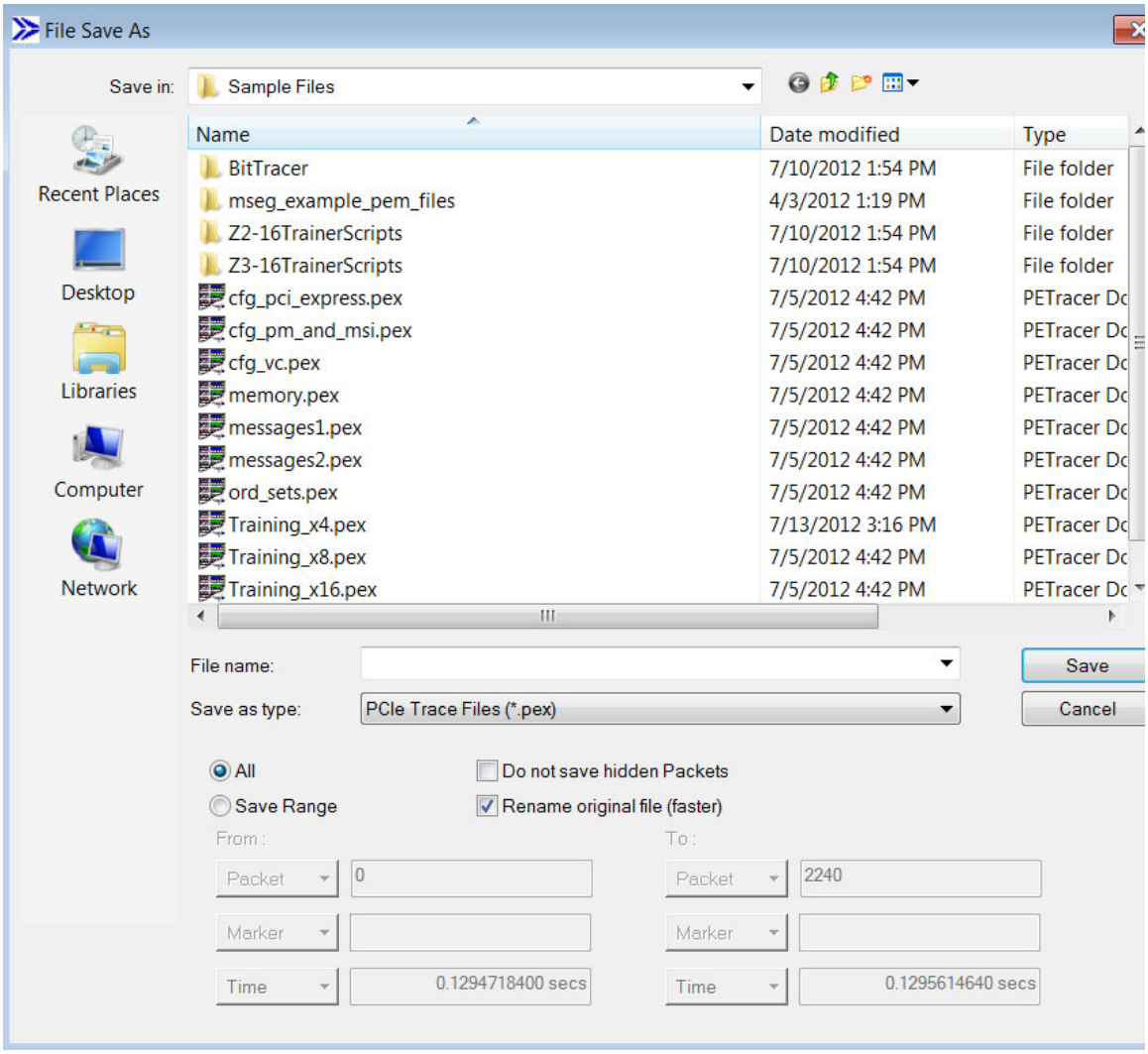


Figure 6.21: File Save As Dialog

If you want to give a unique name to the CATC Trace file, select the **All** option and keep **Rename original file** checked. This is the default setting for the dialog. The existing file will be overwritten with the new file name.

6.1.13 Saving a Portion of a CATC Trace

If you want to save a portion of a CATC Trace file, select **Save packet range**. Enter starting and ending packet numbers in the **From Packet** and **To Packet** fields. By default, it has the numbers of the first and the last packets in the file. The software is going to save all the packets in specified range to the new file, unless you have **Do not save hidden packets** checked. In this case it is going to save all packets in the range, EXCLUDING the currently hidden packets.

6.1.14 Save Copy As Function

If you want to Save a trace (or a portion of a trace) to a new file name but keep the existing file name select Save Copy As. See Figure 6.22.

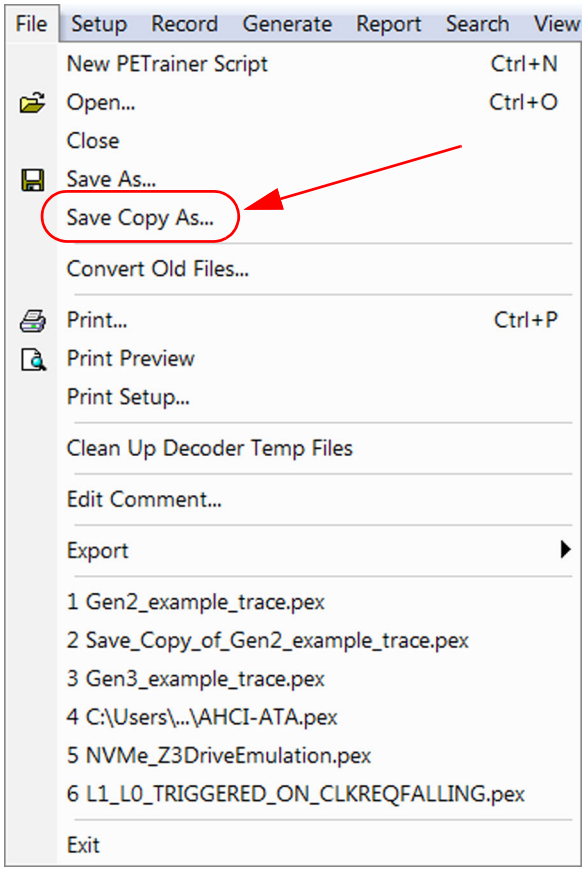


Figure 6.22: File → Save Copy As Function

Select Save Copy As and the following dialog will pop up and you can enter a unique file name (see Figure 6.23 on page 249).

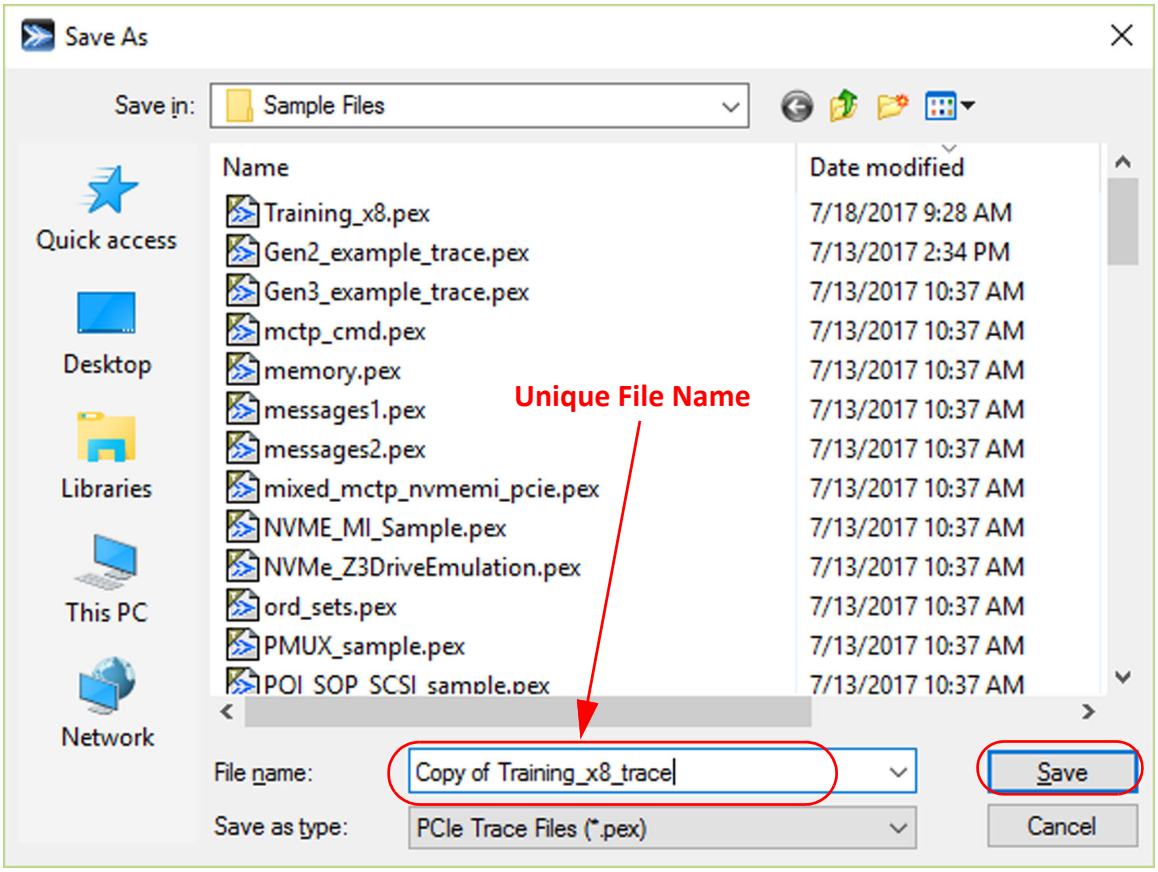


Figure 6.23: Save As Copy Dialog (Sample File Directory Before Save)

Click on the Save button and the trace will be saved with the new file name. This file can be loaded by Selecting File → Open and selecting the new file and selecting the Open button. See Figure 6.24.

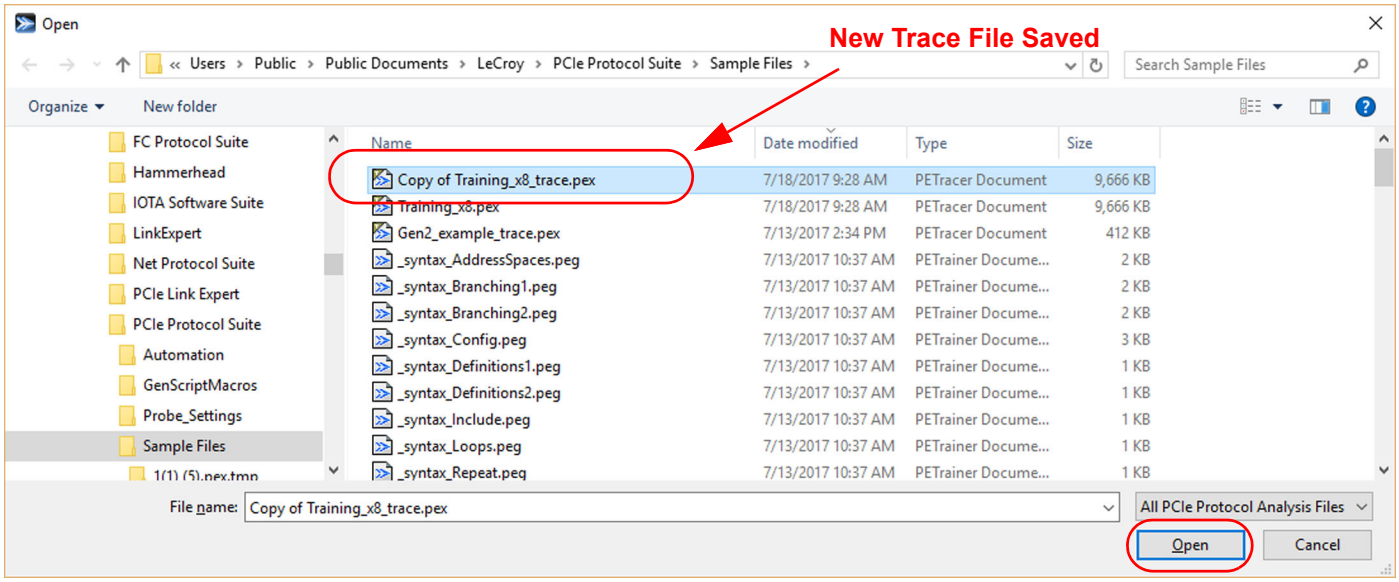


Figure 6.24: File → Open: New Trace File Available

6.1.14.1 Trace File Structure

The captured trace file has an extension of ".pex". When the trace file is loaded, additional decoding and data reduction is done which results in additional files of data which are placed in a folder of the same name as the trace file (with the extension ".tmp"). This allows the trace file to be loaded and displayed quickly during subsequent viewings.

When copying a trace file, or sending it to someone, you can chose to send just the .pex file. In that case, the software re-generates the additional folder and files when the trace is first opened. The other choice is to send the additional folder with contents along with the .pex file, which will save the rebuilding effort when the file is opened again. The choice is up to the user. If you do NOT want these files kept, and don't mind the extra time it takes to re-build these every time you load a trace file, then you can select this in the Recording Options.

If the additional files ever become out of date (newer software structures from a new release, etc.) or if any of the files are lost or damaged, the software will rebuild a fresh version of the information.

6.1.15 Exporting a CATC Trace File

By default, PCIe Protocol Analysis saves CATC Trace files in the **.pex** format. However, you can export a CATC Trace to a file in any of the following other formats:

- Text
- Comma Separated Value (CSV)
- Generator file format

Exporting to Generator file format is a simple way to create a script file from your CATC Trace. Only PCI Express packets will be exported to a script. All transaction levels, including supported SSD decodes, can be exported to Text or CSV Text.

To export a CATC Trace file, select **File > Export**.

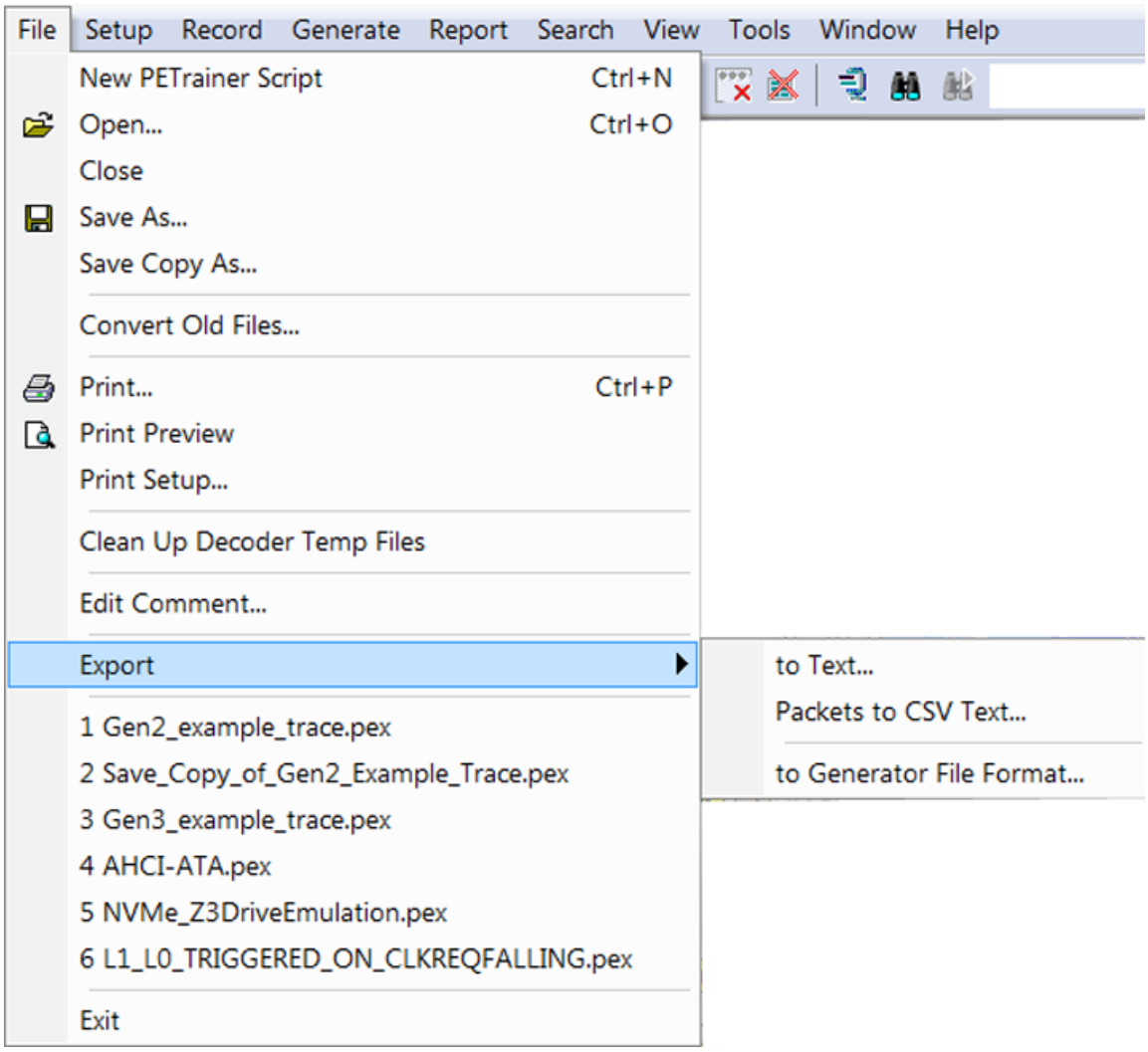


Figure 6.25: Exporting a File

6.1.16 Export: To Text

Select Export => To Text, a window pops up that has a button to select legacy format, which would not effect older scripts (see Figure 6.26) or to use the newer default format. See Figure 6.28 on page 253.

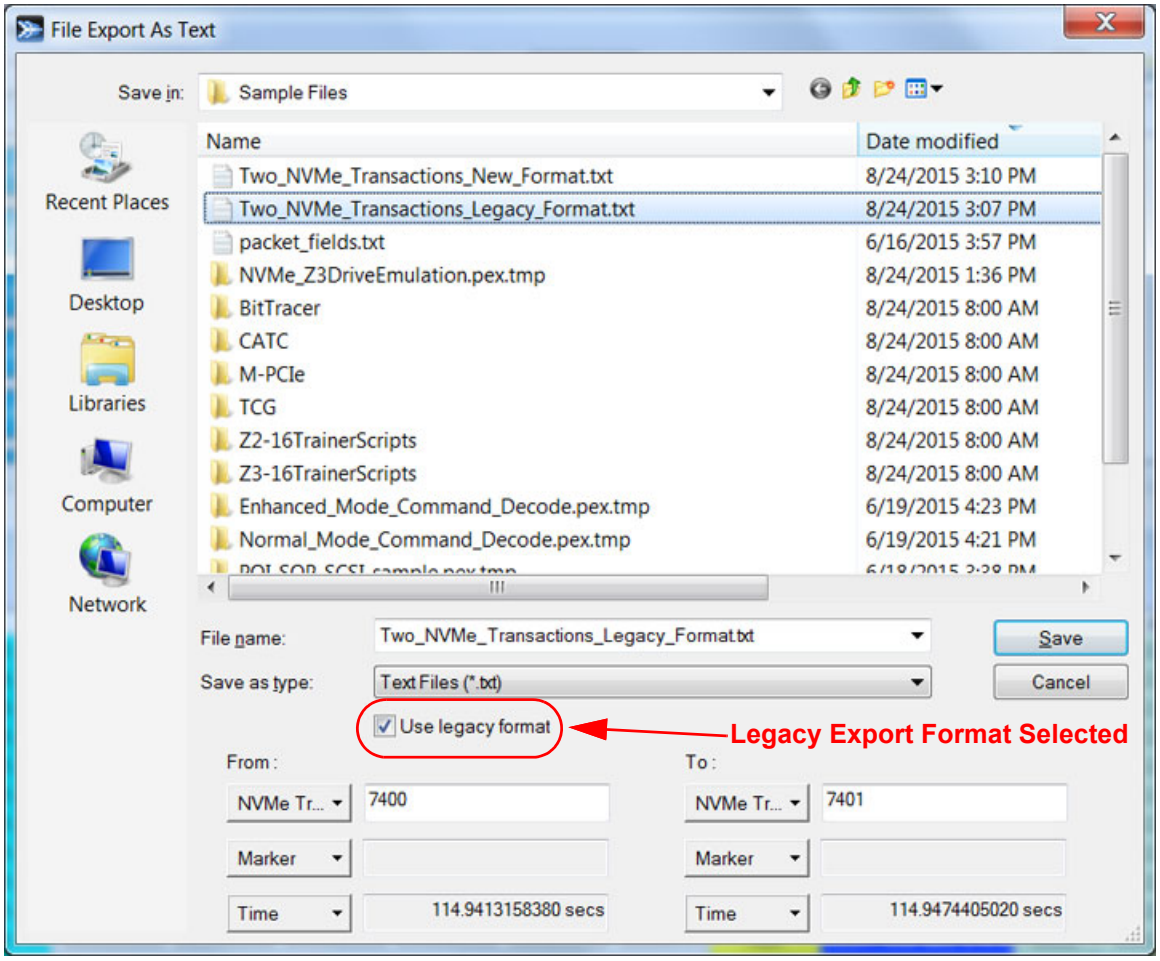


Figure 6.26: Export Two NVMe Transactions to Text File, Legacy Format

You can also select to Export only a portion of the Trace by setting the “From” and “To” menu items at the bottom of the dialog. You can select from Packets (or decoded Items see Figure 6.27) , Markers or Time see Figure 6.28 on page 253.

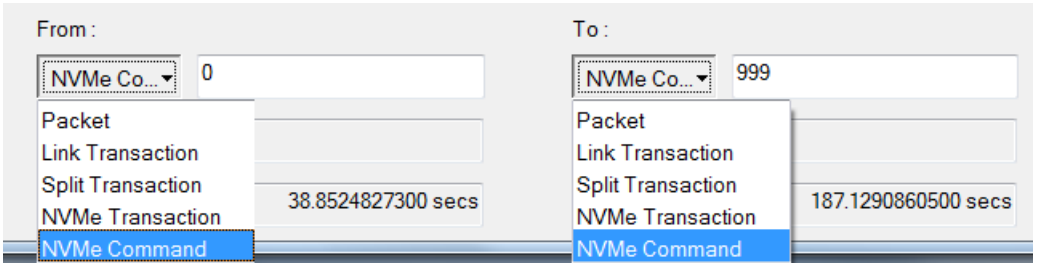


Figure 6.27: From and To Delimiters

The newer default format has the following characteristics:

- Removes spaces from time stamp format, i.e. "0002 . 742 651 908" → 2.742651908
- Adds time delta value to the export
- Modifies 'Data' field to show '4 B' or 1 KB instead of '1 dword'
- QID / CID fields will be in decimal format rather than hexadecimal, i.e. 0x0007 → 7

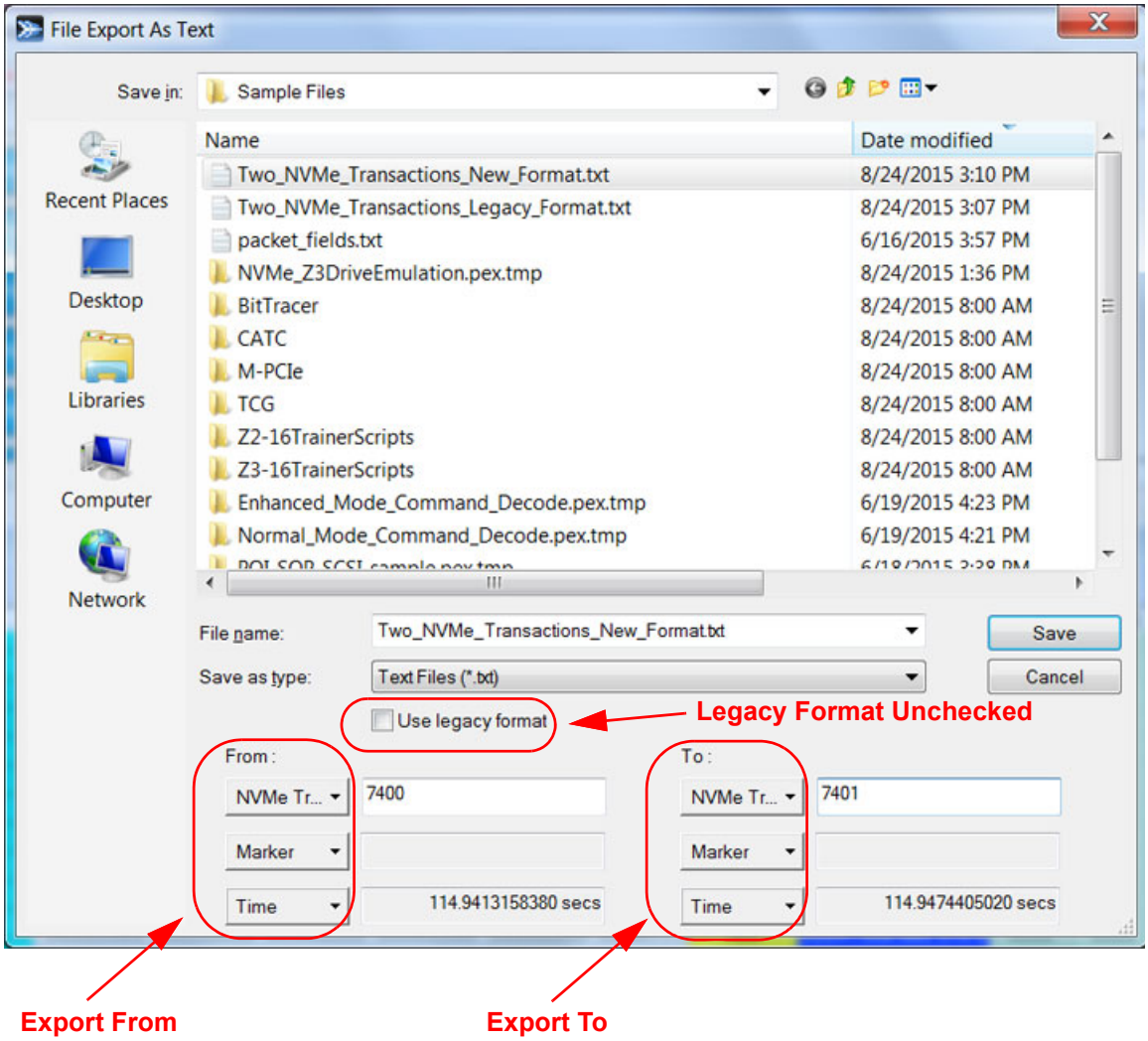


Figure 6.28: Export Two NVMe Transactions to Text File, New Format

You can see the differences in the two file formats below:

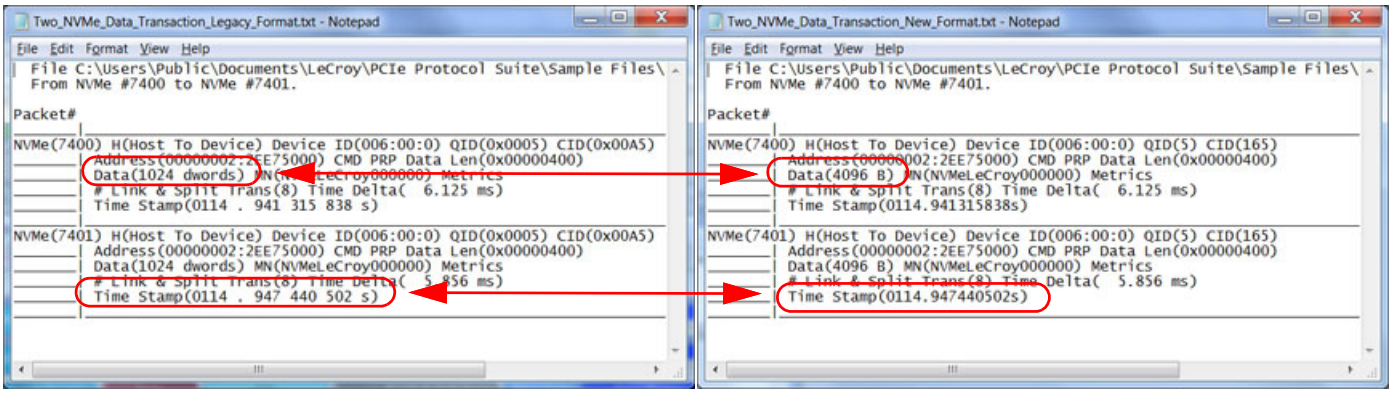


Figure 6.29: Export Trace Data to Text: Legacy vs New Format

6.1.17 Export: Packets to CSV Text

Now we'll Export Packets to CSV text using the legacy format, see Figure 6.30.

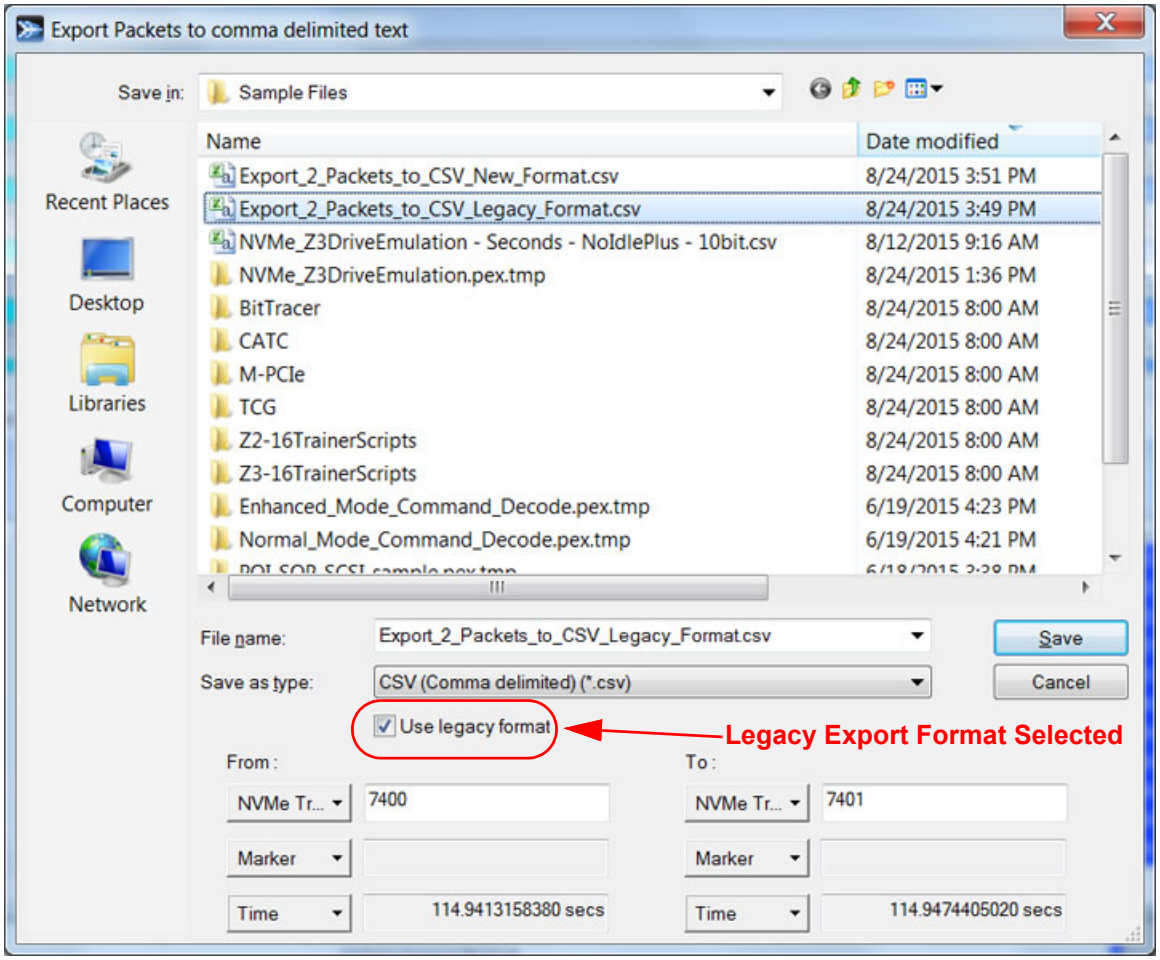


Figure 6.30: Export Packets to Comma Delimited Text: Legacy Format

Or we can export Packets to CSV text using the new format, see Figure 6.31.

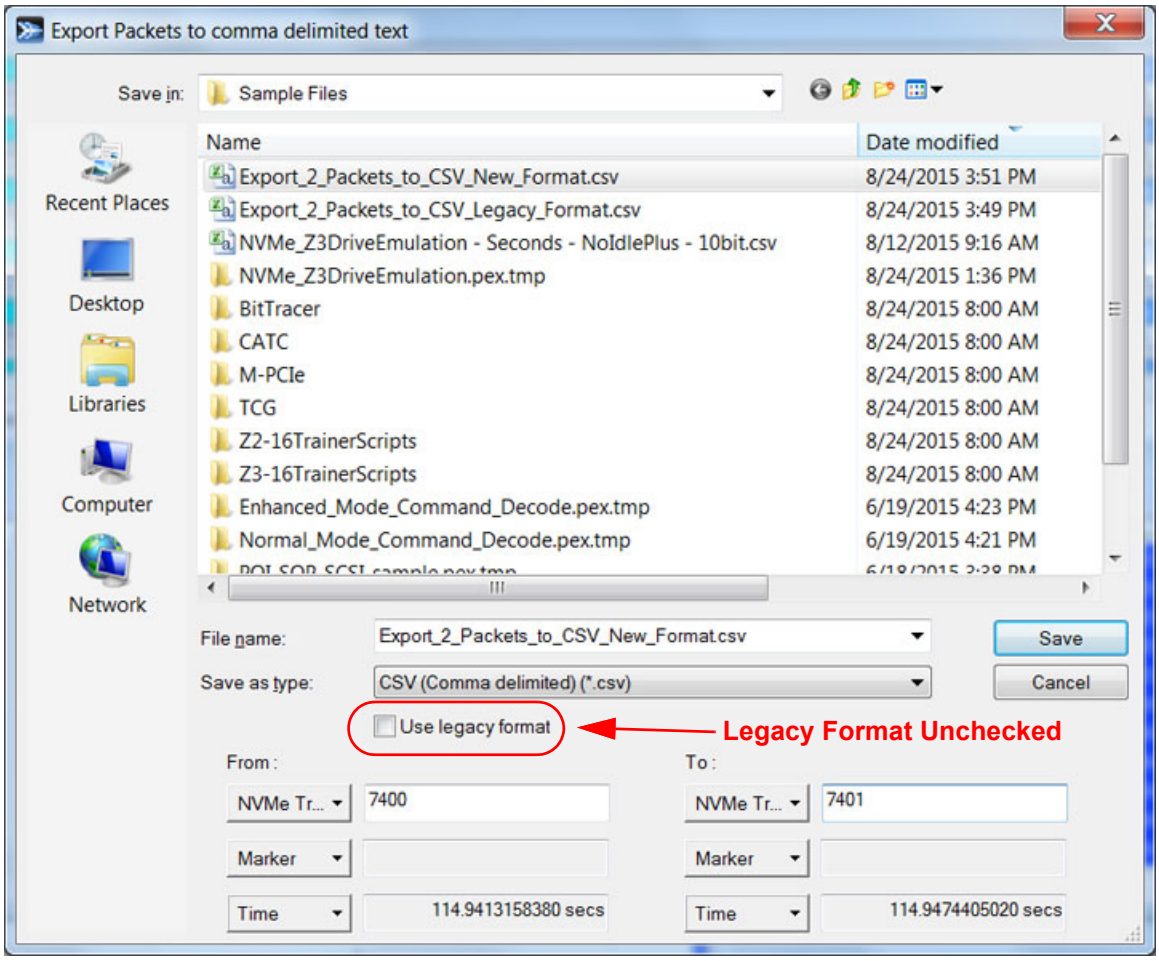


Figure 6.31: Export Packets to Comma Delimited Text: New Format

The differences in the two files can be seen in Figure 6.32.

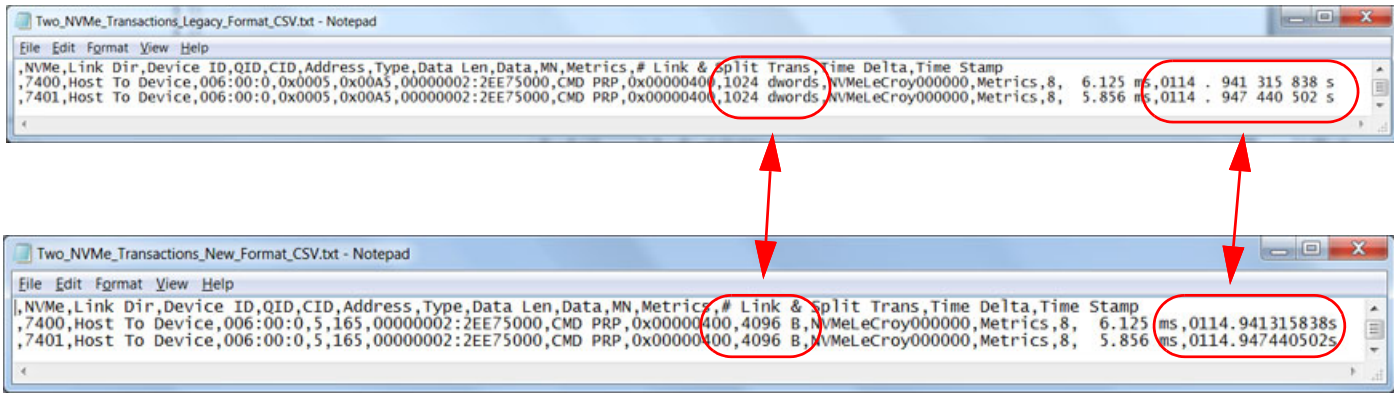


Figure 6.32: Export Packets to CSV Text: Legacy vs New Format

6.1.17.1 Export: To Generator File Format

To export a Trace File to Generator File format, choose that option. See Figure 6.33

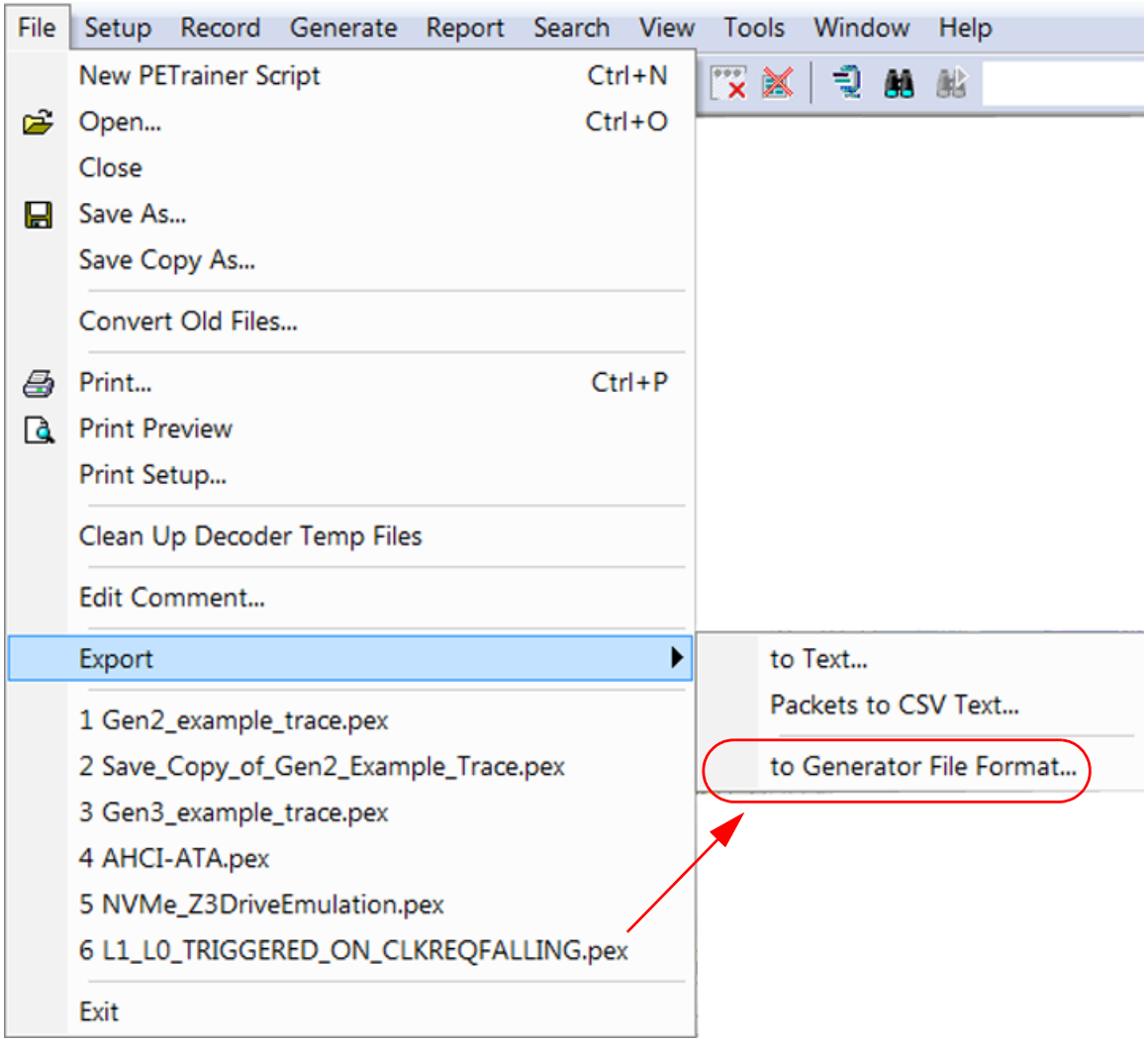


Figure 6.33: Export to Generator File Format

The purpose of Exporting a Trace file to Generator File Format is so that you can load that Generator file into a Teledyne LeCroy Exerciser (i.e. Z58) to generate data traffic to test a device.

Exporting a CATC Trace to a Traffic Generation File

A simple way to create a script file is to open a CATC Trace and then to export the CATC Trace data to a generation file:

1. Open a CATC Trace file.
2. Select **File > Export > to Generator File Format**.
3. Select the desired options from the File Export dialog box as shown below. See Figure 6.34 on page 257.

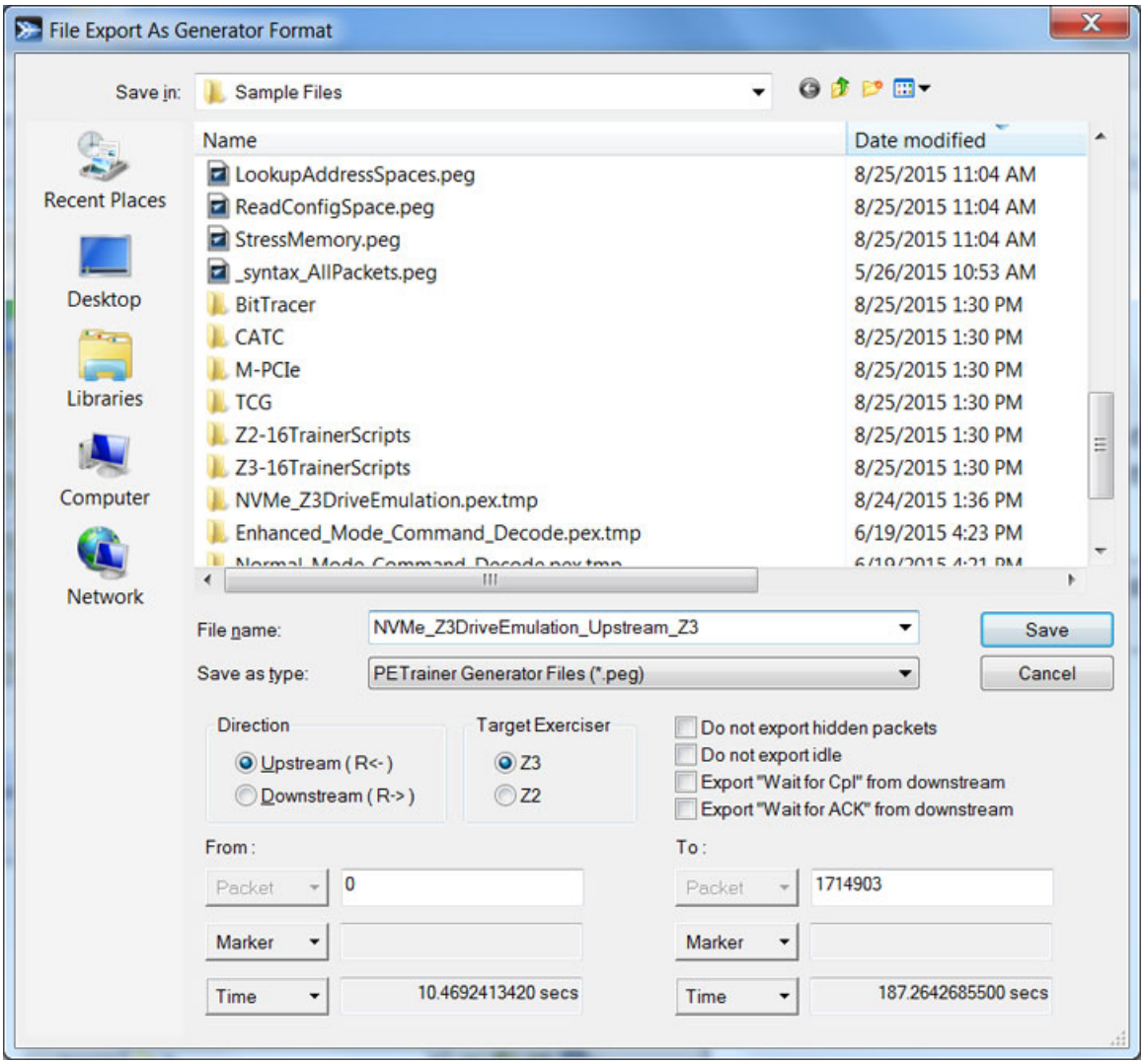


Figure 6.34: File Export As Generator Format Dialog.

Direction

Selects the direction of the traffic to be exported (Upstream or Downstream). In this case we chose Upstream. This will affect the Export “Wait for Cpl” and “Wait for ACK” options.

Target Exerciser

Select the type of Exerciser you plan to use (Z58, Z3 or Z2).

From and To

Selects a range for exporting. You can export all or part of the CATC Trace. You can select a range of Packets, Markers or Time.

Do not export hidden packets

Ignores any packets hidden through the various hide options.

Do not export Idle packets

Excludes Idles from the export.

Export "Wait for Cpl" from downstream

Exports all **Wait for Completions** from the opposite direction. **Wait = TLP** is a script command.

Export "Wait for ACK" from downstream

Exports all **Wait for ACK DLLPs** from the opposite direction.

6.1.17.2 Export From Data Flow View

You can also Export Trace Data from the Data Flow view (see Figure 6.35).

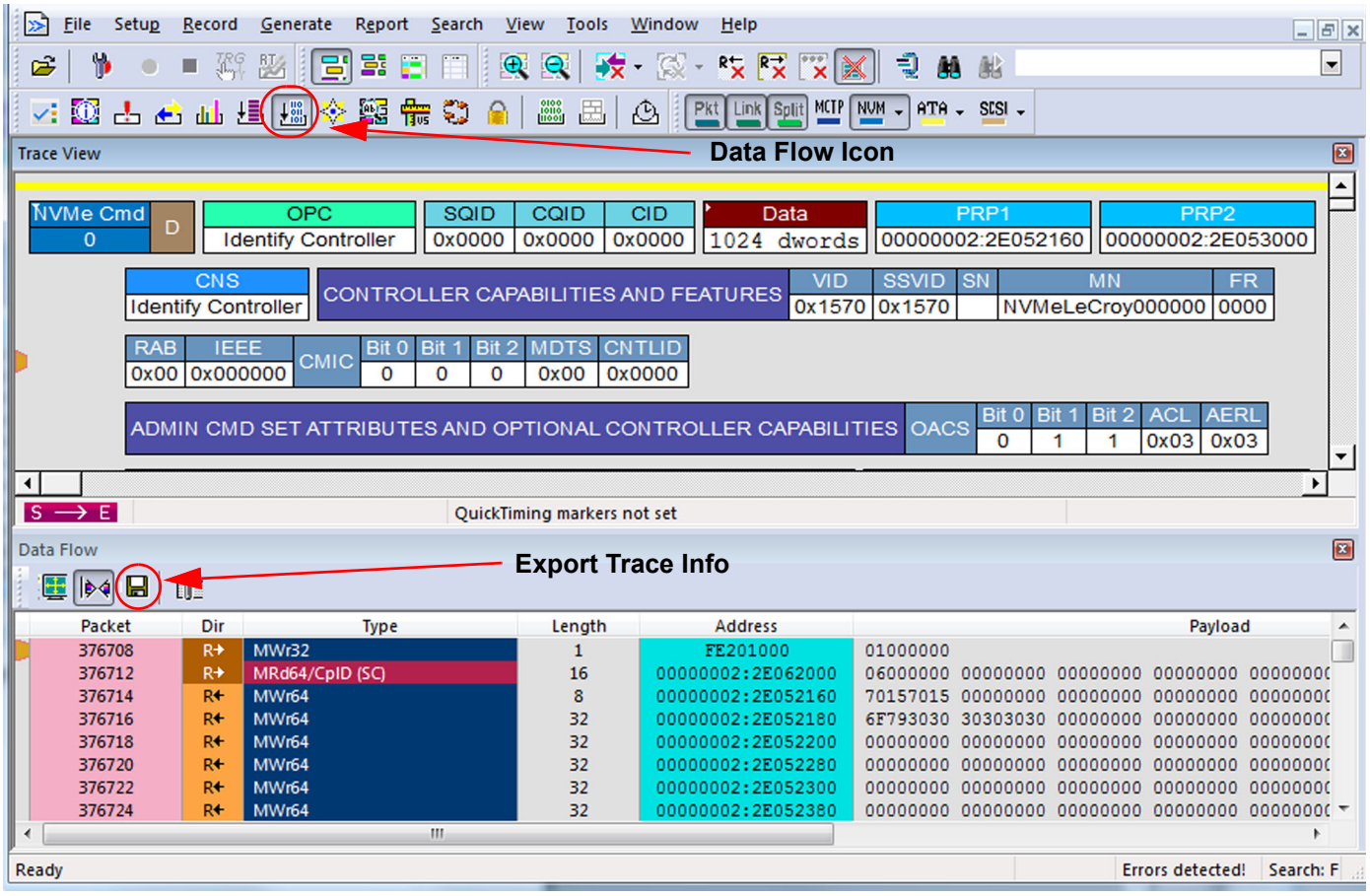


Figure 6.35: Data Flow View: Export by Selecting Save Icon

Export the Data Flow View information by selecting the Save icon. A new window will pop up where you can decide on the file name and path as well as whether the New data file format or the Legacy data file format is used. In this first example, we've chosen the Legacy format. See Figure 6.36.

6.1.17.3 Data Flow CSV File: Legacy Format

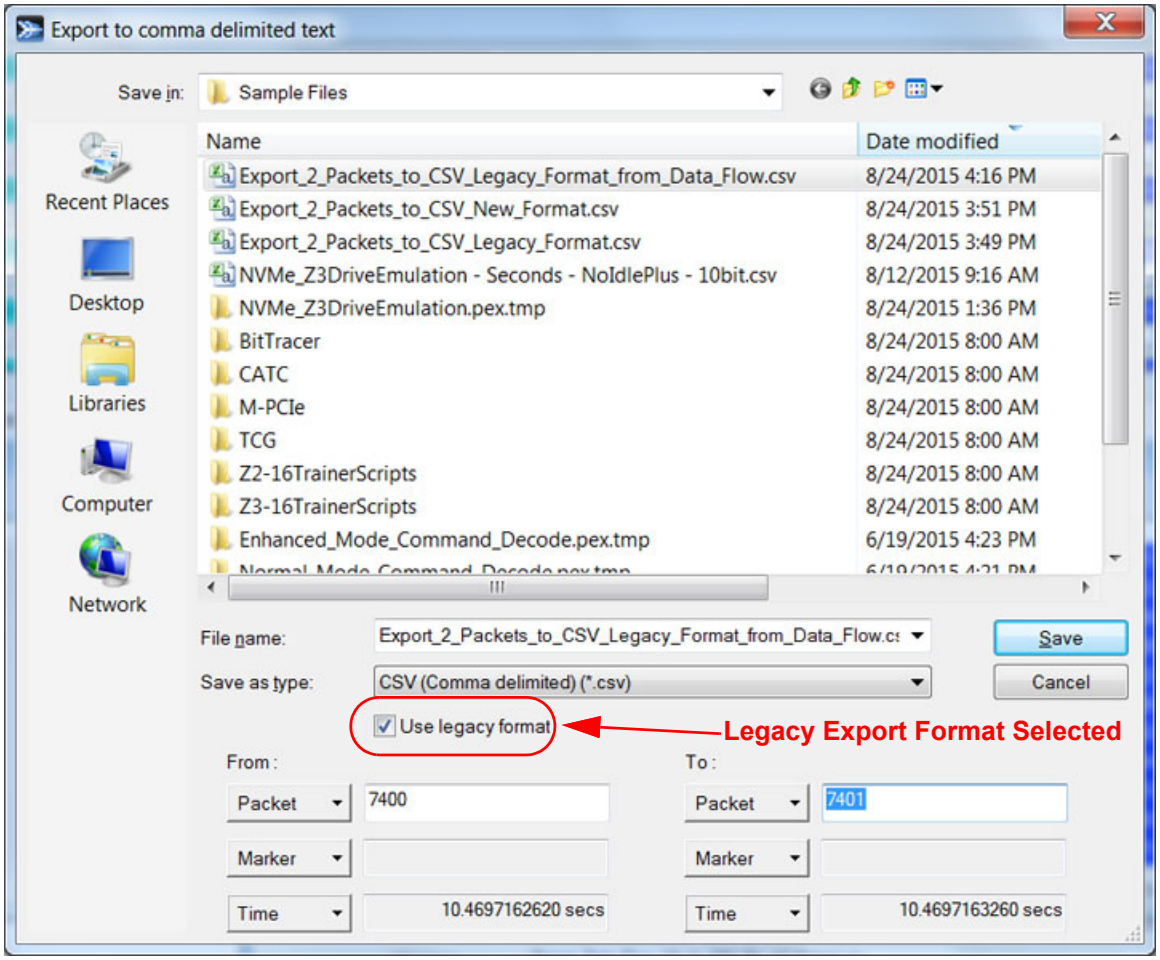


Figure 6.36: Data Flow View: Export Packets to Comma Delimited Text: Legacy Format

6.1.17.4 Data Flow CSV File: New Format

Next we'll chose the New Data format for the CSV file. See Figure 6.37.

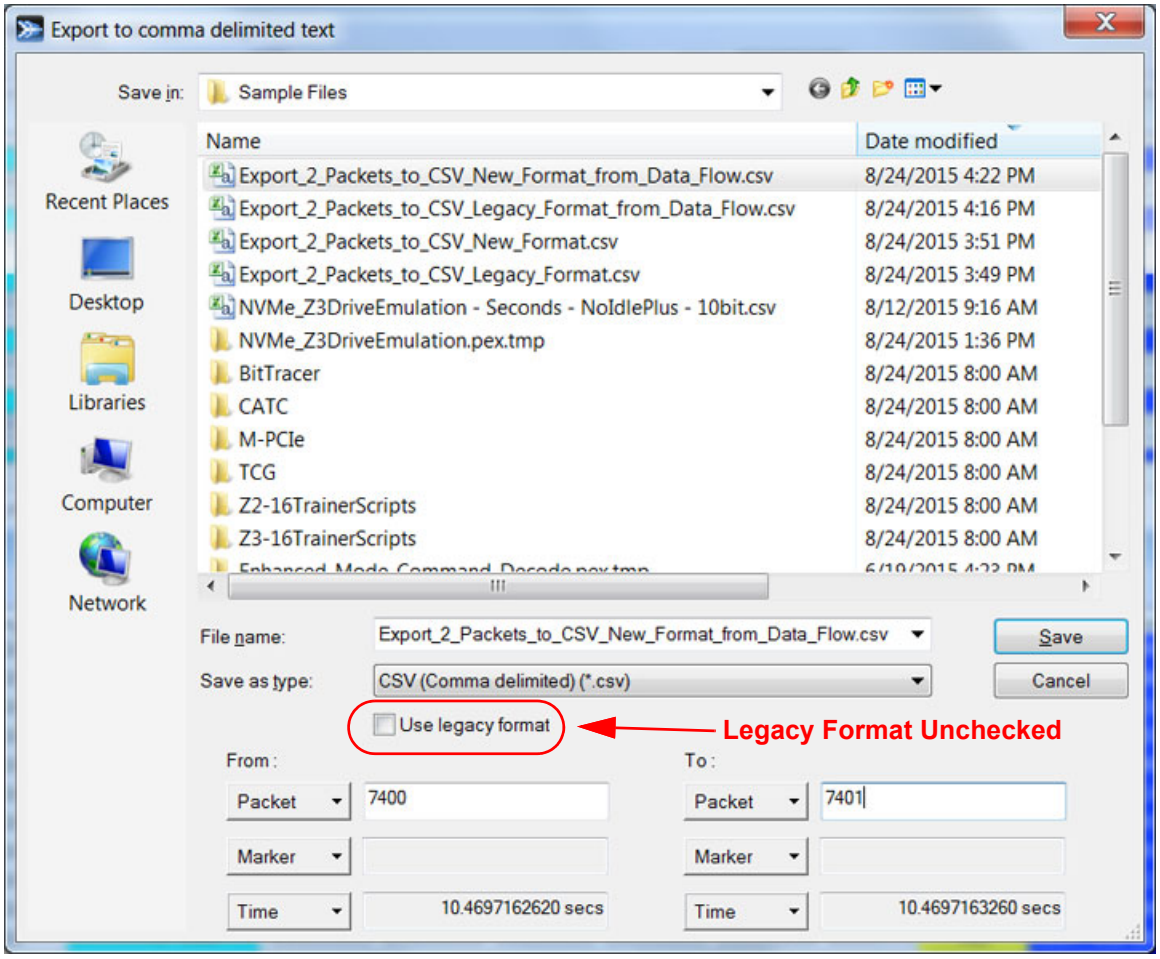


Figure 6.37: Data Flow View: Export Packets to Comma Delimited Text: New Format

6.1.18 Printing Data Files

To print all or part of the open CATC Trace:

1. Select **File > Print** from the menu or

   click the **Printer**  button on the toolbar.

   The Print Packets dialog displays (see Figure 6.38 on page 261).

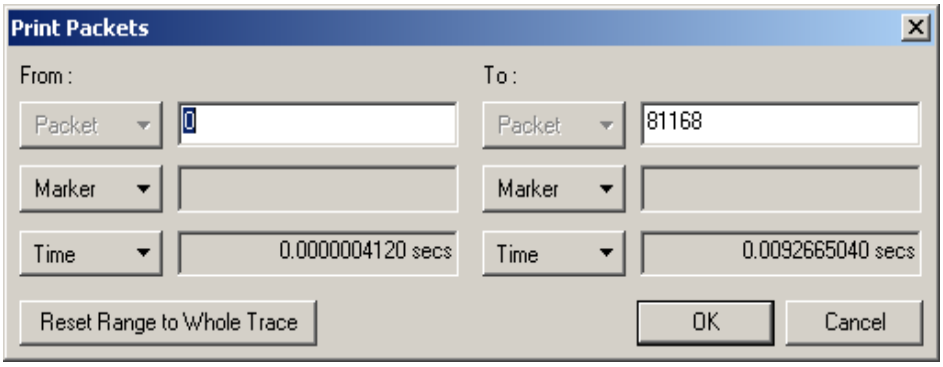


Figure 6.38: Print Packets Dialog

2. To select a range of packets, enter values in the **From packet #** and **To packet #** fields and click **Print**.
3. To print an entire file, leave the From and To fields empty and click **Print**.

The specified traffic information is printed as currently displayed, in color or gray scale as supported by your printer. Any CATC Trace File comments you entered are printed following the current document name at the top of each page.

Note: CATC Trace File comments can be created by using **Edit Comment** on the File menu.

6.1.19 Analyzer Chat Window

PCIe Protocol Analysis has a Chat window that allows you to communicate with users on remote host machines. For Chat to work, two conditions must be met:

- The host machines must have PCIe Protocol Analysis installed and running.
- The host machines must be listed in each other's All Connected Devices list. This means that your host machine must have the remote host machine listed in its Analyzer Devices window and the remote host machine must have your host machine listed in its Network Browse window. See Figure 6.39 on page 262.

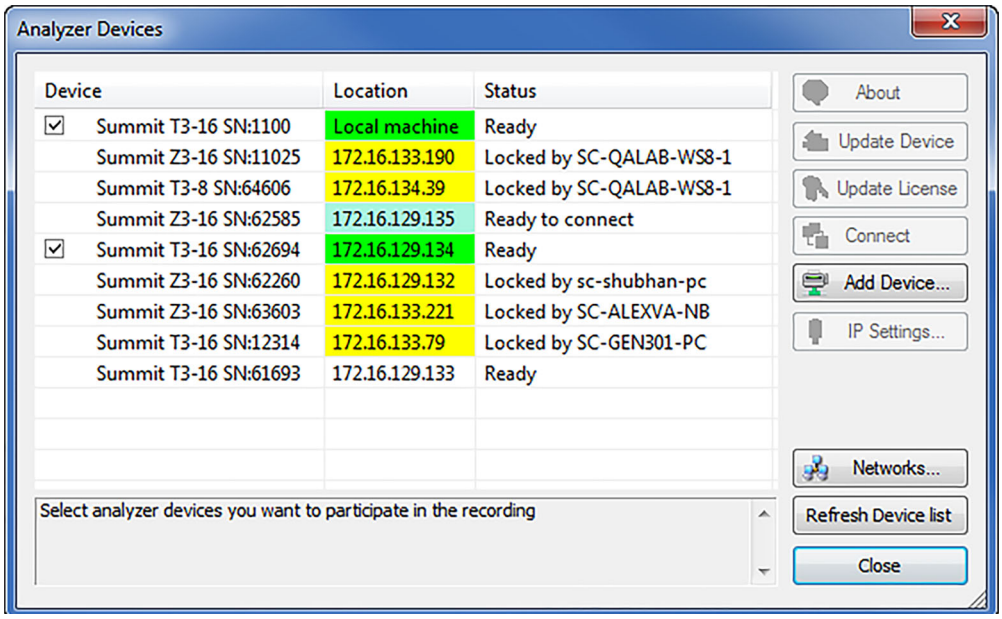


Figure 6.39: Analyzer Network Dialog

If the above conditions are met, a Chat session is initiated by running the command: **View > Analyzer Network Chat Bar**. The following dialog box opens.

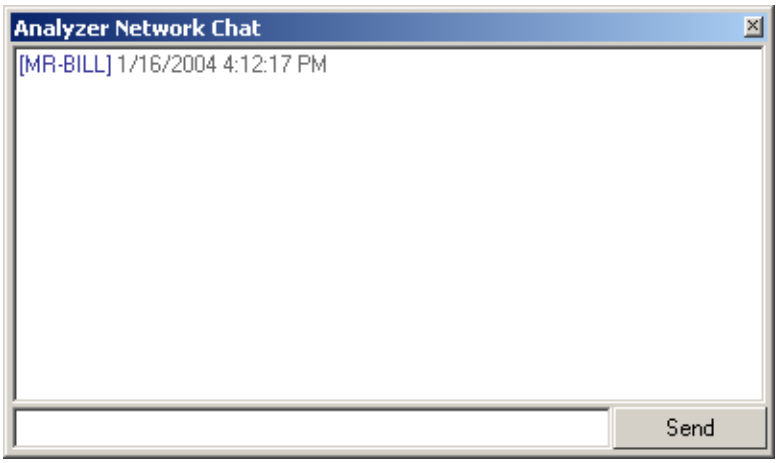


Figure 6.40: Analyzer Network Chat Dialog

Enter some text, then press **Send**. The message is then broadcast to all host machines listed in your network browse window. If a target host machine also lists your host machine in its Network Browse window, then it can receive your message. When the message arrives, the Chat window automatically opens.

6.1.19.1 CrossSync Control Panel

The CrossSync Control Panel allows you to select analyzers for synchronization and manage the recording process. It supports a wide combination of Teledyne LeCroy's flagship analyzers including PCI Express, USB, DDR, Serial ATA (SATA), Serial Attached SCSI (SAS), Fibre Channel (FC) and Ethernet.

CrossSync is Teledyne LeCroy's analyzer synchronization solution that enables time-aligned display of protocol traffic from multiple daisy-chained analyzers showing packet traffic from multiple high-speed serial busses. A lightweight software control panel allows users to select analyzers for synchronization and manage the recording process. Captured traffic is displayed using the latest analyzer software (in separate windows) with all the protocol specific search and reporting features.

Captured packets are displayed in separate windows that share a common time scale. Navigating the traffic in either direction will scroll to the same timestamp in a synchronized window. When using the CrossSync option, users can access the full complement of analysis capabilities available within the individual Teledyne LeCroy software. Search, reporting, and decoding all operate normally.

This feature is available with the Teledyne LeCroy PCIe Protocol Analysis application.

Launching the CrossSync Control Panel

To launch CrossSync from the PCIe Protocol Analysis application, select the '**Launch CrossSync Control Panel**' entry in the 'Setup' menu (see the screen below). Or, you can launch CrossSync from the '**Start**' menu.

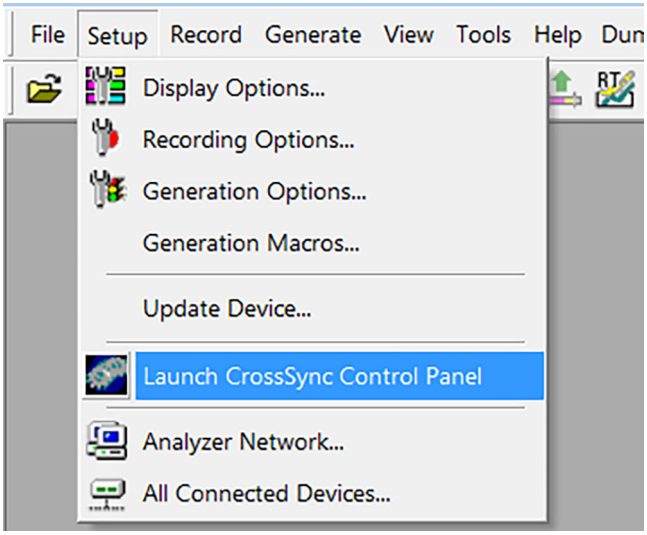


Figure 6.41: Launching CrossSync from the PCIe Protocol Analysis Application

Please refer to the *CrossSync Control Panel User Manual* for more information.

6.2 Recording Options

Note: Once the PCIe Specification Compatibility has been set in the **Generation Options** → **Link** tab, the Recording options for the Z58 will be set to the same option Revision 4.0 Version 0.5 or Revision 4.0 Version 0.7. See "Link Generation Options" on page 107.

6.2.1 Recording Overview

After installing the software recording options should be set prior to recording. The recording options define the behavior of the Summit Z58 Protocol Exerciser during recording. You can create, save and load previously saved recordings. This section explains how to define recording options on the Summit Z58 Protocol Exerciser.

6.2.2 General Dialog Box

The Recording Options dialog is used to configure a recording.

To open the Recording Options window, click  or select the command **Setup > Recording Options**.

Note: There are separate sets of Recording Options for each Analyzer type. To set the Analyzer type, select the appropriate platform from the Target Analyzer menu in the General dialog box of the Recording Options.

The General dialog box displays options that affect all recordings (see Figure 6.42 on page 265).

6.2.3 Recording Options-General dialog box

This section describes the General dialog box recording options.

6.2.3.1 Recording Options: Simple Mode, Snapshot

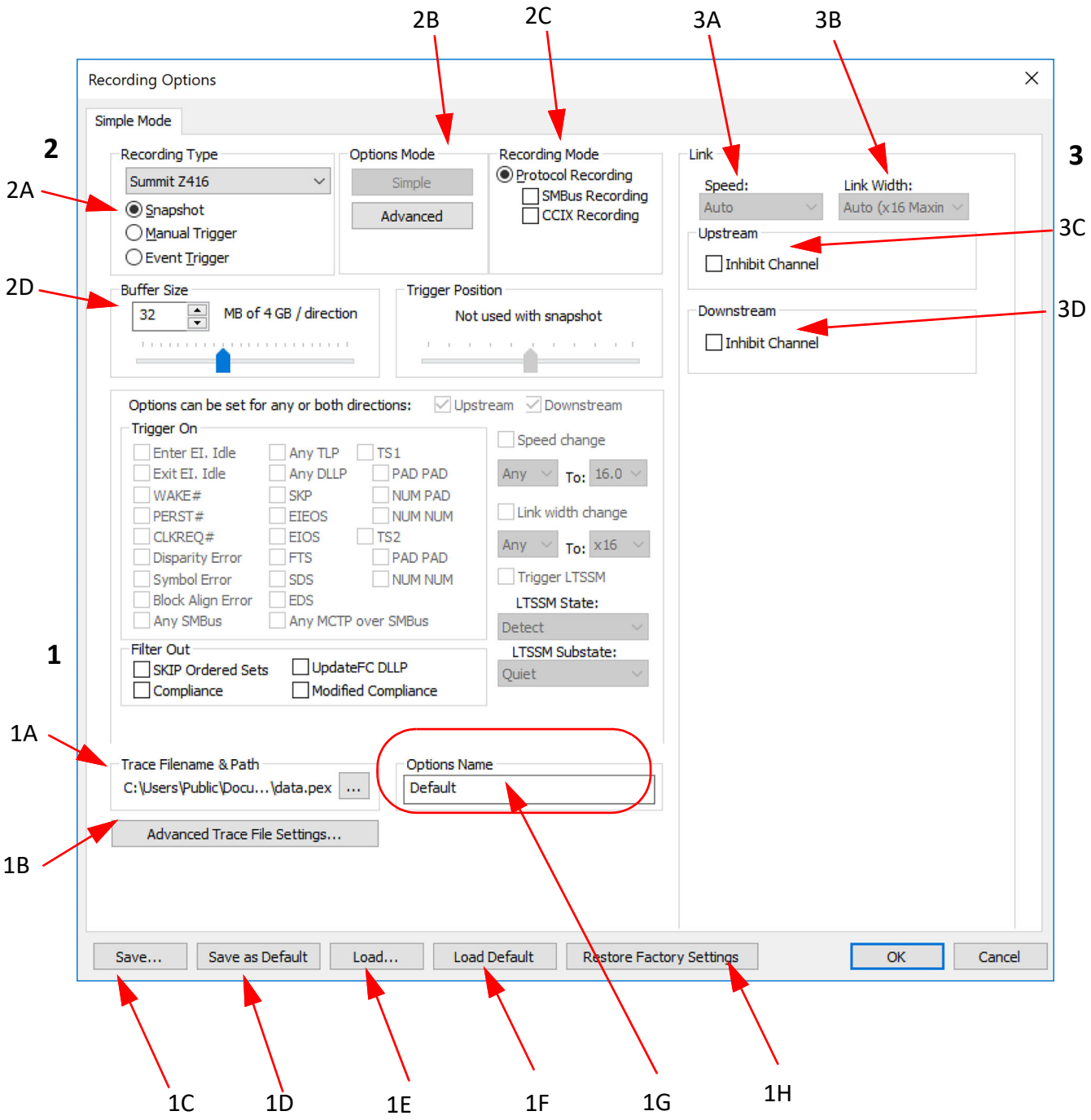


Figure 6.42: Summit Z58 Recording Options: Simple Mode, Snapshot

Note: Please refer to the figure callout numbers in each of the sections below to co-relate to Figure 6.42 shown above.

6.2.4 Simple/Advanced Mode

The recording options can be defined in Simple or Advanced mode. The Simple Mode allows quick access to commonly used options. Advanced Mode allows you to choose more complex triggering schemes for recording. See Figure 6.43 or Figure 6.42 on page 265: 2B.

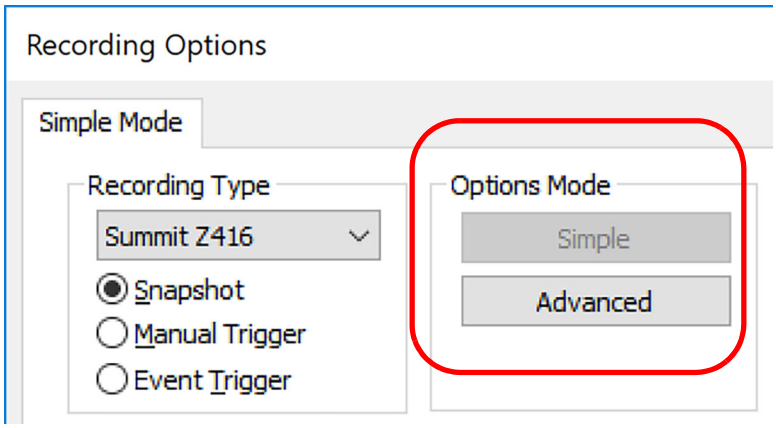


Figure 6.43: Recording Options Mode: Simple/Advanced

6.2.5 Trace Filename and Path

The Trace Filename and Path button sets the path and CATC Trace name for the recording. It allows you to change the default file name and path for the recorded CATC Trace file. The pre-defined name is **data.pex**. See Figure 6.42 on page 265: 1A.

1. Select the **Recording File Name** button.
2. The Specify Trace File Name dialog opens to navigate to the directory you want.
3. Enter the new file name in the File name field.
4. Click the **Save** button.

   This action does not do any immediate save operation. It just changes the default name and uses it in subsequent recordings.

6.2.6 Advanced Trace File Settings

You can set the maximum number of traces that can be opened at one time when recording (from 1 to 10). You can also auto-delete traces if your recording session goes beyond the limit set (from 1 to 10). See Figure 6.42 on page 265: 1B or Figure 6.44 and Figure 6.45.

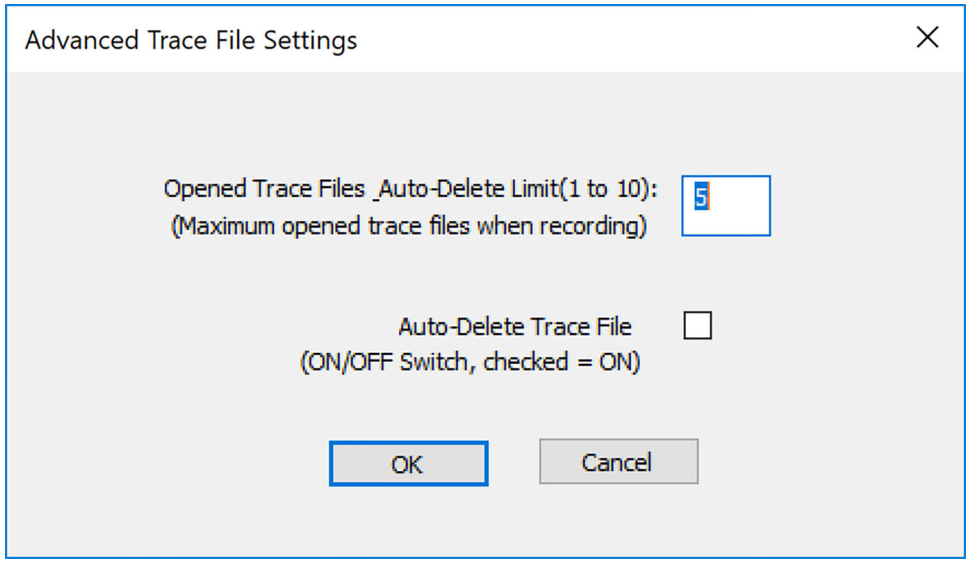


Figure 6.44: Advanced Trace File Settings: 5 Open Traces at a time

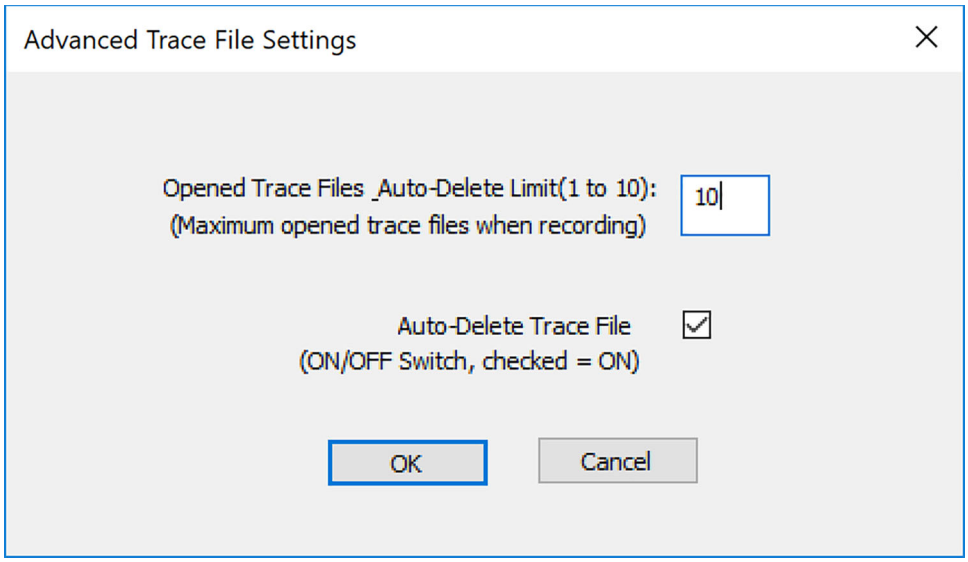


Figure 6.45: Advanced Trace File Settings: 10 Open Traces at a time, Auto-Delete when maximum number reached (10)

6.2.7 Saving and Loading Previously Saved Recording Options

You can save a recording or load previously saved recordings. In the general tab the following Save options are available (see Figure 6.42 on page 265: 1C, 1D).

6.2.7.1 Setting Default Recording Options

To save the current recording options into the default Recording Options file:

Click **Save As Default**: See Figure 6.42 on page 265: 1D. The default file for the options is **default.rec**.

When the PCIe Protocol Analysis begins execution, it automatically loads the **default.rec** file, if one exists.

Options Name: See Figure 6.42 on page 265: 1G

The Options Name is a descriptive, supplemental label that you can assign to a Recording Options file so you can easily recall what settings are in the Recording Options file.

For example, if your Recording Options file were named **StandardSettings.rec**, your Options Name could be a long descriptive label such as **Standard Record Options used for all normal Recordings**.

Save: See Figure 6.42 on page 265: 1C

Saves the current options to whatever file name you provide.

Save As Default: See Figure 6.42 on page 265: 1D

Saves the current options into the default options file. This file is called **default.rec** or any other name you have assigned to the default options file. Whenever the Teledyne LeCroy PCIe Protocol Analysis begins execution, it automatically loads the default file, if one exists.

Load: See Figure 6.42 on page 265: 1E

Loads a previously saved set of recording options.

Load Default: See Figure 6.42 on page 265: 1F

Loads a previously saved set of default recording options.

Restore Factory Settings: See Figure 6.42 on page 265: 1H

Loads a previously saved set of default recording options.

OK: Applies changes and closes the Recording Options dialog.

Cancel: Cancels changes and closes the Recording Options dialog.

6.2.7.2 Loading Recording Options

In the Recording Options menu, you can load a previously saved recording options file.

To load Recording Options:

1. Select **Setup > Recording Options** from the menu.
2. Click the **Load** button from the Recording Options dialog (see Figure 6.42 on page 265: 1E). The Load dialog opens and lists previously saved options files (***.rec**).
3. Select a file and click **OK**. The options file loads.

6.2.7.3 Saving Recording Options

Recording Options settings can be saved and later reused. Recording options settings are stored in ***.rec** files.

1. Open the Recording Options dialog by selecting **Setup > Recording Options.**
2. Set your options, then click **Save** See Figure 6.42 on page 265: 1C.

3. Enter a unique file name. The **.rec** extension is added by default.(optional) To add a descriptive label to this file to help you remember what options were set, use the **Options Name** box.

6.2.8 Recording Type

Recording Type allows you to specify the type of recording you want to make (See Figure 6.42 on page 265: 2A). They are:

- Snapshot
- Manual Trigger
- Event Trigger

6.2.8.1 Target Analyzer Options

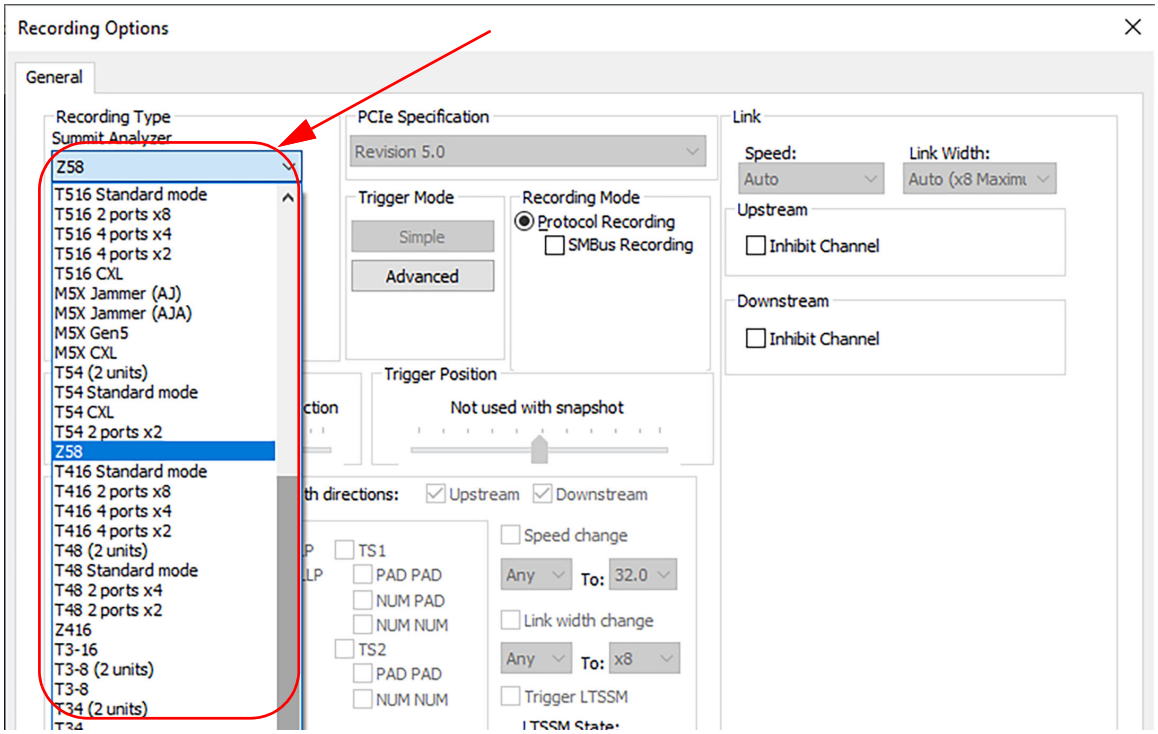


Figure 6.46: Summit Z58 Target Analyzer Options

When the analyzer is not yet detected, you can choose the analyzer from the drop-down menu which displays the following:

- **Summit T54** (2 Units): Displays the same options as Summit T54 but lists **Unit 1** and **Unit 2** in the Link Section on the right. In a two-unit setup, **Unit 1** and **Unit 2** are two separate Analyzers linked together with a combined link width of x8.
- Summit T54: Displays the options for the Summit T54 Analyzer.
- Summit T54 2 port x2: Displays the options for the Summit T54 Analyzer used in Multiport mode.
- Summit T416 Standard: Displays the options for the Summit T416 Analyzer.
- Summit T416 2 Ports x8: Displays the options for the Summit T416 Analyzer used in Multiport mode.
- Summit T416 4 Ports x4: Displays the options for the Summit T416 Analyzer used

in Multiport mode.

- Summit T416 4 Ports x2: Displays the options for the Summit T416 Analyzer used in Multiport mode.
- Summit T48 Standard: Displays the options for the Summit T48 Analyzer.
- Summit T48 2 Ports x4: Displays the options for the Summit T48 Analyzer used in Multiport mode.
- Summit T48 2 Ports x2: Displays the options for the Summit T48 Analyzer used in Multiport mode.
- **Summit T48** (2 Units): Displays the same options as Summit T3-8 but lists **Unit 1** and **Unit 2** in the Link Section on the right. In a two-unit setup, **Unit 1** and **Unit 2** are two separate Analyzers linked together.
- **Summit M5x Jammer (AJ)**: Displays the options for the Summit M5x Analyzer/ Jammer
- Summit M5x Jammer (AJA): Displays the options for the Summit M5x Analyzer/ Jammer/Analyzer
- Sumit M5x Analyzer (Gen5): Displays the options for the Summit M5x Analyzer configured for Gen5
- Summit T3-16: Displays the options for the Summit T3-16 Analyzer.
- **Summit T3-8** (2 Units): Displays the same options as Summit T3-8 but lists **Unit 1** and **Unit 2** in the Link Section on the right. In a two-unit setup, **Unit 1** and **Unit 2** are two separate Analyzers linked together.
- **Summit T3-8**: Displays the options for the Summit T3-8 Analyzer.
- **Summit T34** (2 Units): Displays the same options as Summit T34 but lists **Unit 1** and **Unit 2** in the Link Section on the right. In a two-unit setup, **Unit 1** and **Unit 2** are two separate Analyzers linked together.
- Summit T34: Displays the options for the Summit T34 Analyzer.
- Summit Z58: Displays the options for the analyzer portion of the Z58.
- **Summit T28**: Displays the options for the Summit T28 Analyzer.
- Summit T24: Displays the options for the Summit T24 Analyzer.

6.2.9 Recording Mode

As shown in Figure 6.42 on page 265: 2C, the Summit Z58 Protocol Exerciser is detected and the recording modes available for it are displayed.

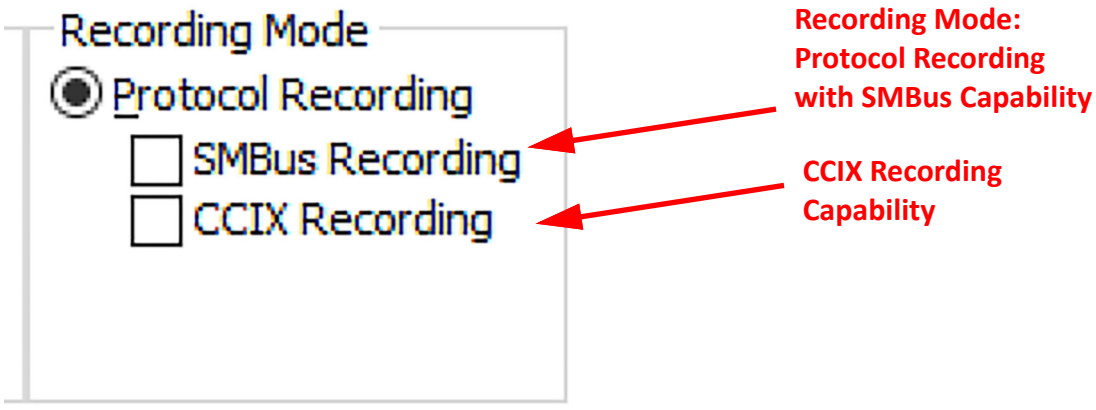


Figure 6.47: Recording Mode Options

6.2.9.1 Protocol Recording

The Protocol Recording mode is an intelligent mode that understands the protocol and displays the recorded data according to the specification. By default it uses the CATC Trace View to show the traffic happening on the wire.

You can use most of the triggering, filtering and sequencing features.

6.2.9.2 SMBus Recording

When this mode is also selected both Data traffic and SMBus traffic will be recorded for the following events:

- Any SMBus
- Any MCTP over SMBus

For an example of SMBus traffic see "SMBus Recording" on page 271.

6.2.9.3 Recording the CCIX Protocol (Simple and Advanced Mode)

Simple Mode

PCIe Protocol Analysis software can record the Cache Coherent Interconnect for Accelerators (CCIX) transaction protocol.

CCIX is a high-performance, low latency, chip-to-chip interconnect architecture that provides a cache coherent framework for heterogeneous system architectures. Cache coherency is automatically maintained at all time between the central processing unit and the various other accelerators in the system. Operating over standard PCIe, CCIX supports signaling rates between 16 GT/s and 25 GT/s per link with support for port aggregation for higher performance.

CCIX is largely an extension of the PCI Express architecture, consists of a number of stacked protocol layers.

- CCIX Protocol Layer - coherency protocol that manages memory reads and writes, provides a mapping for the on-chip architecture-dependent coherency protocols (e.g., AMBA CHI/ACE). This layer also defines the cache state (e.g. shared/unique, clean/dirty).
- CCIX Link Layer - formatting protocol for transport (e.g., PCIe). This layer also manages link aggregation.
- CCIX Transport Specification
- PCIe Transaction Layer - Handles PCIe transactions. The layer also supports virtual channels, permitting transmission for different data streams across a single shared link.
- CCIX Transaction Layer - Handles CCIX transactions. This layer optimizes out superfluous PCIe packet fields, reducing overhead.
- PCIe Data Link Layer - Handles standard data link layer (e.g., CRC, ACK).
- CCIX/PCIe Physical Layer - Handles standard PCIe physical layer. This layer also supports 25 GT/s ESM mode.

CCIX decoding relies on Traffic Class (TC) to Virtual Channel (VC) mapping to be configured. If not configured you'll get the warning message below when you select the CCIX checkbox in Simple Recording mode. See Figure 6.48 on page 272.

CCIX decoding is also discussed in more detail in "Decoding CCIX Protocol" on page 406.

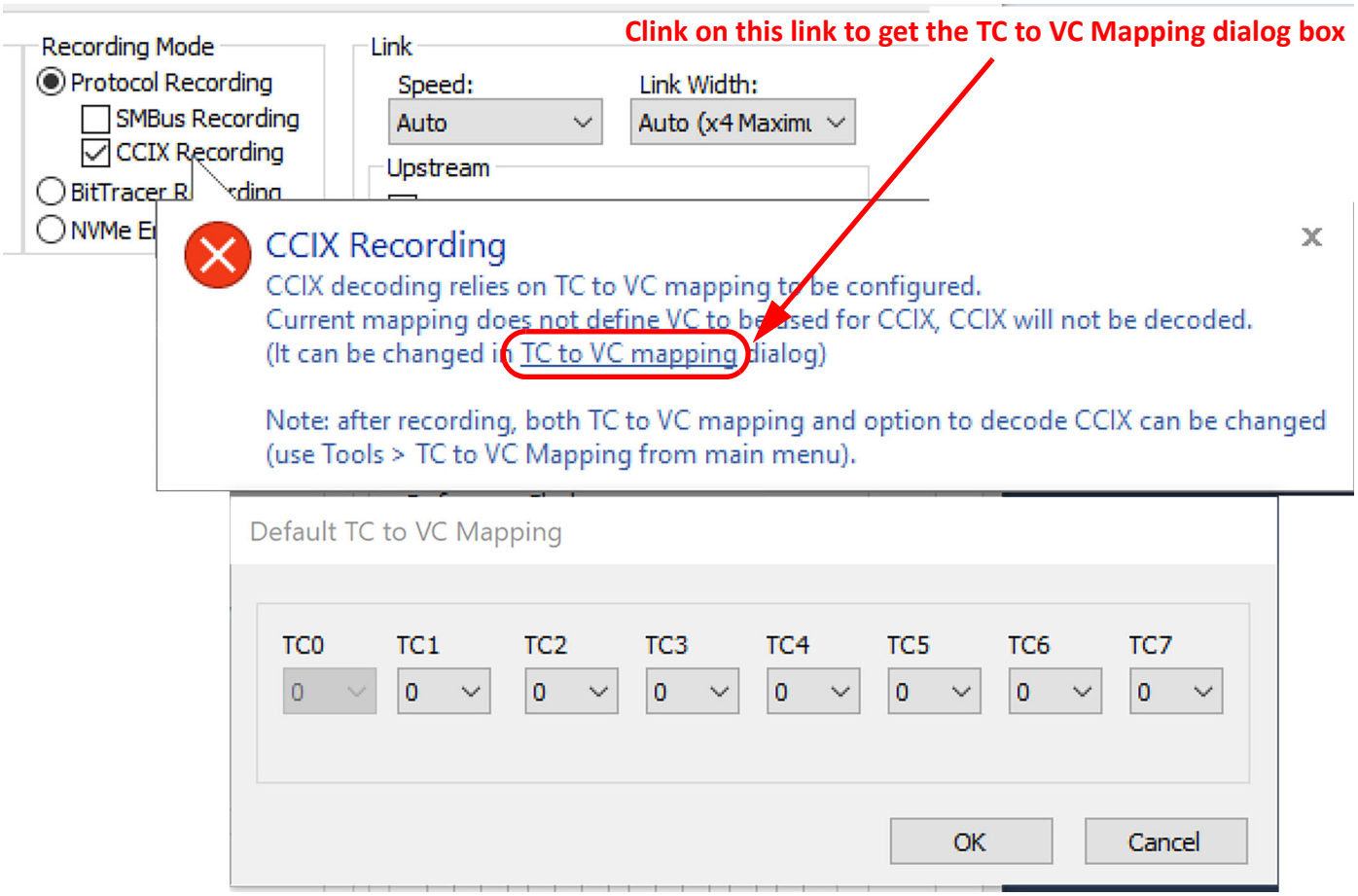


Figure 6.48: Selecting CCIX Recording Before Mapping from TC to VC

After mapping TC to VC the warning message goes away, as shown in Figure 6.49 on page 273

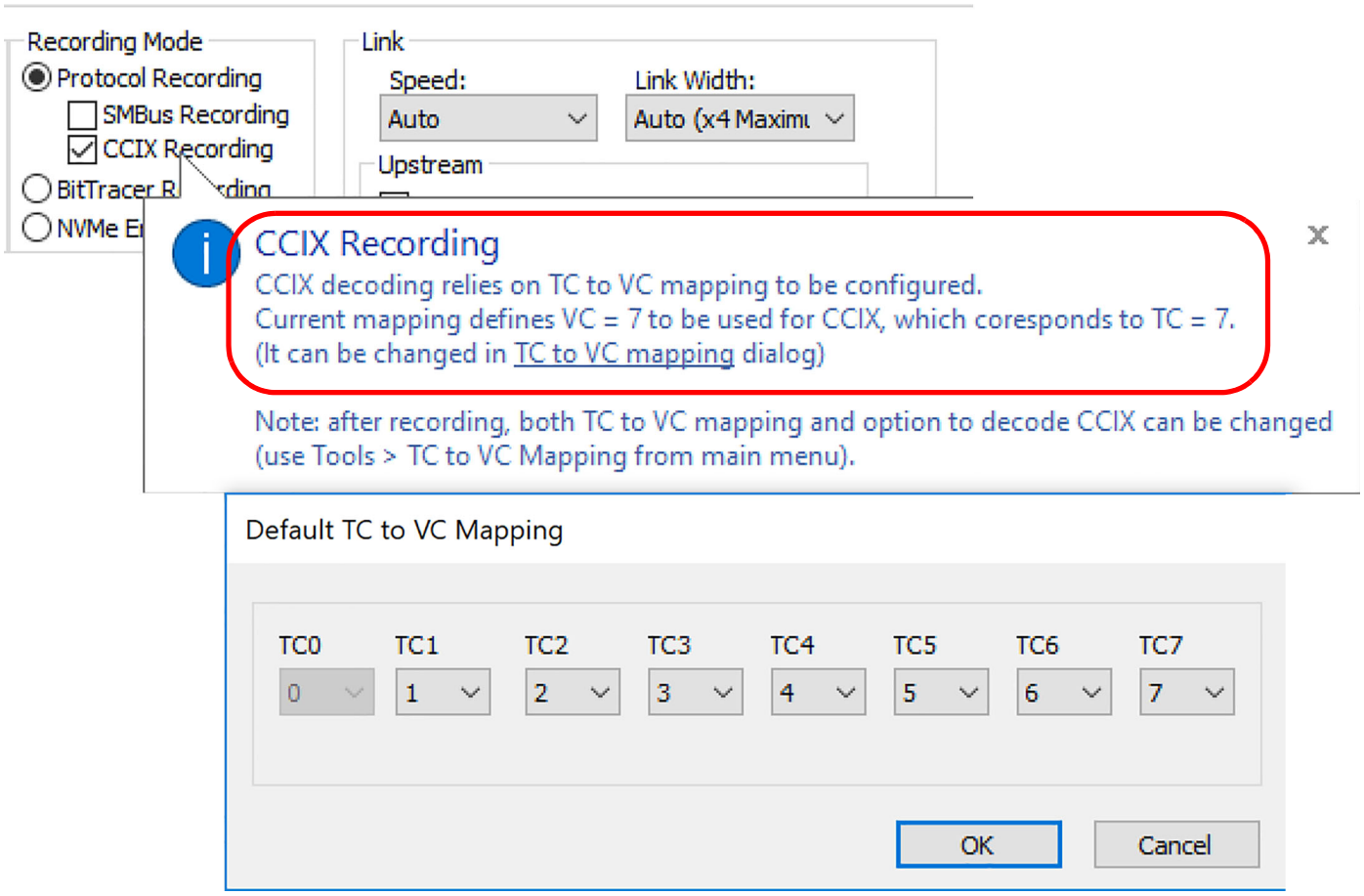


Figure 6.49: Selecting CCIX Recording After Mapping from TC to VC

The Protocol Recording mode is an intelligent mode that understands the protocol and displays the recorded data according to the specification. By default it uses the CATC Trace View to show the traffic happening on the wire.

6.2.10 Snapshot

A recording of a pre-determined length. You set the recording length in the Buffer Size box. Recording begins when you click the **Rec** button on the toolbar and ends when the selected buffer size is filled or when you press the **Stop** button. see Figure 6.42 on page 265: 2A.

6.2.11 Buffer Size

The Buffer Size allows the Analyzer to record traffic to its buffer and then upload the CATC Trace to the host machine. Recordings are limited in size to the size of the Analyzer's buffer, see Figure 6.42 on page 265: 2C. The Buffer Size slide-bar allows you to set the size of the recording buffer (see Figure 6.50). The figure below is one example of Buffer Size but the maximum Buffer Size is dependent on the product being used.

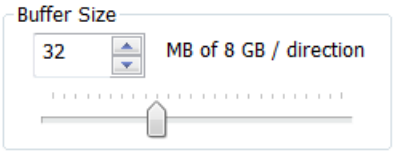


Figure 6.50: Buffer Size Slide Bar

The size selection is per direction. For example, selecting 32 MB creates two memory areas of that size.

After you have set the Buffer Size, you must set the Recording type and Trigger position options. These options determine how the buffer is used.

Note: The Buffer Size slide-bar does not precisely portray the buffer size because of the way the packets are stored in the Analyzer's memory.

6.2.12 Viewing Legacy Multi-Segmented CATC Traces

Current PCIe Protocol Analysis handles traces as large as the maximum buffer size selected. It does not need to generate segmented traces, but is able to open segmented traces generated with older software versions. Simply open the *.pem extension file and the trace will be converted to a new format single trace. If opening a *.pex file part of a segmented trace make sure not to update the file in order for the original segmented index to work properly.

6.2.13 Link Settings

The Link options panel allows you to manage links (see Figure 6.51). By default the Link Data Speed and Link Width are set to Auto.

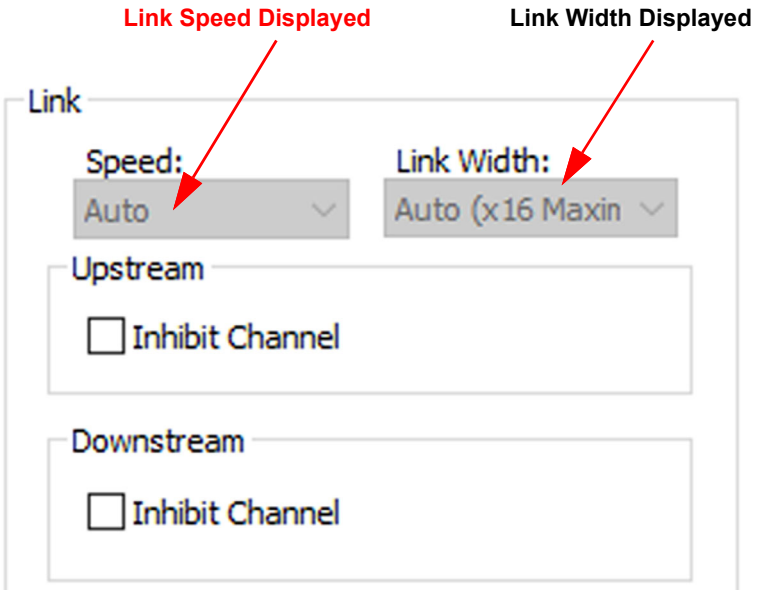


Figure 6.51: Link Options for Summit Z58

6.2.14 Link Speed and Link Width Limitations

The Link Speed and Link Width are set to Auto and Auto x16 by default. There are certain limitations of Data Rate and Link Width, which are set by the Generation Options (see "Z5 General Options Dialog Layout" on page 99) and as outlined below (see Table 6.2).

TABLE 6.2: Data Rate vs. Link Width

Date Rate (GT/s)	Link Width
2.5/5.0	Up to x16
8.0	Up to x16
16.0	Up to x16
32.0	Up to x16

You can Inhibit Upstream traffic or Downstream traffic from being recorded. See Figure 6.42 on page 265: 3C and 3D.

6.2.15 Recording Options: Trigger on Events

6.2.15.1 Simple Mode: Z58 Triggers

You can select Events to trigger on by selecting the checkboxes shown below. See Figure 6.52.

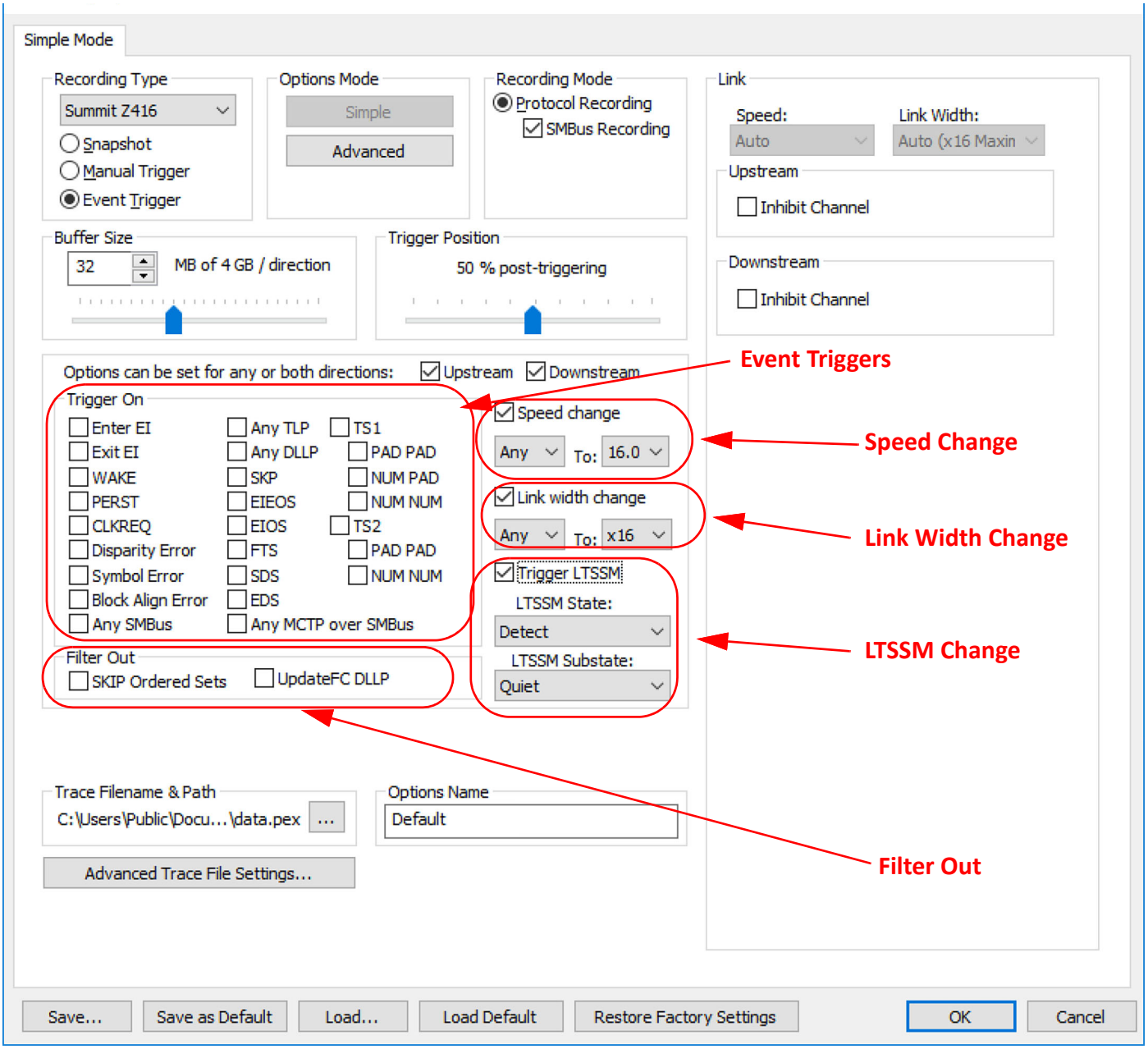


Figure 6.52: Simple Mode: Trigger Events

6.2.15.2 Trigger Position

You can also select the trigger position within the trace. See Figure 6.53.

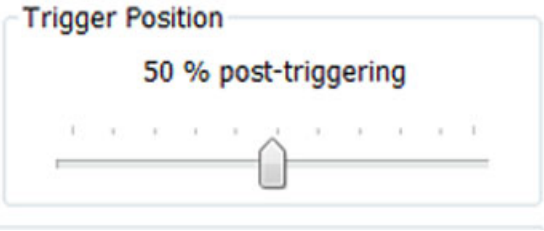


Figure 6.53: Recording Mode: Simple → Event Trigger: Trigger Position

6.2.15.3 Advanced Mode: Z58 Trigger On

You can select Events to trigger on by selecting the Event Trigger button as shown in Figure 6.54.

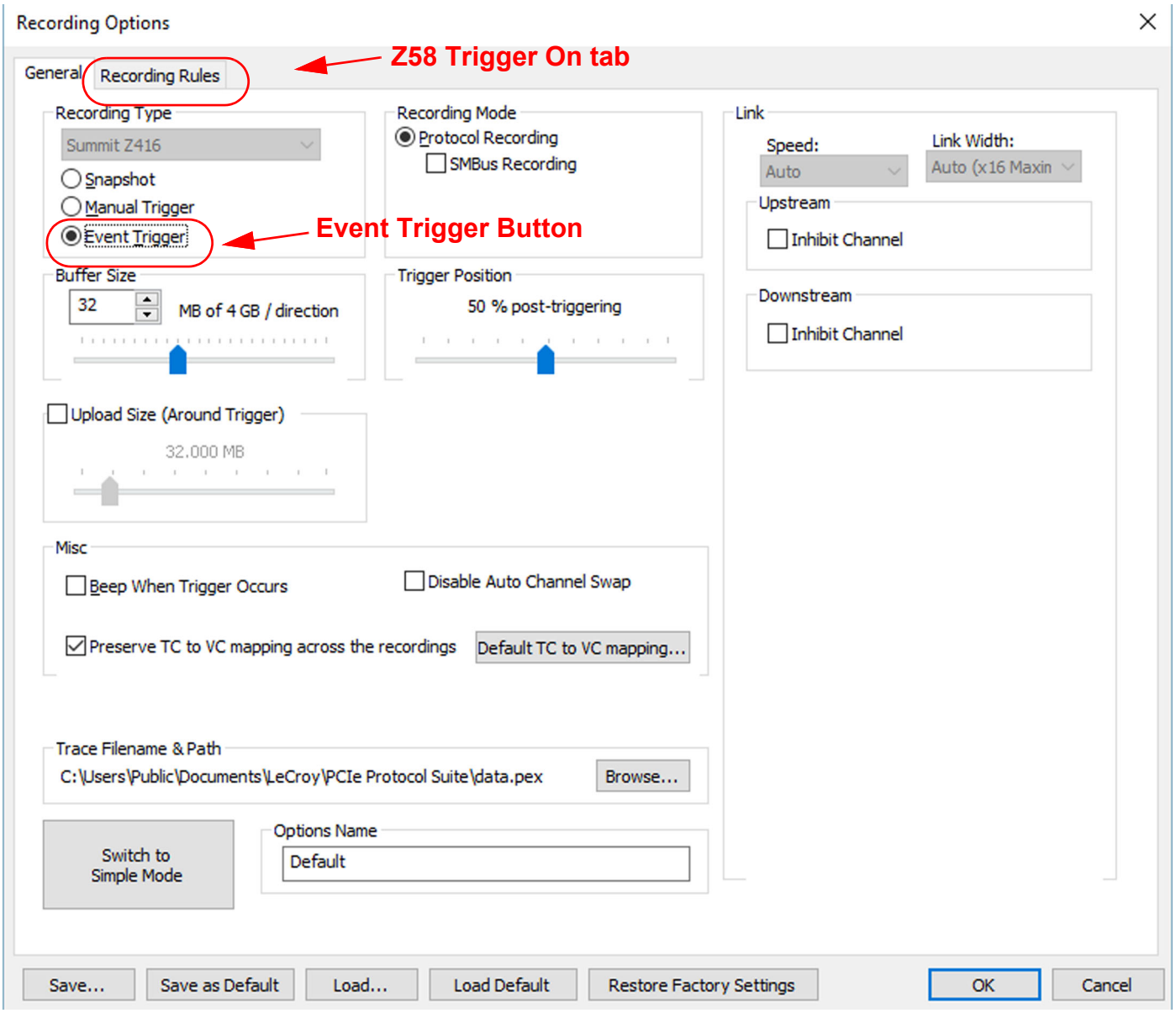


Figure 6.54: Recording Options Z58: Simple Mode → Event Trigger

6.2.15.4 Z58 Trigger On Tab

Then select the Z58 Trigger on tab, which will display all of the types of events you can trigger and filter on. See Figure 6.55.

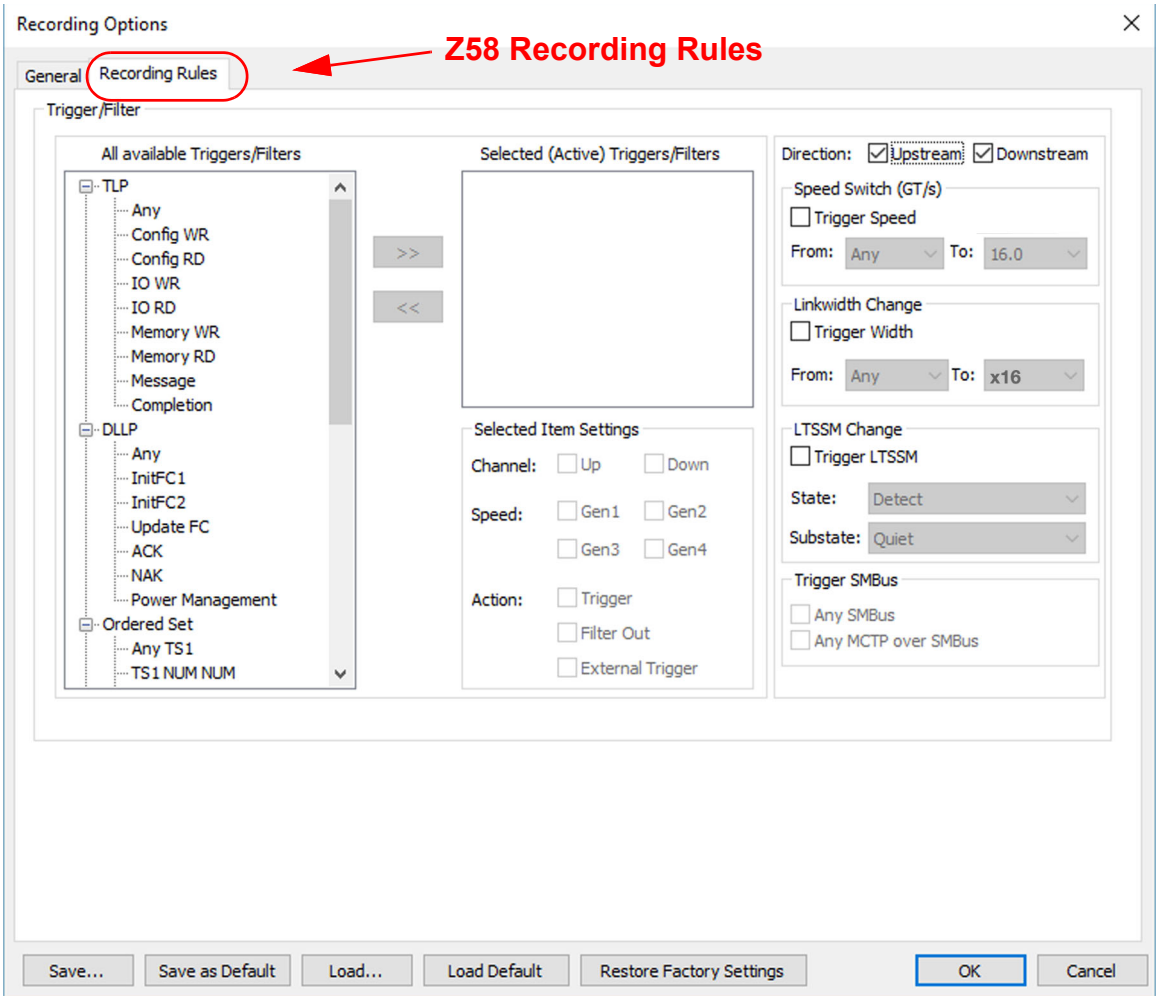


Figure 6.55: Recording Options Z58: Simple Mode → Z58 Trigger On Tab Selected

6.2.15.5 Advanced Recording Options

Options in Advanced Mode: Disable Auto Channel Swap

One Recording Option that becomes available in Advanced Mode is Disable Auto Channel Swap. See Figure 5.6.

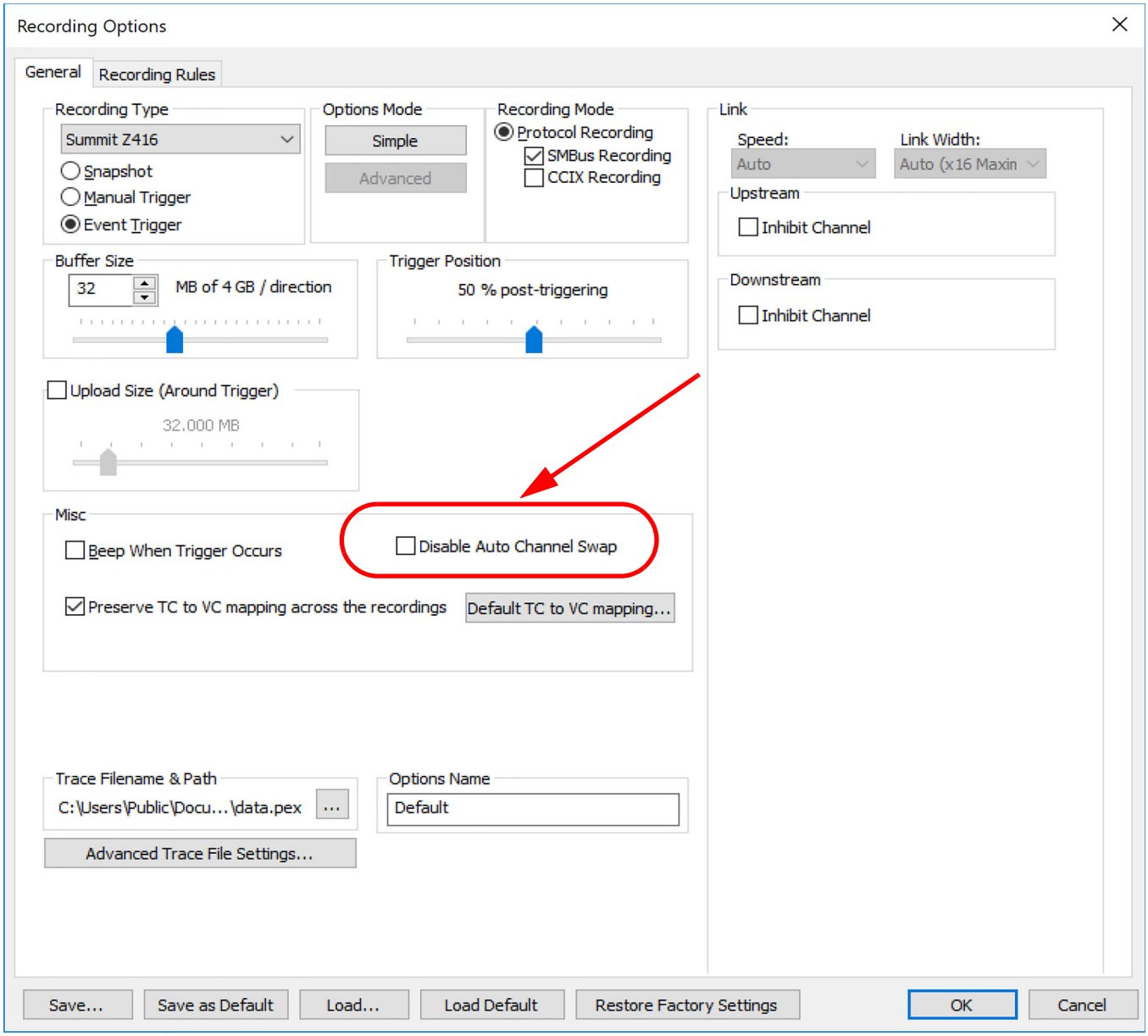


Figure 6.56: Recording Options: Advance → Disable Auto Channel Swap

If Disable Auto Channel Swap **is not selected** the PCIe Analysis software will swap the direction of the traffic data based on it's internal analysis of the traffic on the bus (channel direction swapping is enabled).

If Disable Auto Channel Swap **is selected** the PCIe Analysis software will record the traffic data as the Summit analyzer sees it and this depends on the way the connections were made to probe the bus (channel direction swapping is disabled).

Options in Advanced Mode: CCIX

Another option that becomes available in Advanced Mode is CCIX. See Figure 6.57.

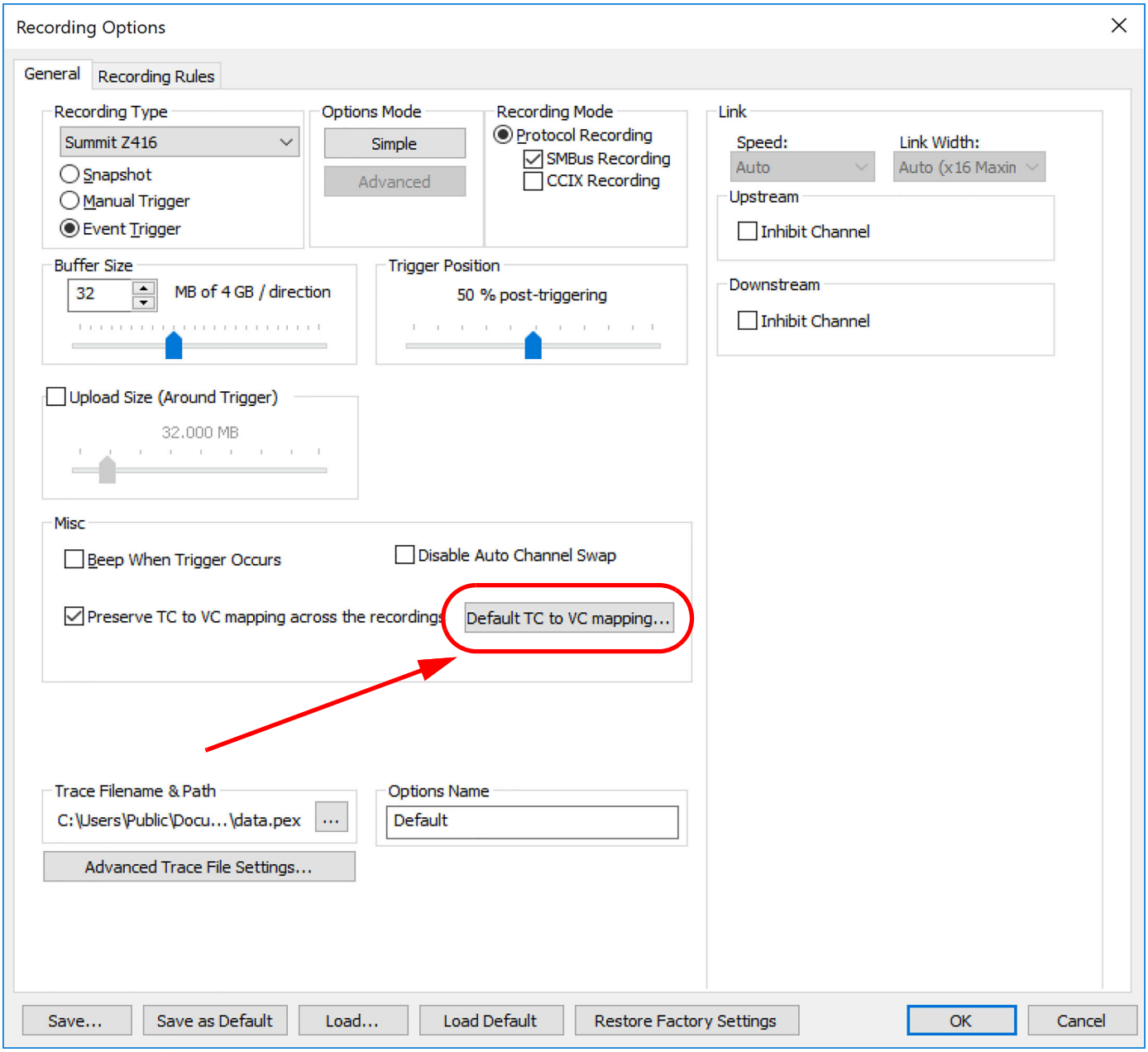


Figure 6.57: M5xAdvanced Recording Mode: Default TC to VC mapping

If you select Default TC to VC mapping, the following dialog box pops up and you can enable CCIX to be decoded. See Figure 6.58 on page 281.

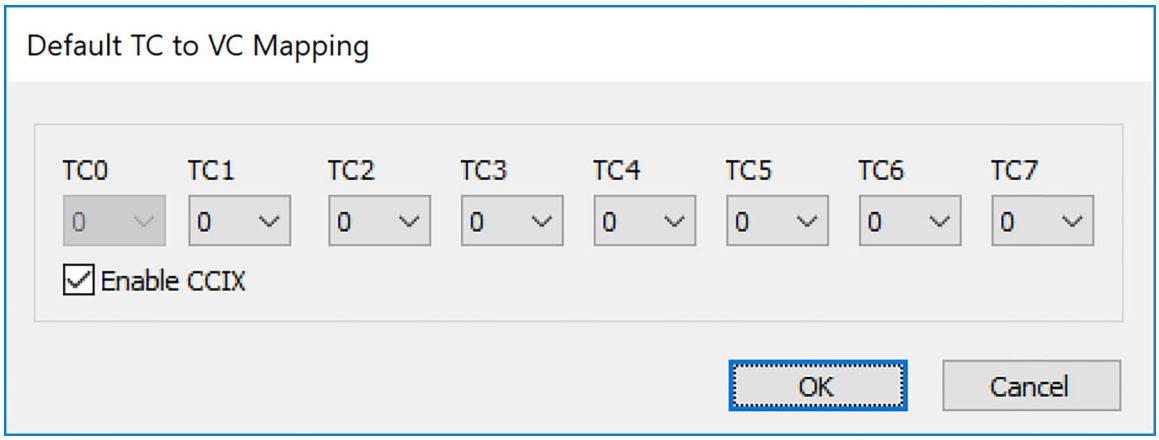


Figure 6.58: CCIX Enabled

For more details about CCIX refer to "Decoding CCIX Protocol" on page 406.

6.2.15.6 Trigger / Filter on Events

In Simple Mode with Event Trigger selected, you can trigger on the following events:

TLP

- Any TLP
- Config WR
- Config RD
- IO WR
- IO RD
- Memory WR
- Memory RD
- Message
- Completion

DLP

- Any DLLP
- InitFC1
- InitFC2
- Update FC
- ACK
- NAK
- Power Management

Ordered Set

- Any TS1
- TS1 NUM NUM
- TS1 PSAD PAD
- TS1 NUM PAD
- Any TS2
- TS2 NUM NUM

- ❑ TS2 PAD PAD
- ❑ SKP
- ❑ Control SKP
- ❑ EIEOS
- ❑ EIOS
- ❑ FTS
- ❑ SDS
- ❑ EDS

Link State

- ❑ Enter EI
- ❑ Exit EI
- ❑ WAKE#
- ❑ PERST#
- ❑ CLKREQ#

Errors

- ❑ RD Error
- ❑ Invalid Symbol
- ❑ Block Align Error

- ❑ Speed Switch (GT/s)
  - ■ Trigger Speed
    - ● From and To (see Figure 6.59)

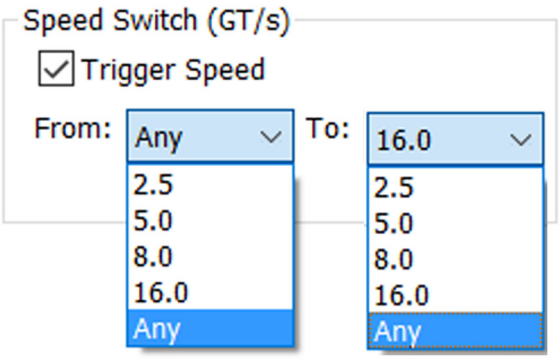


Figure 6.59: Speed Switch (GT/s): Trigger Speed → From and To

- ❑ Linkwidth Change
  - ■ Trigger Width
    - ● From and To (see Figure 6.60)

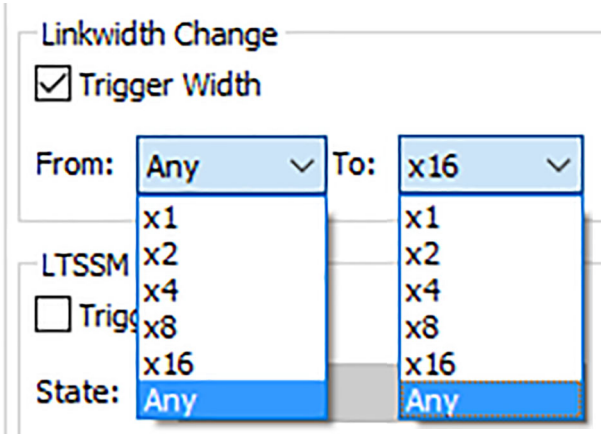


Figure 6.60: Linkwidth Change: Trigger Width→ From and To

- LTSSM
  - Trigger LTSSM
    - LTSSM State
    - LTSSM Substate (see Figure 6.61)

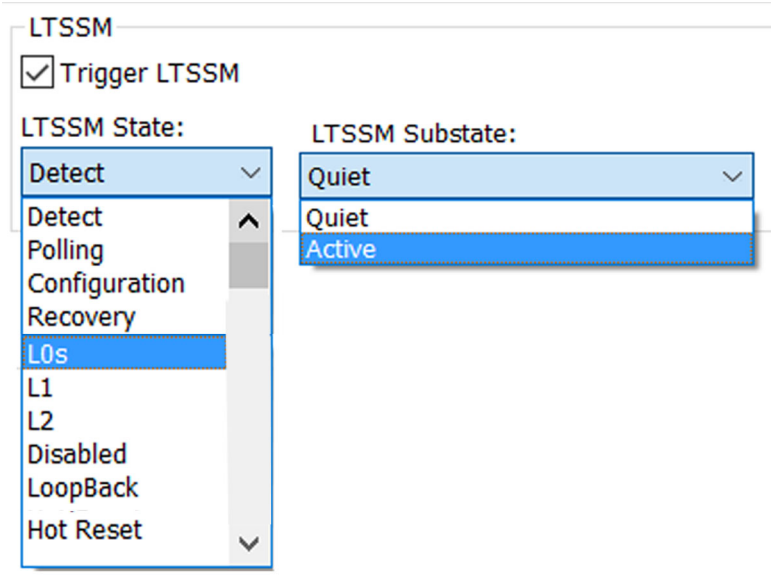


Figure 6.61: LTSSM: Trigger LTSSM → LTSSM State and LTSSM Substate

Trigger SMBus

- Any SMBus
- Any MCTP over SMBus

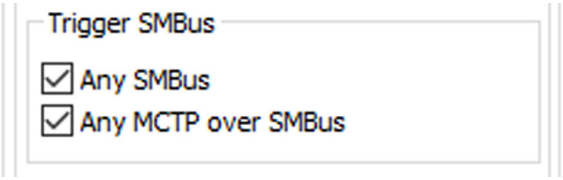


Figure 6.62: Trigger on SMBus Options

Offset from Defined Trigger Event and Actual Trigger Event Captured in Trace

In the following cases there may be some offset between the defined trigger event and the actual trigger event as displayed in the trace file. The triggers which result in an offset are:

- Any TLP
- Any DLLP
- LTSSM State

Defined LTSSM Trigger

A typical example in shown below. The defined trigger is:

Trigger LTSSM → LTSSM State: Configuration → LTSSM Substate: Linkwidth start

See Figure 6.63.

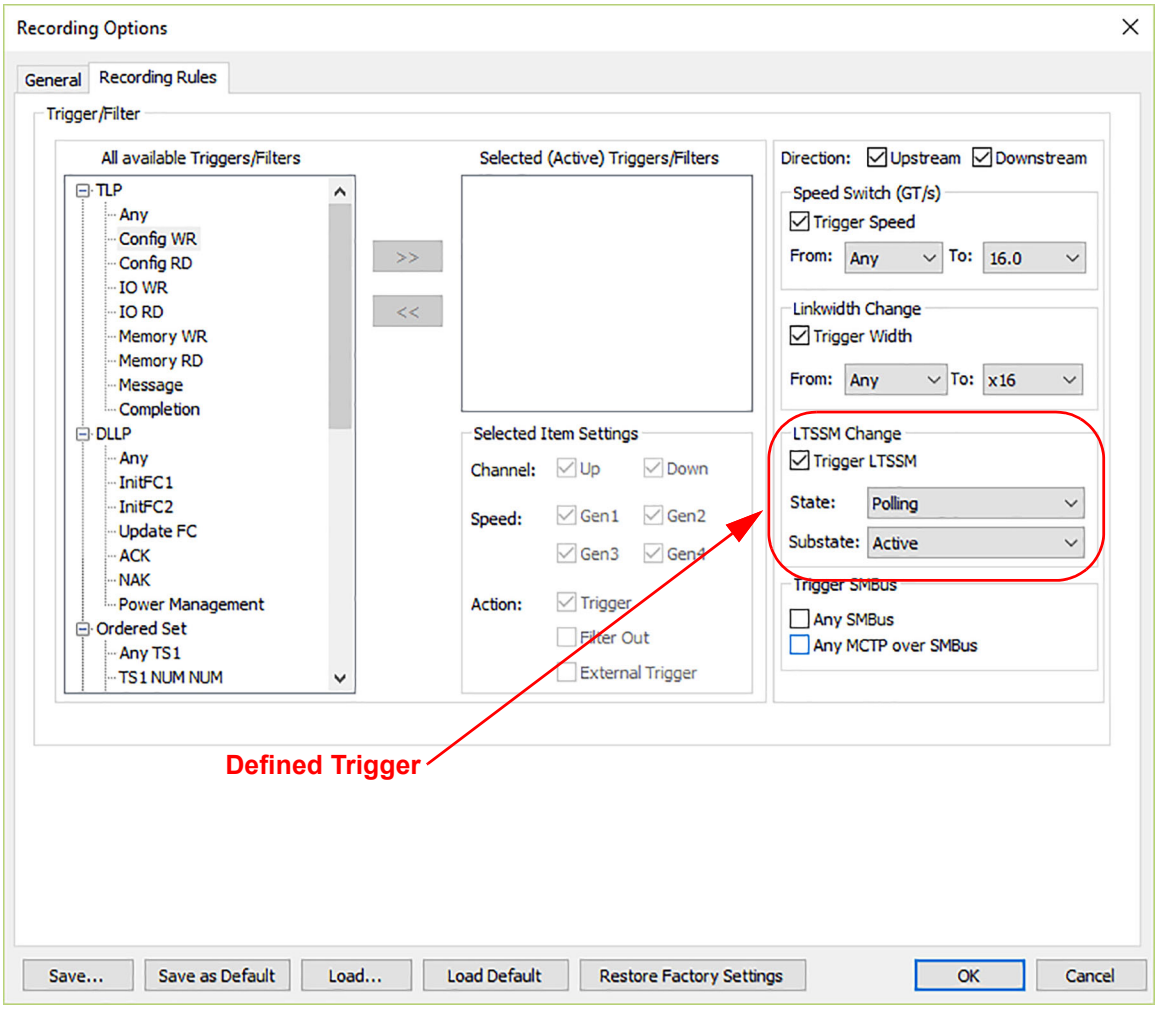


Figure 6.63: Defined Trigger → LTSSM State: Polling, LTSSM Substate: Active

Resulting Trace File

Note: Resulting trace file displaying the offset from the actual trigger packet to the defined trigger packet. See Figure 6.64.

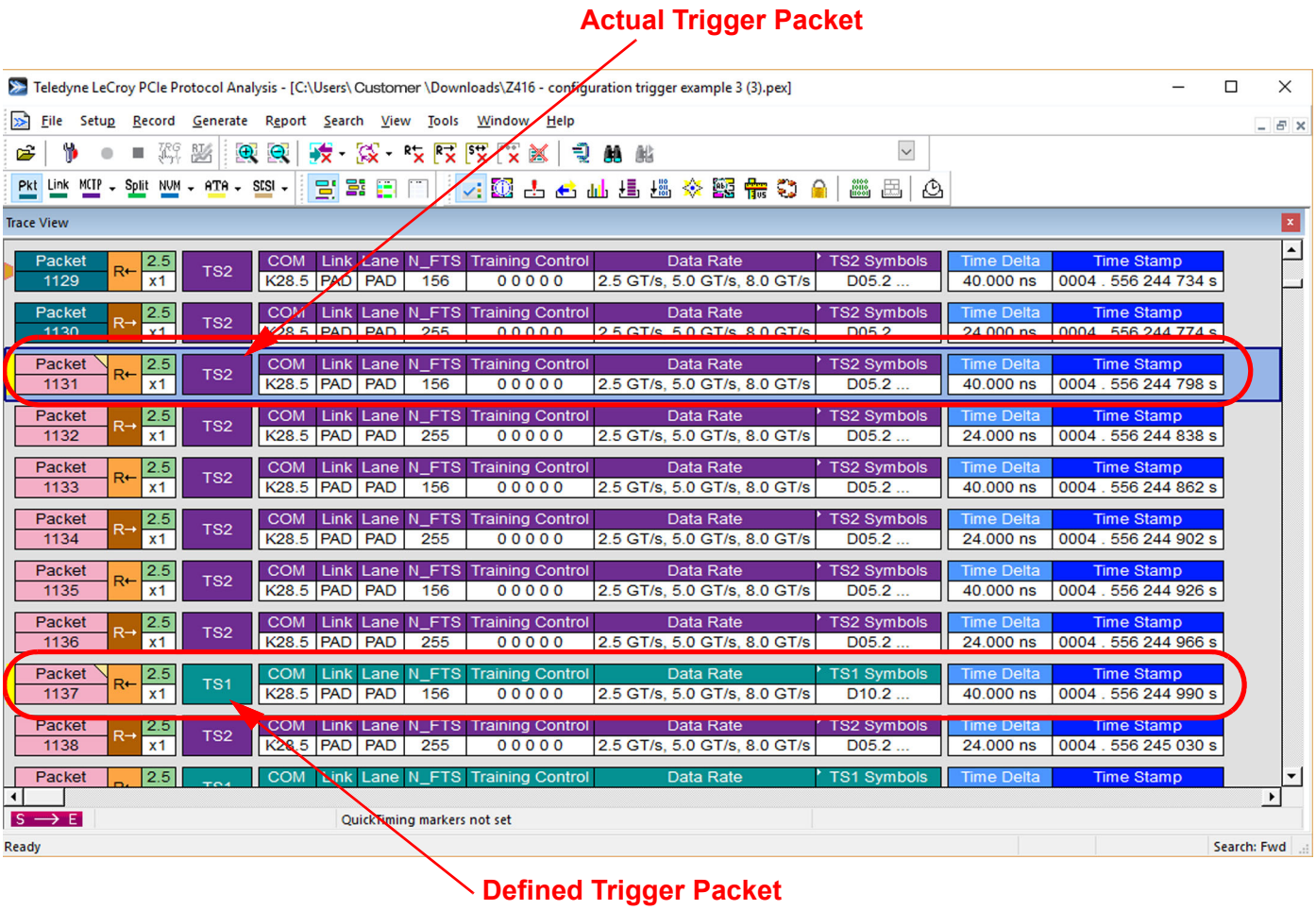


Figure 6.64: Trace File showing Offset From Actual Trigger Packet versus Defined Trigger Packet

6.2.16 Save

The Save function in the Recording Rules and the Probe settings tab has the following options (see Figure 6.65 on page 287):

- Save the whole Recording Options (.rec)
- Save only the Recording Rules portions of the recording options (.rr)
- Save only the Probe Settings portions of the recording options (.ps)

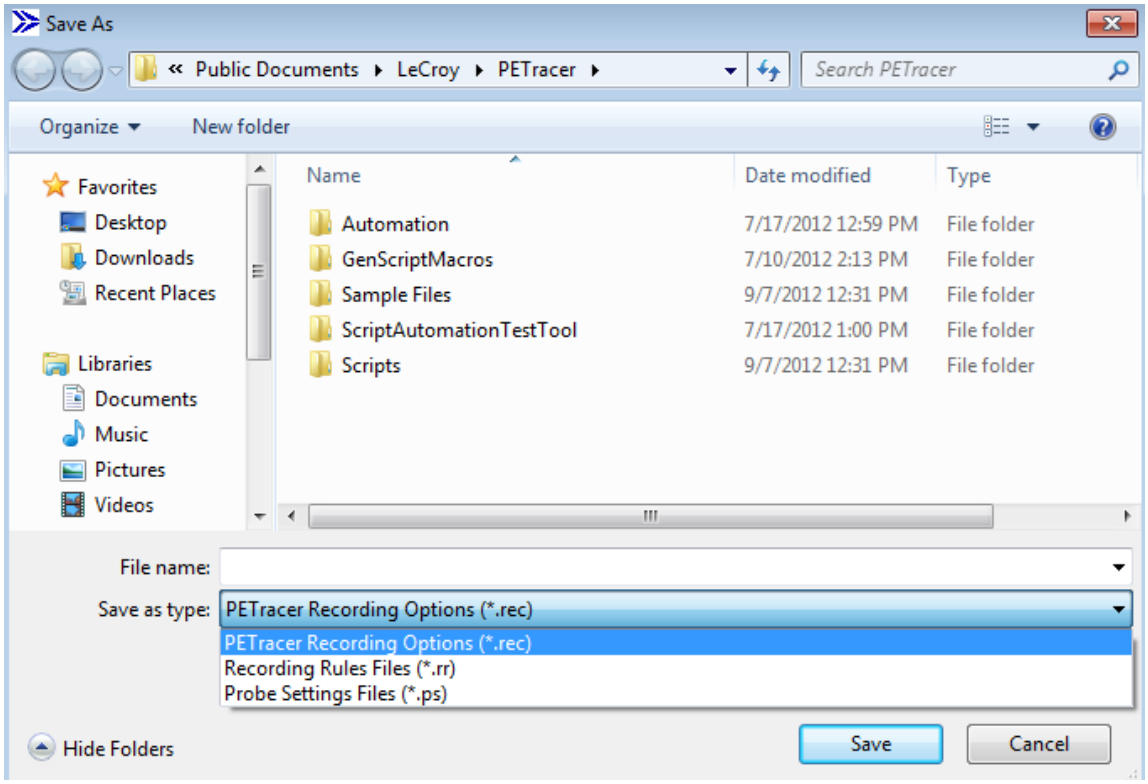


Figure 6.65: Save Dialog

6.2.17 Load

The Load function in the Recording Rules and the Probe settings tab has the following options (see Figure 6.66 on page 288):

- Load the whole Recording Options (.rec)
- Load the Recording Options of a PCIe Trace Files (.pex)
- Load only the Recording Rules portions of the recording options (.rr)
- Load only the Probe Settings portions of the recording options (.ps)

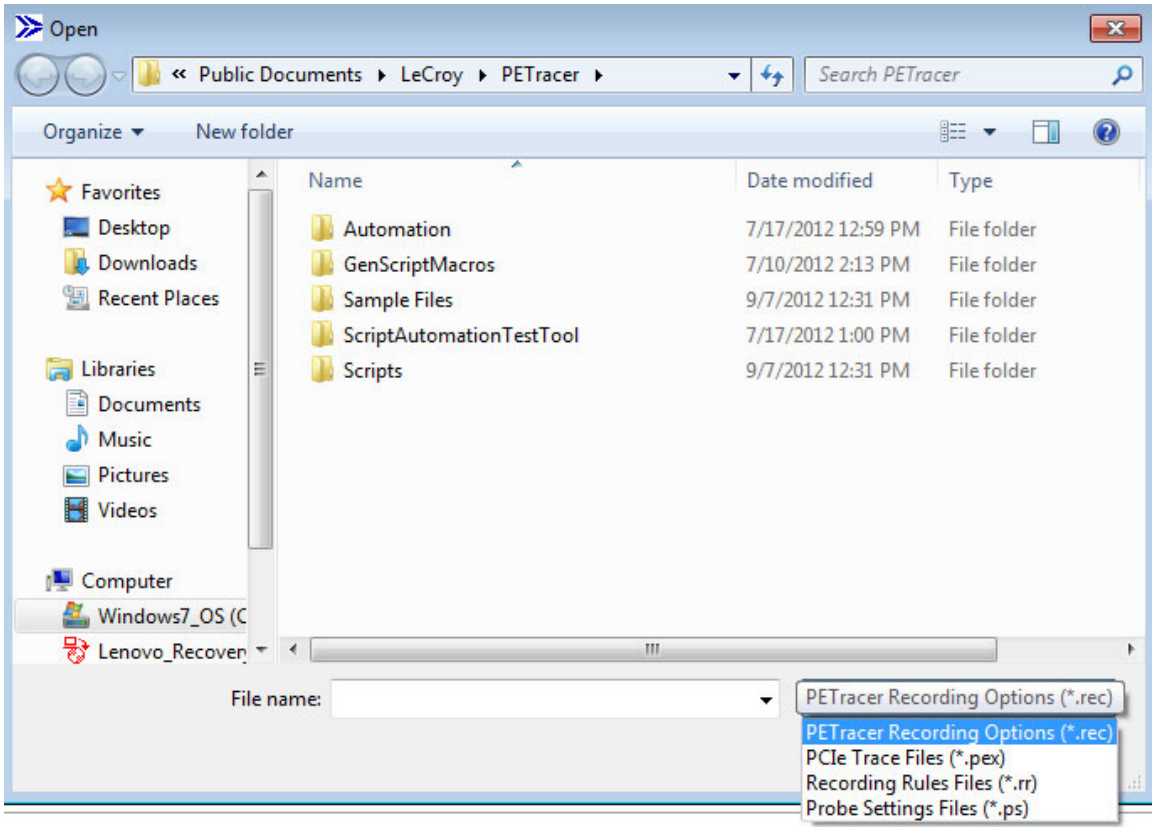


Figure 6.66: Load Dialog

6.3 Reading CATC Traces

This sections describes the options available when you're viewing/reading a CATC trace.

6.3.1 Viewing PCI Express CATC Traces

PCIe Protocol Analysis™ displays traffic as labeled, color-coded, and time-stamped rows.

Note: The time stamp resolution is 1 nano second and the accuracy is 16 nano seconds.

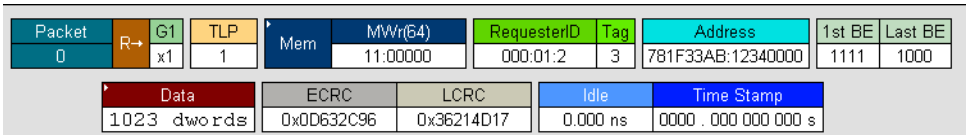


Figure 6.67: Typical CATC Trace

Tool tips provide details about fields within the CATC Trace. Hold the mouse cursor over a field to see a tool tip.

Additional information is available from pop-up menus. For example, if you click the left mouse button on the first cell in a packet a menu appears with an option to view Raw 10b Codes.

6.3.2 Expand and Collapse Data Fields

Packet data fields are displayed in a short format by default.

You can view a data field's long format by performing one of the following three actions:

- Click the **small triangle** in the left corner.
- Double-click anywhere in the data field.
- Click once in the Data Field with the left mouse button, then choose **Expand Data** from the pop-up menu.

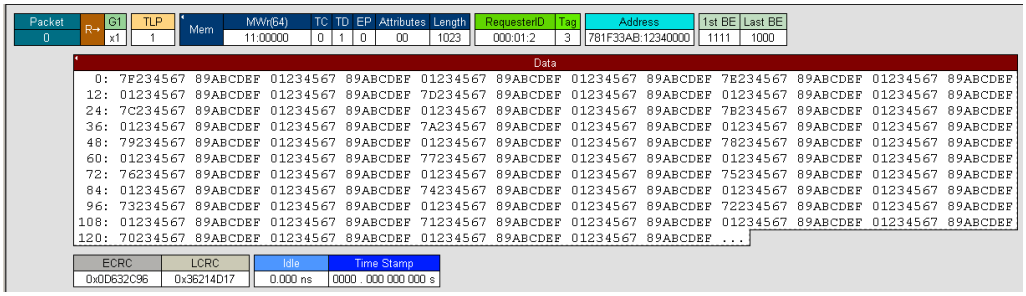


Figure 6.68: CATC Trace: Expanded Data View

A repeat of any above methods causes the display to return to a Short Data format.

6.3.3 Resizing Cells

Data cells can be resized by pointing the mouse pointer on the edge of a data cell, depressing and holding the left mouse button, and then repositioning the mouse pointer while keeping the mouse button depressed.

6.3.4 Pop-up Menus

The Analyzer software makes extensive use of pop-up menus. In some instances, pop-up menus provide the only means of accessing dialogs that contain detailed information about cells within the CATC Trace, for example, the Show Configuration Space dialog.

To see a pop-up menu, left-click or right-click a **cell** within the CATC Trace. Right-click or left-click behavior depends on the Display Options setting. For default left-click, the right-click menu is not cell-dependent. For other left-click behavior, the type of menu that opens varies depending on the type of cell that is selected. Take some time to explore CATC Traces and the various pop-up menus.

6.3.5 View Data Block

To view the raw bits that make up the data in a data field, left-click a data field, then click  or select **View Data Block** from the pop-up menu to display the Data Block window

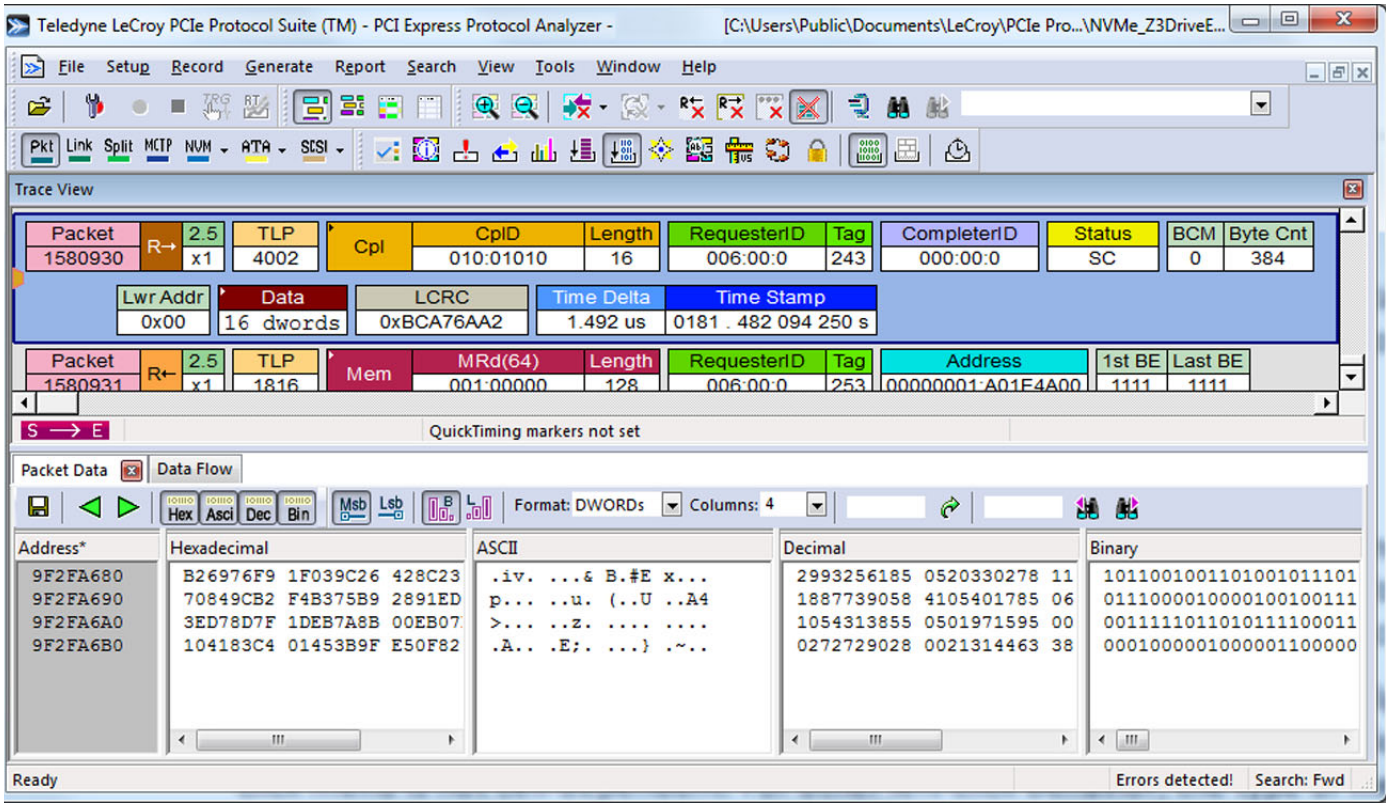


Figure 6.69: Viewing a Data Block

You can display data in Hexadecimal, ASCII, Decimal, or Binary formats.

Bit Order is Most Significant Bit or Least Significant Bit.

You can display data in Big Endian or Little Endian.

Format lets you display data as BYTEs, WORDs, or DWORDs.

Columns lets you select the number of columns.

You can enter hexadecimal offset values.

You can go to or search Previous or Next.

6.3.5.1 Save Data Block

You can also **Save** the data in Hexadecimal, ASCII, Decimal, or Binary formats. See Figure 6.70.

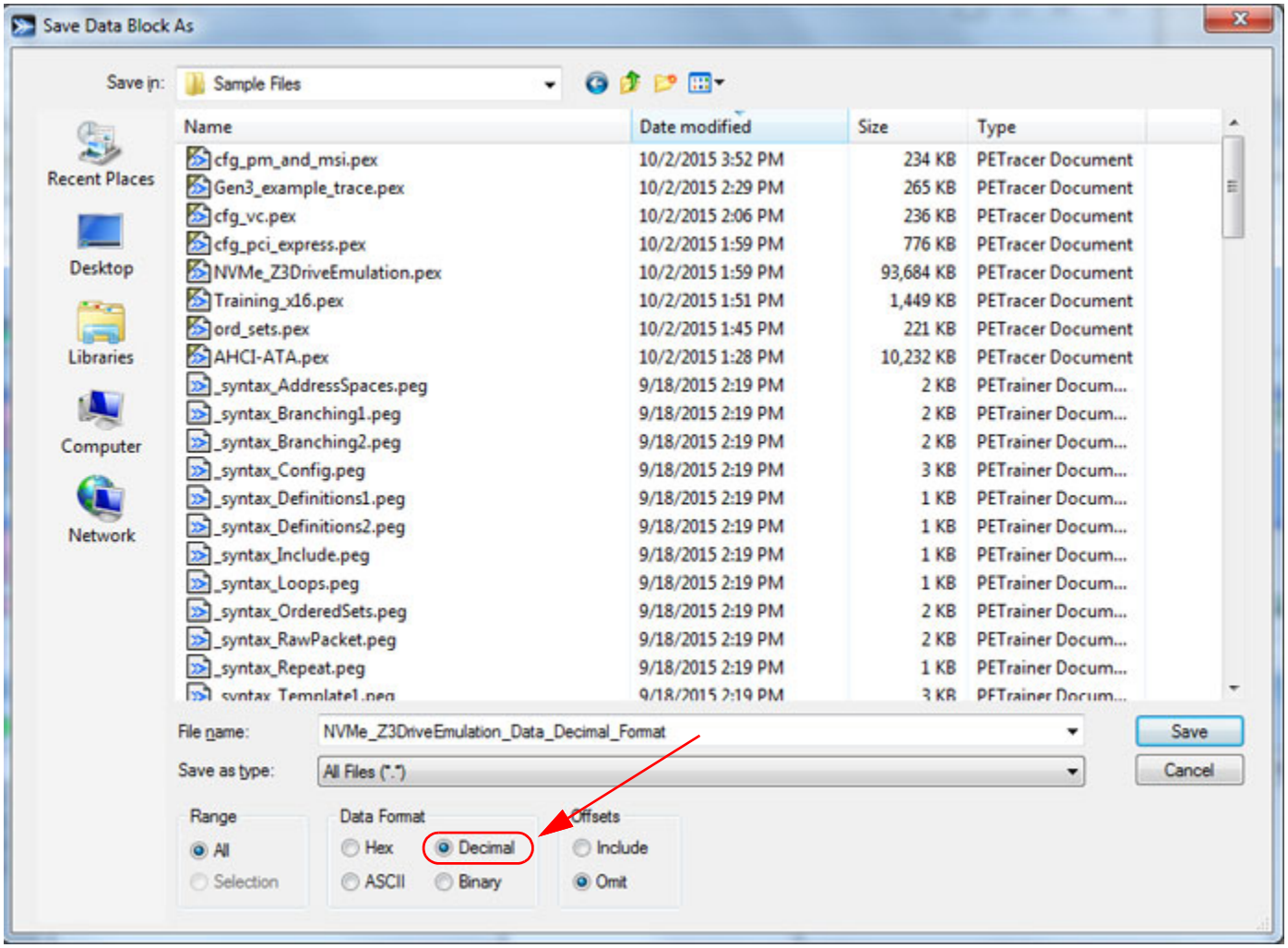


Figure 6.70: Save Data Block In Hex, Decimal, ASCII or Binary

The Saved file is shown in Figure 6.71 on page 291.

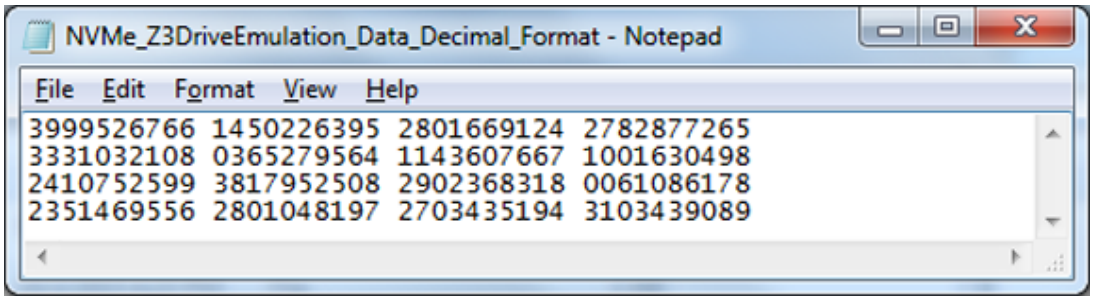


Figure 6.71: Saved Data File in Decimal Format

6.3.6 Show Raw 10b Codes

You can view the raw bits that make up the data field by right-clicking the field and selecting **View Data Block** from the pop-up menu.

To view Raw 10b Codes:

1. Right-click the **first cell** in a packet.
2. Select **Show Raw 10b Codes** from the pop-up menu to display the Raw 10b Codes window.

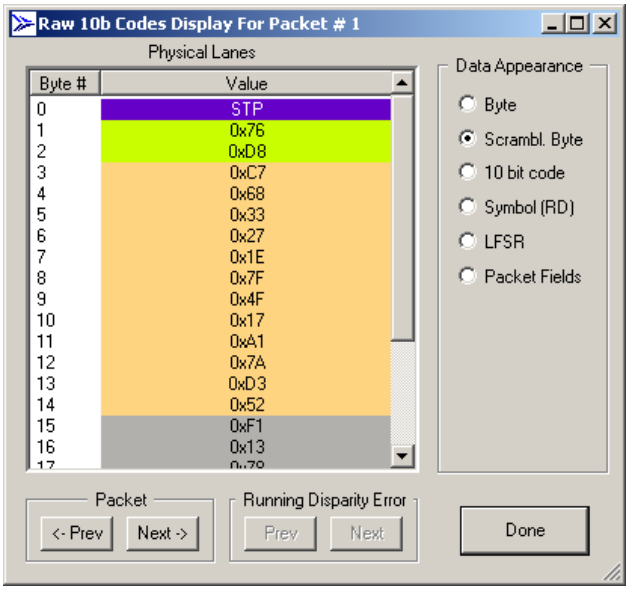


Figure 6.72: Show Raw 10b Codes Dialog

3. To change the format of the data, use the options along the right side of the dialog.
4. To navigate the CATC Trace, use the **Prev** and **Next** buttons.

6.3.7 Show Header Fields

You can view details about header fields by opening the Show Header Fields dialog.

1. Click a **header.** A pop-up menu displays (see the following figure).

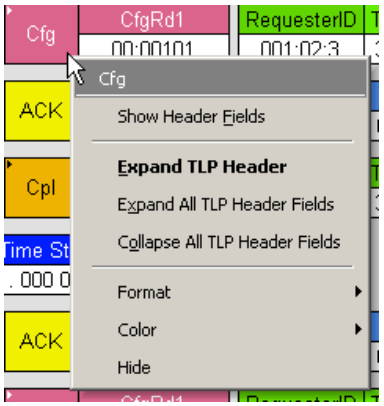


Figure 6.73: CATC Trace View: Header Popup Menu

2. Select **Show Header Fields**. The following dialog opens.

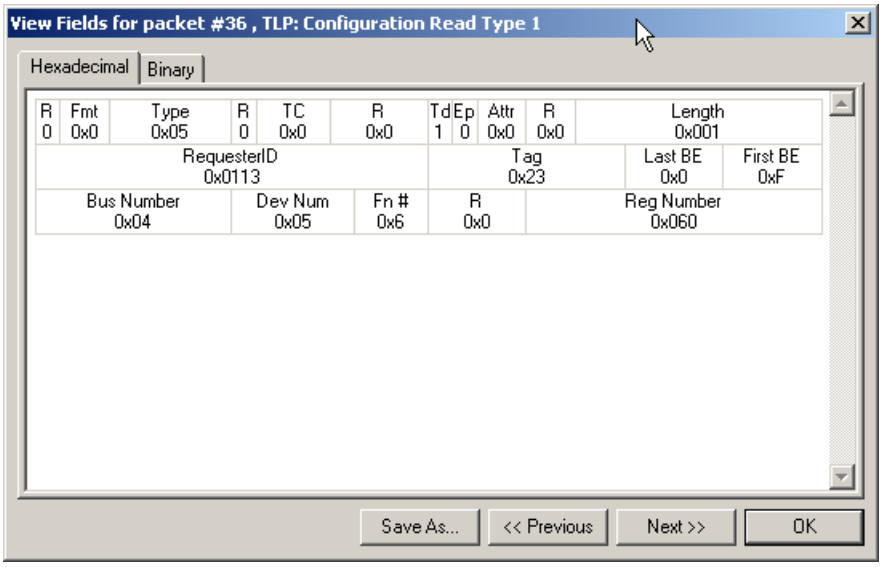


Figure 6.74: Viewing Packet Fields

3. Use the **Prev** and **Next** buttons to navigate to other headers.

6.3.8 Packet Cell Popup Menus

The Packet cell has a right-click pop-up menu that includes the following topics. See Figure 6.75 on page 293.

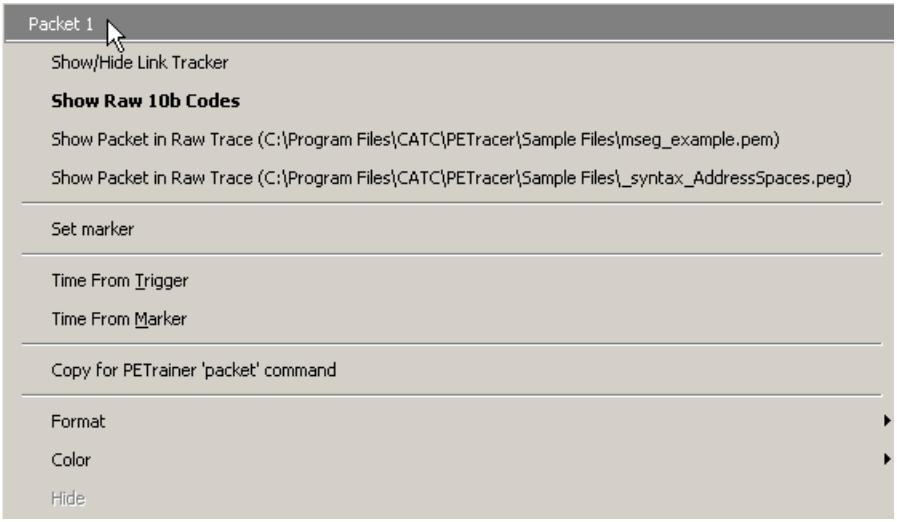


Figure 6.75: Packet Cell Popup Menu

Each topic can be selected and generate more information about the topic. The following sections describe each of the topics in the menu.

6.3.8.1 Show/Hide Link Tracker

Click on the “Show/Hide Link Tracker” and the Link Tracker View will show up in the Main Display window. See Figure 6.76.

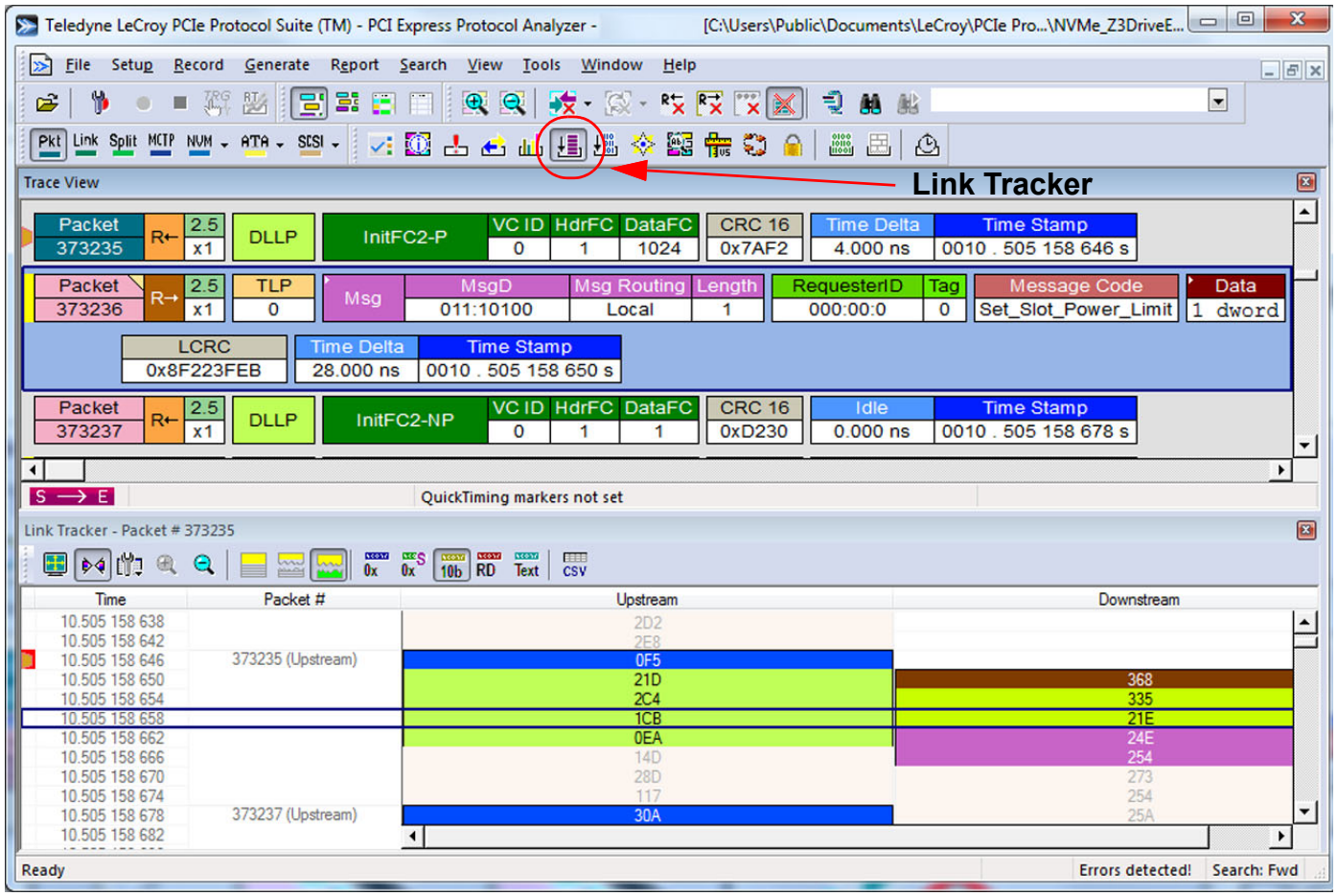


Figure 6.76: Packet Cell Popup Menus: Trace View and Link Tracker View

Link Tracker is discussed in more detail in “Link Tracker” on page 508.

6.3.8.2 Show Raw 10b Codes

Click on Show Raw 10b Codes and the Raw Symbols Display for the selected Packet pops up. See Figure 6.77.

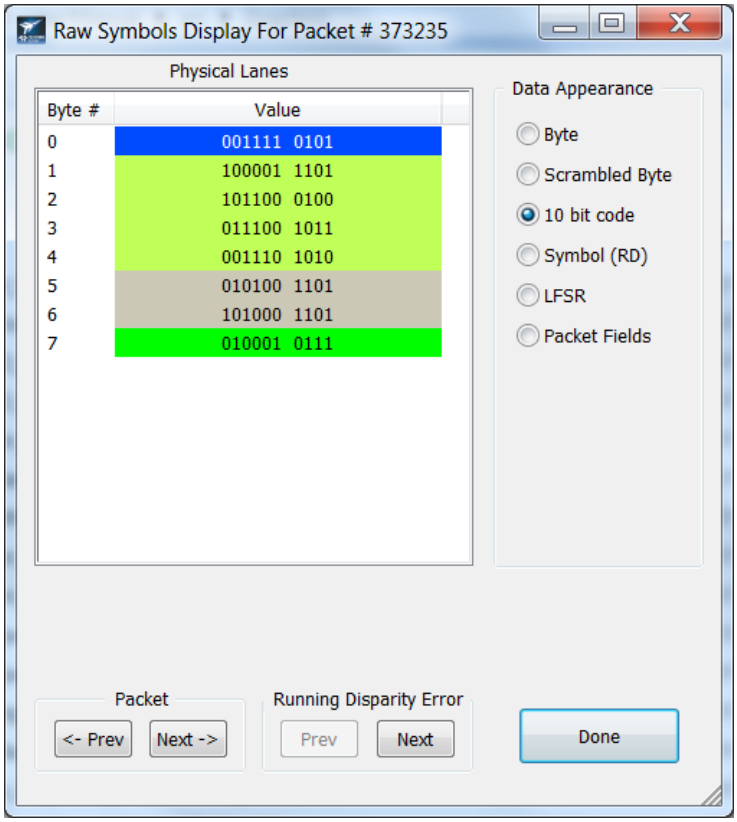


Figure 6.77: Packet Cell Popup Menus: Show Raw 10b Codes

Raw 10b Codes is discussed in more detail in "Show Raw 10b Codes" on page 291.

6.3.8.3 Time From Trigger

Select Time From Trigger and the Timing Calculator pops up. See Figure 6.78.

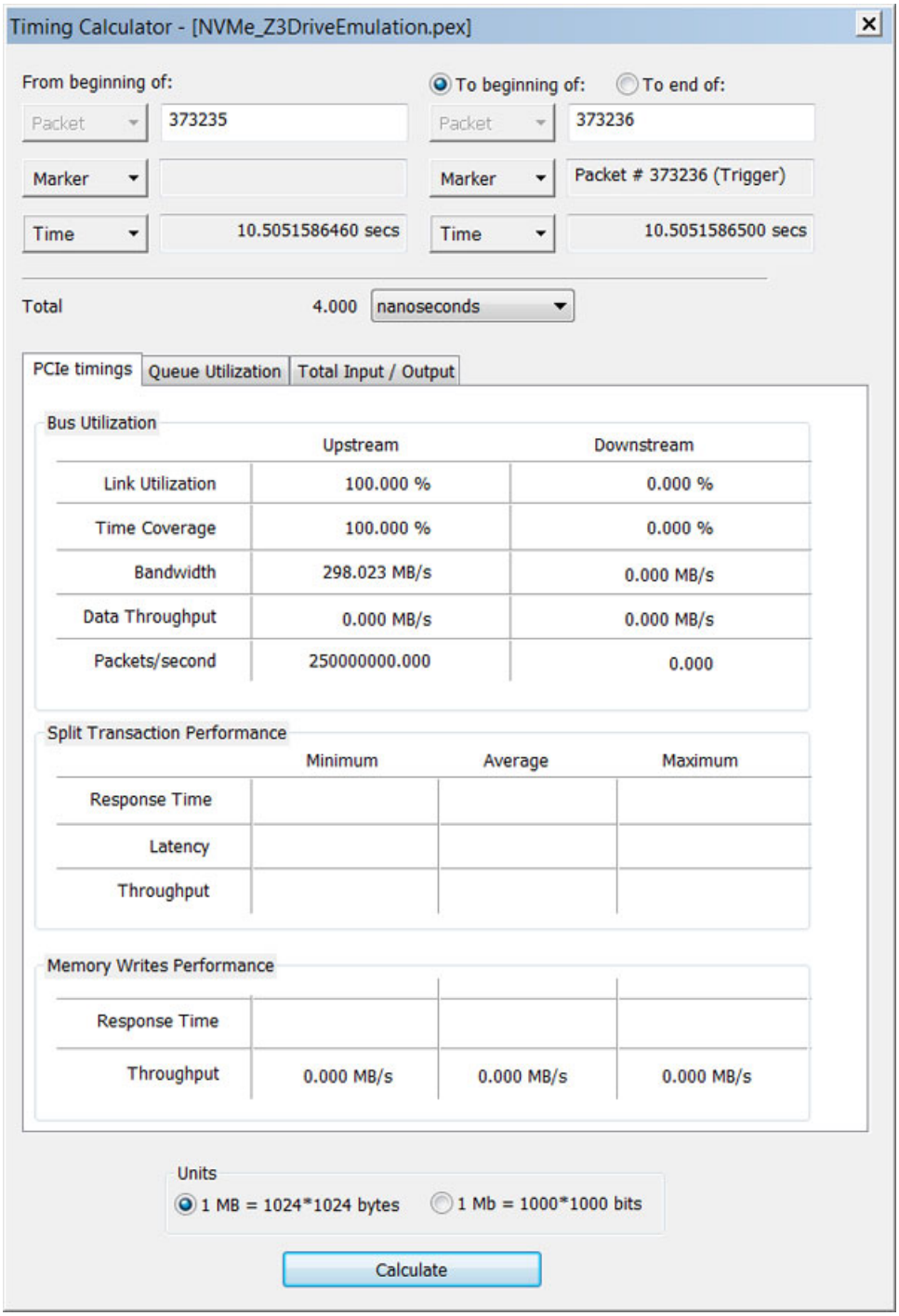


Figure 6.78: Packet Cell Popup Menus: Timing Calculator

The Timing Calculator is discussed in more detail in “Timing Calculator” on page 549.

6.3.8.4 Time From Marker

Click on Time From Marker and the following menu pops up along with the Timing Calculator. See Figure 6.79.

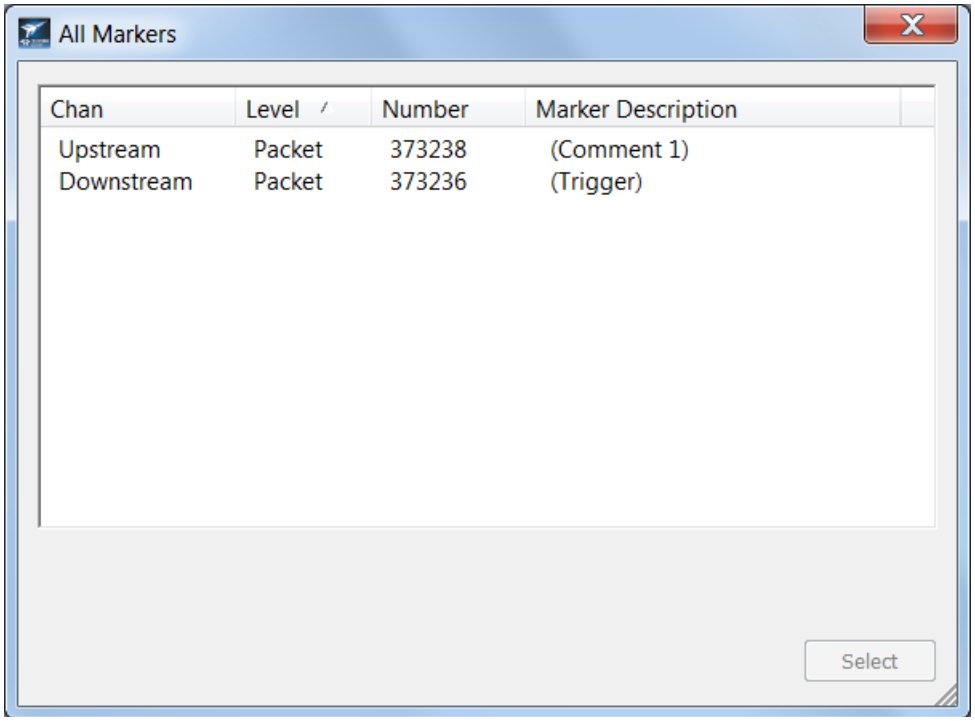


Figure 6.79: Packet Cell Popup Menus

Markers are discussed in more detail in "Set Marker" on page 301 and the Timing Calculator is discussed in more detail in "Timing Calculator" on page 549.

6.3.8.5 Copy for PETrainer 'packet' command

Select a packet, right click to bring up the Packet Cell Popup Menu, select the Copy for PETrainer 'packet' command and the tool will copy the Packet information which can then be copied into a PETrainer script for use with Teledyne LeCroy exercisers (Z58 etc.).

An example is shown below of a typical Packet and the PETrainer commands generated:

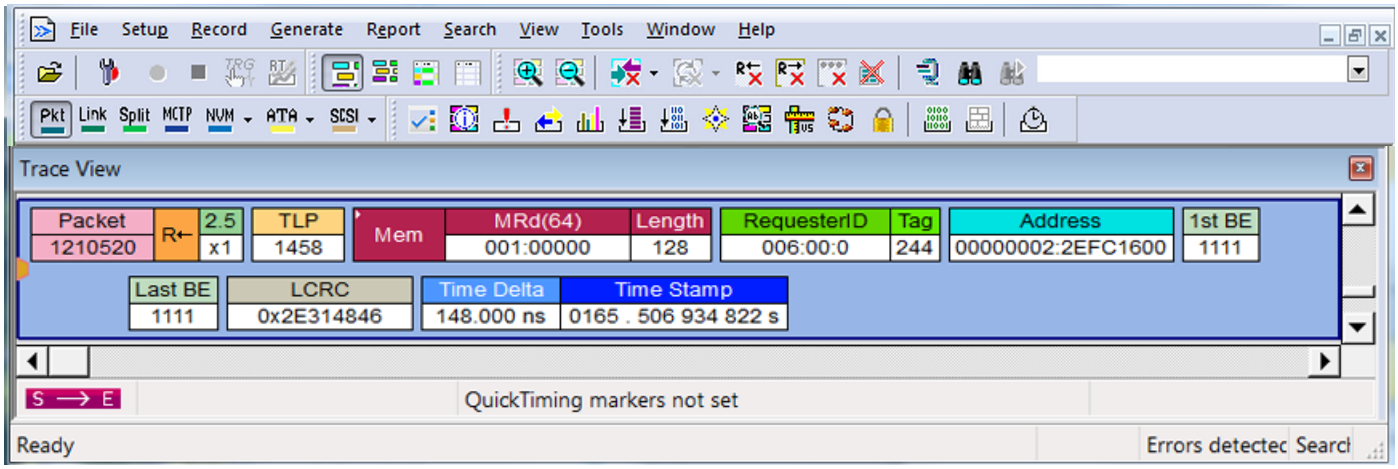


Figure 6.80: Packet Cell Popup Menus: Copy for PETrainer 'packet' Command

The script produced looks like this and can be copied into an existing trainer script:

packet = TLP {

PSN = 0x5B2

TLPType = MRd64

TC = 0x0

TD = 0x0

TH = 0x0

EP = 0x0

IDBasedOrdering = 0x0

Ordering = 0x0

Snoop = 0x0

AT = 0x0

Length = 0x80

RequesterId = (6:0:0)

Tag = 0xF4

LastDwBe = 0xF

FirstDwBe = 0xF

AddressHi = 0x2

AddressLo = 0x2EFC1600

}

6.3.8.6 Set Start Quick Timing Marker

Sets the start packet for the Quick Timing marker. An S symbol is displayed at the packet.

Quick Timing provides immediate time deltas and bandwidth calculations. If the Start is placed on a packet that contains an Address and Endpoint, the bandwidth for that combination is displayed in the Status Bar below the trace data.

Quick Timing Markers are special ""Start"" and ""End"" markers used to mark the boundaries of the calculations. The results are shown in a special Quick Timing Bar at the bottom of the TraceView. The markers are set from a context sensitive menu.

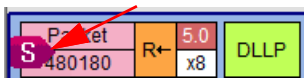


Figure 6.81: Packet Cell Popup Menus: Set Start Quick Timer Marker

6.3.8.7 Set End Quick Timing Marker

Sets the end packet for the Quick Timing marker. An E symbol is displayed at the packet.

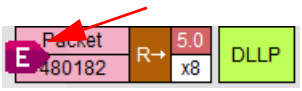


Figure 6.82: Packet Cell Popup Menus: Set End Quick Timer Marker

6.3.8.8 Tag Pop Up Menu

You can get a "Tag" pop up menu if you scroll over a RequesterID and it's associated Tag block as shown below (see Figure 6.83). The Summit Z58 can decode the following tags:

- Use 5/8/10 bit tag (no phantom functions)
- Use 9 bit phantom function tag
- Use 10 bit phantom function tag
- Use 11 bit phantom function tag

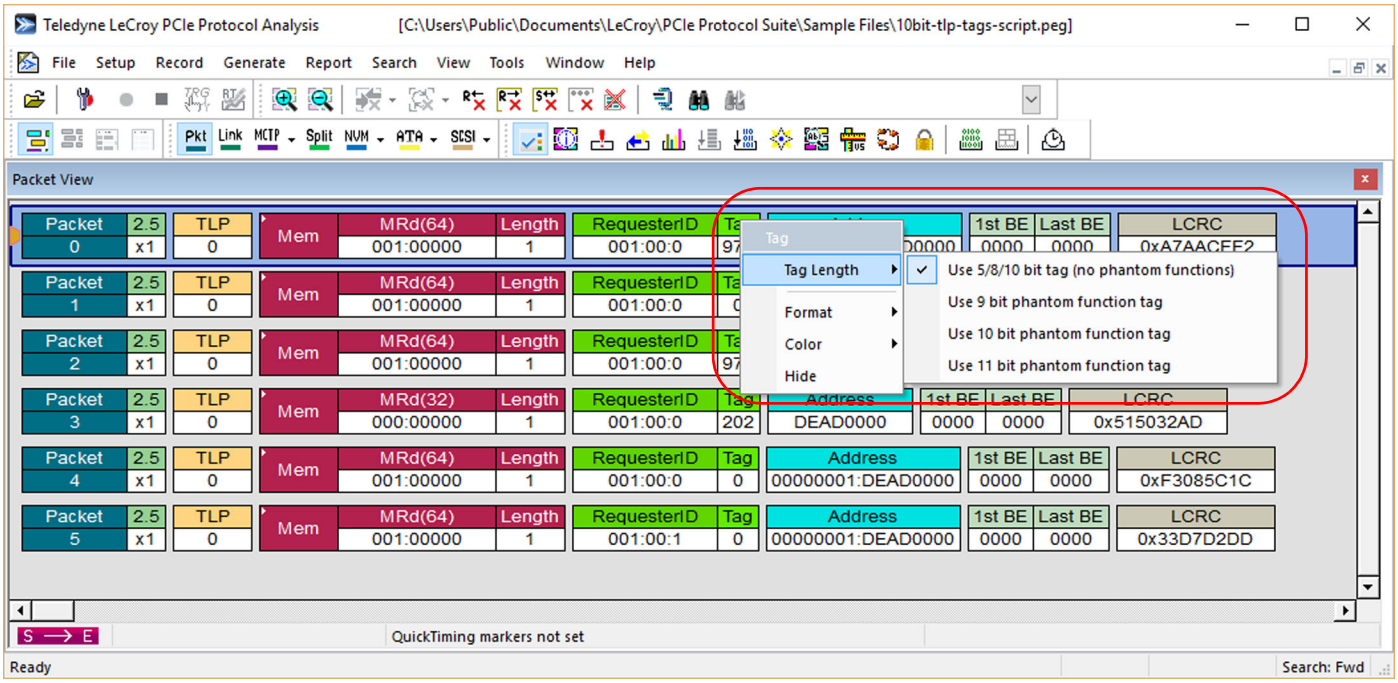


Figure 6.83: Packet Cell Popup Menus: Tag Length Pop Up Menu selections

The tag also has a tooltip associated with it to give you more information about the Packet's RequesterID Tag. See Figure 6.84 on page 300 and Figure 6.85 on page 300.

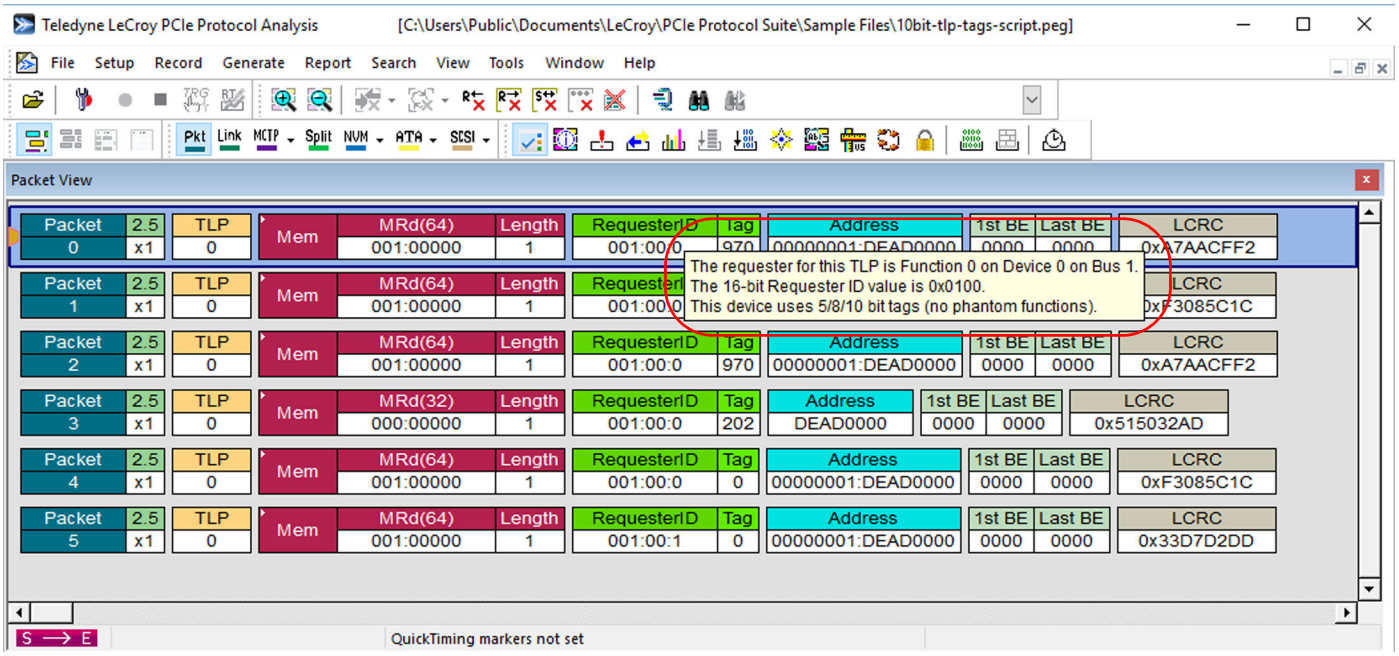


Figure 6.84: Packet Cell: Tag Tooltip

The Summit Z58 can also decode RegisterID blocks that use phantom function tags. As shown in the figure below. See Figure 6.85.

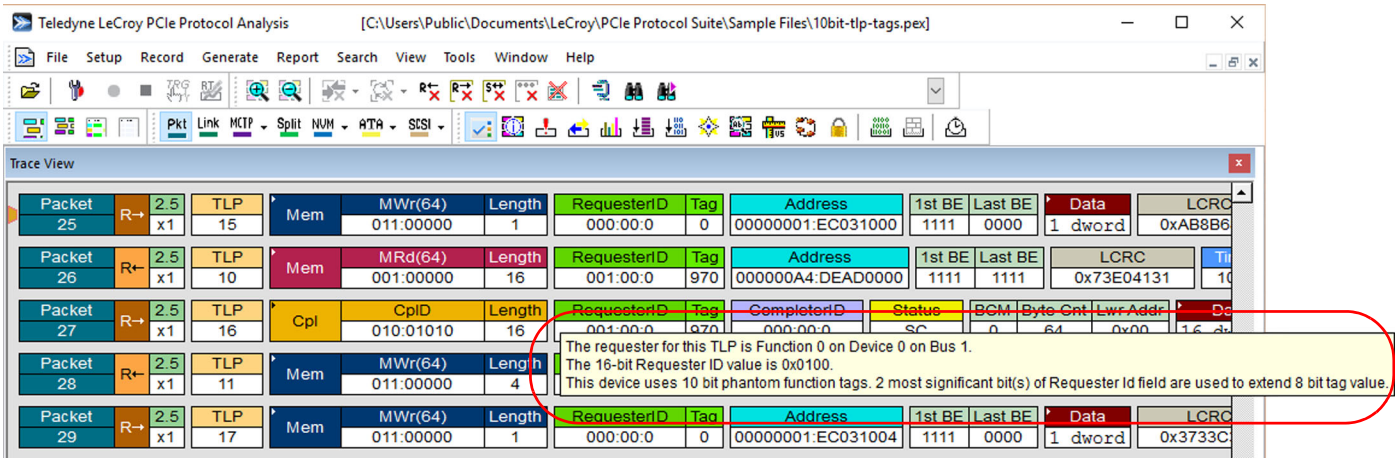


Figure 6.85: Packet Cell: Phantom Function Tag Tooltip

Quick Timing Bar

The Quick Timing Bar (see Figure 6.86 on page 301) at the bottom of the Trace View display window shows the following data between Markers:

- Delta Time
- Bus Utilization (both from Device to Host and from Host to Device)
- Data Throughput (both from Device to Host and from Host to Device)

Right click in the Quick Timing Bar to pop-up the menu to include or exclude the last selected packet/transaction from the timing, bus utilization and throughput calculations.

The data can be display in either MB = 1024*1024 Bytes or Mb = 1000*1000 bits.

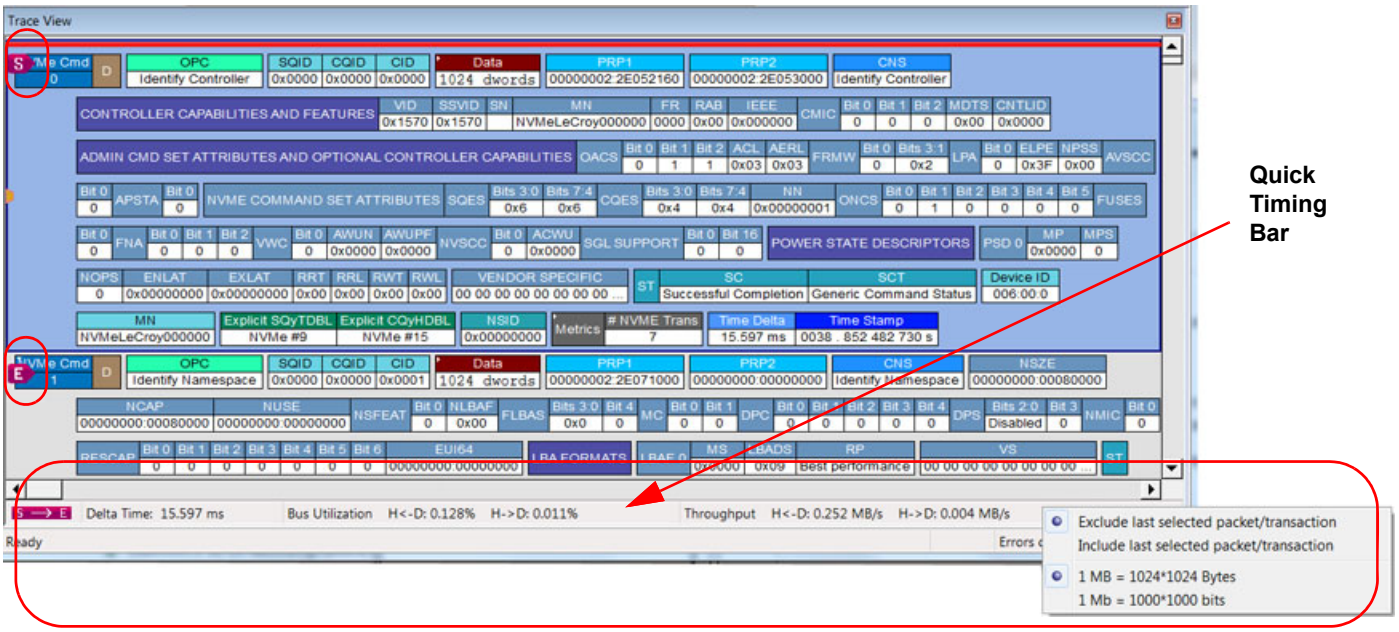


Figure 6.86: Quick Time Bar

6.3.8.9 Delete All Quick Timing Markers

Deletes all Quick Timing markers.

6.3.8.10 Set Marker

A marker is a unique label for a packet that allows you to go to that packet and also serves as a **comment string** for a specific packet. When you select a marker, the identified packet appears at the top of the screen. Packets that have been **marked** have a red bar on the left edge.

To set a marker, perform the following steps:

1. Right-click the **Packet** field of the packet you want to mark (see Figure 6.87 on page 302) or hover over the packet and click **Ctrl+K,** or select the packet and click **Ctrl+L**.

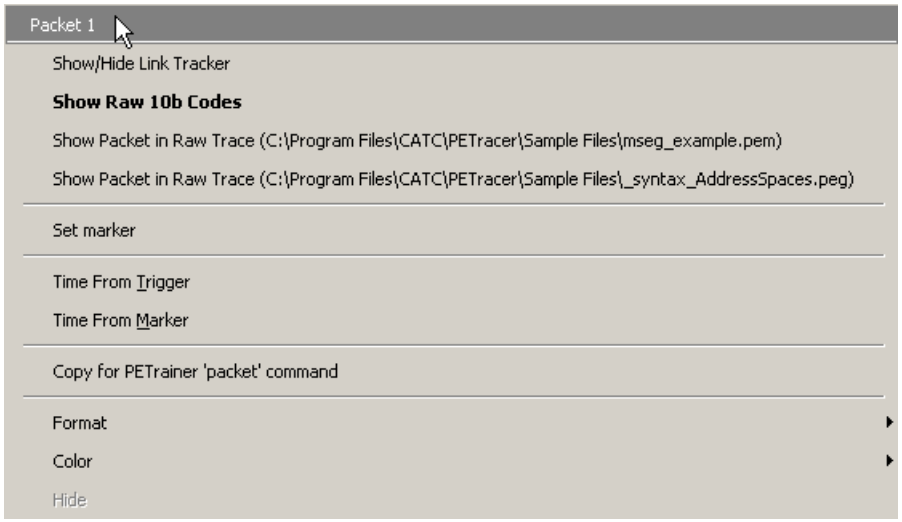


Figure 6.87: CATC Trace: Set Marker

2. Click **Set Marker**.
3. When the Create Marker for Packet # pop-up displays (see Figure 6.88), enter a unique identifier for the packet in the Comment field.

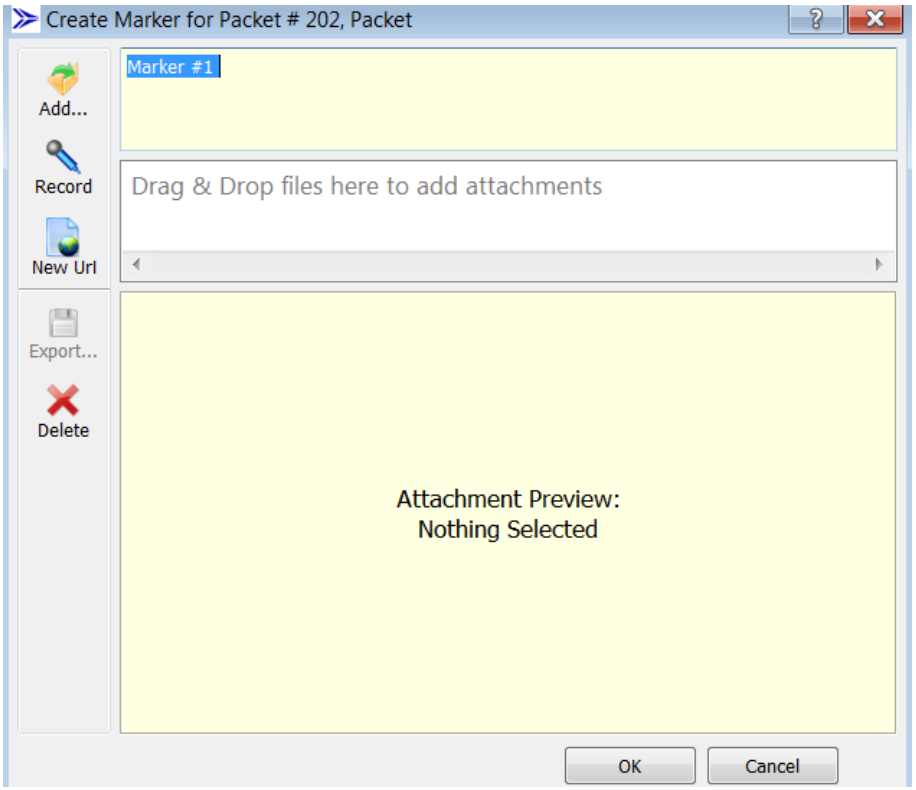


Figure 6.88: Create Marker for Packet Dialog

Later, you can go directly to this packet using the Go To Marker operation in the Search Menu.

6.3.8.11 Edit or Clear Marker

To change a markers identifier, or clear (delete) the marker:

1. Right-click the **Packet** field of the desired packet to display a pop-up menu (see Figure 6.89).

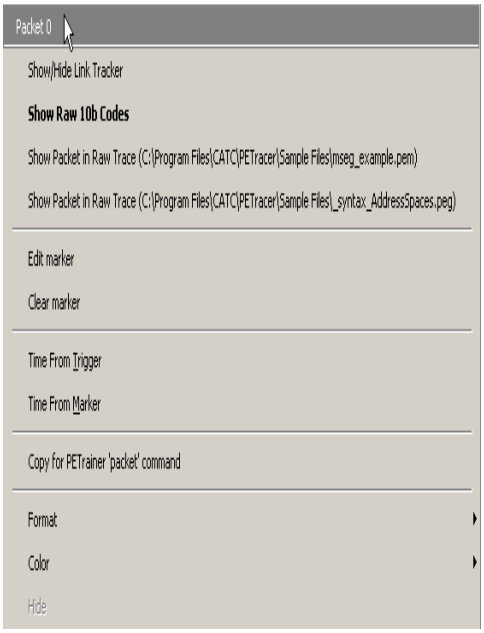


Figure 6.89: Edit Marker Pop-up Menu

2. Choose **Edit Marker** and enter a new identifier into the Edit Marker for Packer # pop-up, or
   choose **Clear Marker**. When you choose Clear Marker, the marker is removed and the red line disappears.

6.3.8.12 Format

Selecting Format from the Packet Cell Popup Menus will allow you to change the format of the data from Hex, Decimal, Binary or ASCII. See Figure 6.90.

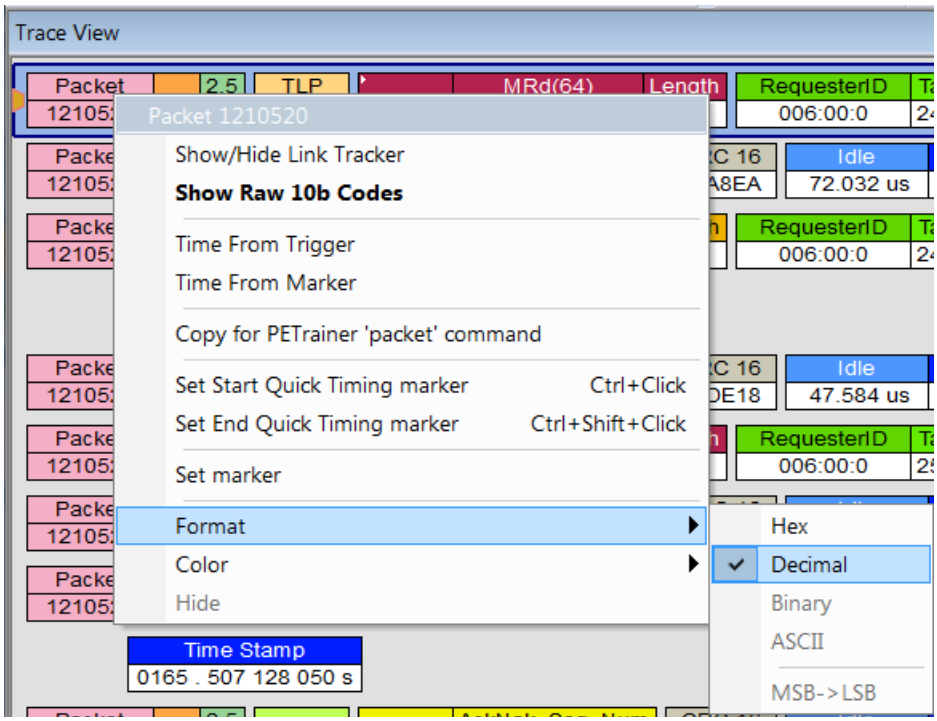


Figure 6.90: Packet Cell Popup Menus: Format

6.3.8.13 Color

Selecting the Packet Cell Popup Menu Color allows you to change the color of the Packet Cell. See Figure 6.91. Choose one of the twenty standard colors or pick Other for more choices.

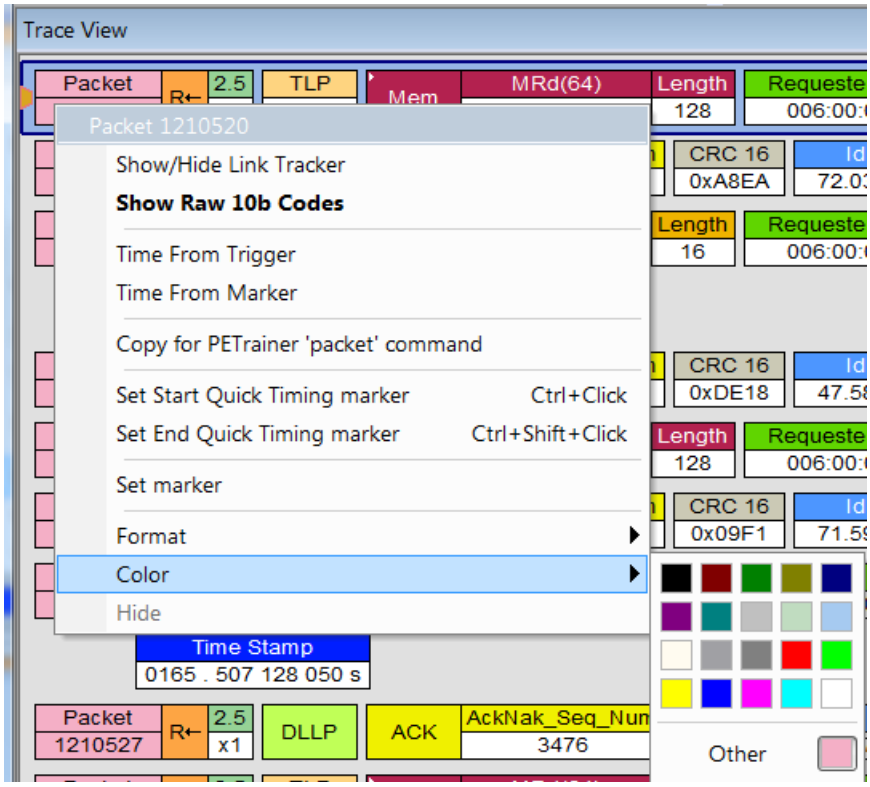


Figure 6.91: Packet Cell Popup Menus: Color

6.3.8.14 Other Packet Cell Popup Menus

Packet Header R→ Cell Popup Menu

The Packet Header R→ cell has a pop-up menu (see Figure 6.92) with the Swap Upstream/ Downstream command, which changes the directionality of the packets in the CATC Trace.

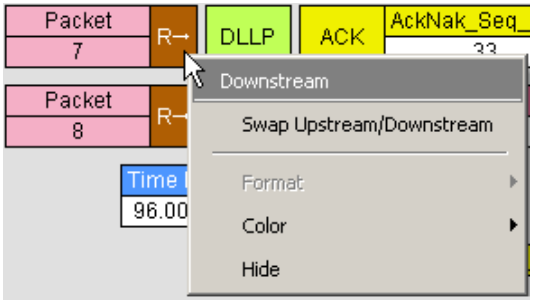


Figure 6.92: CATC Trace View: Packet Header Direction Popup Menu

Packet Header Speed Cell Popup Menu

The Packet Header Speed cell has a pop-up menu with the Show Header Fields command (see "Show Header Fields" on page 292), which exposes a detailed view of the selected Header field (see the following figure).

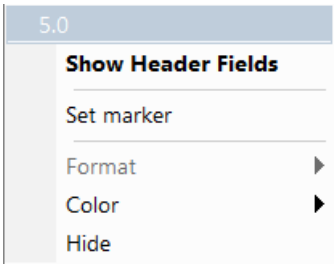


Figure 6.93: CATC Trace View: Packet Header Speed Popup Menu

6.3.9 Compressed CATC Trace View

The Compressed CATC Trace view shows fields in the format "Attribute: Value", whereas the normal CATC View shows the attribute name on top and the value below.

The Compressed CATC Trace view has almost all the information of the normal CATC View and behaves mostly the same way, while displaying more information on each window (see Figure 6.94 on page 306).

To compress the CATC Trace:

- Click  on the toolbar.

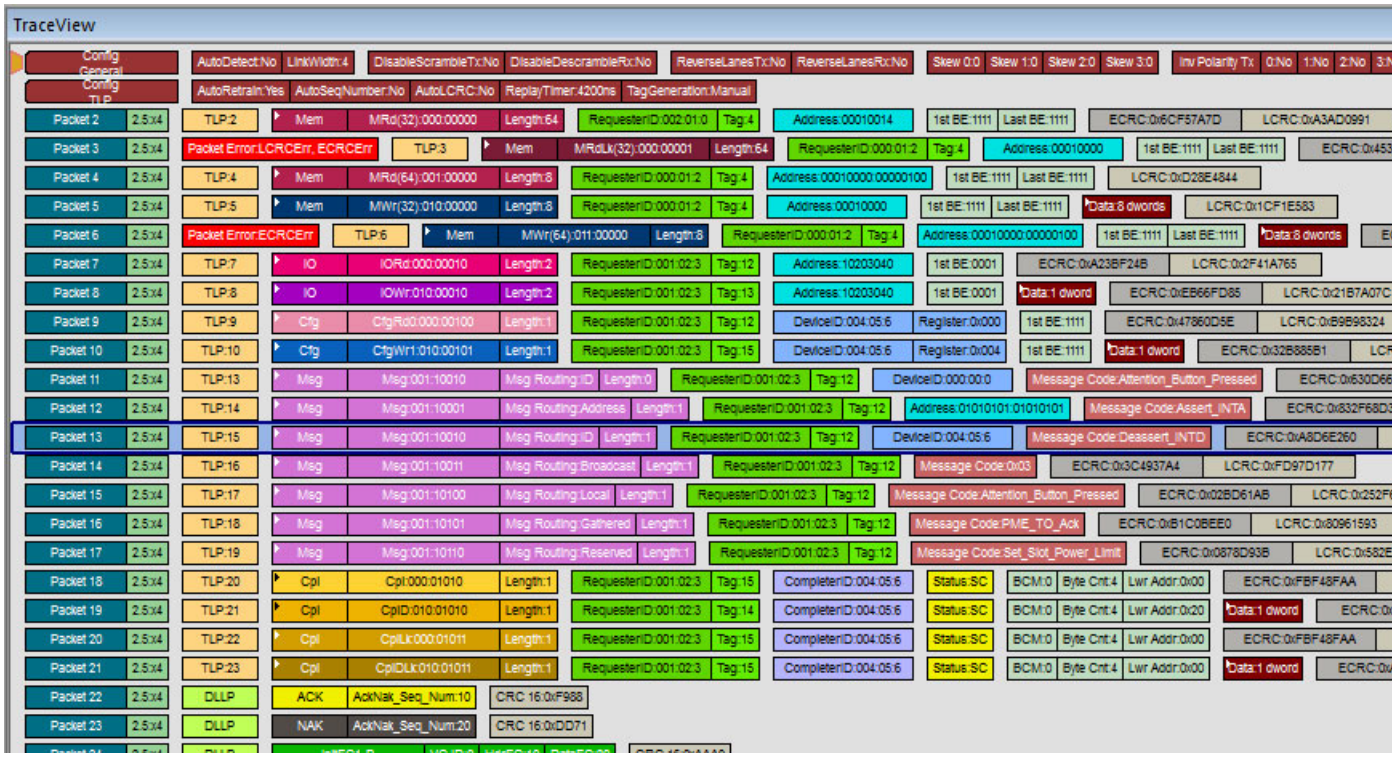


Figure 6.94: Compressed CATC Trace

- Click  on the toolbar to return to the normal CATC Trace View, or Select **View → Trace Views → CATC Trace.**

6.3.10 Spreadsheet View

You can view the CATC Trace as a spreadsheet in color or black and white.

Click  on the toolbar to display the Spreadsheet View (see Figure 6.95 and Figure 6.96).

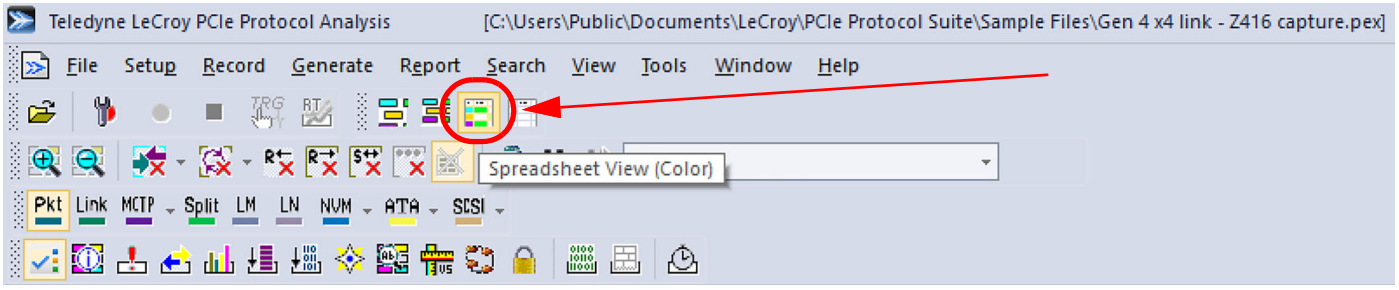
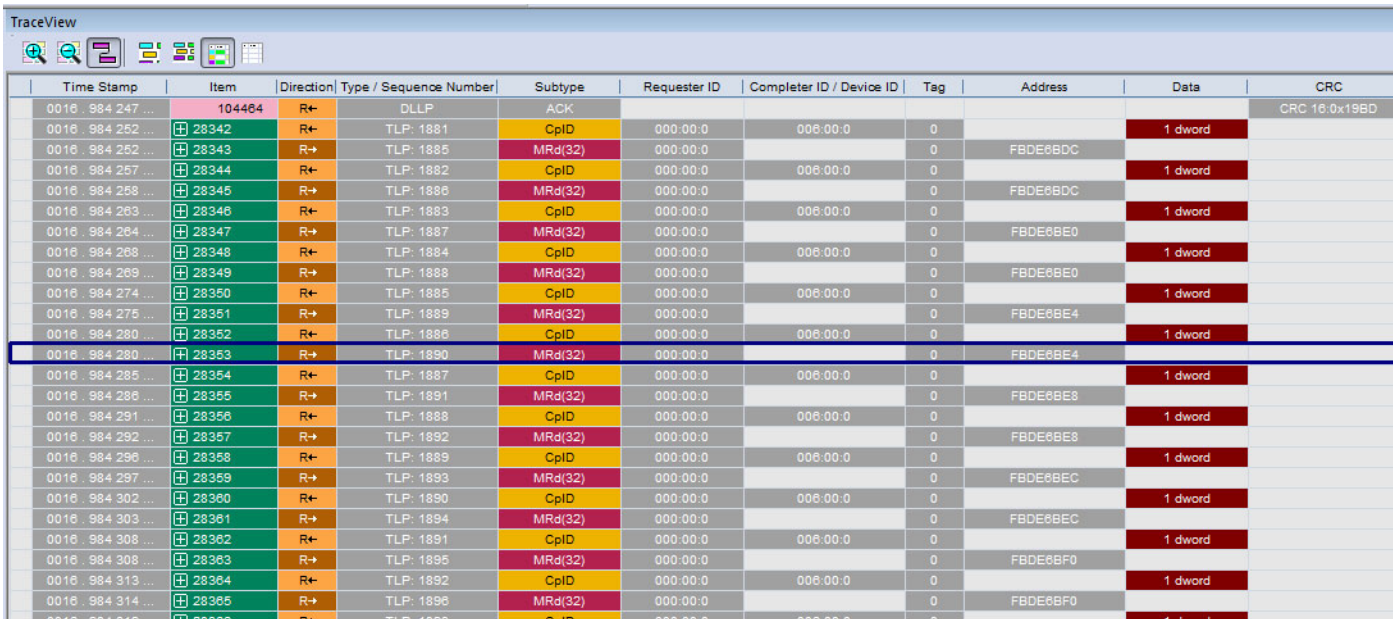


Figure 6.95: Spreadsheet View Icon in Toolbar

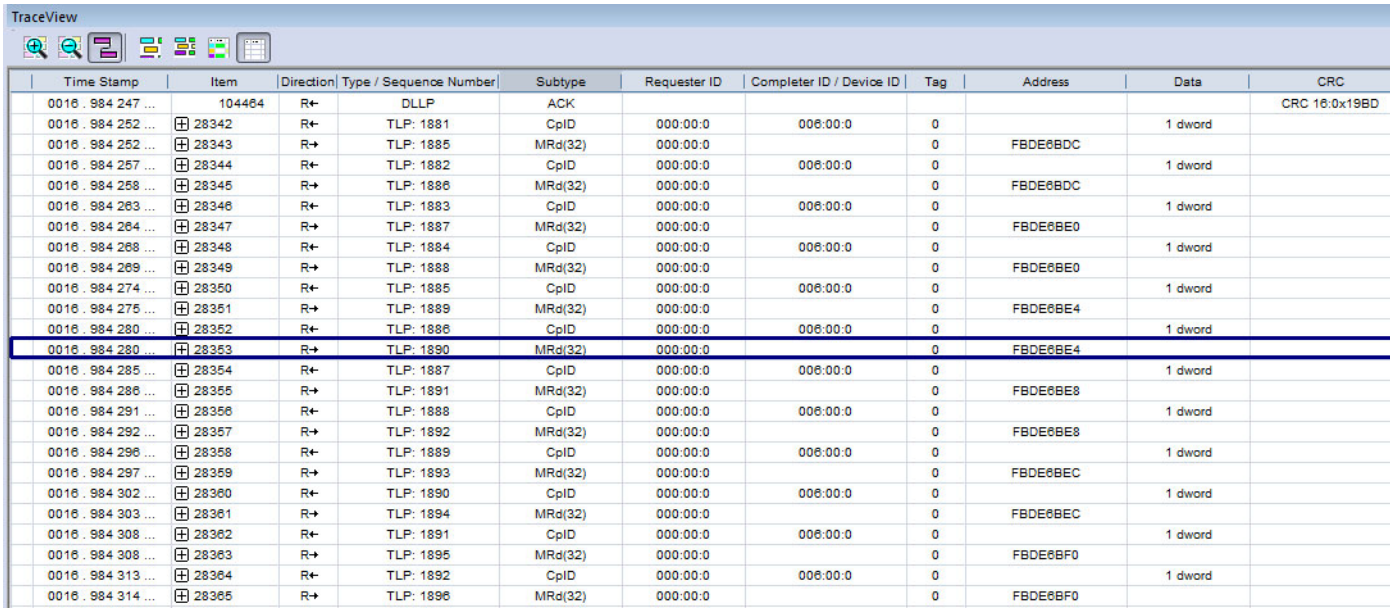
You can see the resulting Spreadsheet View of the trace below.



Time Stamp	Item	Direction	Type / Sequence Number	Subtype	Requester ID	Completer ID / Device ID	Tag	Address	Data	CRC
0016 . 984 247 ...	104464	R←	DLLP	ACK						CRC 16:0x19BD
0016 . 984 252 ...	28342	R←	TLP: 1881	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 252 ...	28343	R→	TLP: 1885	MRd(32)	000:00:0		0	FBDE6BDC		
0016 . 984 257 ...	28344	R←	TLP: 1882	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 258 ...	28345	R→	TLP: 1886	MRd(32)	000:00:0		0	FBDE6BDC		
0016 . 984 263 ...	28346	R←	TLP: 1883	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 264 ...	28347	R→	TLP: 1887	MRd(32)	000:00:0		0	FBDE6BE0		
0016 . 984 268 ...	28348	R←	TLP: 1884	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 269 ...	28349	R→	TLP: 1888	MRd(32)	000:00:0		0	FBDE6BE0		
0016 . 984 274 ...	28350	R←	TLP: 1885	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 275 ...	28351	R→	TLP: 1889	MRd(32)	000:00:0		0	FBDE6BE4		
0016 . 984 280 ...	28352	R←	TLP: 1886	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 280 ...	28353	R→	TLP: 1890	MRd(32)	000:00:0		0	FBDE6BE4		
0016 . 984 285 ...	28354	R←	TLP: 1887	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 286 ...	28355	R→	TLP: 1891	MRd(32)	000:00:0		0	FBDE6BE8		
0016 . 984 291 ...	28356	R←	TLP: 1888	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 292 ...	28357	R→	TLP: 1892	MRd(32)	000:00:0		0	FBDE6BE8		
0016 . 984 296 ...	28358	R←	TLP: 1889	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 297 ...	28359	R→	TLP: 1893	MRd(32)	000:00:0		0	FBDE6BEC		
0016 . 984 302 ...	28360	R←	TLP: 1890	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 303 ...	28361	R→	TLP: 1894	MRd(32)	000:00:0		0	FBDE6BEC		
0016 . 984 308 ...	28362	R←	TLP: 1891	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 308 ...	28363	R→	TLP: 1895	MRd(32)	000:00:0		0	FBDE6BF0		
0016 . 984 313 ...	28364	R←	TLP: 1892	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 314 ...	28365	R→	TLP: 1896	MRd(32)	000:00:0		0	FBDE6BF0		

Figure 6.96: Spreadsheet View (Color)

- Click  on the toolbar to display the Spreadsheet View B/W.



Time Stamp	Item	Direction	Type / Sequence Number	Subtype	Requester ID	Completer ID / Device ID	Tag	Address	Data	CRC
0016 . 984 247 ...	104464	R←	DLLP	ACK						CRC 16:0x19BD
0016 . 984 252 ...	28342	R←	TLP: 1881	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 252 ...	28343	R→	TLP: 1885	MRd(32)	000:00:0		0	FBDE6BDC		
0016 . 984 257 ...	28344	R←	TLP: 1882	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 258 ...	28345	R→	TLP: 1886	MRd(32)	000:00:0		0	FBDE6BDC		
0016 . 984 263 ...	28346	R←	TLP: 1883	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 264 ...	28347	R→	TLP: 1887	MRd(32)	000:00:0		0	FBDE6BE0		
0016 . 984 268 ...	28348	R←	TLP: 1884	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 269 ...	28349	R→	TLP: 1888	MRd(32)	000:00:0		0	FBDE6BE0		
0016 . 984 274 ...	28350	R←	TLP: 1885	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 275 ...	28351	R→	TLP: 1889	MRd(32)	000:00:0		0	FBDE6BE4		
0016 . 984 280 ...	28352	R←	TLP: 1886	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 280 ...	28353	R→	TLP: 1890	MRd(32)	000:00:0		0	FBDE6BE4		
0016 . 984 285 ...	28354	R←	TLP: 1887	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 286 ...	28355	R→	TLP: 1891	MRd(32)	000:00:0		0	FBDE6BE8		
0016 . 984 291 ...	28356	R←	TLP: 1888	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 292 ...	28357	R→	TLP: 1892	MRd(32)	000:00:0		0	FBDE6BE8		
0016 . 984 296 ...	28358	R←	TLP: 1889	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 297 ...	28359	R→	TLP: 1893	MRd(32)	000:00:0		0	FBDE6BEC		
0016 . 984 302 ...	28360	R←	TLP: 1890	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 303 ...	28361	R→	TLP: 1894	MRd(32)	000:00:0		0	FBDE6BEC		
0016 . 984 308 ...	28362	R←	TLP: 1891	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 308 ...	28363	R→	TLP: 1895	MRd(32)	000:00:0		0	FBDE6BF0		
0016 . 984 313 ...	28364	R←	TLP: 1892	CpID	000:00:0	006:00:0	0		1 dword	
0016 . 984 314 ...	28365	R→	TLP: 1896	MRd(32)	000:00:0		0	FBDE6BF0		

Figure 6.97: Spreadsheet View (Black And White)

6.3.10.1 Columns

Right click on any column and the following options pop up. See Figure 6.98.

You can perform the following options:

- Add a Standard Column if one has been deleted
- Add a column with specific types of information for the current row selected
- Remove a column

- Restore the default columns

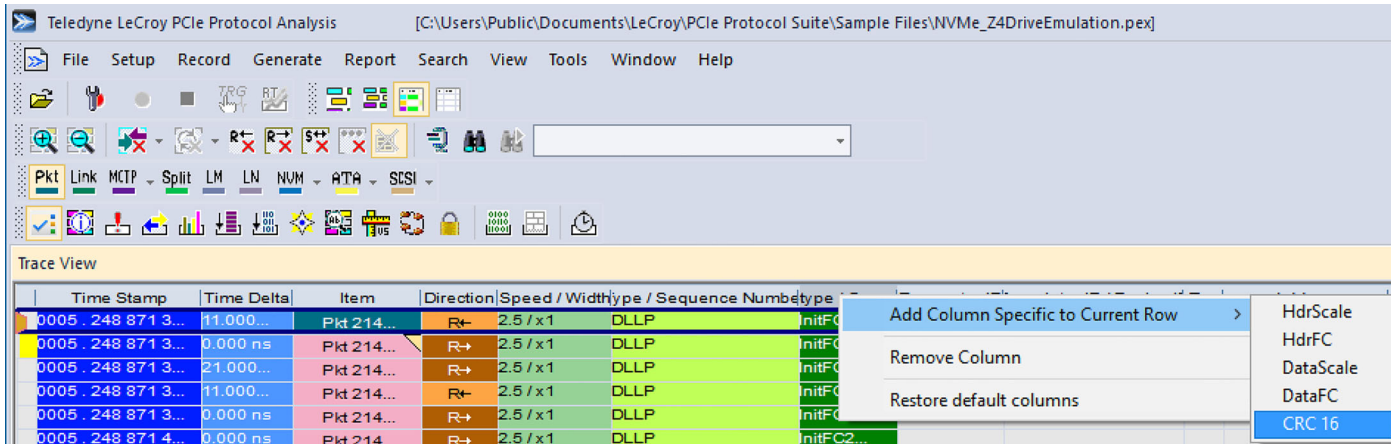


Figure 6.98: Add Columns Specific to Current Row

You can add a column with the CRC 16 values. See Figure 6.99

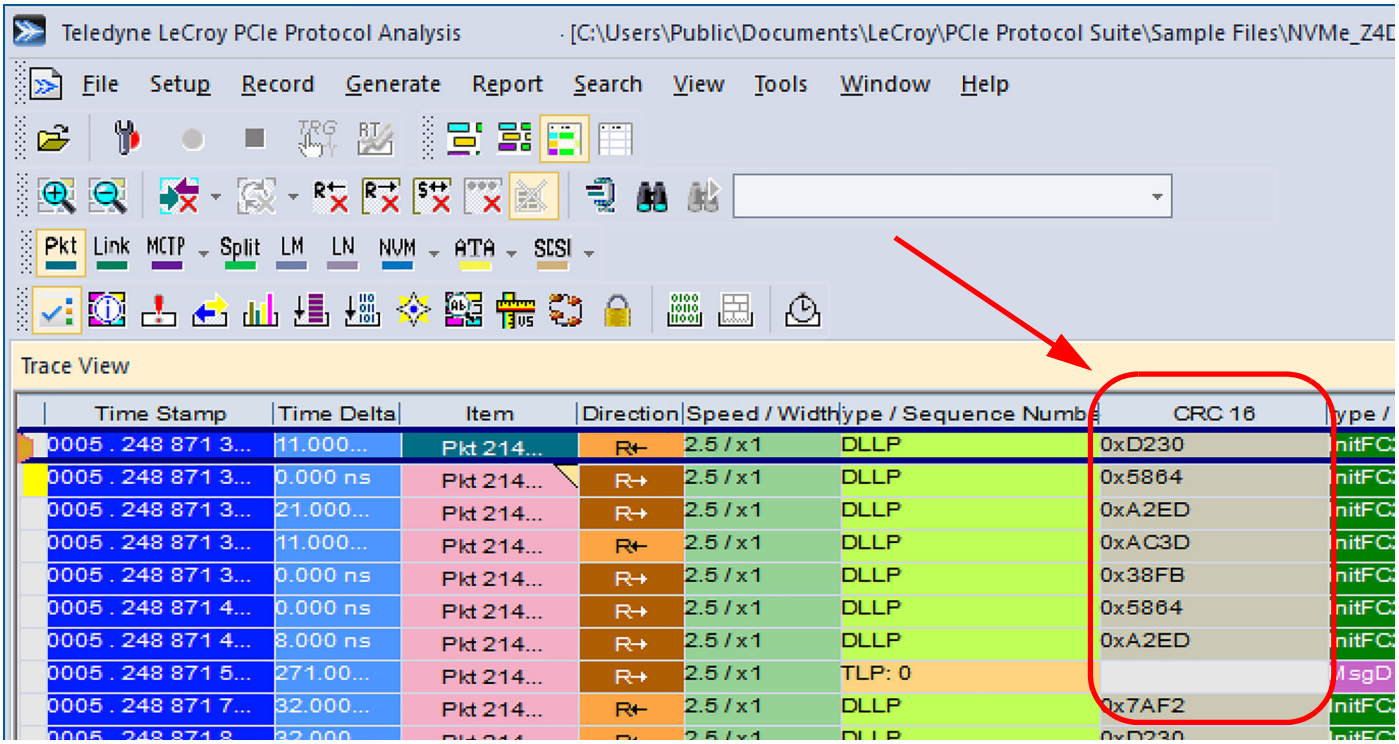


Figure 6.99: Added Column with CRC 16

You can delete the column that you right clicked on. See Figure 6.100.

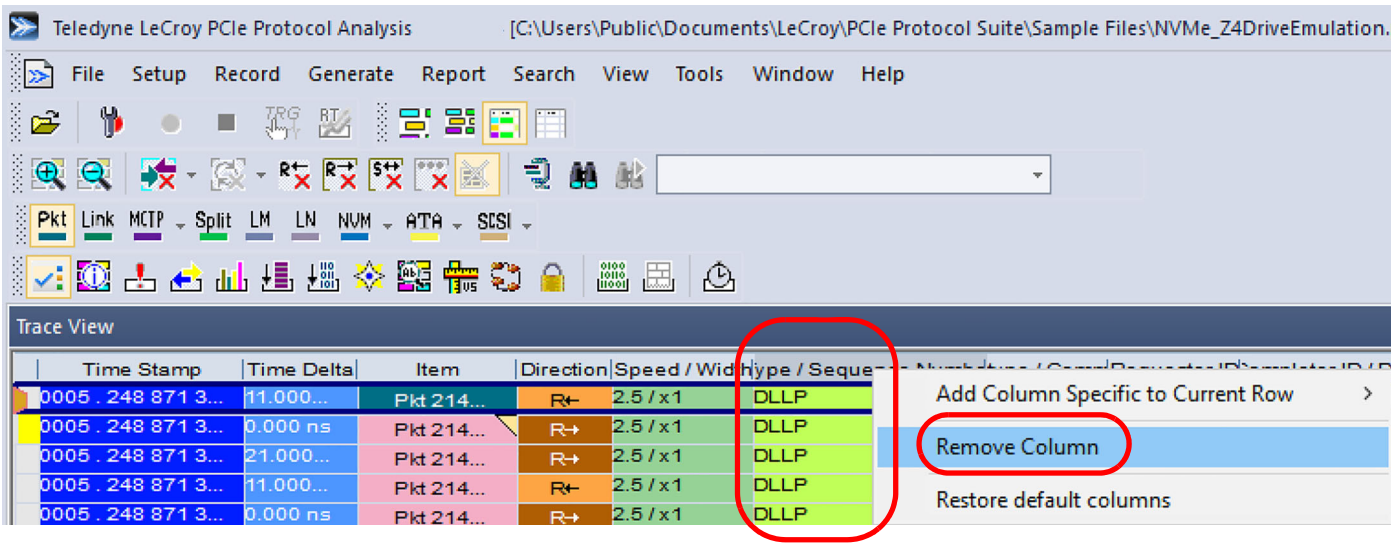


Figure 6.100: Right Click on Type/Sequence Number Column

Click on Remove Column and it's deleted from Spreadsheet View. See Figure 6.101.

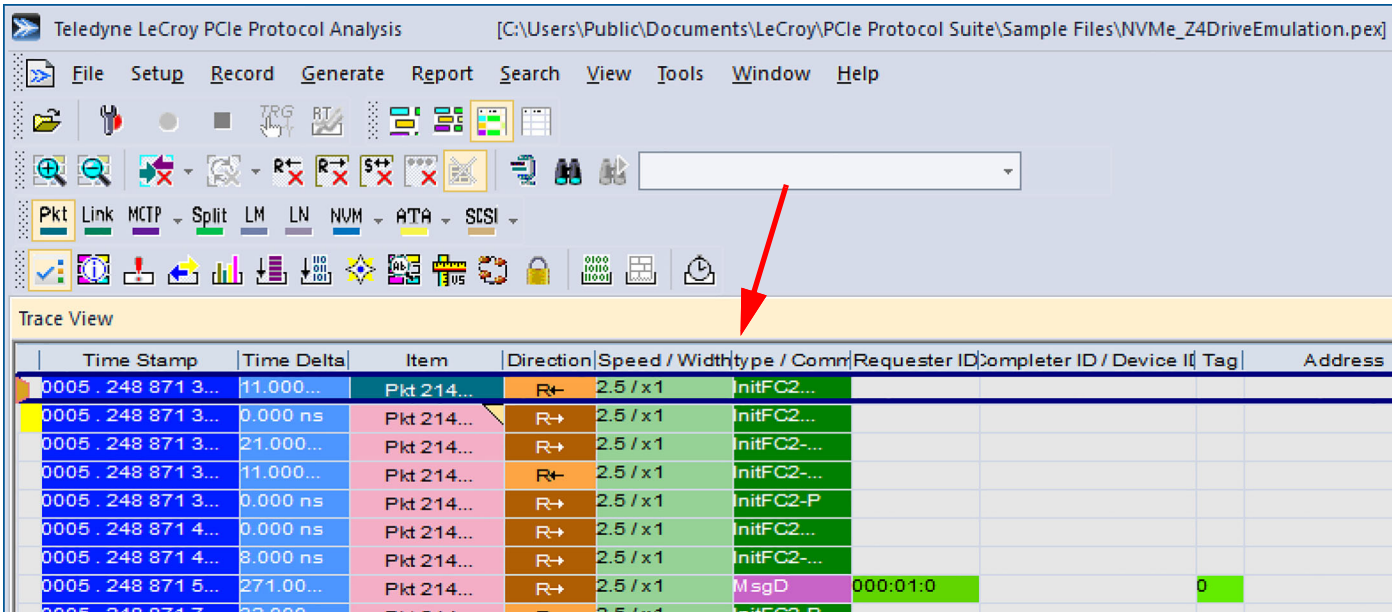


Figure 6.101: Selected Column Removed

You can also Restore the set of system Default columns. See Figure 6.102 on page 310.

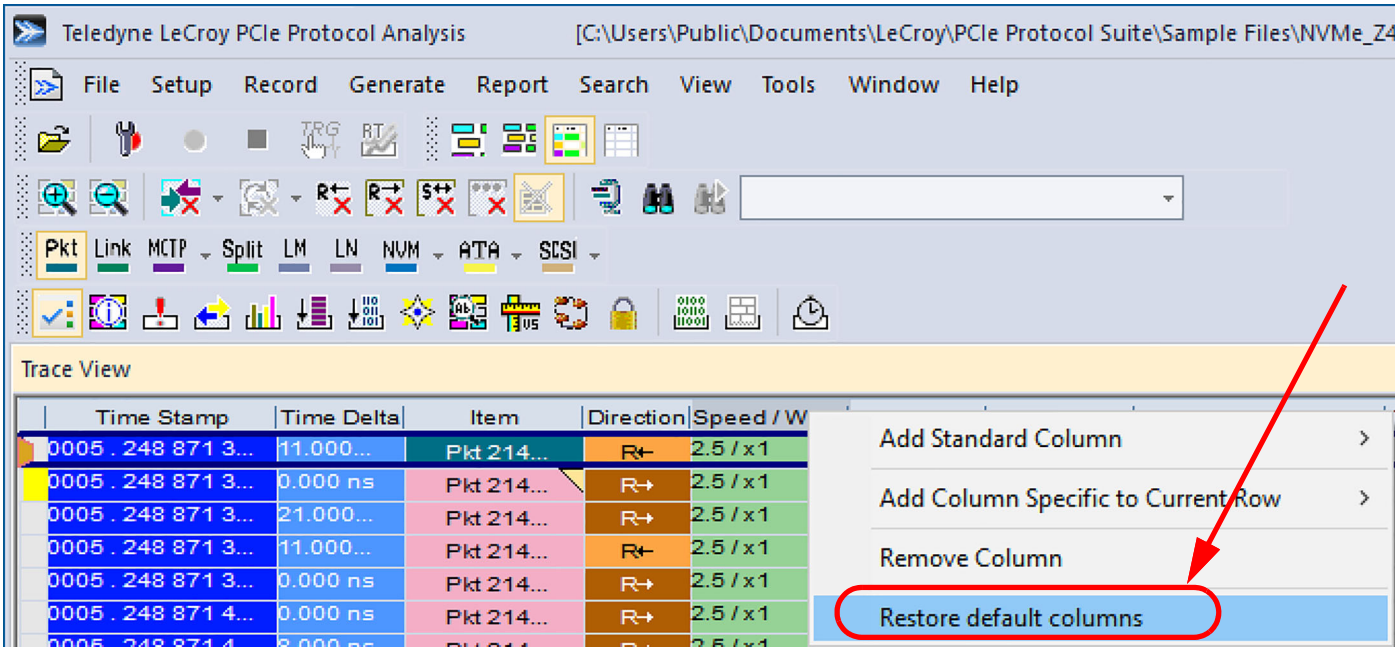


Figure 6.102: Restore Default Columns

If you select Restore default columns you'll get a Warning message. See Figure 6.103.

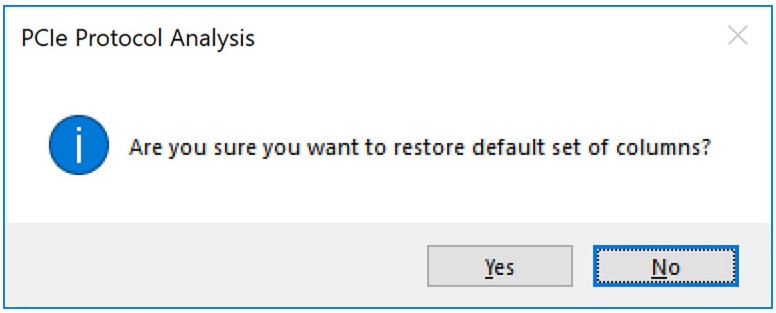


Figure 6.103: Warning Message about Restoring Default Set of Columns

Click on Yes and you'll get the default set of columns. See Figure 6.104 on page 311.

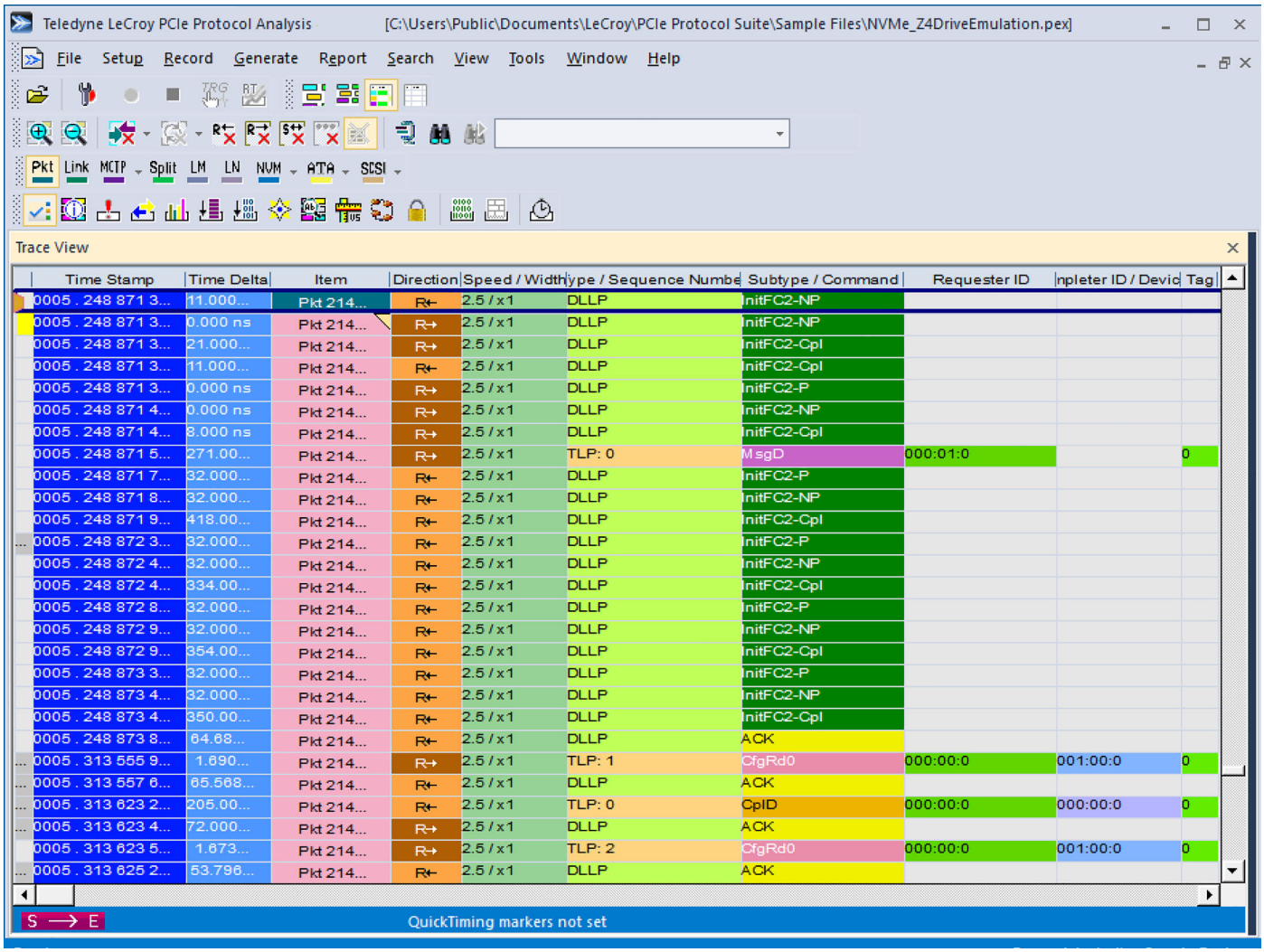


Figure 6.104: Default Set of Columns

6.3.11 Detail View and Spreadsheet View

In the Spreadsheet View, double-click a packet, transaction, or transfer, or select a field and then click on the toolbar, to display the Detail View (see Figure 6.105 on page 312).

To put a Detail View header as a column in the Spreadsheet View, drag the header to a column divider in the Spreadsheet View.

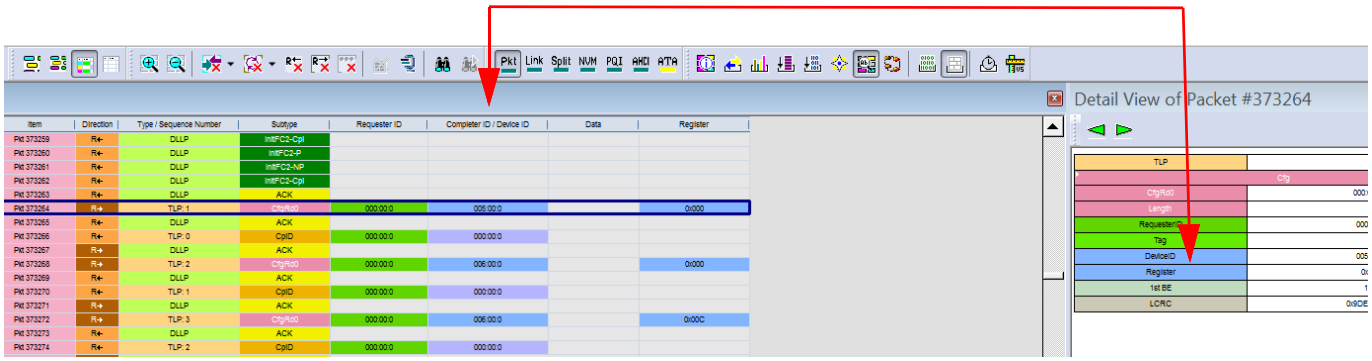


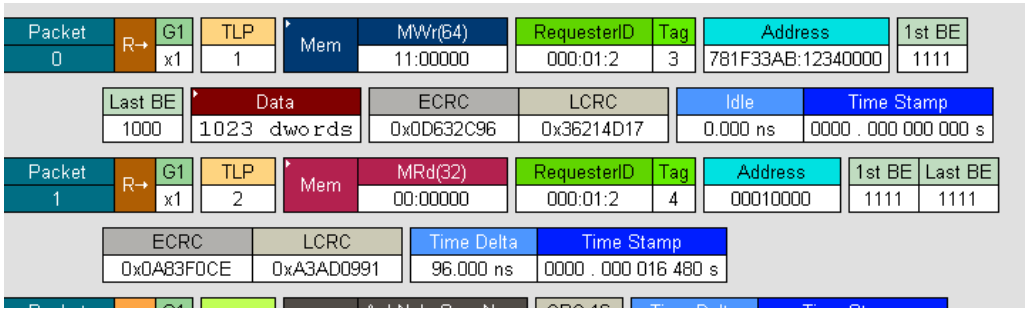
Figure 6.105: Detail View in Spreadsheet View

6.3.12 Decoding Traffic

The PCIe Protocol Analysis has several decode levels:

6.3.12.1 Packet

Packet level decode Pkt includes all TLP packets, DLLP packets, and all ordered sets.



Note: The PCI-E 3.0 (and 2.1 with Errata) specifications state that there are two formats of the AER capability structure, and the AER_CAP_VER field indicates if format 1 or format 2 is used.

The difference between format 1 and format 2 is whether or not the TLP Prefix Header section is present in the AER capability, even if it is not actually implemented.

This means that:

- If AER_CAP_VER = 1 and it is not a Root Port or RC Event Collector, there are 11 DWs (00h to 24h)in the total AER Capability structure.
- If AER_CAP_VER = 1 and it is a Root Port or RC Event Collector, there are 14 DWs (00h to 34h)in the total AER Capability structure.
- If AER_CAP_VER = 2 then, there are 18 DWs (00h to 44h) in the total AER Capability structure.

In fact, there are PCI-E 3.0 compliant devices that have AER_CAP_VER=1.

Example H/W:

A PCI-E 3.0 device that supports Multiple Header Recording, but does NOT support TLP Prefixes. This device is allowed to have AER_CAP_VER=1, and Multiple_Header_Recording_Capable=1

Therefore, the Teledyne LeCroy software decodes the Multiple_Header_Recording_Capable field regardless of the value of AER_CAP_VER.

Note: The Protocol Mode of the CATC View may show individual symbols grouped as a "packet" such as in the case where electrical symbols arrive before fast training sequences. Such group of symbols will also be reported in the summary. See Figure 6.106.

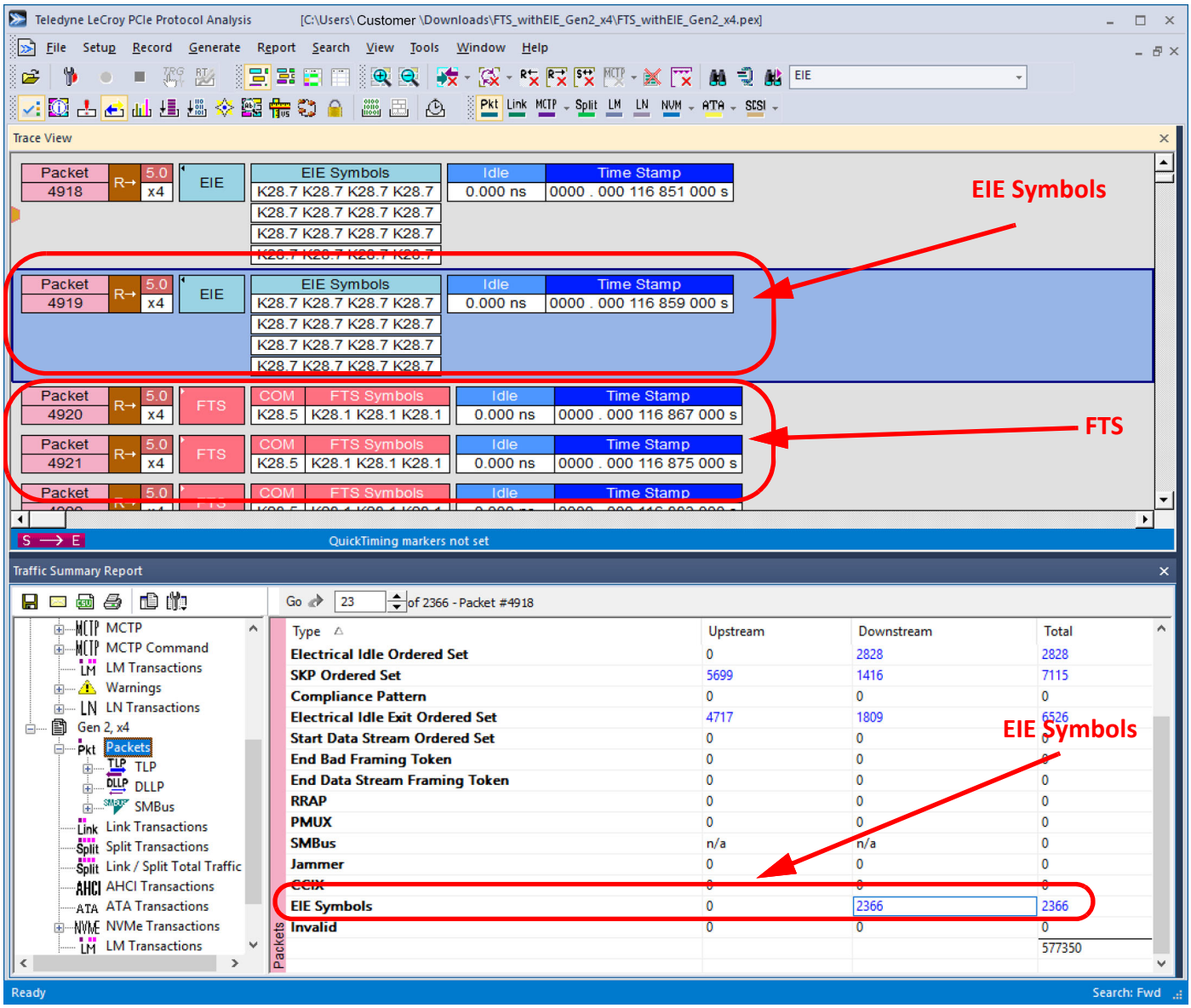
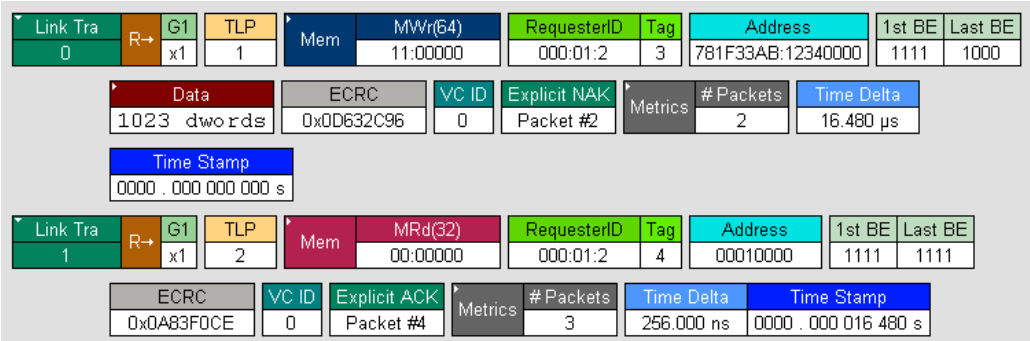


Figure 6.106: EIE Symbols Decoded before FTS

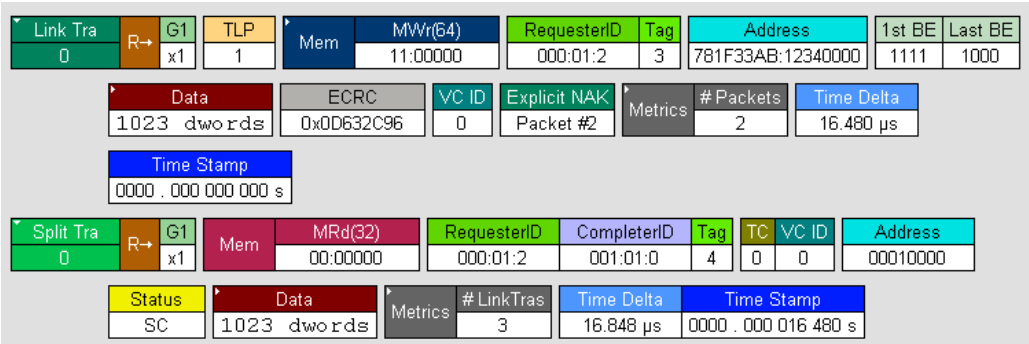
6.3.12.2 Link

Link level decode Link is composed of TLP packets matched with a corresponding ACK or NAK coming from the opposite direction.



6.3.12.3 Split

Split level decode Split is composed of two Link transactions, the Request TLP and the Completion TLP from the other direction.



6.3.12.4 Lane Margining Decoding

The purpose Lane Margining LM is to determine if the PCIe Protocol Analysis software can run a series of commands to do the equivalent of moving the sampling point of the transceiver backwards or forwards in time (time margining) or at a higher or lower voltage (voltage margining). If there is enough margin to still reliably capture data without errors at that new sampling point then the system software can determine how much margin exists within the system. An example trace that shows some of the commands and response is shown below. See Figure 6.107.

Typical Lane Margining Commands and Responses

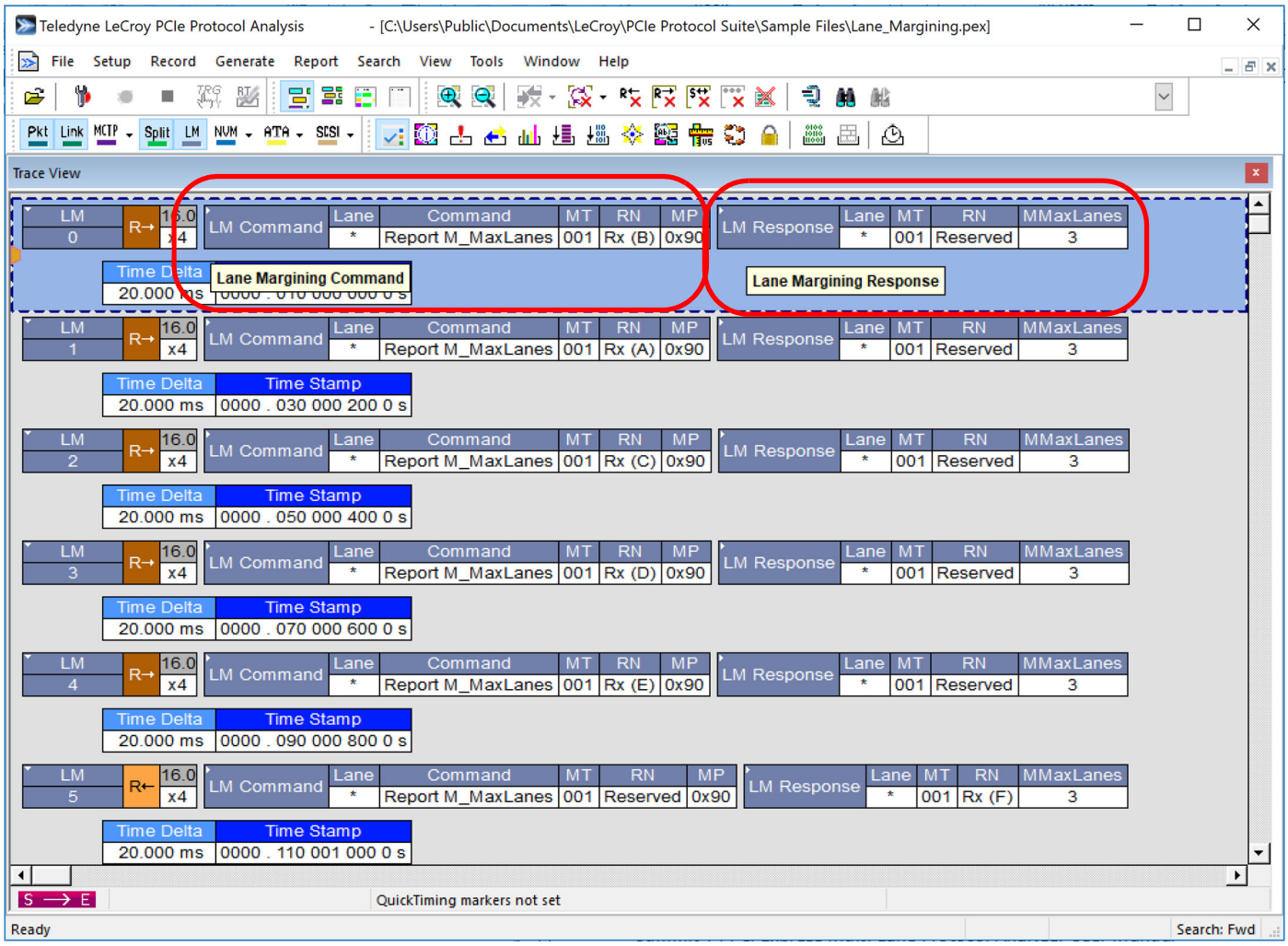


Figure 6.107: Lane Margining Decoding: Command and Response

More Lane Margining Commands and Responses are shown in Figure 6.108 on page 316.

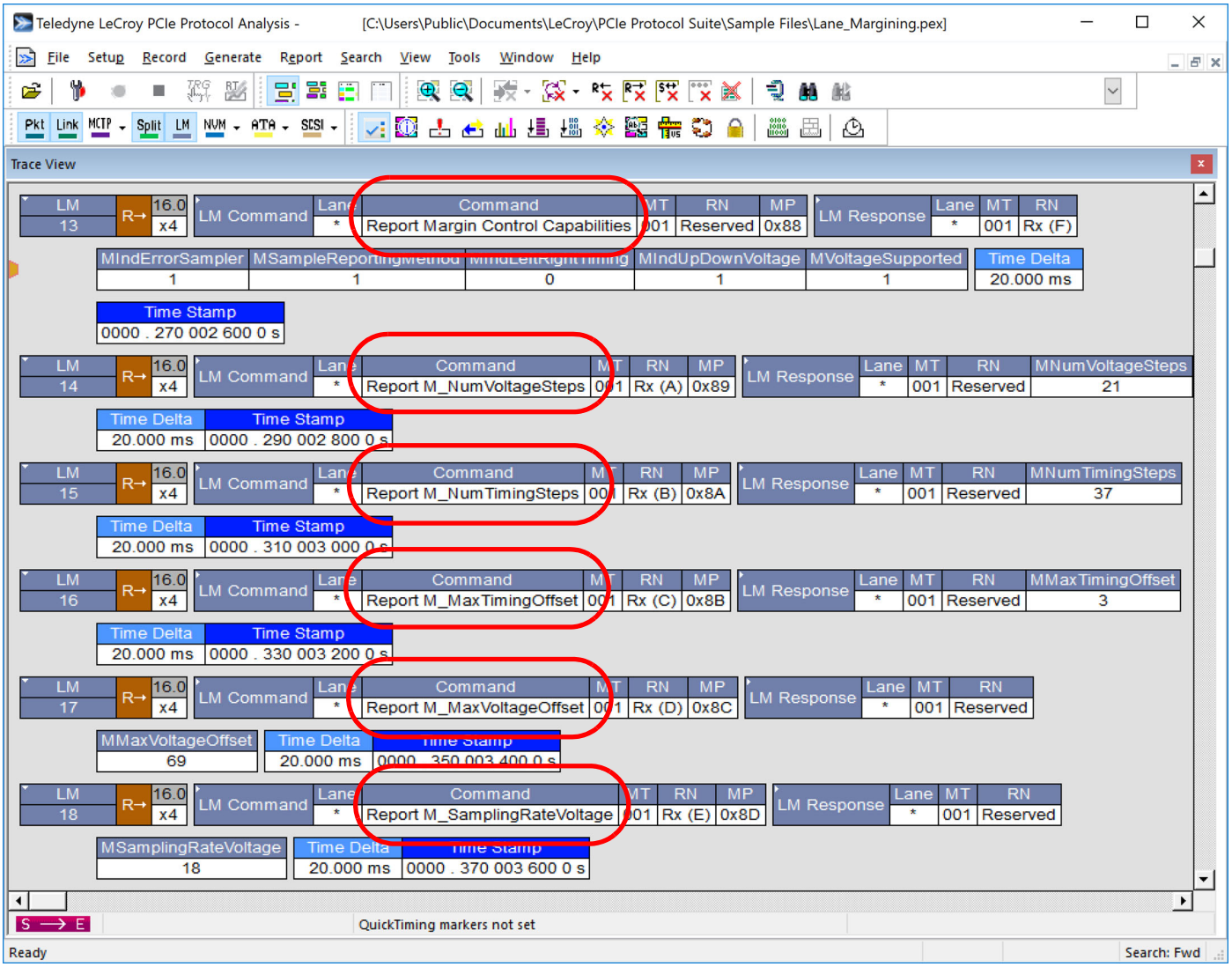


Figure 6.108: More Lane Margining Commands and Responses

Lane Margining Command: Step Margin to Timing Offset

The Lane Margining Command: Step Margin to Timing Offset in shown in Figure 6.109.

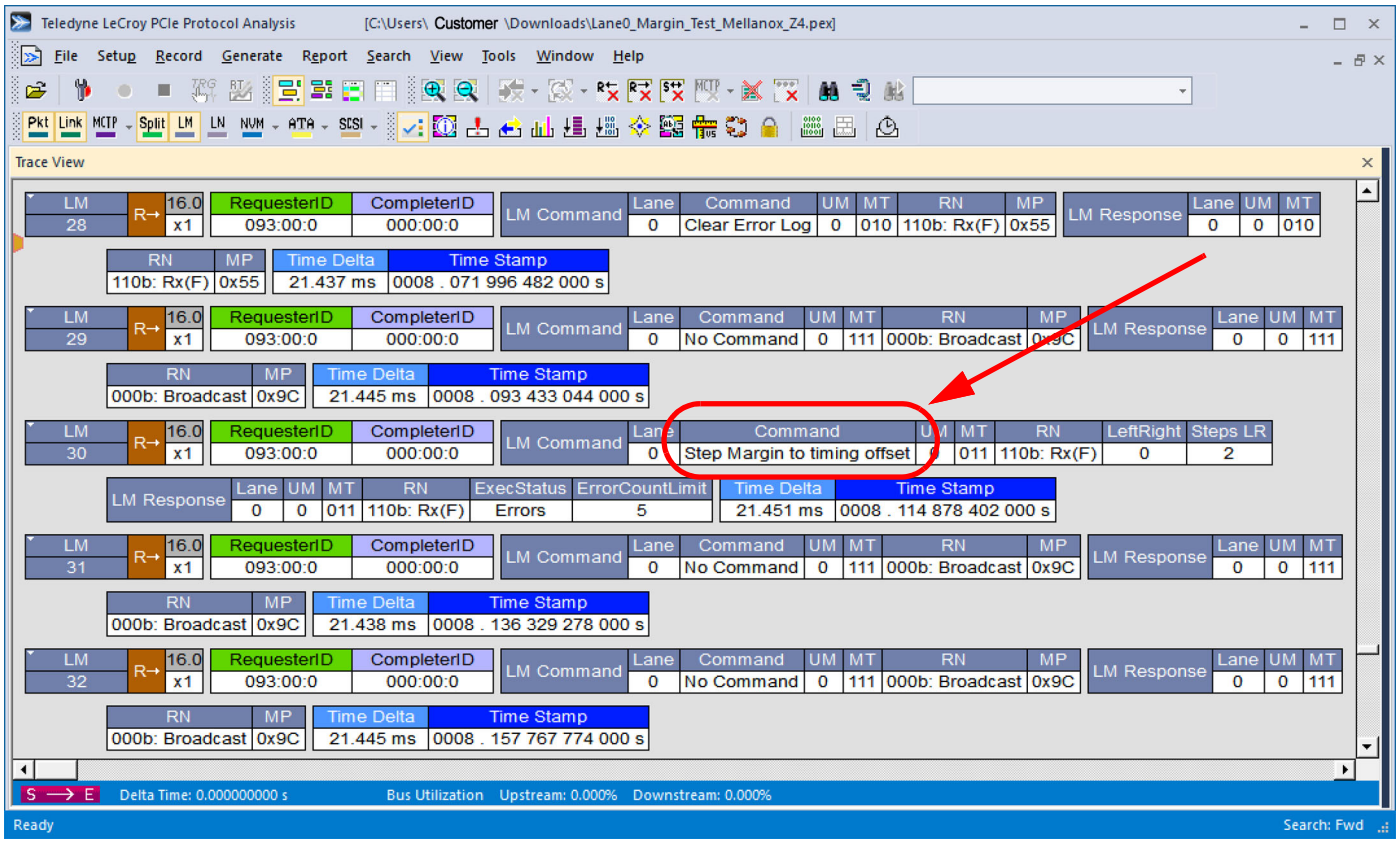


Figure 6.109: Lane Margining Command: Step Margin to Timing Offset

Lane Margining Errors

Lane Margining errors can also be decoded. As shown in the sample below (see Figure 6.110).

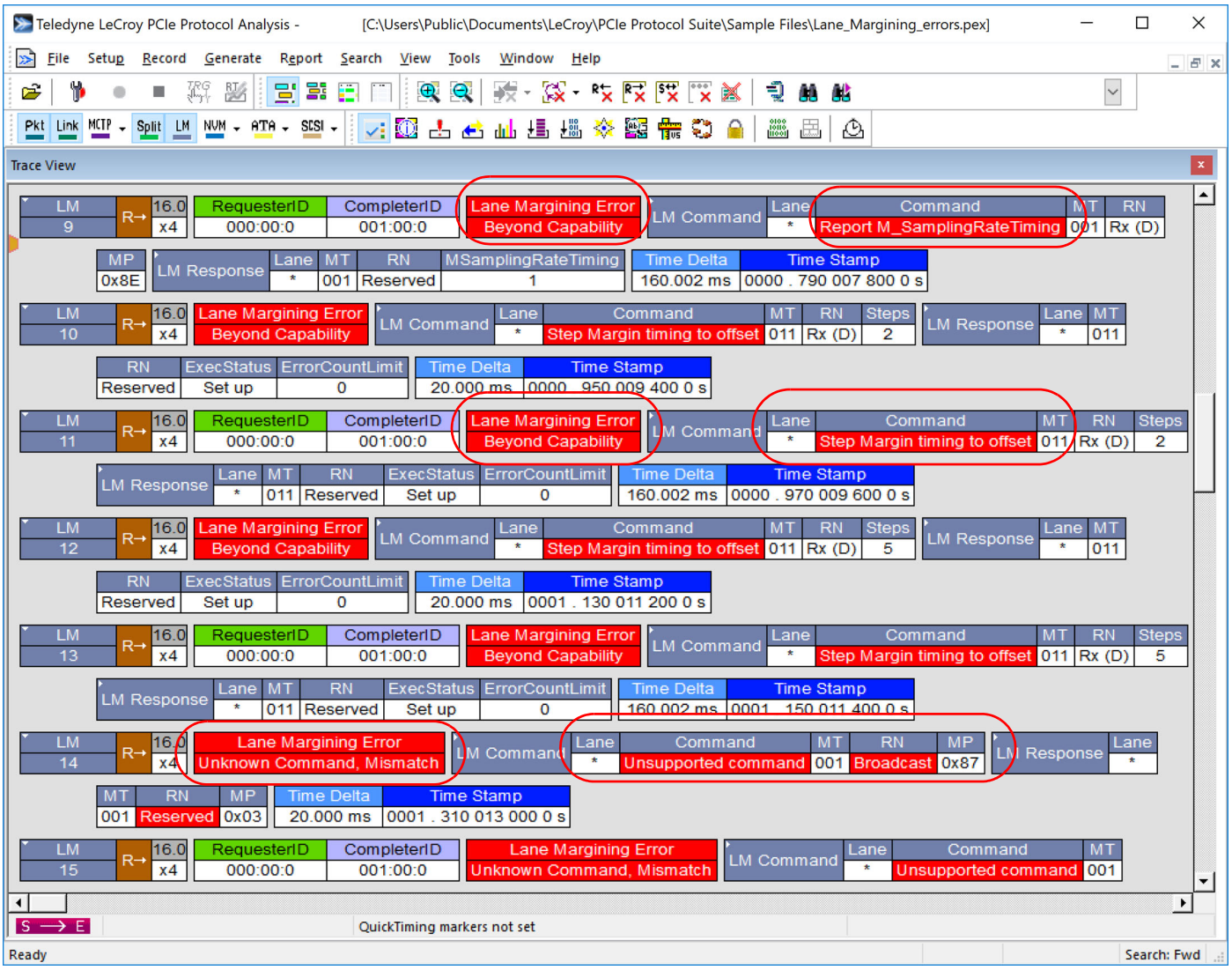


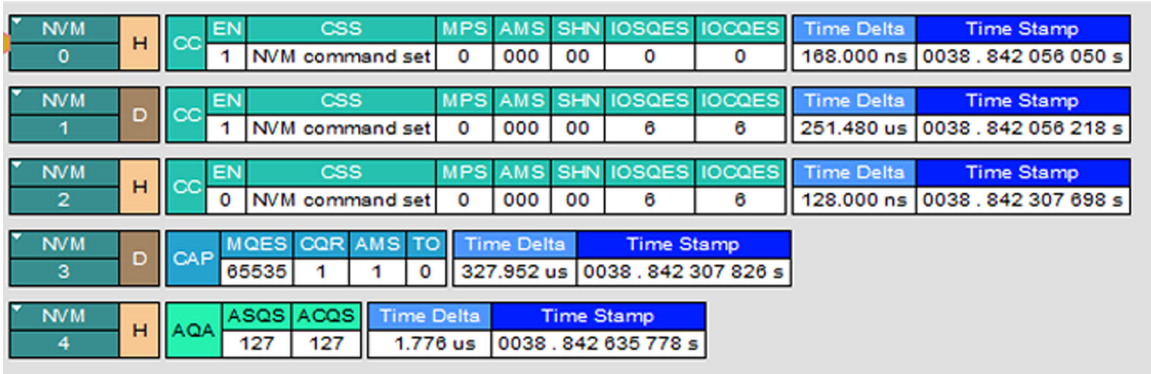
Figure 6.110: Lane Margining Errors: Decoded

6.3.12.5 NVMe Decoding

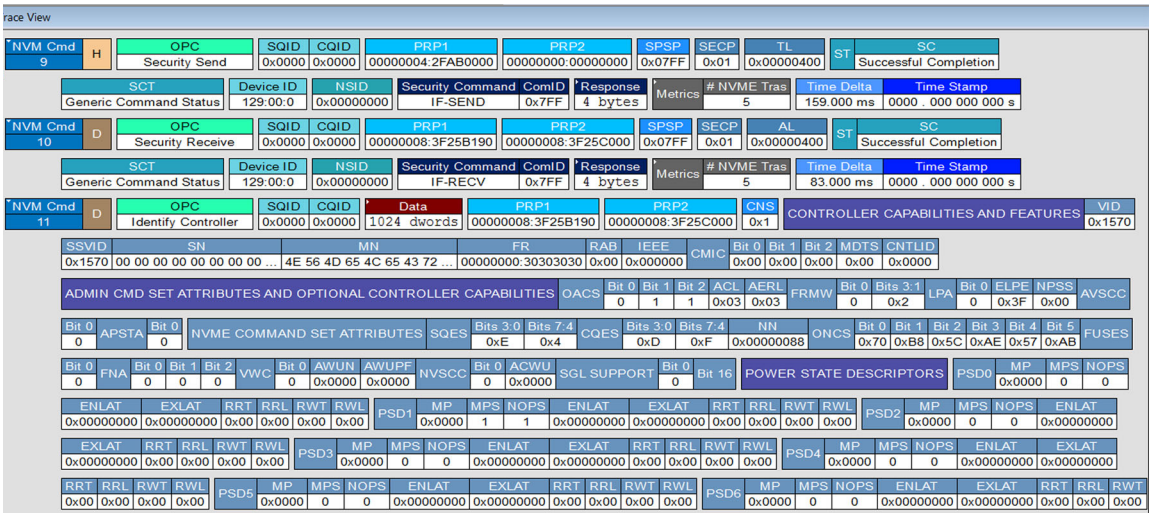
To decode the NVMe protocol there are two levels available: NVMe Transaction level, which decodes the individual NVMe transactions from the PCI Express protocol and NVMe Command level, which gathers NVMe transactions into a single command. If the top level button 

is selected, it will decode the NVMe Command level directly.

The NVMe Transaction level option displays NVMe transactions. PCIe Protocol Analysis decodes the storage commands starting from lower PCI Express Transaction Layer decodes. In the case of NVMe, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level and finally the NVMe Transaction decode level.



The NVMe Command level option displays NVMe Commands. The NVME commands decode all the lower level decodes first.



Note: As of software version 7.34, the NVMe decoding will be performed properly even if the ACK DLLPs have been filtered.

Note: As of software version 7.34, once the NVMe decoding has been applied, it will be kept in a separate temporary file not the Trace file (see "Trace File Structure" on page 250). The next time the trace is opened for review there will be no need to re-decode, making opening of the file in NVMe mode faster.

Note: As of software version 7.36 Beta, the NVMe decoding can handle multiple controller resets within the same recording.

NVMe: Device ID and Model Name Decoded

As of software version 7.34, the Device ID and Device Model Name field is displayed in the decoded command (see Figure 6.111 and Figure 6.112 on page 320).

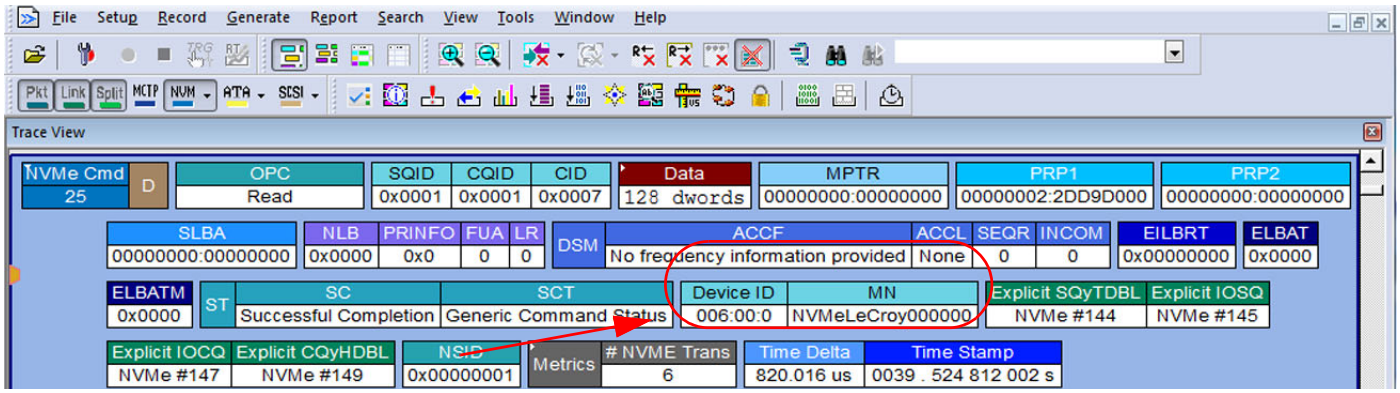


Figure 6.111: Device ID and Model Number Decoded from NVMe Trace

The trace must contain the device enumeration sequence so the decoding picks up the associated base addresses and NVMe transactions can be properly decoded. If the enumeration sequence is not available the base addresses must be manually entered in the PCIe SSD Configuration dialog from the Tools menu. See Figure 6.112 on page 320.

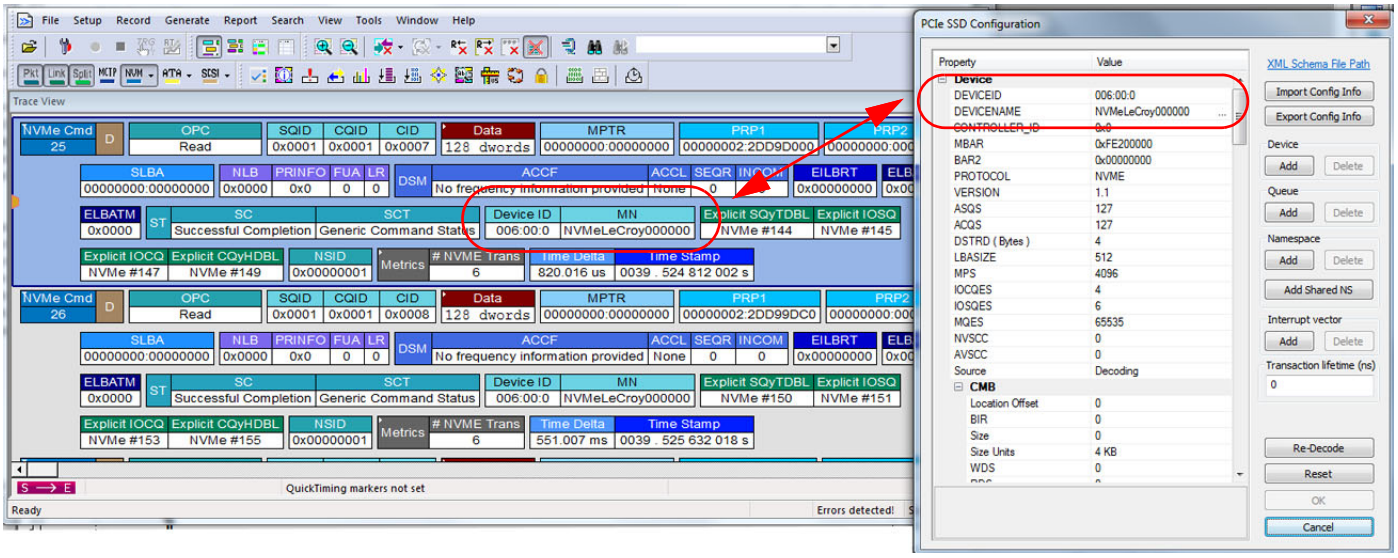
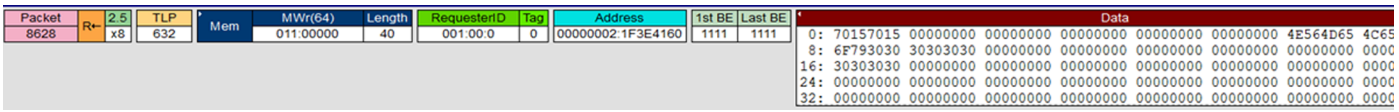


Figure 6.112: Device ID and Device Model Name Shown in SSD Configuration Dialog

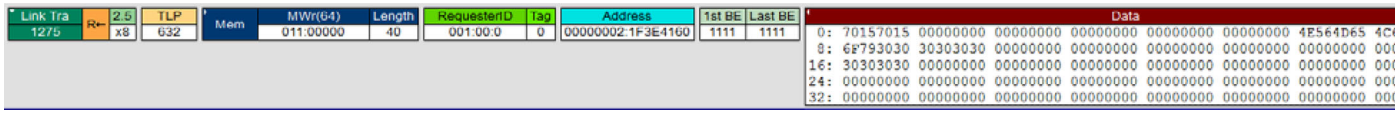
NVMe: Data Field on Packets

While the data field section displayed for a PCIe packet shows the actual payload for that PCIe packet (as shown below):

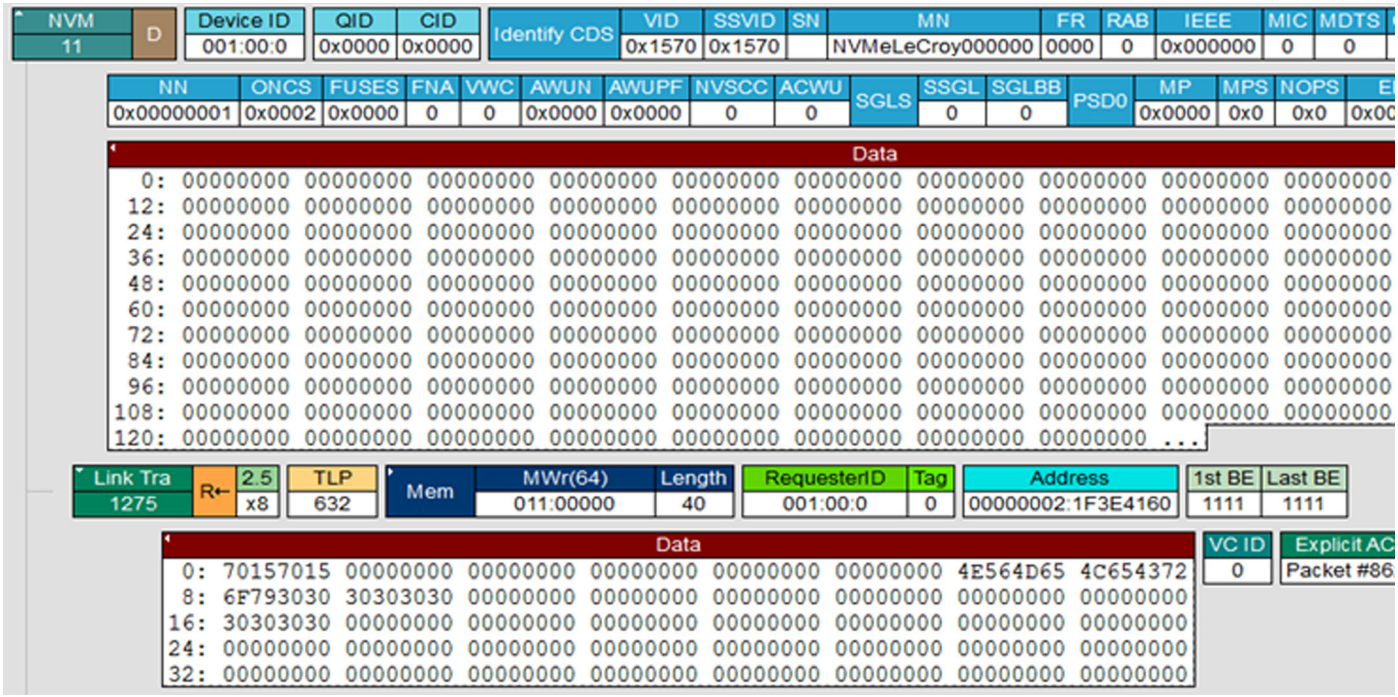


The content for this field changes depending on the decode level selected and the particular command decoded.

For example, at the PCIe transaction level, this field still reflects the PCIe payload field involved in the PCIe transaction (as shown below):

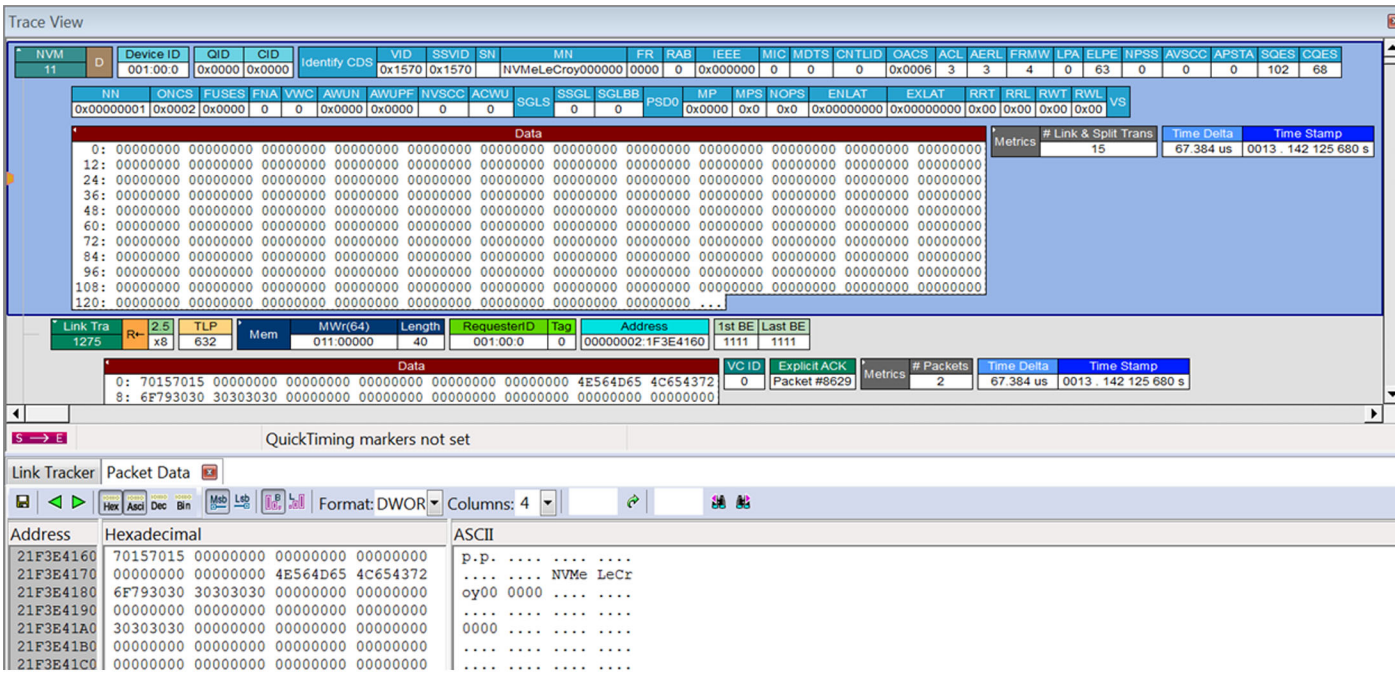


At the NVMe transaction level for identify command is shown below:



The data is shown according to NVMe specification. The portion of data that can be parsed into fields is parsed and drawn in named cells. The portion of data that cannot be parsed (i.e. 'vendor specific' portion is not parsed and is shown as a plain data).

In case you need to see this plain data (not parsed by named fields) the packet data view can be used. (as shown below):



NVMe: Trusted Computing Group Decode

Trusted Computing Group decodes are shown using the NVMe Command Level if they are present in the trace, as shown in Figure 6.113.

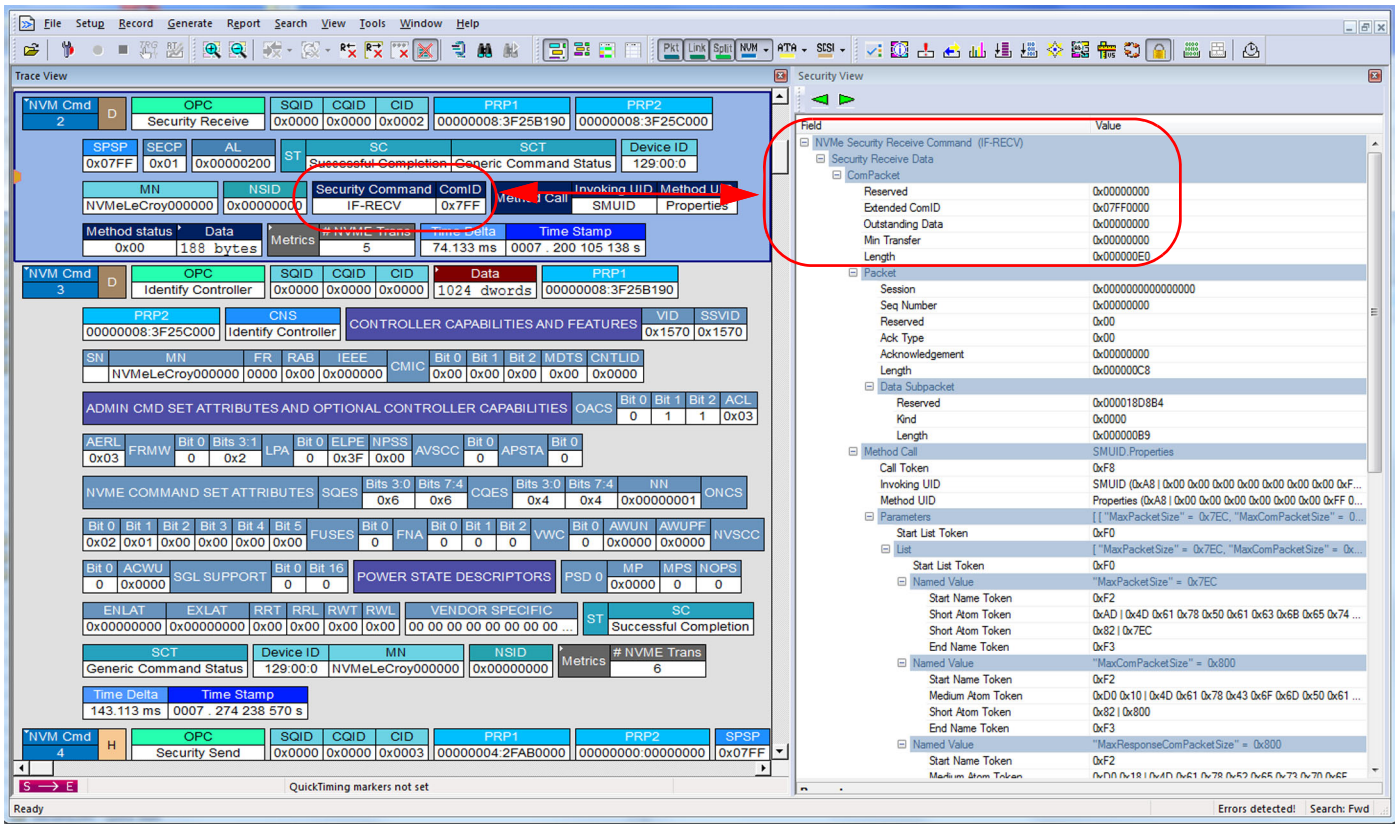


Figure 6.113: NVMe Command with TCG Details

The Opal Storage Specification

The Opal Storage Specification is a set of specifications for features of data storage devices (such as disk drives) that enhance their security. For example, it defines a way of encrypting the stored data so that an unauthorized person who gains possession of the device cannot see the data. That is, it is a specification for self-encrypting drives (SED).

The specification is published by the Trusted Computing Group Storage Workgroup.

The Opal SSC (Security Subsystem Class) is an implementation profile for Storage Devices built to:

- Protect the confidentiality of stored user data against unauthorized access once it leaves the owner's control (involving a power cycle and subsequent de-authentication).
- Enable interoperability between multiple SD vendors.

NVMe: TCG Opal Decoded

The PCIe Protocol Software can decode and display Opal TCG fields. See Figure 6.114.

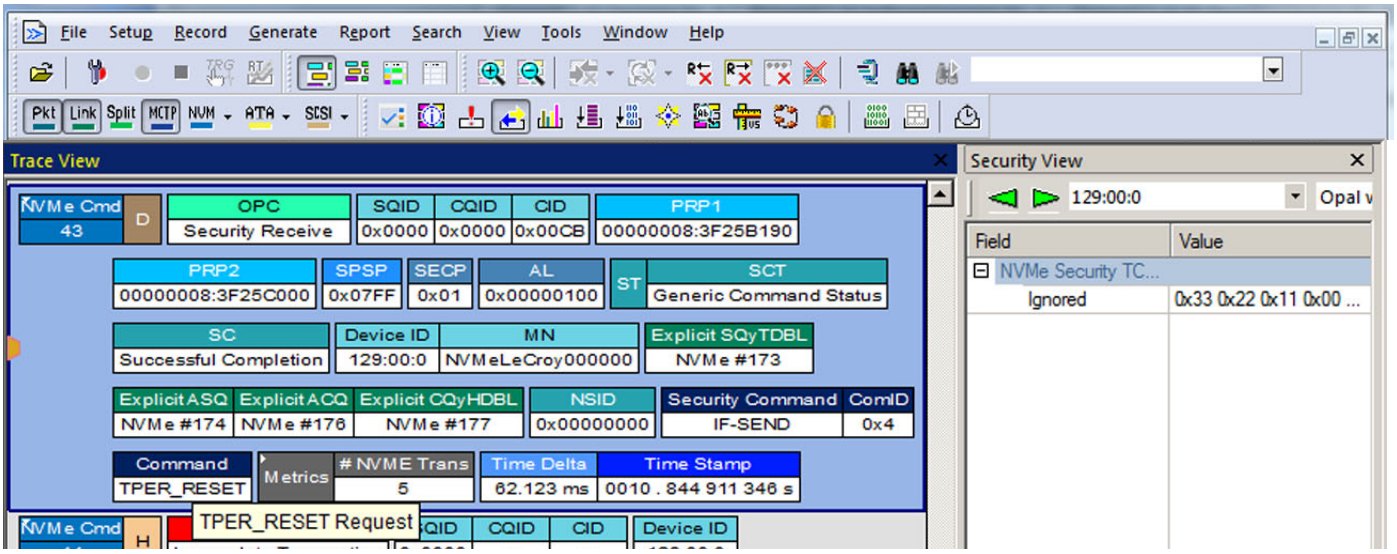


Figure 6.114: NVMe Trace: Opal TCG Security Fields Decoded

A more detailed view of the security field is shown in Figure 6.115 on page 324.

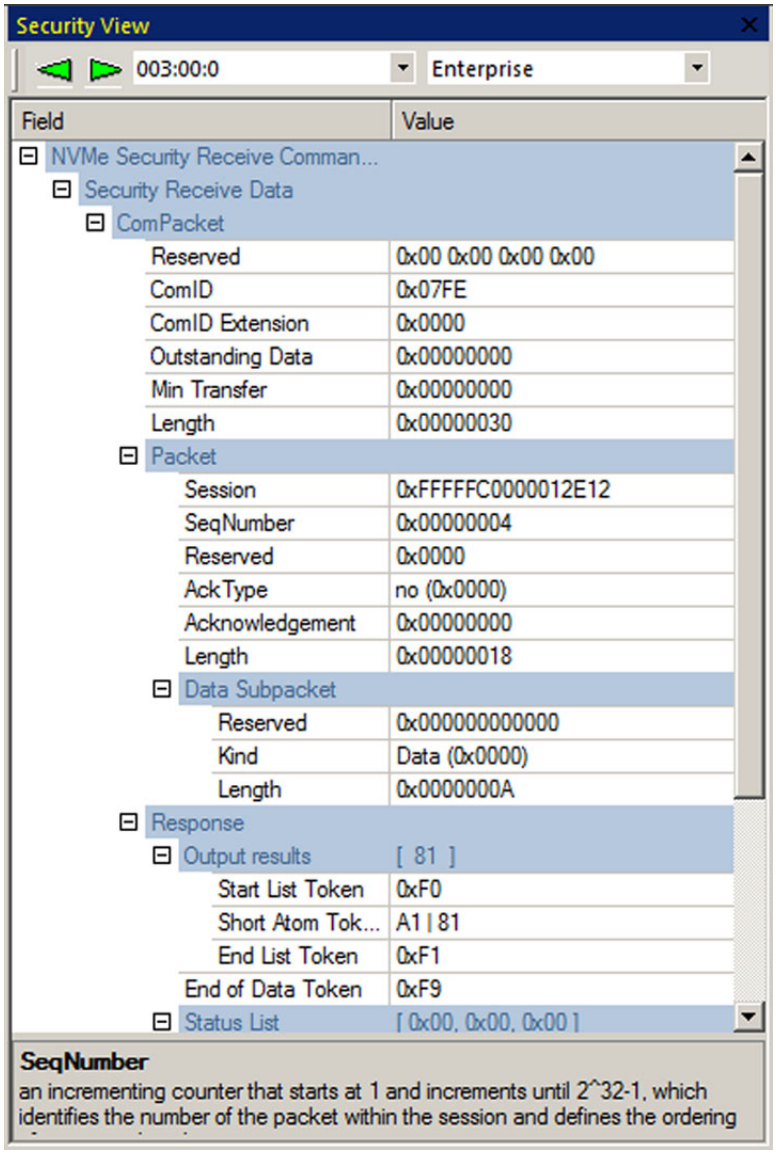


Figure 6.115: NVMe Trace: Opal TCG Security Fields Decoded in Detail

Opalite Version 0.1: Decoded

The PCIe Protocol Analysis software can decode the TCG transaction: Opalite Security Version 0.1 (as shown in Figure 6.116 and Figure 6.117 on page 326 below):

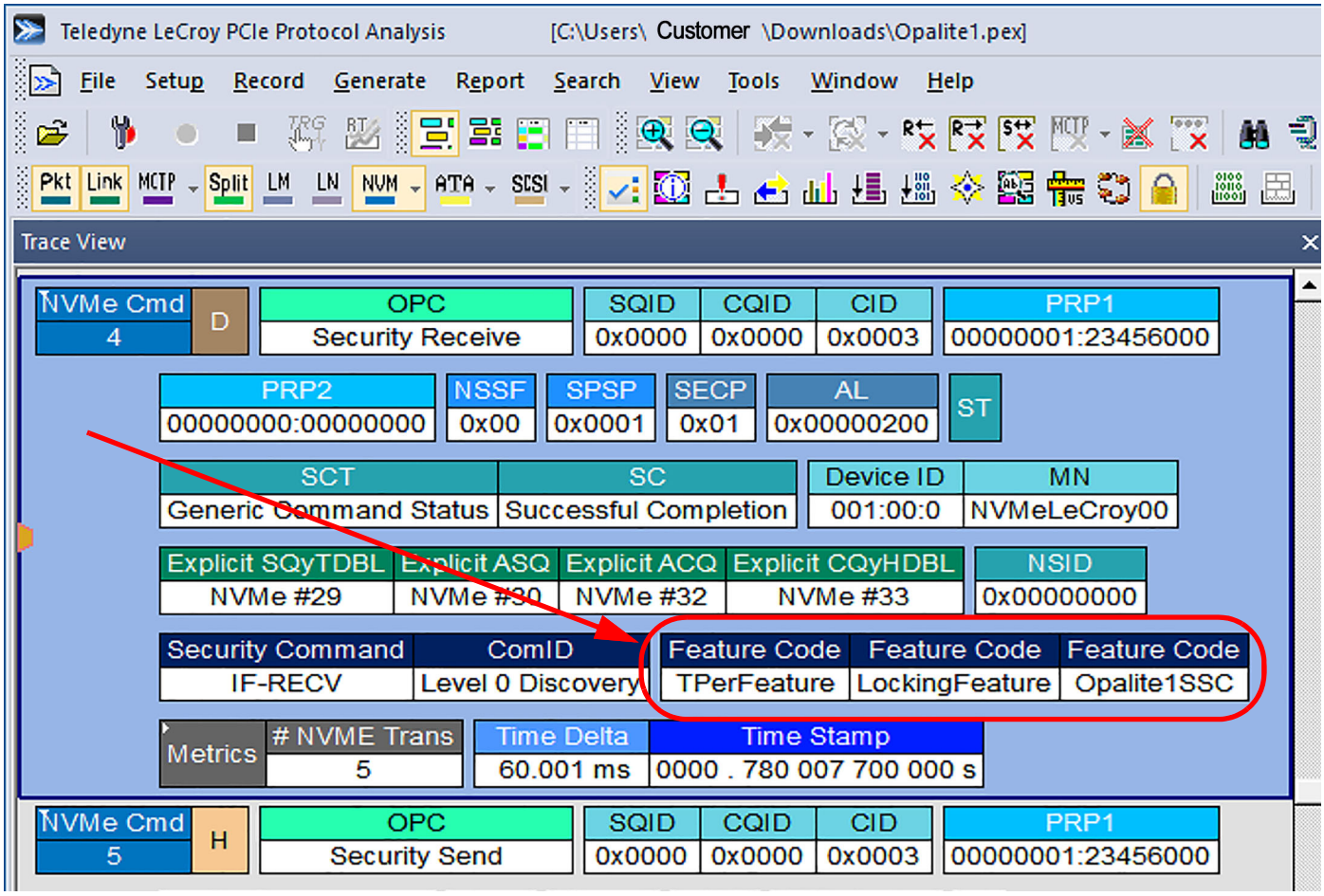


Figure 6.116: NVMe Trace: Opalite v0.1 TCG Security Fields Decoded

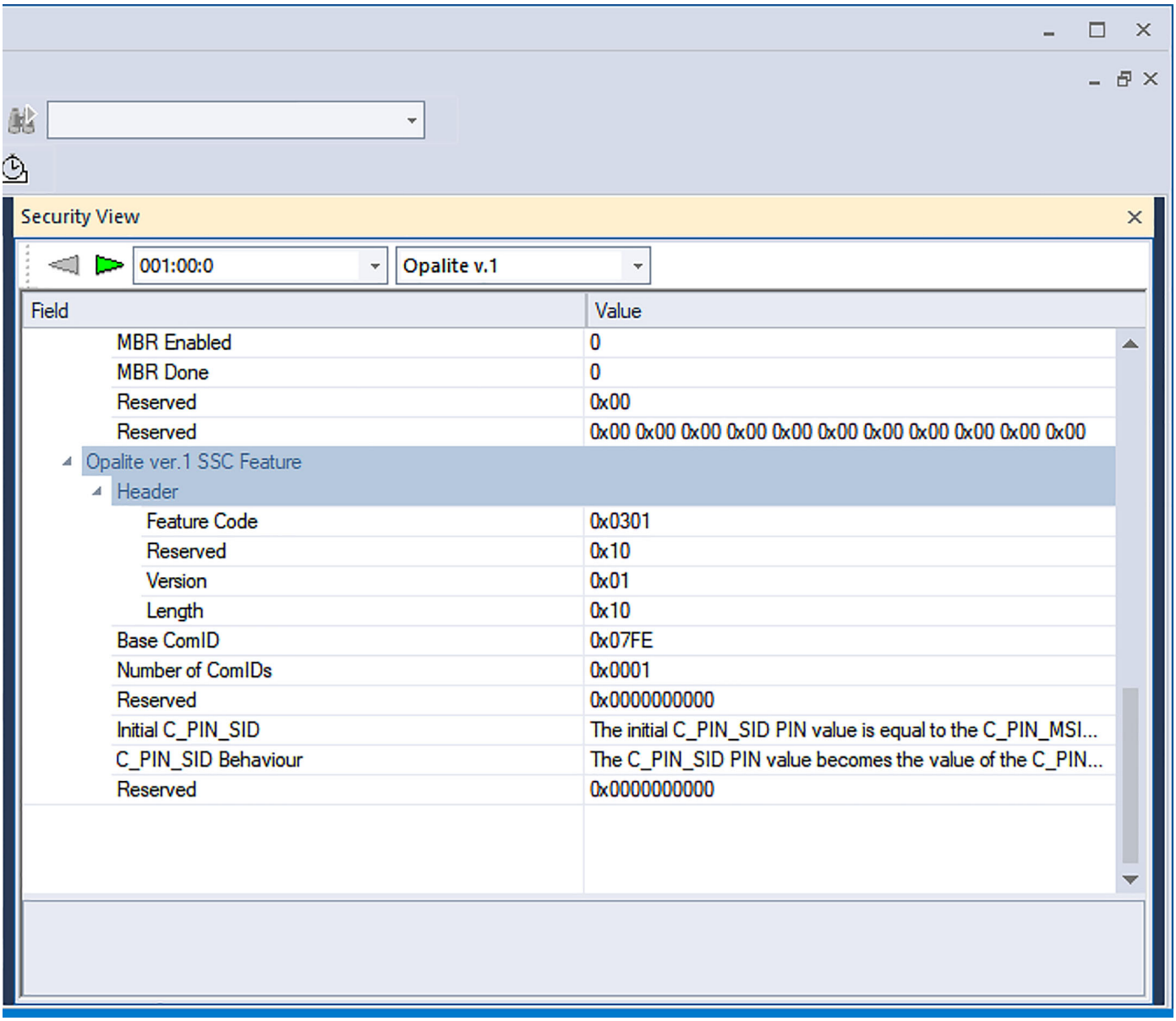


Figure 6.117: NVMe Trace: Opalite v0.1 TCG Security Fields Decoded → Details

NVMe: Command IOPS and Doorbell Statistical Information

IOPS and Doorbell statistical information can be displayed from an NVMe Trace by selecting an NVMe Packet with a Read or Write Command and viewing the Metrics box. See Figure 6.118 and Figure 6.119 on page 327.

The Doorbell statistics include:

- SQdoorbell to CQdoorbell,
  (time from Submission Doorbell to Completion Doorbell)
- SQDoorbell to CQentry,
  (time from SQ doorbell to command completion)
- SQentry to CQentry,

(time from submission command to command completion

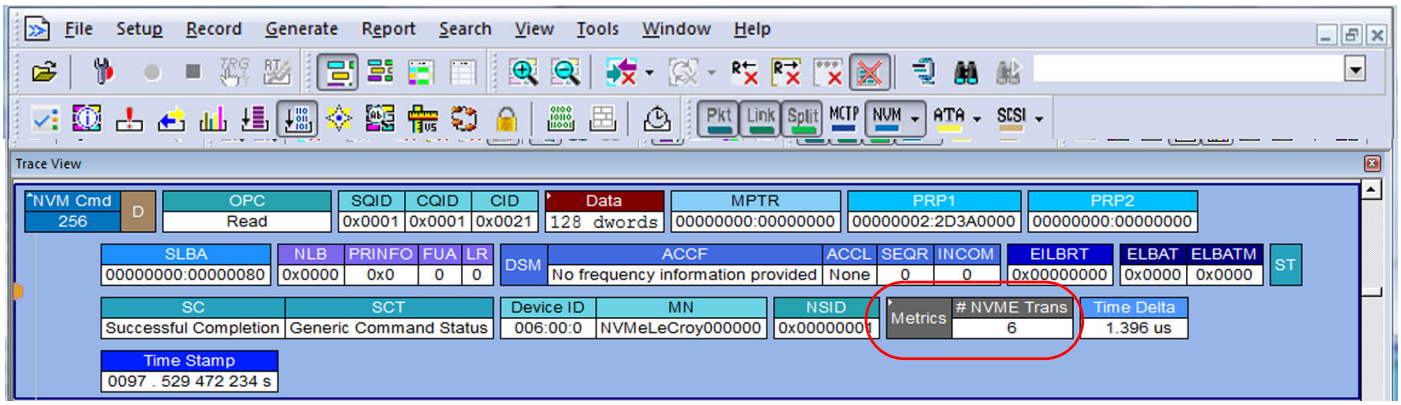


Figure 6.118: NVMe Read Command Packet with Metrics Box

Move the cursor over the Metrics box to display the information about the NVMe Command. See Figure 6.119.

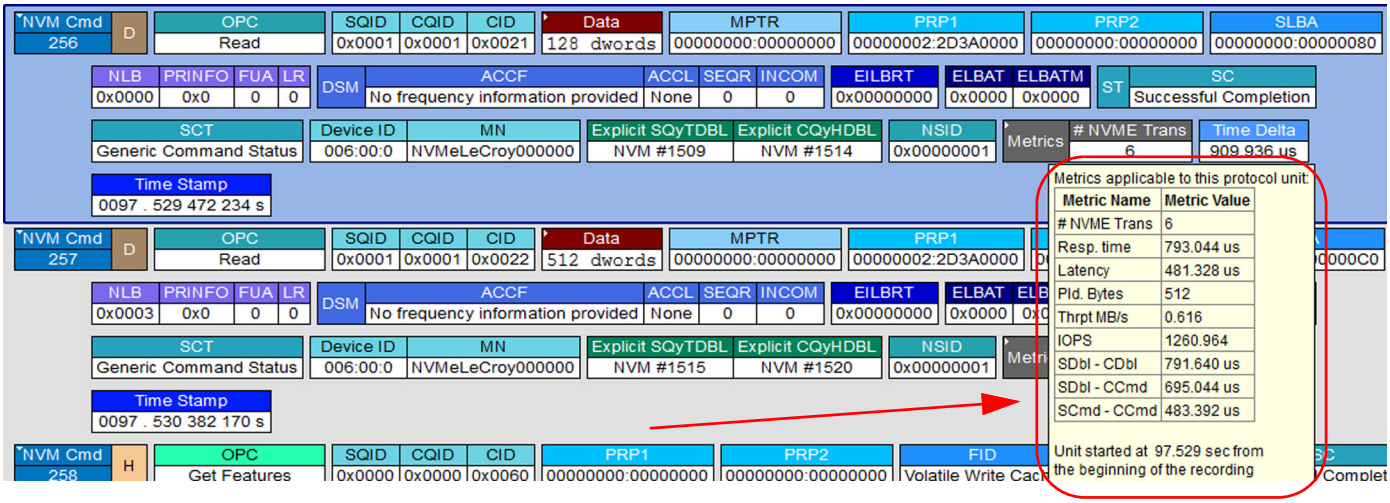


Figure 6.119: NVMe Read Command Packet with Metrics Displayed

If you click on the white arrow in the Metrics box, the information about the packet will be displayed in the Trace. See Figure 6.120.

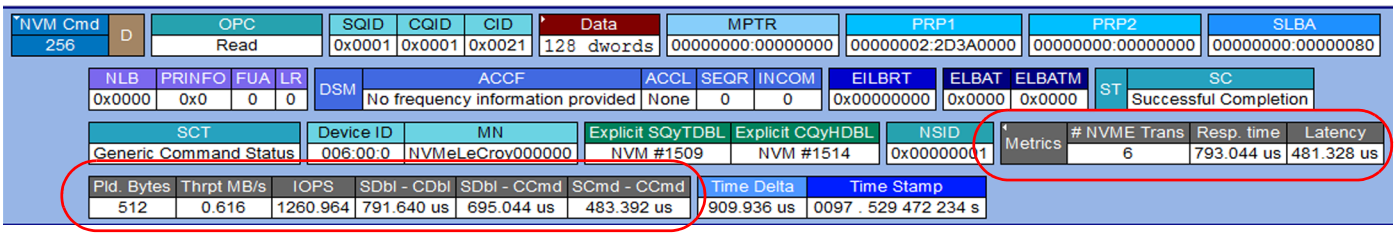


Figure 6.120: NVMe Read Command Packet with Metrics Displayed in Trace

The IOPS value is defined when you move the cursor over the IOPS box. See Figure 6.121.

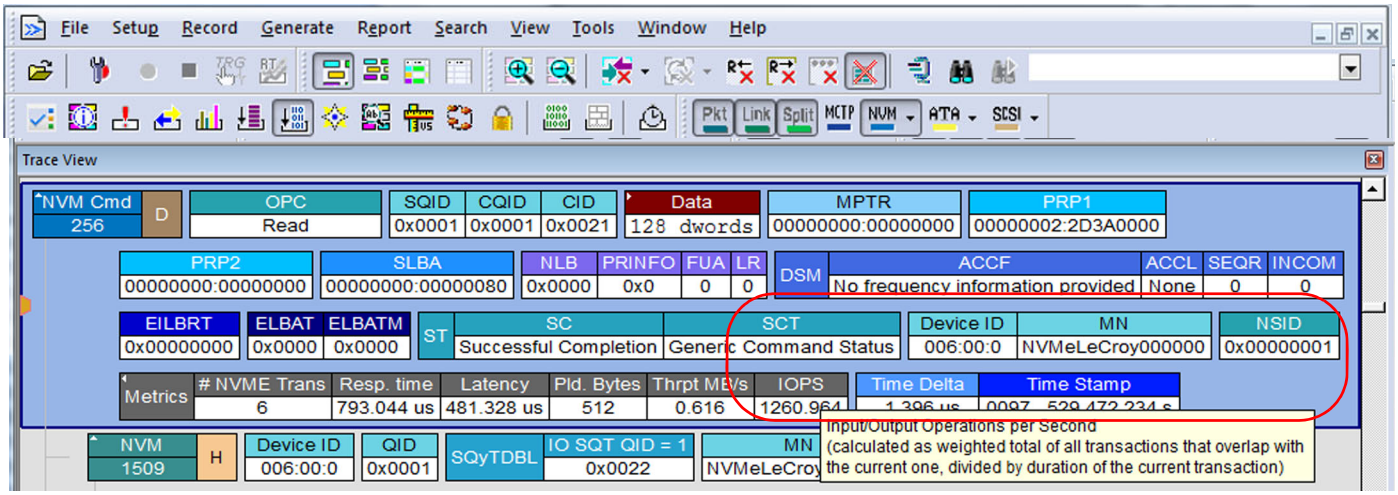


Figure 6.121: NVMe READ Command: IOPS Defined

The NMV Command IOPS can be viewed in Bus Utilization mode by selecting the Bus Utilization icon in the toolbar and selecting the Graph areas icon. See Figure 6.122.

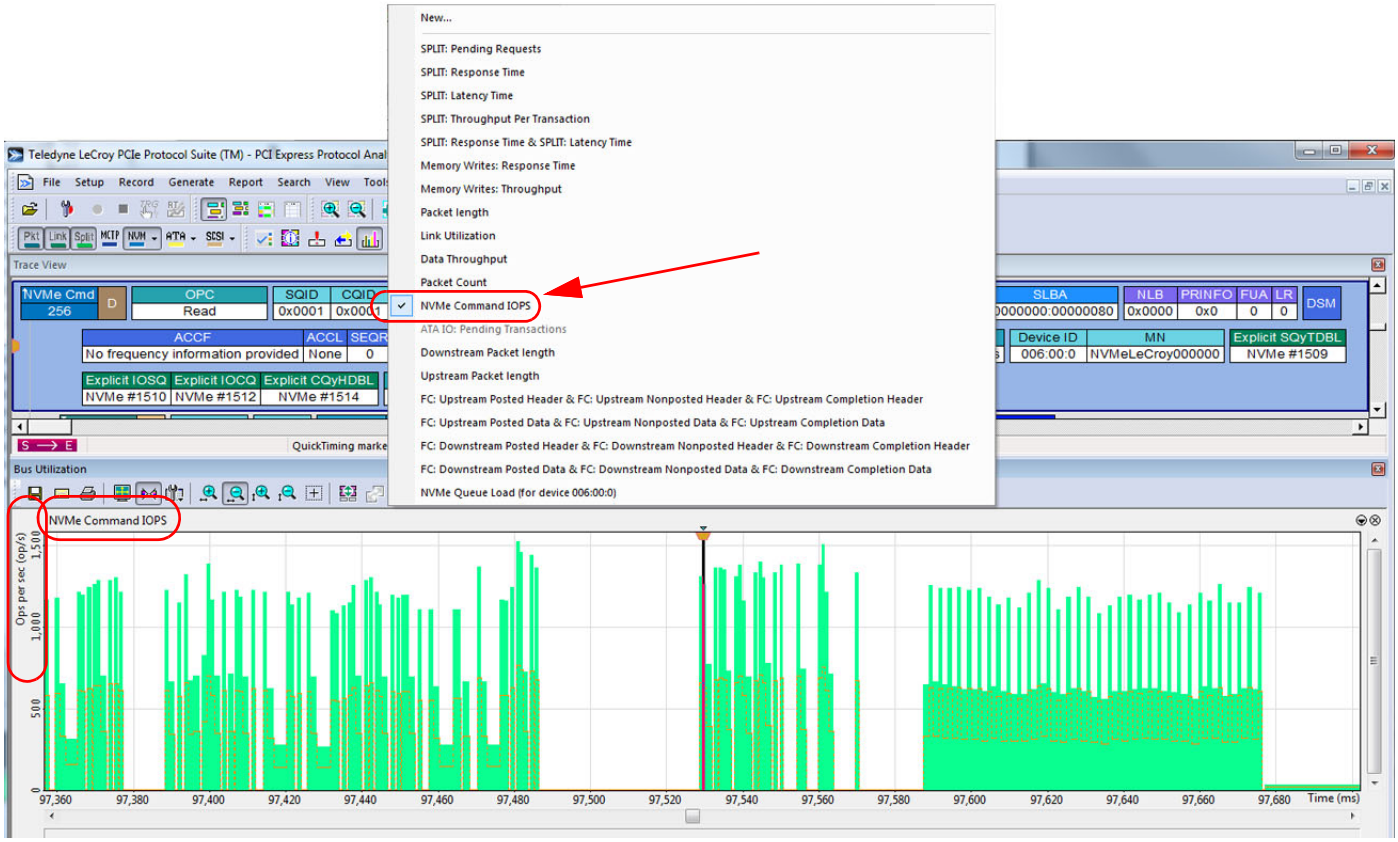


Figure 6.122: NVMe READ Command: Bus Utilization -- IOPS

NVMe Command IOPS is also displayed in the Spreadsheet and Detailed Views. See Figure 6.123.

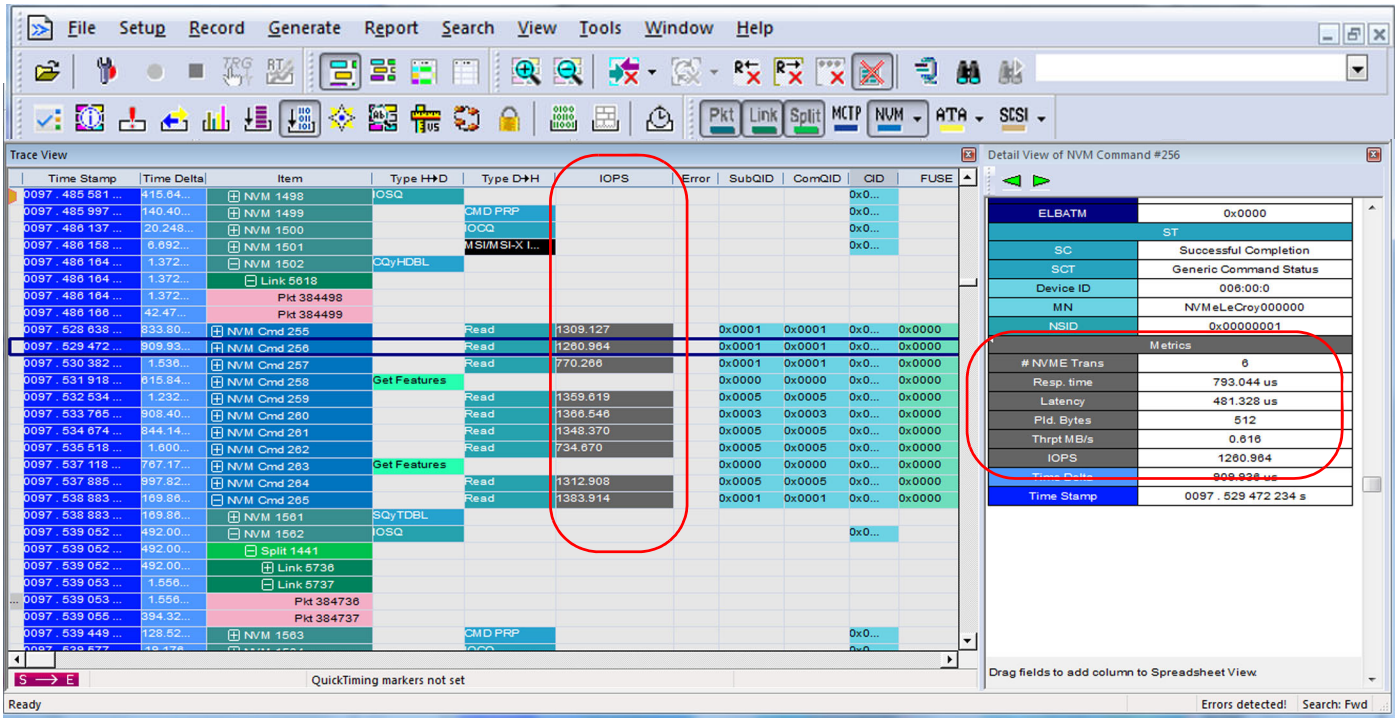


Figure 6.123: NVMe READ Command: IOPS Statistics

NVMe: Decode for Doorbells

Each type of doorbell's cell of an NVMe command is able to represent 1 of 4 states:

- Explicit (NVMe command contain concrete DBL). See Figure 6.124 on page 331.
- Implicit (Some doorbells implicitly complete previous commands. Such commands do not have a doorbell that can be associated one to one. This will be indicated in the trace.)
- Missing (NVMe cmd Is Incomplete, and DBL missing)
- Filtered (DBL is filtered out in Recording rules)

Tooltips:

- For SQyTDBL: Command was explicitly/implicitly initiated by SQyTDBL in NVMe #number (See Figure 6.124 on page 331)
- For CQyHDBL: Command was explicitly/implicitly finished by CQyHDBL in NVMe #number
- For Missing Doorbells: Doorbell is missing
- For Filtered: Doorbells are filtered out

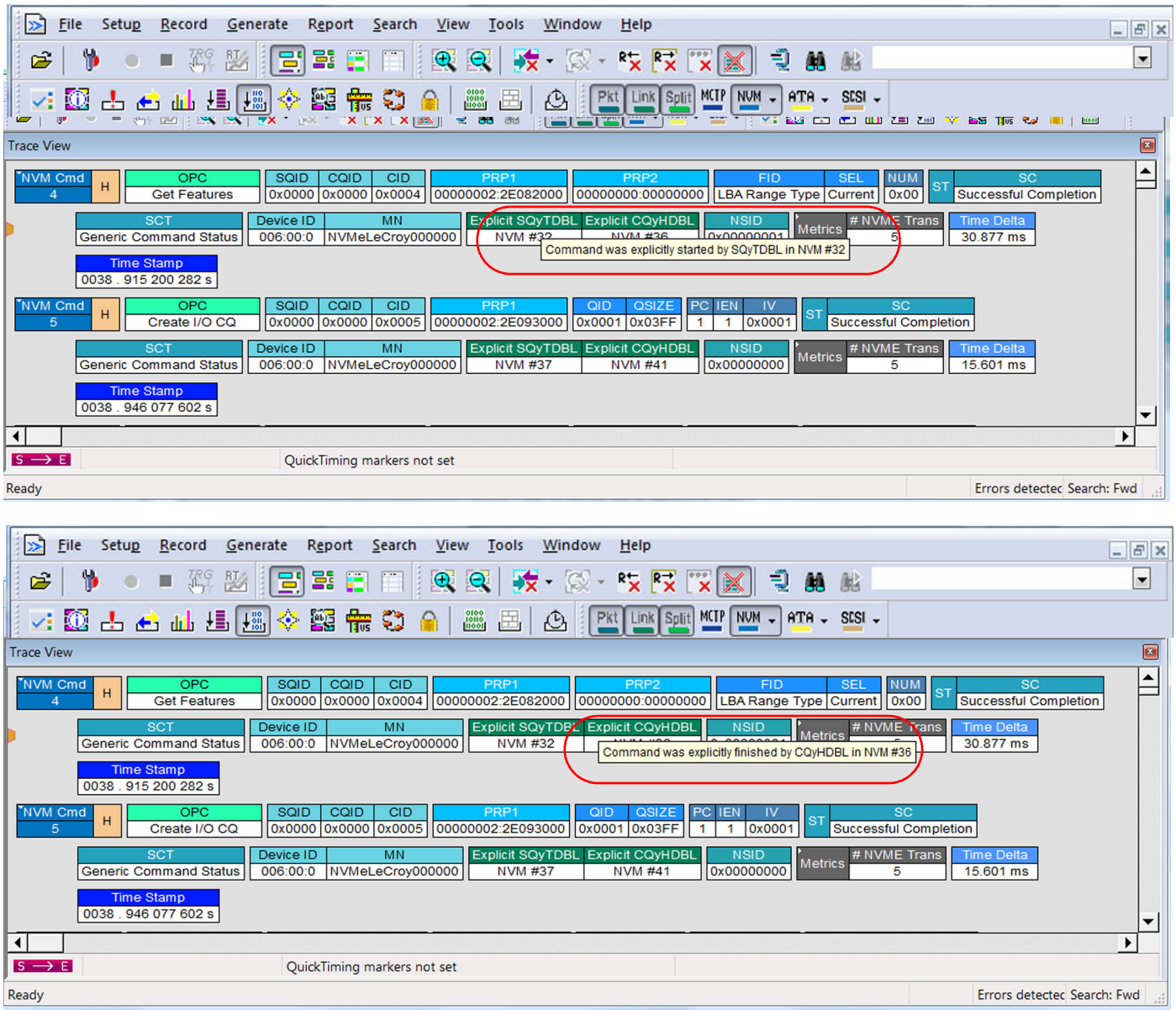


Figure 6.124: NVMe Decoding: Example of Explicit Doorbell in Trace with Tool Tips

NVMe Commands and Transactions: Data Throughput

Data Throughput is defined as the Payload divided by response time, expressed in MB per second (MB = 1024*1024 bytes) for both Commands and Transactions. See Figure 6.125 and Figure 6.126.

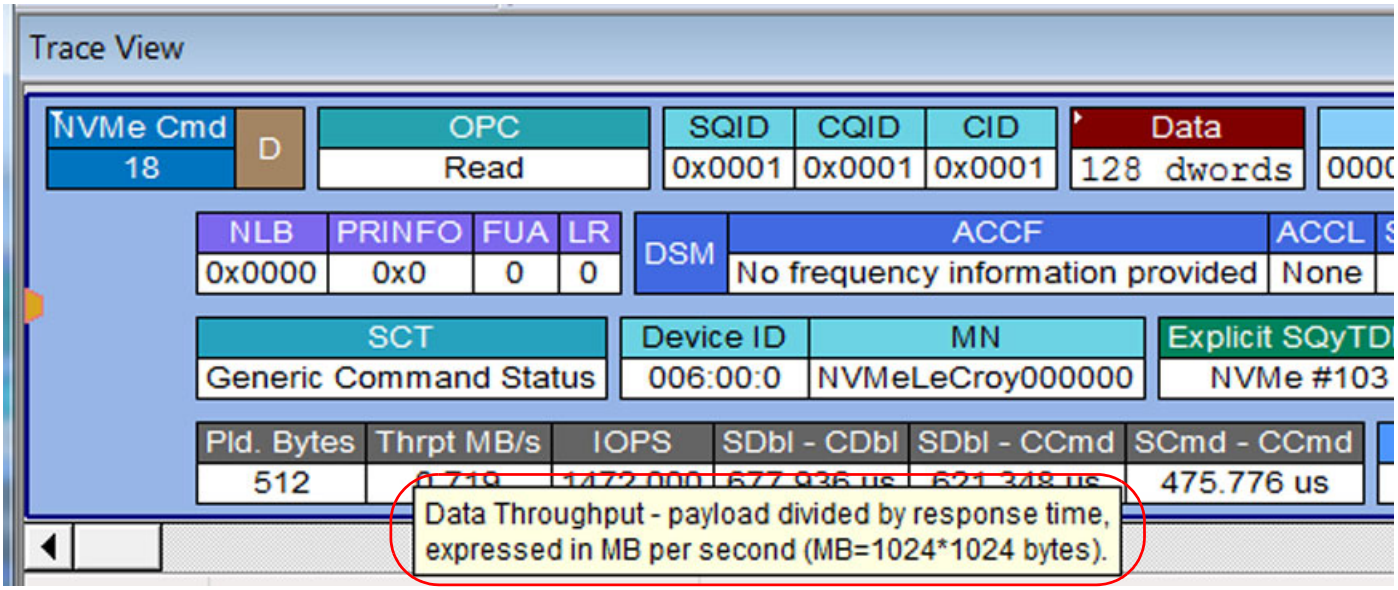


Figure 6.125: NVMe Command: Data Throughput

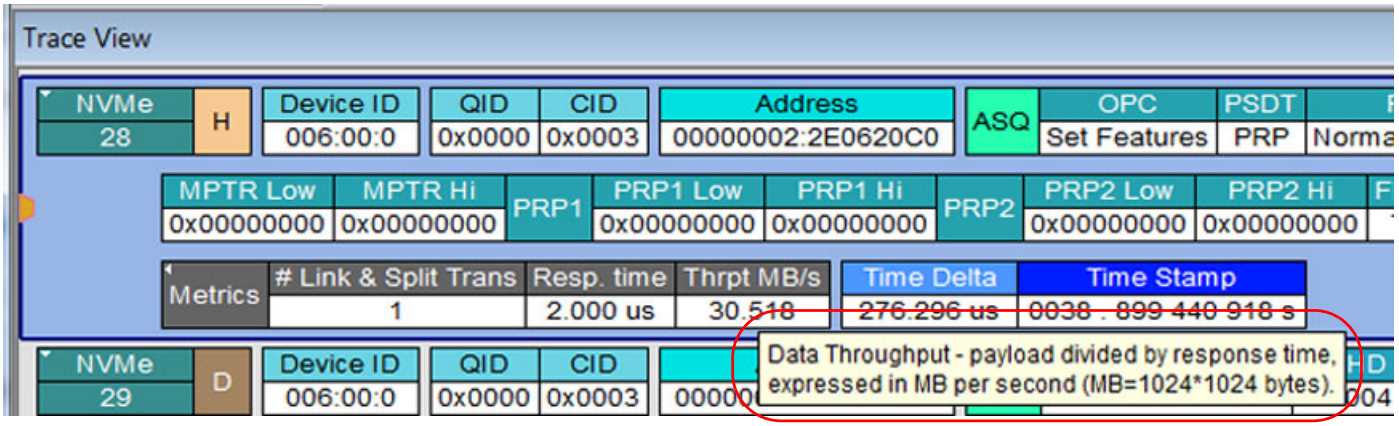


Figure 6.126: NVMe Transaction: Data Throughput

NVMe Decoding vs. NVMe Specification

After decoding an NVMe Trace you can view both the NVME data traffic in the Trace View as well as formatted per the NVMe Specification. The NVMe Specification View is brought up by selecting the NVMe Specification icon in the tool bar (see Figure 6.127).

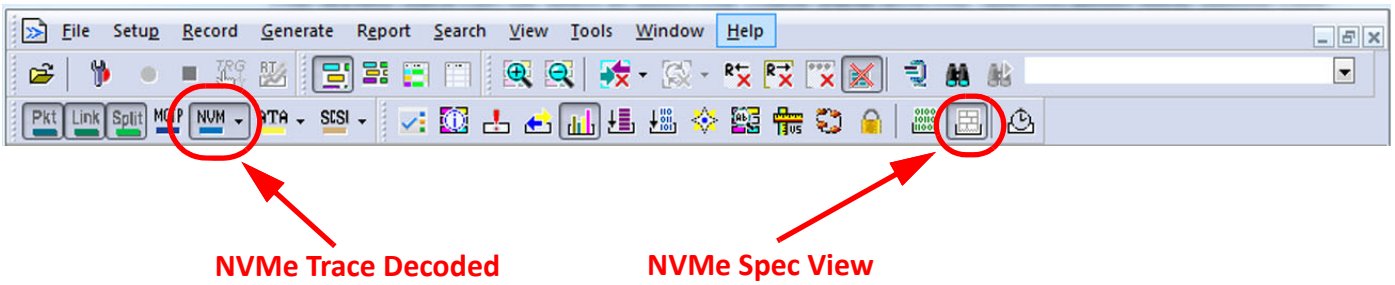


Figure 6.127: PCIe Protocol Analysis Toolbar → NVMe Specification View

The NVMe data can be seen in both the Trace View and the Specification view below (see Figure 6.128 and Figure 6.129 on page 334).

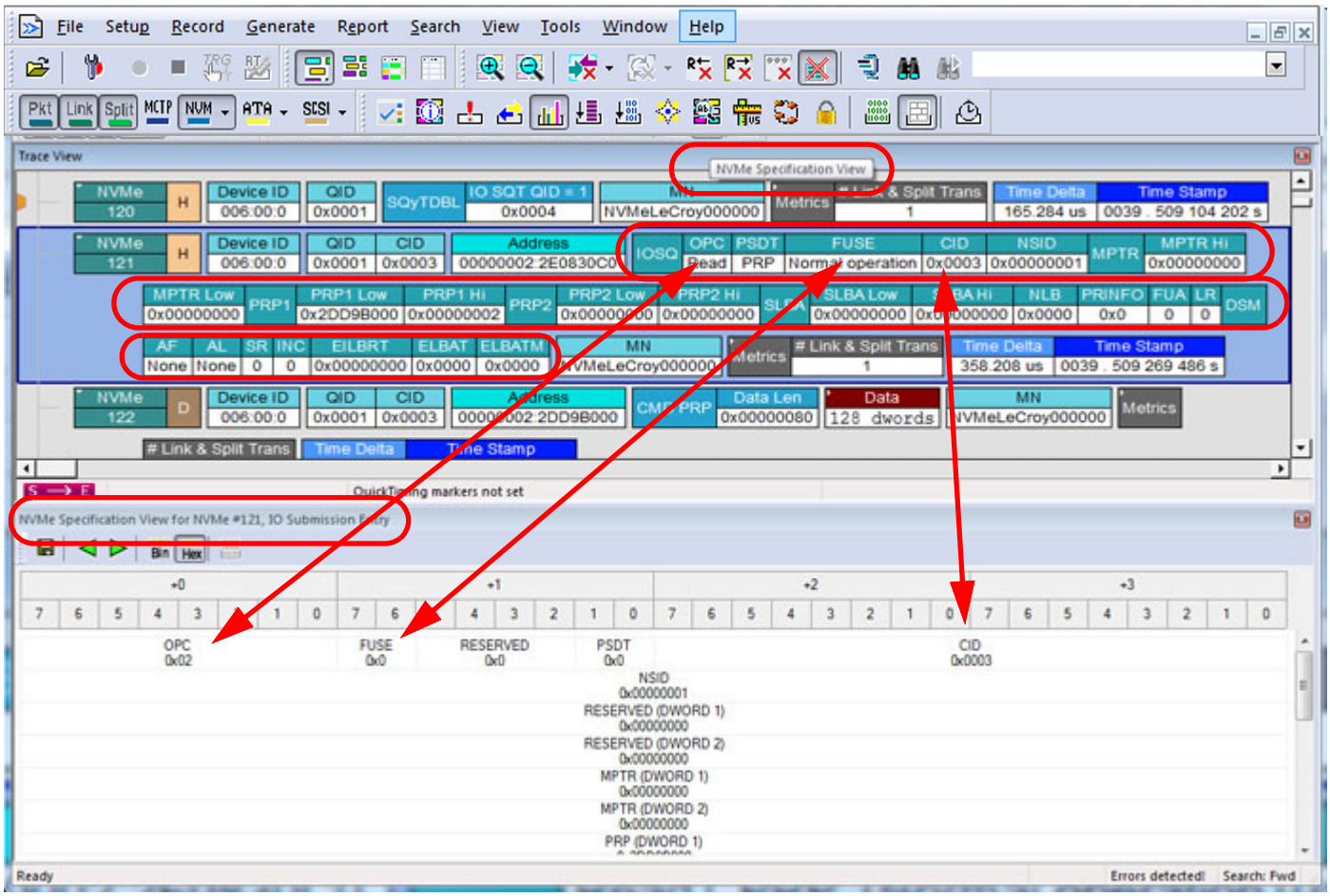


Figure 6.128: Decoding NVMe Trace → Trace View vs. Spec View (Part 1)

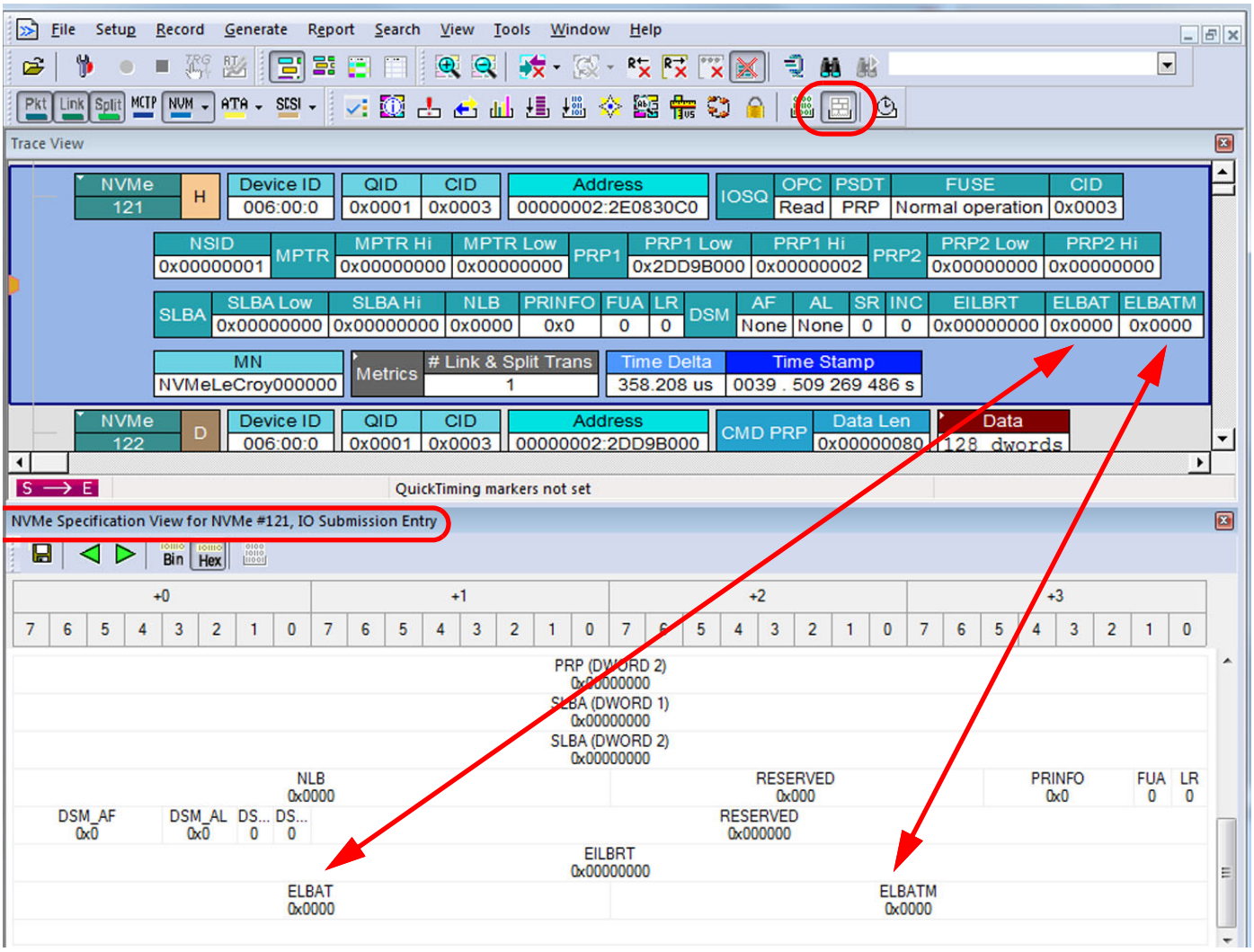


Figure 6.129: Decoding NVMe Trace → Trace View vs. Spec View (Part 2)

If you move the cursor over a specific data block a Tool Tip will pop up with more information about the data block. See Figure 6.130

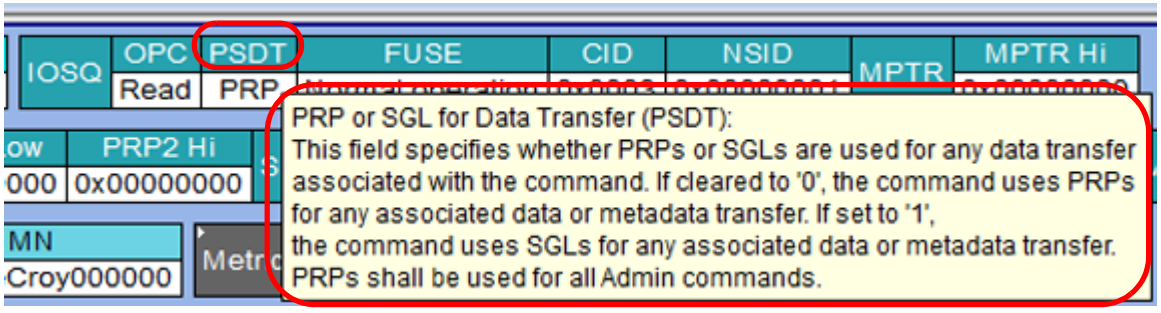


Figure 6.130: NVMe Specification: Trace View Tool Tip

Similar Tool Tips are available in the NVMe Specification View. See Figure 6.131 on page 335.

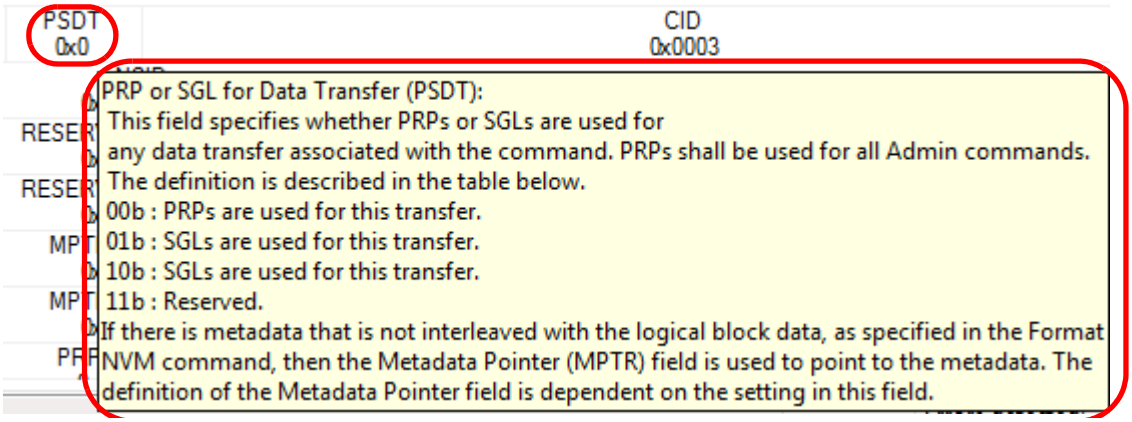


Figure 6.131: NVMe Specification View: Tool Tip

The NVMe Specification View is also available from the Main Toolbar under Report → NVMe Specification. See Figure 6.132.

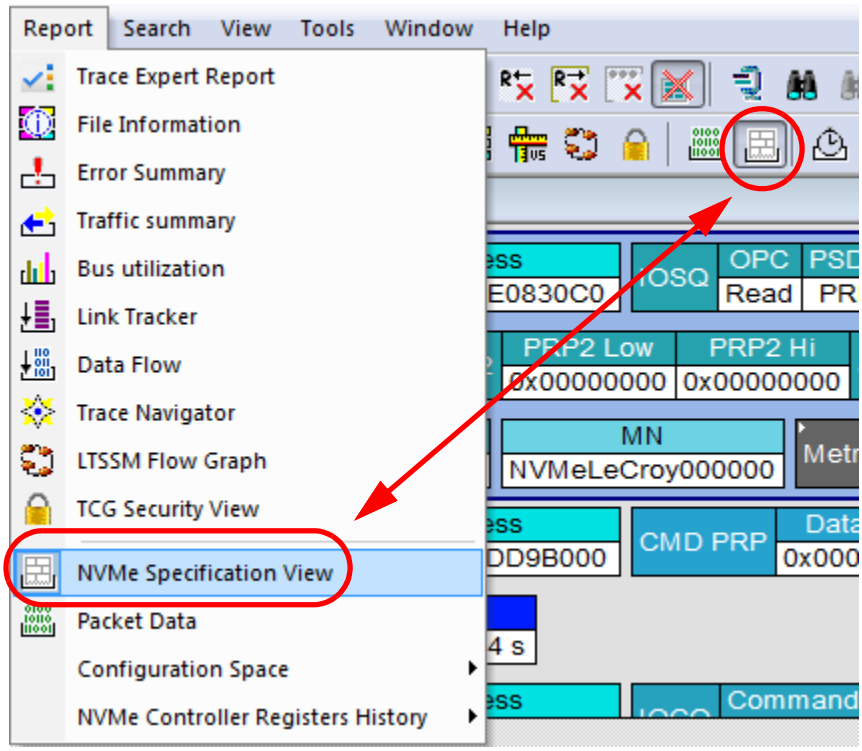


Figure 6.132: Report: NVMe Specification

NVMe Controller Register

To view the NVMe Controller Registers perform the following steps:

1. Load a trace with NVMe data traffic.
2. Select Packet, Link, Split, NVMe, Hide Unrelated Traffic and View → Wrap to produce the following display (see Figure 6.133).

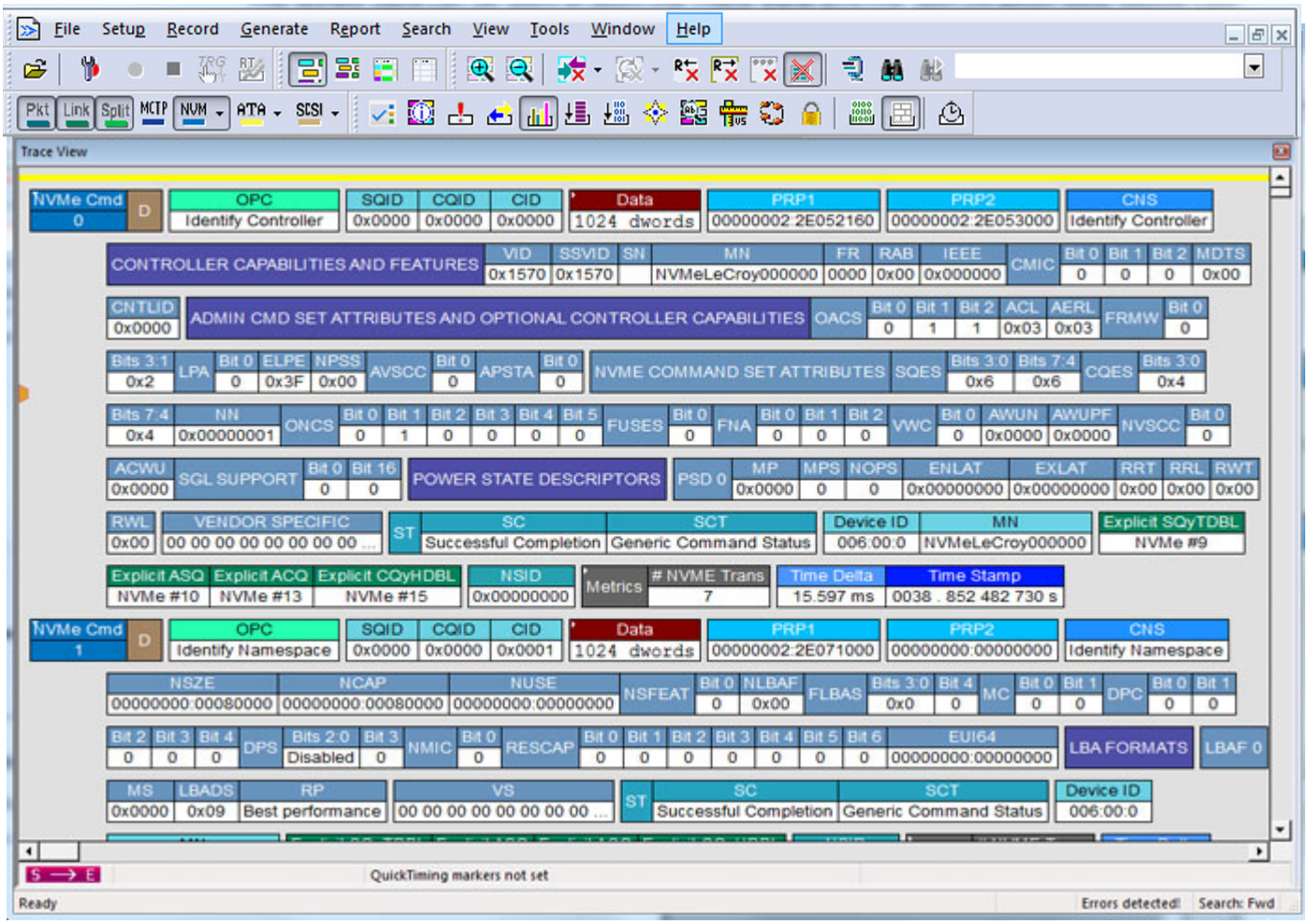


Figure 6.133: NVMe Trace Loaded

3. Select Reports → NVMe Controller Registers History (see Figure 6.134 on page 337).

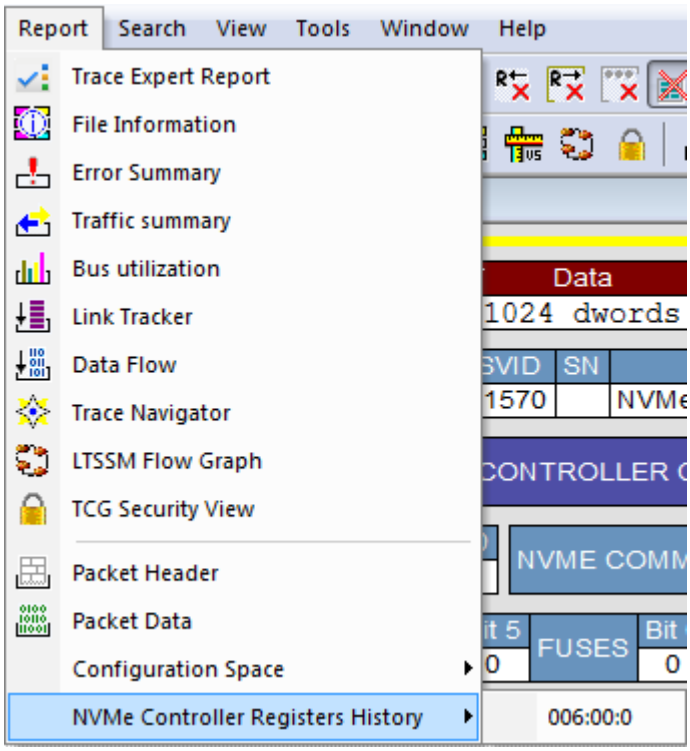


Figure 6.134: Reports → NVMe Controller Registers History

4. Select the time shown (006:00:0) and the following display will pop up. See Figure 6.135 on page 338.

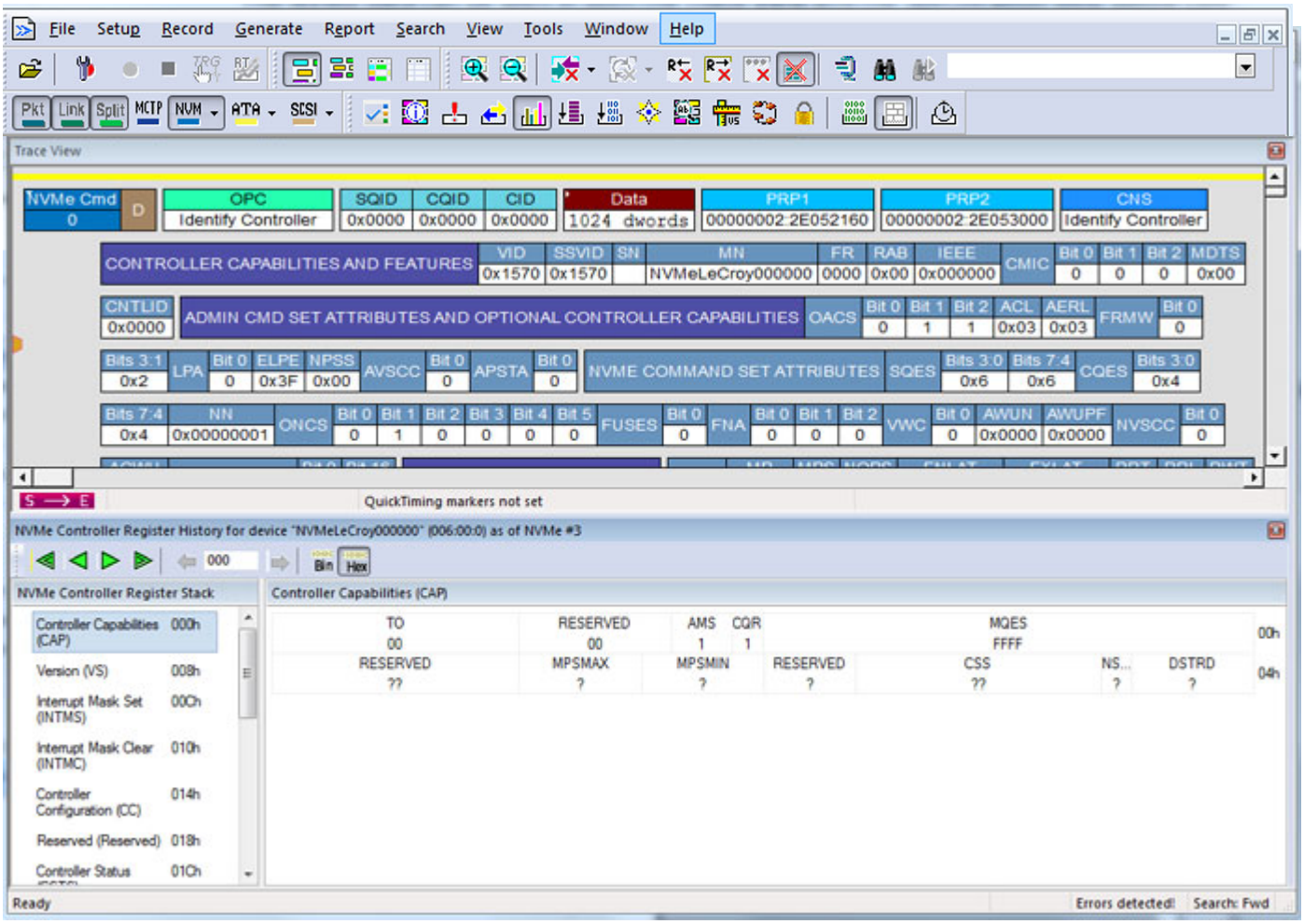


Figure 6.135: Reports → NVMe Controller Registers History Displayed

5. If you zoom in on the green arrows, you can:

a. Go to the First NVMe Controller Register

b. Go to the Previous NVMe Controller Register

c. Go to the Next NVMe Controller Register

d. Go to the Last NVMe Controller Register

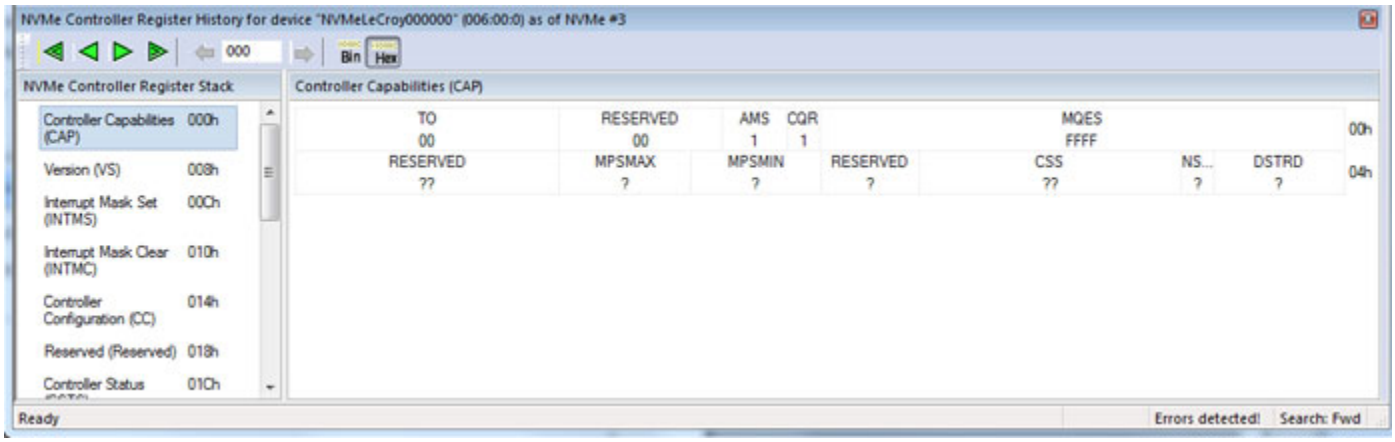


Figure 6.136: NVMe Controller Registers: Controller Capabilities (CAP) 000h Displayed

5. As an example you could click on the Next NVMe arrow and the Admin Queue Attributes would be displayed (see Figure 6.137).

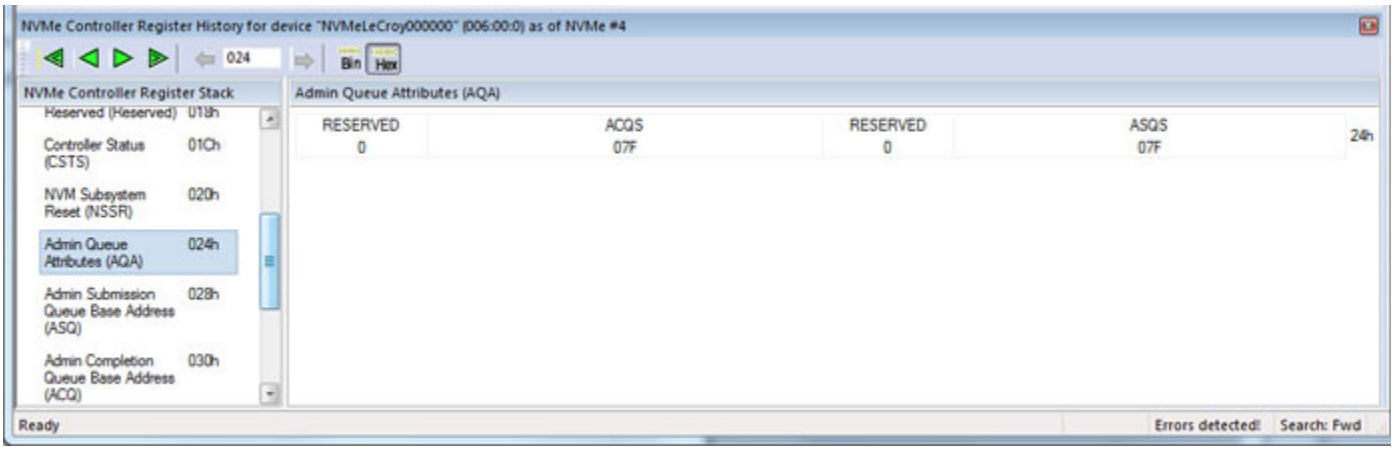


Figure 6.137: NVMe Controller Registers: Admin Queue Attributes (AQA) 024h Displayed

6. You can continue clicking the Green arrow to see more of the NVMe Controller Register Stack. See Figure 6.138 on page 339.

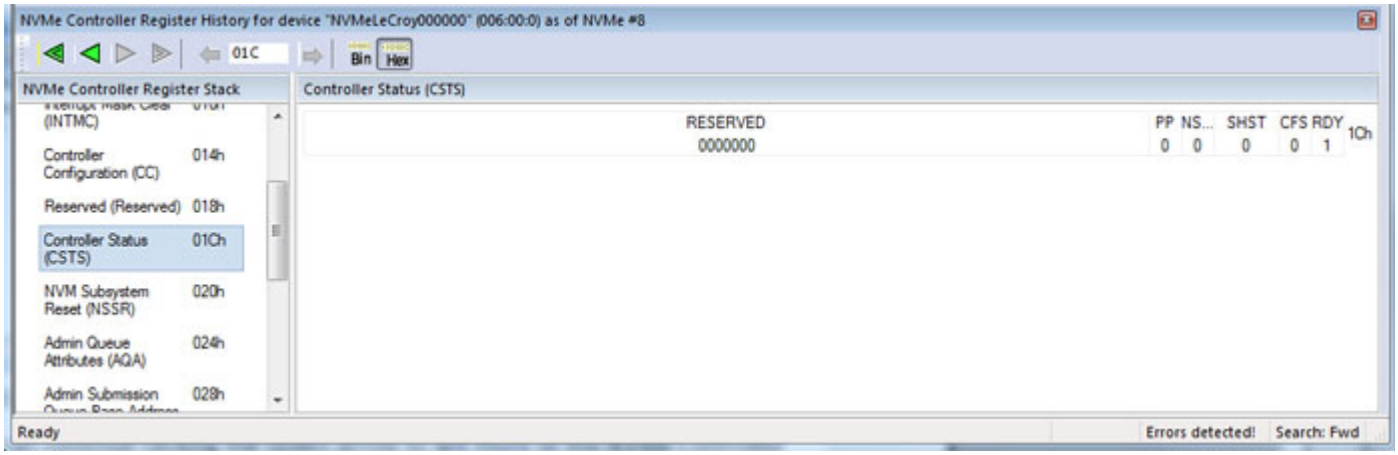


Figure 6.138: NVMe Controller Registers: Controller Status (CSTS) 01Ch

Decoding Multiple NVMe Commands for a Single MemRead or MemWrite

In some cases, a controller may fetch multiple NVMe commands in a single Memory Read or Write. At the NVMe Command level, the Analyzer software will decode this and show that there is an Implicit I/O Submission Queue Entry for that command and refer to the NVMe Transaction where the command was fetched from the Submission Queue. See Figure 6.139. NVMe transactions that are part of the current NVMe command are labeled as Explicit. In this case, the I/O Completion Queue contains NVMe transaction 311924 and it's labeled as an Explicit entry (also shown in Figure 6.139).

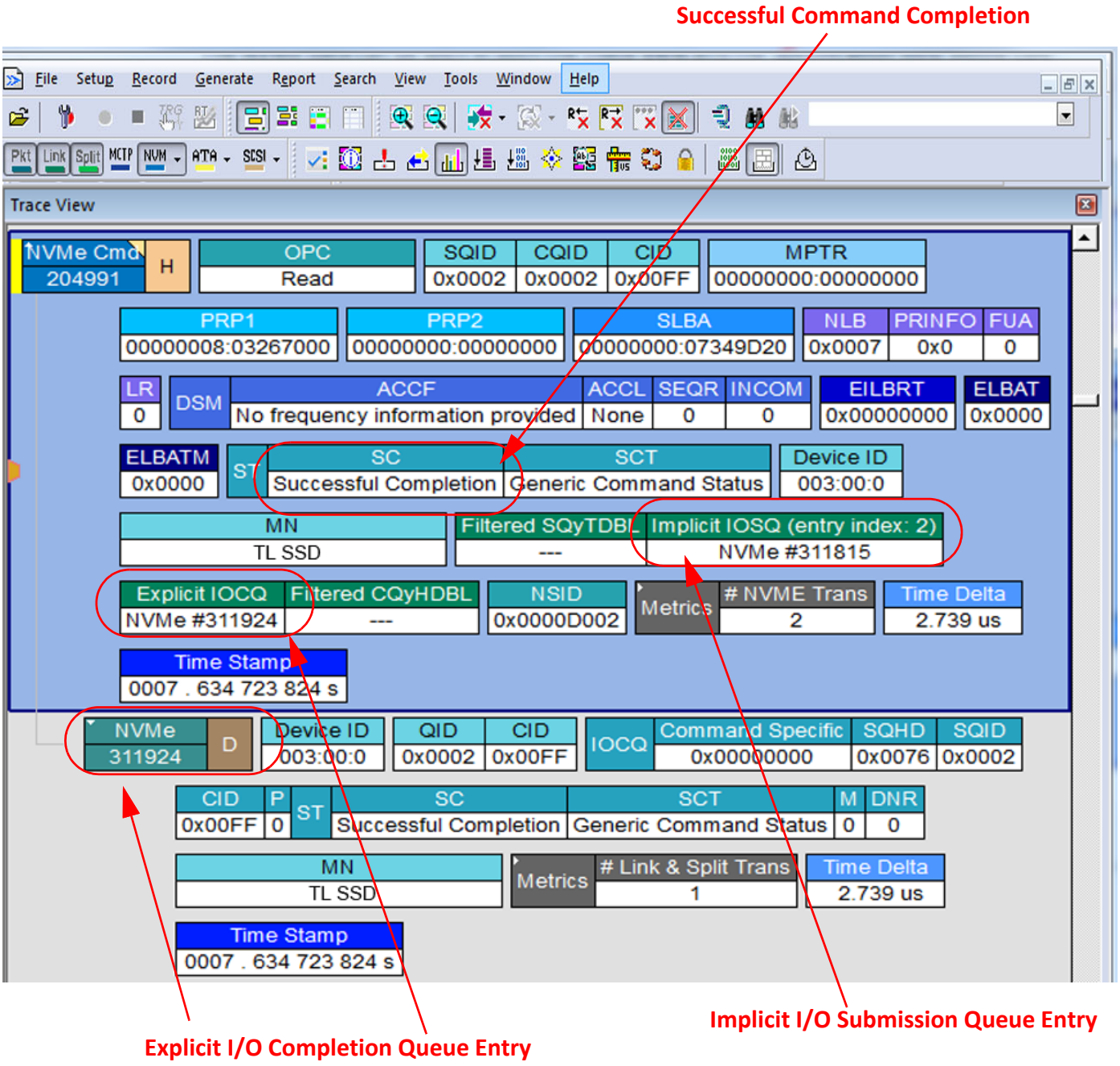


Figure 6.139: Implicit I/O Submission Queue Entry (IOSQ) and Explicit I/O Completion Queue Entry (IOCQ)

NVMe Transactions Decoded for NVMe Read Command:

- Implicit IOSQ: NVMe Transaction #311815 (entry index: 2)
- Explicit IOCQ: NVMe Transaction #311924 (part of this NVMe command: 204991)

The Implicit NVMe transaction (referenced by the Implicit label vs. Explicit label) can be found by right clicking on the NVMe transaction number in the trace display (see Figure 6.140).

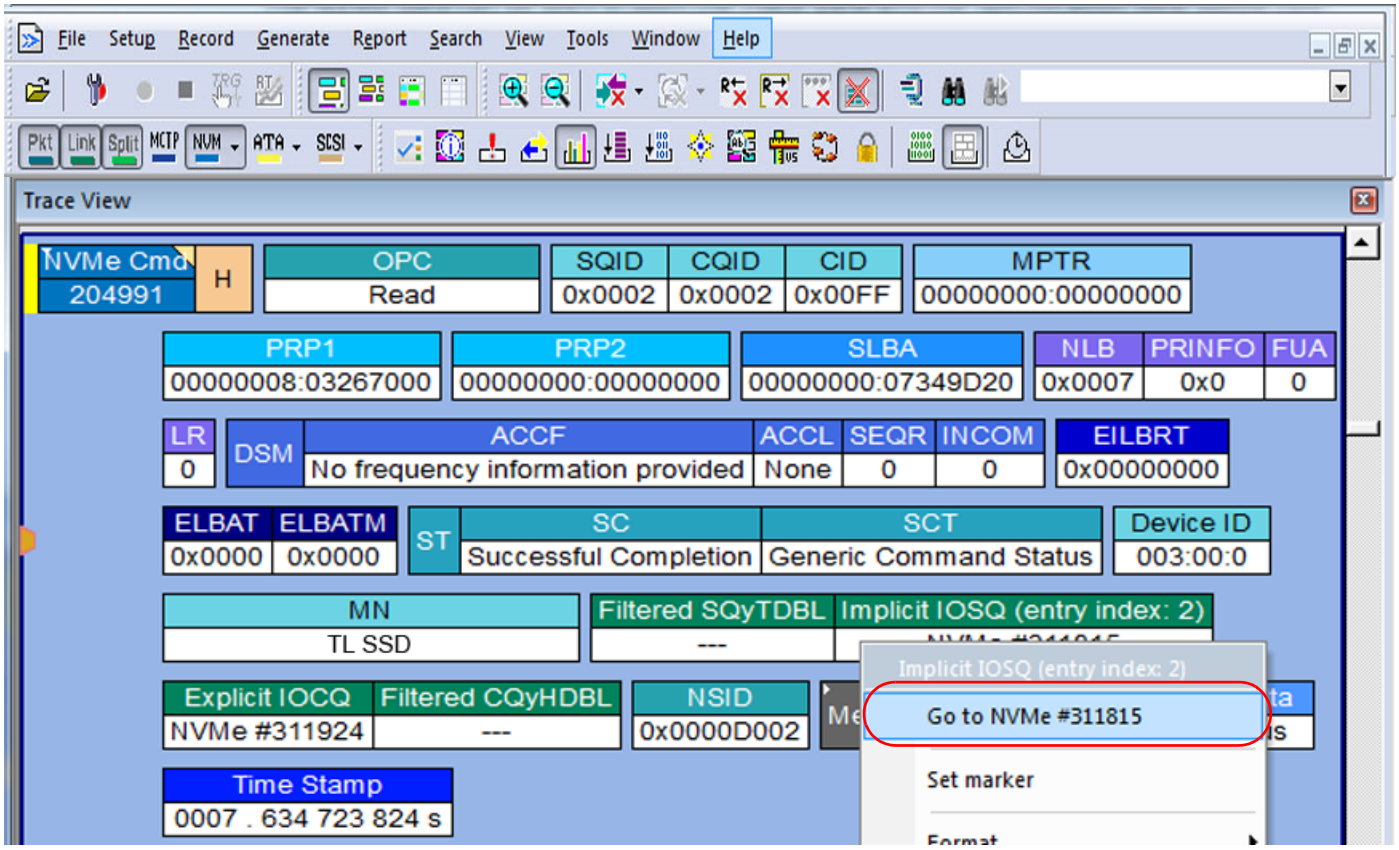


Figure 6.140: Implicit IOSQ Command

The display will be updated to that NVMe Transaction Number (and show the NVMe Command that it's a part of. In this case the Implicit NVMe Transaction (311815) is part of NVMe Command Number 204918. See Figure 6.141 on page 342)

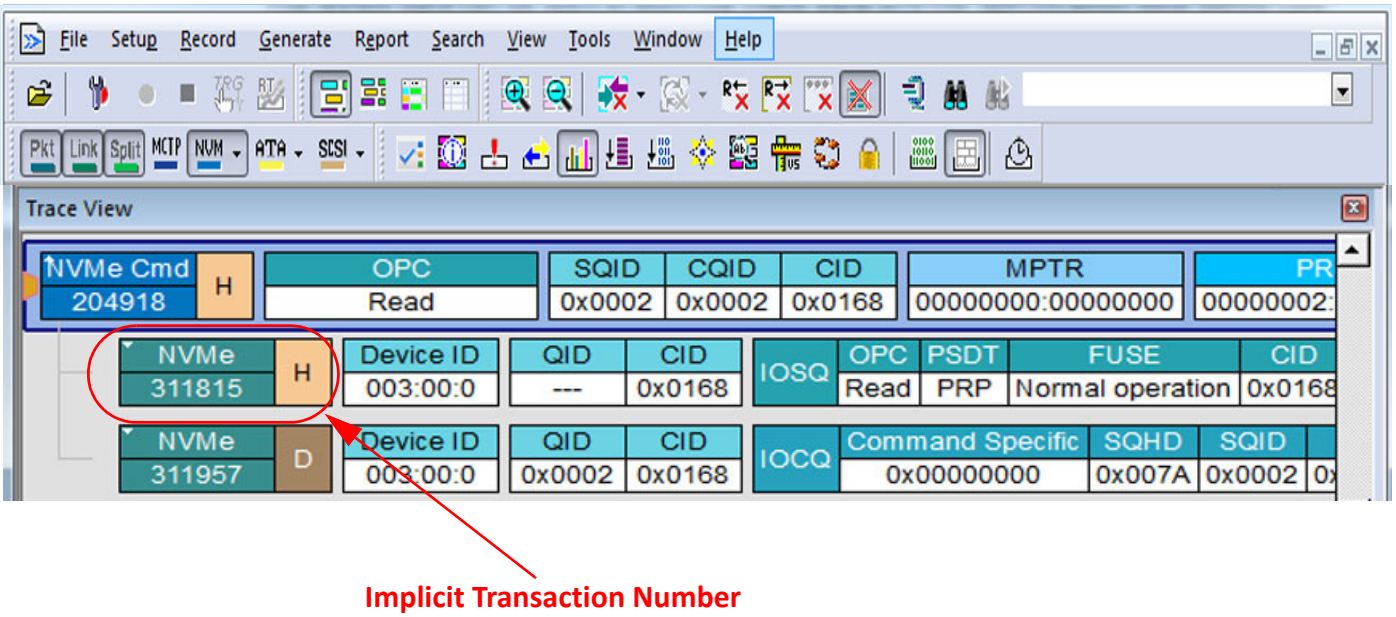


Figure 6.141: NVMe Transaction #318815: Part of NVMe Command 204918

If you expand the NVMe Transaction 311815 down to the Packet level (312224), you'll see two commands (32 DWORDS). See Figure 6.142.

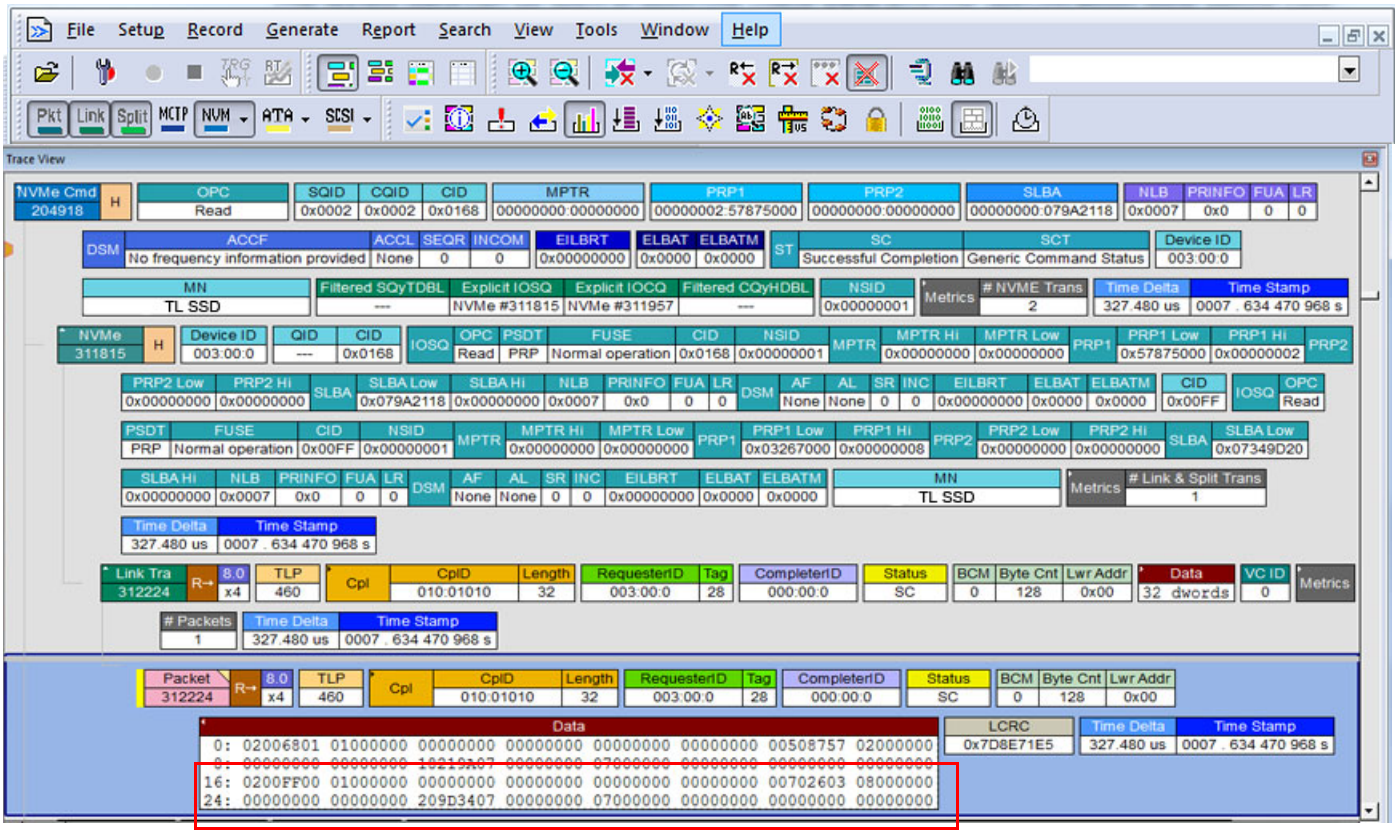


Figure 6.142: Implicit NVMe Transaction Decoded to Packet Level with Two Commands

6.3.12.6 NVMe 1.2 Specification Decoding

The PCIe Protocol Analysis has several enhancements to decode the NVMe 1.2 Specification (as seen in the following figures: Figure 6.143, Figure 6.144, Figure 6.145 on page 345 and Figure 6.146 on page 346).

- Name Space Management
- Replay Protected Memory Blocks
- SSD Dialog Shared NameSpace
- SSD Dialog Version and CMB Configurations

The figure below (Figure 6.143) shows the support added for decoding of the namespace management commands in NVMe data traffic.

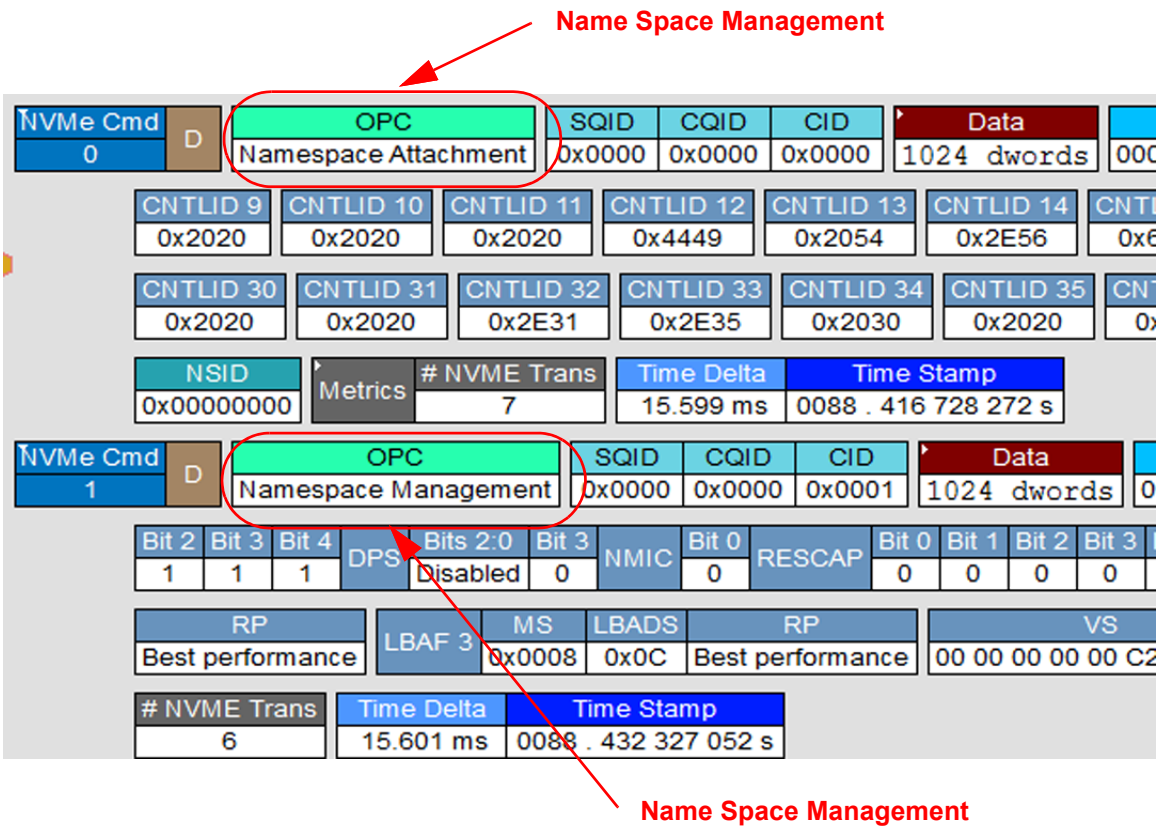


Figure 6.143: NVMe 1.2 Specification: Name Space Management

The Namespace Management command is used to create a namespace or delete a namespace. The Namespace Attachment command is used to attach and detach controllers from a namespace. Namespace management is intended for use during manufacturing or by a system administrator.

When a namespace is detached from a controller or deleted it becomes an inactive namespace on that controller. Previously submitted but uncompleted or subsequently submitted commands to the affected namespace are handled by the controller as if they were issued to an inactive namespace.

The figure below (Figure 6.144) shows the support added for the Replay Protected Memory Block (RPMB) command in NVMe data traffic.

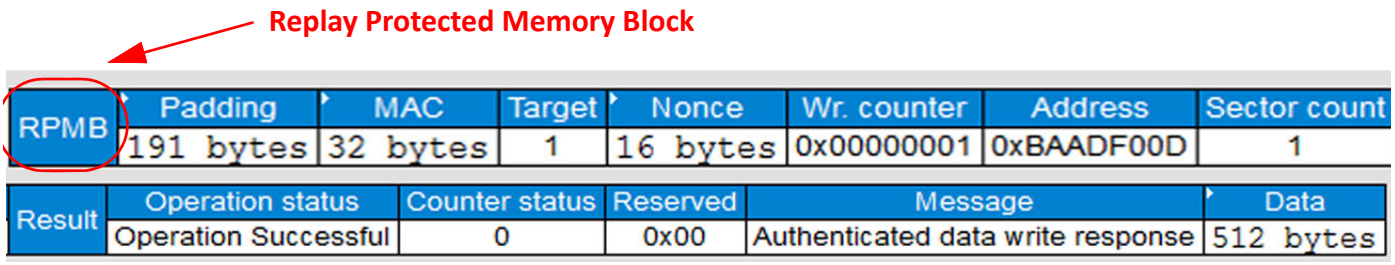


Figure 6.144: NVMe 1.2 Specification: Replay Protected Memory Block

The Replay Protected Memory Block (RPMB) provides a means for the system to store data to a specific memory area in an authenticated and replay protected manner. This is provided by first programming authentication key information to the controller that is used as a shared secret. The system is not authenticated in this phase, therefore the authentication key programming should be done in a secure environment (e.g., as part of the manufacturing process). The authentication key is utilized to sign the read and write accesses made to the replay protected memory area with a Message Authentication Code (MAC). Use of random number (nonce) generation and a write count register provide additional protection against replay of messages where messages could be recorded and played back later by an attacker.

The figure below (Figure 6.145) shows the support added for the Shared Namespace command in NVMe data traffic.

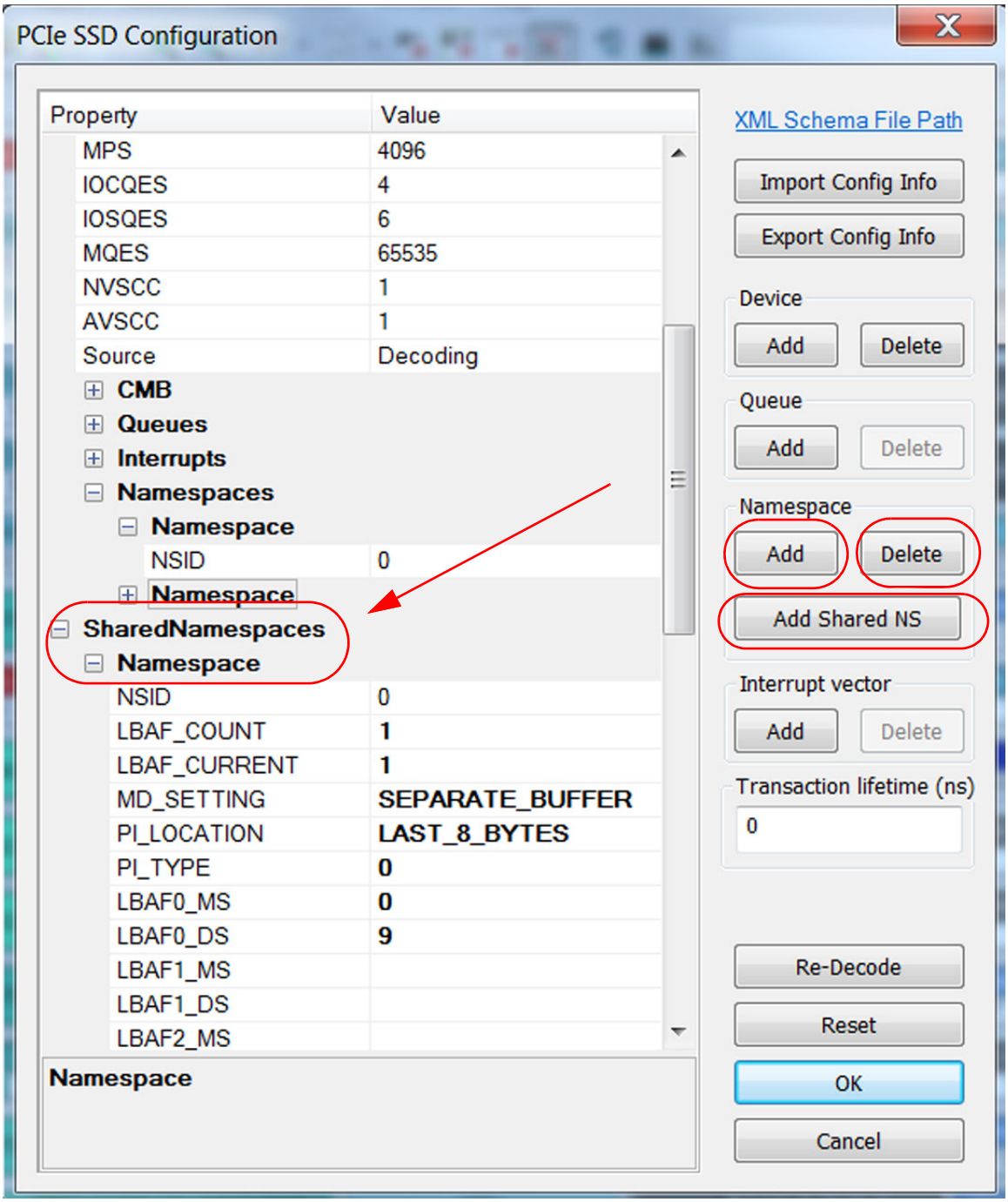


Figure 6.145: NVMe 1.2 Specification: Shared Namespaces

You can “Add” or “Delete” a namespace or Add a Shared namespace. A shared namespace is defined as a namespace that is accessible by two or more controllers in an NVM subsystem. A host may determine whether a namespace is a private namespace or may be a shared namespace by the value of the Namespace Multi-path I/O and Namespace Sharing Capabilities (NMIC) field in the Identify Namespace data structure.

The figure below (Figure 6.146) shows the added support for the Controller Memory Buffer (CMB) as defined in the NVMe 1.2 Spec.

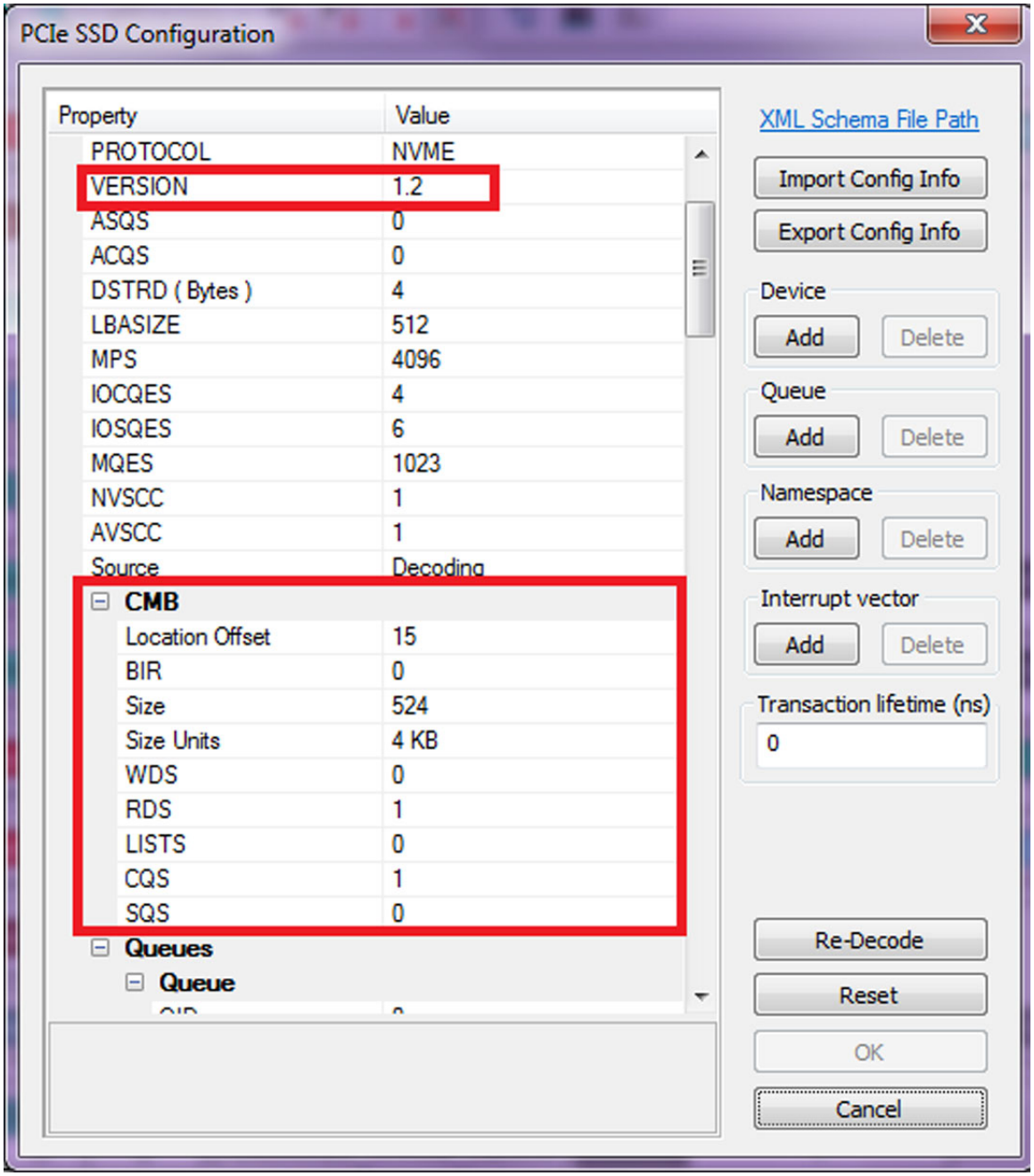


Figure 6.146: NVMe 1.2 Specification: SSD Dialog Version and CMB Configuration

The Controller Memory Buffer (CMB) is a region of general purpose read/write memory on the controller that may be used for a variety of purposes. The controller indicates which purposes the memory may be used for by setting support flags in the CMBSZ register.

6.3.12.7 Support for Physical Region Page (PRP) and Scatter Gather List (SGL) in Controller Memory Buffer (CMB)

The PCIe Protocol Analysis software supports PRP and SGL in CMB. See Figure 6.147 through Figure 6.149 on page 349.

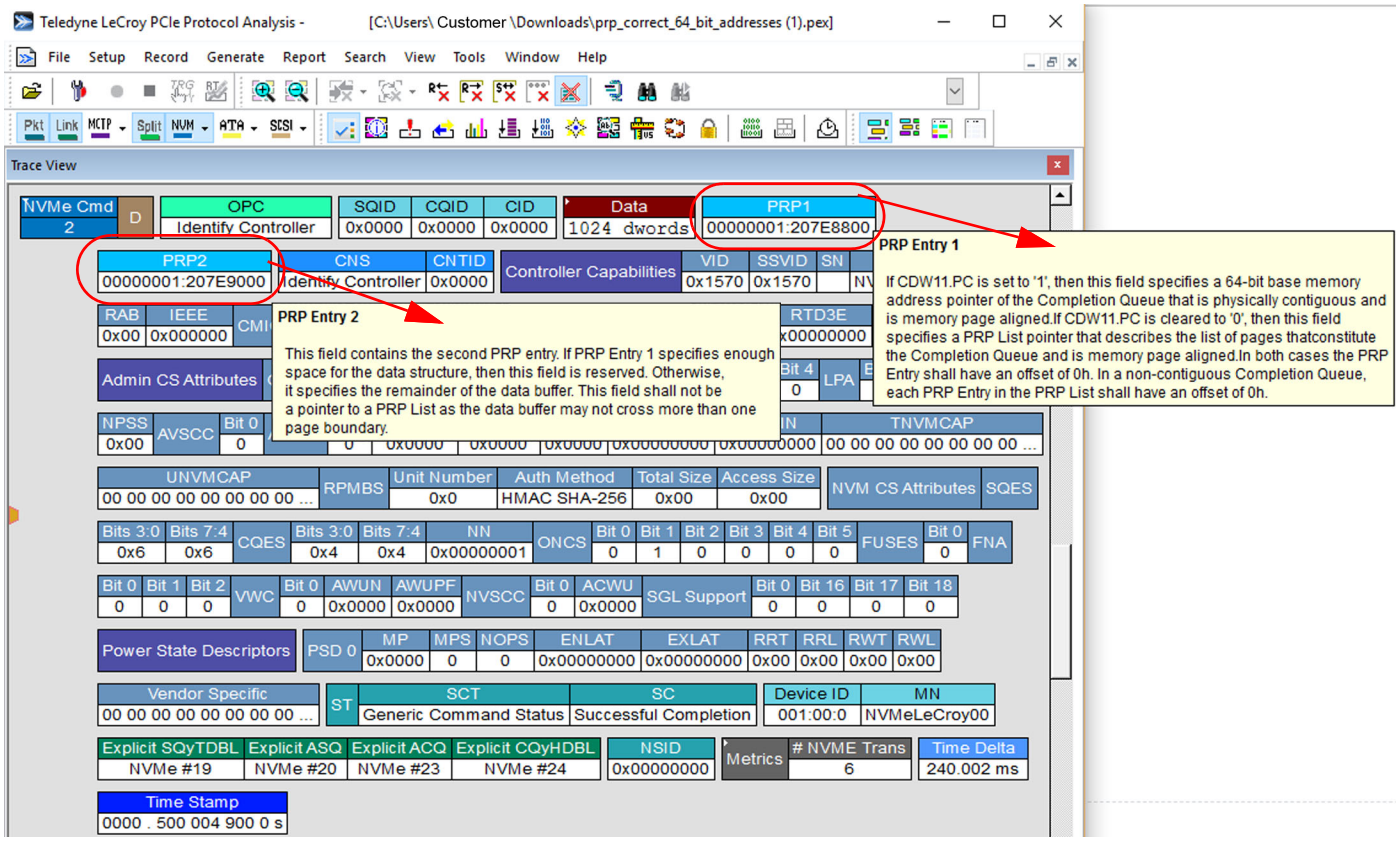


Figure 6.147: PRP1 and PRP2 in CMB Supported in PCIe Protocol Analysis Software

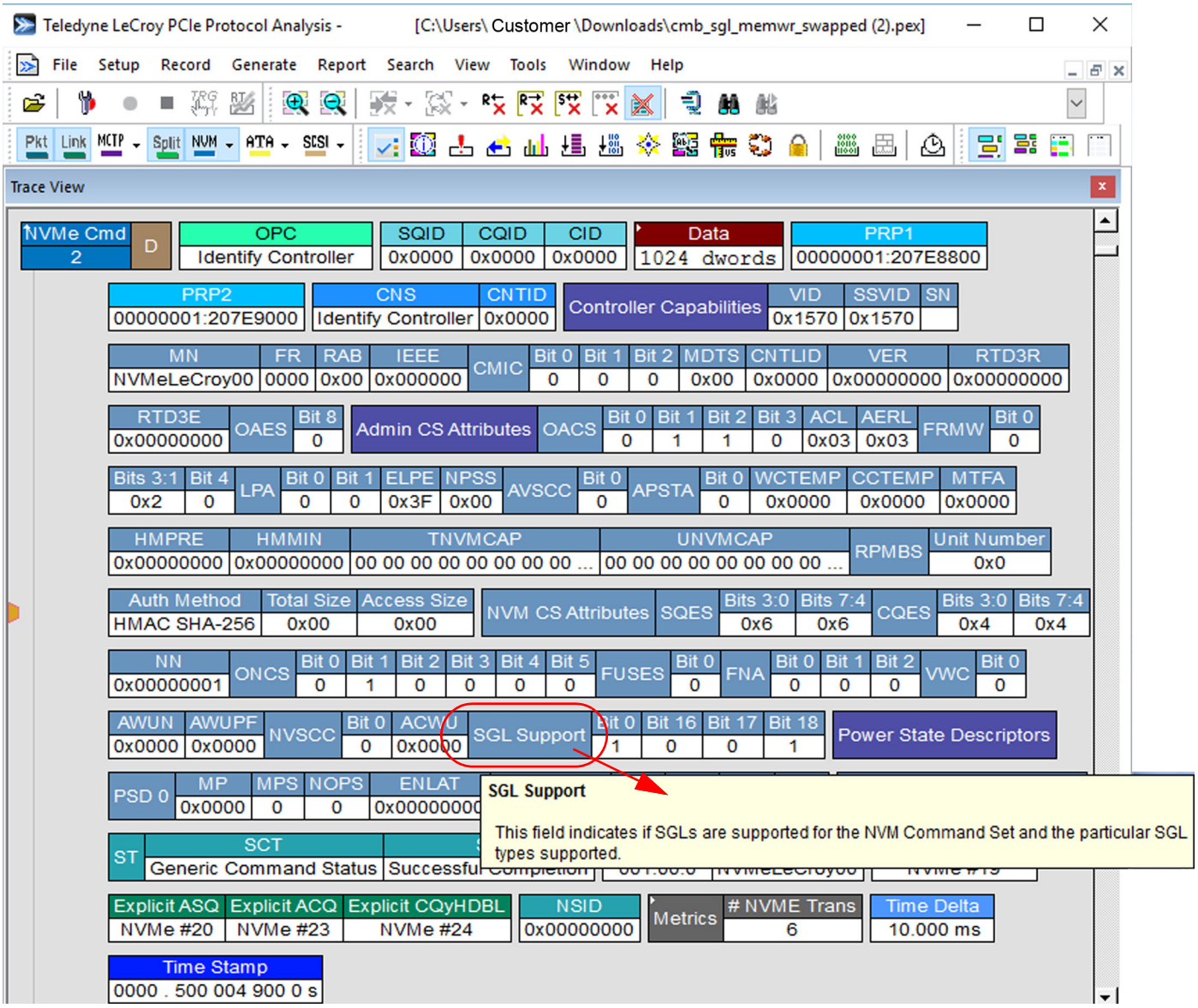


Figure 6.148: SGL Descriptor Supported in PCIe Protocol Analysis Software

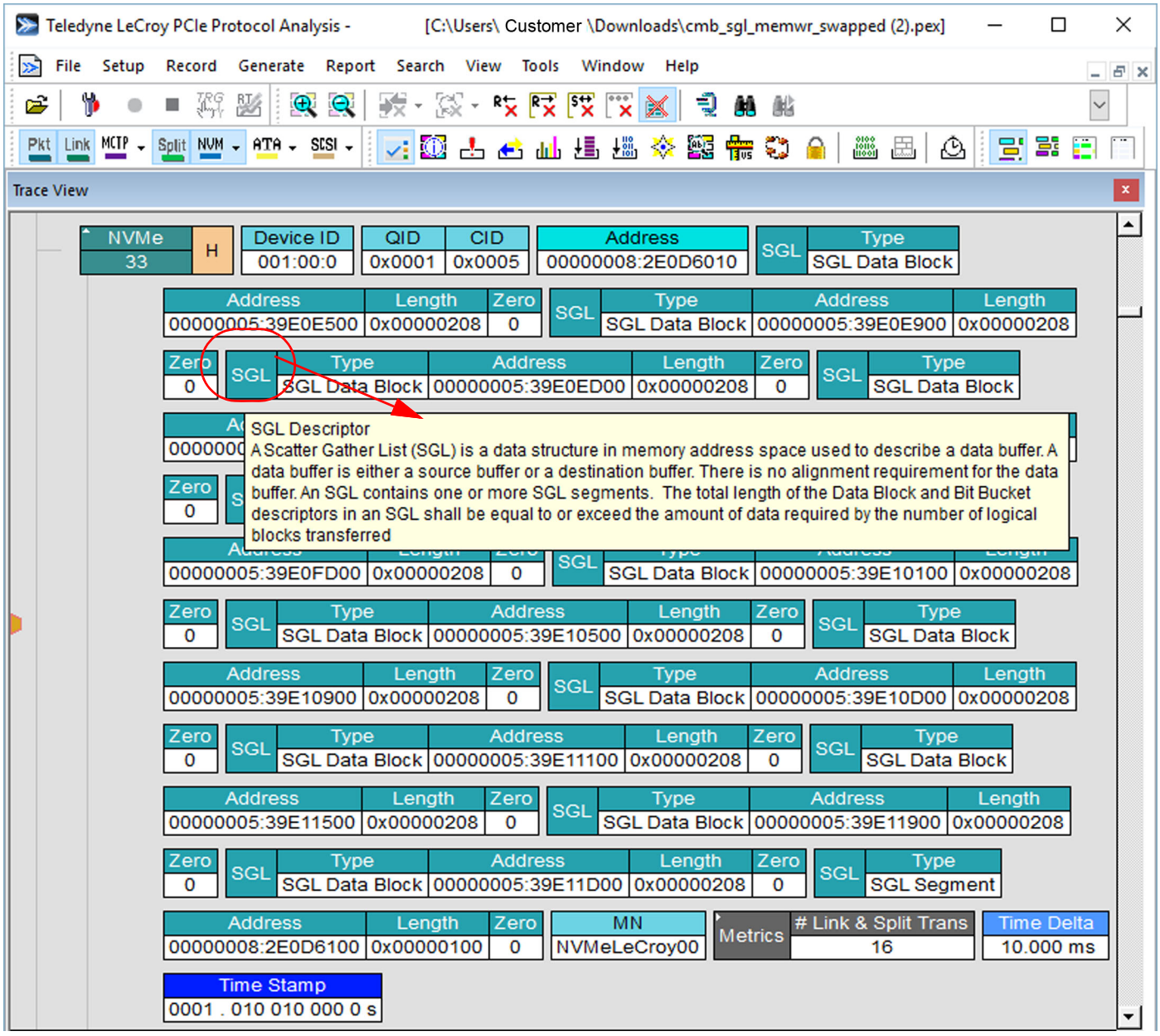


Figure 6.149: SGL Descriptor Tooltip

6.3.12.8 NVMe Decoding for Host Memory Buffer FID

The PCIe Protocol Analysis software can decode NVMe Host Memory Buffer FID as shown in Figure 6.150.

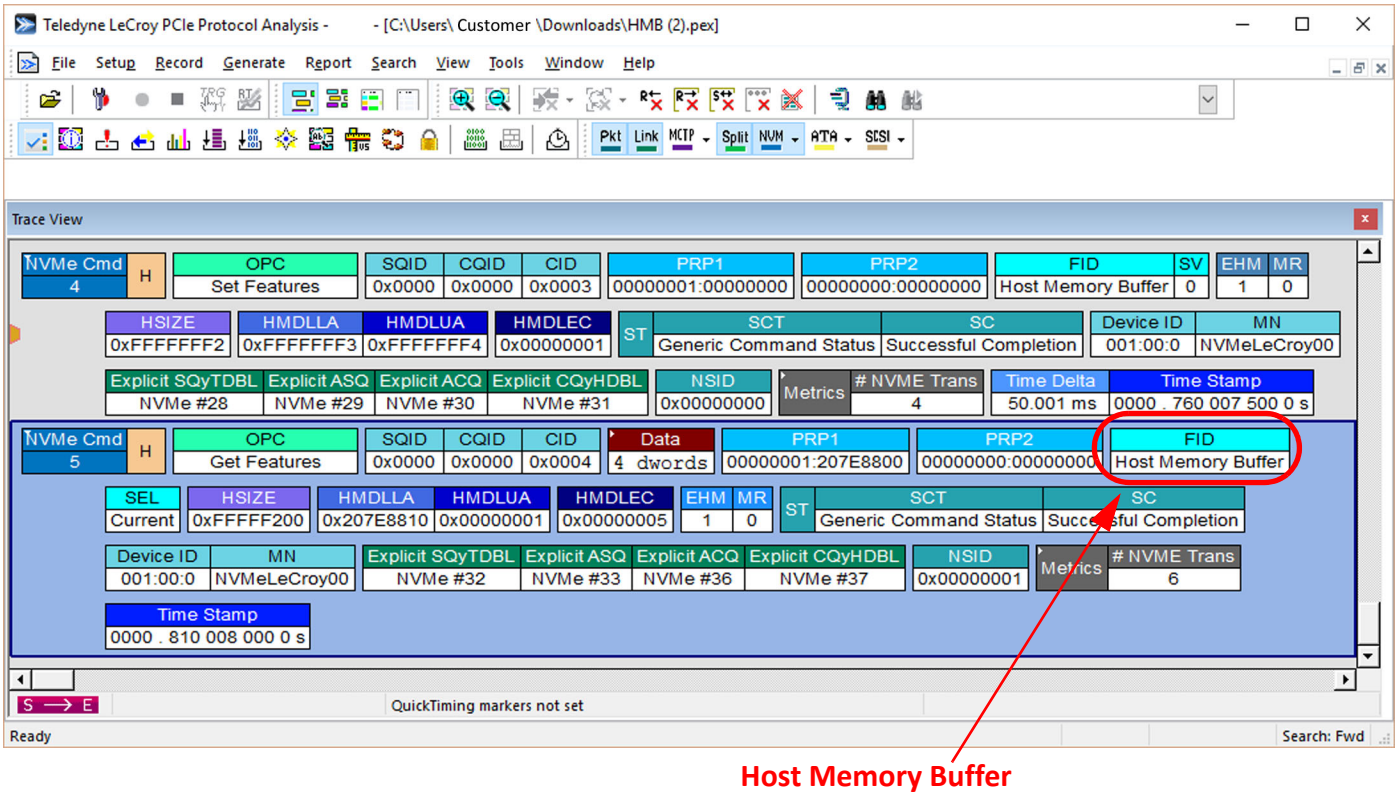
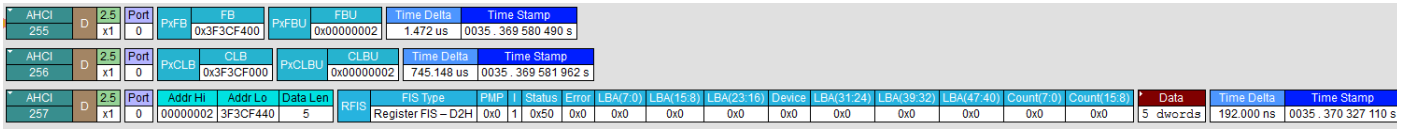


Figure 6.150: NVMe Trace with Host Memory Buffer FID Properly Decoded

6.3.12.9 AHCI

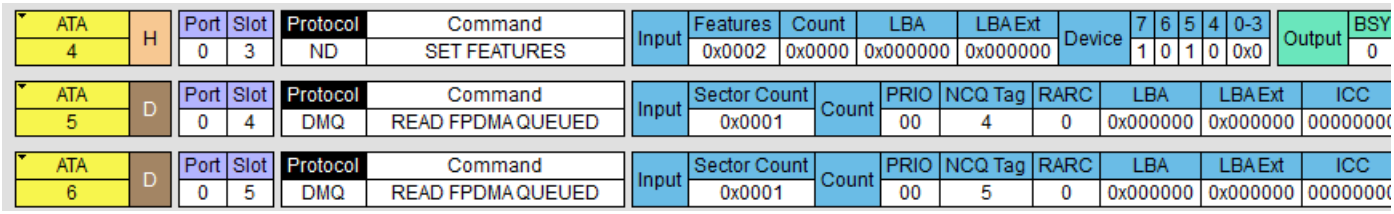
AHCI level decode displays AHCI transactions. PCIe Protocol Analysis decodes the storage commands starting from lower Transaction Layer decodes. In the case of AHCI, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level and finally the AHCI decode level.



Note: The trace must contain the device enumeration sequence so the decoding picks up the associated base addresses and AHCI transactions can be properly decoded. If the enumeration sequence is not available the base addresses must be manually entered in the PCIe SSD Configuration dialog from the Tools menu.

6.3.12.10 ATA

ATA level decode displays ATA transactions. PCIe Protocol Analysis decodes the storage commands starting from lower Transaction Layer decodes. In the case of ATA, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level, then AHCI level and finally the ATA decode level.



Note: The trace must contain the device enumeration sequence so the decoding picks up the associated base addresses and ATA transactions can be properly decoded. If the enumeration sequence is not available the base addresses must be manually entered in the PCIe SSD Configuration dialog from the Tools menu.

ATA IO: Pending Transactions Statistical Report

ATA IO Pending Transactions statistical information can be displayed from an ATA Trace by selecting an ATA Packet and viewing the Metrics box. See Figure 6.151.

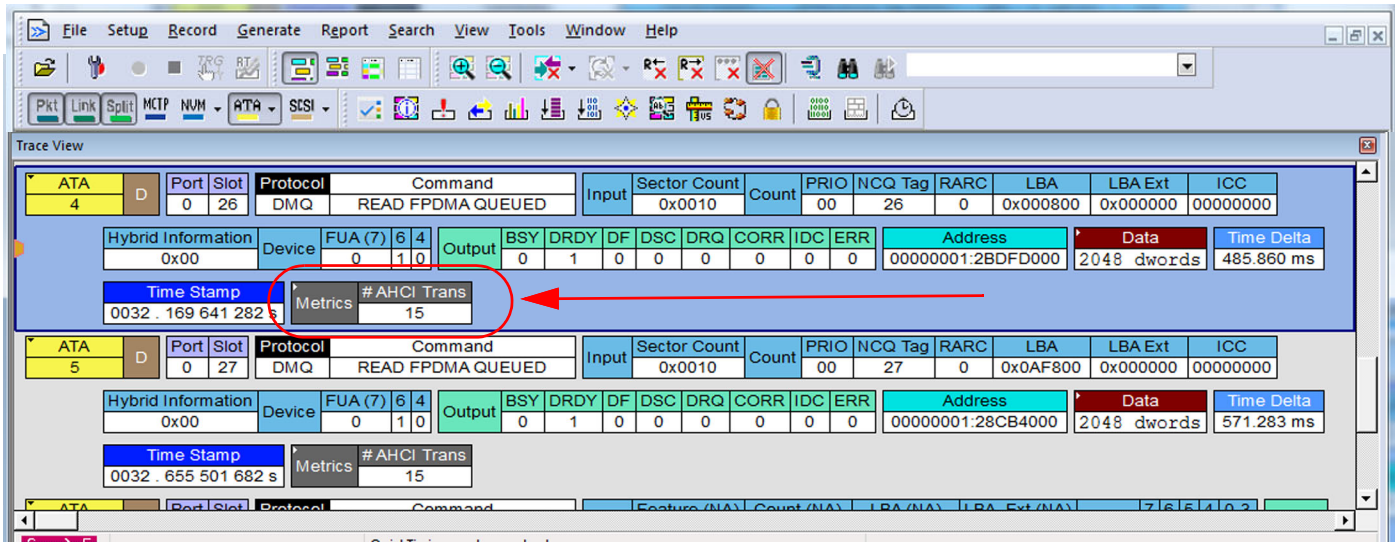


Figure 6.151: ATA IO Pending Transactions: Metrics Box

Move the cursor over the Metrics box to display the information about the ATA Packet. See Figure 6.152 on page 352.

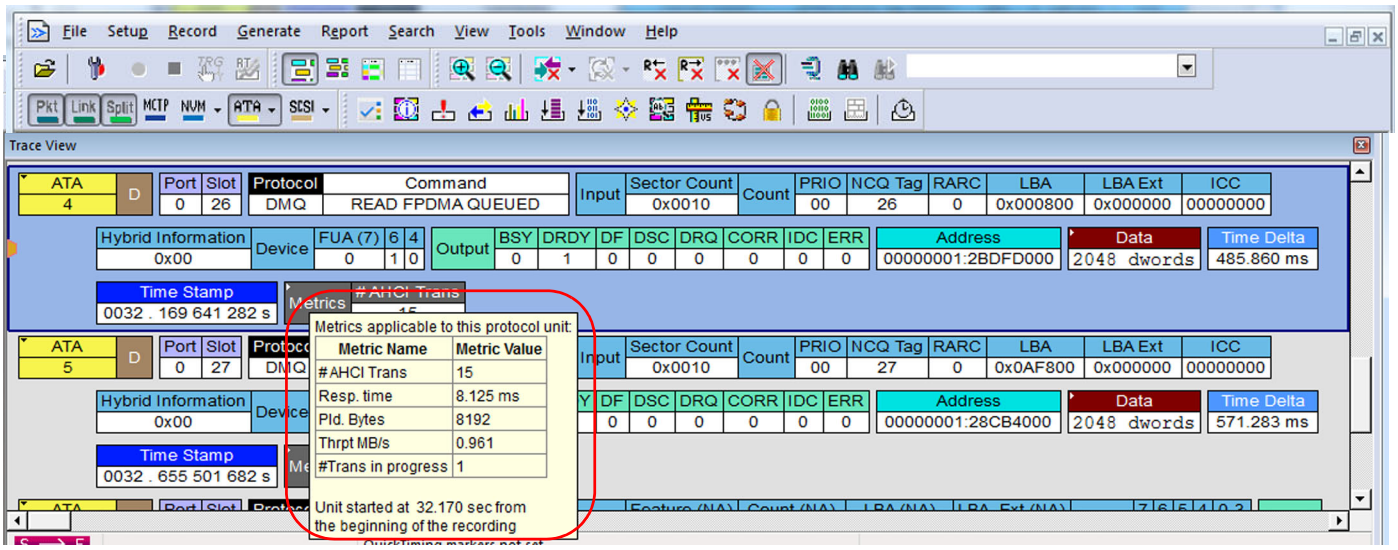


Figure 6.152: ATA IO Pending Transactions: Metrics Box -- Information Displayed

You can click on the small white arrow in the Metrics box to display the information in the Trace. See Figure 6.153.

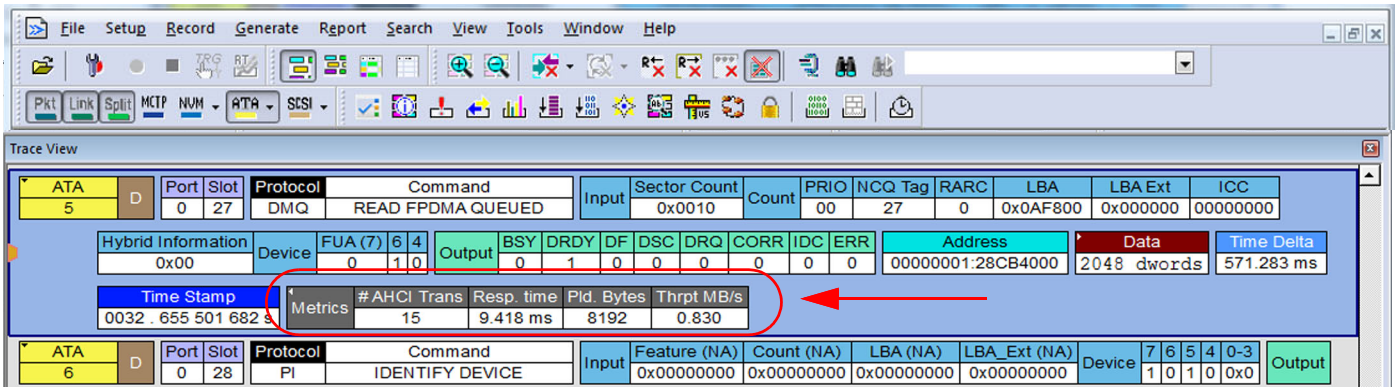


Figure 6.153: ATA IO Pending Transactions: Metrics Displayed in Trace

You can also view the ATA IO Pending Transactions by selecting the Bus Utilization icon in the toolbar and selecting the Graph Areas icon. See Figure 6.154 on page 353.

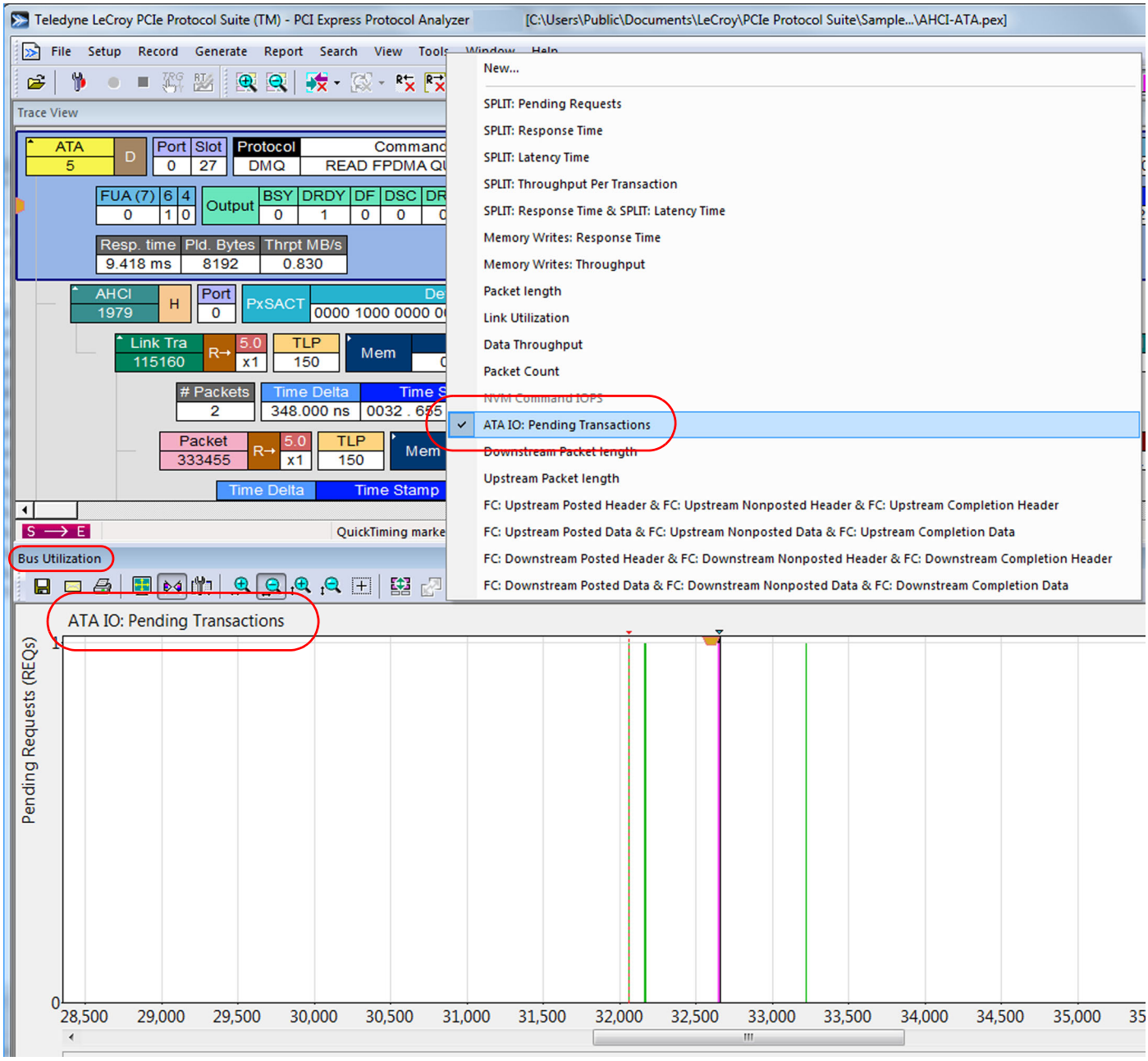
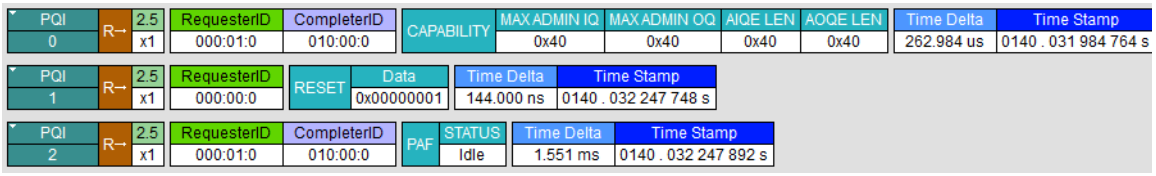


Figure 6.154: ATA IO Pending Transactions: Bus Utilization View

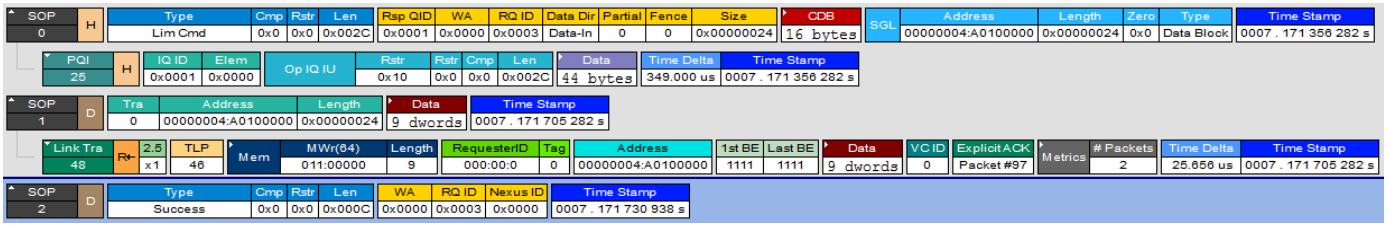
6.3.12.11 PQI

PQI level decode PQI displays PQI transactions. PCIe Protocol Analysis decodes the storage commands starting from lower Transaction Layer decodes. In the case of PQI, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level and finally the PQI decode level.



6.3.12.12 SOP

SOP level decode SOP displays SOP transactions. PCIe Protocol Analysis decodes the storage commands starting from lower Transaction Layer decodes. In the case of SOP, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level, then PQI level and finally the SOP decode level.



Note: The trace must contain the device enumeration sequence so the decoding picks up the associated base addresses and SOP transactions can be properly decoded. If the enumeration sequence is not available the base addresses must be manually entered in the PCIe SSD Configuration dialog from the Tools menu.

6.3.12.13 SCSI

SCSI level decode SCSI displays SCSI transactions. PCIe Protocol Analysis decodes the storage commands starting from lower Transaction Layer decodes. In the case of SCSI, it will decode first the Packet Level, then the Link Transaction level, then the Split Transaction Level, then PQI level and finally the SCSI decode level.



Note: The trace must contain the device enumeration sequence so the decoding picks up the associated base addresses and SCSI transactions can be properly decoded. If the enumeration sequence is not available, the base addresses must be manually entered in the PCIe SSD Configuration dialog from the Tools menu.

6.3.12.14 Decoding MCTP (Management Component Transport Protocol)

MCTP Levels in Floating Transactions Bar Window

To decode MCTP traffic you must first load a trace containing MCTP traffic. You can get a visual representation of the MCTP Command structure by pulling the Transaction Level Toolbar (see

Figure 6.155) down into the trace and the Floating Transaction Level Bar Window will be shown (see Figure 6.156). The Transaction Level Window shows that the MCTP Command is made up of Links and Packets. You can also see that NVMe, ATA and SCSI traffic consists of Link and Split transactions.



Figure 6.155: Transaction Level Toolbar

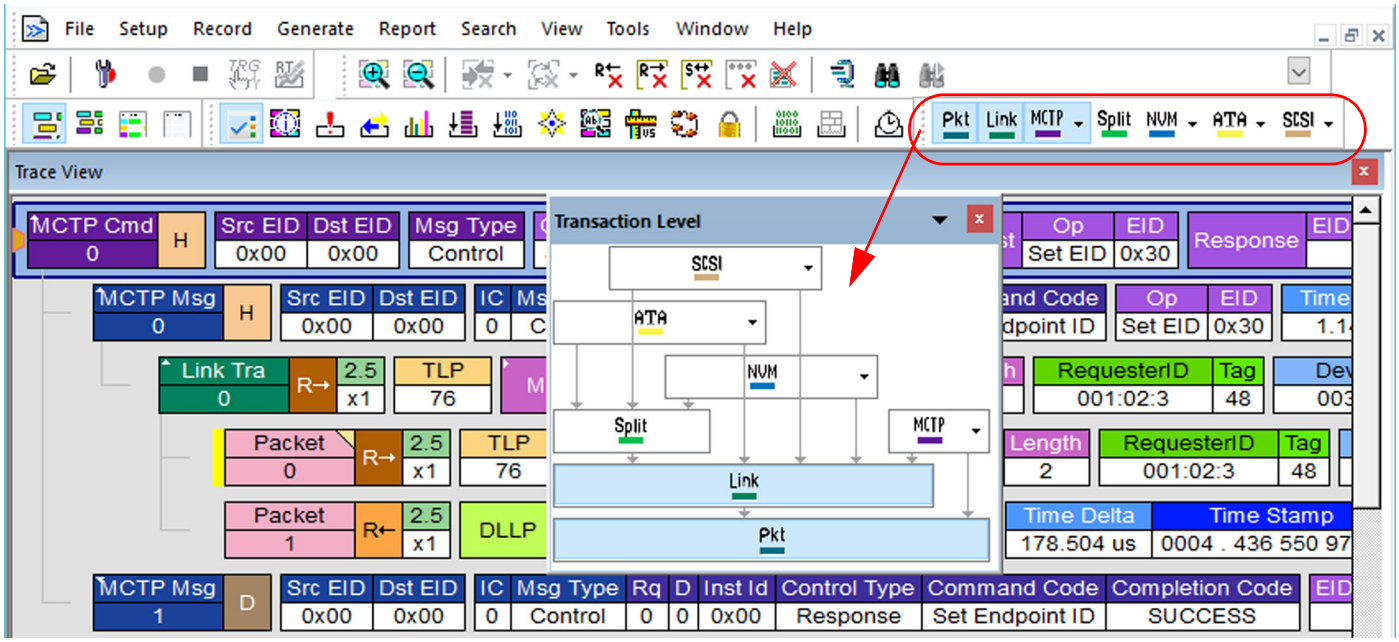


Figure 6.156: MCTP Levels in Floating Transaction Bar Window

Decoding MCTP Commands

MCTP traffic can be decoded and displayed as either MCTP Commands or MCTP Messages.

To decode MCTP traffic you must first load a trace containing MCTP traffic. Then click the MCTP icon on the toolbar and select MCTP Commands. See Figure 6.157.

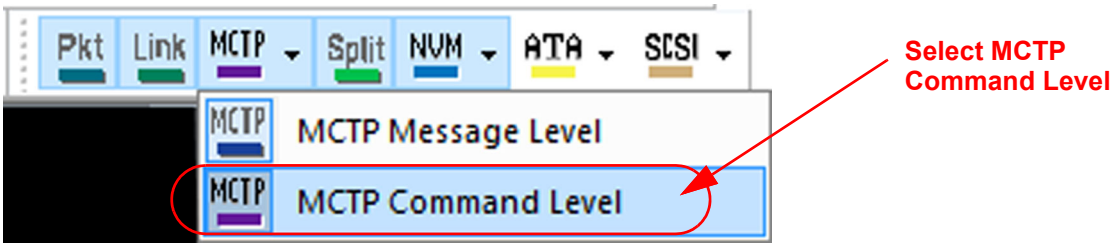


Figure 6.157: MCTP Decoding Icon on Toolbar

This will decode MCTP Commands in the trace. The following types of MCTP Message Types can be decoded:

- MCTP Control: See Figure 6.158 on page 356
- NC-SI: See Figure 6.158 on page 356
- PLDM: See Figure 6.159 on page 357

- PLDM: Firmware Commands Decoded → See Figure 6.160 on page 357 and Figure 6.161 on page 358.

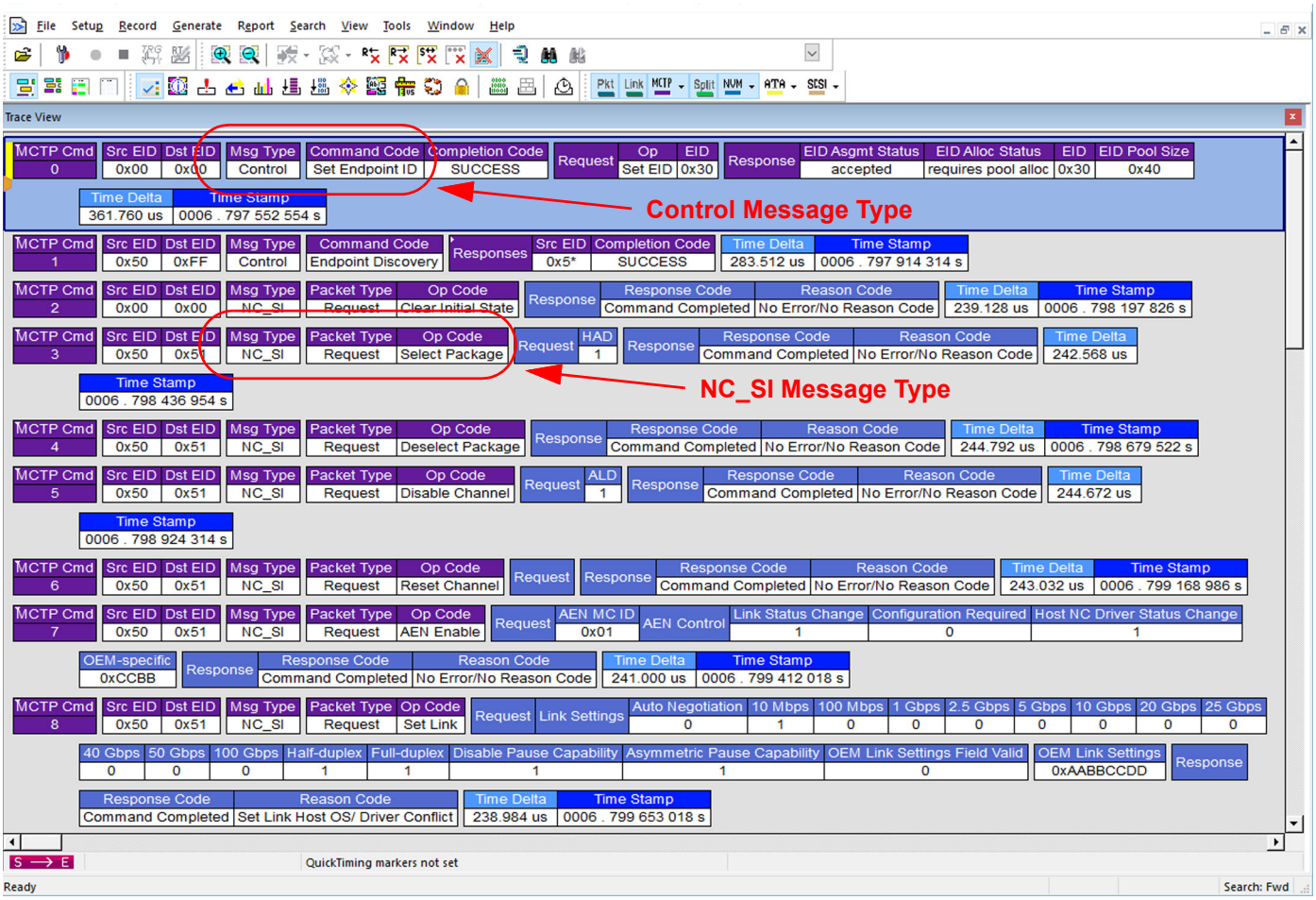


Figure 6.158: MCTP Commands Decoded: Control and NC_SI Types

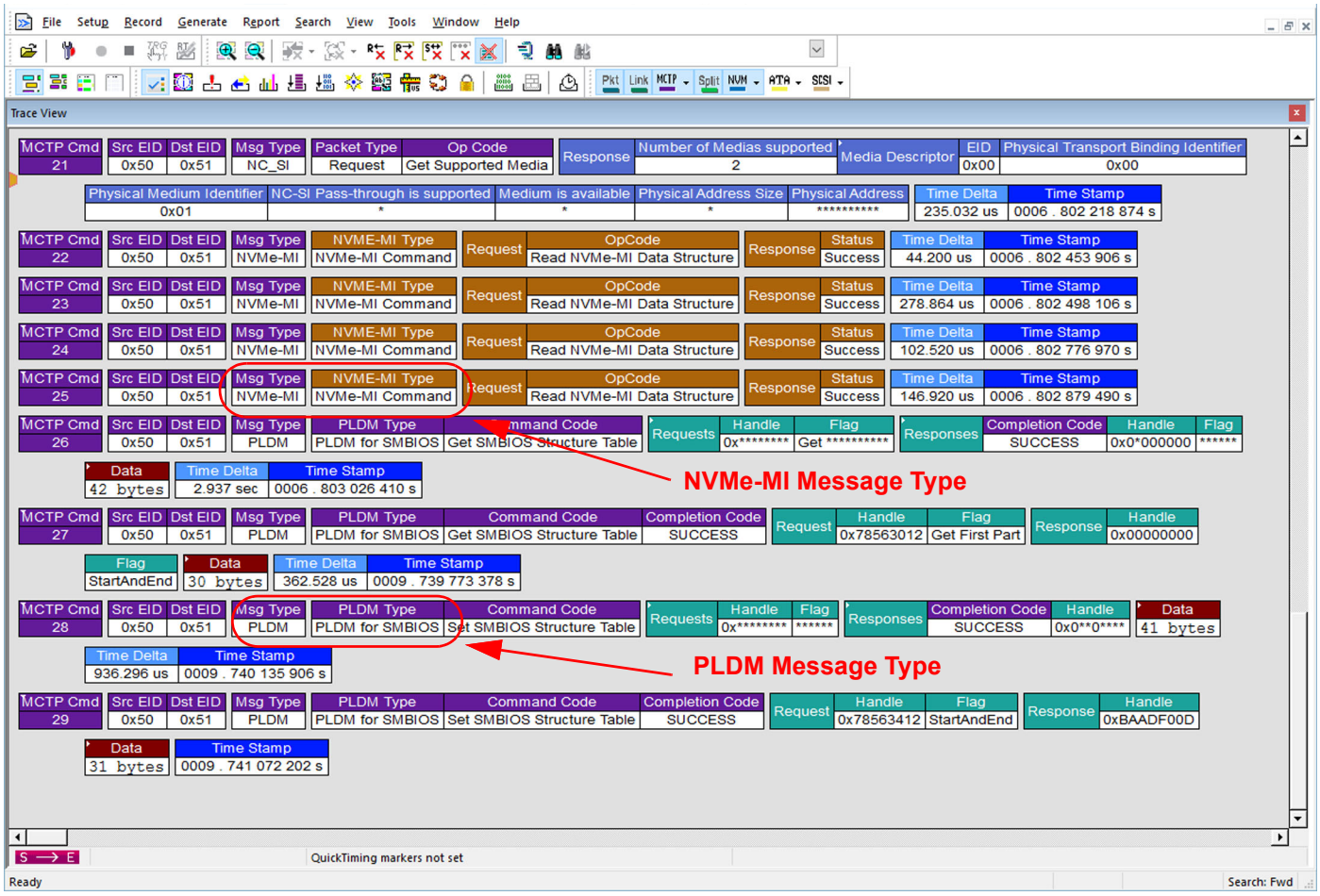


Figure 6.159: MCTP Commands Decoded: NVMe-MI and PLDM Types

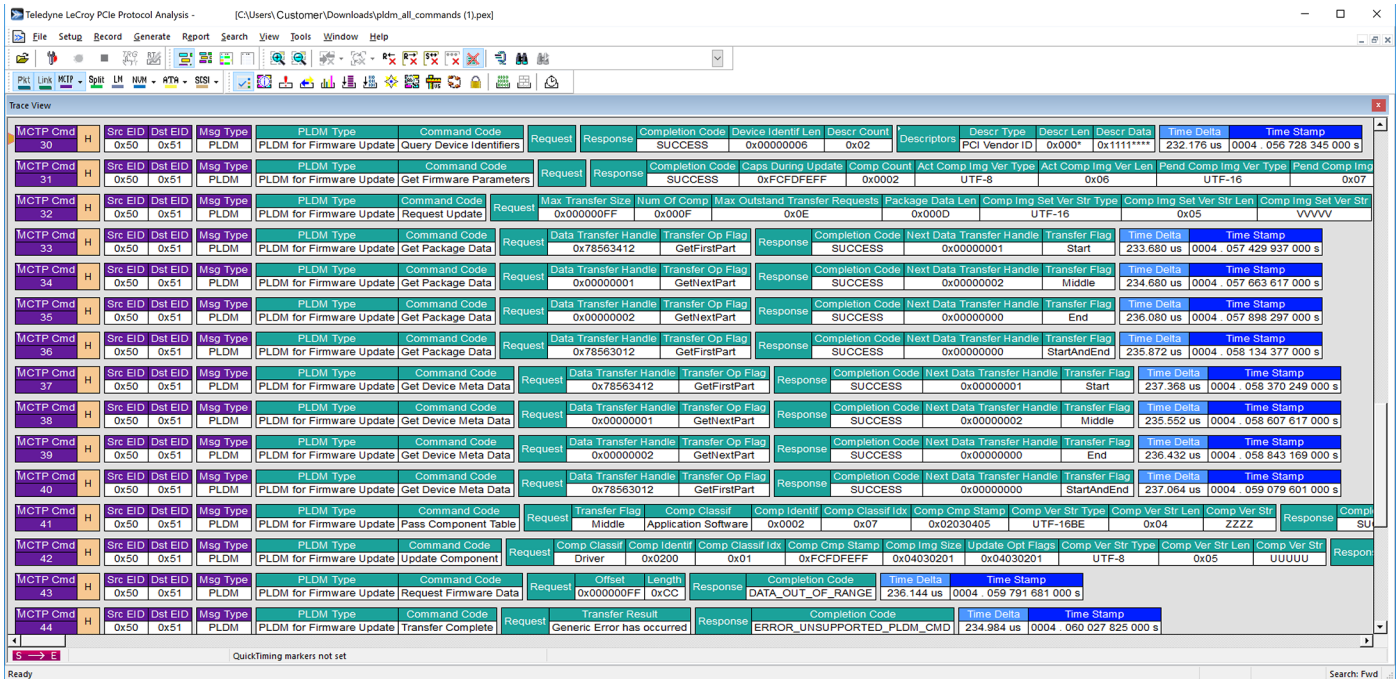


Figure 6.160: PLDM Firmware Update Commands Decoded

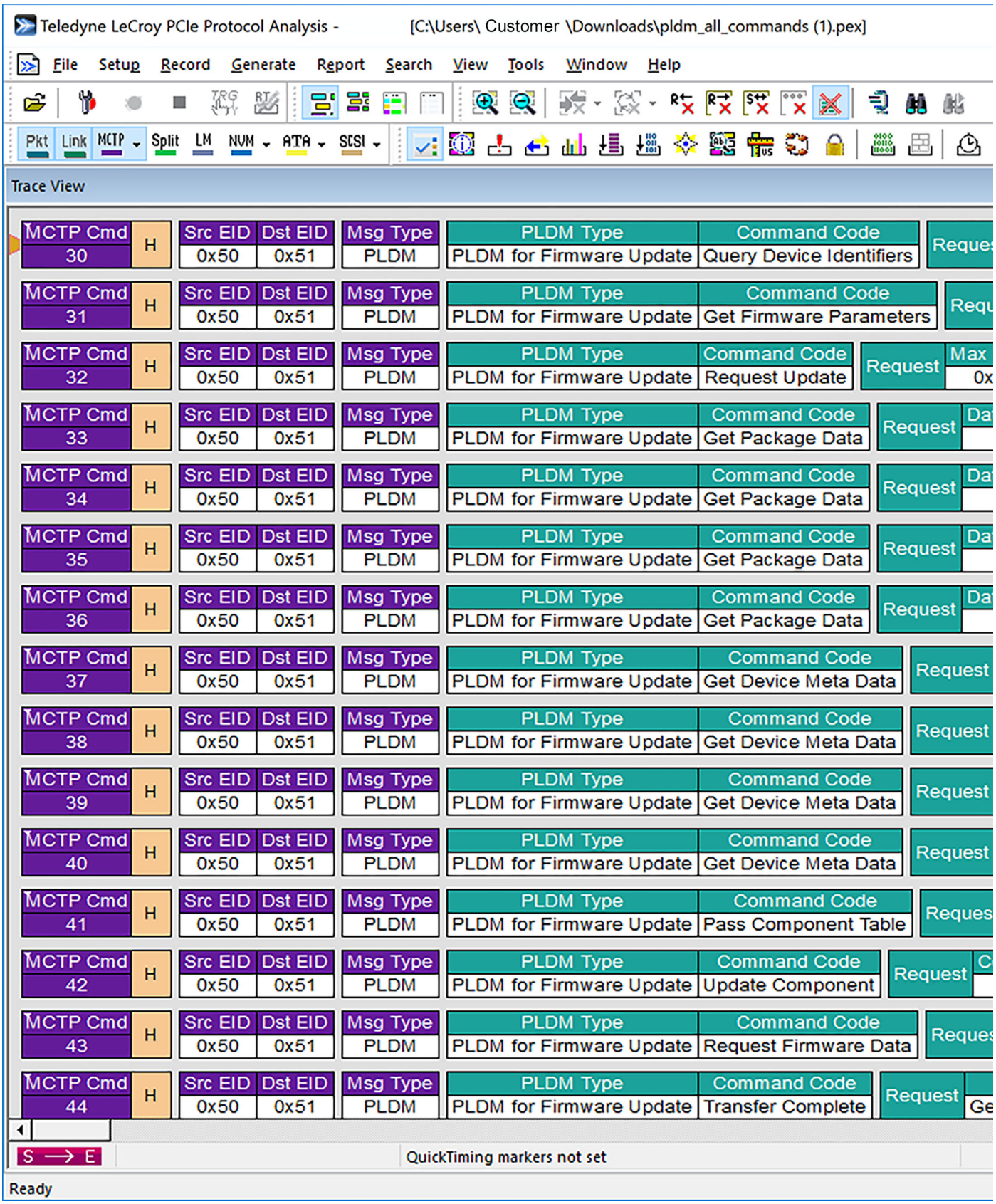


Figure 6.161: PLDM Firmware Update Commands Decoded (Details shown)

Expanding MCTP Commands

If you expand any MCTP command, you'll see all of the MCTP messages and lower level packets that make up the command. In this case we expanded MCTP Command 0. It consists of MCTP Message 0 from the Host and MCTP Message 1 from the Device. If you expand MCTP Message 0, you'll see that it consists of Link Transaction 0, which can be expanded down to Packet 0 and Packet 1. Notice that MCTP Command 0, MCTP Message 0, Link Transaction 0 and Packet 0 all have the same Timestamp: 0006.797.552.554 seconds. The response from the Device occurs as 0006.797.553.698 seconds. See Figure 6.162 on page 359.

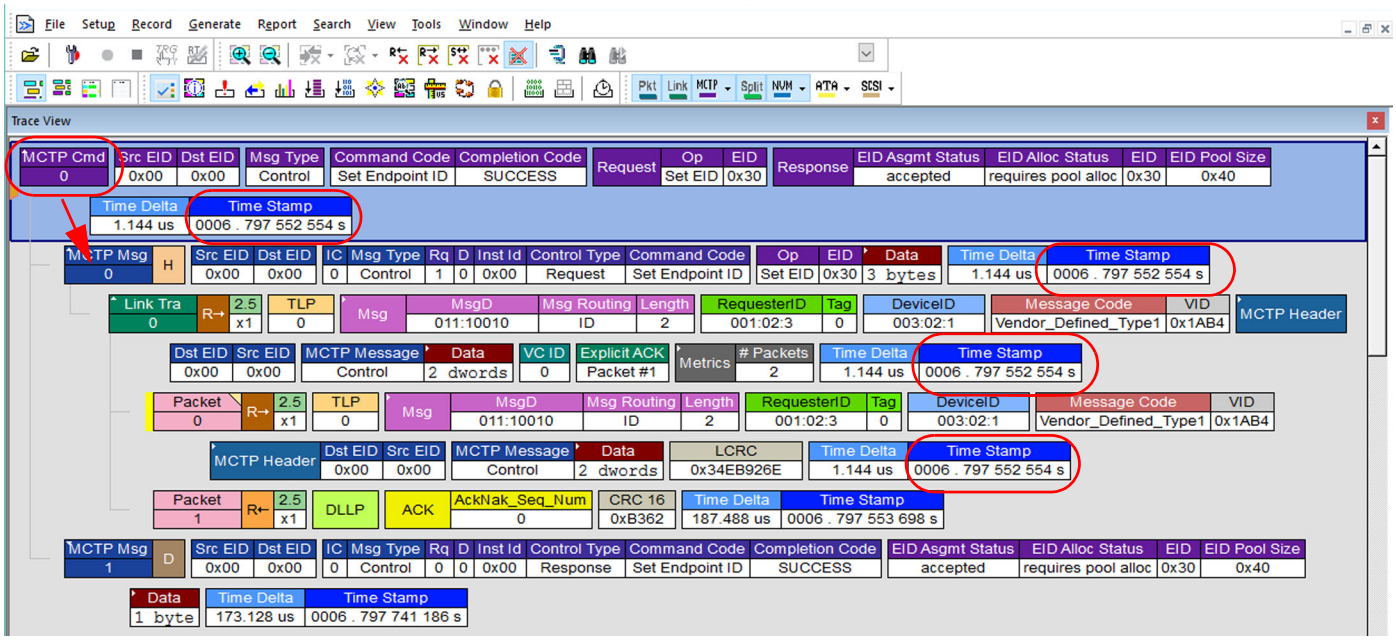


Figure 6.162: MCTP Command 0 Expanded

Decoding MCTP Messages

If you had selected MCTP Messages to be decoded instead of Commands, only the MCTP Messages would be displayed. See Figure 6.163.

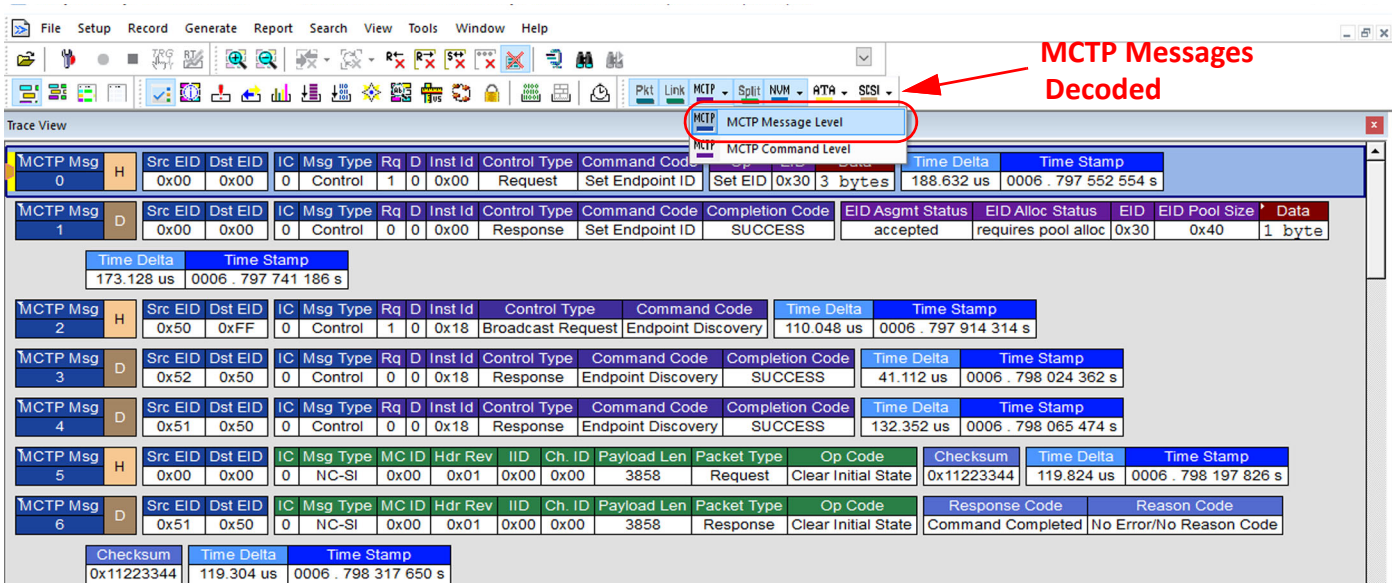


Figure 6.163: MCTP Messages Decoded

If you expand the MCTP Message you'll see the same information you saw by expanding the MCTP Command. See Figure 6.164 on page 360.

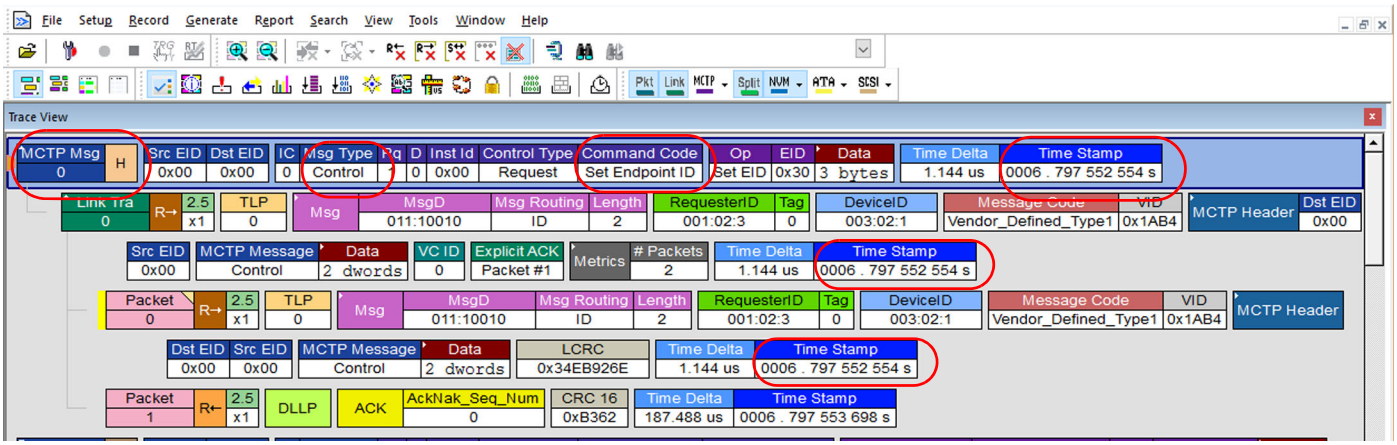


Figure 6.164: Expanding MCTP Message

MCTP Commands with SMBus Traffic

To decode an MCTP command with SMBus traffic you must first load a trace with the appropriate traffic. Then decode MCTP traffic by clicking on the MCTP icon in the toolbar. In the example shown below we've loaded a trace that has SMBus traffic within an MCTP message that is part of an MCTP command. See Figure 6.165.

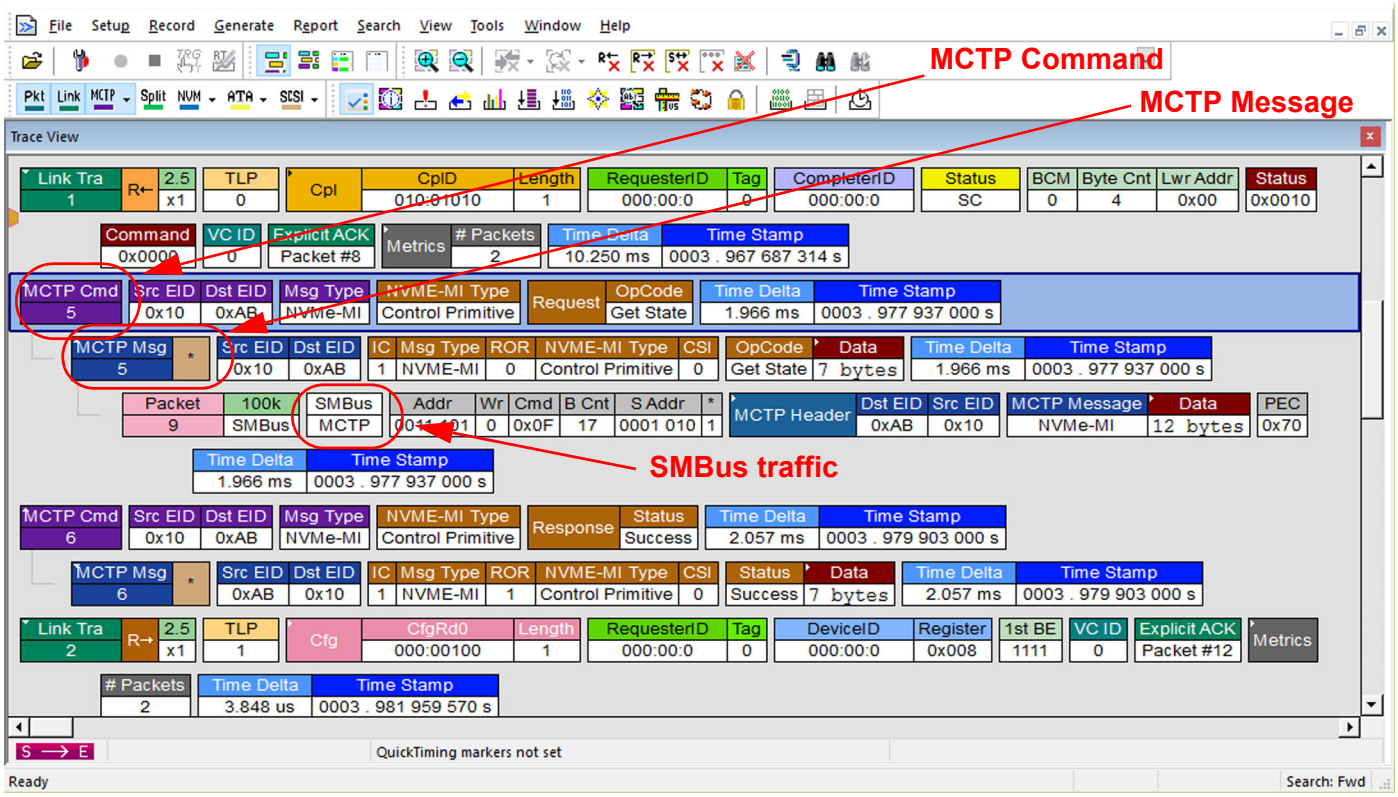


Figure 6.165: MCTP Command with SMBus Traffic

MCTP Commands: Request from Host, Response from Device

MCTP commands can be decoded as shown below (see Figure 6.166). As you can see the MCTP Command is made up of MCTP messages. One is from the Host the response is from the Device.

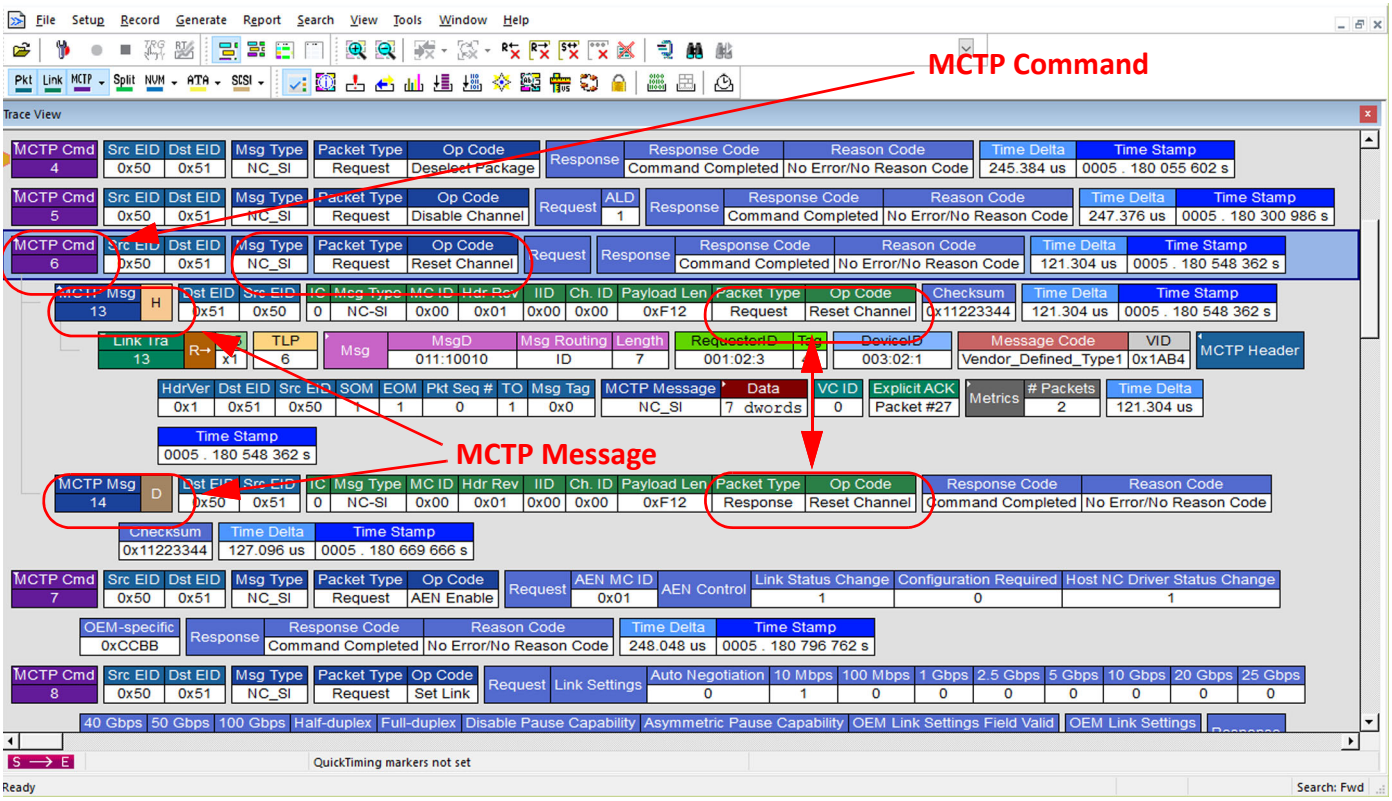


Figure 6.166: Decoding MCTP Commands

Decoding MCTP Messages and Transactions

Note: To decode MCTP messages and transactions you'll need a license for your analyzer. If you don't have a MCTP license a warning message will pop up. See Figure 6.167.

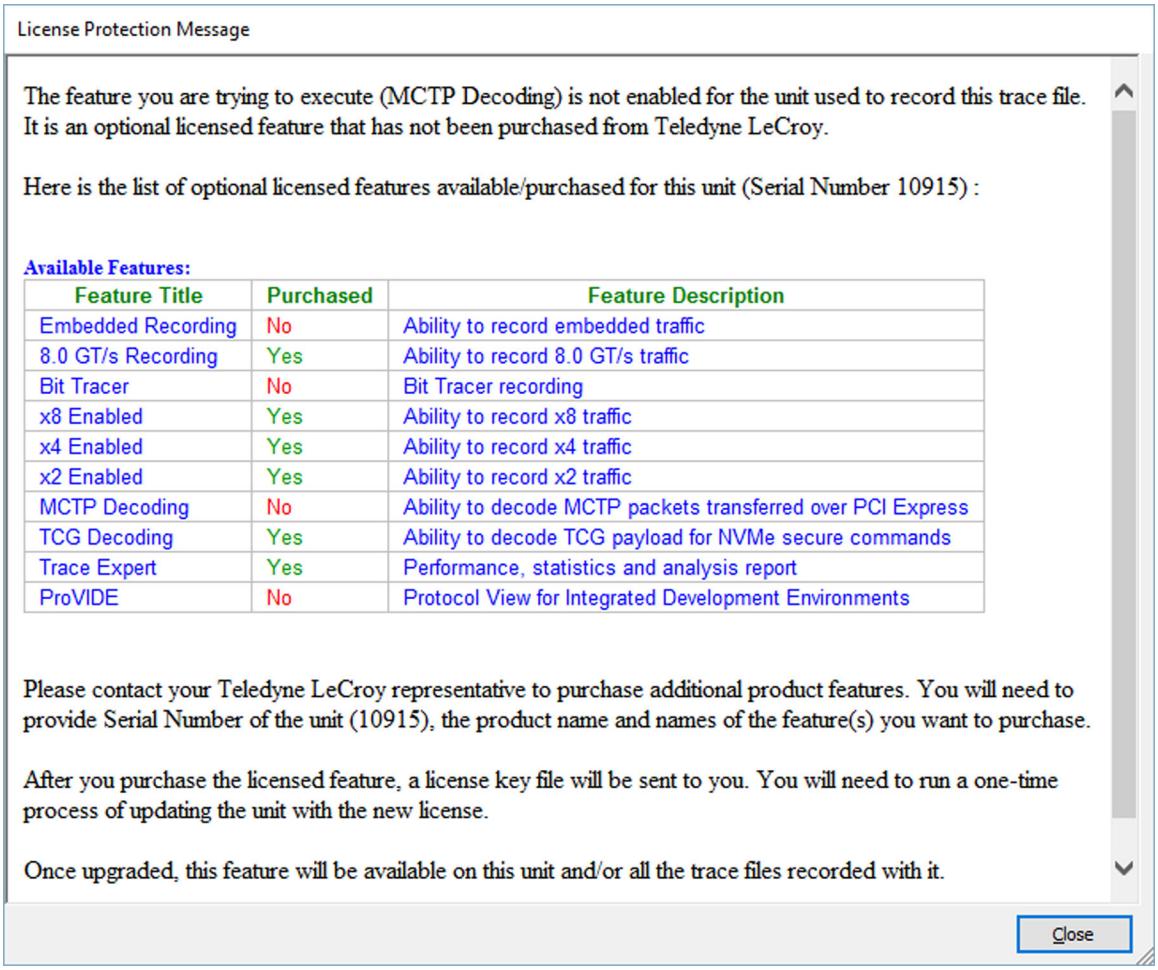


Figure 6.167: Warning Message: No MCTP License

You can decode both MCTP messages and transactions within traces by selecting CATC Trace View, Decoding Packets, Links and MCTP 

. You'll see there the transaction contains an MCTP Header and an MCTP Message. See Figure 6.168 on page 364.

MCTP Messages

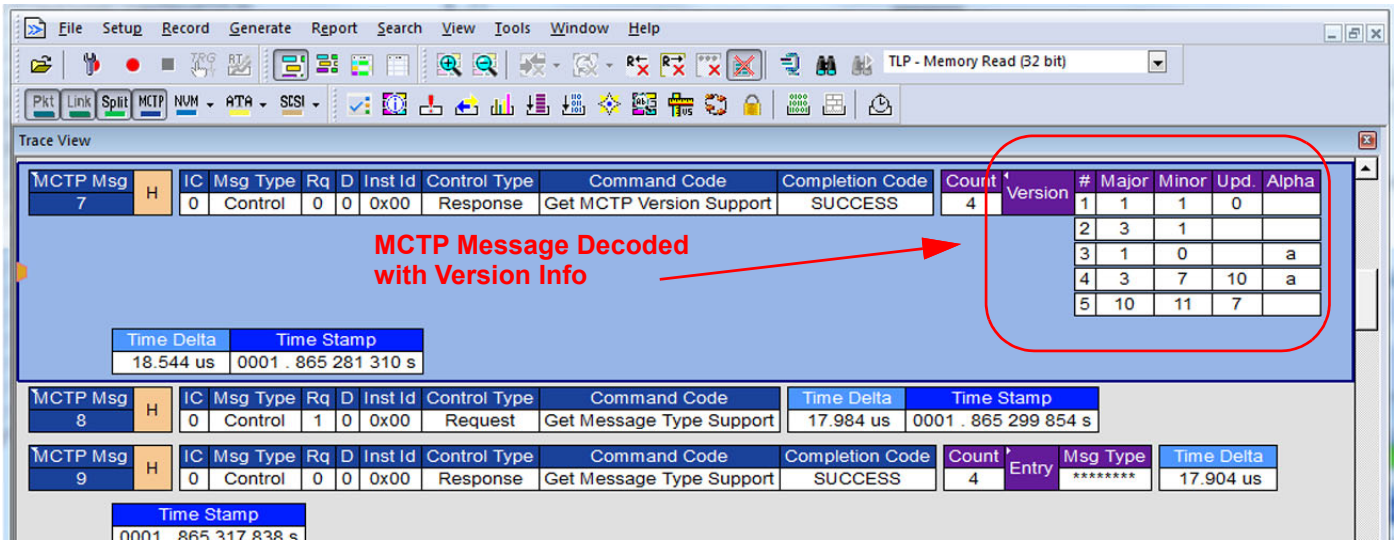


Figure 6.168: MCTP Message Decoded

MCTP Transactions

The Link Transaction will decode an MCTP Header and an MCTP Message containing a Msg Type, a Control Type and a Command Code. See Figure 6.169.

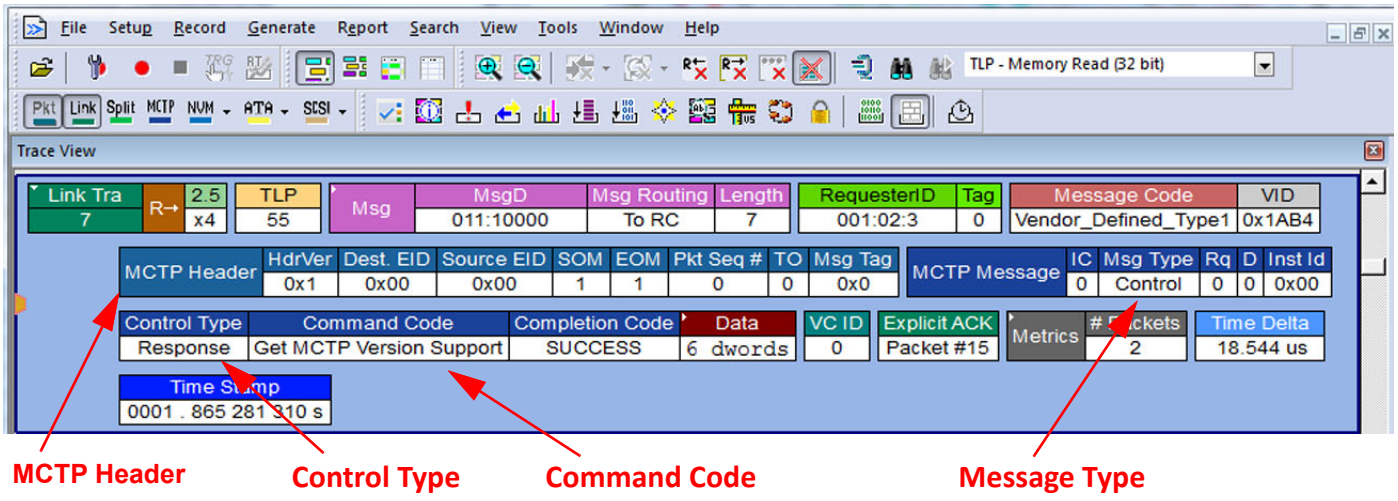


Figure 6.169: Decoding MCTP Transactions

MCTP Errors Reported

You can also display the following types of Errors from the Detailed View of the Trace:

- RsvdNotNull: RSVD field shall be 0
- InvalidHdrVer: Header version field should be set to 1
- InvalidDstEId: Destination Endpoint IDs 1 through 7 are reserved for future definition

- InvalidSrcEId: Source Endpoint IDs 1 through 7 are reserved for future definition
- ICNotNull: IC bit shall always be 0 for MCTP control messages

See Figure 6.170 on page 365.

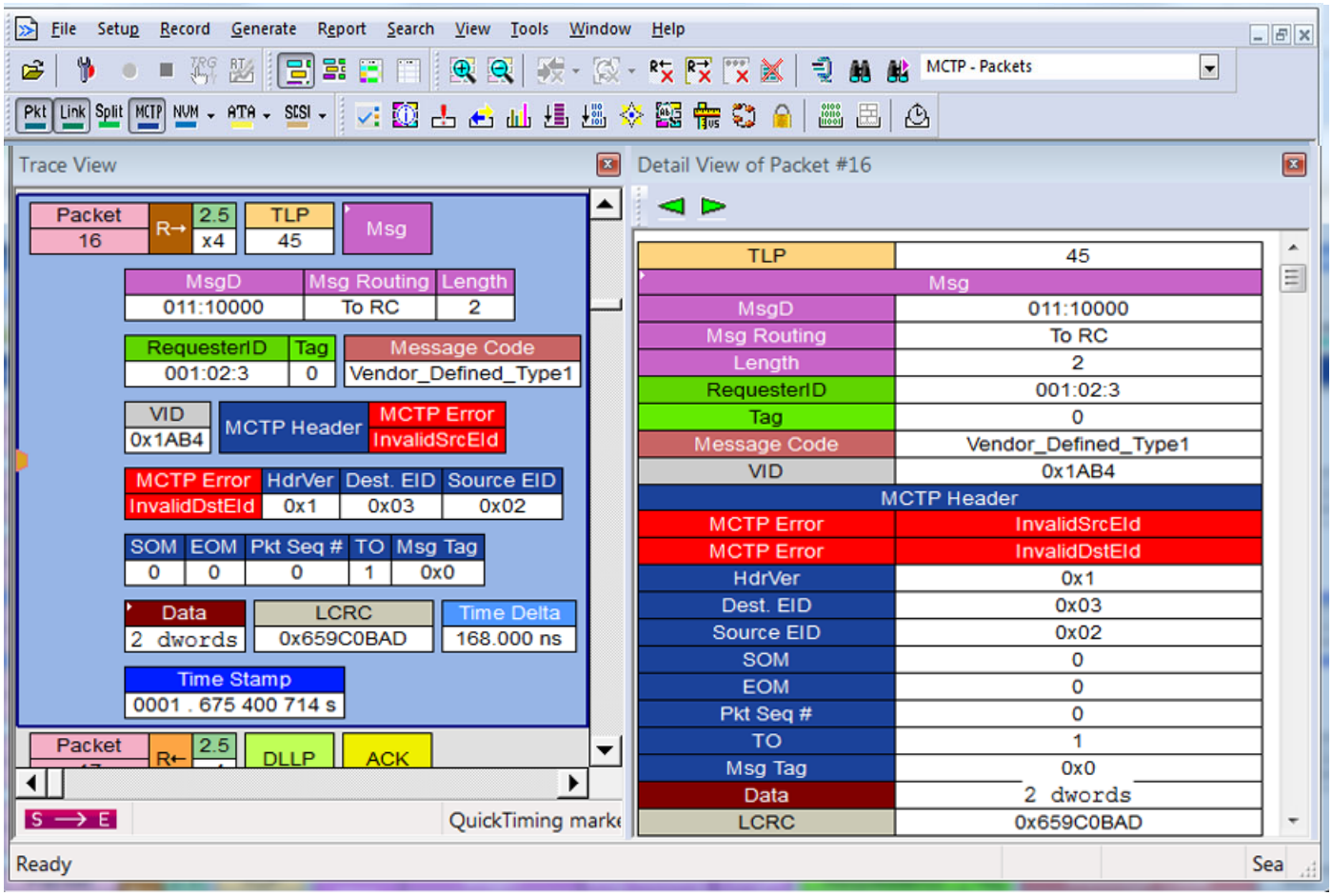


Figure 6.170: MCTP Transaction Errors Reported

MCTP Trace In Spreadsheet View

MCTP Traces can be displayed in Spreadsheet View. See Figure 6.171.

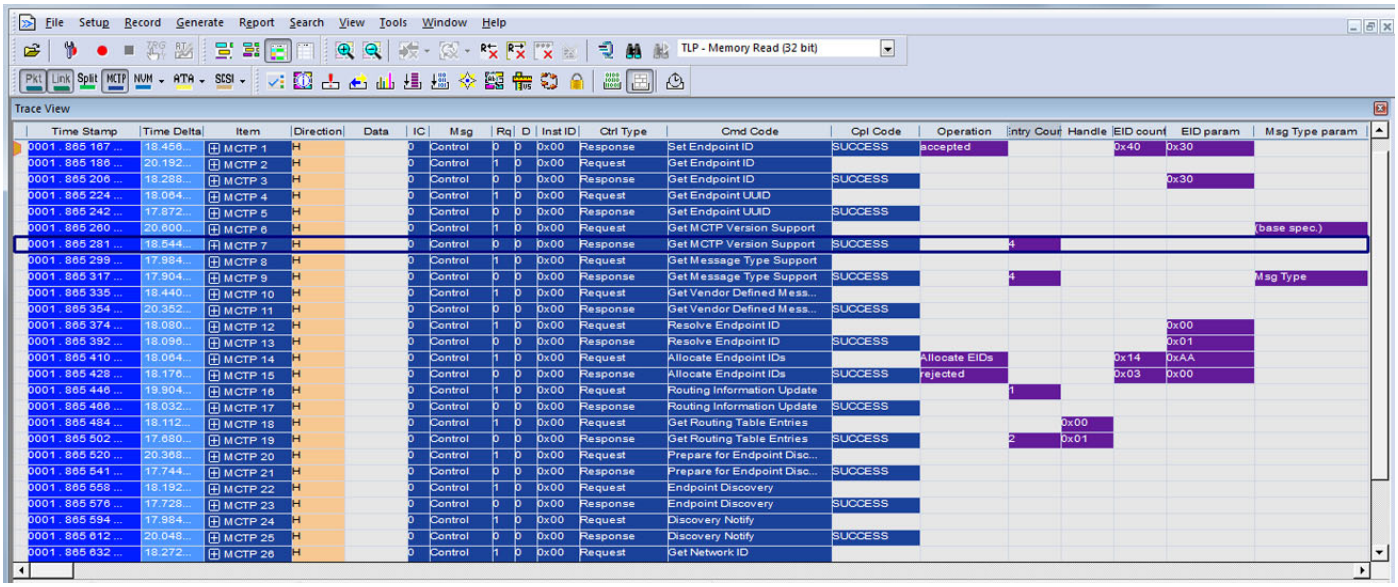


Figure 6.171: MCTP Trace in Spreadsheet View

Decoding MCTP Messages with PLDM Message Types

You can decode MCTP Messages with Platform Level Data Model (PLDM) Message types within traces by selecting CATC Trace View, Decoding Packets, Links and MCTP 

. You'll see that the message contains an MCTP Header and an PLDM Message. See Figure 6.172. In the example shown below there are both PLDM Requests and PLDM Responses.

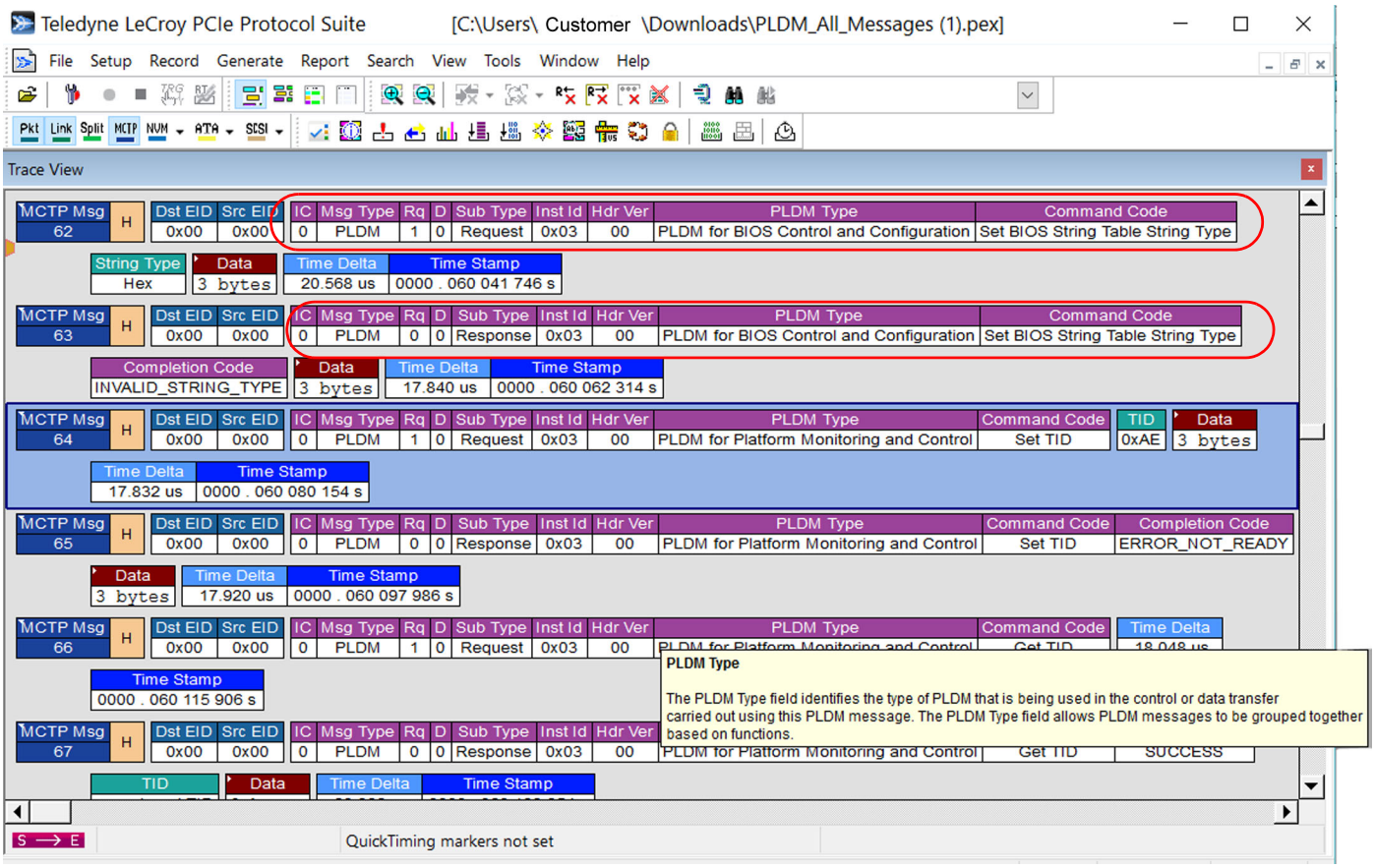


Figure 6.172: MCTP Message with PLDM Message Type

Decoding MCTP Messages with NC-SI Message Types

You can decode MCTP Messages with Network Controller Side Band Interface (NC-SI) Message types within traces by selecting CATC Trace View, Decoding Packets, Links and MCTP 

. You'll see that the message contains an MCTP Header and an NC-SI Message. See Figure 6.173. In the example shown below, there is an NC-SI Request packet type followed by the NC-SI packet Response.

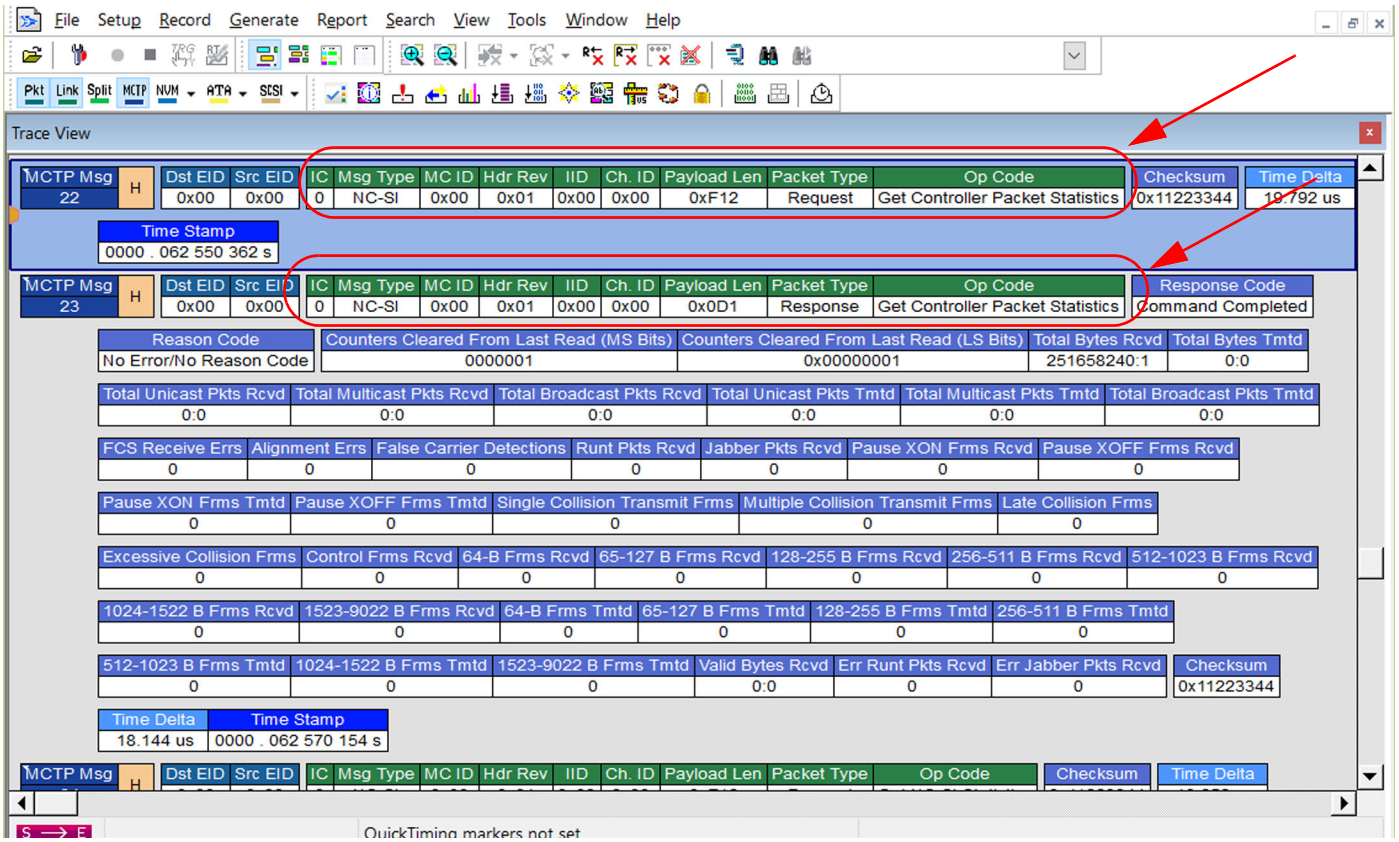


Figure 6.173: MCTP Message with NC-SI Message Type

Decoding Side Band Signals

There are a number of side band signals which are decoded by the PCIe Protocol Analysis and will be displayed in the Trace View:

- PERST# (Asserted and Deasserted)
- WAKE# (Asserted and Deasserted)
- CLKREQ# (Asserted and Deasserted)

These signals are displayed as Link Events. They can be found in the trace by using the **Search → Go to → Link Event** function from the Main Toolbar.

Since these signals have no direction they will be displayed once in the upstream direction and once in the downstream direction.

Note: If left floating in the bus, PERST#, WAKE# and CLKREQ# may show up in the trace as events. Make sure these signals are pulled up according to the specification. During beacon phase there might be transitions of WAKE# that will show up in the trace.

MCTP Message Type and IC Cells

You can decode MCTP Messages and IC cells. See Figure 6.174.

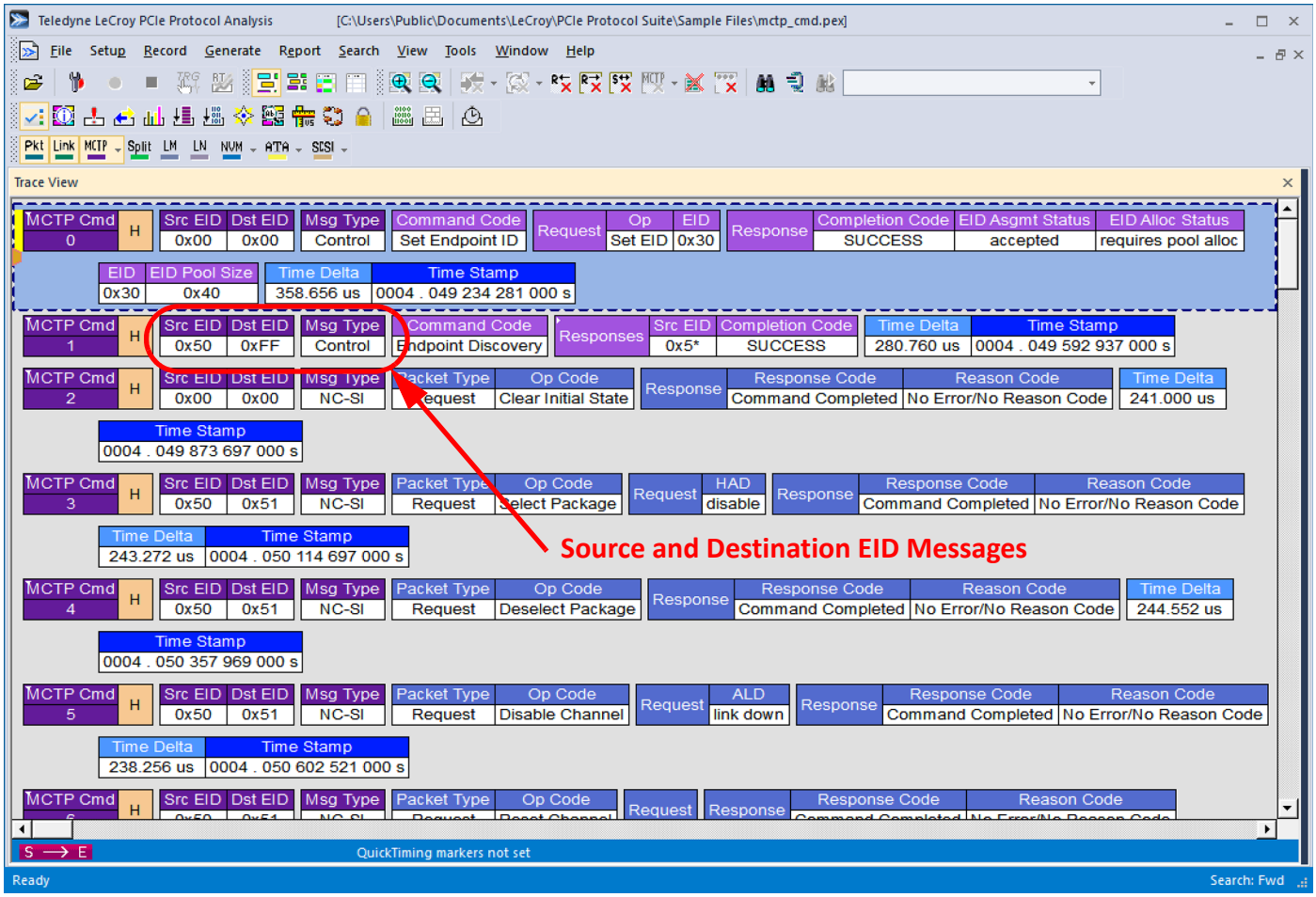


Figure 6.174: MCTP Messages Types and IC Cells Decoded

The colors of the MCTP Messages can be seen in the Display Options. See Figure 6.175 on page 370

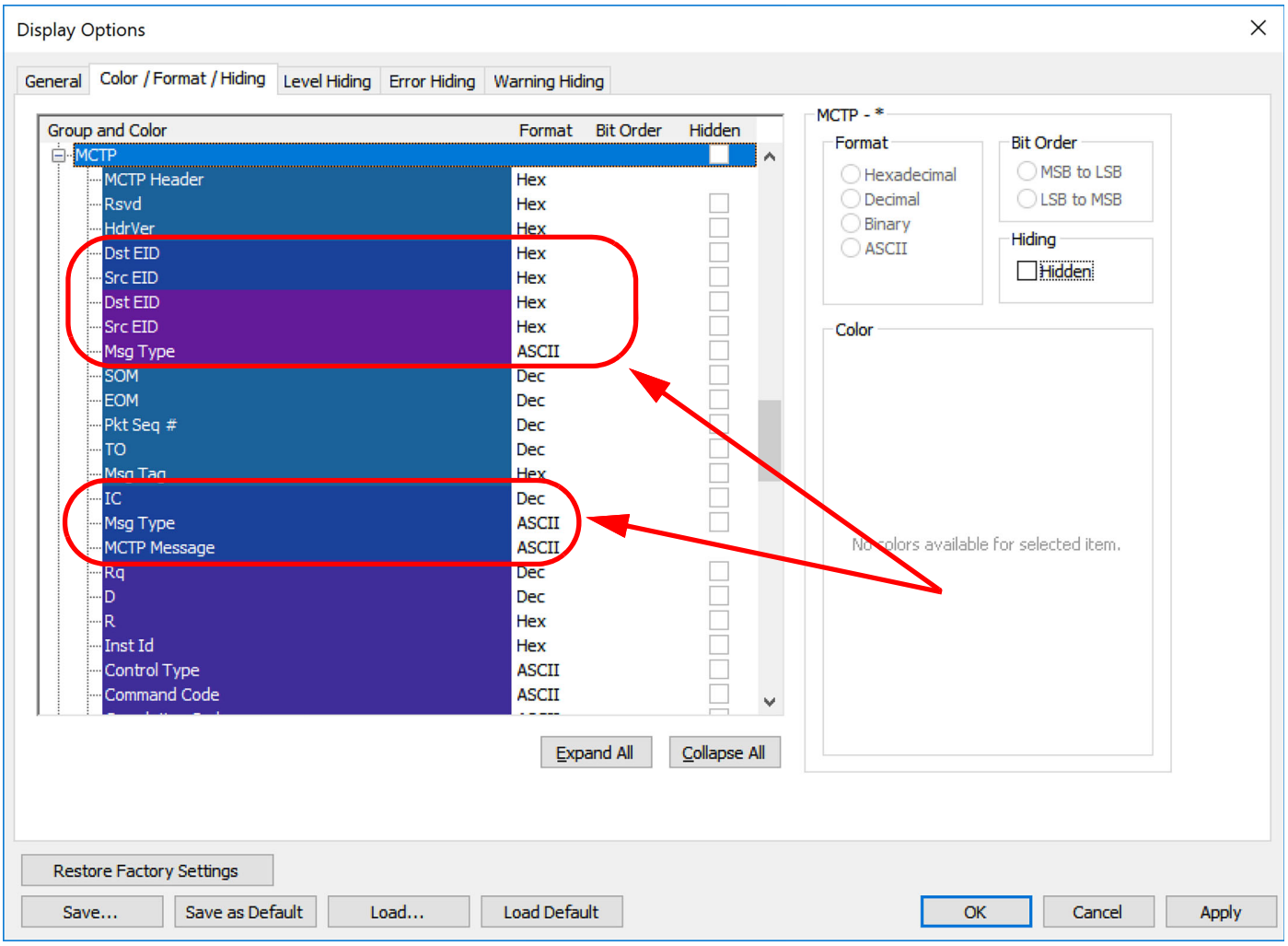


Figure 6.175: MCTP Commands and Transaction Colors from Display Options

6.3.12.15 Decoding MCTP Traffic with SMBus Traffic

The System Management Bus (abbreviated to SMBus or SMB) is a single-ended simple two-wire bus for the purpose of lightweight communication. Most commonly it is found in computer motherboards for communication with the power source for ON/OFF instructions.

It is derived from I^2C for communication with low-bandwidth devices on a motherboard, especially power related chips such as a laptop's rechargeable battery subsystem (see Smart Battery System). Other devices might include temperature, fan or voltage sensors, lid switches and clock chips. PCI add-in cards may connect to an SMBus segment.

A device can provide manufacturer information, indicate its model/part number, save its state for a suspend event, report different types of errors, accept control parameters and return status. The SMBus is generally not user configurable or accessible. Although SMBus devices usually can't identify their functionality, a new PMBus coalition has extended SMBus to include conventions allowing that.

The Summit Z58 can capture SMBus traffic and display it as part of an MCTP message along with normal PCIe Data traffic, as shown in Figure 6.176 and Figure 6.177 on page 371.

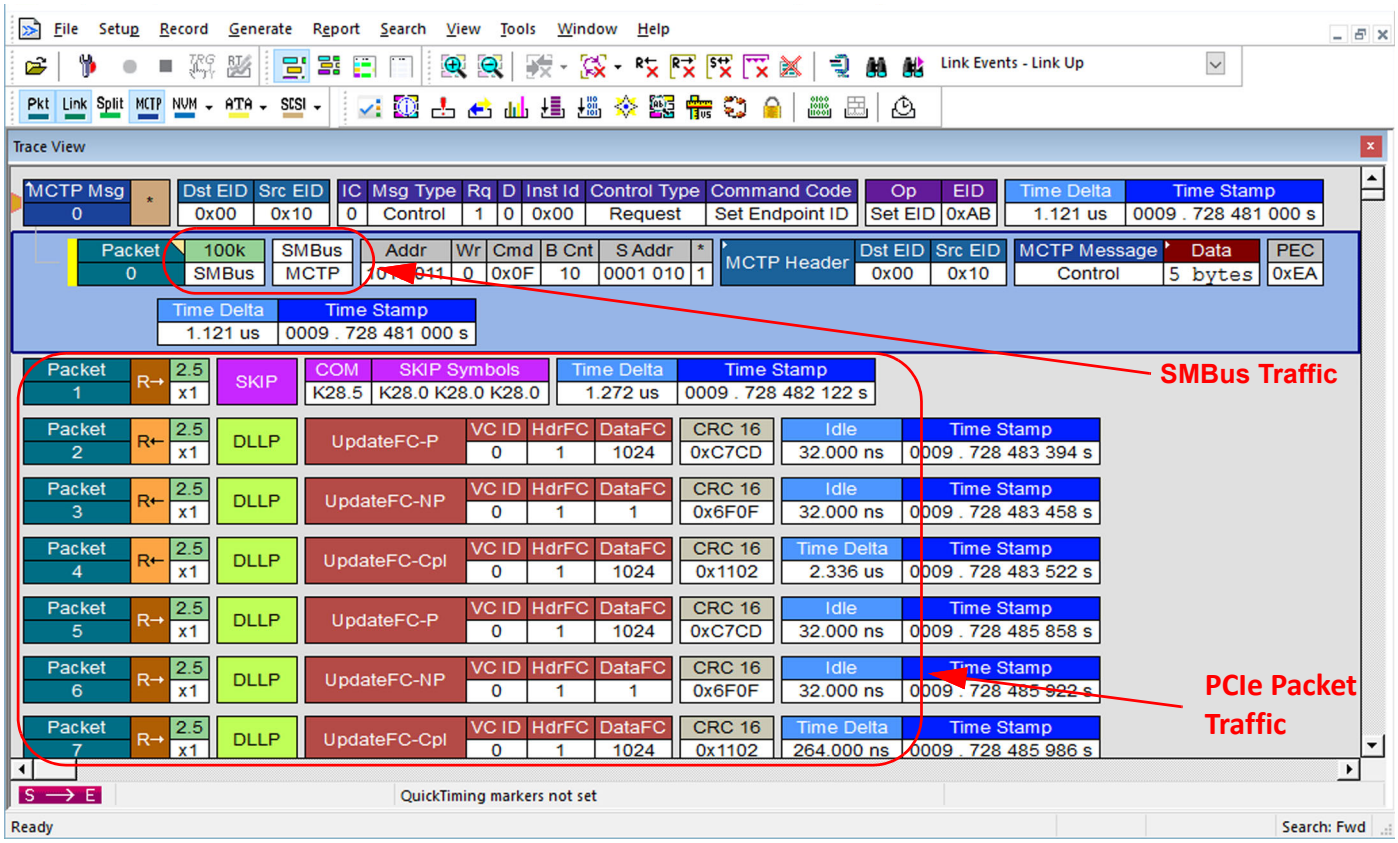


Figure 6.176: MCTP Message with SMBus Sideband Traffic and PCIe Packet Traffic

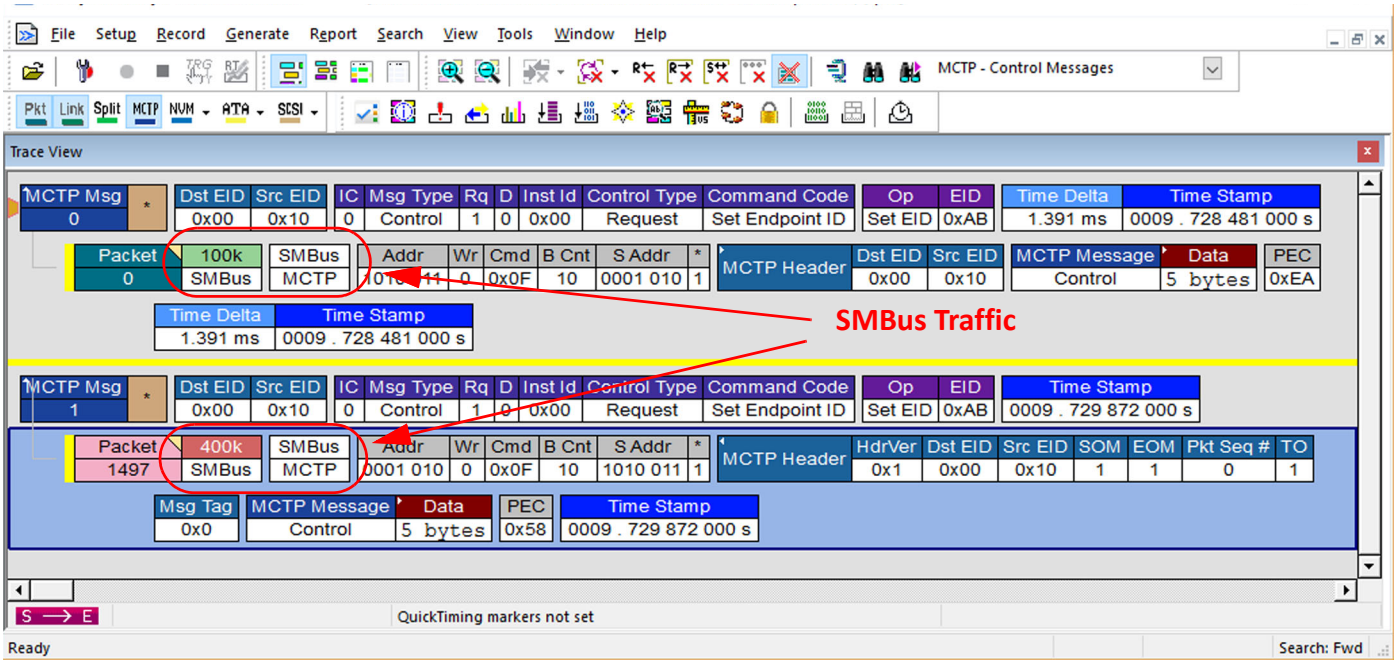


Figure 6.177: SMBus Traffic within two MCTP Messages

Sideband Traffic: Displayed or Hidden

You can decide to Display or Hide Sideband traffic (this includes SMBus traffic) by selecting the Hide Sideband icon in the toolbar. This will Hide the SMBus Traffic. Figure 6.178 shows Sideband traffic displayed. Figure 6.179 on page 373 shows the SMBus traffic Hidden.

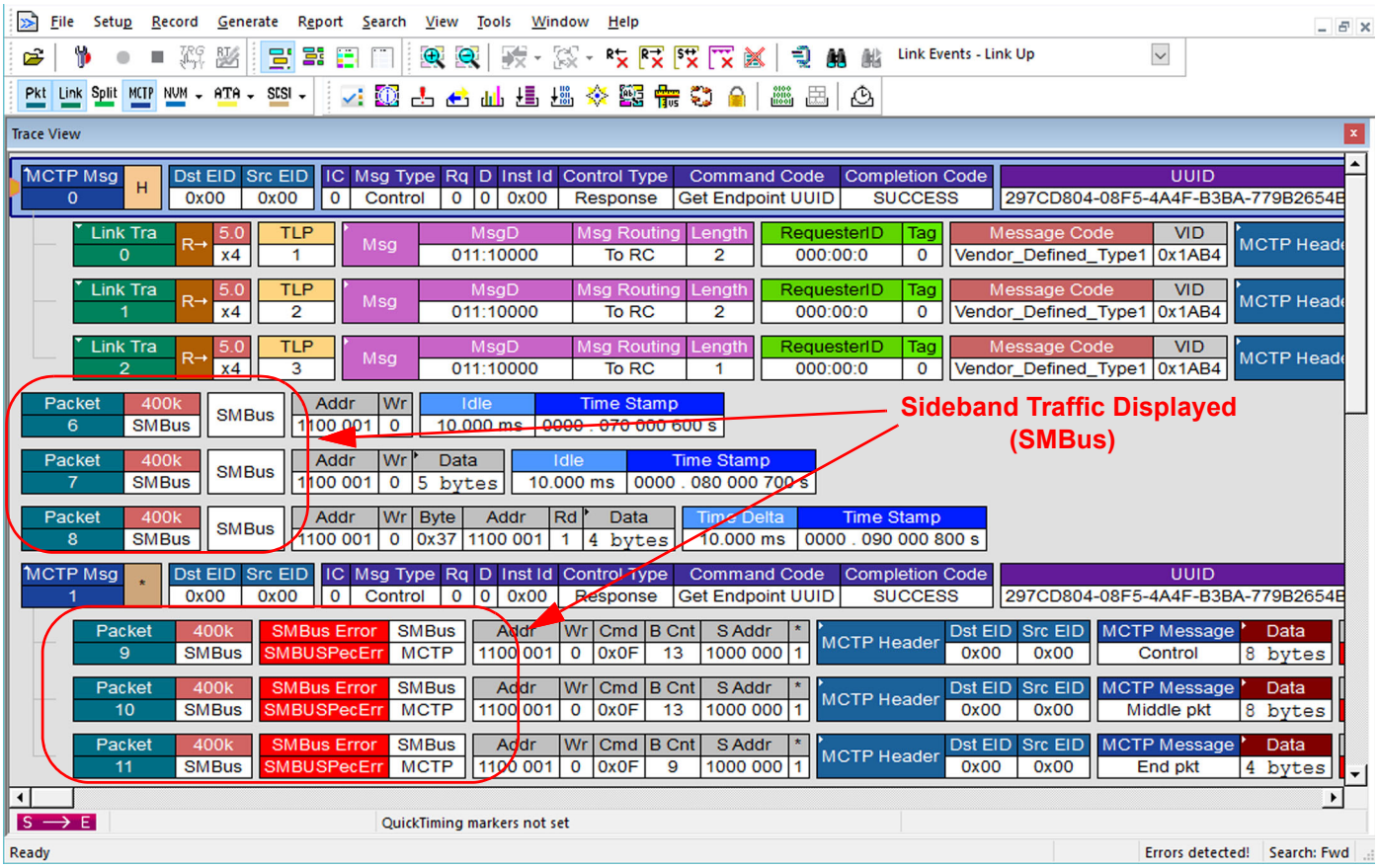


Figure 6.178: Displaying Sideband Traffic (SMBus)

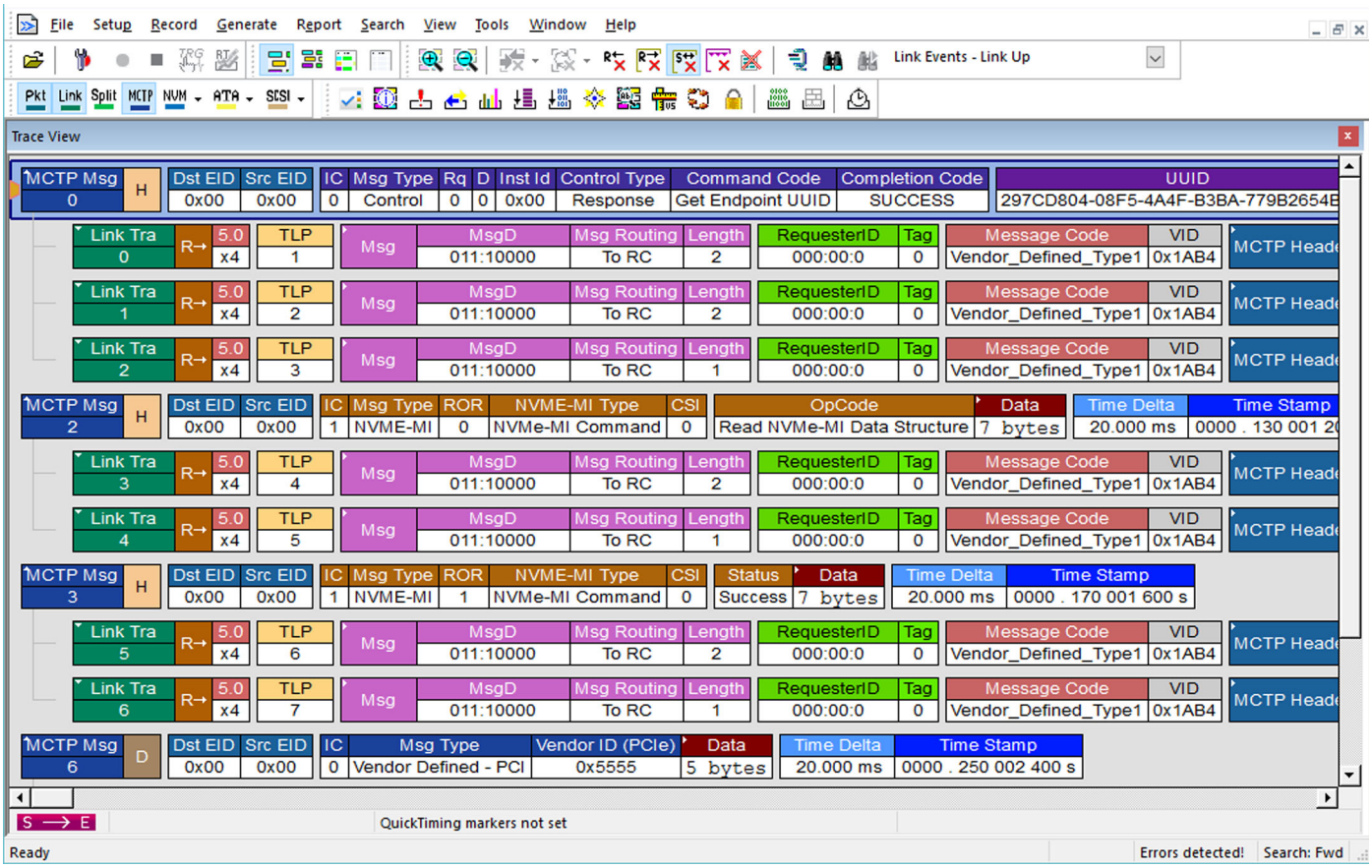


Figure 6.179: Hiding Sideband Traffic (SMBus)

If you compare Figure 6.178 on page 372 and Figure 6.179 you'll see that all the SMBus traffic has been hidden in Figure 6.179. Specifically, Packets 6 - Packet 8 are hidden, which had SMBus traffic and the SMBus traffic in Packets 9 and 10, which were part of MCTP Message 1 are also hidden.

SMBus Errors

The Summit Z58 analyzer can detect a wide variety of SMBus errors (as shown in Figure 6.180 and Figure 6.181 on page 375).

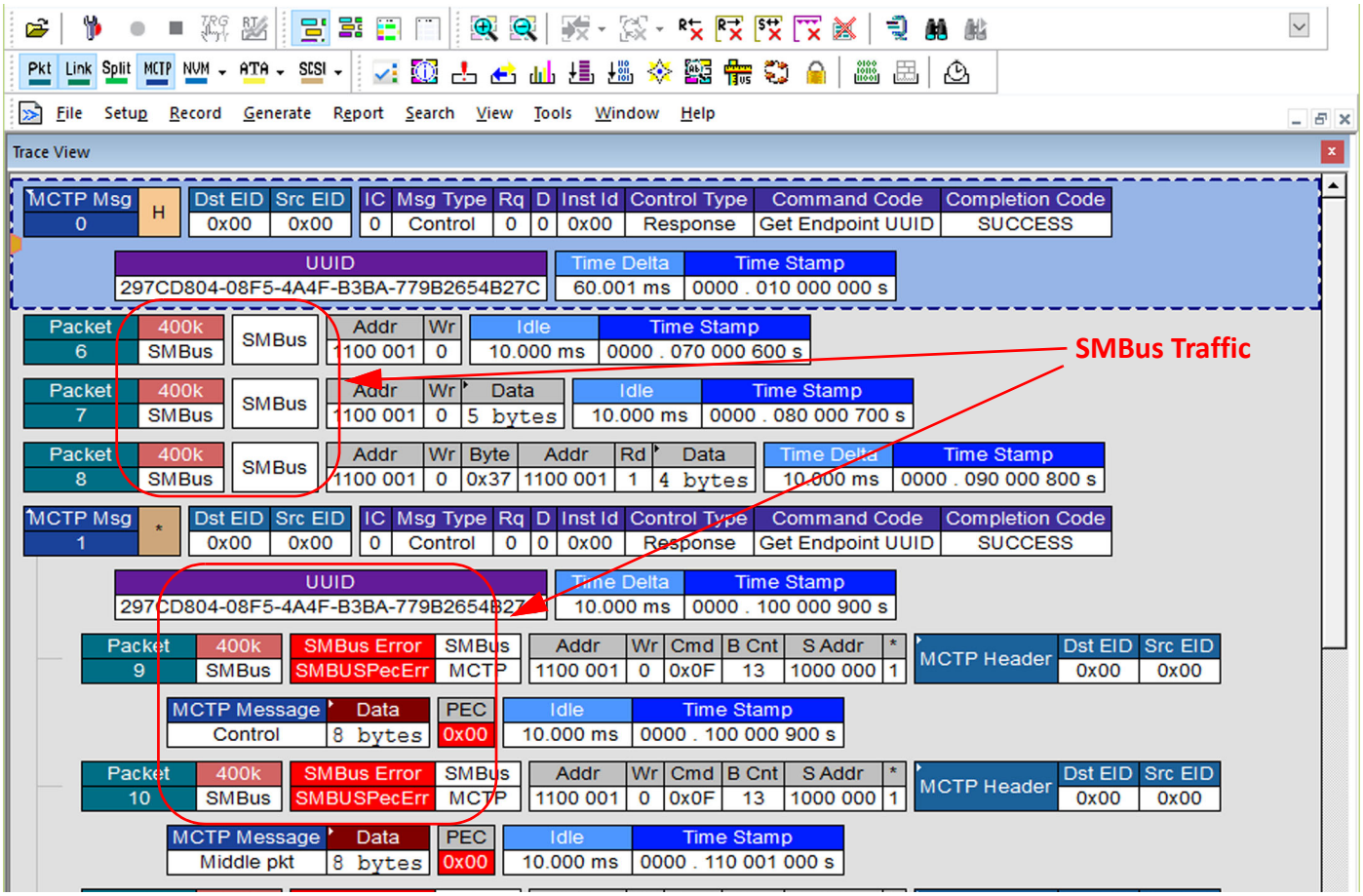


Figure 6.180: SMBus Traffic within two MCTP Messages with Errors

SMBus Error Tooltip

If you scroll over each SMBus Error a tooltip with a detailed explanation of the error will popup. See Figure 6.181.

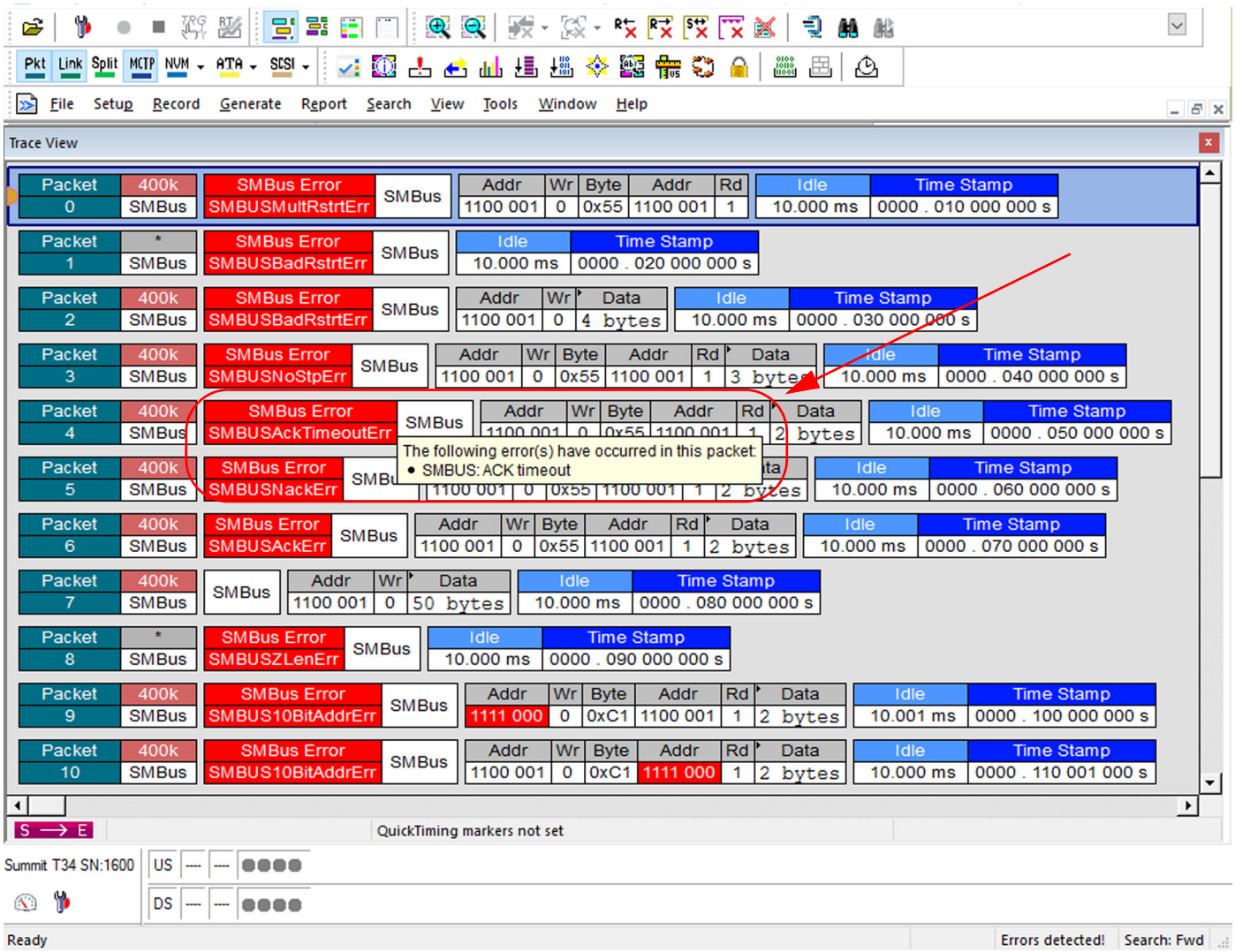


Figure 6.181: Decoding SMBus with Errors

6.3.12.16 Traffic Summary Report: SMBus Errors

Another way of displaying the SMBus errors is to select the Traffic Summary Report (as shown in Figure 6.182).

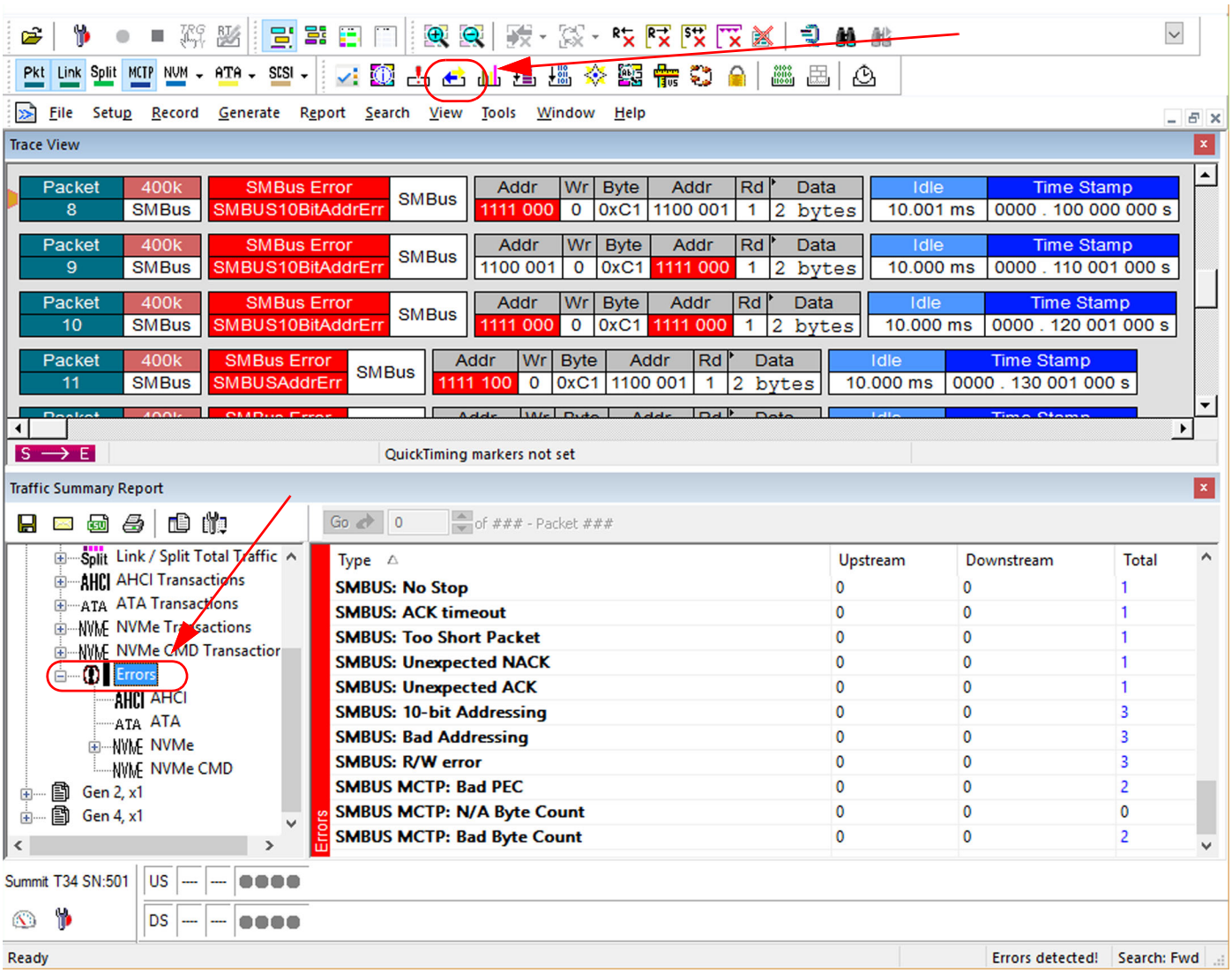


Figure 6.182: Traffic Summary Report: SMBus Errors

The complete set of SMBus errors that the Summit Z58 can detect is contained in the table below: Table 6.3.

TABLE 6.3: SMBus Errors

Bus Error	Description
SMBUSLongPktErr	SMBUS: Too Long Packet
SMBUSMultRstrtErr	SMBUS: More Than One Restart
SMBUSBadRstrtErr	SMBUS: Bad Restart
SMBUSNoStpErr	SMBUS: No Stop
SMBUSAckTimeoutErr	SMBUS: ACK Timeout
SMBUSZLenErr	SMBUS: Too Short Packet
SMBUSNackErr	SMBUS: Unexpected NACK
SMBUSAckErr	SMBUS: Unexpected ACK
SMBUS10BitAddrErr	SMBUS: 10-bit Addressing
SMBUSAddrErr	SMBUS: Bad Addressing
SMBUSRwErr	SMBUS: R/W error
SMBUSPecErr	SMBUS MCTP: Bad PEC
SMBUSNaByteCntErr	SMBUS MCTP: N/A Byte Count
SMBUSByteCntErr	SMBUS MCTP: Bad Byte Count

6.3.12.17 Decoding SMBus with Address Resolution Protocol (ARP)

The PCIe Protocol Analysis can decode SMBus traffic with Address Resolution Protocol as shown below in Figure 6.183.

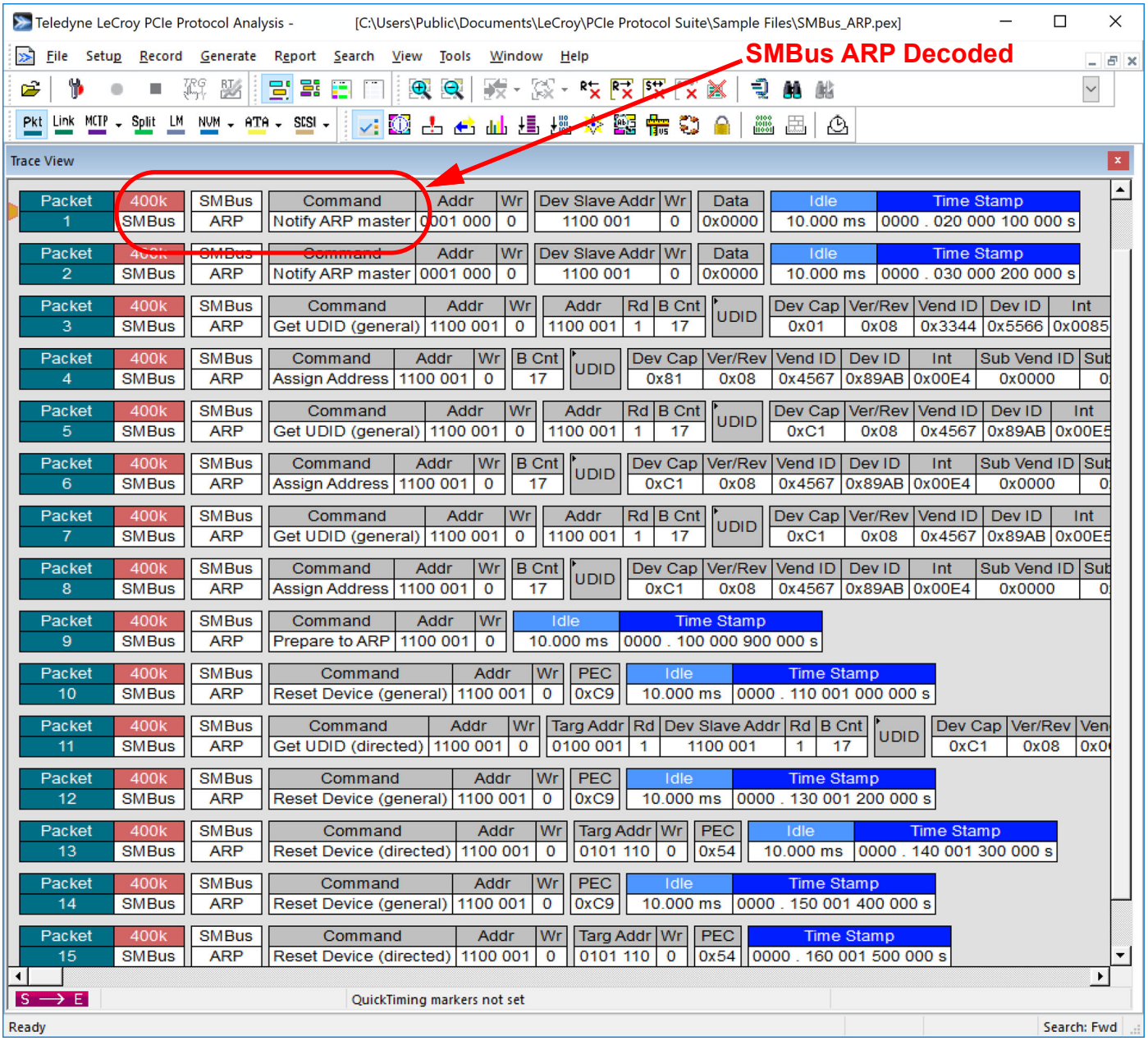


Figure 6.183: SMBus Address Resolution Protocol Decoded

6.3.12.18 Decoding MCTP Traffic with Vendor Defined Messages (VDM)

The PCIe Protocol Analysis can decode MCTP traffic with Vendor Defined Messages (VDM) as shown below in Figure 6.184.

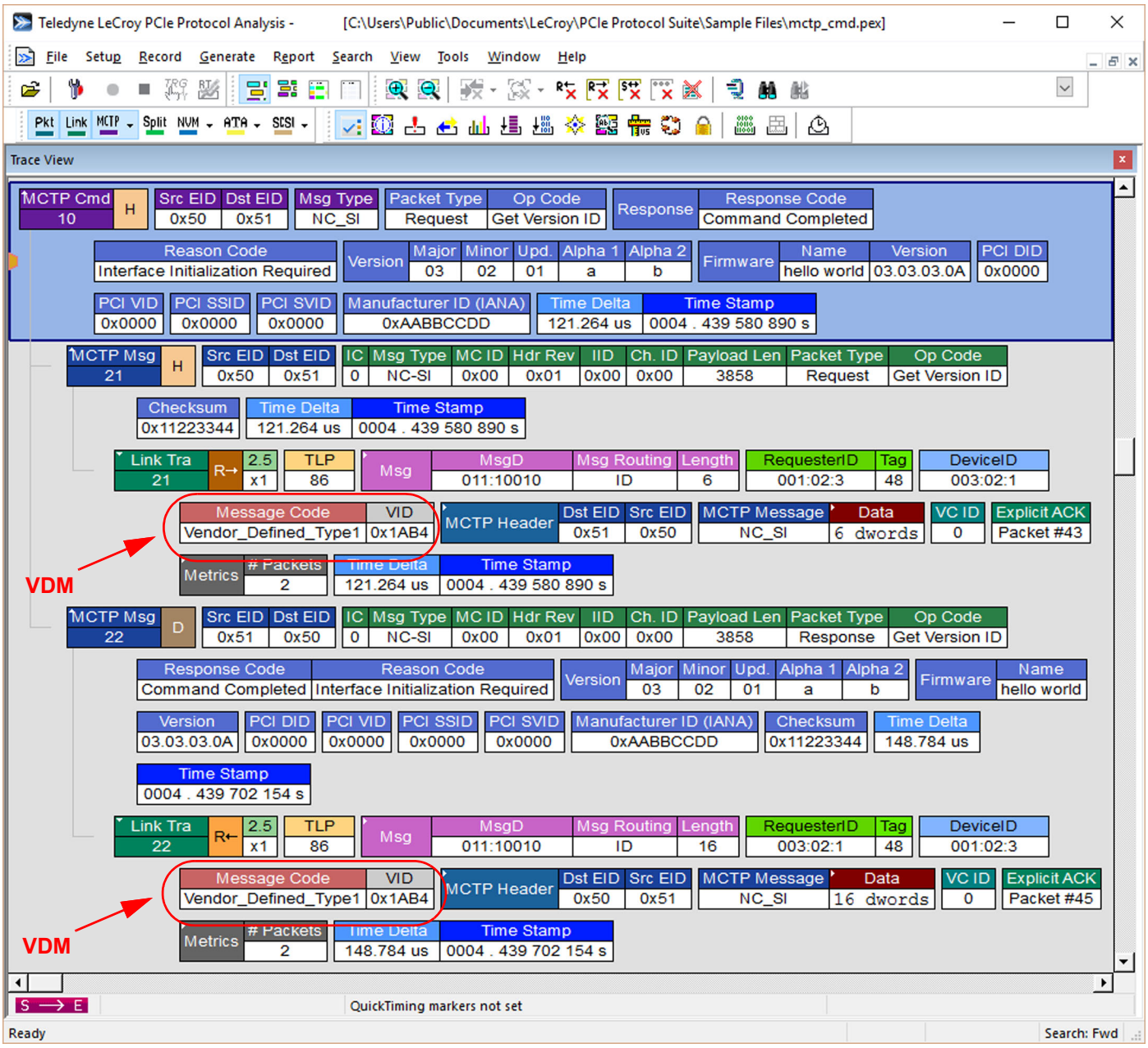


Figure 6.184: MCTP Traffic: Decoding Vendor Defined Messages (VDM)

6.3.12.19 Decoding Data Link Features

The Summit Z58 can decode Data Link Features as shown in Figure 6.185.

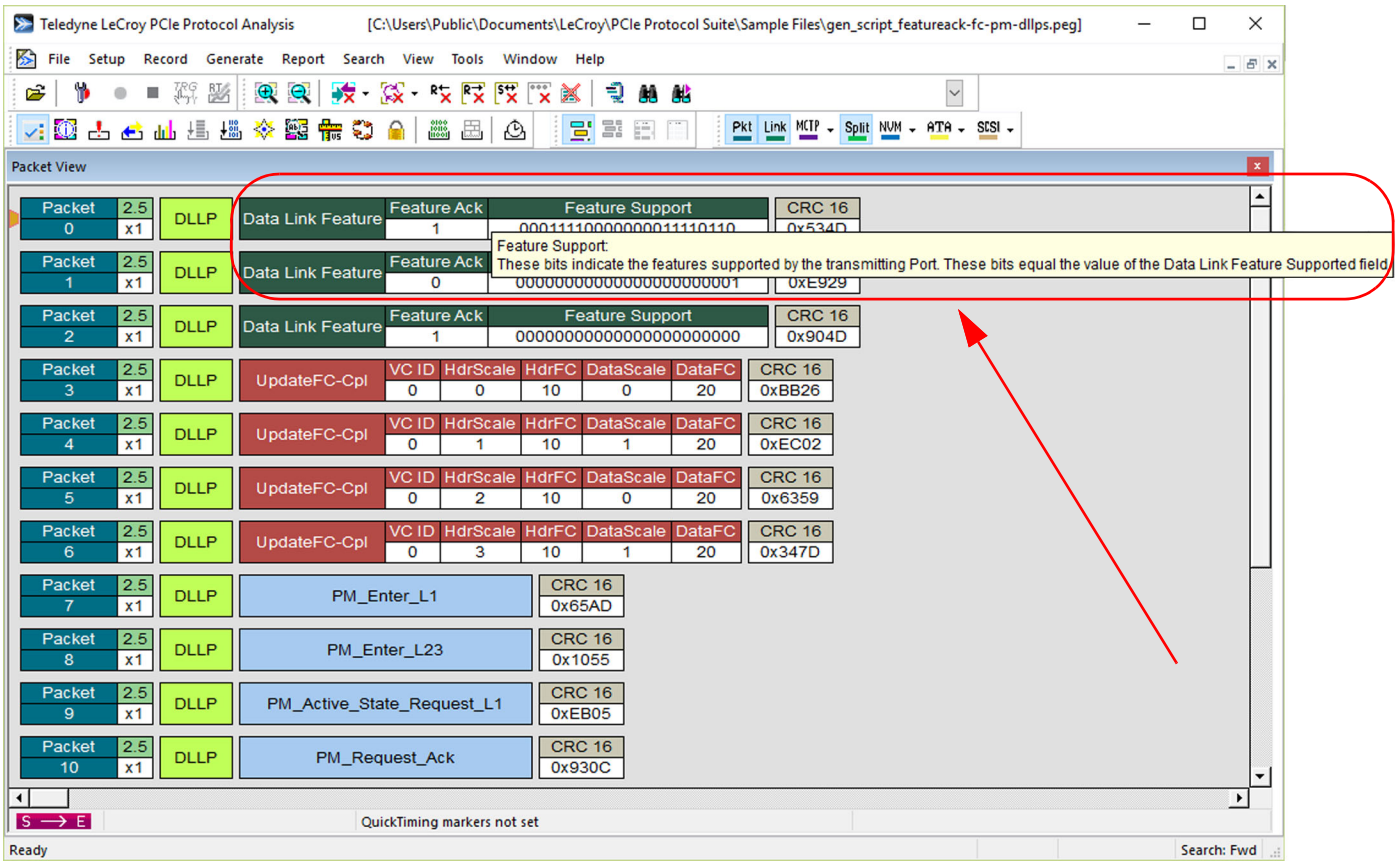


Figure 6.185: Decoding Data Link Features

The supported Data Link Features are defined in the PCIe Specification:

PCI Express® Base Specification Revision 4.0 Version 0.7 dated 11 November 2016.

They are outlined in Table 3.1 on page 202 and are shown below:

Bit Location	Description
0	**Scaled Flow Control** – indicates support for Scaled Flow Control. Scaled Flow Control must be supported in Ports that support 32.0 GT/s or higher operation.
Others	Reserved

6.3.12.20 PMUX Channel ID Found and PMUX Packet Error Decoded in Trace

In the trace both the PMUX Channel ID was found and a Packet PMUX Error was decoded. See Figure 6.263.

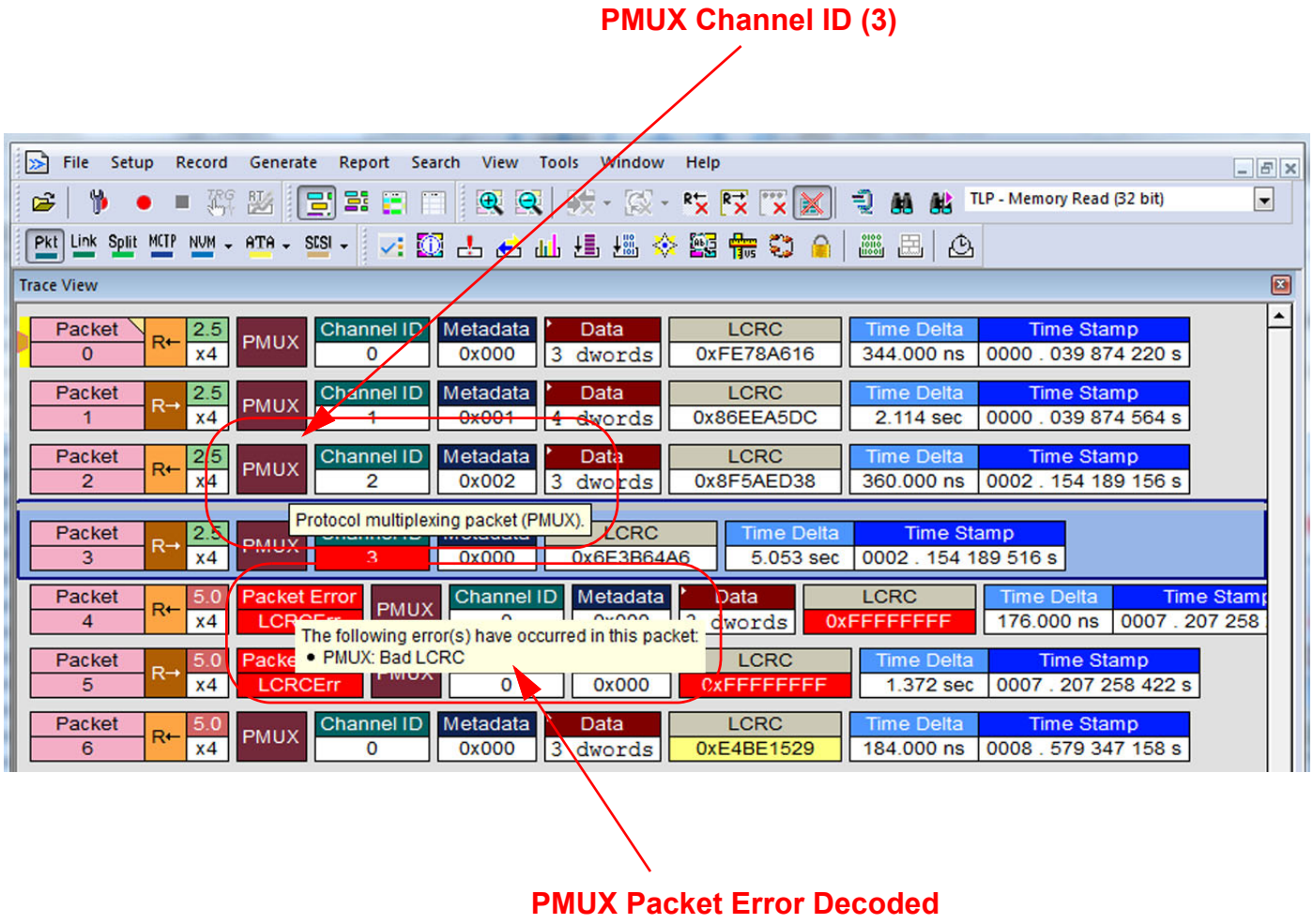


Figure 6.186: PMUX Channel ID (3) Found in Trace and Packet Error Decoded

6.3.12.21 Decoding Traces with Different Class Codes

PCIe Protocol Analysis initially assumes all traces have unknown class codes and that the decoder selected and trace class codes are the same. If after decoding the trace, the class codes of the trace and the decoder selected are different, a warning message pops up showing the correct class code of the trace.

Example: Loading an NVMe Trace and Decoding for ATA

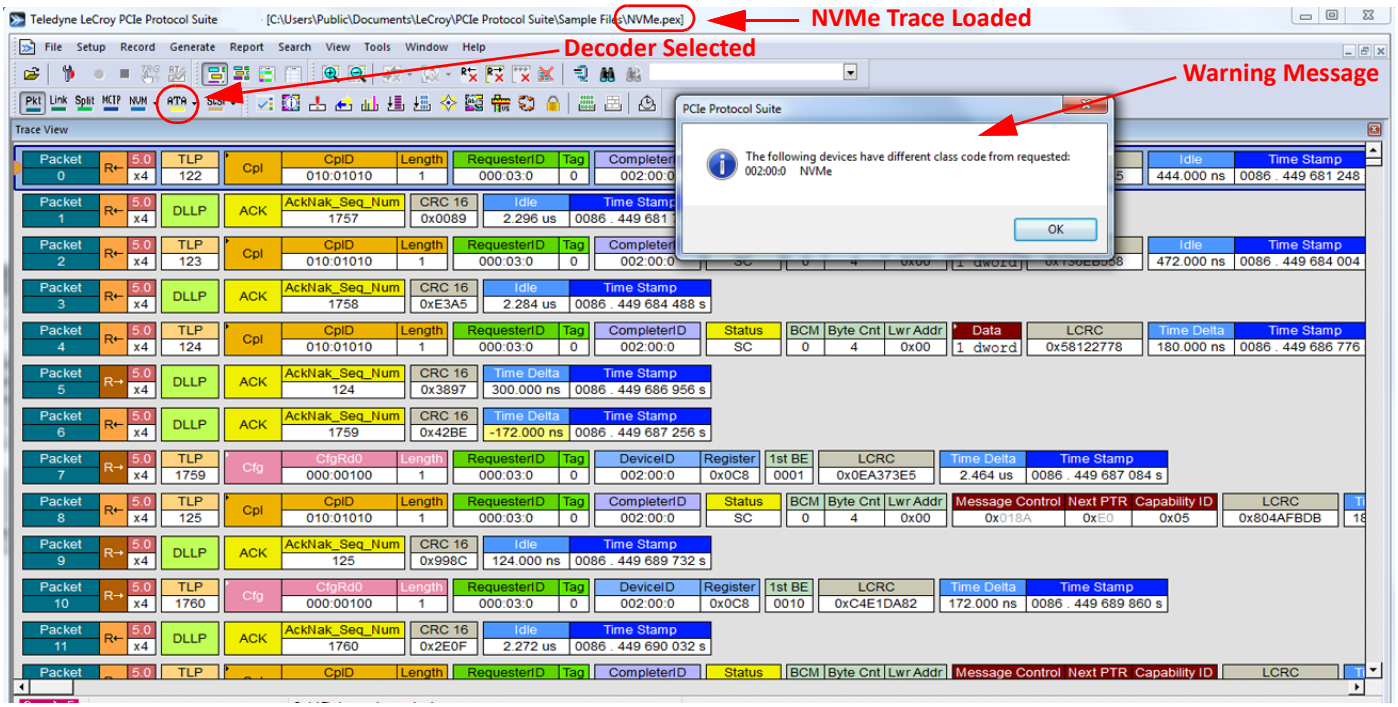


Figure 6.187: NVMe Trace Loaded Different Than ATA Decoder Selected

Example: Loading a PQI Trace and Decoding for NVMe

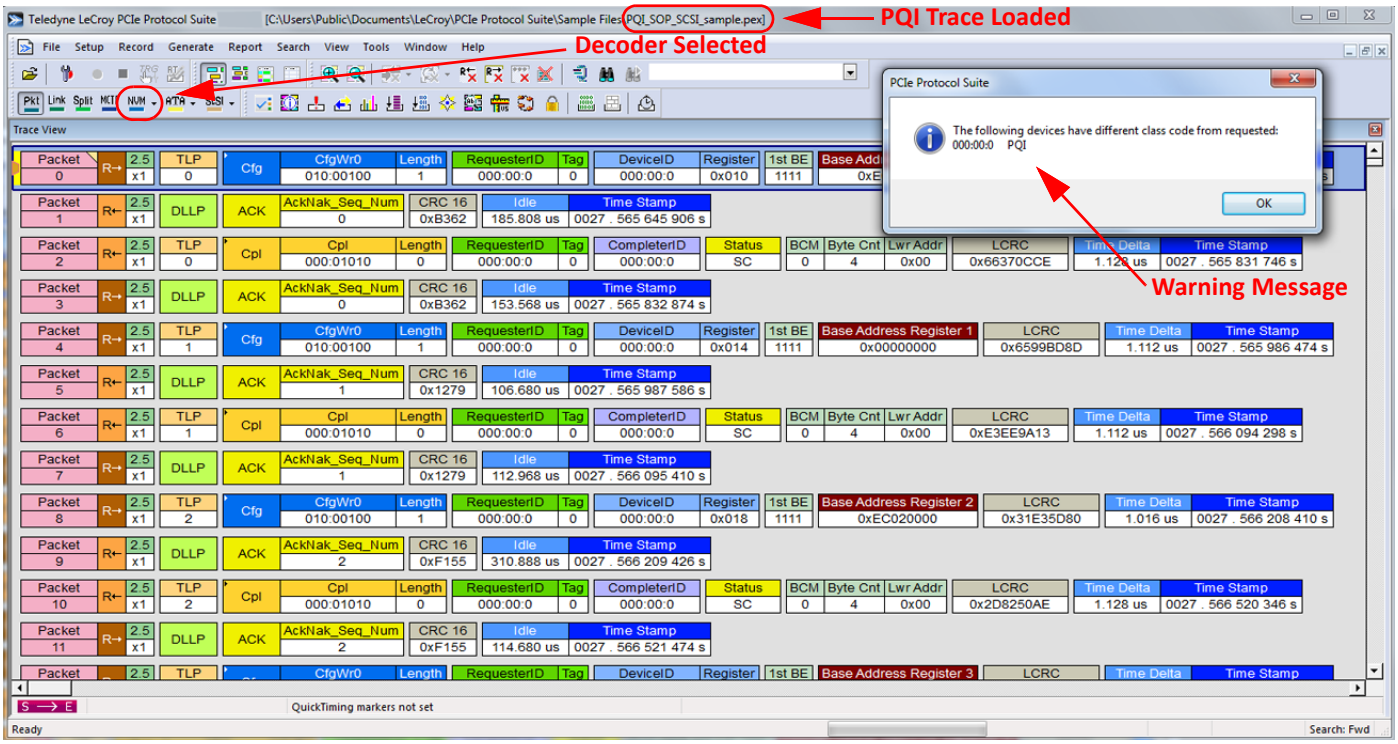


Figure 6.188: PQI Trace Loaded Different Than NVMe Decoder Selected

6.3.12.22 Data Link Features

The Summit Z58 can decode Data Link Features as shown in Figure 6.184.

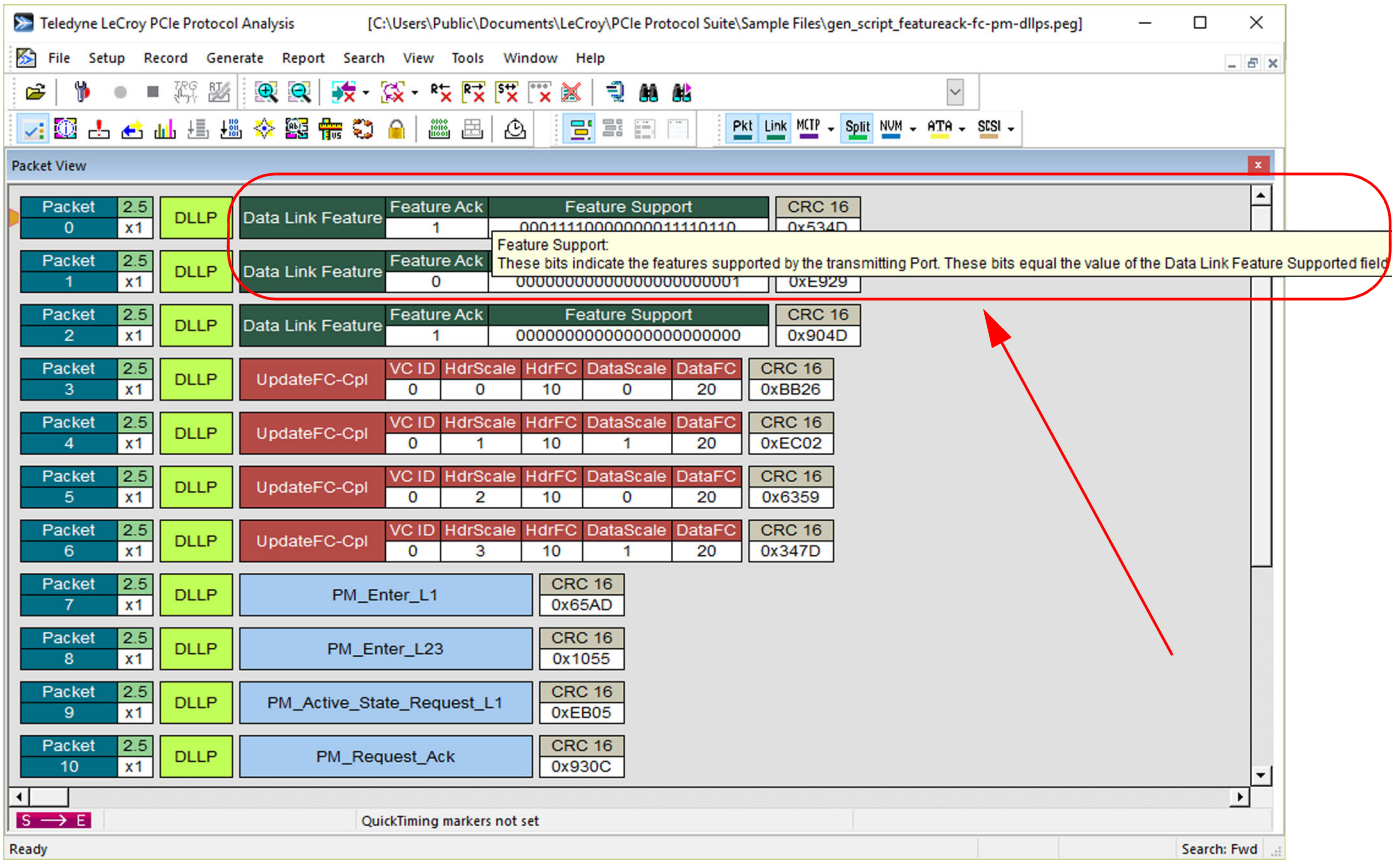


Figure 6.189: Decoding Data Link Features

The supported Data Link Features are defined in the PCIe Specification:

PCI Express® Base Specification Revision 4.0 Version 0.7 dated 11 November 2016.

They are outlined in Table 3.1 on page 202 and are shown below:

Bit Location	Description
0	**Scaled Flow Control** – indicates support for Scaled Flow Control. Scaled Flow Control must be supported in Ports that support 32.0 GT/s or higher operation.
Others	Reserved

6.3.12.23 Decoding PCI-SIG Vendor Defined Messages (VDMs)

PCI-SIG VDMs can be decoded as shown below in Figure 6.190.

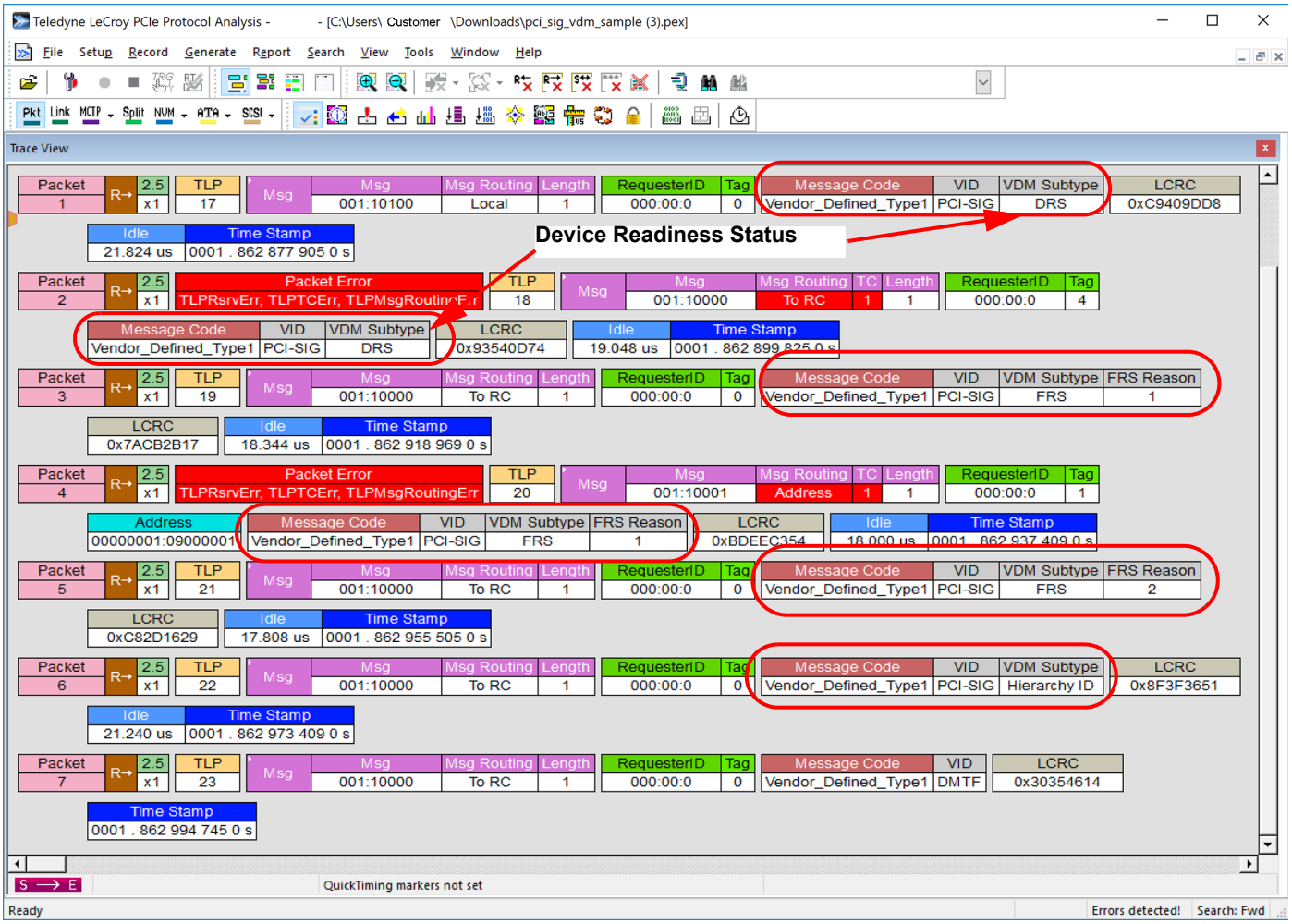


Figure 6.190: Decoding PCI-SIG VDMs

You can roll the cursor over each VDM to display it's tooltip. The one for Device Readiness Status is shown below (see Figure 6.191).

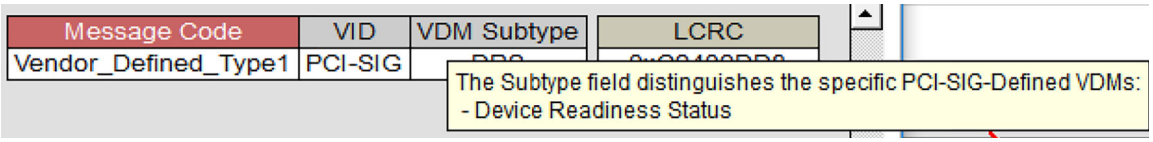


Figure 6.191: Device Readiness Status Tooltip

You can also bring up the decoded trace in Detailed mode (see Figure 6.192 on page 385).

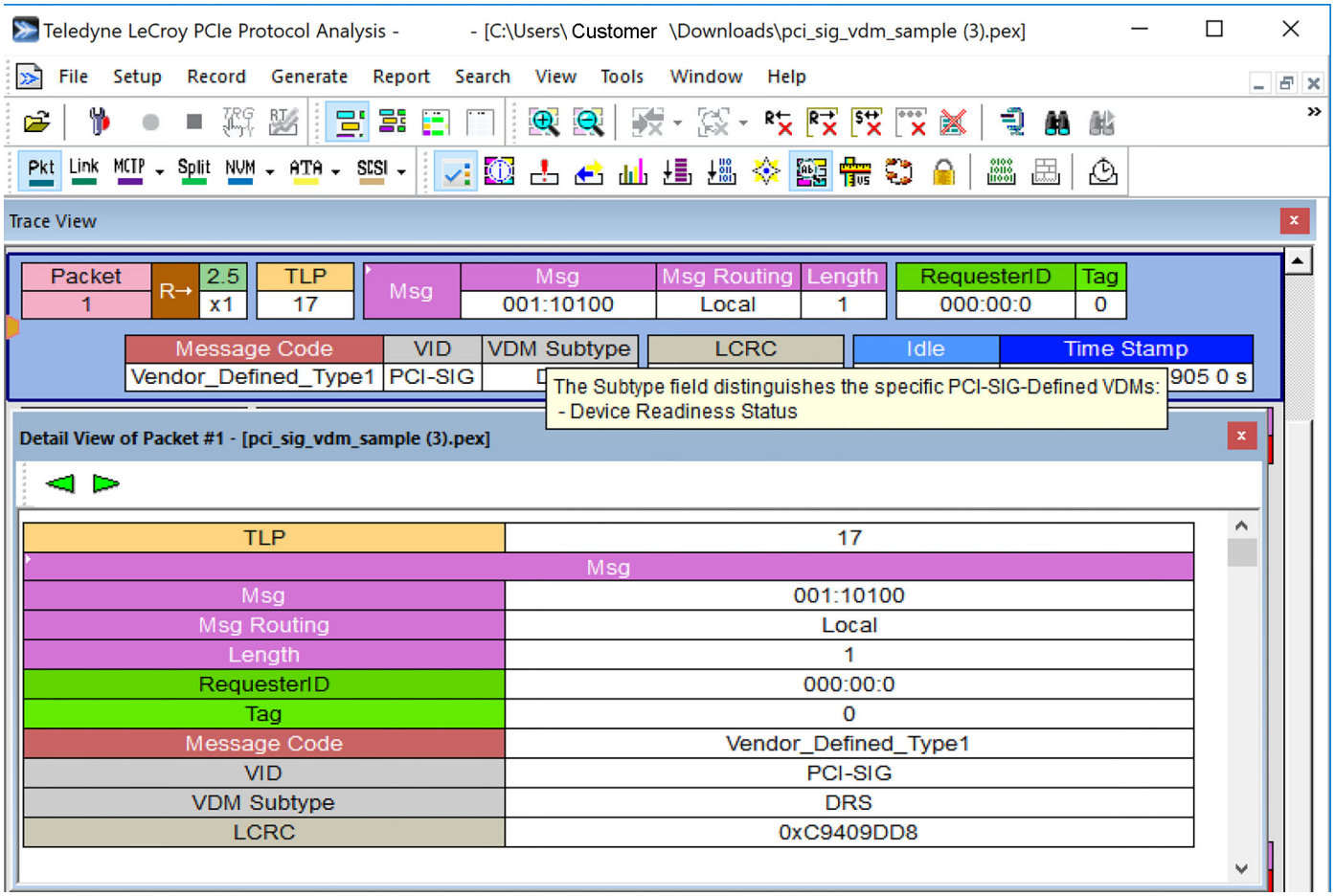


Figure 6.192: Decoding PCI-SIG VDM: Displayed in Detailed Mode

Other VDM Messages include:

- LN
- FRS
  - Reason 1: DRS Message Received
  - Reason 2: D3 Hot to D0 Transition Completed
- Hierarchy ID
- DMTF

6.3.12.24 Decode for NVMe 1.3c Specification

The PCI Express Analysis includes decoding for the following NVMe 1.3c Specification:

- Command Specific Status Code
- Opcodes for Admin commands
- Doorbell Buffer Config commands
- Device Self-Test command
- Directive Receive command
- Directive Send command
- Firmware Commit
- Features
- Get Log Page

- Identify command
- NVMe-Mi Receive command
- NVMe-MI Send command
- Format NVM
- Sanitize command
- Write
- Write Zeros
- Identifier Format 7.10

Some examples are shown below (see Figure 6.193 through Figure 6.196 on page 389).

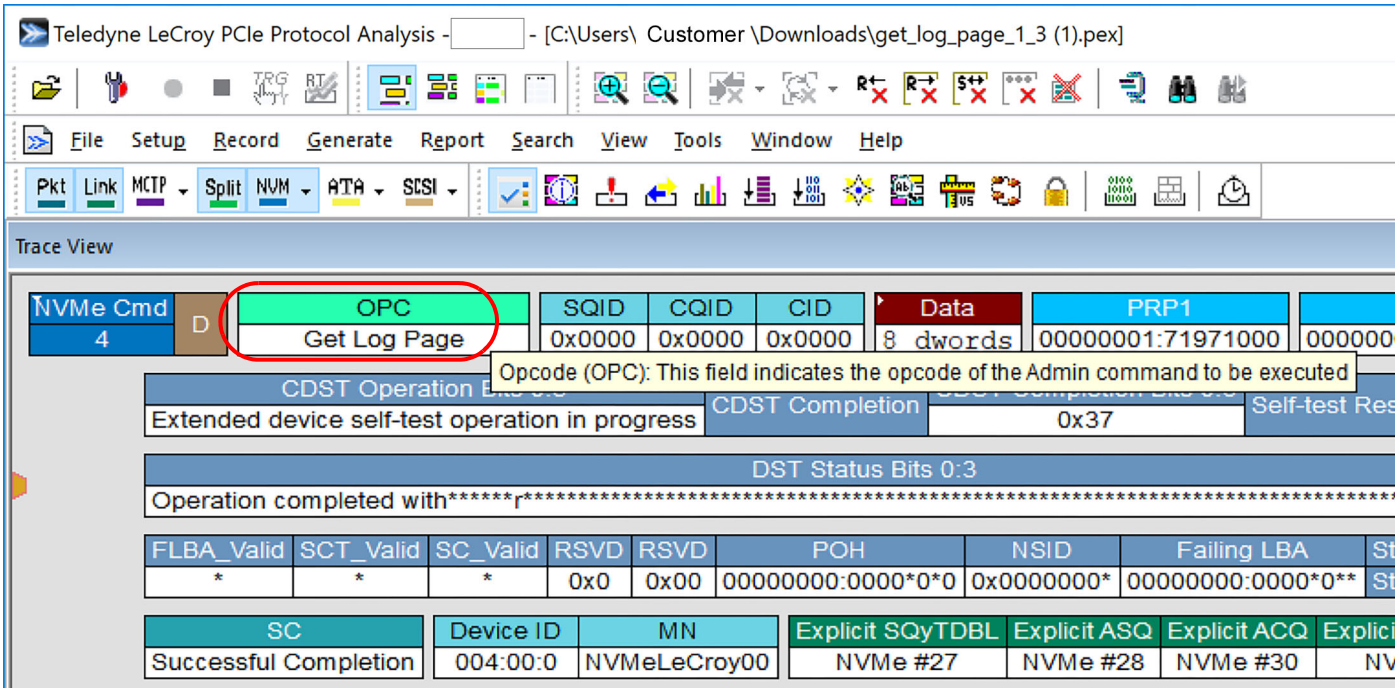


Figure 6.193: NVMe 1.3c Spec: Decodes -→ Get Log Page

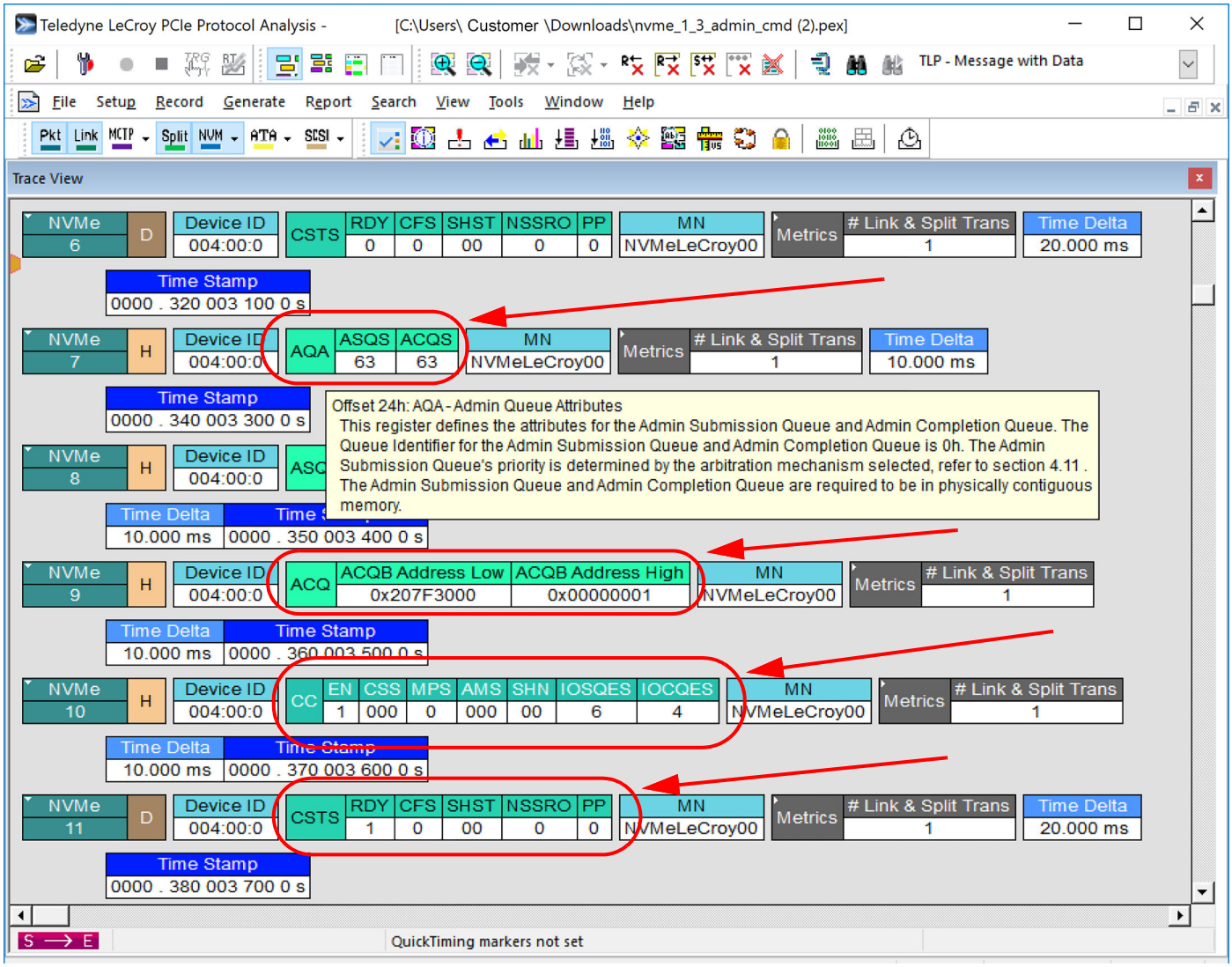


Figure 6.194: NVMe 1.3c Spec: Decodes -→ Admin Commands

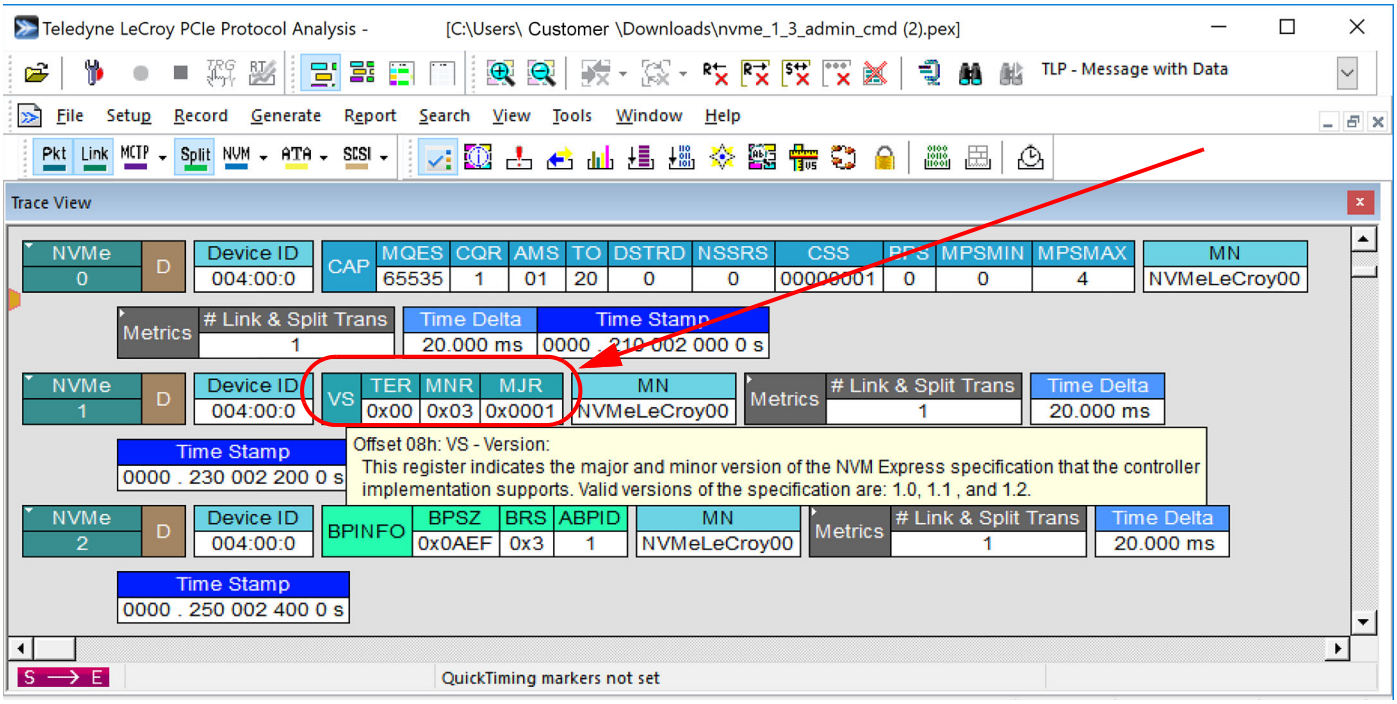


Figure 6.195: NVMe 1.3c Spec: Decodes -→ Spec Version 1.3c

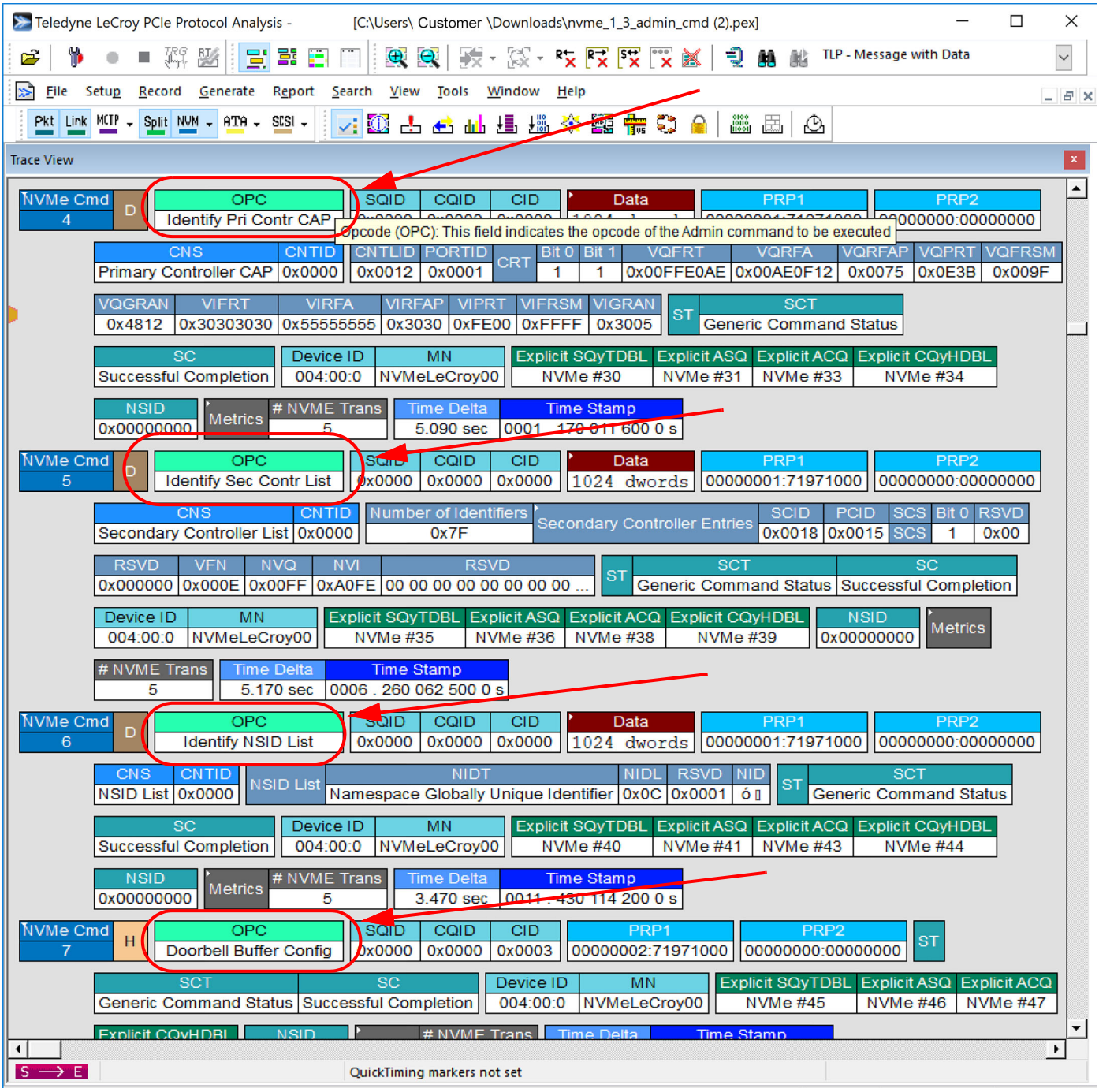


Figure 6.196: NVMe 1.3c Spec: Decodes -→ Opcodes

6.3.12.25 NVMe Warning Messages

The PCIe Protocol Analysis software is capable of decoding the following NVMe Warning messages:

- Trace View
- Traffic Summary
- Search for NVMe Commands
- Search for NVMe Transactions

- Hiding Options

Trace View

If you decode for NVMe Commands and Transactions you'll see the following types of warning messages: See Figure 6.197, Figure 6.198 on page 391, Figure 6.199 on page 391 and Figure 6.200 on page 391.

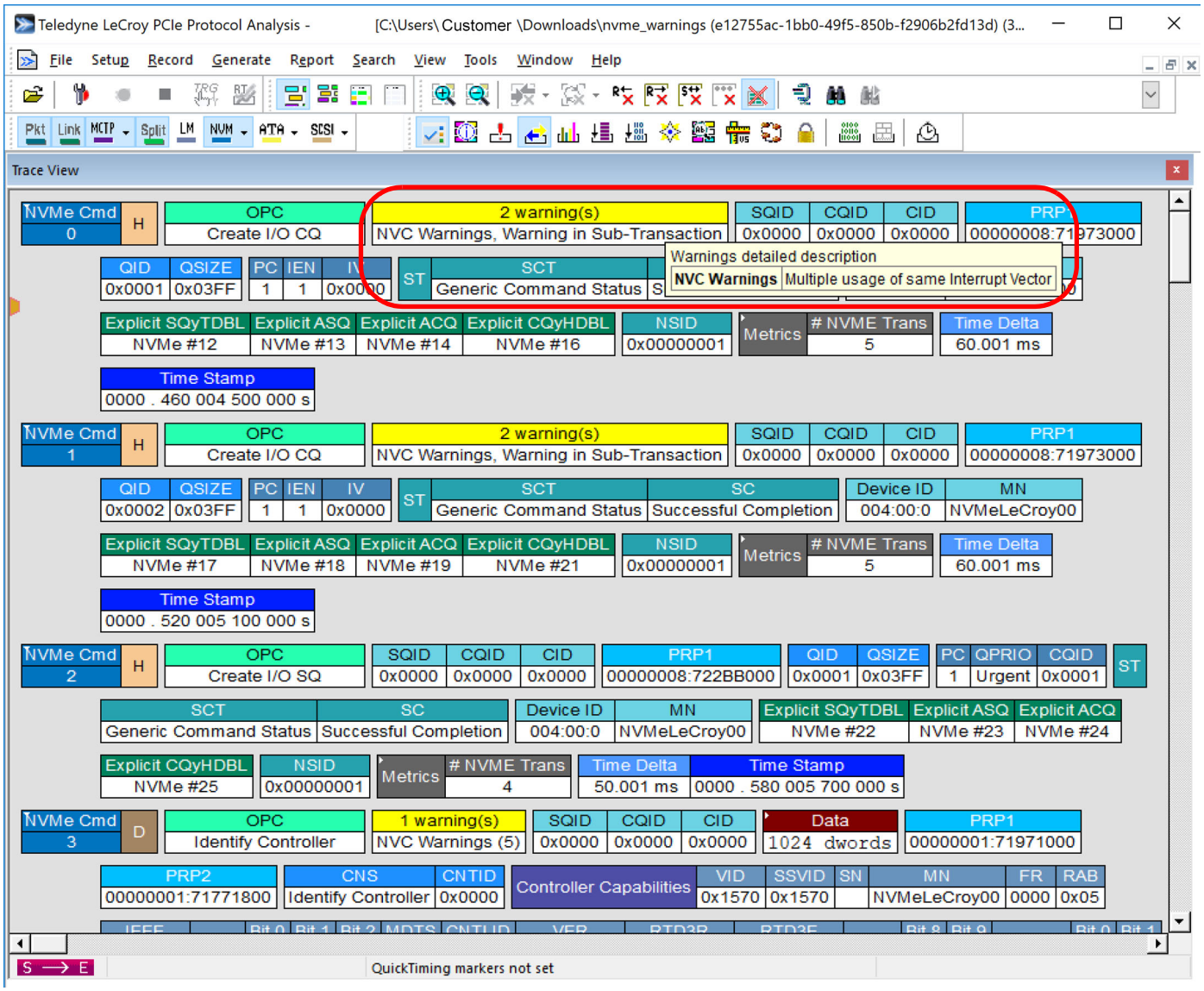


Figure 6.197: NVMe Command: Warning Message 1

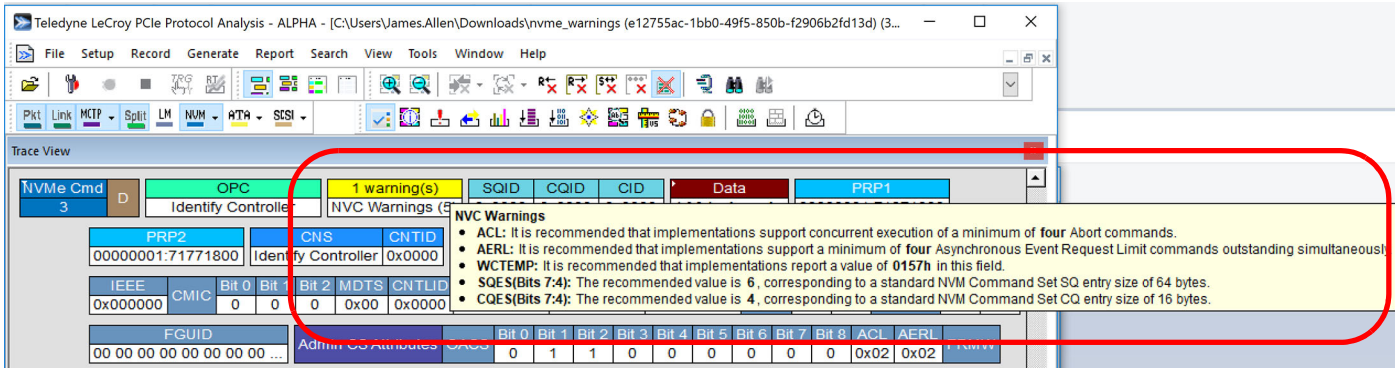


Figure 6.198: NVMe Command: Warning Message 2

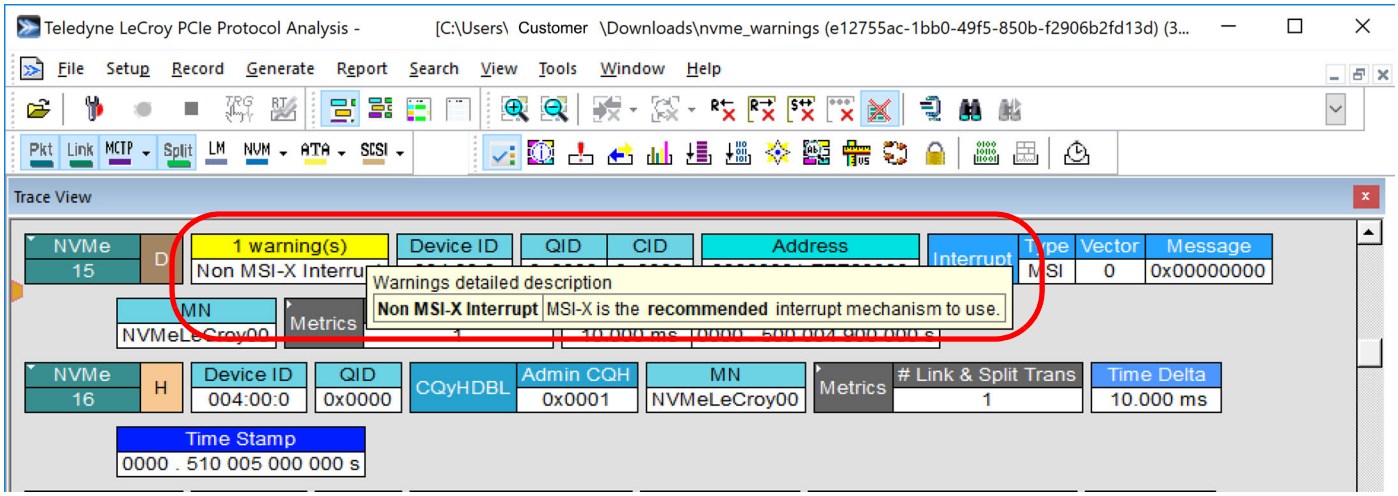


Figure 6.199: NVMe Transaction: Warning Message

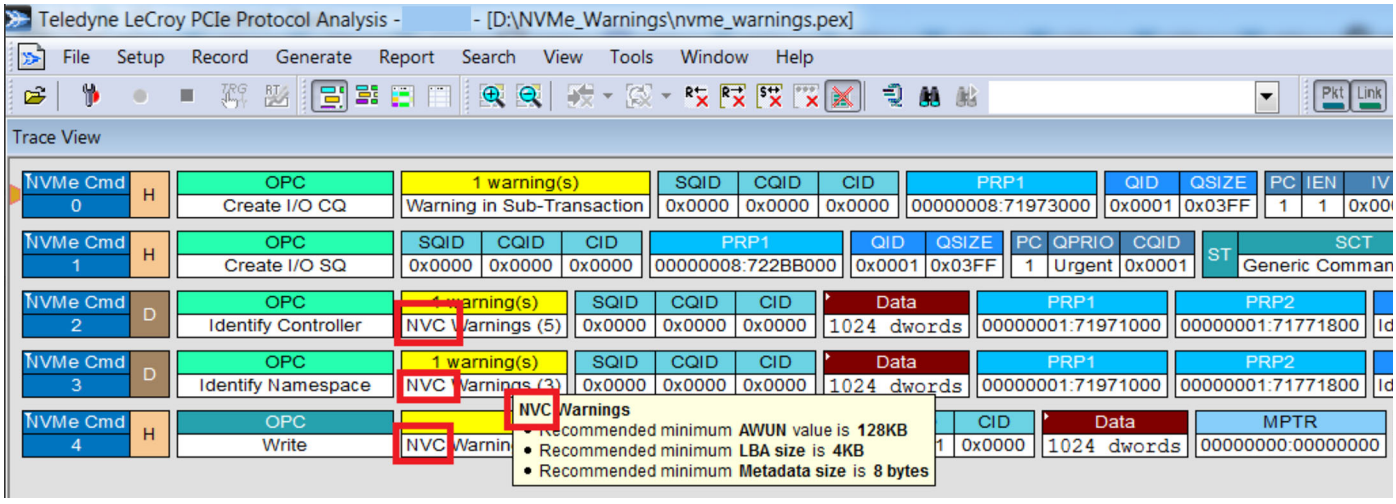


Figure 6.200: NVME Command: NVC Warning Messages

Traffic Summary View

The NVMe Warning Messages can be seen in the Traffic Summary Reports (see Figure 6.202, Figure 6.203 on page 394, Figure 6.204 on page 395 and Figure 6.204 on page 395) below:

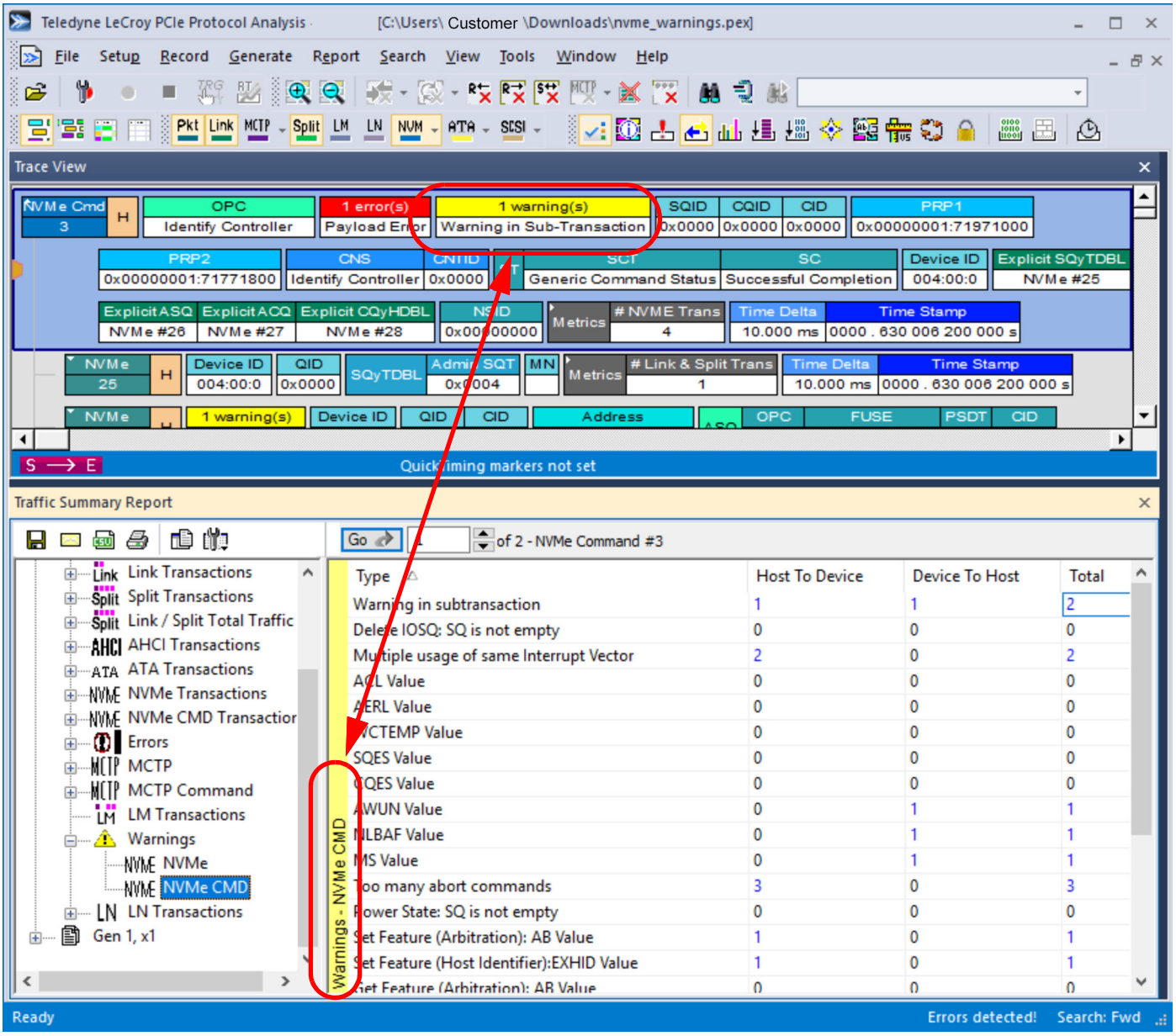


Figure 6.201: Warnings: NVMe CMD

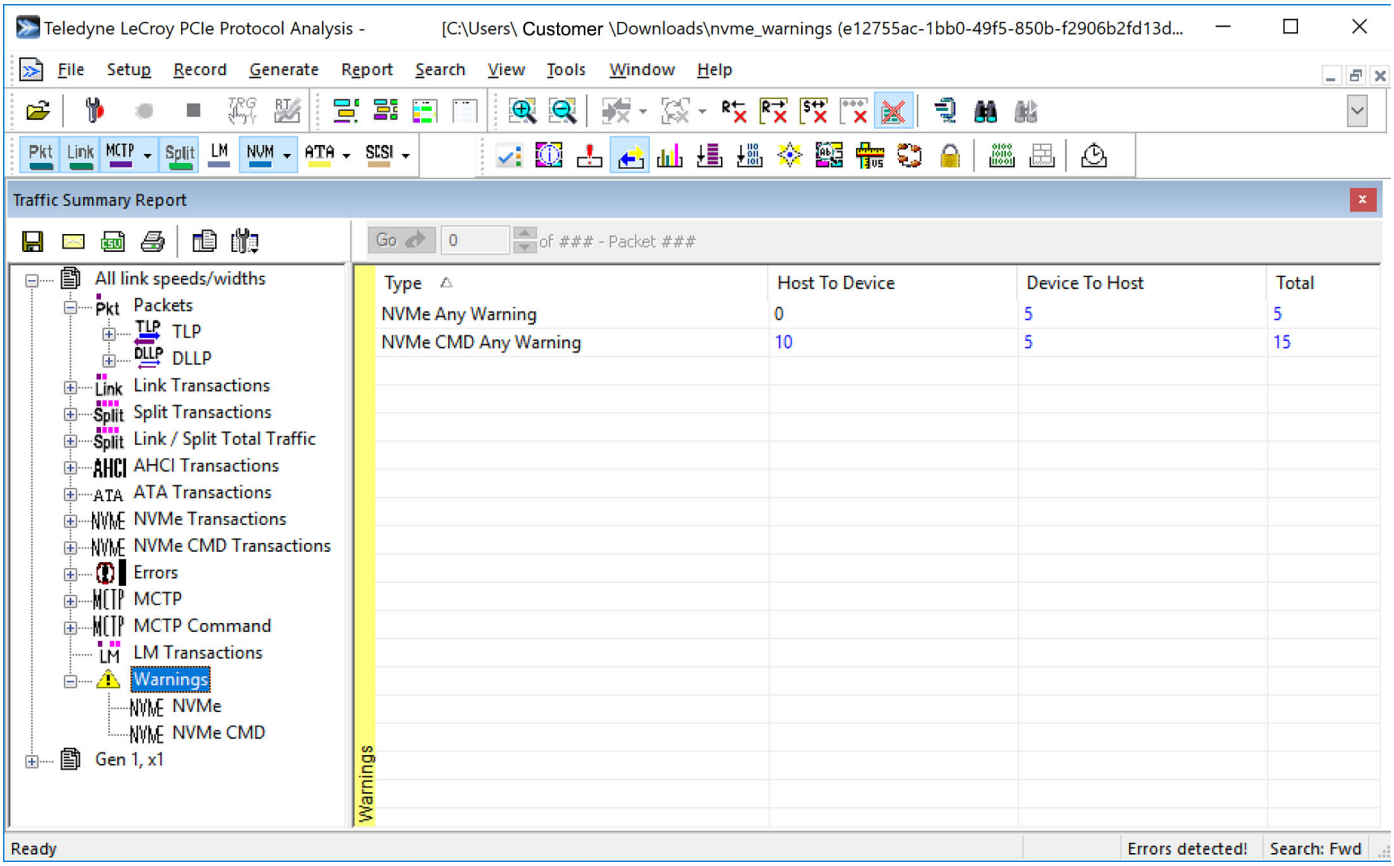


Figure 6.202: NVMe Warning Messages: Traffic Summary

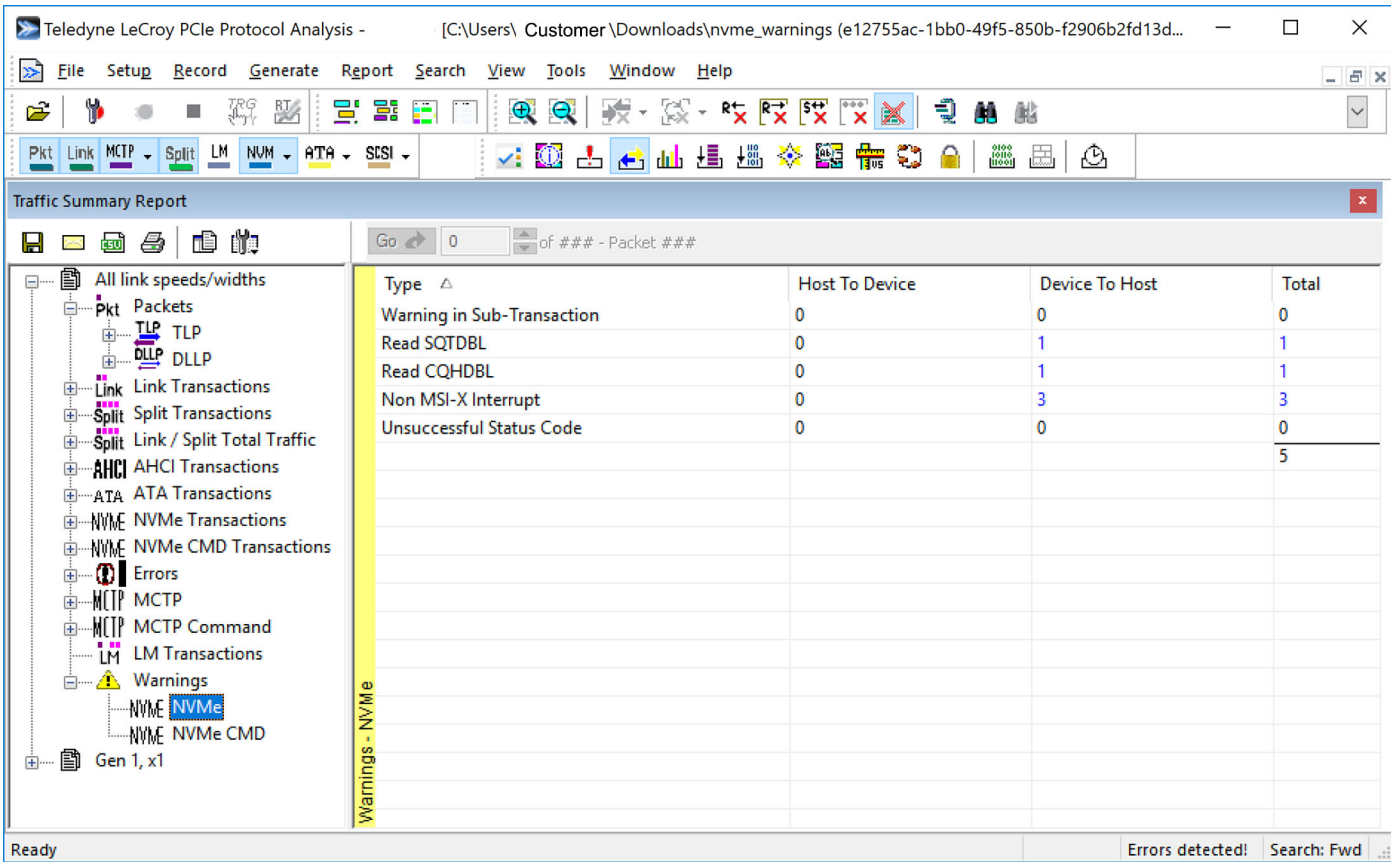


Figure 6.203: NVMe Warning Messages: Traffic Summary NVMe

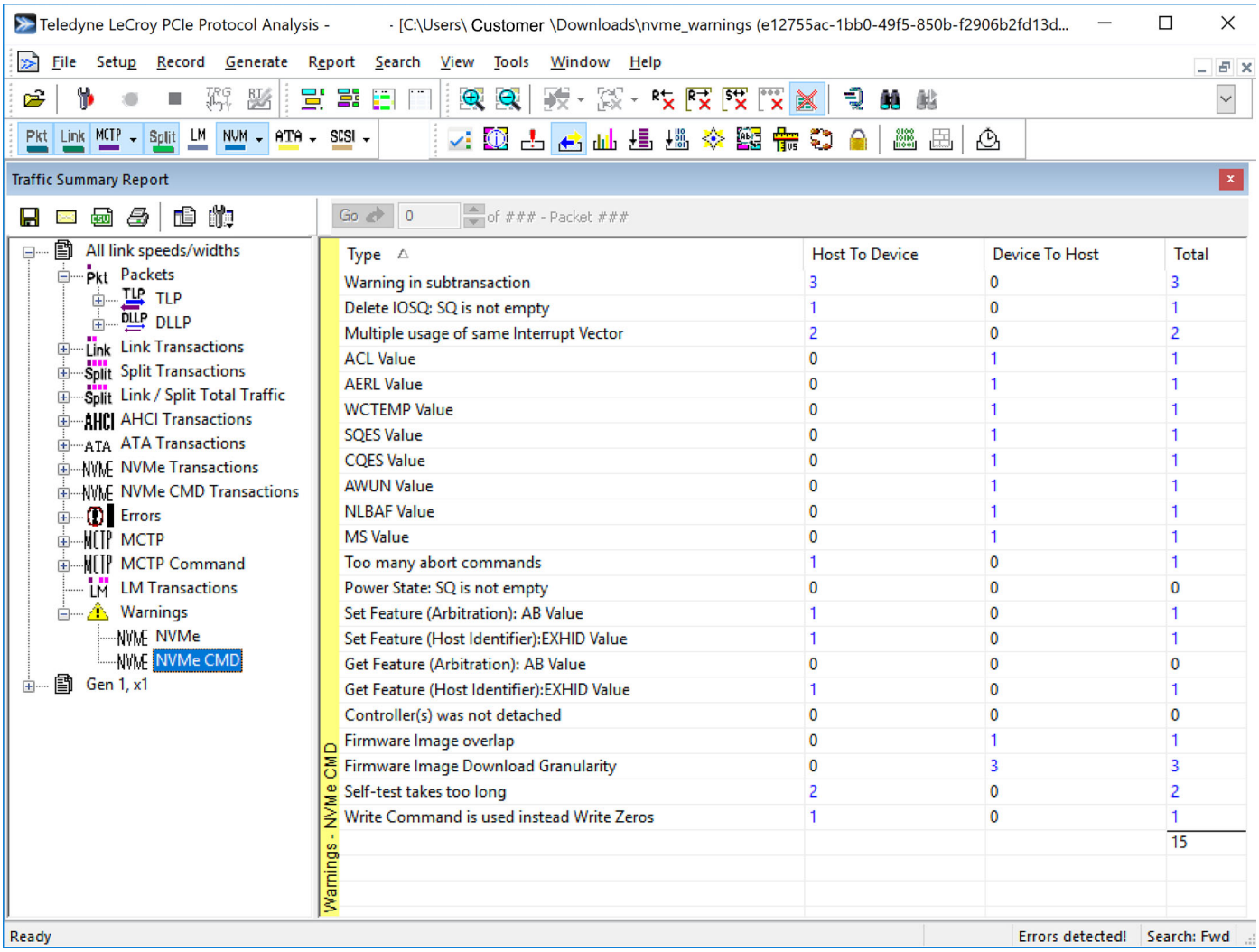


Figure 6.204: NVMe Warning Messages: Traffic Summary NVMe CMD

Find NVMe Commands and Transactions

You can use the “Find” function to display the NVMe Commands and Transactions Warning Messages. See Figure 6.205 on page 396 and Figure 6.206 on page 397.

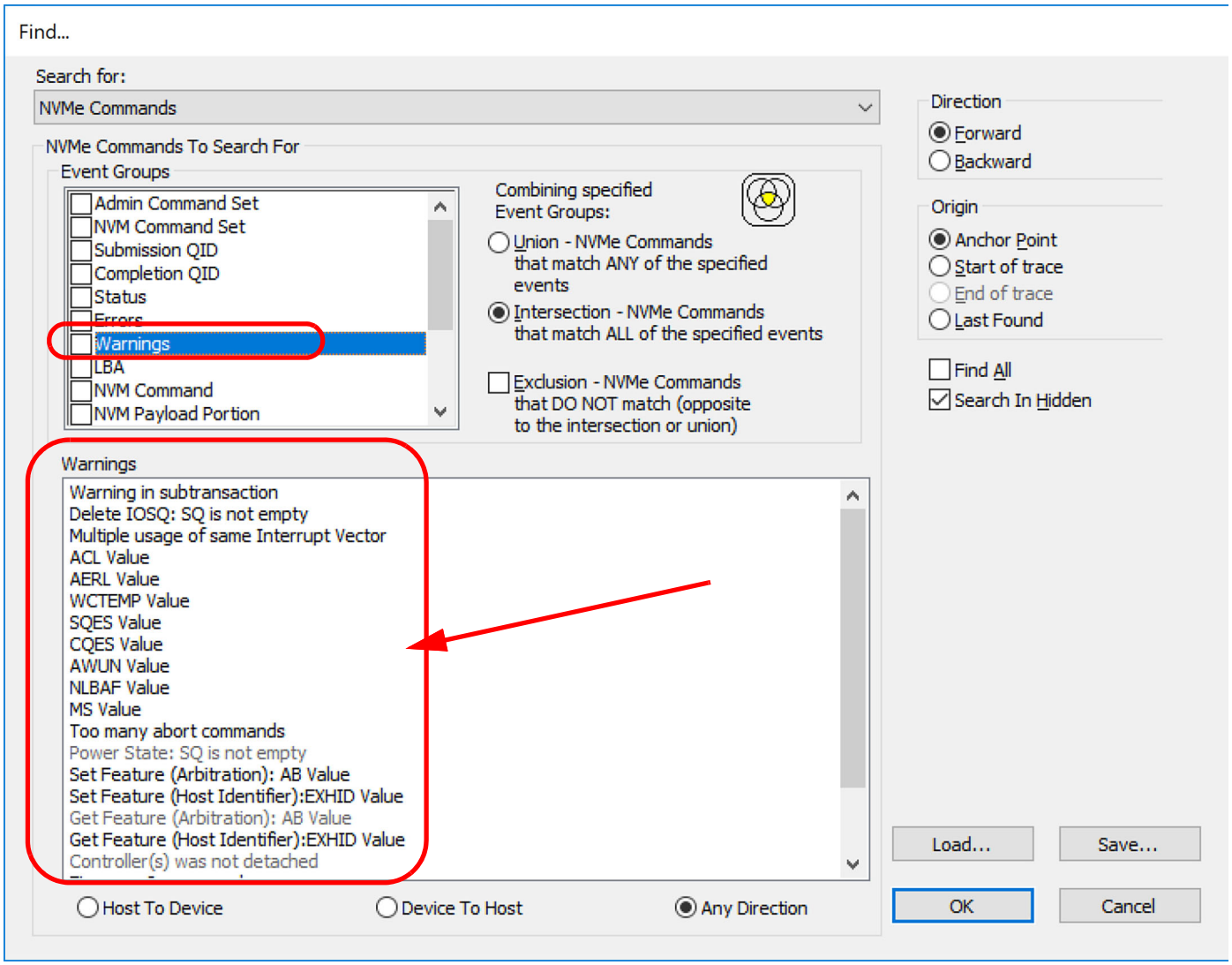


Figure 6.205: Find: NVMe Commands → Warning Messages

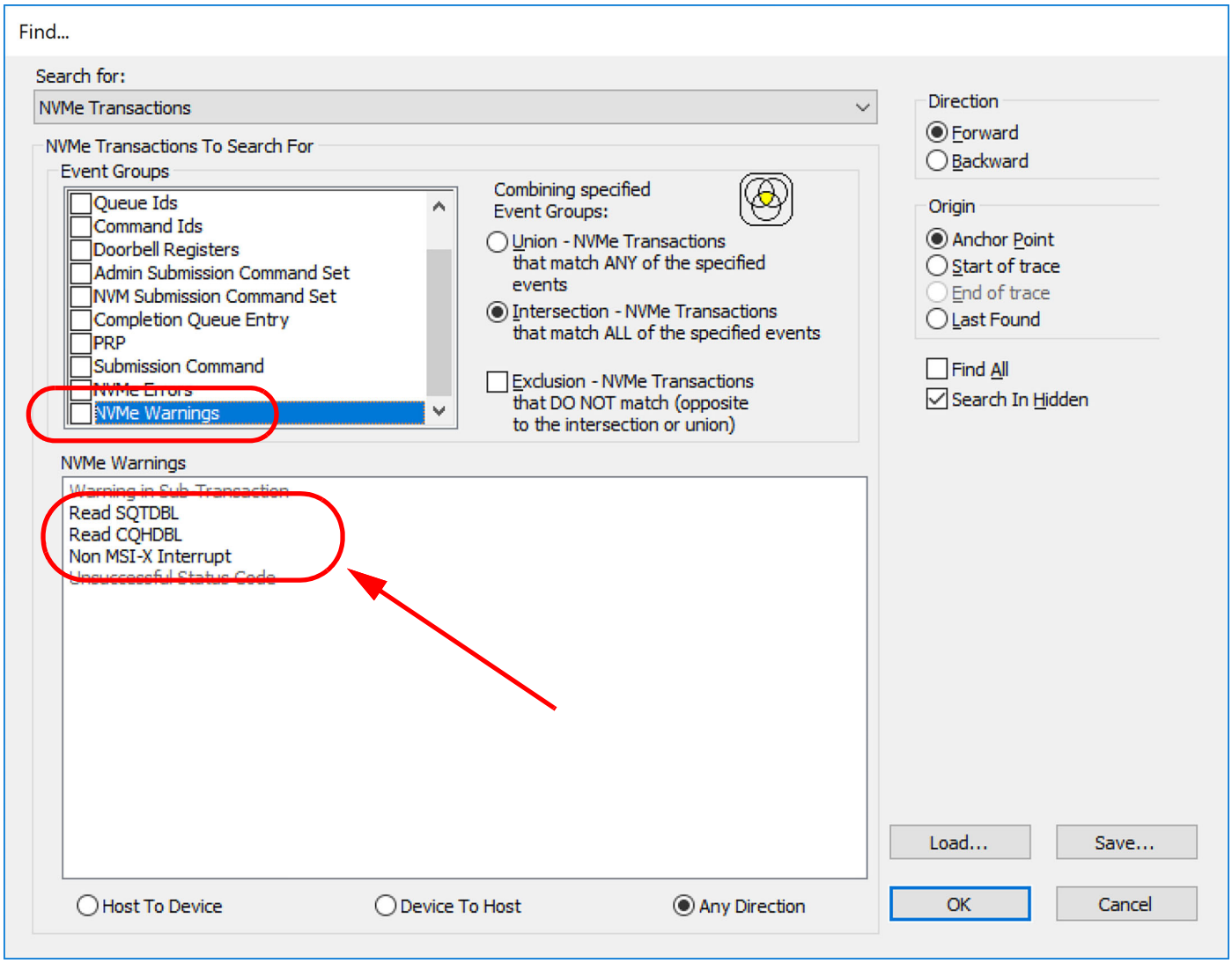


Figure 6.206: Find: NVMe Transactions → Warning Messages

Hiding NVMe Warning Messages

You can also Hide  NVMe Warning Messages to remove them from the traffic. See Figure 6.207 on page 398.

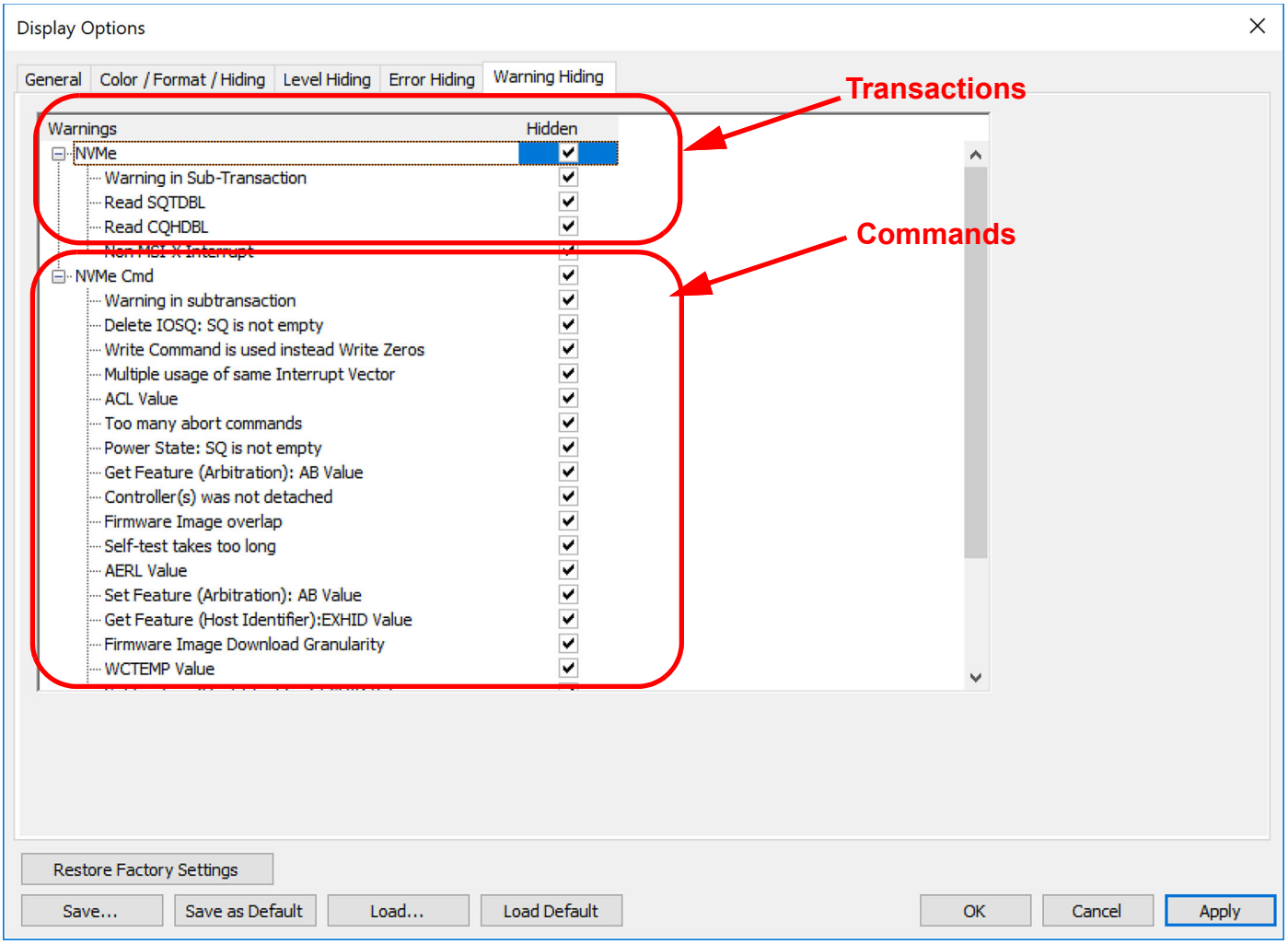


Figure 6.207: Hide → NVMe Warning Messages

6.3.12.26 Warning Messages in Split Traces

The PCIe Protocol Analysis software can decode errors in Split transactions as shown in Figure 6.208.

You can see the following types of Errors:

- Completer Data Inconsistency
- Attributes Mismatch
- Error in sub-transaction

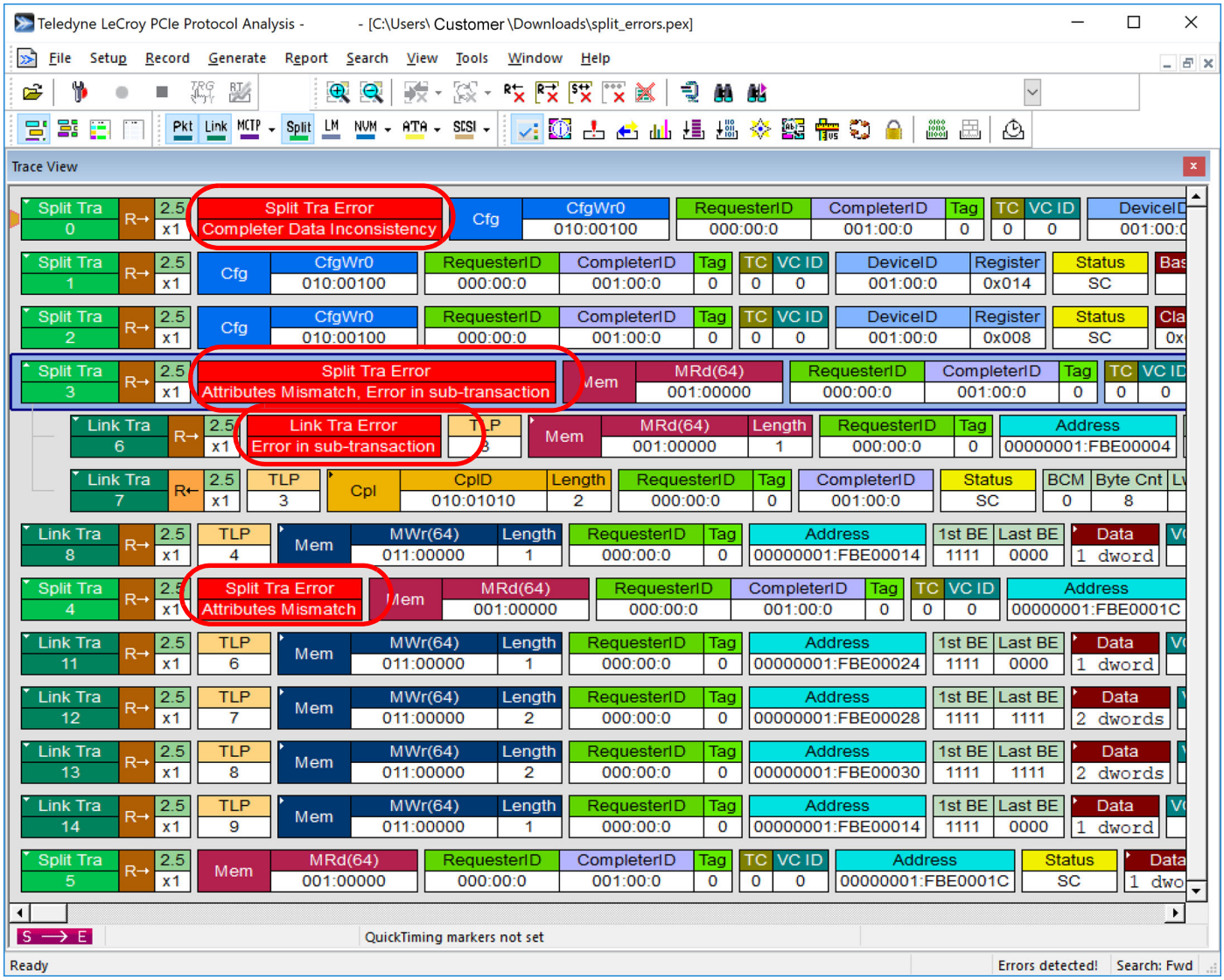


Figure 6.208: Warning Messages in Split Transactions

If you use the Search capability, you will find that the Split Transactions show up in the **Find** → **Search for** → **Split Transactions** → **Errors** as shown in Figure 6.209 on page 400.

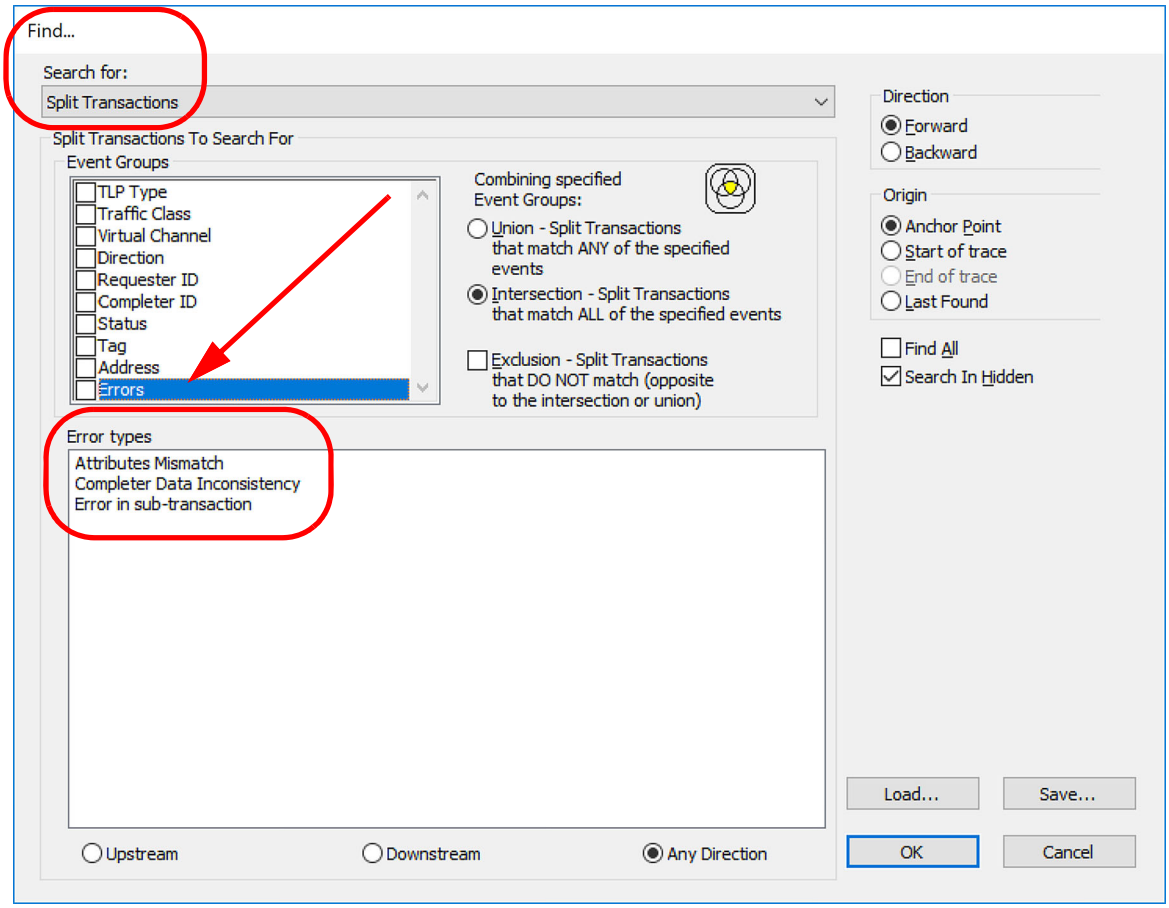


Figure 6.209: Search for Split Transaction Errors

6.3.12.27 Decoding Lightweight Notification (LN) Protocol

The Lightweight Notification Protocol extension would allow co-processors or peripheral chips to talk to each other through system memory using a PCIe transaction without interrupting a host processor. For example, an Ethernet switch could respond to commands to encrypt and decrypt specific data packets while a host processor is inactive.

The PCIe Protocol Analysis software supports the decoding of Gen4 1.0 Lightweight Notification (LN) Protocol as shown in Figure 6.210 as well as the Traffic Summary Report.

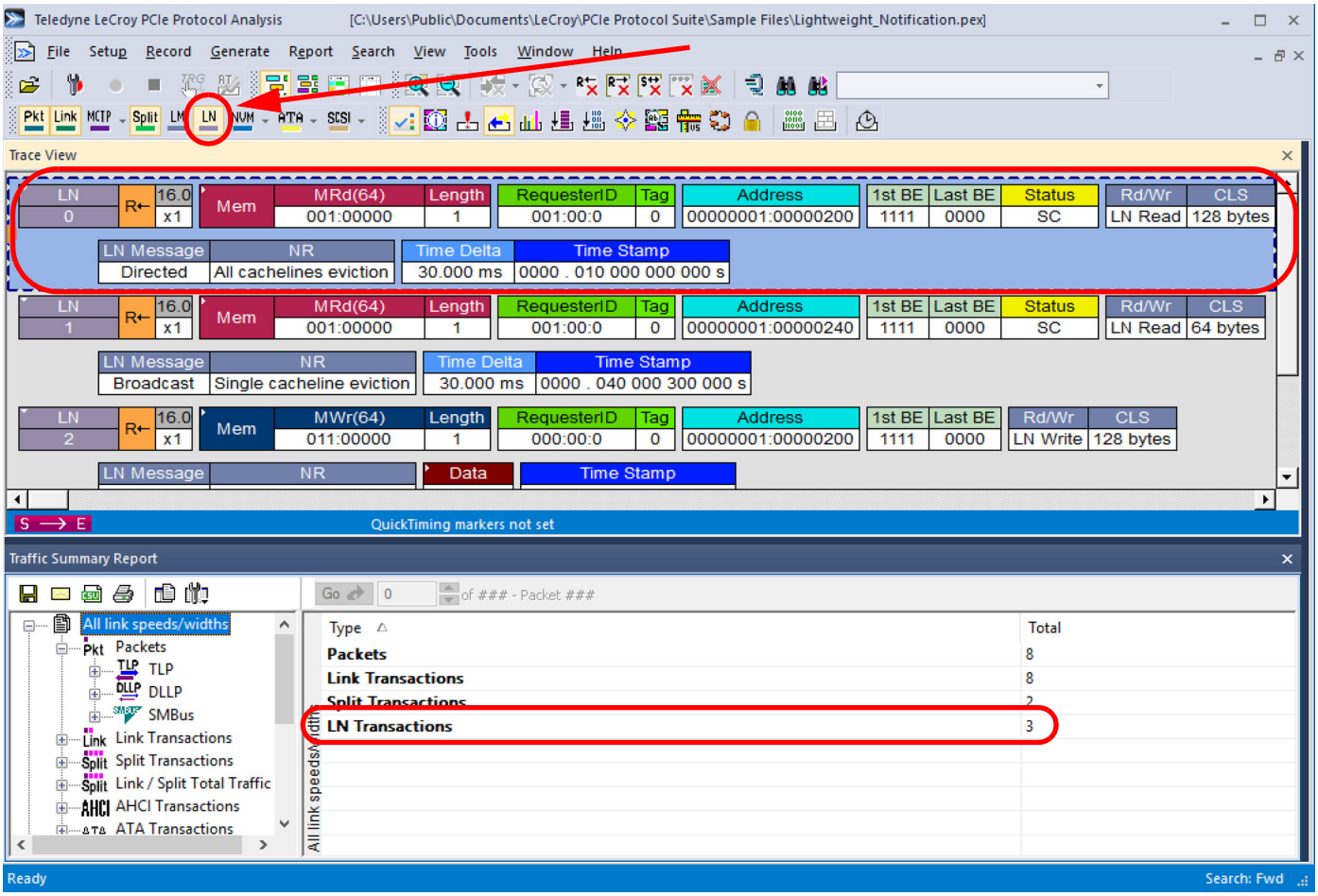


Figure 6.210: Decoding Lightweight Notification (LN) Protocol

Lightweight Notification Protocol Errors

The PCIe Protocol Analysis software also decodes any errors in the LN protocol. See Figure 6.211

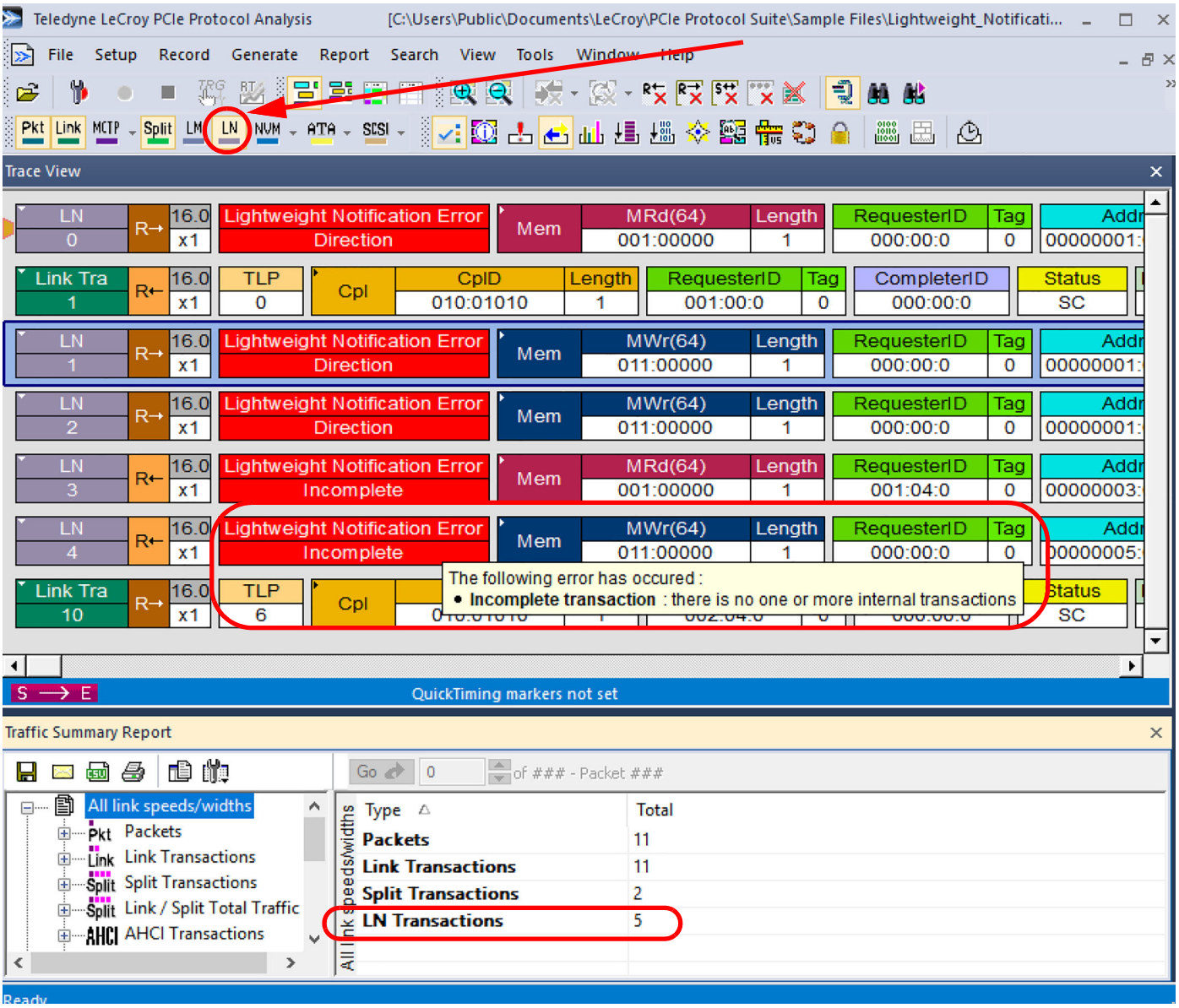


Figure 6.211: Decoding Errors in Lightweight Notification Protocol

Lightweight Notification Protocol in Trace Expert

The LN Protocol is also shown in the Trace Expert View (see Figure 6.212).

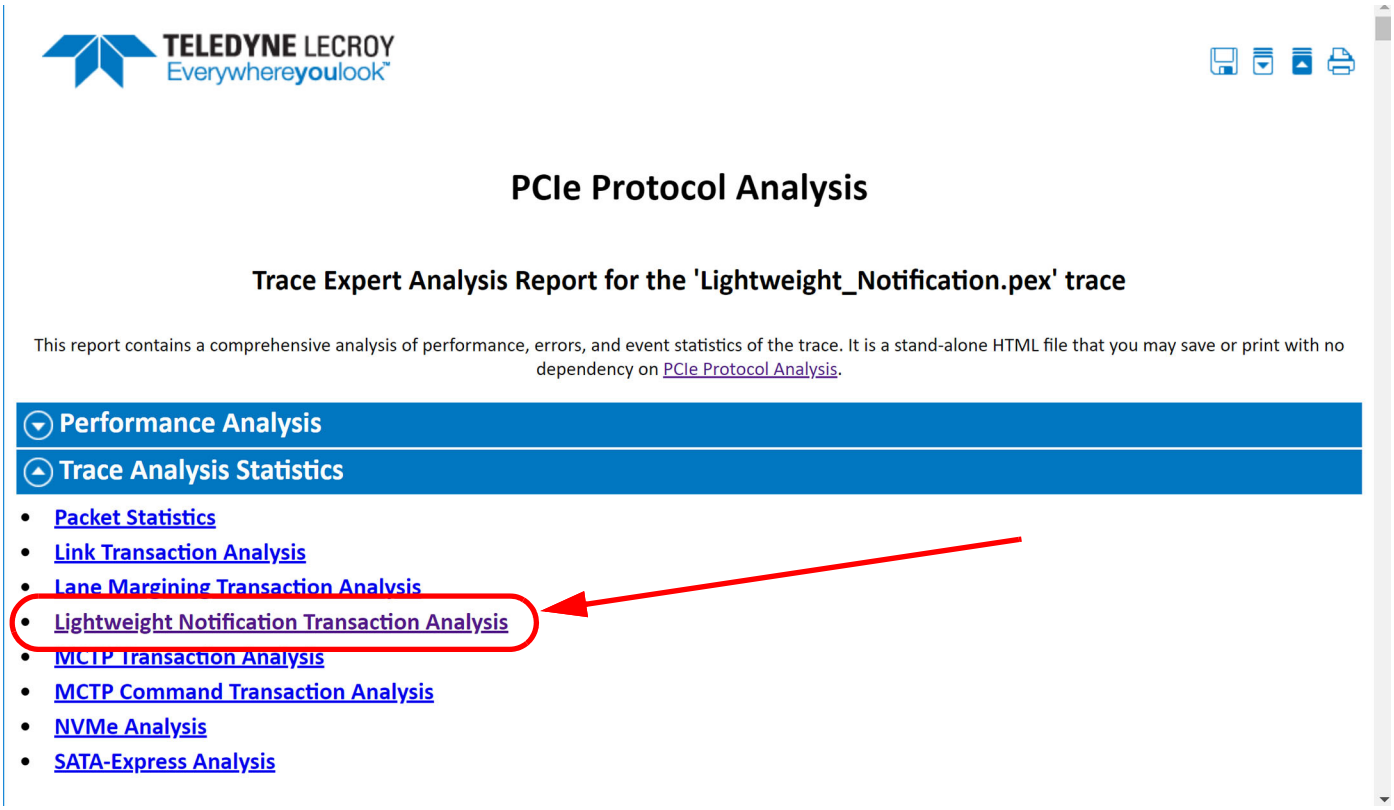
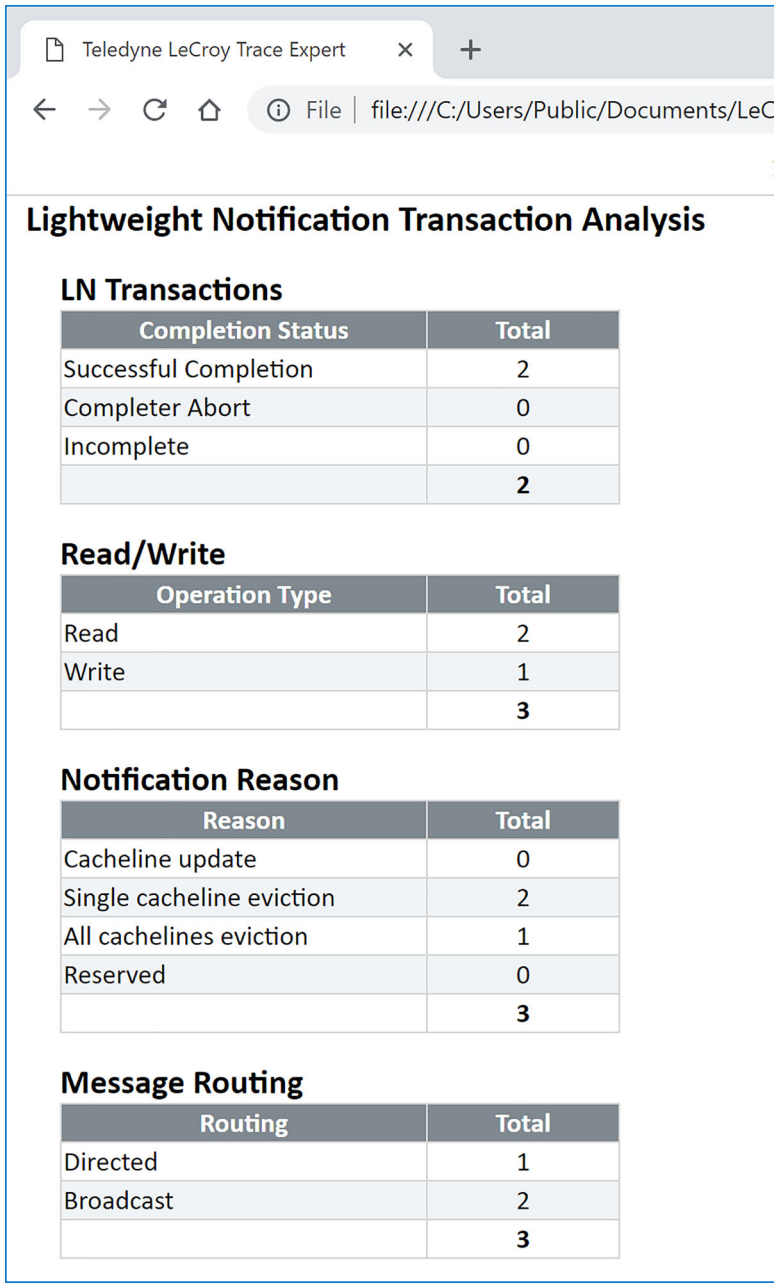


Figure 6.212: Lightweight Notification Transaction Analysis

The details of that LN Transaction Analysis can be seen in Figure 6.213 on page 404.



Lightweight Notification Transaction Analysis

LN Transactions

Completion Status	Total
Successful Completion	2
Completer Abort	0
Incomplete	0
	2

Read/Write

Operation Type	Total
Read	2
Write	1
	3

Notification Reason

Reason	Total
Cacheline update	0
Single cacheline eviction	2
All cachelines eviction	1
Reserved	0
	3

Message Routing

Routing	Total
Directed	1
Broadcast	2
	3

Figure 6.213: LN Transaction Analysis

Lightweight Notification Transaction Analysis Errors: Trace Expert

Lightweight Notification Transaction Analysis Errors can also be seen in Trace Expert. See Figure 6.214.

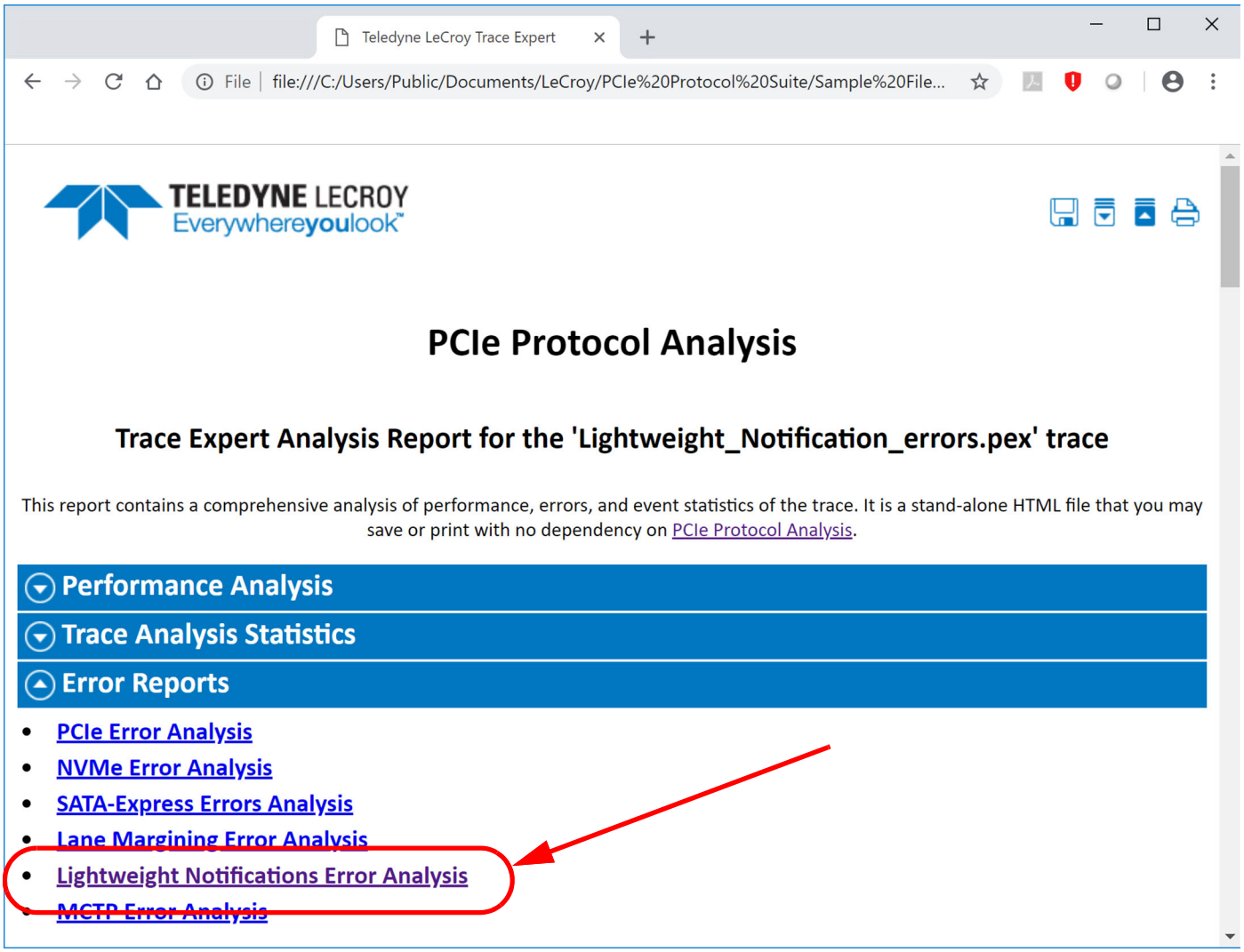


Figure 6.214: Trace Expert: Lightweight Notification Transaction Analysis Errors

Those errors can be seen in detail in Trace Expert (see Figure 6.215 on page 405).

Lightweight Notifications Error Analysis

Lightweight Notifications Errors

Error	Total
Incomplete Transaction	2
Wrong Read/Write Direction	3
Wrong Message Direction	1
Any Error	5

Figure 6.215: Lightweight Notification Errors from Trace Expert

Find: Lightweight Notification Transactions

You can use the Find tool to locate Lightweight Notification transactions. See Figure 6.216.

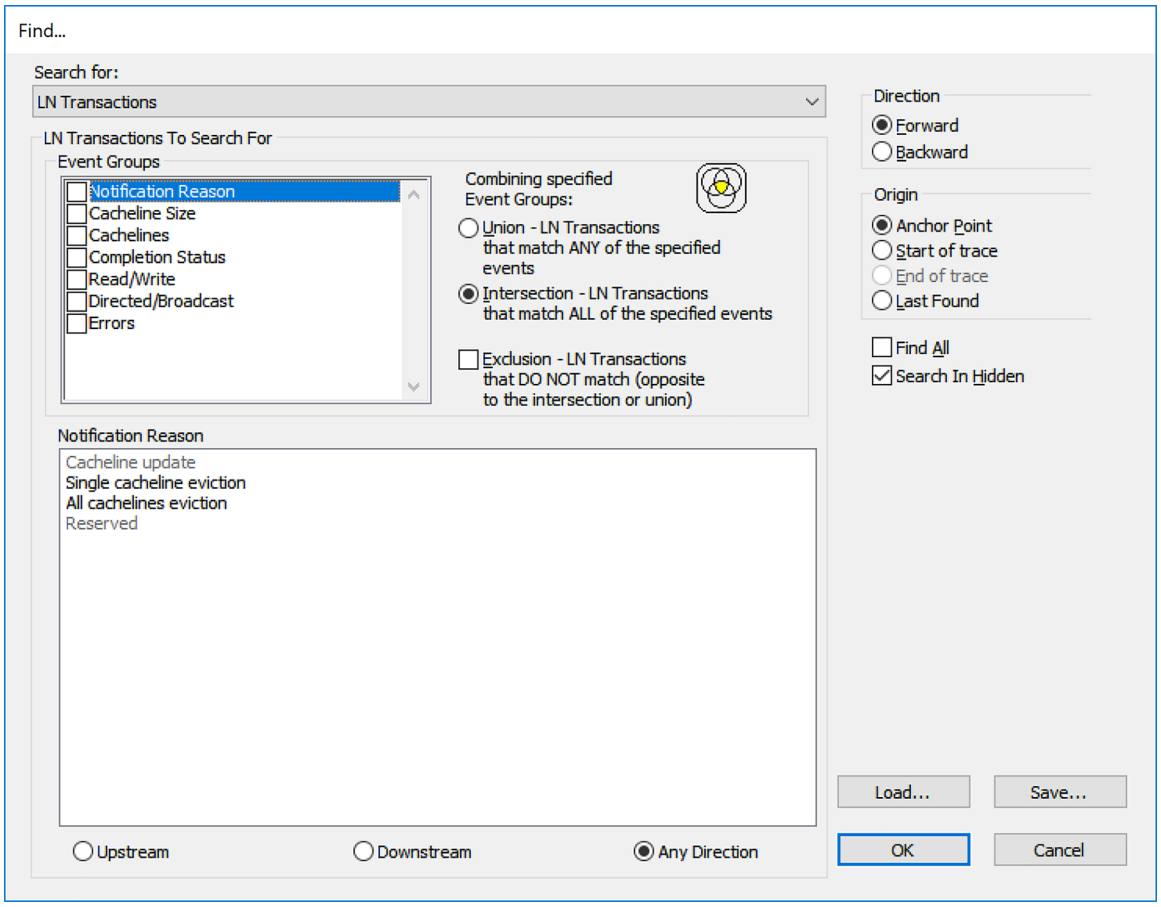


Figure 6.216: Lightweight Notification transactions

6.3.12.28 Decoding CCIX Protocol

PCIe Protocol Analysis software can decode the Cache Coherent Interconnect for Accelerators (CCIX) transaction protocol.

CCIX is a high-performance, low latency, chip-to-chip interconnect architecture that provides a cache coherent framework for heterogeneous system architectures. Cache coherency is automatically maintained at all time between the central processing unit and the various other accelerators in the system. Operating over standard PCIe, CCIX supports signaling rates between 16 GT/s and 25 GT/s per link with support for port aggregation for higher performance.

CCIX is largely an extension of the PCI Express architecture, consists of a number of stacked protocol layers.

- CCIX Protocol Layer - coherency protocol that manages memory reads and writes, provides a mapping for the on-chip architecture-dependent coherency protocols (e.g., AMBA CHI/ACE). This layer also defines the cache state (e.g. shared/unique, clean/dirty).
- CCIX Link Layer - formatting protocol for transport (e.g., PCIe). This layer also

manages link aggregation.

- CCIX Transport Specification
- PCIe Transaction Layer - Handles PCIe transactions. The layer also supports virtual channels, permitting transmission for different data streams across a single shared link.
- CCIX Transaction Layer - Handles CCIX transactions. This layer optimizes out superfluous PCIe packet fields, reducing overhead.
- PCIe Data Link Layer - Handles standard data link layer (e.g., CRC, ACK).
- CCIX/PCIe Physical Layer - Handles standard PCIe physical layer. This layer also supports 25 GT/s ESM mode.

6.3.12.29 Decoding TCG Support of Pyrite

The PCIe Protocol Analysis software is capable of decoding Trusted Computing Group (TCG) Pyrite transactions. See Figure 6.217.

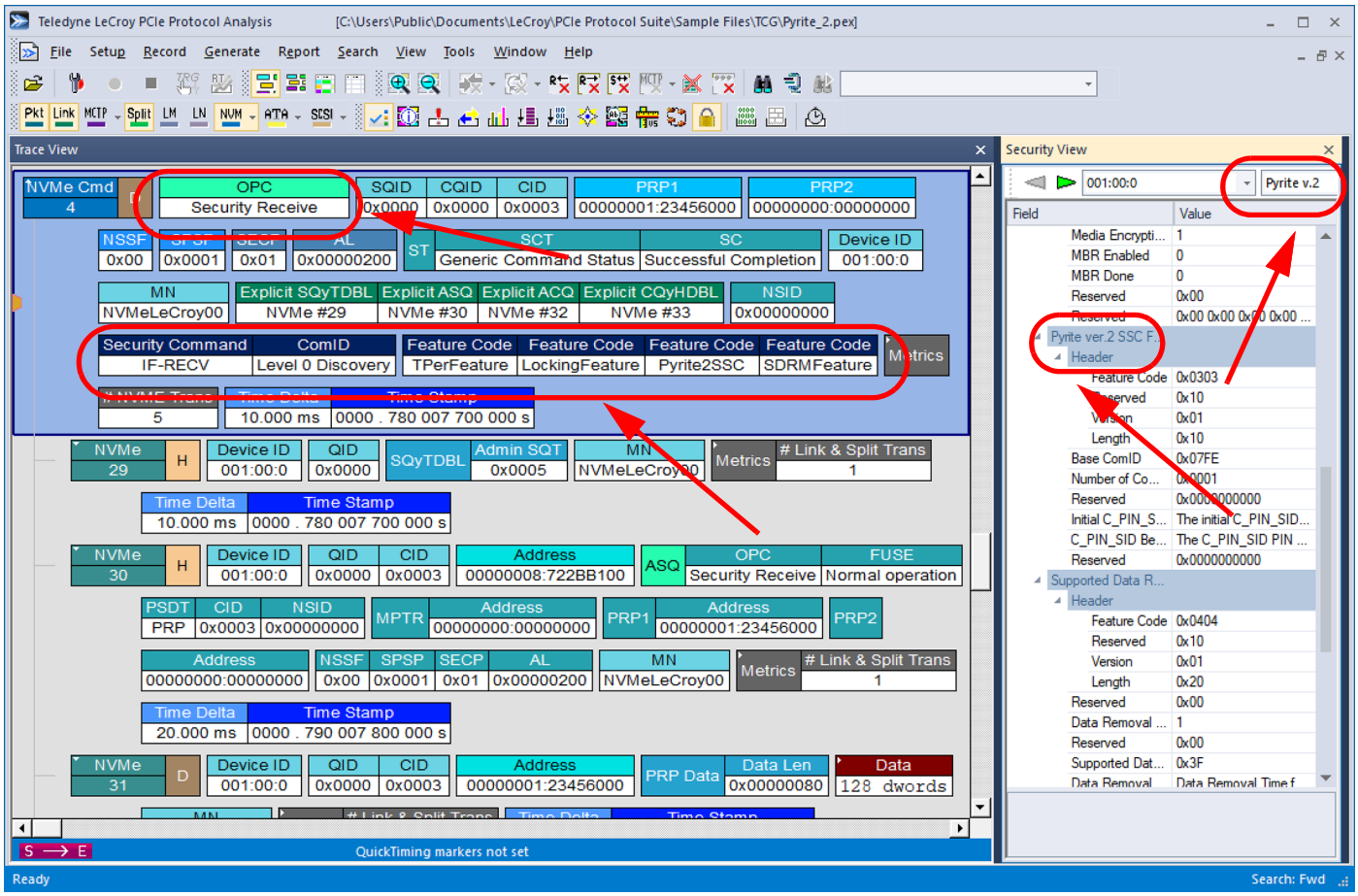


Figure 6.217: TCG Transactions: Decoded → Pyrite

6.3.12.30 MCTP: Simple Hiding

You can hide (or filter out) either MCTP VDM traffic or SMBus MCTP traffic or both by using the MCTP Hide button on the toolbar. See Figure 6.218.

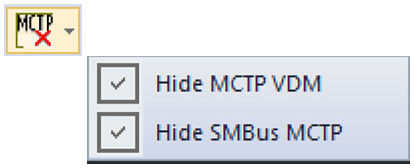


Figure 6.218: MCTP: Simple Hiding Icon

MCTP: Hide VDM Traffic

If you chose to hide only the MCTP VDM traffic a sample trace is shown below without the VDM traffic hidden (see Figure 6.219) and with VDM traffic hidden (see Figure 6.220 on page 409).

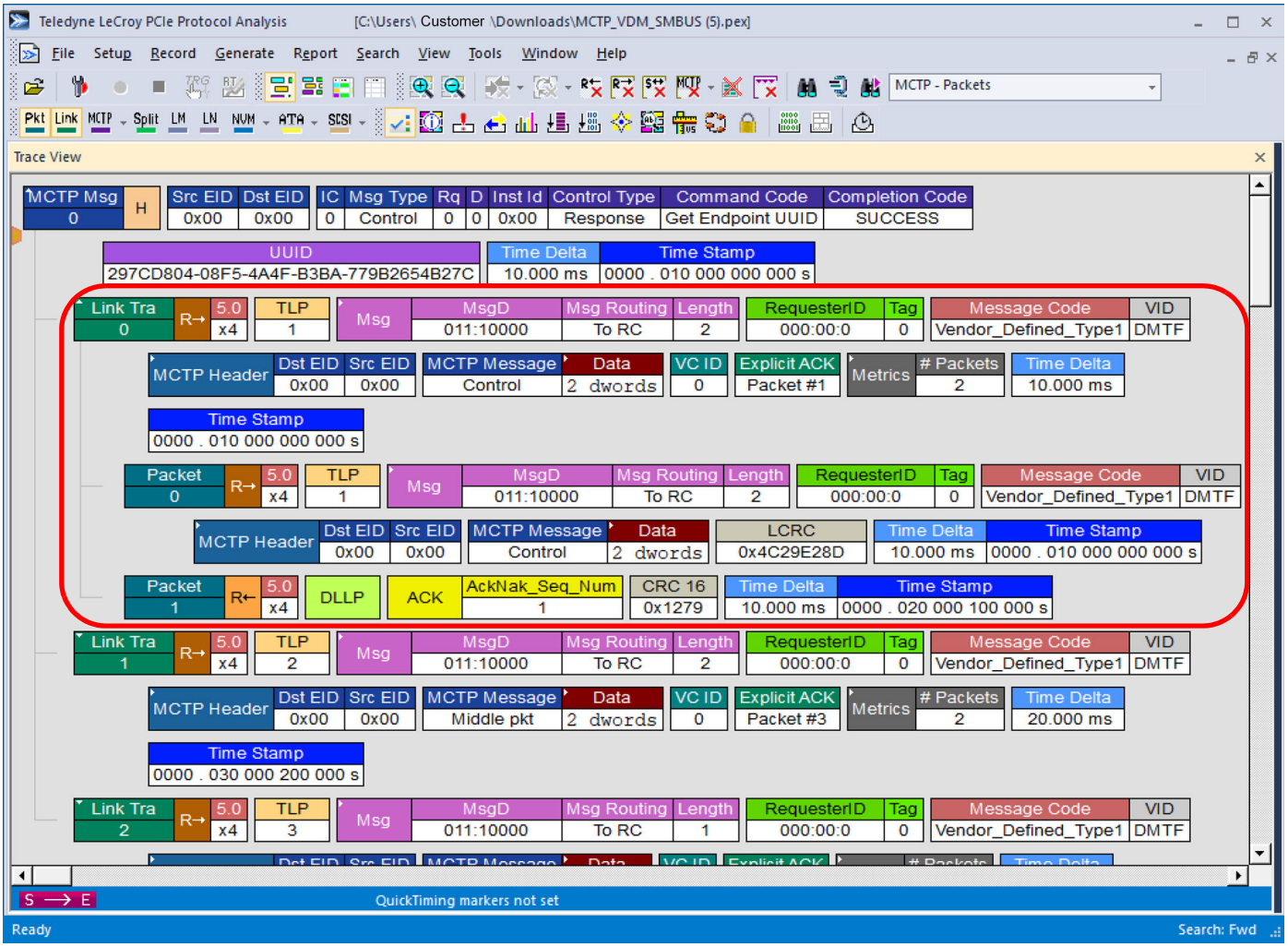


Figure 6.219: MCTP VDN Traffic: Link 0, Packet 0 → Shown

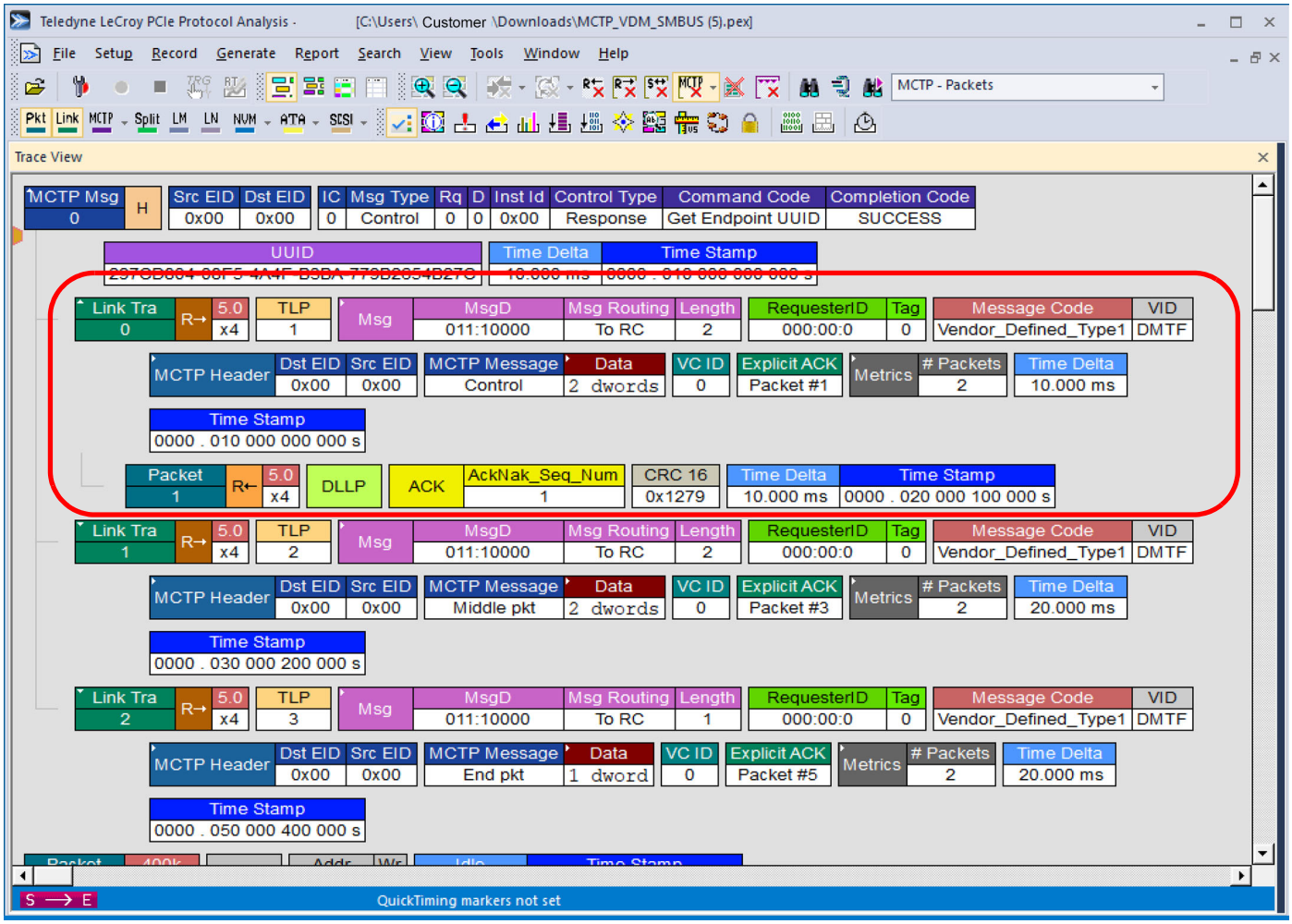


Figure 6.220: MCTP VDN Traffic: Link 0, Packet 0 → Hidden

MCTP: Hide SMBus Traffic

If you chose to hide only the SMBus MCTP traffic a sample trace is shown below without the SMBus traffic hidden (see Figure 6.221) and with SMBus MCTP traffic hidden (see Figure 6.222 on page 410).

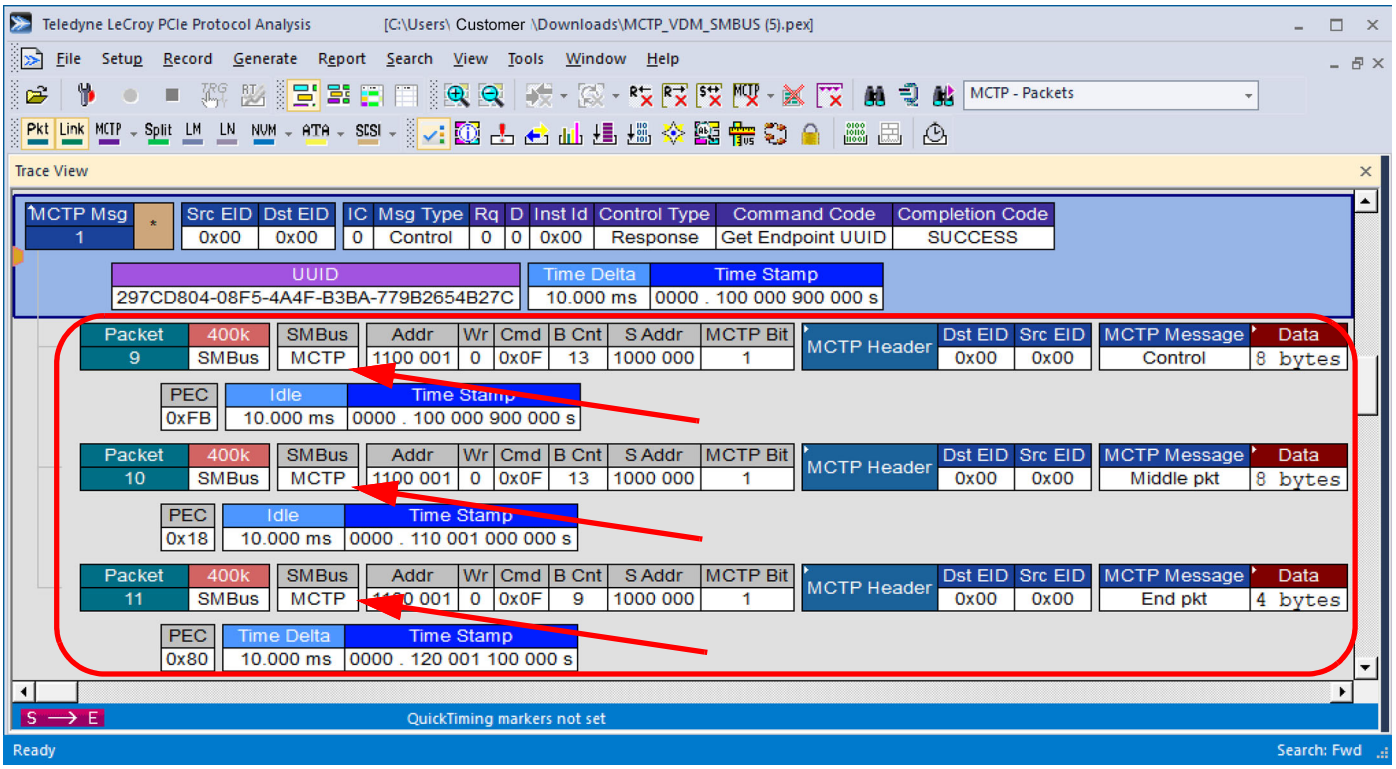


Figure 6.221: MCTP SMBus Traffic: Shown

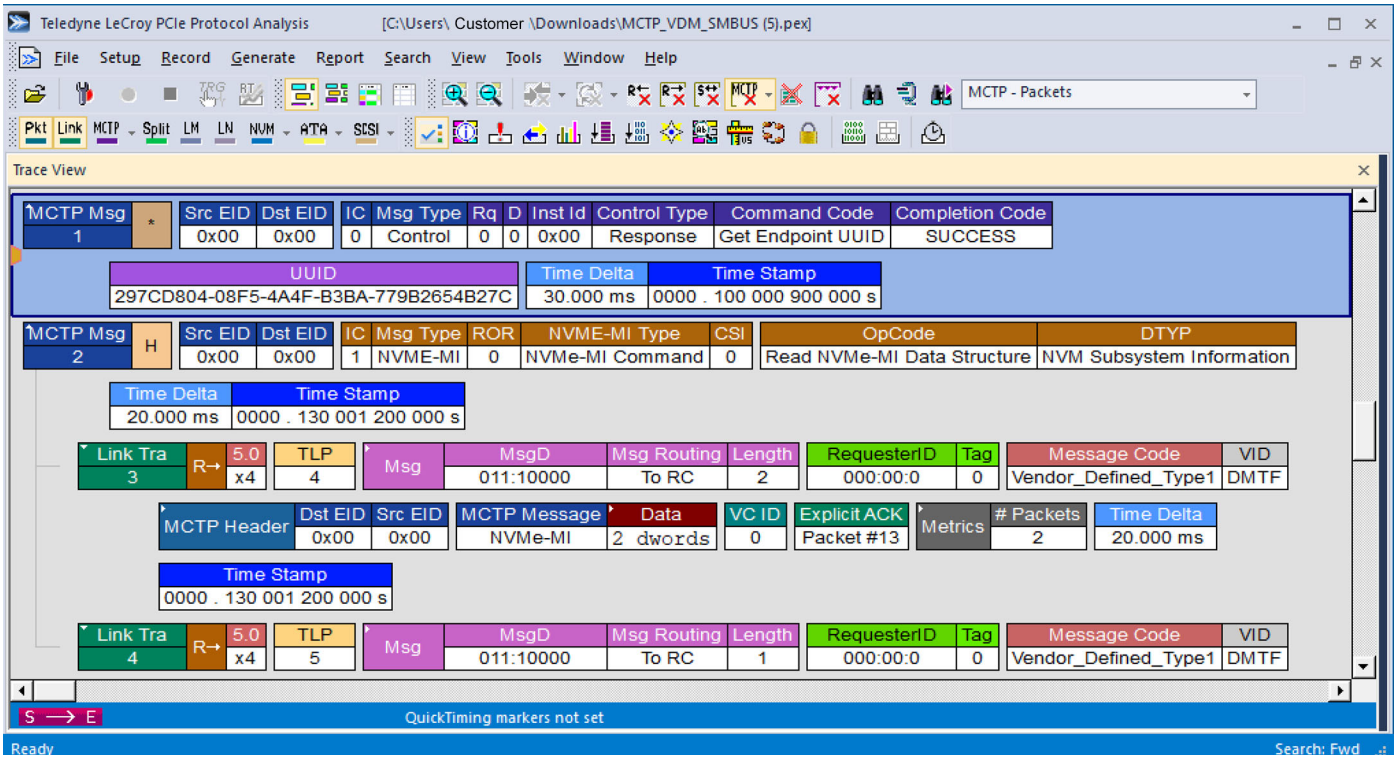


Figure 6.222: MCTP SMBus Traffic: Hidden

6.3.12.31 Decoding NVME-MI Version 1.1

The PCIe Protocol Analysis software can decode NVME-MI Version 1.1 traffic. See Figure 6.223.

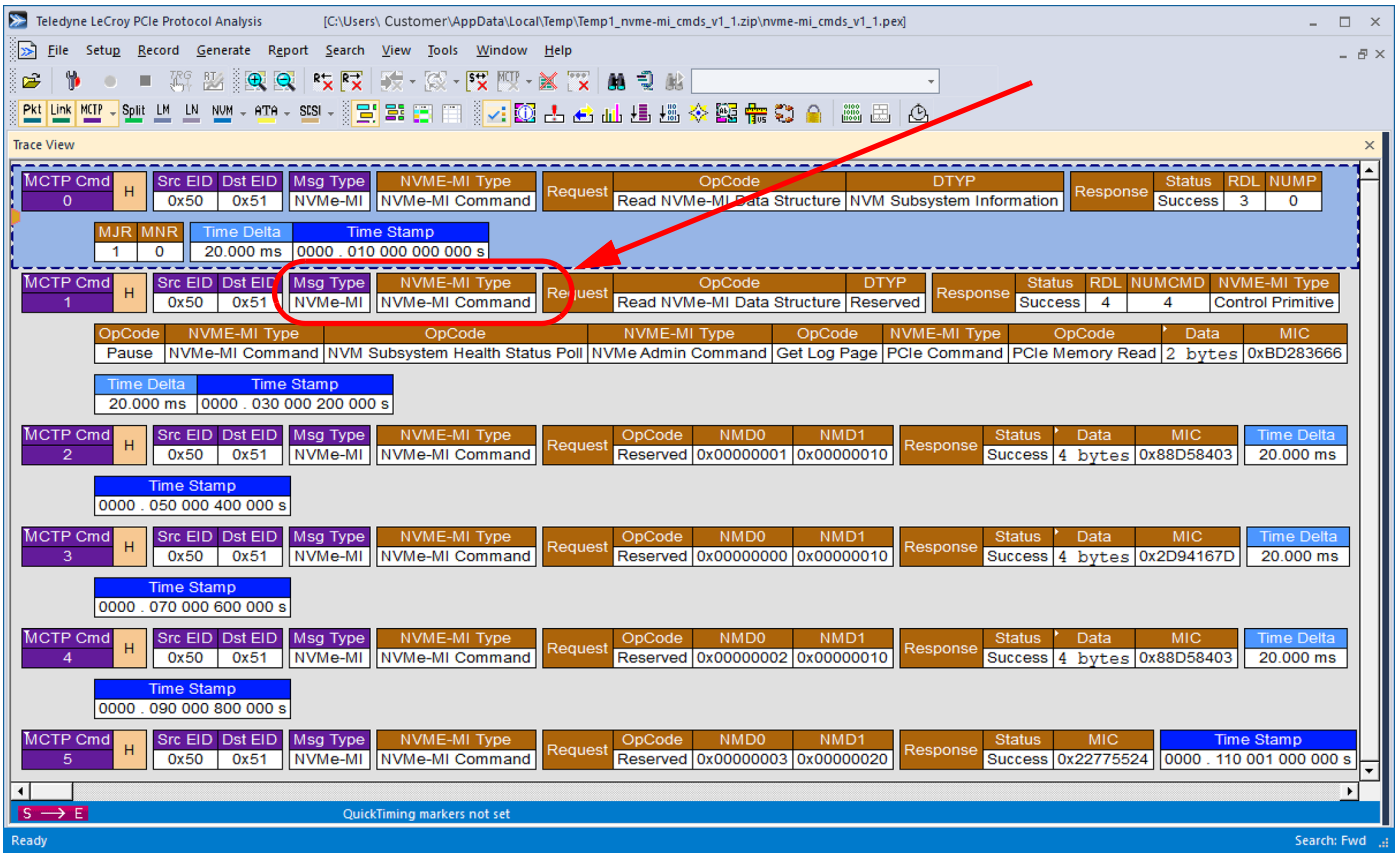


Figure 6.223: Decoding NVME-MI Version 1.1

6.3.12.32 Decoding NVME-MI Version 1.1 with BMC

The PCIe Protocol Analysis software can decode NVME-MI Version 1.1 with Basic Management Commands (BMC) traffic. See Figure 6.224.

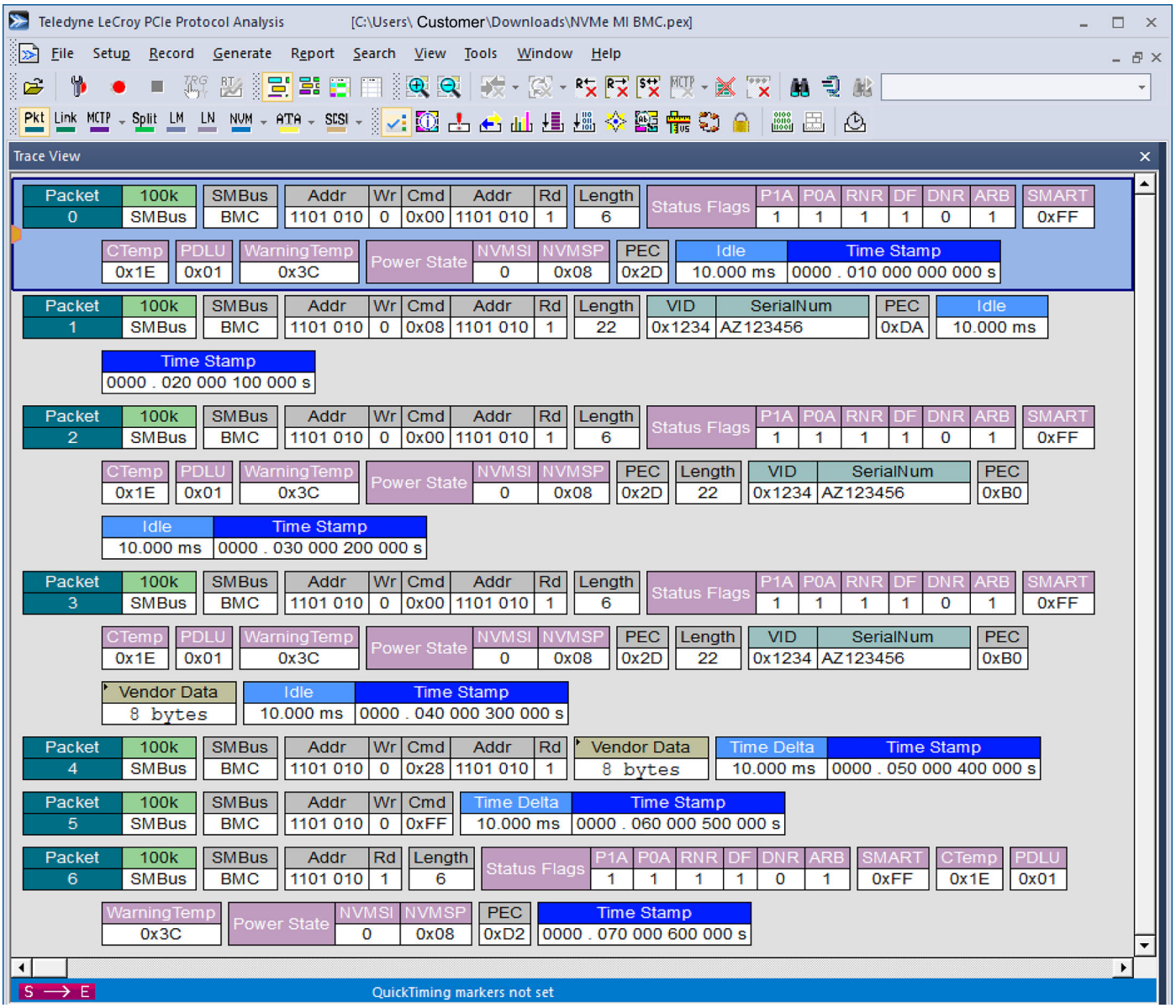


Figure 6.224: Decoding NVMe-MI BMC Traffic

NVMe-MI BMC Errors

The PCIe Protocol Analysis software can decode NVME-MI Version 1.1 with Basic Management Commands (BMC) traffic with errors. See Figure 6.225.

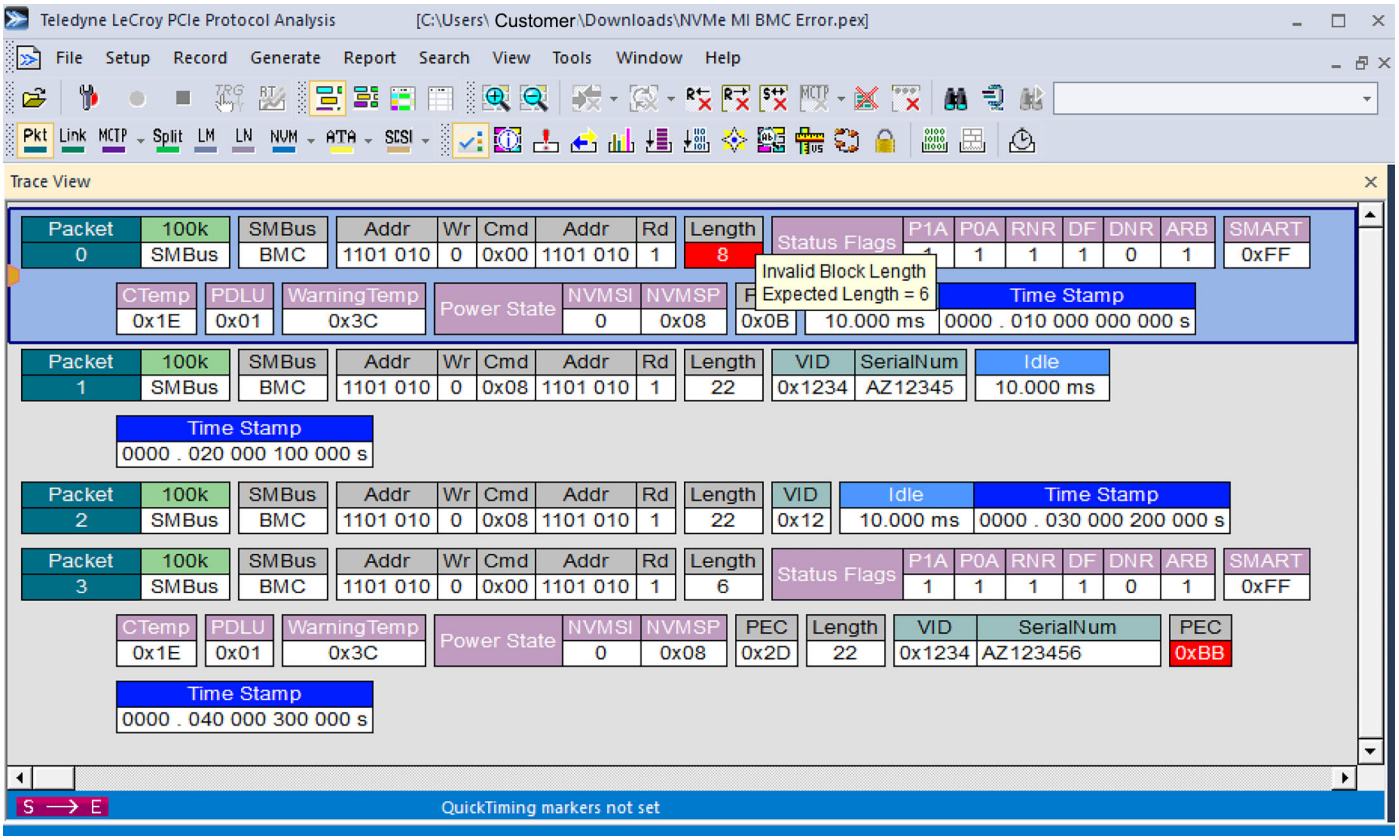


Figure 6.225: Decoding NVMe-MI BMC Errors

Errors Displayed in Traffic Summary

SMBus BMC errors also show up in the Traffic Summary View. See Figure 6.226

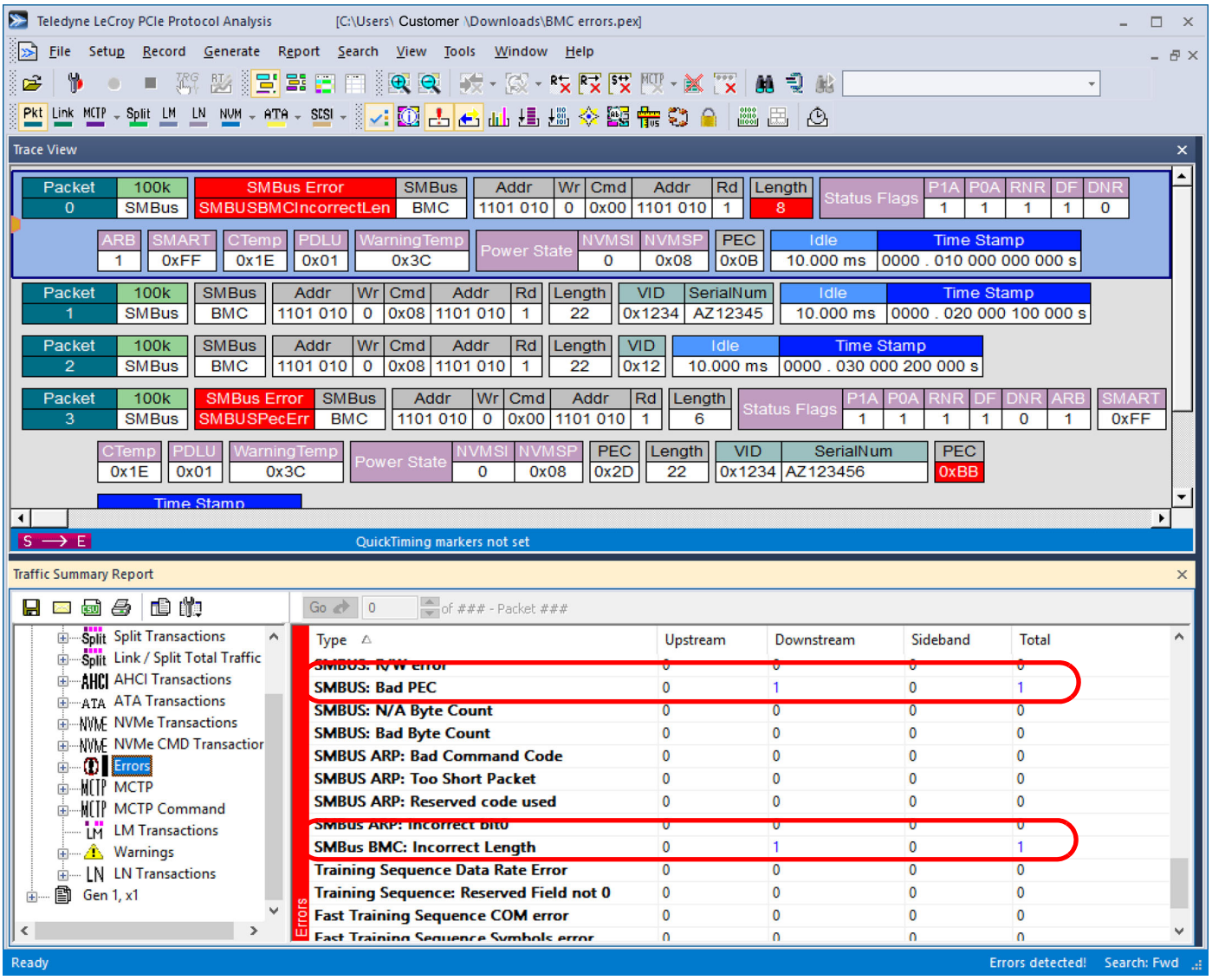


Figure 6.226: SMBus BMC Errors in Traffic Summary

Decoding BMC Commands with Any Offset

The PCIe Protocol Analysis can decode BMC Commands with any offset as shown below in Figure 6.227.

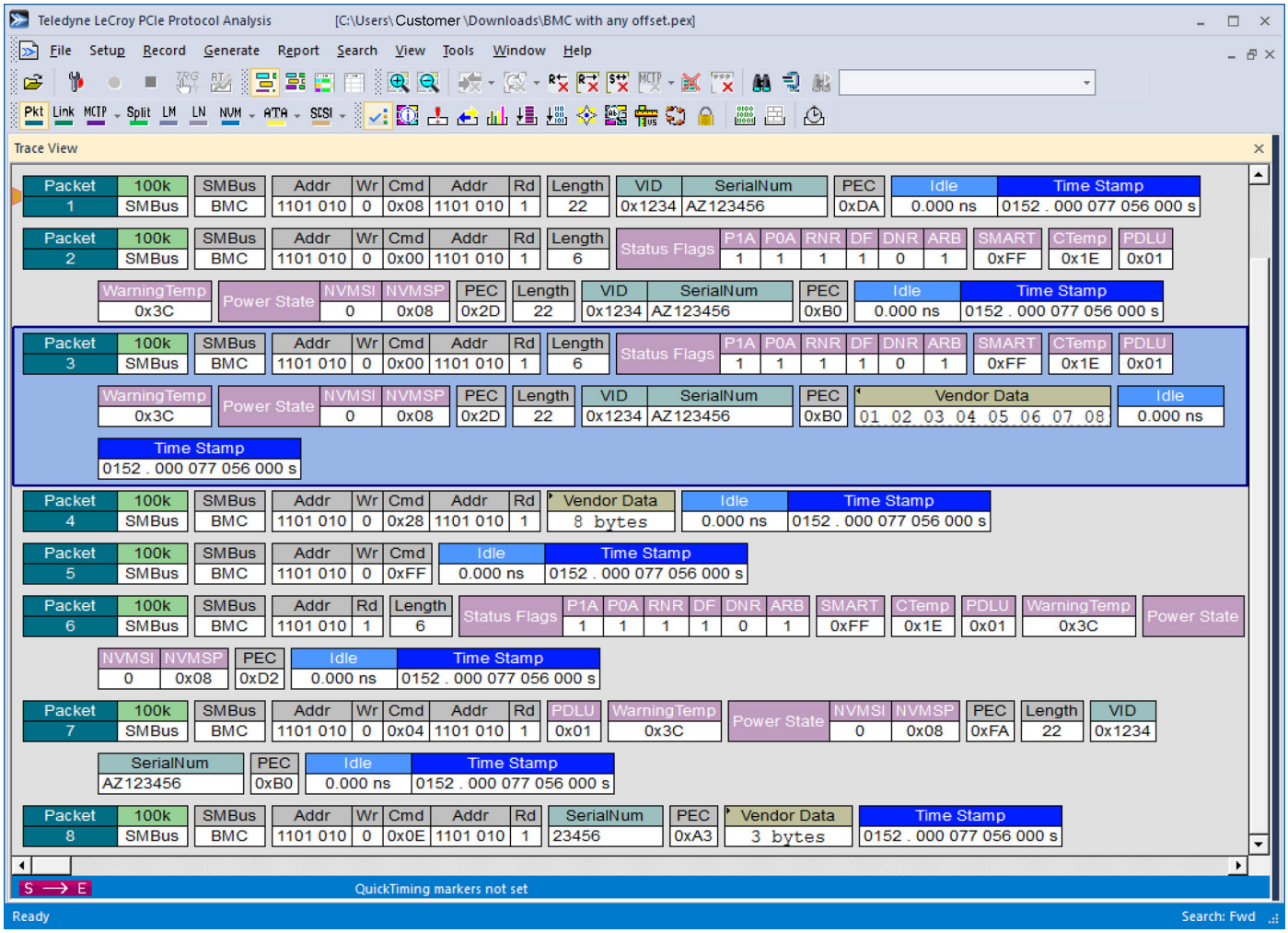


Figure 6.227: Decoding BMC Commands with Any Offset

SMBus Read Commands

When reading data from a DUT with either the ARP GetUDID command or decoding BMC transactions if there is no data in the transaction "???" will be shown in the trace. See Figure 6.228.

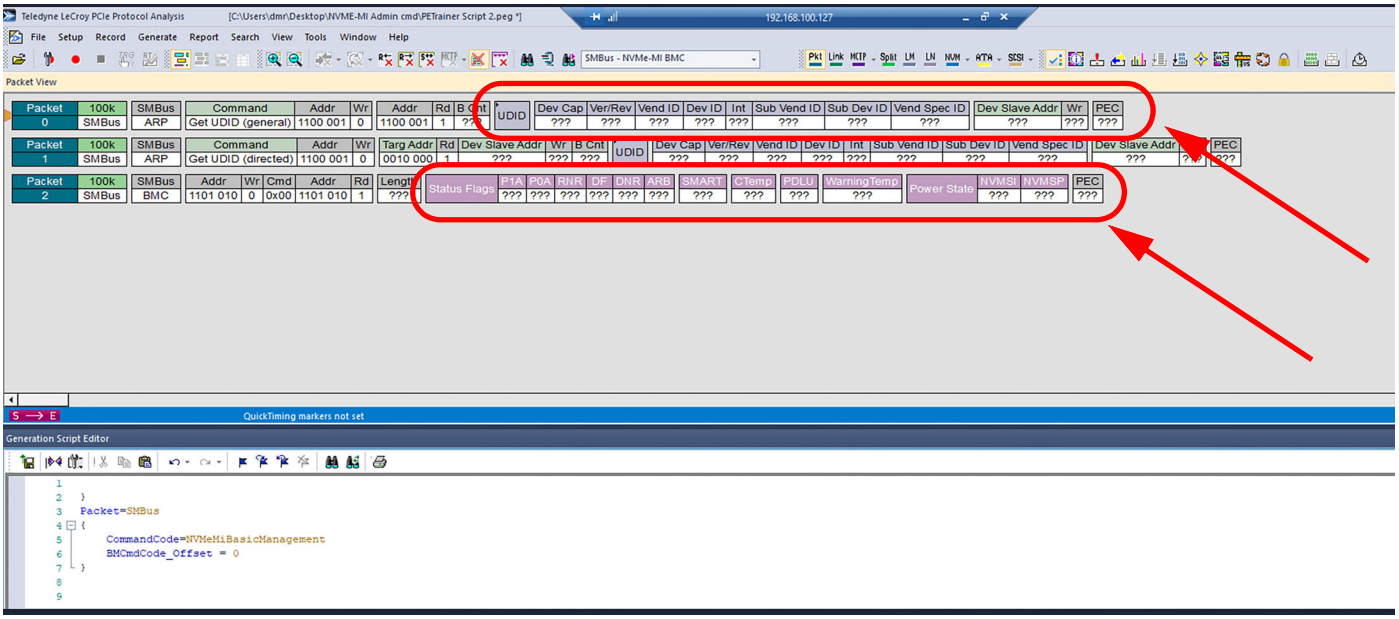


Figure 6.228: Reading BMC transactions from DUT

6.3.12.33 Decoding Traces Exported from USB4 Traces with Tunneled PCIe Traffic

The PCIe Protocol Analysis Suite software is capable of decoding traces exported from USB4 traces which have tunneled PCIe Traffic.

A sample USB4 trace with PCIe tunneled traffic is shown in Figure 6.229. The highlighted Packets #6 and #7 contain Tunneled PCIe traffic with a timestamps of 7.848357050 and 7.848357082 containing DLLP types UpdateFC_Cpl and UpdateFC_NP.

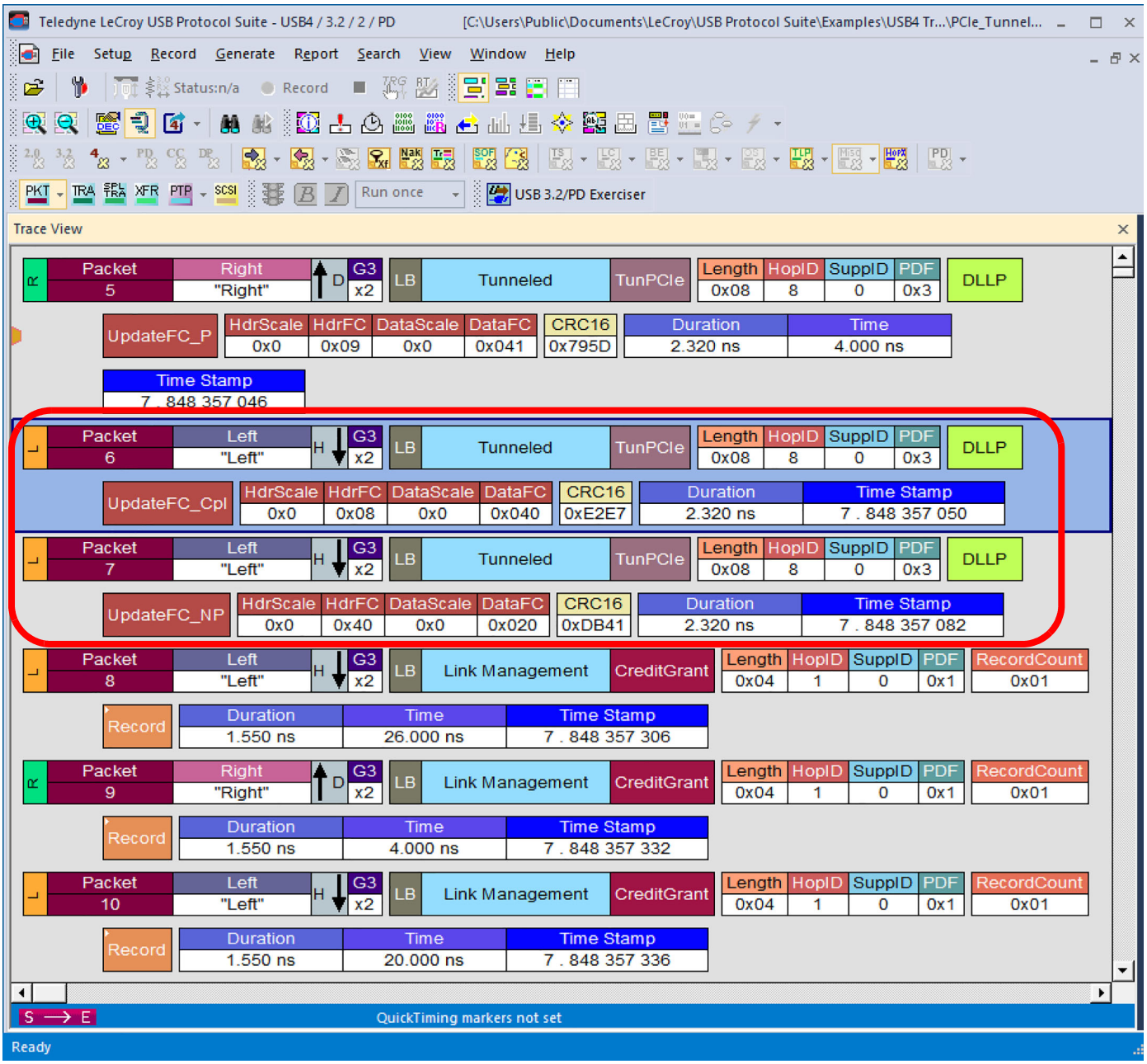


Figure 6.229: USB4 Trace with PCIe Tunneled Traffic

The PCIe Tunneled Traffic from the USB4 trace can be exported to a PCIe trace and decoded and analyzed with the PCIe Protocol Analysis software. See Figure 6.230 on page 418.

The highlighted Packets #4 and #5 contain Tunneled PCIe traffic with a timestamps of 7.848357050 and 7.848357082 containing DLLP types UpdateFC_Cpl and UpdateFC_NP.

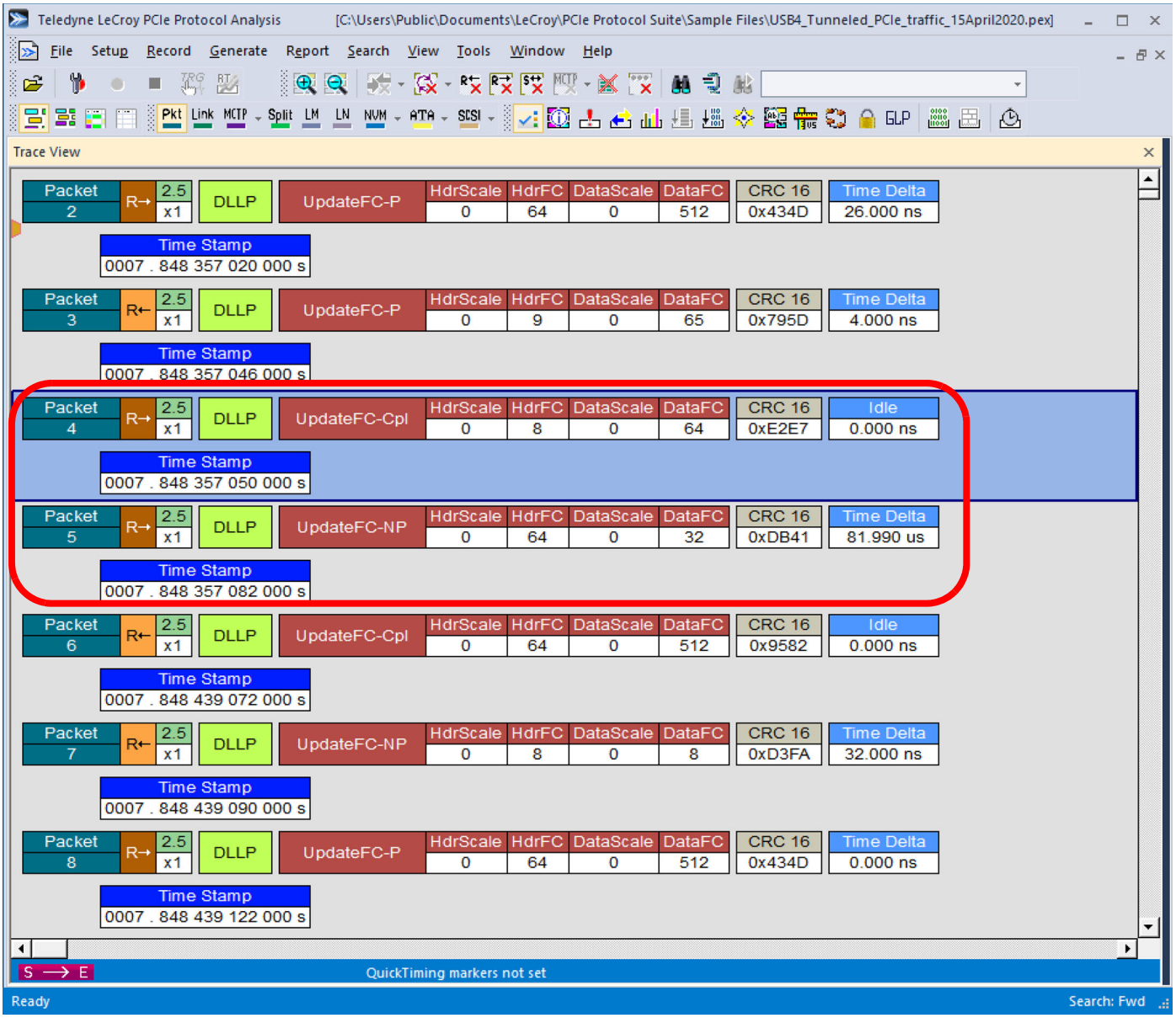


Figure 6.230: PCIe Tunneled Traffic from USB4 Trace Decoded and Analyzed by the PCIe Protocol Analysis software

Note: Link Tracker is disabled for tunneled PCIe packets intentionally, because there is no information about the PCIe link (Link Width, etc.) in USB4 tunnel.

6.4 Searching CATC Traces

This section describes how to search for CATC Trace events.

6.4.1 CATC Trace Search Overview

Several search commands let you navigate a CATC Trace view to search for key events, such as errors and triggers.

To view the search options, click **Search** in the Menu bar.

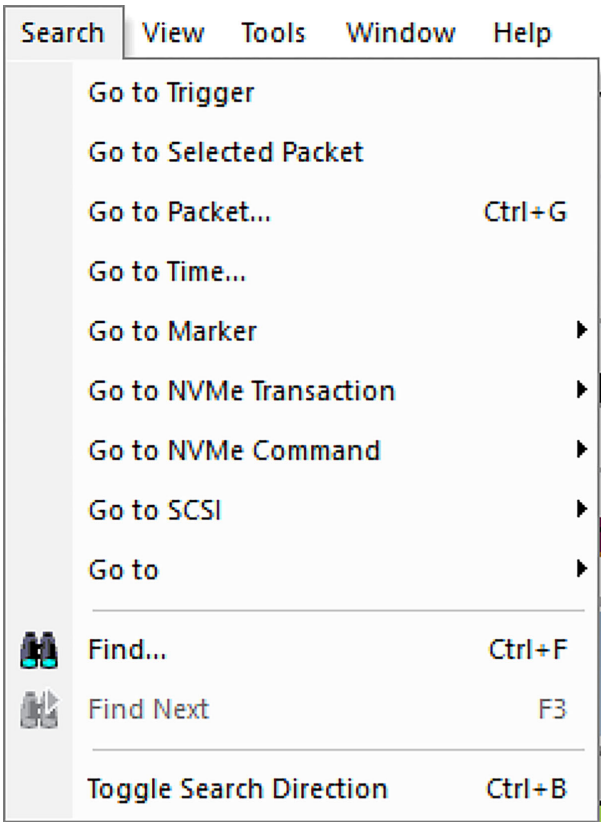


Figure 6.231: Search Menu Options

6.4.2 Go to Trigger

To position a trigger packet at the top of the screen:

Select **Search > Go to Trigger**.

6.4.3 Go to Selected Packet

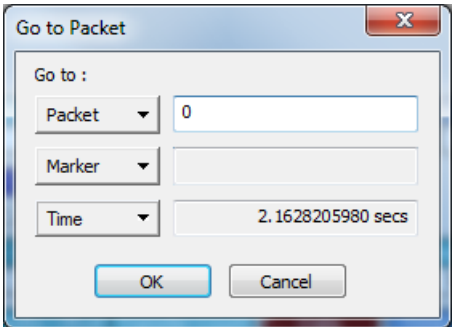
To position a selected packet at the top of the screen:

Select the packet and Select **Search > Go to Selected Packet**.

6.4.4 Go to Packet

To position a specific packet at the top of the screen:

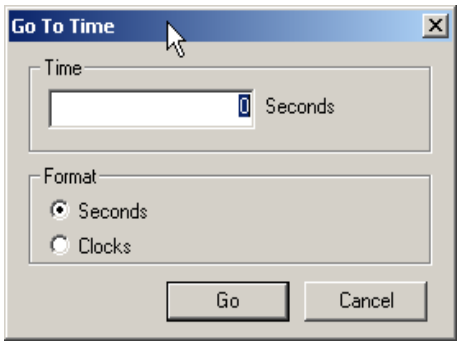
1. Select **Go to Packet** from the Search menu. A pop-up menu prompts you for the packet number, marker, or time (see the following figure).
2. Choose the needed transaction level from the Packet drop-down list and enter the transaction number. Please note that transaction levels is added to list if corresponding level is decoded for current trace file.
3. Click **OK**.



6.4.5 Go to Time

To position a specific time at the top of the screen:

1. Select **Go to Time** from the Search menu. A pop-up menu prompts you for the time in Seconds or Clocks.



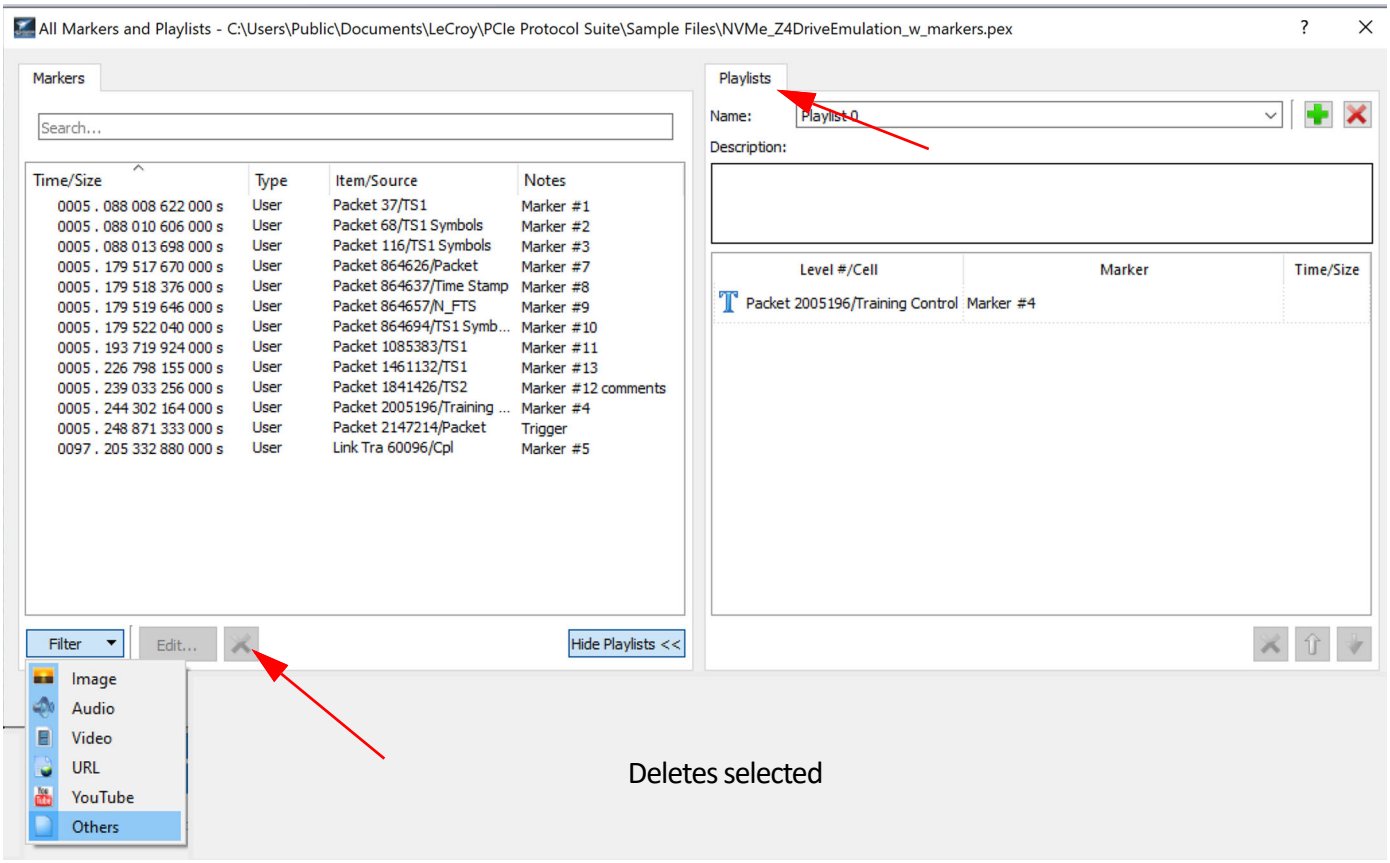
2. Enter the time and format (seconds or clocks).
3. Click **Go**.

6.4.6 Go To Marker

Use this operation to go directly to a specific packet or transaction that has been marked with a unique marker by the Set Marker operation.

To go to a marker:

1. Select **Go To Marker** from the Search Menu.
2. Select the marker you want from the fly-out menu.
   Alternatively, select **All Markers** to display the All Markers and Playlists dialog, then select a marker and click **OK** (see figure on next page).



6.4.6.1 Markers

This section explains the features of Markers. A marker is an entity that flags a physical or logical item of interest within a trace file. A marker contains one or more attachments. You can add a marker to a trace file or unmark a trace file by removing the marker.

Markers are represented graphically in a different way in the application.You can not only add markers to the packets but it is granular enabling you to also add markers to individual cells.

Markers Overview

This functionality provides the user an easy way to navigate through attachments which is a discrete piece of information or data added to a marker, for example, a text description or file, an attachment of a trace file by a predefined order, video or audio files, URL links or any other files.

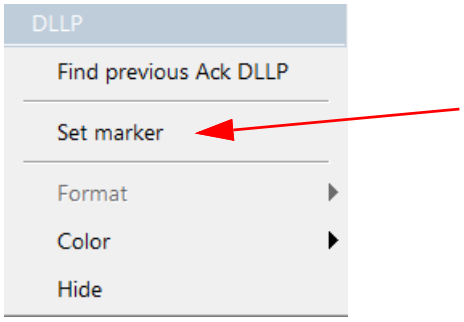
Functionality of Markers

The markers functionality allows you to add markers to:

- Whole packets or frames
- Specific Cells
- Specific values within a cell: Bytes, words, etc.
- The Timestamp of a Packet

You can add attachments to markers.

Right-click on any cell of a packet and select **Set Marker** from the menu as shown below.



The Create Marker dialog displays (see Figure 6.232 on page 422).

Set New Marker

Markers are useful to identify specific points in the data. By default markers follow a numbering convention but can be renamed. Markers can also be inserted by using the keyboard (see Figure 6.232 on page 422):

- Hover your mouse pointer over a packet and press **Ctrl+K** to insert a marker for that packet.
- Click a packet to select it and press **Ctrl+L** to insert a marker for that packet.

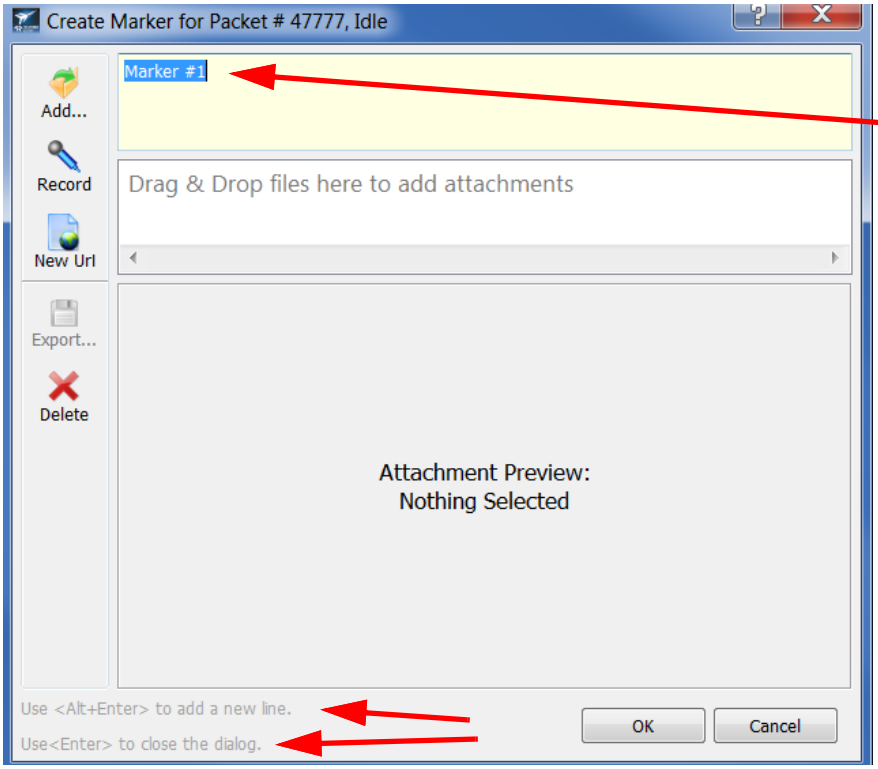


Figure 6.232: Create Marker for Packet Dialog

Click **Enter** to close the Marker dialog.

Click **ALT > Enter** to add a new line.

As shown above you can:

	Add icon. Click on this icon to add any file. See “Adding an Attachment” on page 423.		Export icon. Click on this icon to export an attachment.
	Record icon. Click on this icon to record audio. See “Recording an Audio File” on page 424.		Delete icon. Click on this icon to delete an attachment
	New URL icon. Click on this icon to add any URL.		

6.4.6.2 Attaching Markers

You can attach a discrete piece of information/data to a marker, for example, a text description or file, an attachment of a trace file by a predefined order, video or audio files, URL links or any other files. You can also remove an attachment from a Marker.

6.4.6.3 Adding an Attachment

Perform the following steps to add an attachment to a marker:

1. Right-click on any cell in the trace and select **Set Marker.**

   The Create Marker window displays (see Figure 6.233 on page 424).
2. Click on the **Add** icon.

   The **Add File to the Marker** dialog displays.
3. Go to the file and select it to add it to the marker as an attachment.
4. Click **Open**.

   The file will appear in the Create Marker for Packet... dialog. The Marker # appears in the top panel, the icons are displayed in the second panel and you can click on the icon on the third panel to view the file you are about to attach.
5. Click **OK** to add the attachments.

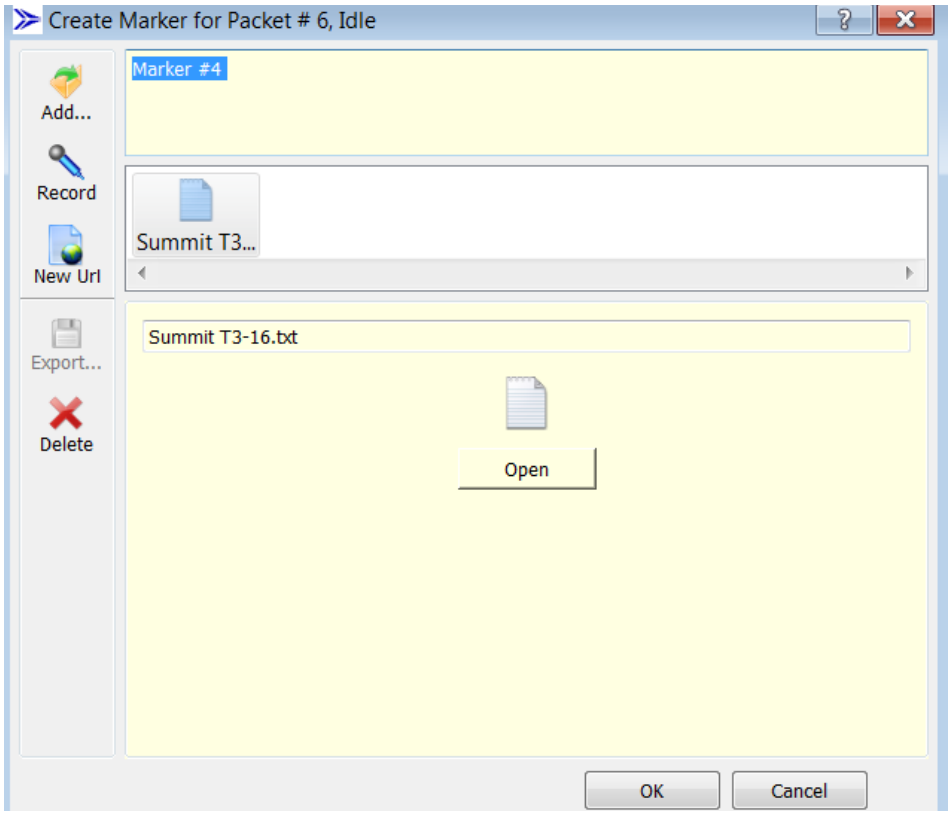


Figure 6.233: Create Marker for Packet Dialog

6.4.6.4 Recording an Audio File

The audio quality supports voice attachment and is not designed for high-quality audio Playback of audio content is not limited and depends on the formats supported by the installed playback engine.

Click the record icon and speak into the microphone to record an audio file.

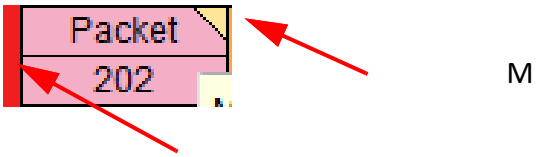
Note: This functionality is disabled if a microphone is not installed.

6.4.6.5 Video Files Supported

The user can attach video clips to the trace file (“add to the marker”). The playback of the Video clips is limited to the formats that are supported by the video codecs installed in the system.

6.4.6.6 Attachment Types and Visualization

The markers are represented graphically by a yellow triangle at the top right of the marked item and a red vertical bar at the left-most cell of a packet as shown below.



M

A marker may comprise any number of attachments of any types.

6.4.6.7 Embedded Attachments to a Marker

Embedded files are attached to the item marked and transported with the trace. You can embed the following types of files to a marker:

- Audio Files
- Video Files
- Image Files
- YouTube Files
- Web Pages
- Text Attachments
- Other Attachments

Attachments are embedded in the marker and saved in the trace file. Once attachments are placed in a marker, the marker can then be presented to a user in a story structured form. On opening the marker the window resembles the marker editing dialog.

Note: The use of Audio and Video markers is limited to the file types supported on a user's system. CATC Walk has been tested with .mp3 and .wmv files, which are supported by Windows as installed. If additional codecs are installed, they should also work, but it is the user's responsibility to choose formats that will work for whomever they intend to exchange CATC trace files (no different than email attachments in this regard). Because of this dependency on installed codecs, there are situations where bugs in the codecs supplied by Microsoft or third-party applications can prevent proper operation of the Teledyne LeCroy PCIe Protocol Analysis application. See the Teledyne LeCroy PCIe Protocol Analysis Application Read-Me file for more information if you have problems with application crashes, etc.

6.4.6.8 Viewing Attachments of a Marker

If you hover over the marked cell (yellow triangle at the top right of the marked item), refer to "Attachment Types and Visualization" on page 424, a window pops up displaying the contents of the marked cell (see Figure 6.234 on page 426).

While hovering over the marked cell, it can start playing the start of the audio or video file, but it will stop after a short time due to the Analyzer's host system timeout for Tooltips. You must click on it to open the audio or video attachment for further listening or viewing.

To view an attachment you can click on any of the icons in the attachment bar and or you can double-click on the icon itself to open the attachment.

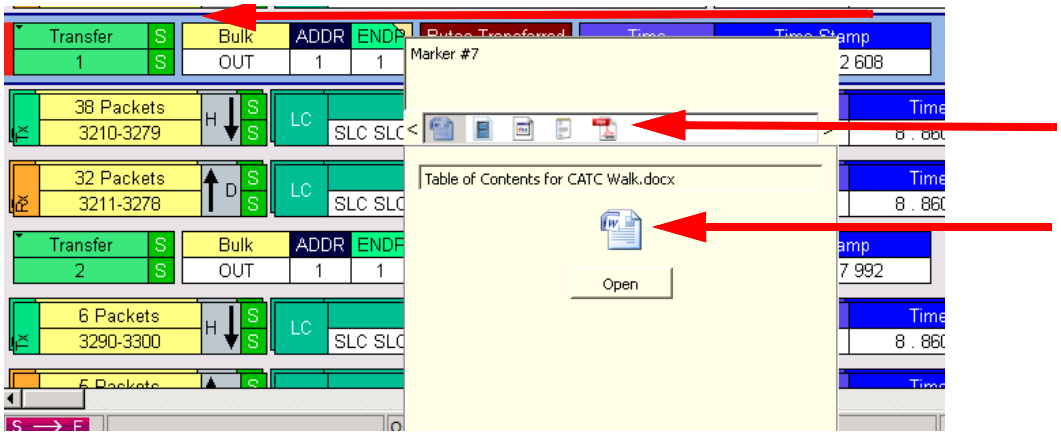


Figure 6.234: Pop-up Displaying Marker Contents

Text

The text attachment is displayed in the icon bar and in the main pop-up window. Text attachments are always shown at the top. The attachment file name is displayed in the field as shown below.

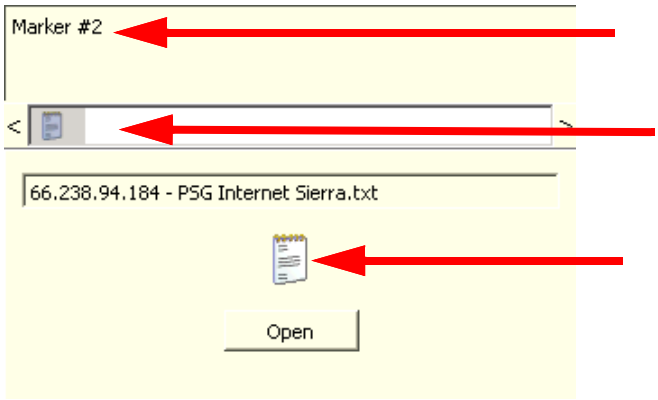


Figure 6.235: Text Attachment Pop-up Window

If there is no attachment, **No Attachments** displays in the status bar at the bottom.

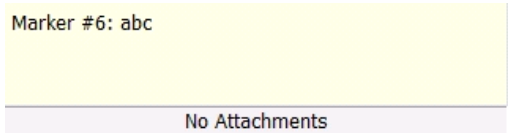


Figure 6.236: No Attachments Pop-up Window

If there are attachments, the status bar is hidden. You can move the cursor to an attachment icon in the list view and a preview of the attachment starts (see Figure 6.237 on page 427).

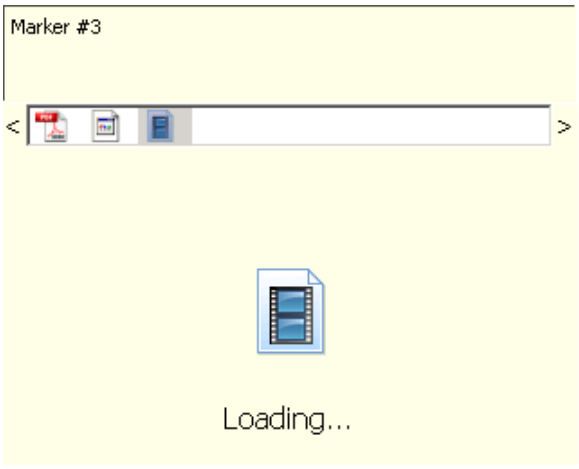


Figure 6.237: Preview Attachments Pop-up Window

Audio

Audio snippets that are recorded and attached to certain point of interest in a trace can be played. The basic Play, Start, Stop, Pause buttons are displayed to listen to the audio file.

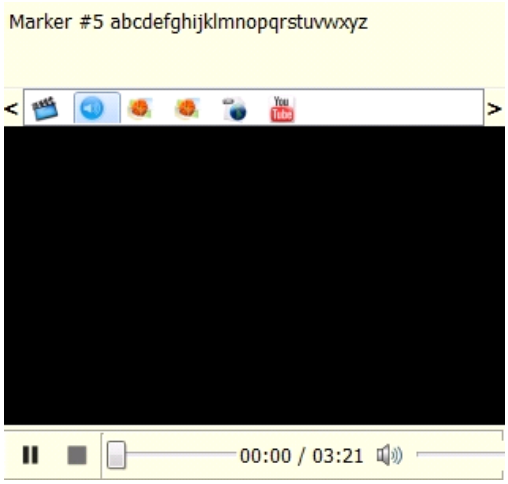


Figure 6.238: Adding a Marker that is an Audio Snippet

Video

Video clips that are recorded and attached to certain point of interest in a trace can be played. The video is embedded in the tooltip with simple playback controls.



Figure 6.239: Adding a Marker that is a Video Clip

File Attachment

You can attach any kind of file, including images, PDFs, documents, media files, etc.

6.4.6.9 URL Link

You can specify a URL that links to a web page (i.e., YouTube), a network location, or a local file-system location. See Figure 6.240.

Web Link

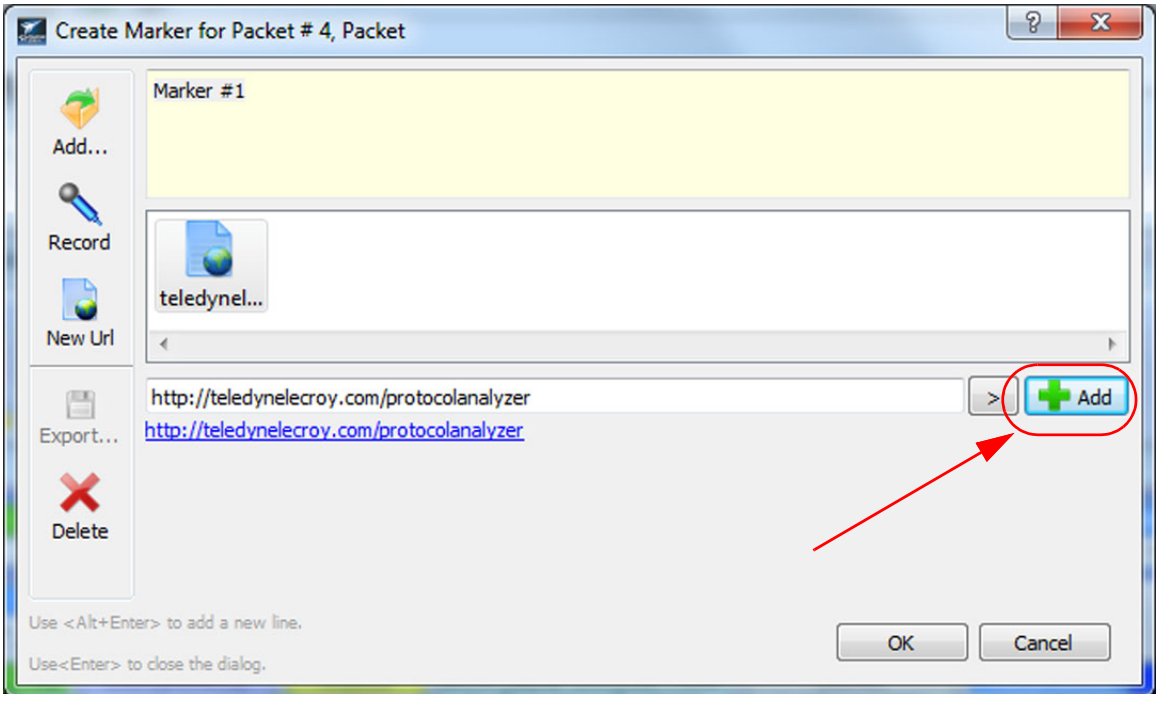


Figure 6.240: Marker: URL Link

After you add the URL marker to the Packet, when you click on the URL it will open in a separate browser window. See Figure 6.241.

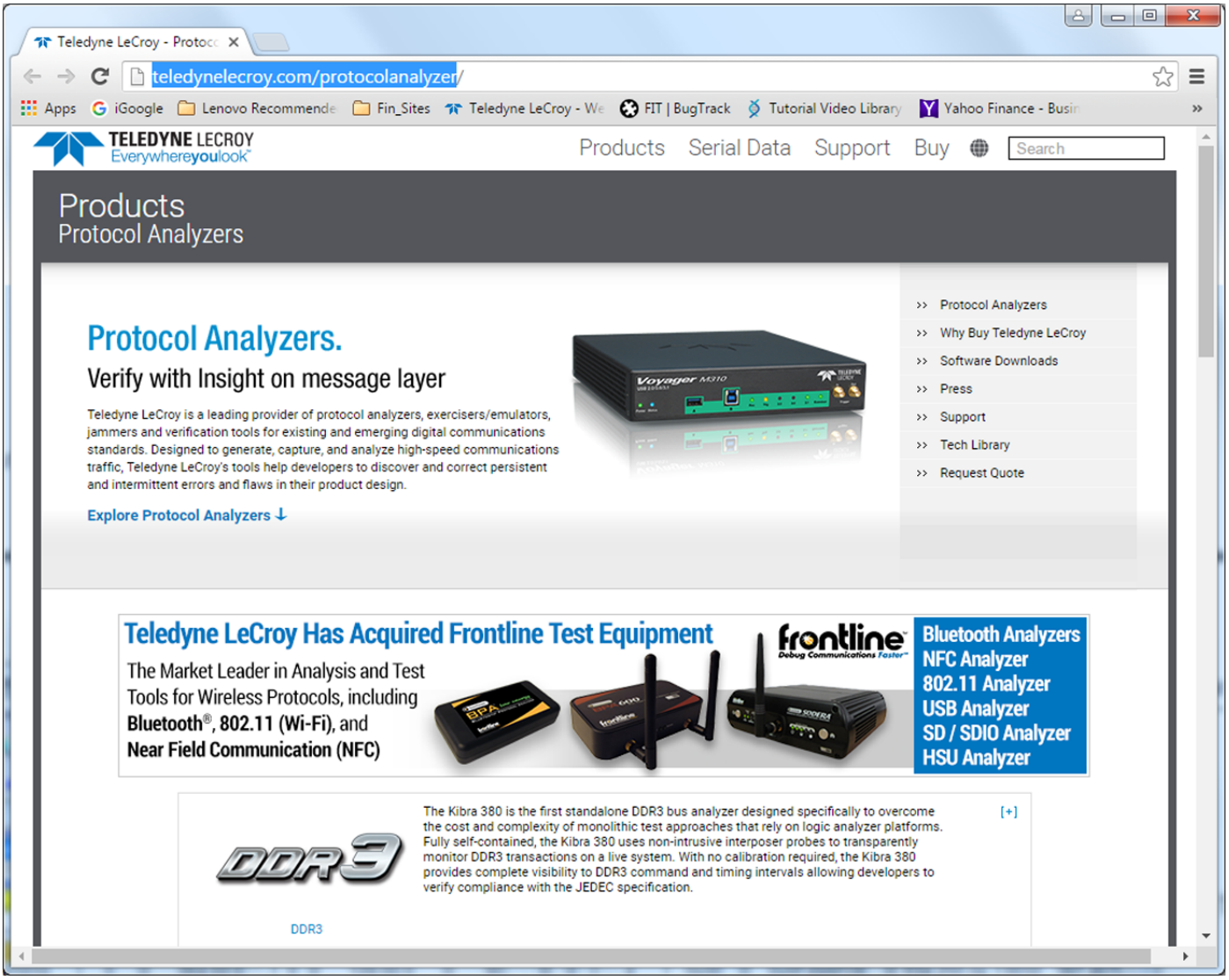


Figure 6.241: Opening a URL Marker in a Separate Window

YouTube Video

YouTube's video player is embedded for YouTube Video playback.



Figure 6.242: Adding a Marker that is a YouTube Video

Images

The image is embedded in the trace.



Figure 6.243: Adding a Marker that is an Image

Other Attachments

Click the **Open** button to open the attachment file with the system's default application for that file type. See Figure 6.244.

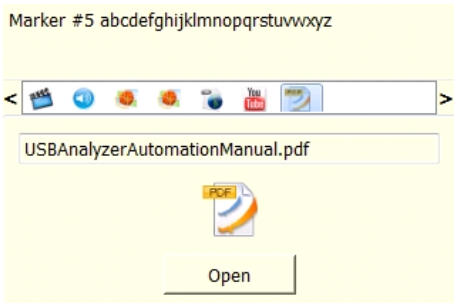


Figure 6.244: Adding a Marker: System Default

6.4.6.10 Edit Marker

To edit a marker, right-click on the marked item and select **Edit marker** from the menu or **Ctrl + L**. The Edit Marker dialog displays. This Edit Marker window can be used to edit one marker at a time.

You can do the following in the Edit Marker dialog:

- Edit text attachment.
- Record audio attachment.
- Add URL link attachment
- Add a file attachment. Click on **File** and click the **Open** button or drag and drop the file.
- Preview audio/video/image/URL/YouTube attachment or open other files with system default application.
- Save an attachment to a file.
- Remove attachment.

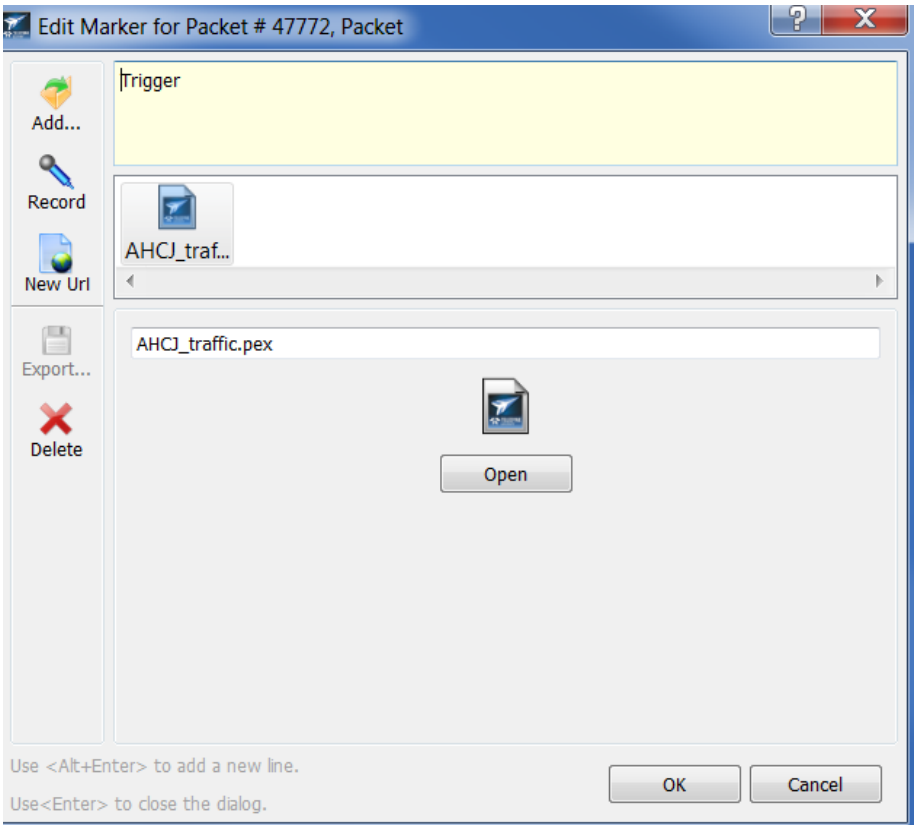


Figure 6.245: EDIT Marker for Packet Dialog

6.4.6.11 All Markers Dialog

Select **Search > Go to Marker > All Markers** or press **Ctrl + M** to display a list of all the markers in the file. The dialog uses a tree structure to show packets, fields and markers (see Figure 6.246 on page 432). The features of the Markers dialog are:

- All Markers are displayed.
- All attachments within the marker are displayed. Hovering over the marker displays a tool-tip displaying the size of all the attachments.
- You can collapse or expand the item marked to view the attachments.
- The Time and size of audio and video files are displayed.
- You can edit Playlists from this window.
- You can edit, delete a marker or delete all markers from this location.
- You can filter attachments within the marker.
- You can select a range of markers by clicking **Shift** and selecting a range.
- You can select multiple markers by clicking **Ctrl** and selecting individual markers.
- Double-click on a marker to go to that marker in the trace and close the dialog.
- You can sort by Timestamps (or any other displayed title) in ascending or descending order. See Figure 6.247 on page 433.

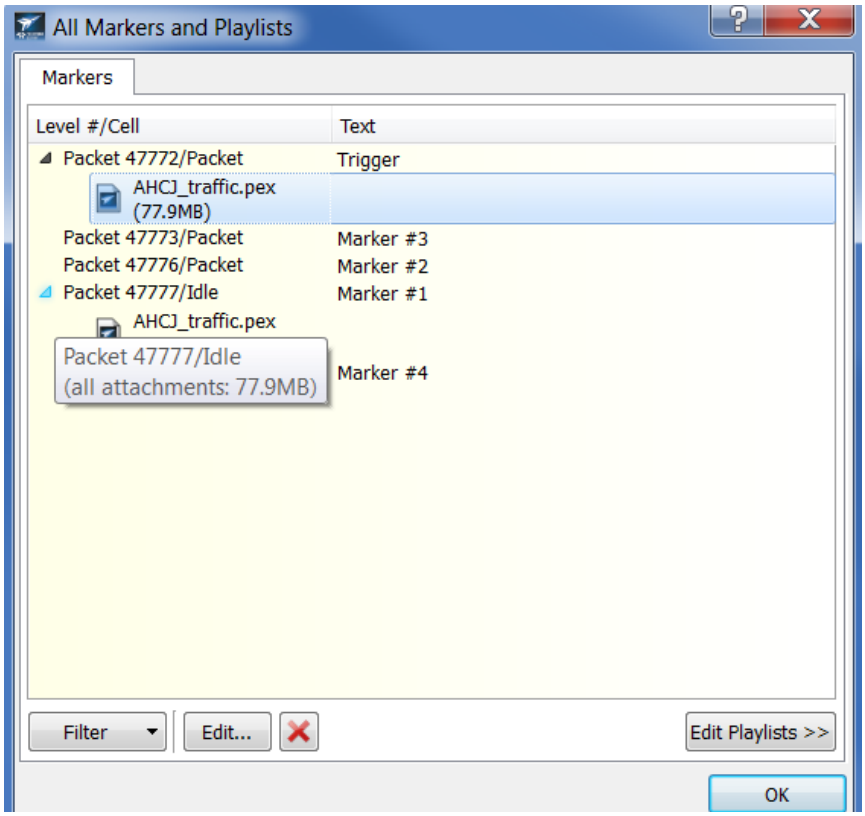


Figure 6.246: All Markers and Playlists Dialog

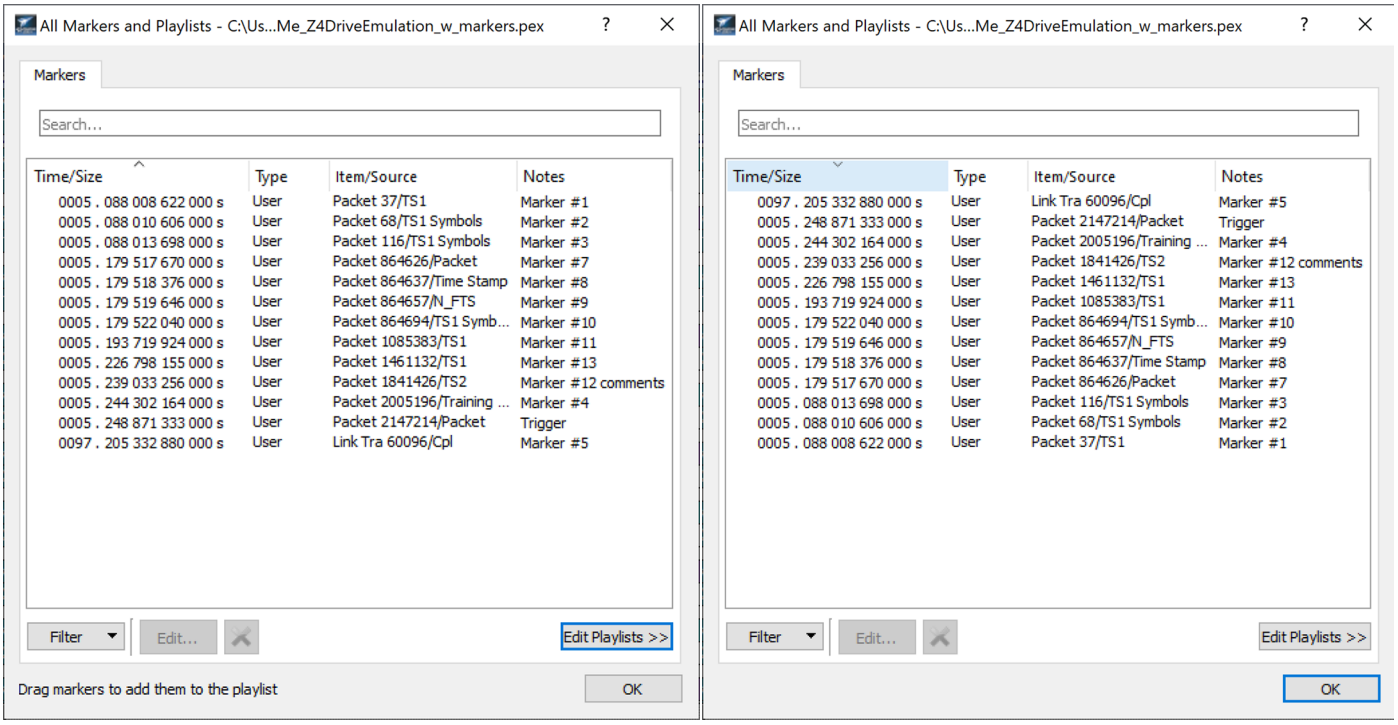


Figure 6.247: Markers Sorted by Timestamps in Ascending and Descending Order

You can filter to show or hide text, image, audio, video, URL, YouTube videos and other files.

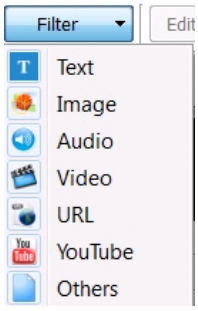


Figure 6.248: Filter Dialog

Clicking delete on markers to delete markers with attachments displays the Delete Marker(s) dialog. Checking the “Don’t ask again” checkbox will not display this confirmation dialog again.

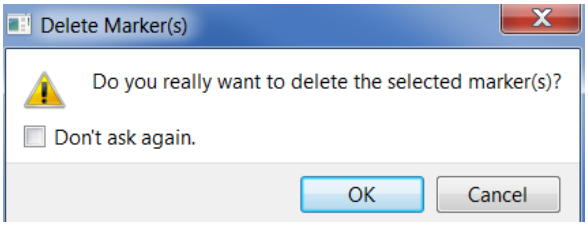


Figure 6.249: Confirmation Dialog

6.4.6.12 CATC Walk Playlist

This feature allows users to configure sequences of attachments into playlists. Any arbitrary order of attachments are allowed, and there are no limits on the number of playlists supported. This

feature can be used for collaborating among developers as well for training, support and marketing purposes.

To access a playlist click on the **View** menu in the top toolbar of application, select **CATC Walk** and then select **Manage Playlists** as shown below.

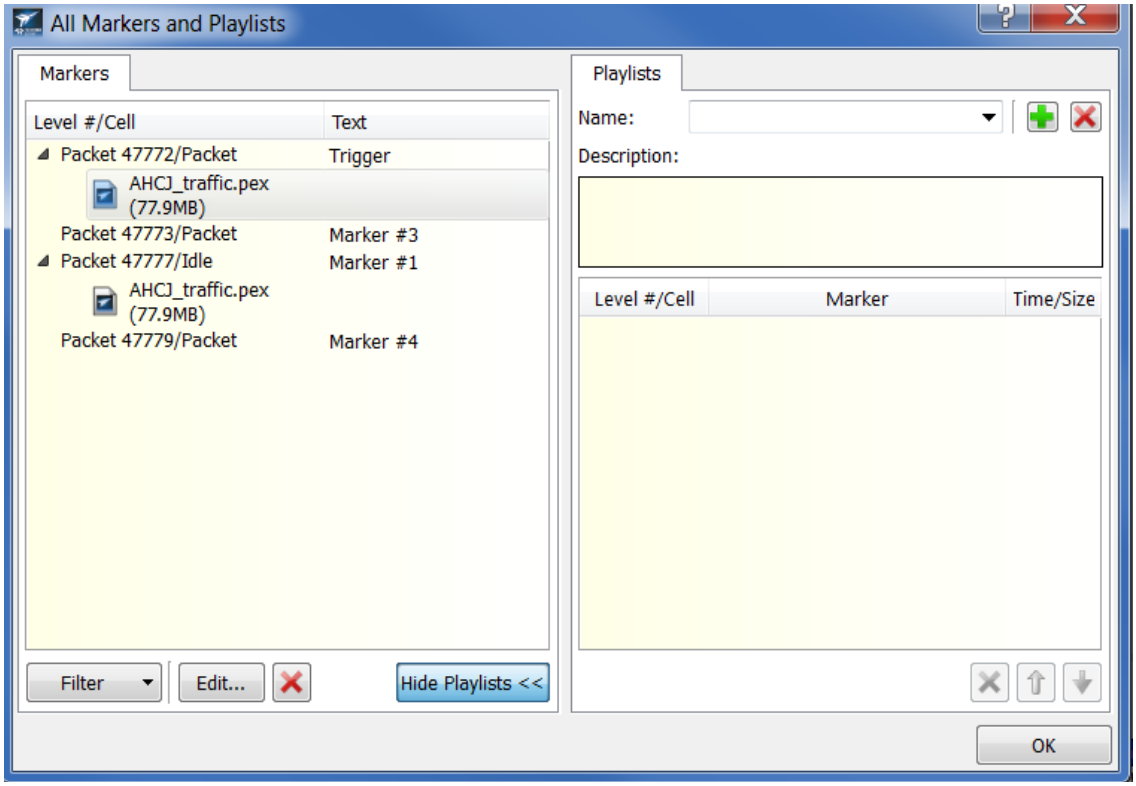


Figure 6.250: Edit CATC Walk Playlists Dialog

6.4.6.13 Playlist Functionality

You can do the following to manage playlists:

- Remove or edit current playlists
- Edit the playlist name
- Edit the playlist description
- List the sequence of attachments in current playlist
- List of all available attachments and drag/drop to a playlist.

As shown in the previous figure the Playlist window lists the markers with their attachments on the left and the playlist on the right.

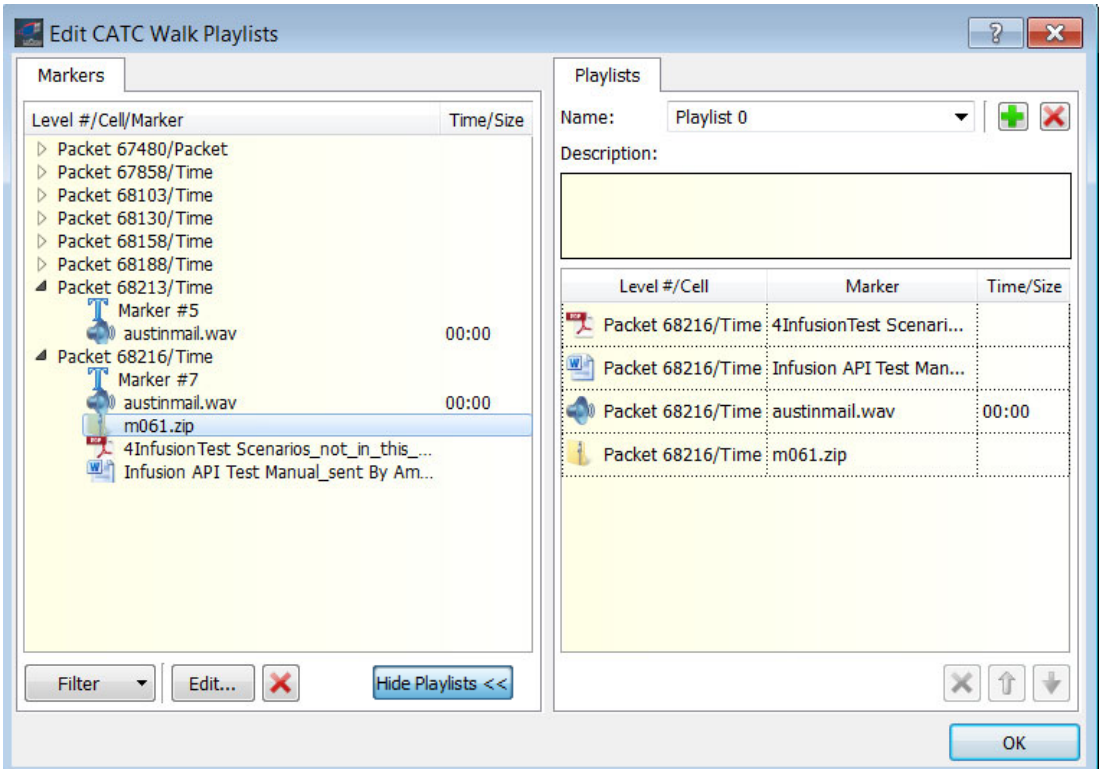


Figure 6.251: Edit CATC Walk Playlists Dialog

You can drag and drop and item or attachment from the **Marker** panel into the **Playlist** panel and build a story. Give a description of the playlist in the **Description** field and you can give a name to the playlist in the **Name** field.

You can add a new playlist by clicking on the green plus sign (+) on the right top corner of the Playlist panel, or delete a playlist by clicking the red (x) button.

If you have more than one playlist saved click on the Name drop-down arrow to select it. The drop-down menu lists all the available playlists

6.4.6.14 Playback Window

To playback a playlist, click on the **View** menu in the top toolbar of application, select **CATC Walk** and then select **Play > Playlist 1** as shown below.

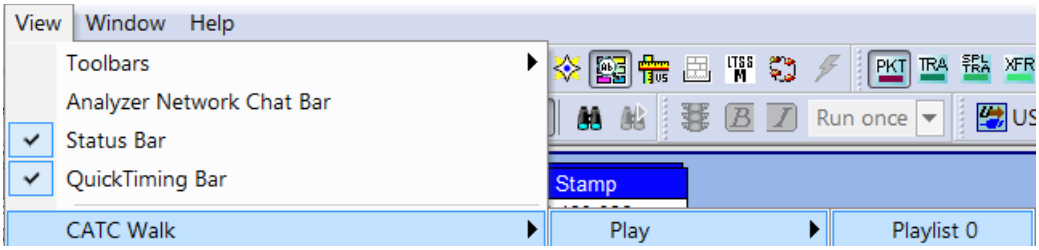


Figure 6.252: View Dialog

The attachment item starts to play in the Playback window (see Figure 6.253).

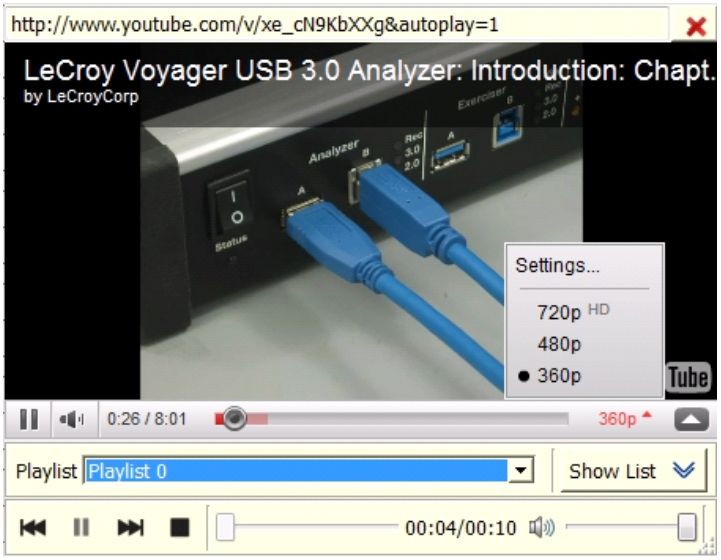


Figure 6.253: Playback Window

The playback window is re-sizable. The close button at the top right corner and the size grip for resizing at the bottom right corner will hide automatically when moving the cursor out of the window.

Users can provide commentary to a captured trace, converting it into a script or a story and can transfer this meta-information to others.

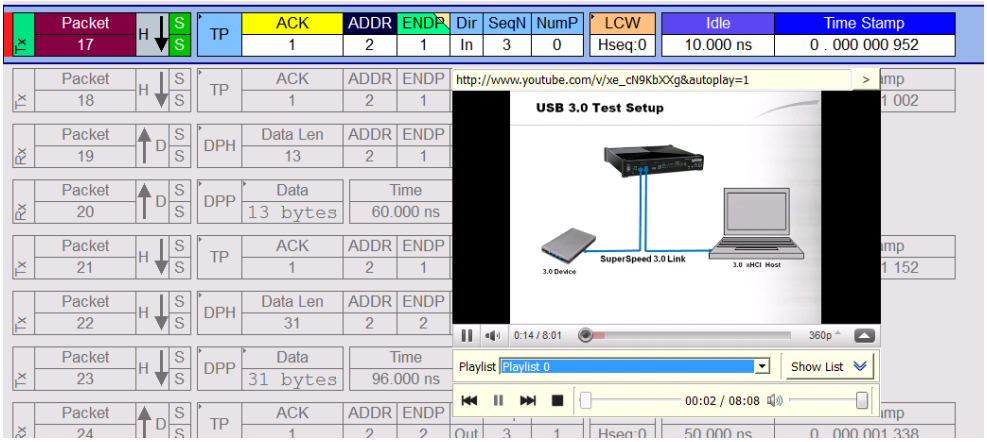
Playlist Playback Controls

The playlist playback control buttons are (see the screen capture on the next page):

- Play/Pause
- Stop
- Jump to Next attachment
- Jump to Previous attachment
- Seek slider for seeking to positions in media streams
- Volume slider
- Playback speed slider (for text attachments)

As a playlist is played back, the playback window is displayed in close proximity to the marked area, just like a regular tooltip window.

As the playback progresses, the view jumps to the element corresponding to the current attachment being played and the marked element is highlighted. During playback the user is prevented from interacting with the trace. To reinforce this restriction, the trace view is grayed-out visually, and only the packet with the item corresponding to the current attachment is colorized.



Playlist Playback View

6.5 Go to NVMe Transactions and Commands

The Go to NVMe Transaction and NVMe Command tabs in the Search menu provides a quick way to search for both NVMe Transactions and NVMe Commands.

6.5.1 NVMe Transaction

The NVMe search capability can also search for the following types of NVMe Transactions:

- Controller Registers
- Other NVMe Entities
- Doorbell Registers
- Admin Submission Command Set
- NVM Submission Command Set
- Completion Queue Entry
- NVMe Errors

As shown in Figure 6.254 on page 438

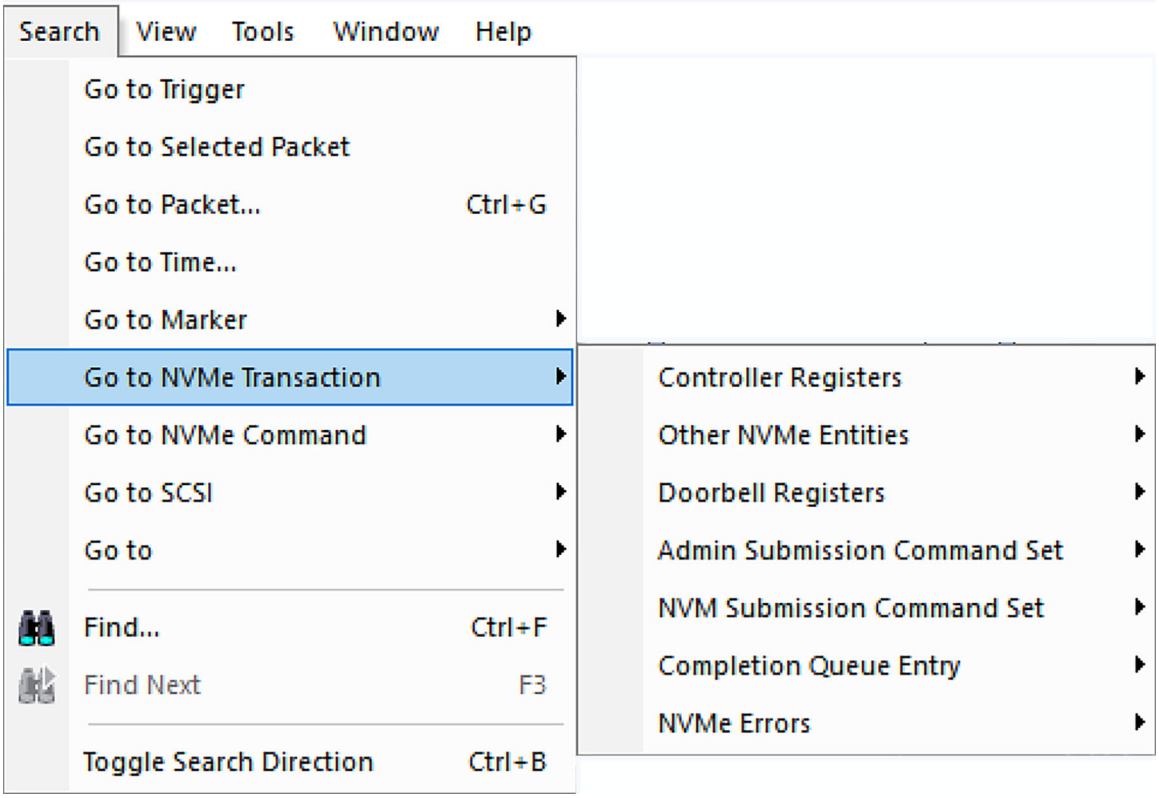


Figure 6.254: Search: NVMe Transaction Types

6.5.2 NVMe Command

The NVMe search capability can also search for the following types of NVMe Commands:

- Admin Command Set
- NVM Command Set
- Status
- Errors
- TCG Types
- TCG Method
- TCG Invoker
- TCG Com ID
- TCG Ext Com ID

As shown below in Figure 6.255 on page 439.

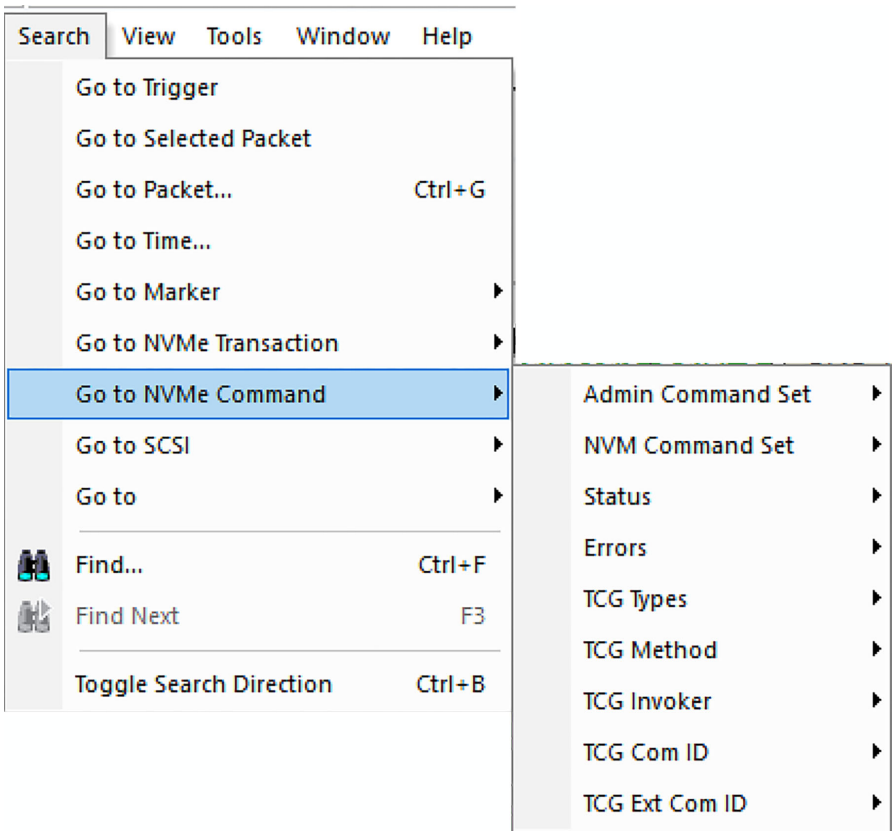


Figure 6.255: Search: NVMe Command Types

6.5.3 Go To SCSI Menu

The **Go To SCSI** menu in the Search menu provides a quick way to search for a packet based on a SCSI commands and sub-commands. You can search for the following types of events:

- SCSI Operation
- Command Status
- Task Management
- Task Management Response
- Error
- SCSI Logical Unit Number

6.5.4 Go To Menu

The **Go To menu** in the Search menu provides a quick way to search for a packet based on a simple condition. You can search for the following types of events:

- TLP Type
- DLLP Type
- Ordered Set
- Link Event
- OBFF Message
- Traffic Class

- ❑ DLLP Virtual Channel
- ❑ TLP Virtual Channel
- ❑ Direction
- ❑ Speed
- ❑ Link Width
- ❑ Requester ID
- ❑ Completer ID
- ❑ Data Lengths
- ❑ Errors

6.5.4.1 Example: Search → Go to → Link Event → Link Up/Link Down

Use the Search → Go to function to find Link Event: Link Up or Link Down.

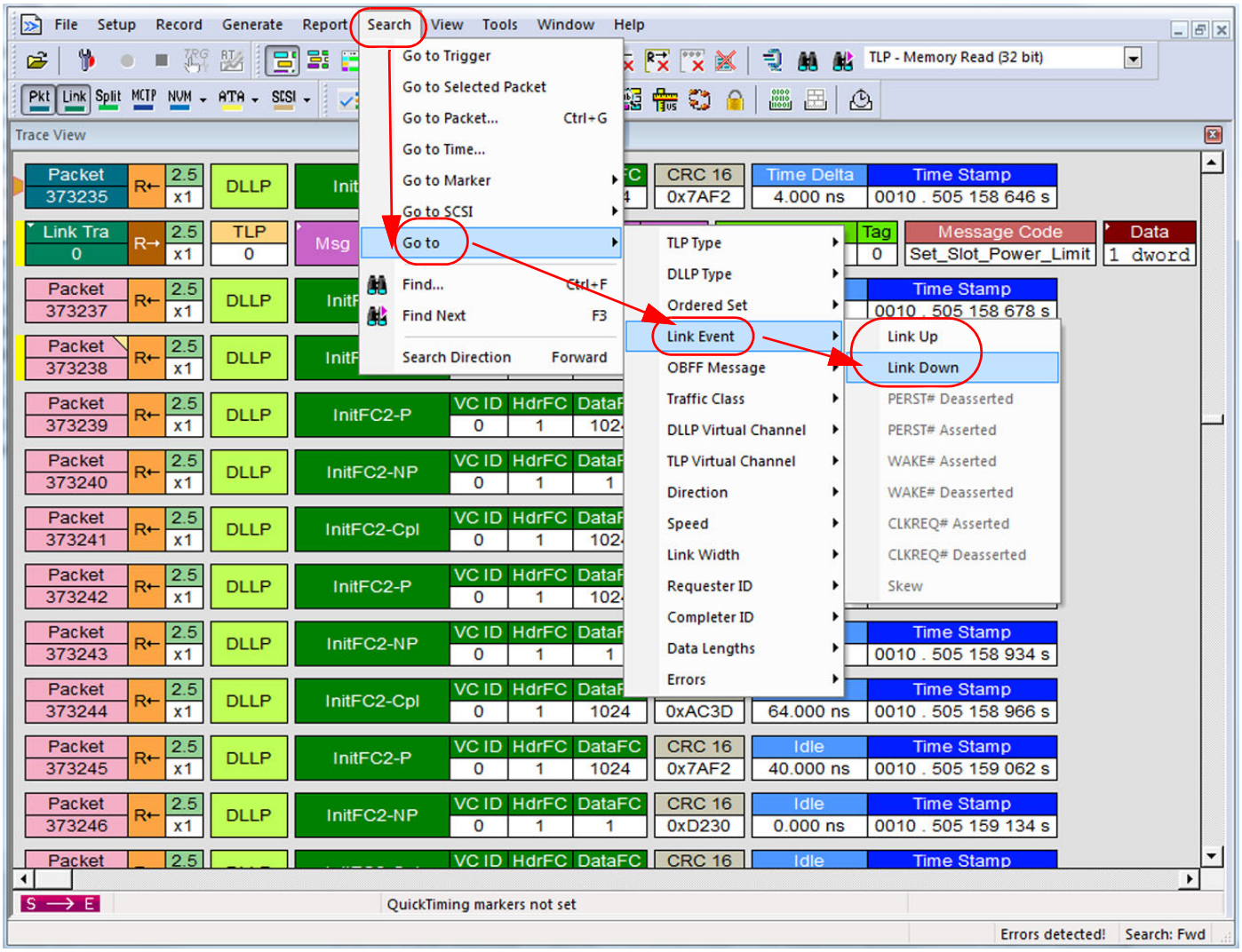


Figure 6.256: Search → Go to → Link Event → Link Up/Link Down: Set Up Search

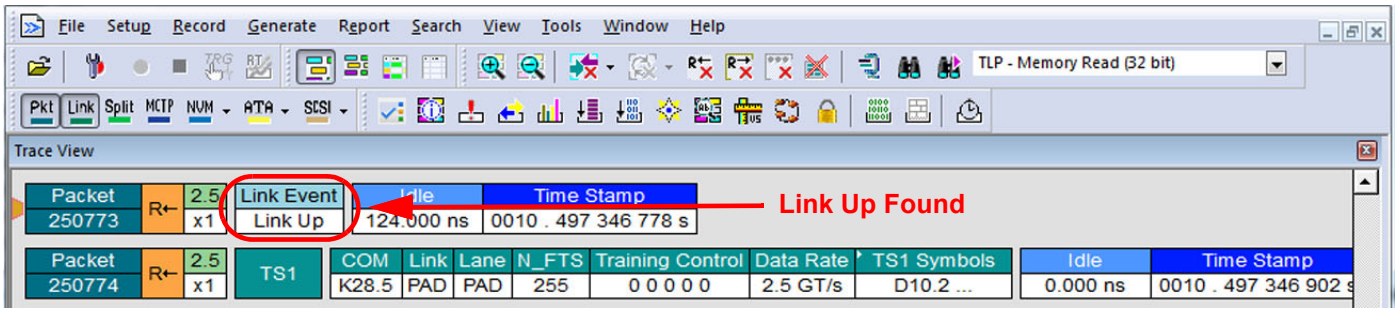


Figure 6.257: Search → Go to → Link Event → Link Up: Found

6.5.5 Find

Find allows you to conduct complex searches in a CATC Trace. You can search by protocol level (Packets, Link Transactions, Split Transactions, NVMe, PQI, AHCI, ATA).

You can search for packets by Event Group: TLP Type, TLP Header, TLP Prefix, TLP Requester ID, TLP Completer ID, TLP Data Pattern, TLP Data Lengths, TLP Tag, TLP Sequence Number, DLLP Type, DLLP Header, DLLP Virtual Channel, ACK/NAK Seq Number, Ordered Sets, Link Event, OBFF Code, Direction, Errors, TS1 Data, TS2 Data.

You can search for link transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag.

You can search for split transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag, Address.

You can search for Lane Margining transactions by Event Group: Margin Commands, Margin Type, Receiver Number or Errors. Each of these Event Groups has a numbers of different event types. See Figure 6.264 on page 448.

You can search for NVMe transactions by the following Event Groups: Controller Registers, Queue IDs, Command IDs, Doorbell Registers, Admin Submission Command Set, NVMe Submission Command Set, Completion Queue Entry, and PRP.

You can search for PQI transactions by Event Group: TLP Type, Traffic Class, Virtual Channel, Direction, Requester ID, Completer ID, Status, Tag, Address.

You can search for AHCI transactions by Event Group: AHCI Register ID, AHCI Port Number, AHCI Slot Number, AHCI Port Multiplier Port, AHCI Raw Address AHCI Direction and, AHCI Errors.

You can search for ATA transactions by Event Group: ATA Register Type, ATA Port Number, ATA Slot Number, ATA Raw Address, ATA port Multiplier Port, ATA Interruption Reason, ATA Error Type ATA Input/Output, ATA Payload Portion, ATA CFIS Fields, ATA RFIS Device to Host Fields, ATA DSFIS Fields, ATA PSFIS Fields, ATA SDBFIS Fields.

You can search for SOP transactions by Event Group: SOP Information Unit ID, SOP Errors.

You can search for SCSI transactions by Event Group: SCSI Operation, Command Status, Task Management, Task Management Response, Errors, SCSI Logical Unit Numbers.

You can search for NVMe Commands by Event Group: Admin Command Set, NVM Command Set, Submission QID, Completion QID, Status, Errors, NVM Command, NVM Payload Portion, TCG Types, TCG Method, TCG Invoker, TCG Com ID or TCG Ext Com ID. See “Example: Search for NVMe Command: NVM Payload Portion” on page 452.

You can search for MCTP messages by Event Group: MCTP Message Type, MCTP Control Command Codes, MCTP Control Completion Codes and MCTP Control Instance ID. See “MCTP Messages to Search For” on page 453. You can also search for PLDM and NC-SI message types within MCTP messages. See “Example: Searching for PLDM Message Types within MCTP Messages” on page 454 and “Example: Searching for NC-SI Message Types within MCTP Messages” on page 455.

The options Union, Intersection, and Exclusion allow you to create complex searches such as “Find x OR y” or “Exclude all x or y.”

To find an item:

1. Open a CATC Trace.
2. Open Find by selecting **Search > Find** from the menu or clicking  (see the following screen capture).

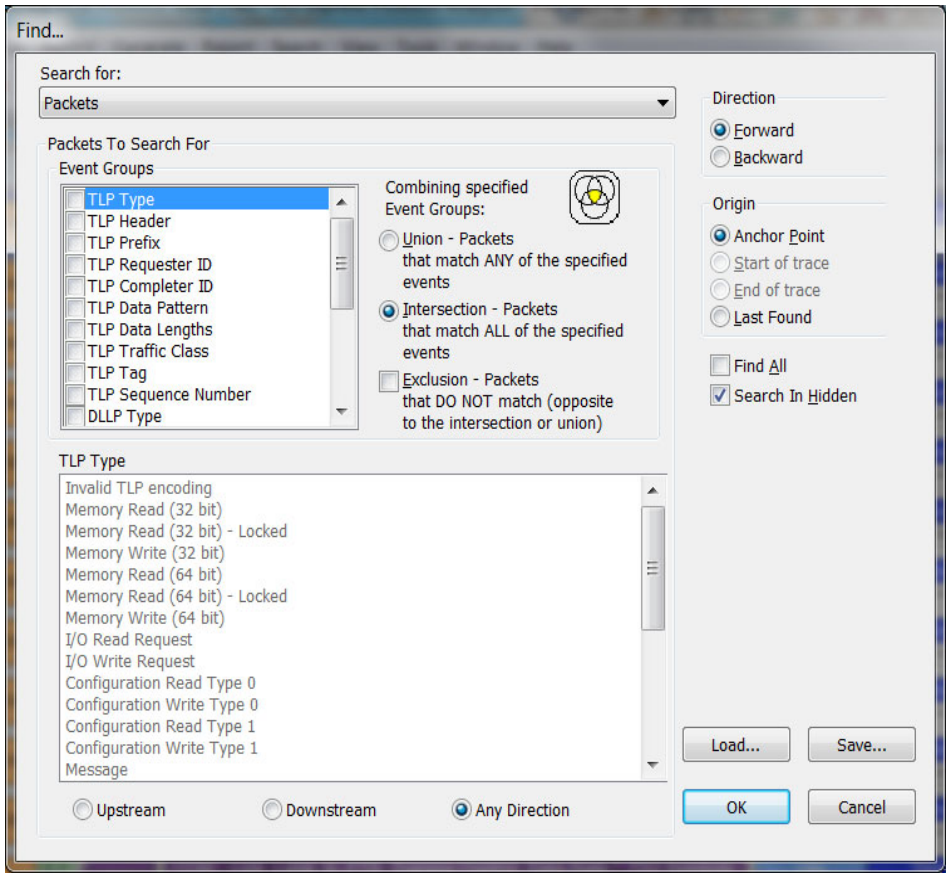
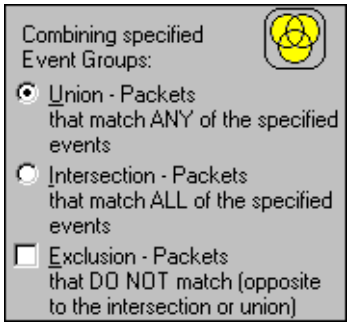


Figure 6.258: Find Dialog

3. From the Search For menu, select a display level such as **Packets**. To search multiple levels, finish steps 3 to 9, and then repeat 3 to 9 for each additional display level.
4. From the Event Groups menu, select an **Event Group**. The menu in the far right of the dialog is context sensitive and changes to reflect the options for that group.
5. In the menu in the far right, select one or more items.
6. Repeat Step 5 for each Event Group of interest for the selected display level.
7. Under Scope, select Current Segment or All Segments to reduce the scope of the search. This applies to old segmented traces, for newer traces leave this option in Current Segment.
8. Under Direction, select **Forward** or **Backward** to select a search direction.
9. Under Origin, select a starting point for the search.

10. Under **Combining Specified Event Groups**, select an option.



The options Union, Intersection, and Exclusion let you set conditions on your searches:

- **Union**: To search for **any** of the selected criteria.
  Example: “Find packets with ANY of the following characteristics …”
- **Intersection**: To search for **all** of the selected criteria.
  Example: “Find packets with ALL of the following characteristics …”
- **Exclude**: To **exclude** items from a search. This option works in conjunction with Union and Intersection. You select Union and Exclude to exclude any of the specified traffic. You select Intersection and Exclude to exclude all of the specified traffic.
  Example: “Exclude packets with ANY of the following …” or
  “Exclude packets with ALL of the following …”

11. Repeat Steps 3 through 9 for additional display levels.
12. **Find All** displays all matching packets or transactions in a separate view.
    NOTE: When **Find All** is checked, the reports display the information for the main trace, however, they do not include Search results.
13. **Search in Hidden** includes hidden packets or transactions in the search.
14. Click **OK**.

6.5.5.1 Event Groups for Packets

The Event Groups for Packets are:

- TLP Type
- TLP Header
- TLP Prefix
- TLP Requester ID
- TLP Completer ID
- TLP Data Pattern
- TLP Data Lengths
- TLP Traffic Class
- TLP Tag
- TLP Sequence Number
- DLLP Type
- DLLP Header
- DLLP Virtual Channel
- ACK/NAK Seq Number

- Ordered Sets
- Link Event
- OBFF Code
- Direction
- Errors
- TS1 Data (see "TS1 and TS2 Event Groups" on page 445)
- TS2 Data (see "TS1 and TS2 Event Groups" on page 445)
- Message Code

TS1 and TS2 Event Groups

Selecting TS1 Data or TS2 Data options allows further definition of the exact field contents to match via the three dialogs show below. The search algorithm will find the specified TS ordered set on any lane.

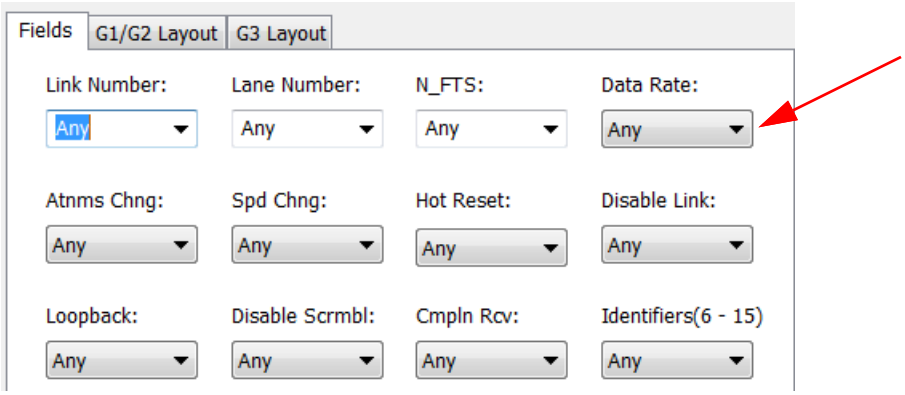


Figure 6.259: TS Data Fields Tab

Select parameters from the drop-down lists to use.

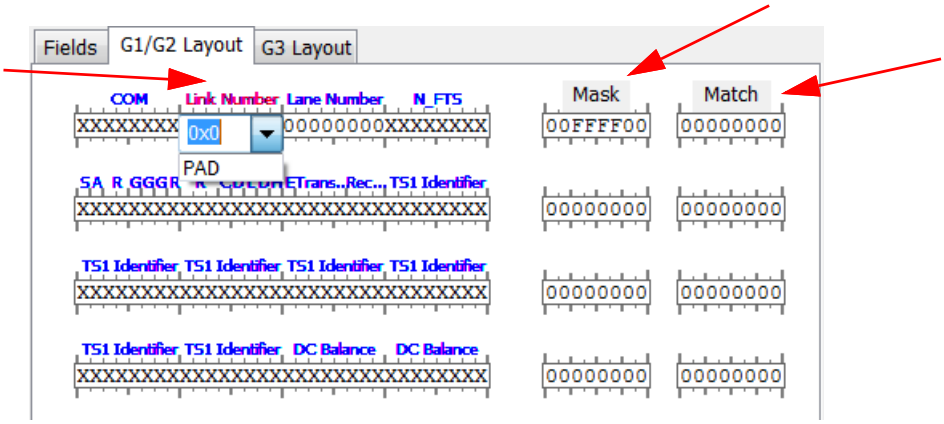


Figure 6.260: TS G1/G2 Layout Tab

Select parameters from the links to use and enter the mask and match values.

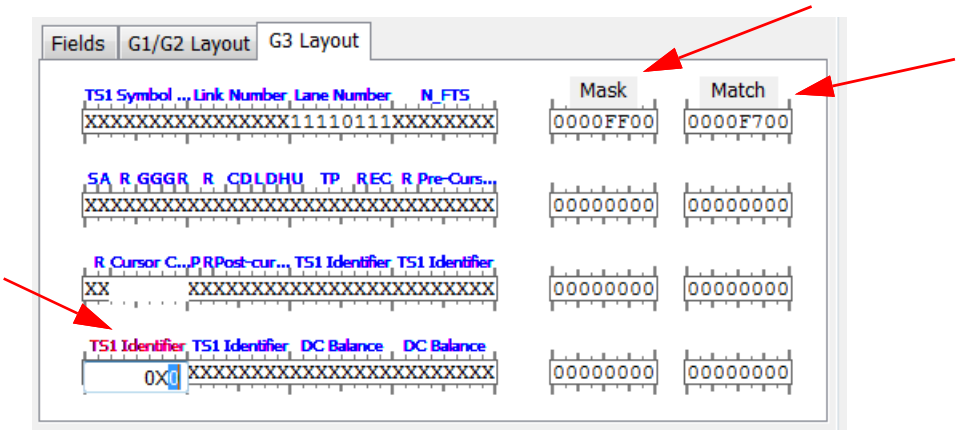


Figure 6.261: TS G3 Layout Tab

Select parameters from the links to use and enter the mask and match values.

6.5.5.2 Example: Search for PMUX Channel ID

In this case, we are searching for the following event:

- PMUX Channel ID (see Figure 6.262)

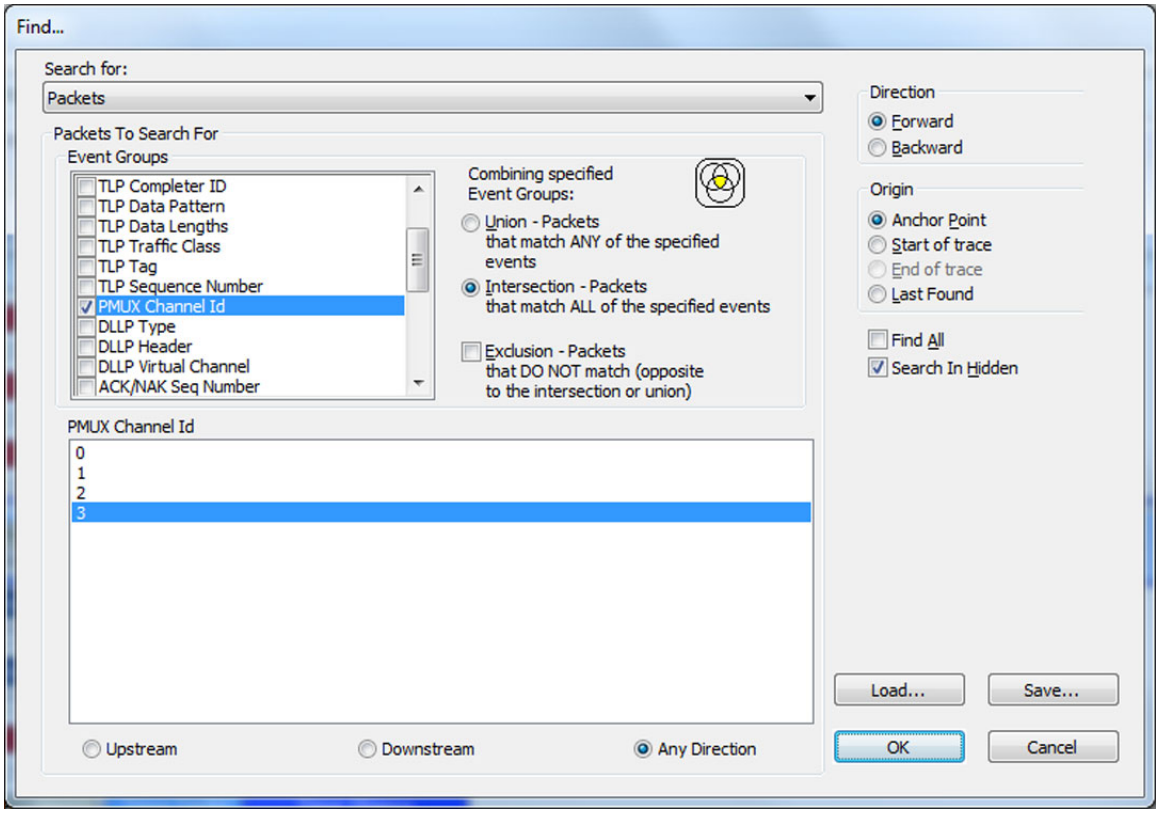


Figure 6.262: Search for: PMUX Channel ID (3)

PMUX Channel ID Found and PMUX Packet Error Decoded in Trace

In the trace both the PMUX Channel ID was found and a Packet PMUX Error was decoded. See Figure 6.263.

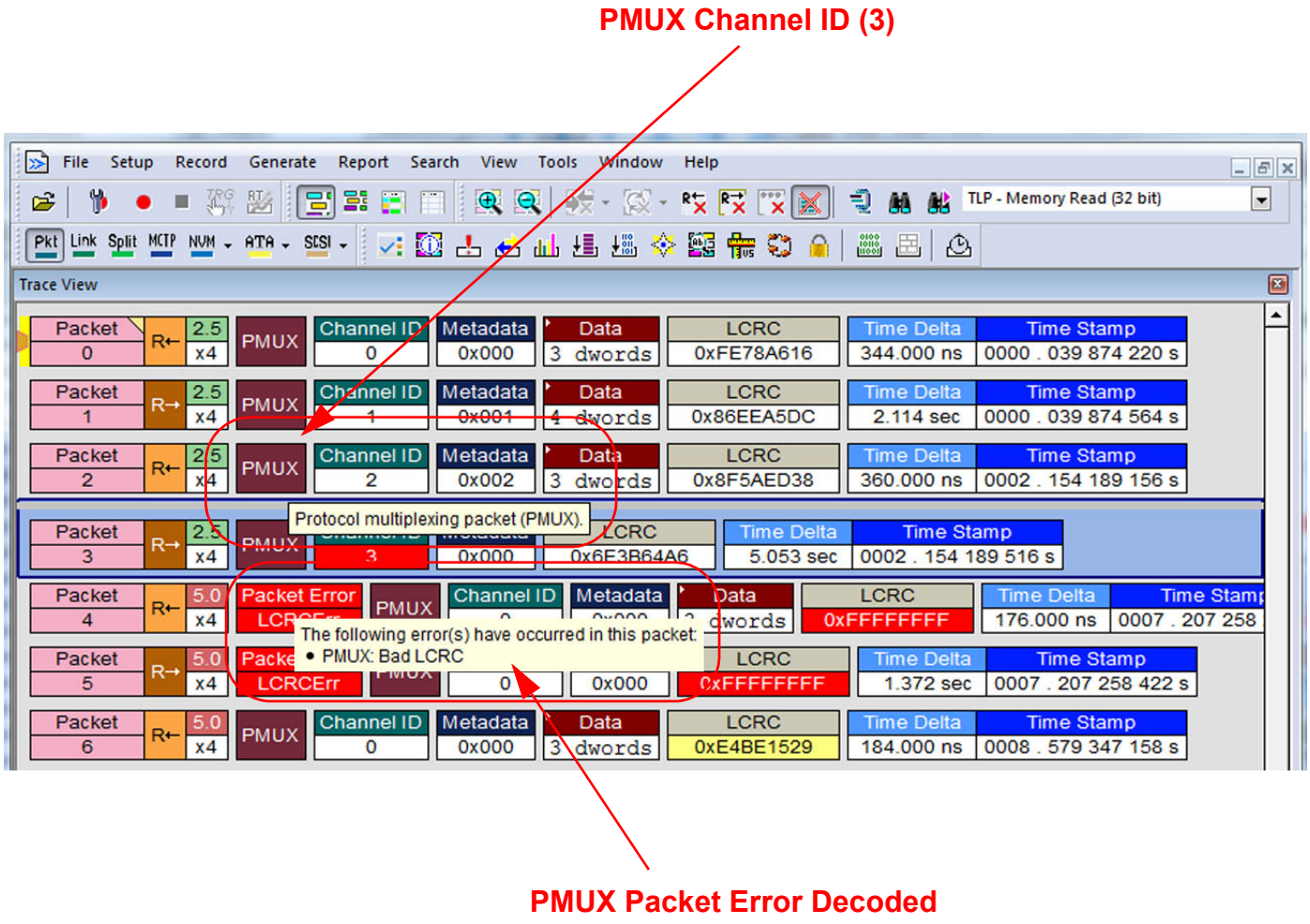


Figure 6.263: PMUX Channel ID (3) Found in Trace and Packet Error Decoded

6.5.5.3 Event Groups for Link Transactions:

- TLP Type
- Traffic Class
- Virtual Channel
- Direction
- RequesterID
- CompleterID
- Status
- Tag

6.5.5.4 Event Groups for Split Transactions:

- TLP Type
- Traffic Class
- Virtual Channel
- Direction
- Requester ID

- Completer ID
- Status
- Tag
- Address

6.5.6 Event Groups for LM Commands

- Margin Command
- Margin Type
- Receiver Number
- Errors

Example: Search for Lane Margining Command: ReportLM_SamplingRateVoltage (see Figure 6.264 on page 448).

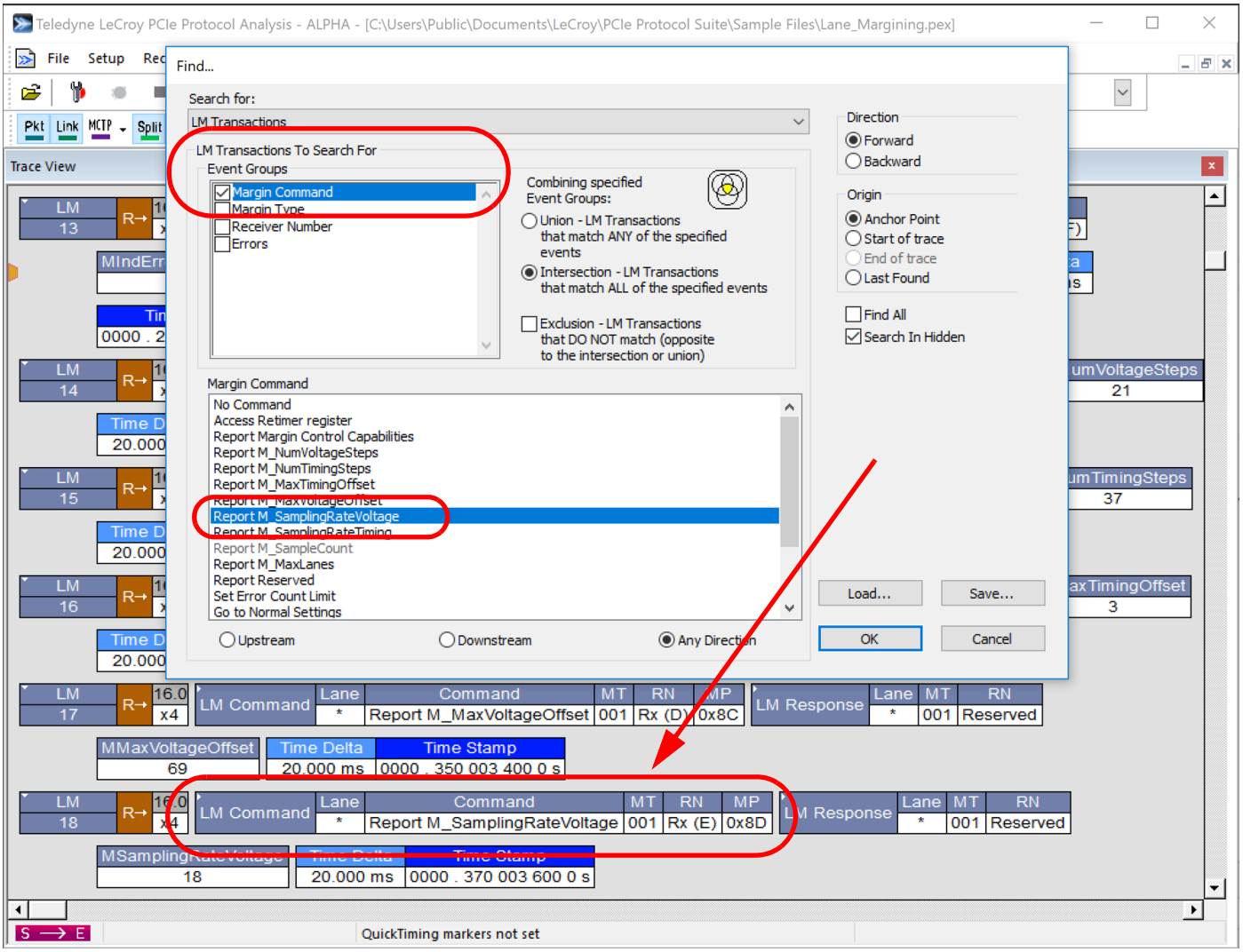


Figure 6.264: Find: Lane Margining Transaction → Margin Command → ReportLM_SamplingRateVoltage

6.5.6.1 Event Groups for NVMe transactions:

- Controller Registers
- Other NVMe Entities
- Queue IDs
- Command IDs
- Doorbell Registers
- Admin Submission Command Set
- NVMe Submission Command Set
- Completion Queue Entry
- PRP
- Submission Command
- NVMe Errors

6.5.6.2 Event Groups for PQI Transactions:

- PQI Register ID
- PQI Admin Functions
- PQI Errors

6.5.6.3 Event Groups for AHCI Transactions:

- AHCI Register ID
- AHCI Port Number
- AHCI Slot Number
- AHCI Port Multiplier Port
- AHCI Raw Address
- AHCI Direction
- AHCI Errors

6.5.6.4 Event Groups for ATA transactions:

- ATA Register Type
- ATA Port Number
- ATA Slot Number
- ATA Raw Address
- ATA Port Multiplier Port
- ATA Interruption Reason
- ATA Error Type
- ATA Input/Output
- ATA Payload Portion
- ATA CFIS Fields
- ATA RFIS Device to Host Fields
- ATA DSFIS Fields
- ATA PSFIS Fields
- ATA SDBFIS Fields

6.5.6.5 Event Groups for SOP Transactions:

- SOP Information Unit ID

- ❑ SOP Errors

6.5.6.6 Event Groups for SCSI Transactions:

- ❑ SCSI Commands
- ❑ Command Status
- ❑ Task Managements
- ❑ Task Management Responses
- ❑ Errors
- ❑ SCSI Logical Unit Numbers

6.5.6.7 Event Groups for NVMe Commands:

- ❑ Admin Command Set
- ❑ NVM Command Set
- ❑ Submission QID
- ❑ Completion QID
- ❑ Status
- ❑ Errors
- ❑ LBA
- ❑ NVM Command
- ❑ NVM Payload Portion
- ❑ TCG Types
- ❑ TCG Method
- ❑ TCG Invoker
- ❑ TCG Com ID
- ❑ TCG Ext Com ID
- ❑ RPMB

Note: When searching for a LBA range, it find commands with LBAs that intersect with the selected address range.

6.5.6.8 Example: Search for NVMe Command

In this case, we are searching for the following event (see Figure 6.265 on page 451):

- ❑ NVMe Command
- ❑ Event Group NVM command
- ❑ Command = 0x02, Read
- ❑ Value = 1
- ❑ Fields = SQID [SELECTED: 1]

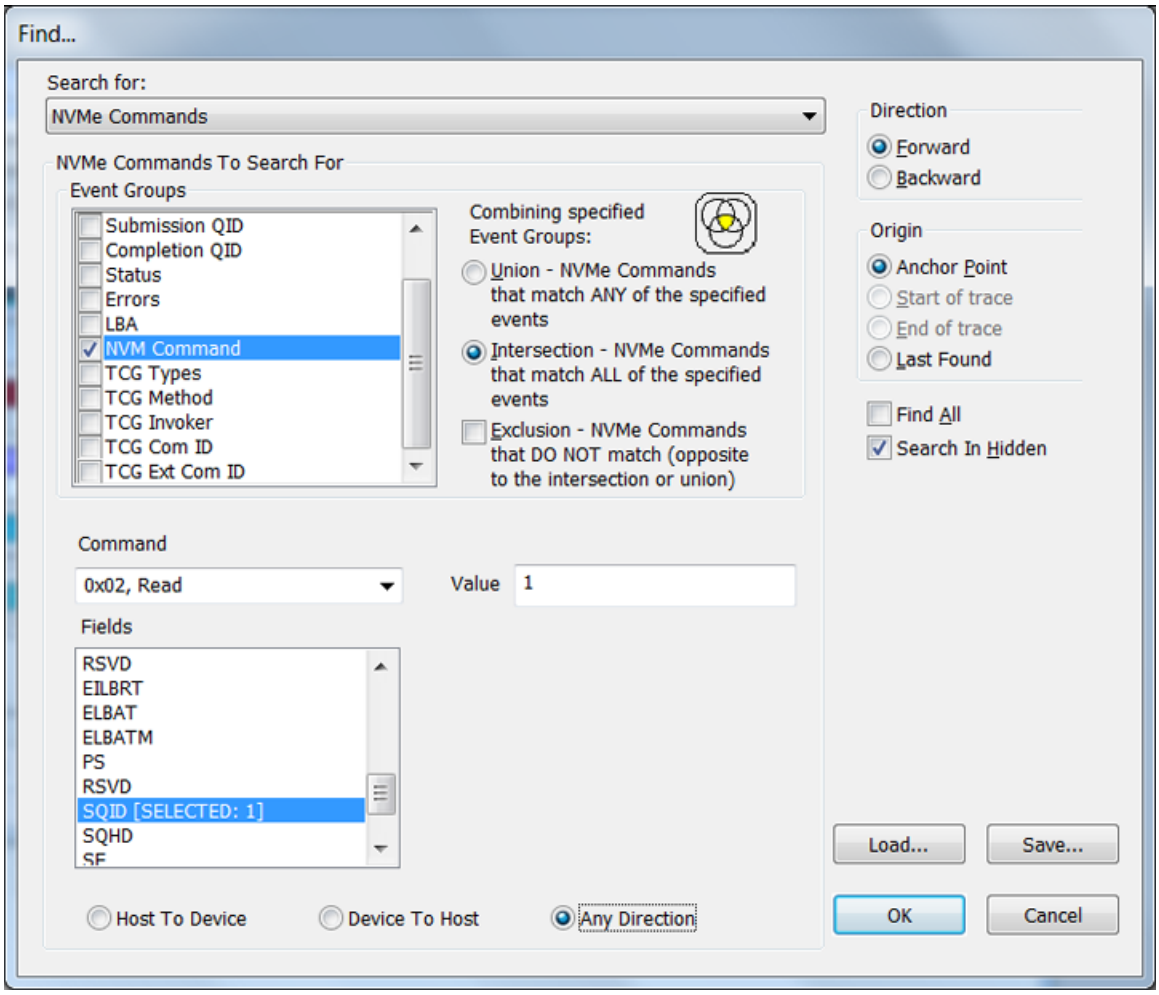


Figure 6.265: Find: Search for NVMe Command

Select OK.

Figure 6.266 shows that NVMe Command #67 is a Read Command that has an SQID value of 1.

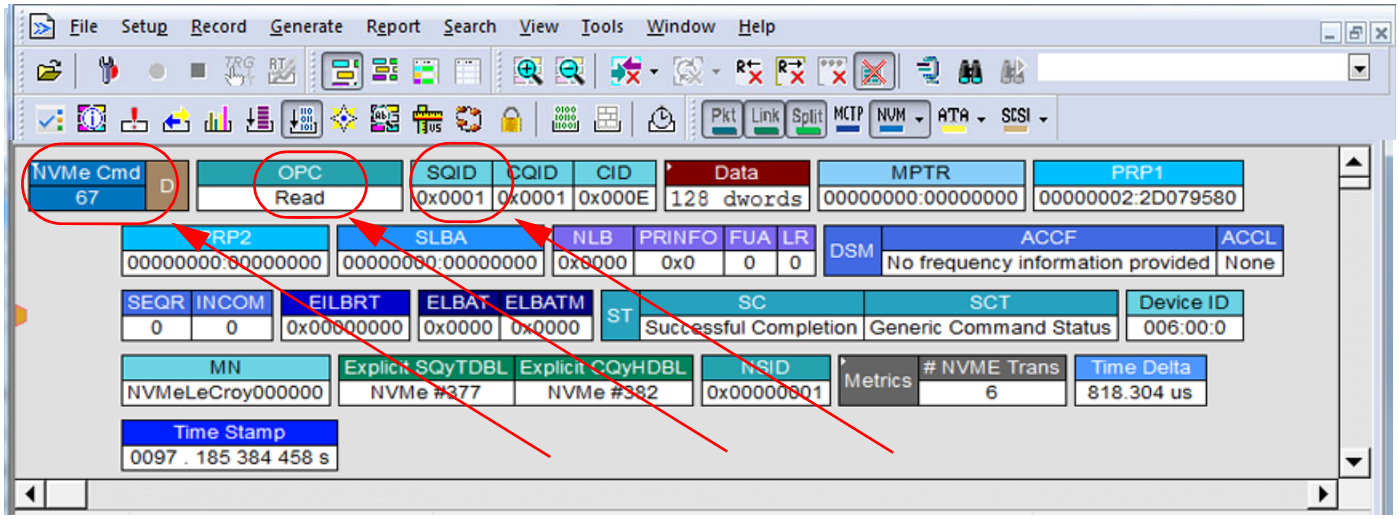


Figure 6.266: Find → Search for NVMe Command → Found

6.5.6.9 Example: Search for NVMe Command: NVM Payload Portion

The Find → Search for: NVMe Commands → Event Groups → NVM Payload Portion will search the currently loaded trace for an NMV Payload. See Figure 6.267.

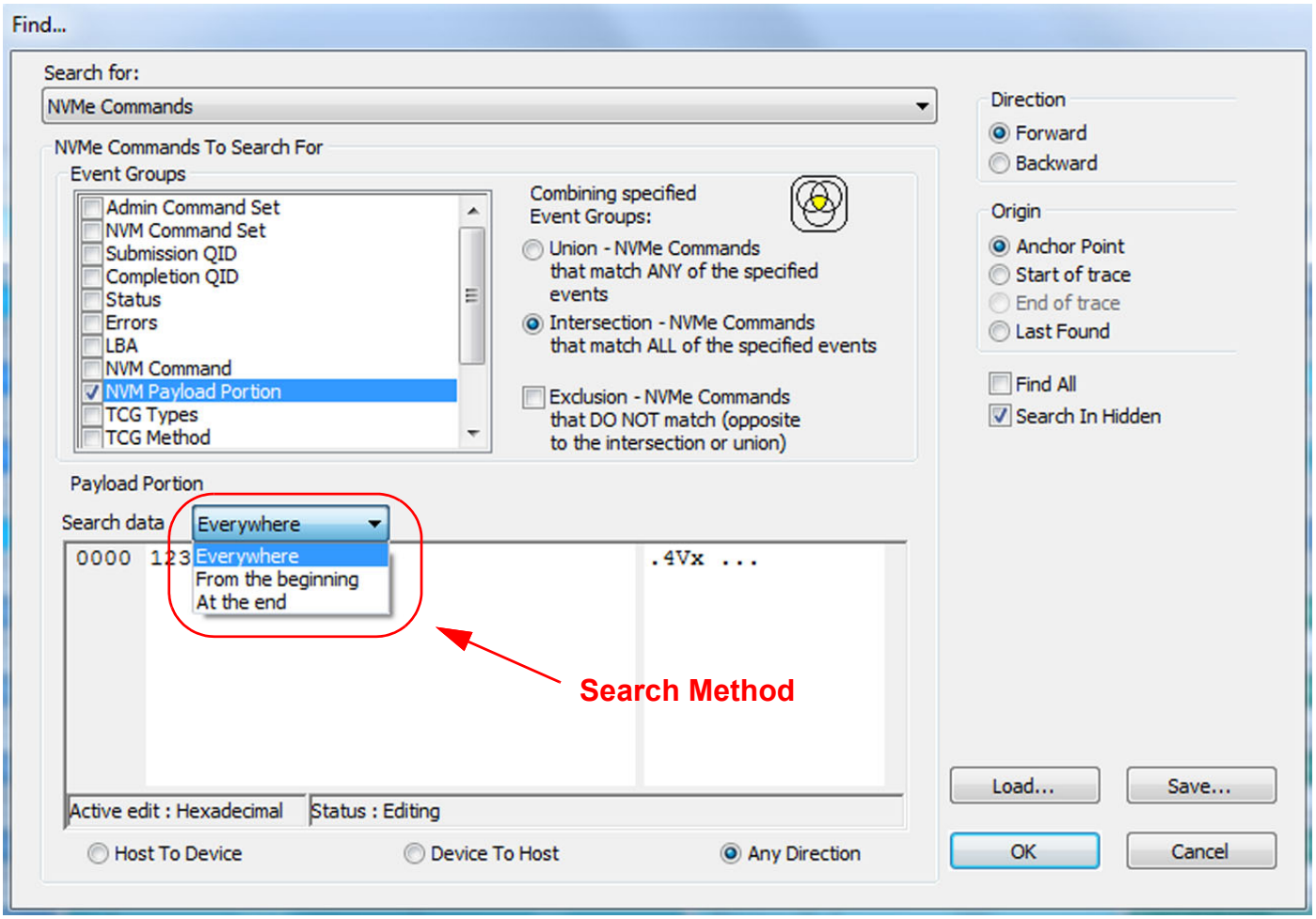


Figure 6.267: Find: Search for NVMe Commands → NVM Payload Portion

There are several methods which can be used to search the NVM Payload for a particular data pattern:

- Everywhere - matching the set pattern anywhere in the payload
- From the beginning - matching the set pattern in the payload at offset 0
- At the end - matching the set pattern with the offset calculated by the length of the pattern from the end of the payload.

The different search methods are illustrated in Figure 6.268 on page 453.

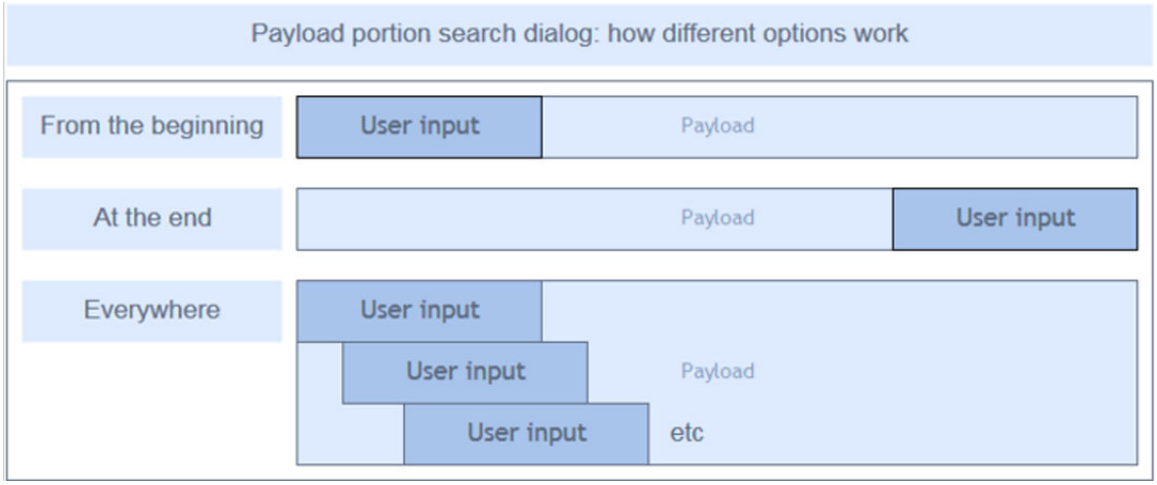


Figure 6.268: Search NVM Payload: Different Methods

6.5.6.10 Event Groups for MCTP Messages:

- MCTP Message Type
- MCTP Control Command Code
- MCTP Control Completion Code
- MCTP Control Instance ID
- MCTP Error
- PLDM Type
- PLDM Command Code
- PLDM Completion Code
- NCSI Command
- NCSI Response
- NCSI AEN Type

6.5.6.11 MCTP Messages to Search For

The Event Groups for MCTP Messages are:

- MCTP Message Type
- MCTP Control Command Code
- MCTP Control Completion Code
- MCTP Control Instance ID

You can search for a number of MCTP Messages → Event Groups → MCTP Control Command Codes. See Figure 6.269.

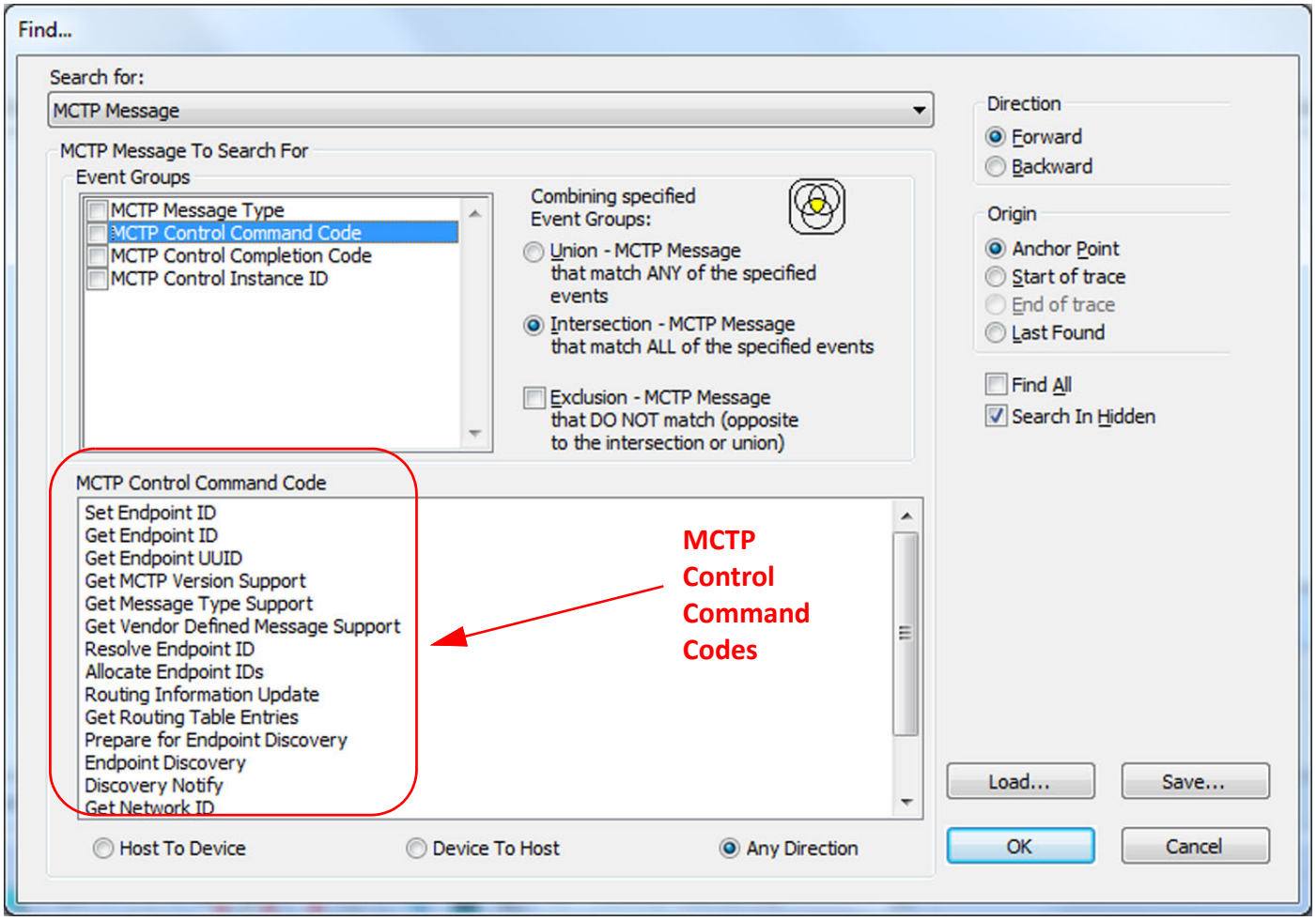


Figure 6.269: Search for MCTP Messages

6.5.6.12 Example: Searching for PLDM Message Types within MCTP Messages

You can search for the following PLDM Message Types within an MTCP Message:

- PLDM Type
- PLDM Command code
- PLDM Completion code

See Figure 6.270.

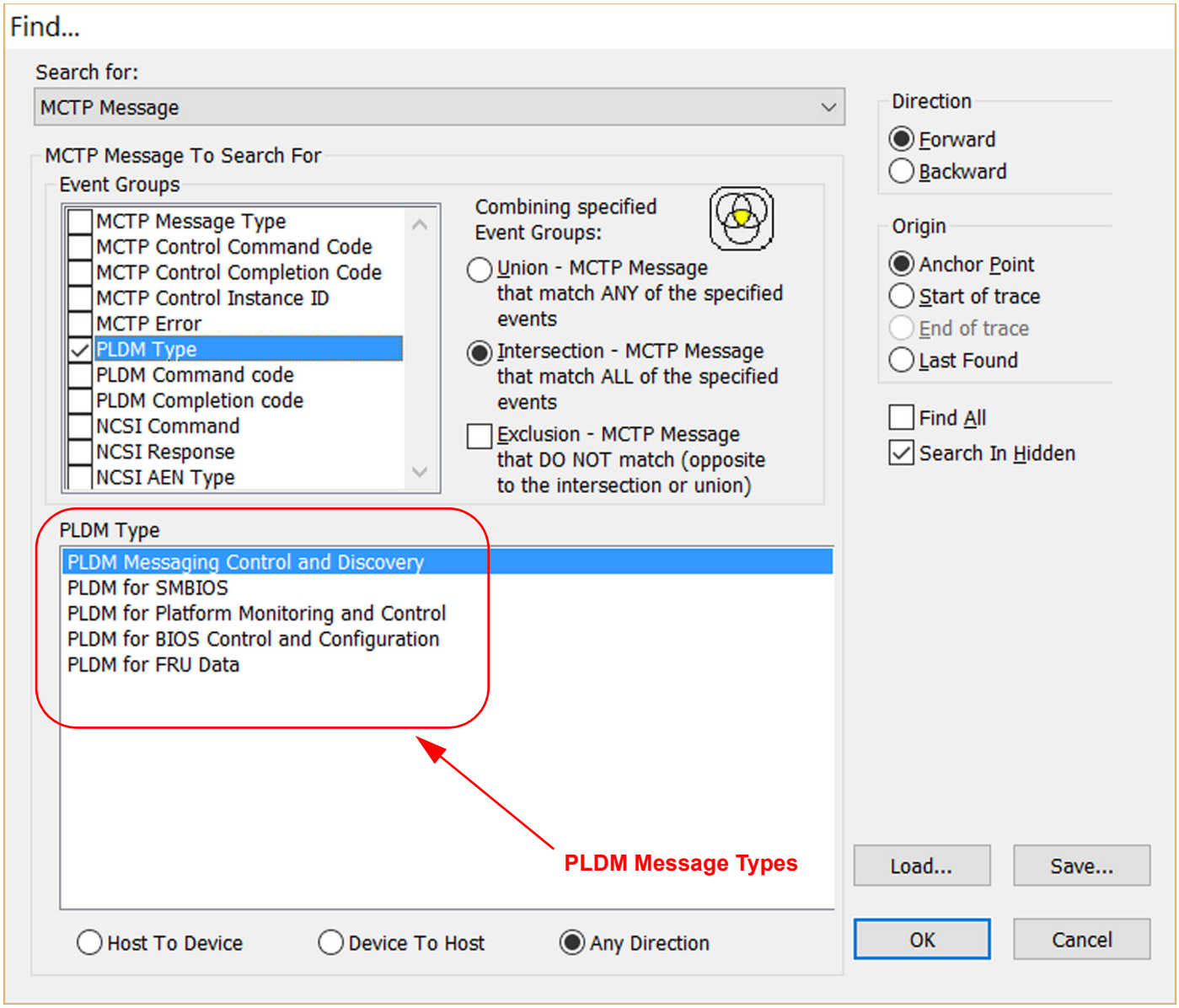


Figure 6.270: Search for PLDM Message Types with MCTP Message

6.5.6.13 Example: Searching for NC-SI Message Types within MCTP Messages

You can search for the following NC-SI Message Types within an MTCP Message:

- NCSI Command
- NCSI Response
- NCSI AEN Type

See Figure 6.271.

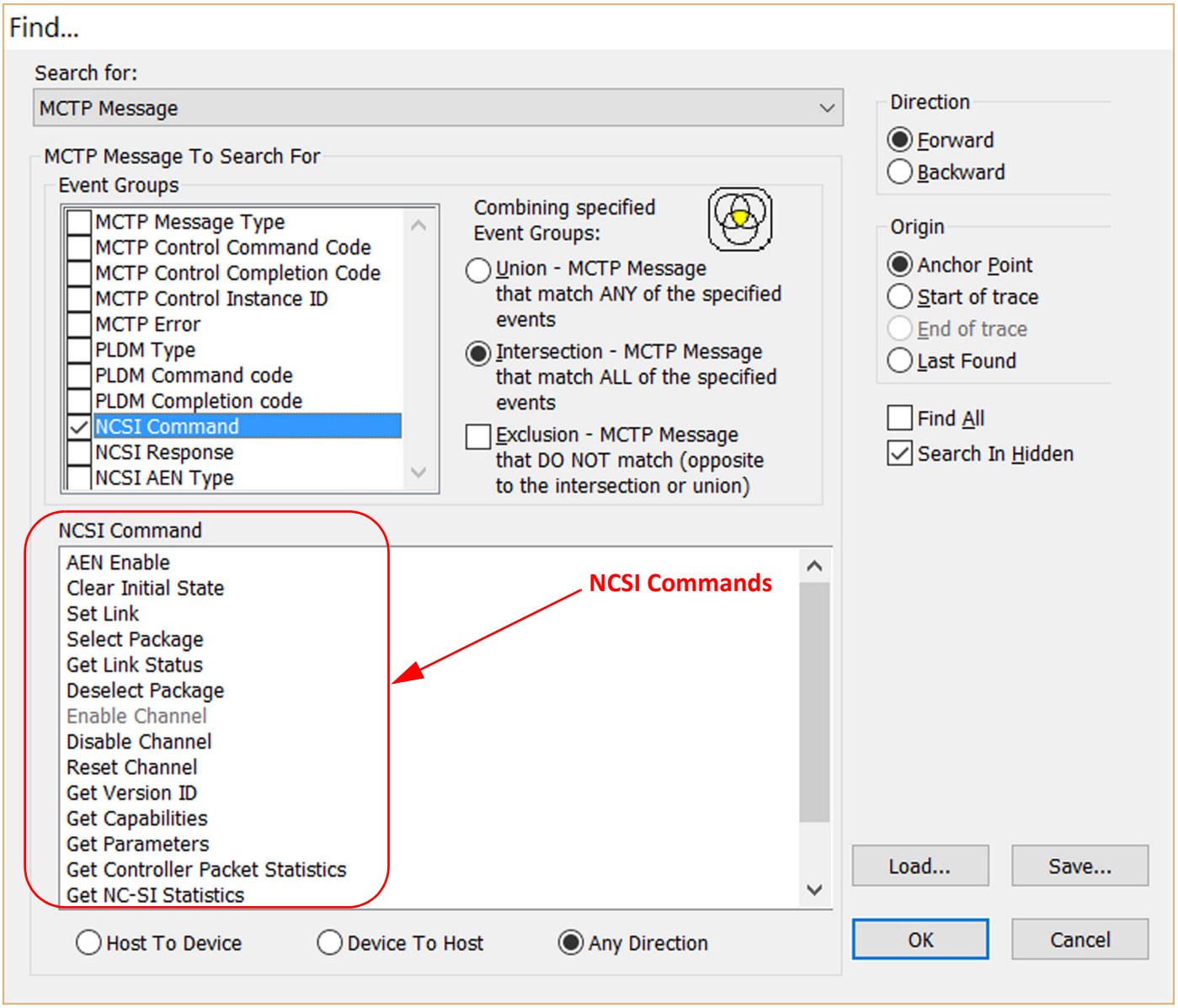


Figure 6.271: Searching for NC-SI Message Types within an MCTP Message

6.5.6.14 Example: Search for DLLP Header → Flow Control Feature

In this case, we are searching for the following event:

- DLLP Header → Data Link Feature → Flow Control Packet: Fields and Layout (see Figure 6.272 and Figure 6.273 on page 458)

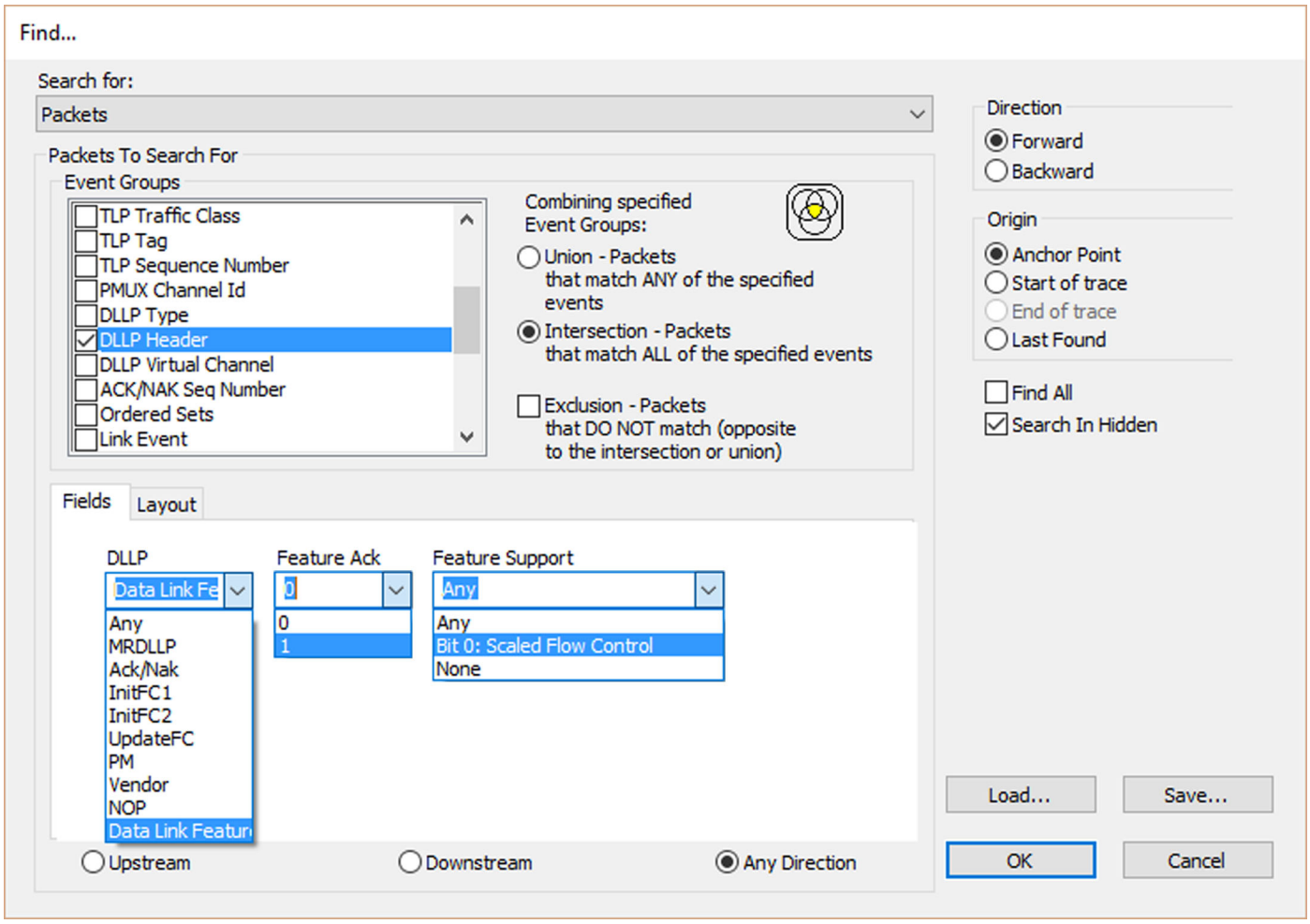


Figure 6.272: Search for: Flow Control Packet → Fields

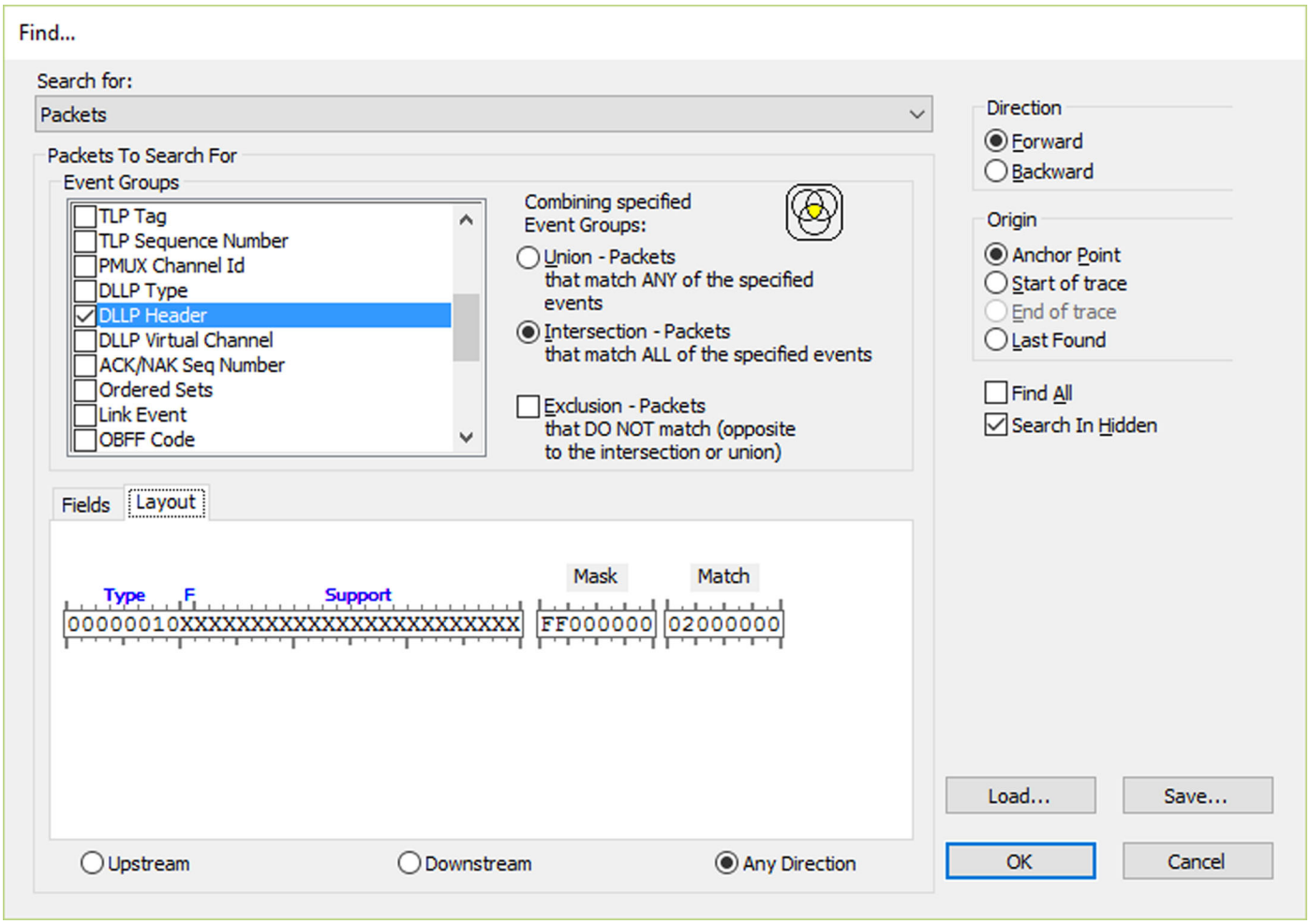


Figure 6.273: Search for: Search for: Flow Control Packet → Layout

6.5.7 Find Next Packet Type

Use Find Next or click  to search for the next packet meeting the search criteria.

6.5.7.1 Quick Search Feature

As an example, the NVMe_Z3DriveEmulation Trace has been loaded from the C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\Sample Files (see Figure 6.274).

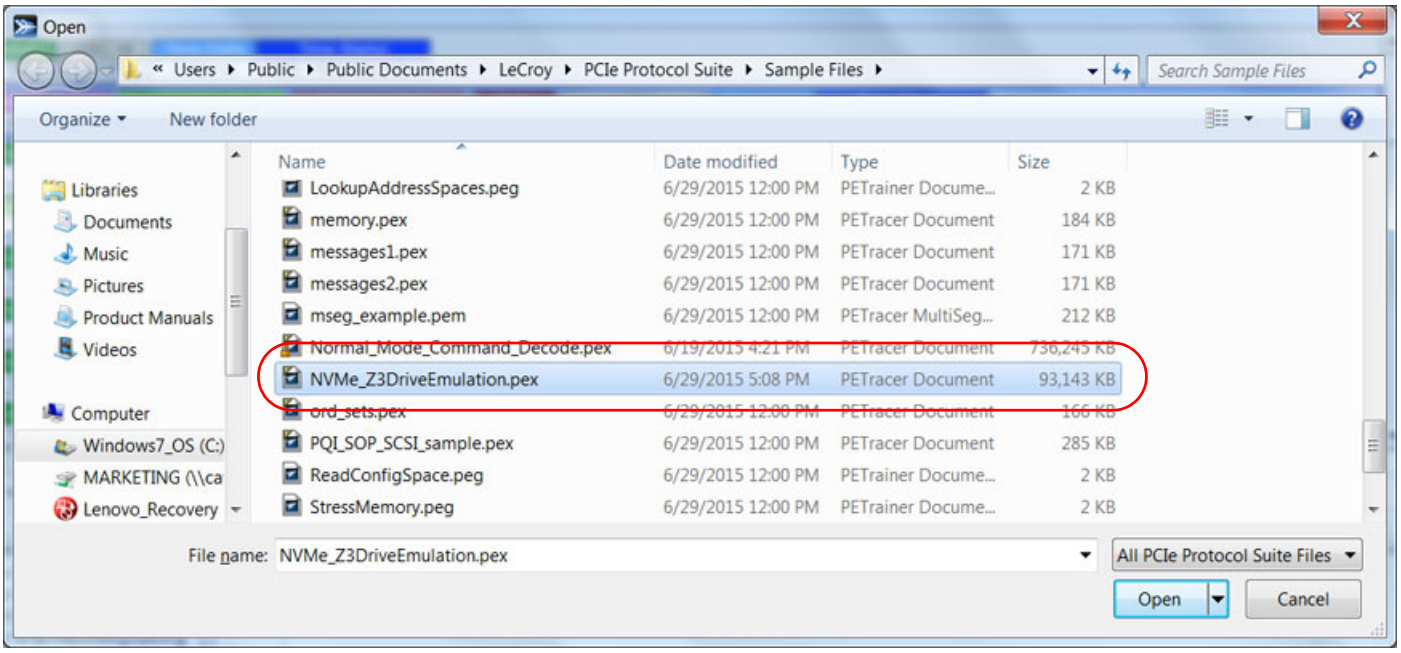


Figure 6.274: Location of Trace File to be Loaded

Select the NVMe_Z3DriveEmulation.pex file and click on Open.

The Main Menu will look like Figure 6.275 on page 460 after you chosen to look for NVMe commands and removed unrelated traffic.

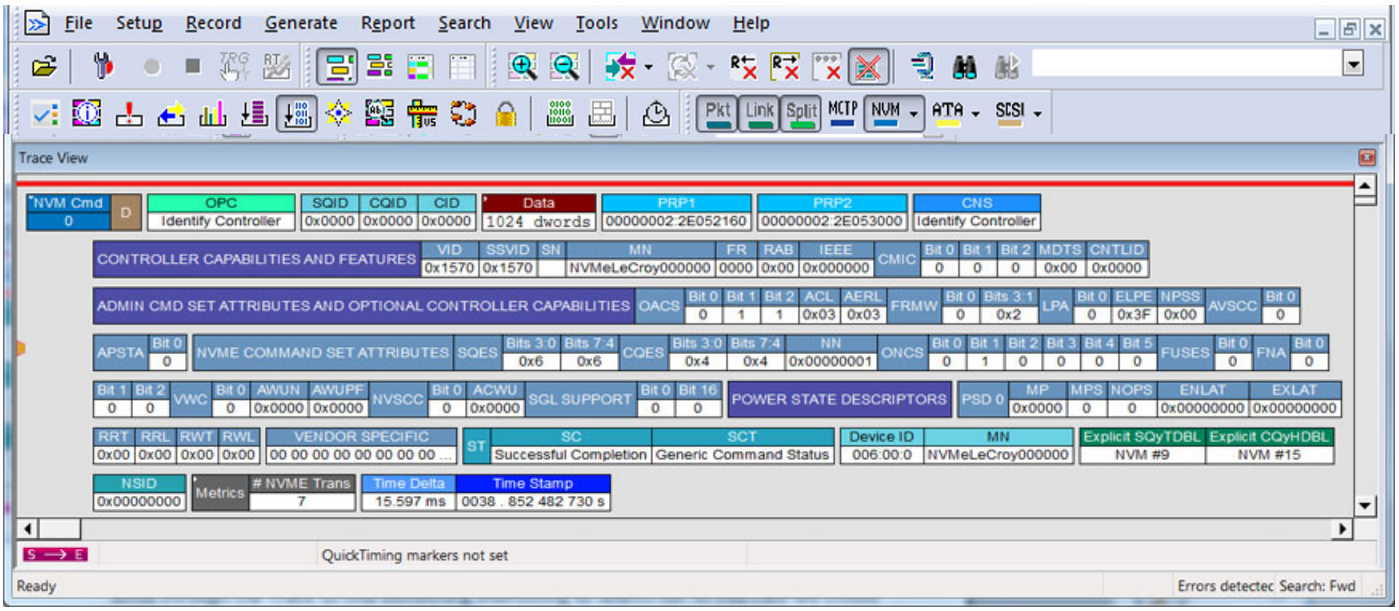


Figure 6.275: Main Menu with NVMe_Z3DriveEmulation Trace Loaded

Enter a term to search for in the Search Window.

In this case, we chose “NVM #66 

.

Place the cursor inside the Search Window and click the Enter key. The results are shown below (see Figure 6.276).

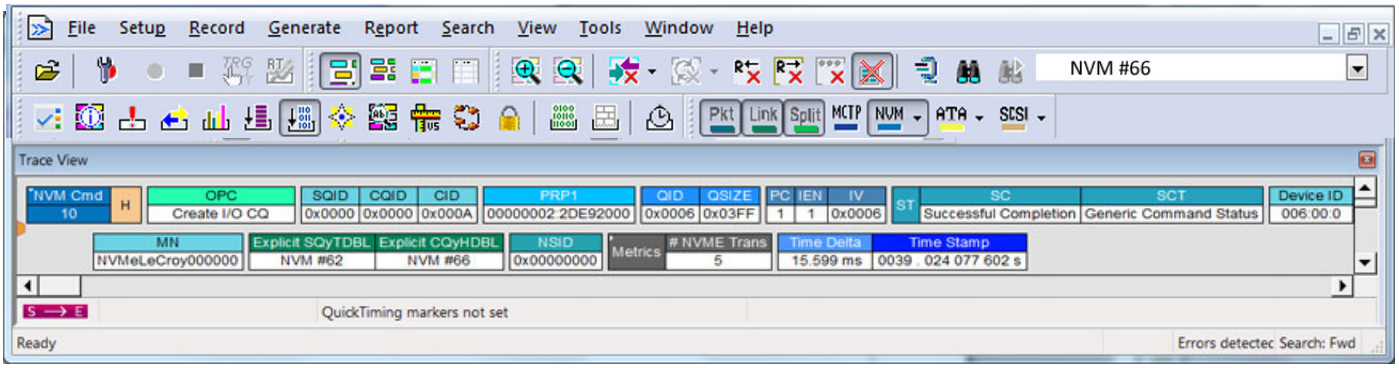


Figure 6.276: Search for NVM #66

Once the packet in the Trace has been found, the NVM #66 can be seen to be part of a doorbell event (Explicit SQyTDBL: NVM #62 with the response of Explicit CQyHDBL NVM #66).

This was just an example, you can search for any of the pre-defined terms (Figure 6.11 on page 233) or chose your own term or event to search for.

If you started Searching in the middle of the Trace the following windows will pop up:

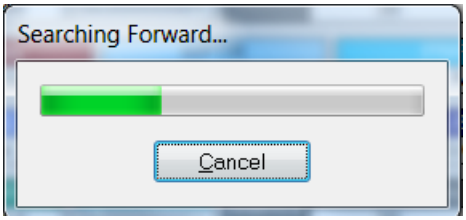


Figure 6.277: Search Progress Window

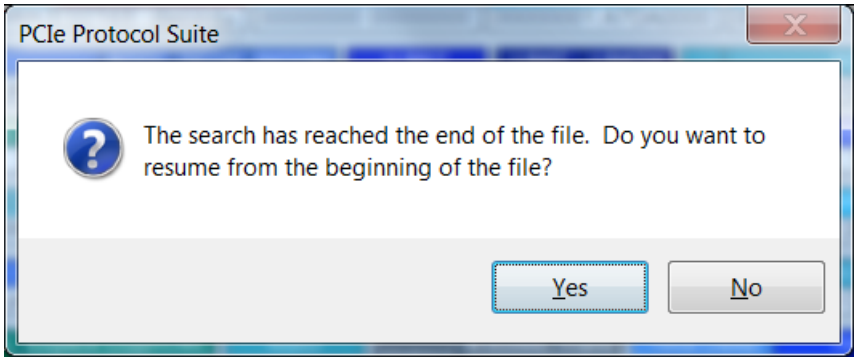


Figure 6.278: Resume Searching From Beginning of Trace

If you select Yes, the tool will continue searching from the start of the Trace, then the following window will pop up:

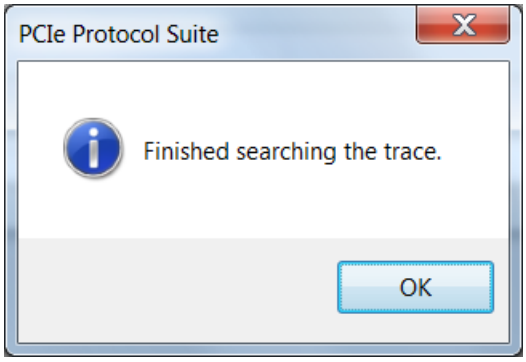


Figure 6.279: Finished Searching Trace

If the tool hasn't moved to a new Packet, the term being Searched for was not found.

6.5.7.2 Quick Search for MCTP Transactions

MCTP traces can use the Quick Search feature to look for MCTP Packets and Control Messages. See Figure 6.280.

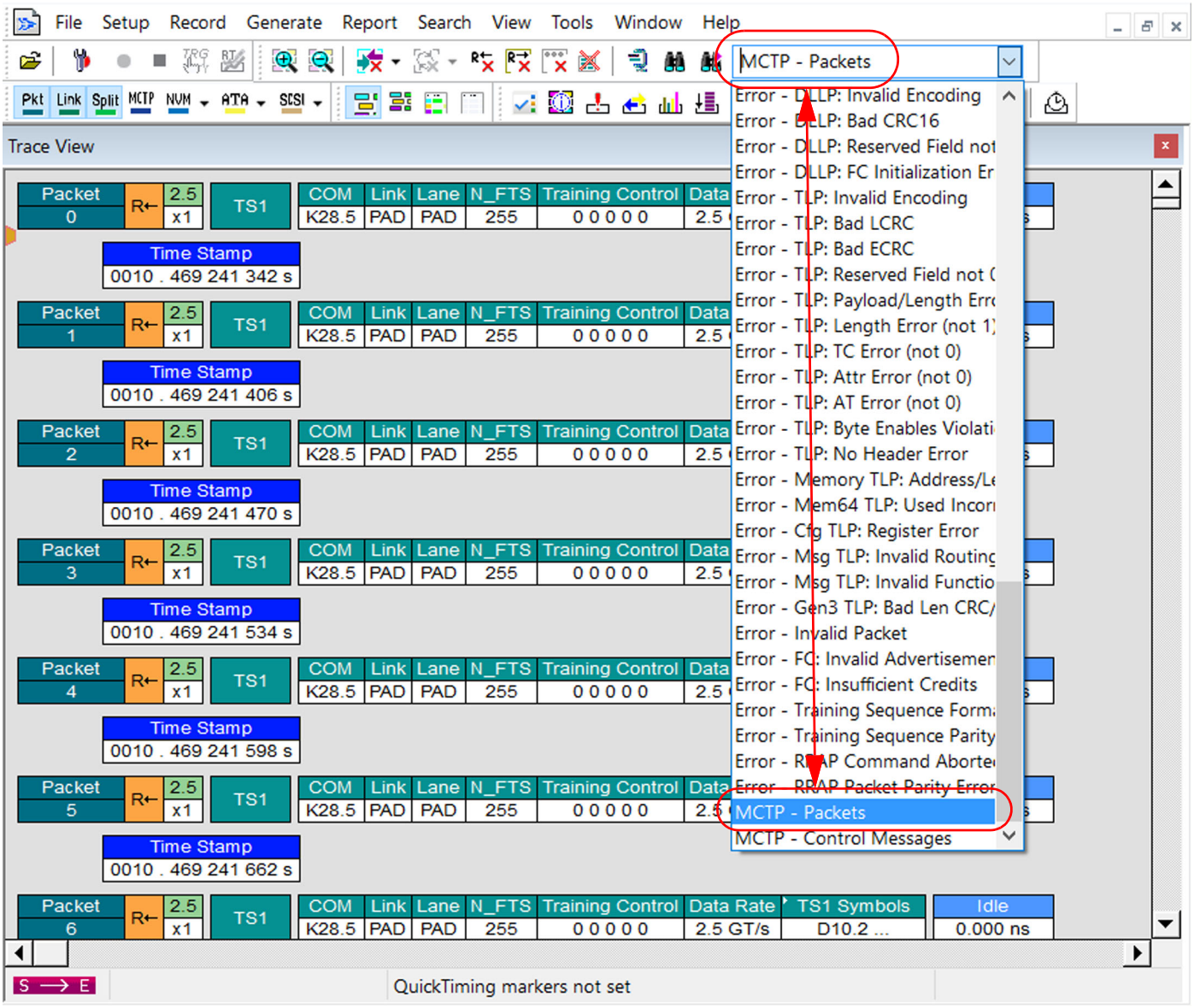


Figure 6.280: Quick Search Feature: MCTP Transactions

6.5.8 Toggle Search Direction

Search direction can be toggled back and forth by using the command under the Search menu. Search Direction controls the direction of the search. Each time Toggle Search Direction is selected, the search order is reversed. For example, if the previous search was **forward**, choosing **Toggle Search Direction** toggles the current search to **backward**.

To verify the direction of a search look at the lower right corner of the screen. **Search: Bwd** or **Search: Fwd** should appear. If a direction is not indicated, it means that the status bar is turned off.

To turn on the Status bar, select from the menu **View > Status Bar**.

Keyboard shortcuts can also be used to control search direction: Ctrl+b toggles the search direction.

6.6 Display Options

6.6.1 Setting Display Options

Display Options allow you to customize the colors and formats of displayed traffic.

To open the Display Options dialog at the General tab, Select **Setup > Display Options** from the menu or click the **Display Options** button  on the toolbar. See Figure 6.281.

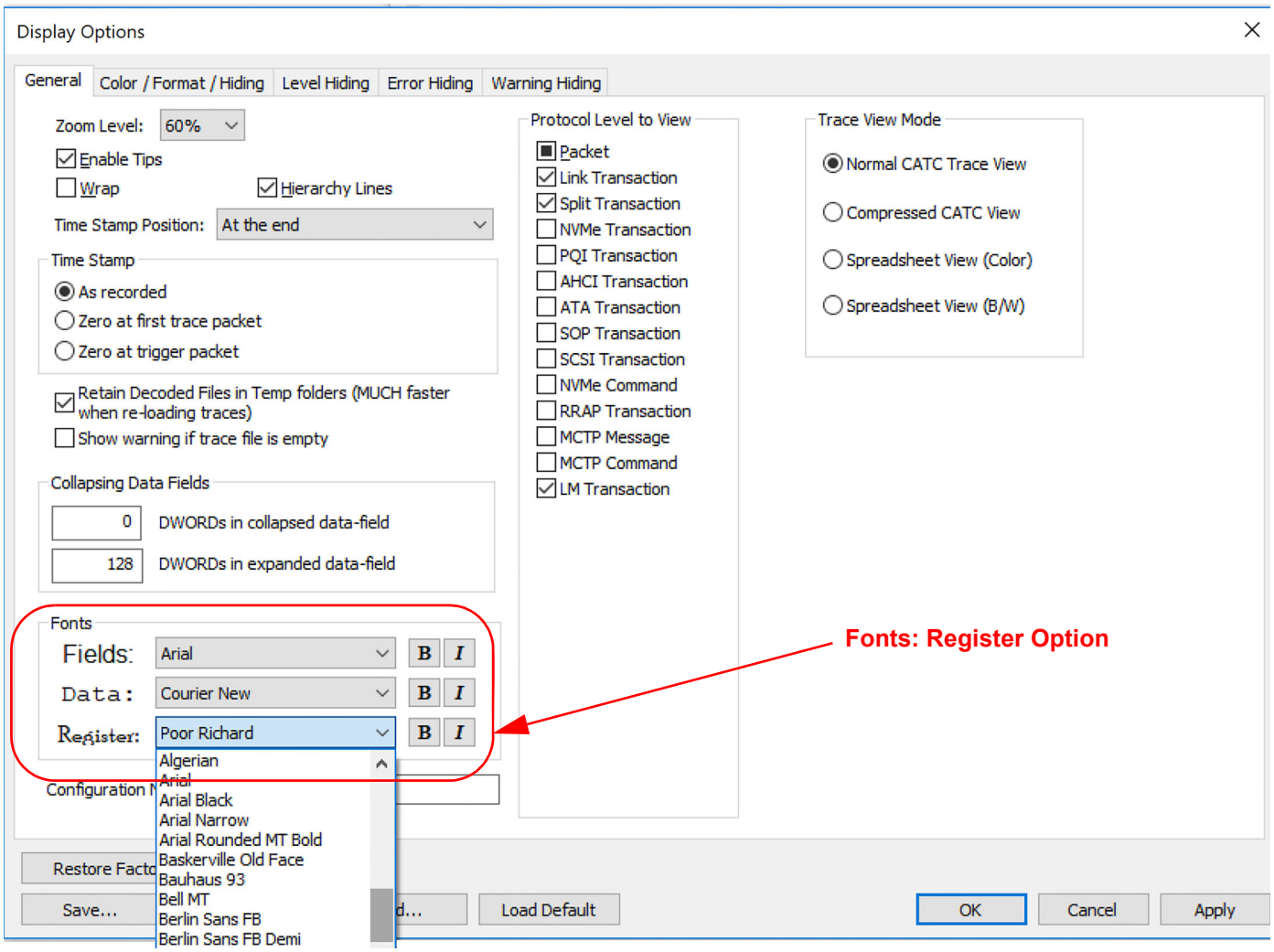


Figure 6.281: Display Options Dialog - General Tab

6.6.2 Specifying General Display Options

The Display Options General tab allows you to specify:

Zoom Level: Defines the size of packet fields in the packet view. Zoom level is adjustable as 10, 20, 40, 60, 80, 100, 120, 140, 160, 180 and 200 percent.

Enable Tool tips: Allows information to be displayed on a packet by resting your mouse pointer over it.

Wrap: Allows packets, Link Transactions, and Split Transactions to wrap within the display.

Hierarchy Lines: Adds lines to the trace view indicating relations between packets, Link Transactions, and Split Transactions.

Timestamp position: Moves timestamp location from end of packet to beginning of packet, or merges it with the packet number.

Retain Decoded Files: Decoded Files are retained in Temp folders, which makes re-loading the trace much faster.

Empty Trace File Warning: If you've chosen recording conditions which result in an empty trace (no traffic is recorded), a warning message is displayed.

Protocol Level to View: Allows the CATC Trace to be displayed in different hierarchical levels: Packets, Link Transactions, Split Transactions, NVMe Commands, PQI, AHCI, ATA, SOP, SCSI commands, RRAP, MCTP and LM transactions.

Time Stamp: Gives you options for setting the timestamp to zero for either the first CATC Trace packet or the trigger packet or for leaving the stamp unchanged as it was originally recorded.

Trace View Mode: Displays Normal CATC Trace View, Compressed CATC View, Spreadsheet View (Color), and Spreadsheet View (B/W).

6.6.2.1 Collapsing Data Fields

This affects the "Data" field in the TLP packets when using the collapse feature (see Figure 6.282 on page 466).

0 in the collapsed field means no data will be shown. 128 in the expanded field means 128 DWords will be shown when the data field is expanded.

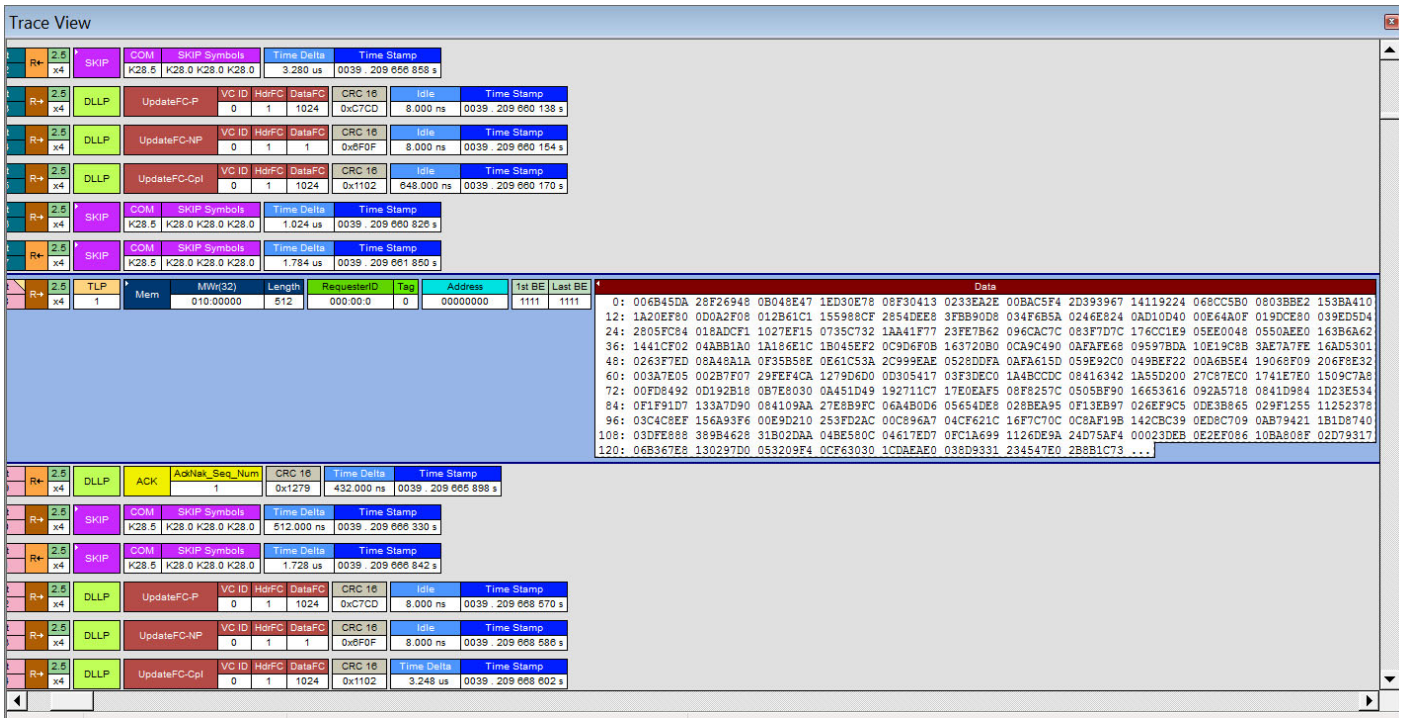


Figure 6.282: Expanded Data Field

6.6.2.2 Fonts

Fonts: Allows the appearance of field text and/or data text as well as Registers to be defined.

6.6.2.3 Configuration Name

Display Configuration Name: This field is used to enter a text string to be associated with the current set of Display Options. This name is saved with the Display Options file, and appears as part of the title of the packet view window that uses this set of Display Options.

6.6.2.4 Color, Format, and Hiding Options

The Color/Format/Hiding tab allows you to customize the colors and formats associated with each field in the CATC Trace and to selectively hide fields or packets. You access these display options by selecting **Setup > Display Options > Color/Format/Hiding** tab (see Figure 6.283 on page 467).

The Color/Format/Hiding property page lets you set how fields display in a CATC Trace. This property page lets you set field color and data format (binary, hex, decimal, ASCII), and lets you hide selected fields from the display.

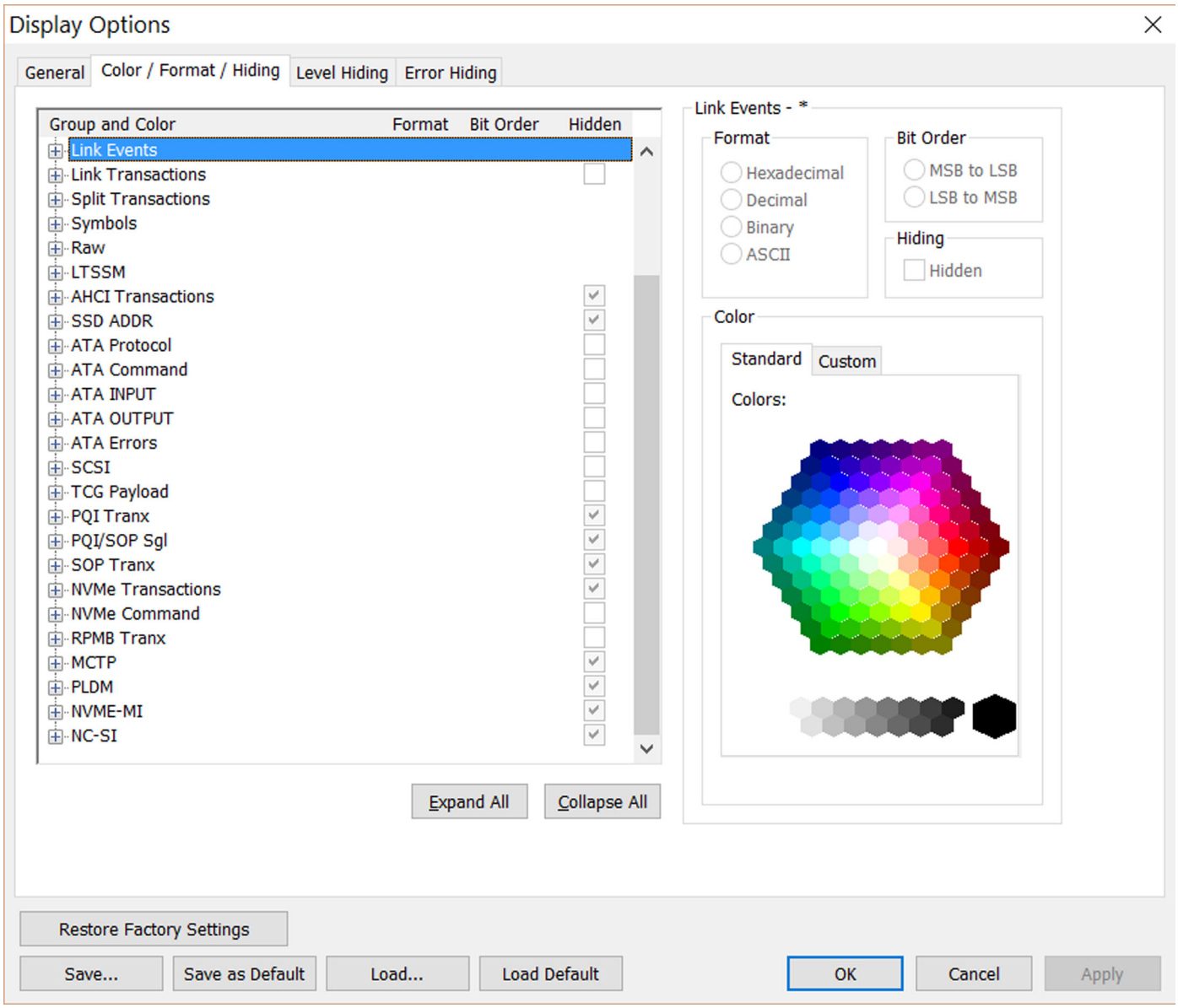


Figure 6.283: Display Options Dialog - Color/Format/Hiding Tab

6.6.2.5 Setting Field Colors

The Field Colors tab allows you to customize the colors associated with each field used in the packet view.

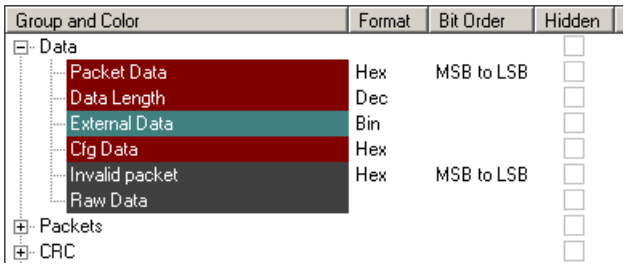
You may experiment with this option to achieve a color combination that suits you.

Select or change the trigger color using the color buttons labeled **- Packet #** and **+ Packet #** (before and after trigger) found under the Packet# section of the Field Colors window.

You select or change a color by clicking the appropriate color button. This action causes a color palette to pop up. Select the desired color and press OK.

1. Click **View > Set Display Options** to open the Display Options dialog.
2. Select the **Color/Format/Hiding** property page (see following figure).

3. Under the Group and Colors column, click the **plus** symbol (**+**) next to the group you want to reformat. The group expands to show the individual fields within the group. Each field has a color, as shown below:



4. Click the colored cell that you want to change. A color palette appears.
5. Click a color in the palette, then click **Apply** or **OK**.

Note: The colors of the following Frame types cannot be changed:

- Invalid Data (frame error) field (red)
- Softbit Errors (yellow)

You can also change color by right-clicking a field in the CATC Trace and selecting Color from the pop-up menu (see Figure 6.284 on page 469).

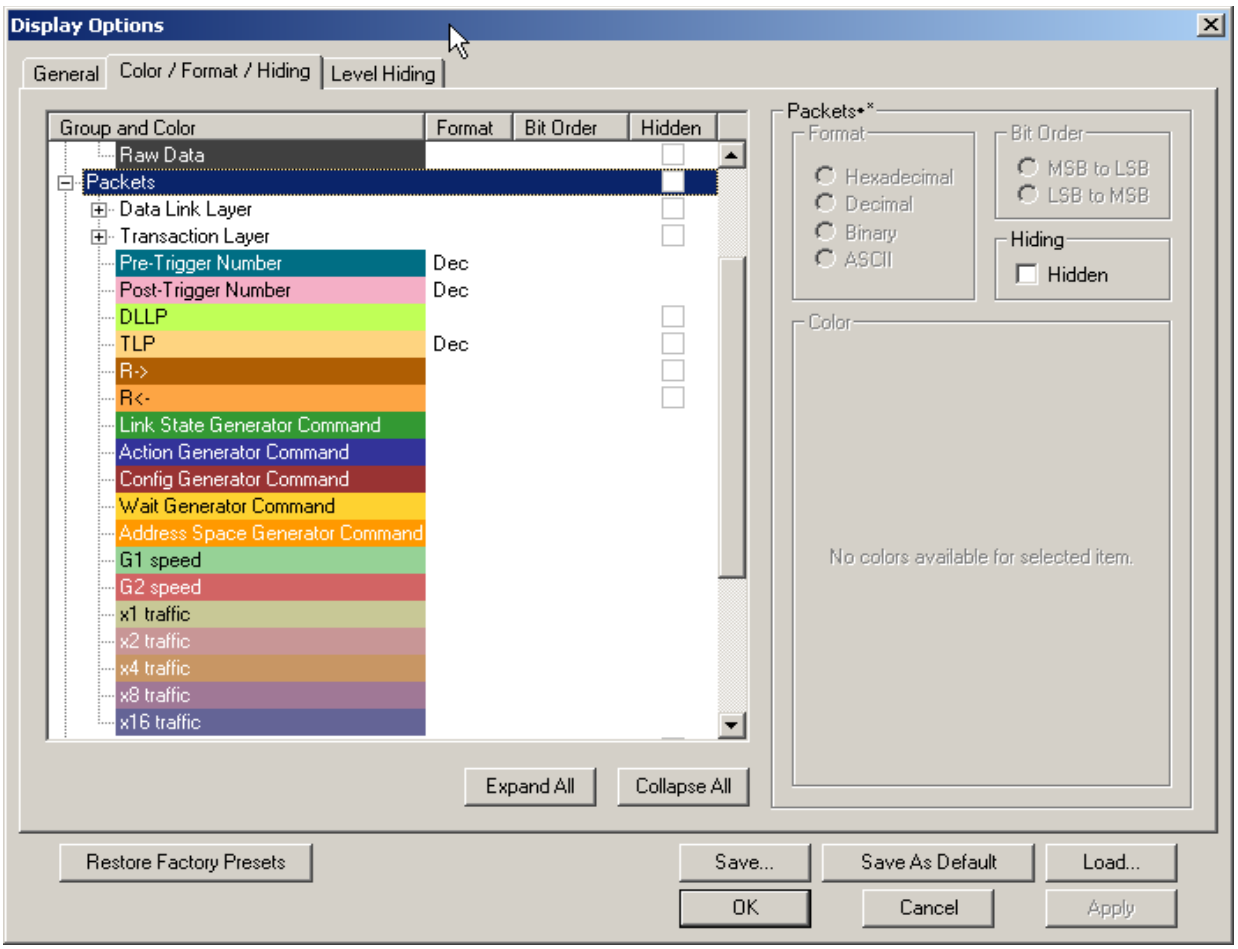


Figure 6.284: Display Options Dialog Color/Format/Hiding Tab

6.6.2.6 Changing Field Formats

The Field Formats tab allows you to define the way various numeric fields are shown in the packet display. You can select Hexadecimal, Decimal, Binary, or ASCII for certain fields or groups of fields.

To change a field's format, click the plus sign (+) next to a field in the list. This causes the selected item to expand so you can see its constituent sub-fields. Select a sub-field, and then choose the format from the formatting choices that appear at the bottom right of the window (see Figure 6.285 on page 469).

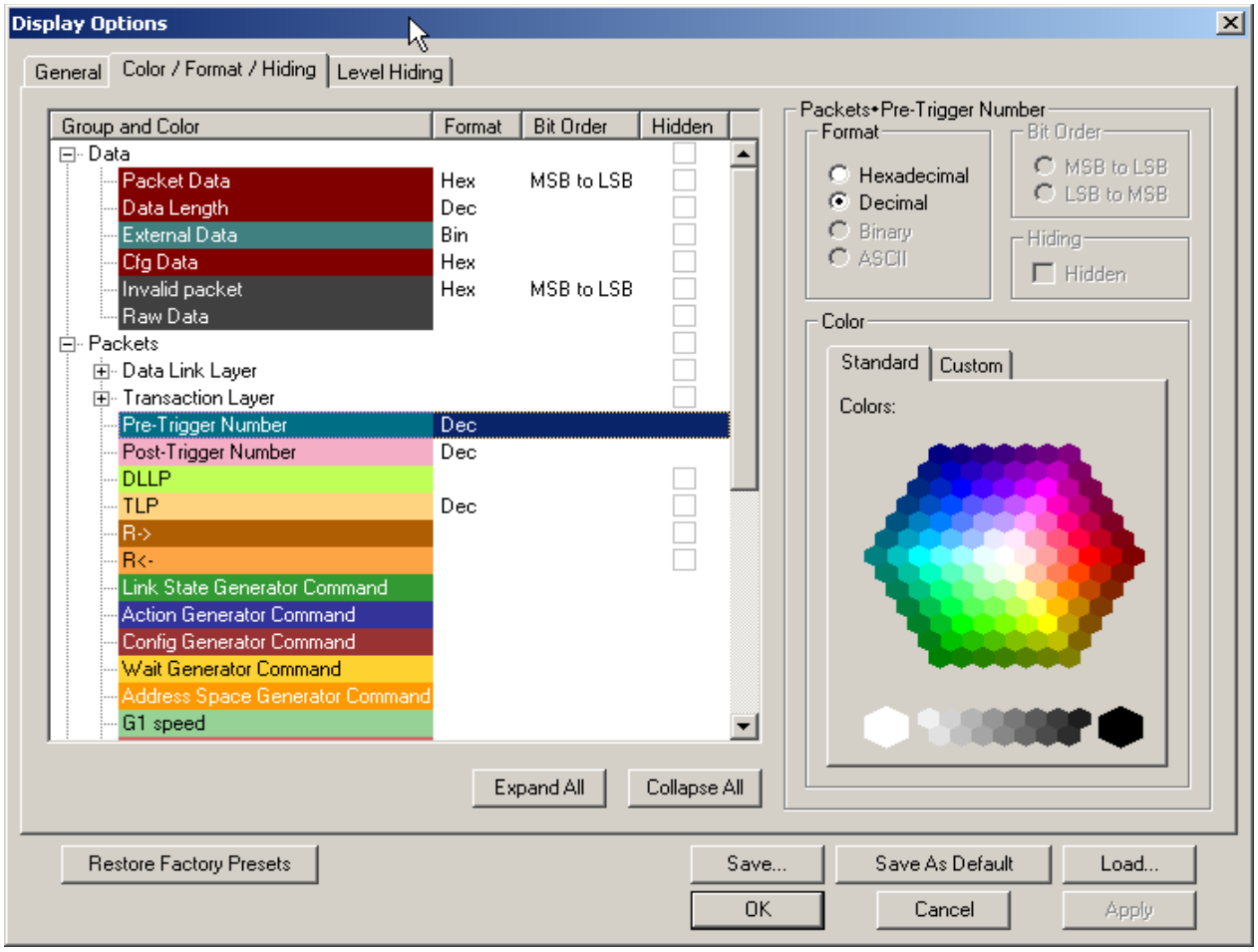
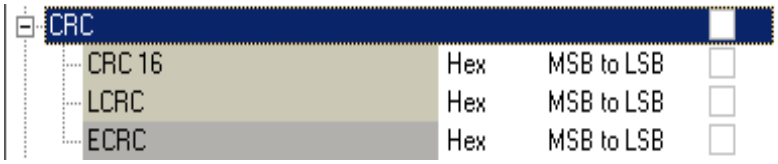


Figure 6.285: Display Options Dialog Color/Format/Hiding Tab

To change the format of alphanumeric characters in a field:

1. Under the Group and Colors column, click the **plus** symbol (**+**) next to the group you want to reformat. The group expands to show the individual fields within the group (as shown above).
2. Click the **row** representing the field that you want to reformat. If the field can be reformatted, the format options become active, and choose an option from the list as shown below:



3. Select a **format**.
4. Specify the bit order in the displayed fields by checking/unchecking the **MSB > LSB** checkboxes.
5. Click **Apply** or **OK**.

6.6.2.7 Hiding Fields

To hide a field:

1. Under the Group and Colors column, click the **plus** symbol (**+**) next to the group that has the field(s) you want to hide. The group expands to show the individual fields within the group (as shown above).
2. Click the **checkbox** in the row representing the field that you want to hide.
3. Click **Apply** or **OK**.

6.6.2.8 Hiding Levels

The Level Hiding page lets you hide traffic by Event Group (see Figure 6.286 on page 471). If you select one or more event types from the Event Group list, the selected types are hidden from the CATC Trace.

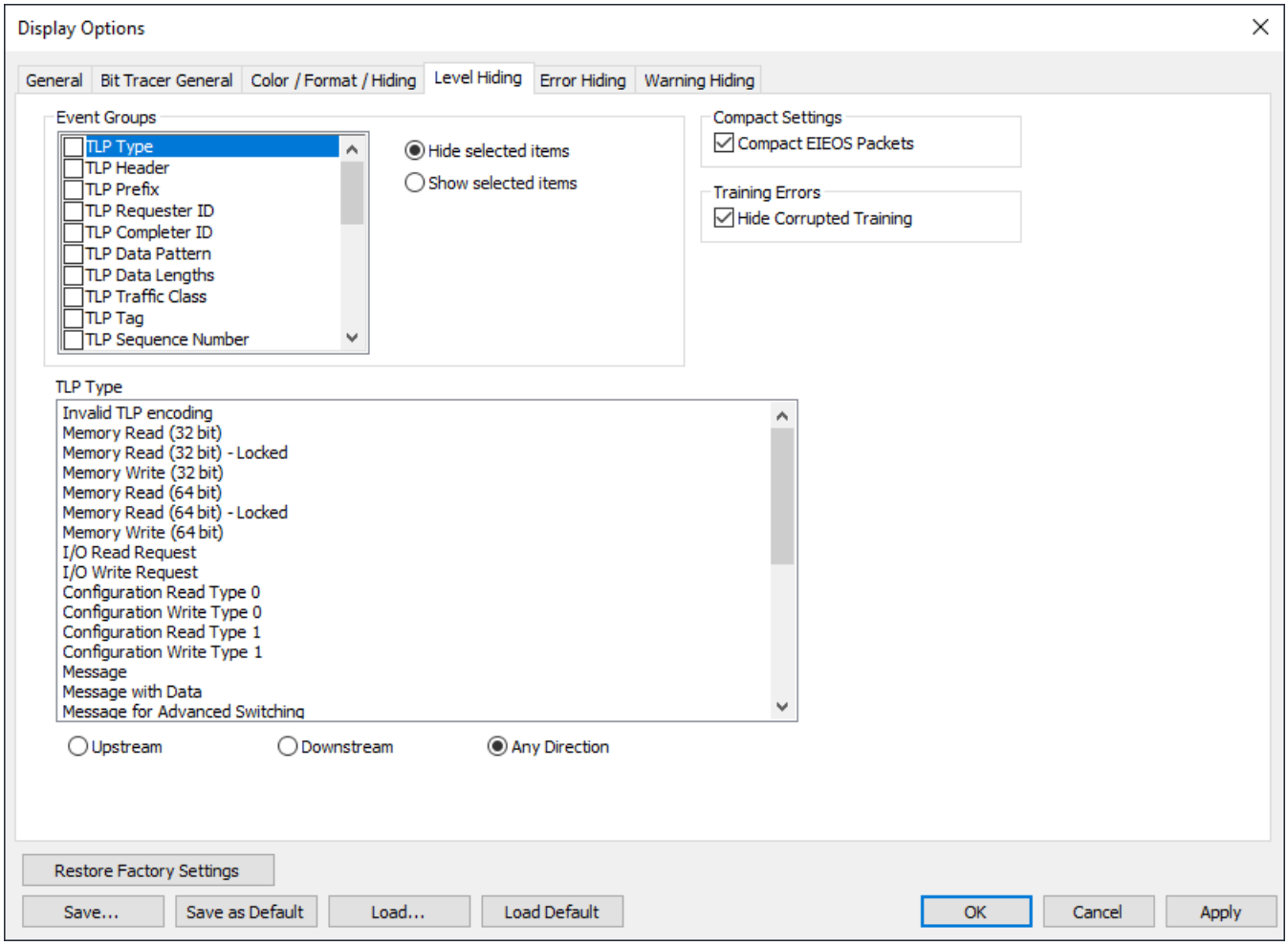


Figure 6.286: Display Options Dialog - Level Hiding Tab

To hide a level:

1. Select an Event Group.
2. Select whether to **Hide** or **Show selected items**.
3. Select **Upstream, Downstream**, or **Any Direction**.
4. (Optional) Select **Compact EIEOS packets**.
5. (Optional) Select **Hide Corrupted Training**.
6. Click **OK**.

The Event Groups for Packets are:

- ❑ TLP Type
- ❑ TLP Header
- ❑ TLP Requester ID
- ❑ TLP Completer ID
- ❑ TLP Data Pattern
- ❑ TLP Data Lengths

- TLP Traffic Class
- TLP Tag
- TLP Sequence Number
- DLLP Type
- DLLP Header
- DLLP Virtual Channel
- ACK/NAK Seq Number
- Ordered Sets
- Link Event
- OBFF Code
- Direction
- Errors
- TS1 Data
- TS2 Data

The Event Groups for Link Transactions are:

- TLP Type
- Traffic Class
- Virtual Channel
- Direction
- RequesterID
- CompleterID
- Status
- Tag

The Event Groups for Split Transactions are:

- TLP Type
- Traffic Class
- Virtual Channel
- Direction
- RequesterID
- CompleterID
- Status
- Tag
- Address

The Event Groups for NVMe transactions are:

- Controller Registers
- Other NVMe Entities
- Queue IDs
- Command IDs
- Doorbell Registers
- Admin Submission Command Set
- NVMe Submission Command Set
- Completion Queue Entry
- PRP
- Submission Command

- NVMe Errors

The Event Groups for PQI Transactions are:

- PQI Register ID
- PQI Admin Functions
- PQI Errors

The Event Groups for AHCI Transactions are:

- AHCI Register ID
- AHCI Port Number
- AHCI Slot Number
- AHCI Port Multiplier Port
- AHCI Raw Address
- AHCI Direction
- AHCI Errors

The Event Groups for ATA transactions are:

- ATA Register Type
- ATA Port Number
- ATA Slot Number
- ATA Raw Address
- ATA Port Multiplier Port
- ATA Interruption Reason
- ATA Error Type
- ATA Input/Output
- ATA Payload Portion
- ATA CFIS Fields
- ATA RFIS Device to Host Fields
- ATA DSFIS Fields
- ATA PSFIS Fields
- ATA SDBFIS Fields

The Event Groups for SOP transactions are:

- SOP Information Unit ID
- SOP Errors

The Event Groups for SCSI transactions are:

- SCSI Operation
- Command Status
- Task Management
- Task Management Response
- Errors
- SCSI Logical Unit Numbers

The Event Groups for NVMe Commands are:

- Admin Command Set
- NVME Command Set

- Submission QID
- Completion QID
- Status
- Errors
- TCG Types
- TCG Method
- TCG Invoker
- TCG Com ID
- TCG Ext Com ID

6.6.3 Error Hiding

The Error Hiding page lets you hide errors by Transaction Types (see Figure 6.287). If you select one or more transaction types from the list, the selected types are hidden from the CATC Trace.

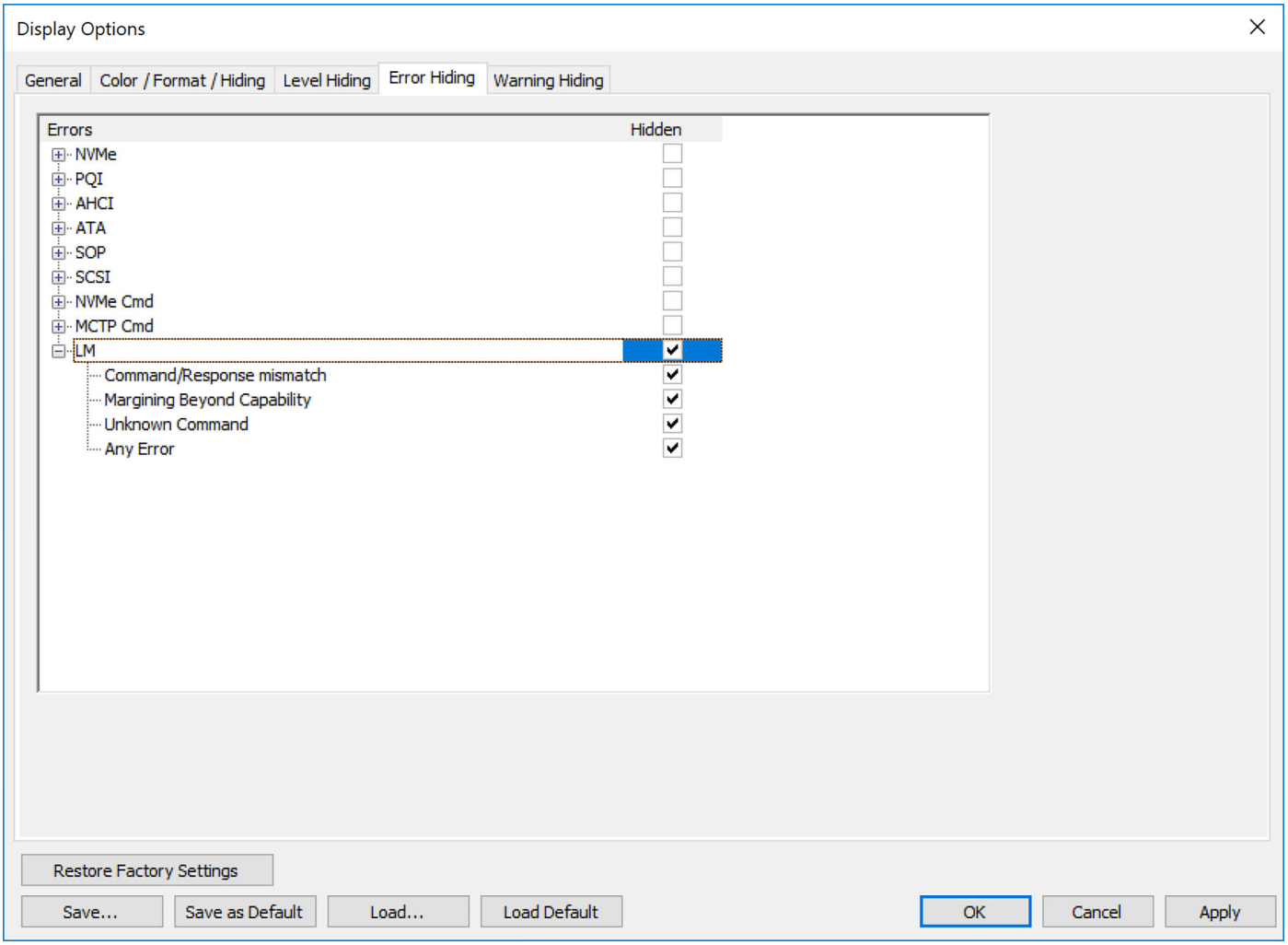


Figure 6.287: Display Options: Error Hiding → Lane Margining Options shown

6.6.3.1 Transaction Types

The Transaction Types which can have their errors hidden include:

- NVMe
- PQI
- AHCI
- ATA
- SOP
- SCSI
- NVMe Cmds
- MCTP
- LM

Each Transaction Type has a large selection of errors that can be selectively hidden. See Figure 6.288, Figure 6.289 on page 477 and Figure 6.290 on page 478.

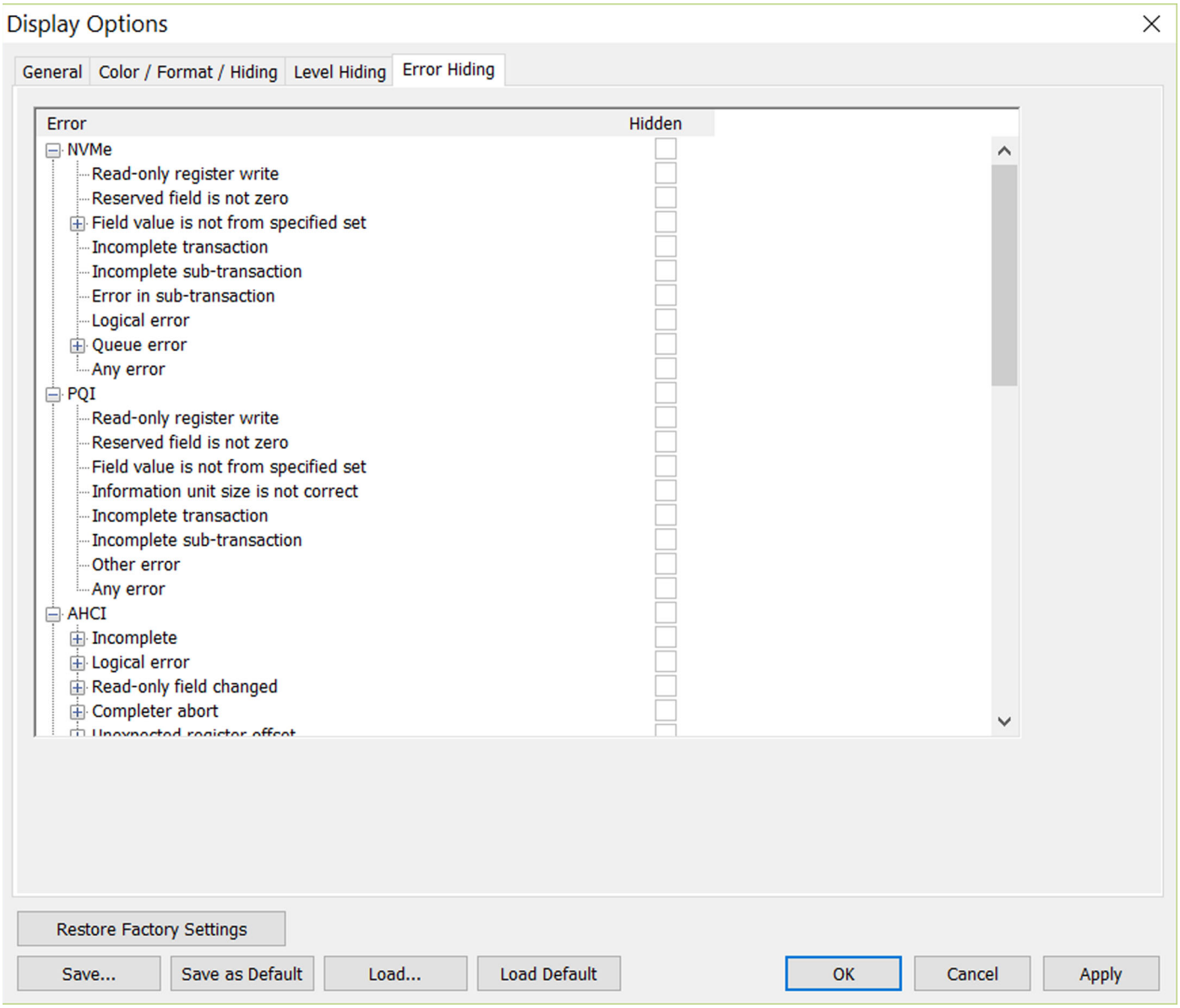


Figure 6.288: Display Options: Error Hiding → Transaction Types: NVMe/PQI/AHCI

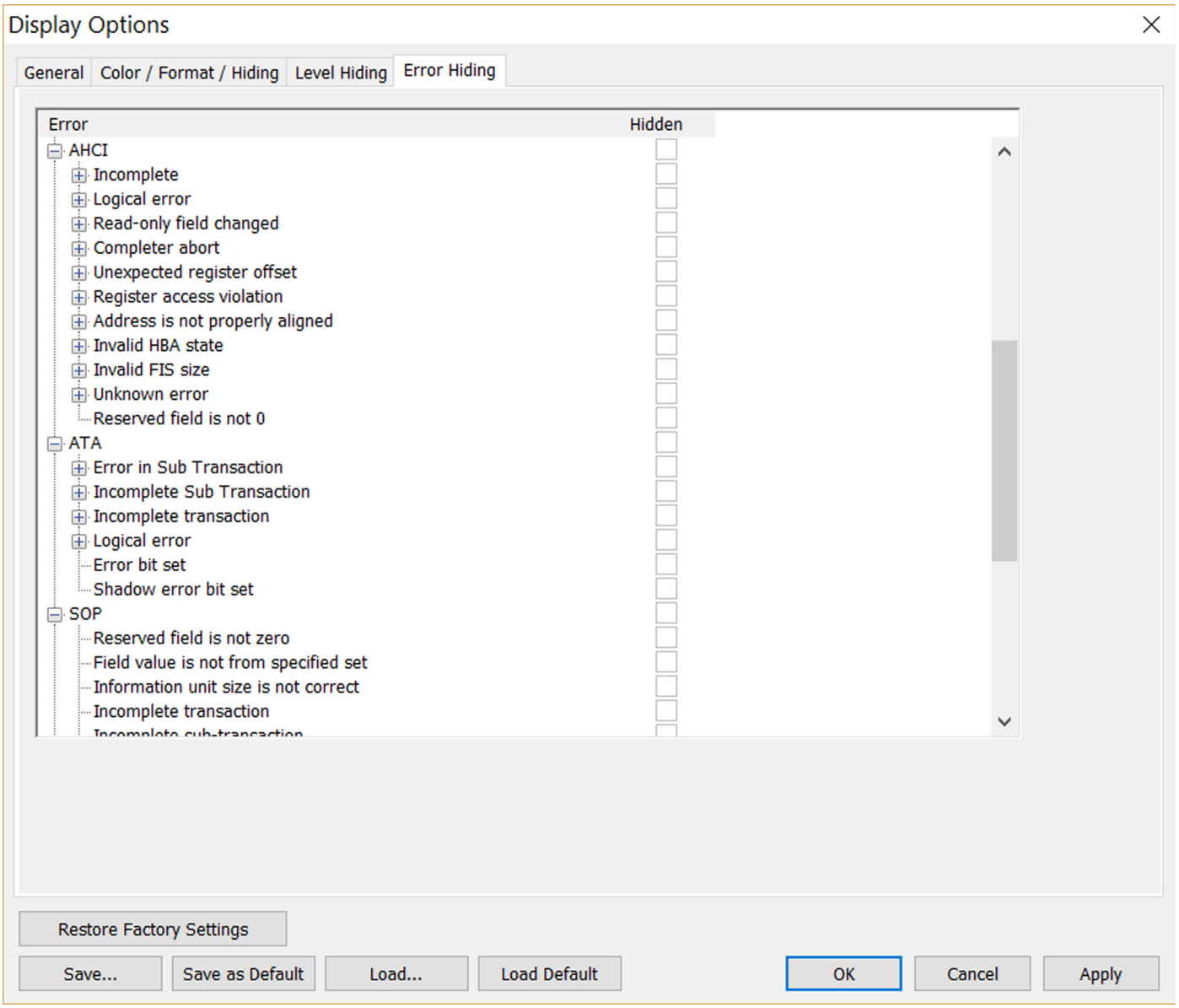


Figure 6.289: Display Options: Error Hiding → Transaction Types: AHCI/ATA/SOP

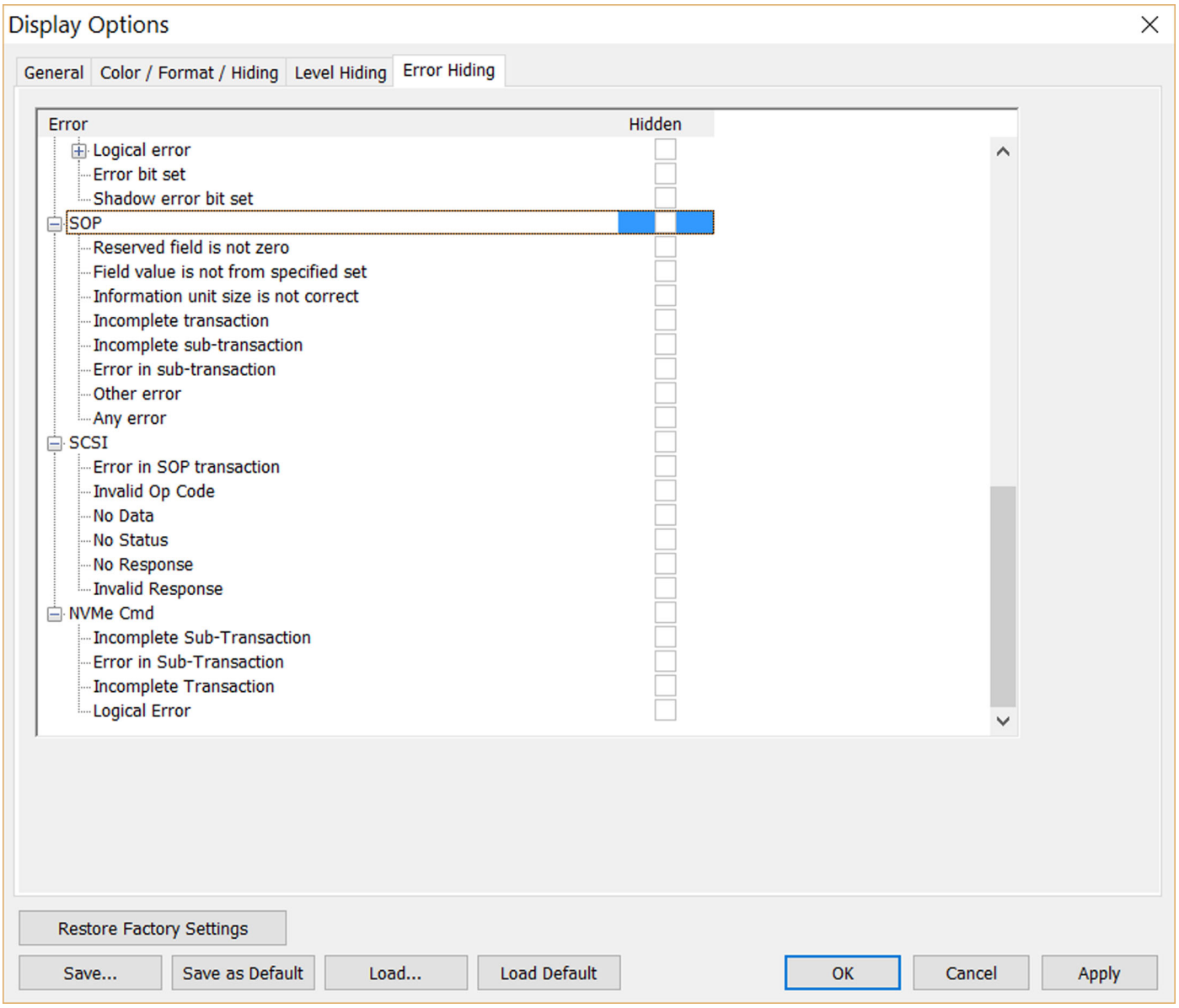


Figure 6.290: Display Options: Error Hiding → Transaction Types: SOP/SCSI/NVMe Cmd

6.6.4 Warning Hiding

The Warning Hiding page lets you hide warnings by Transaction Types (see Figure 6.291). If you select one or more transaction types from the list, the selected warnings are hidden from the CATC Trace.

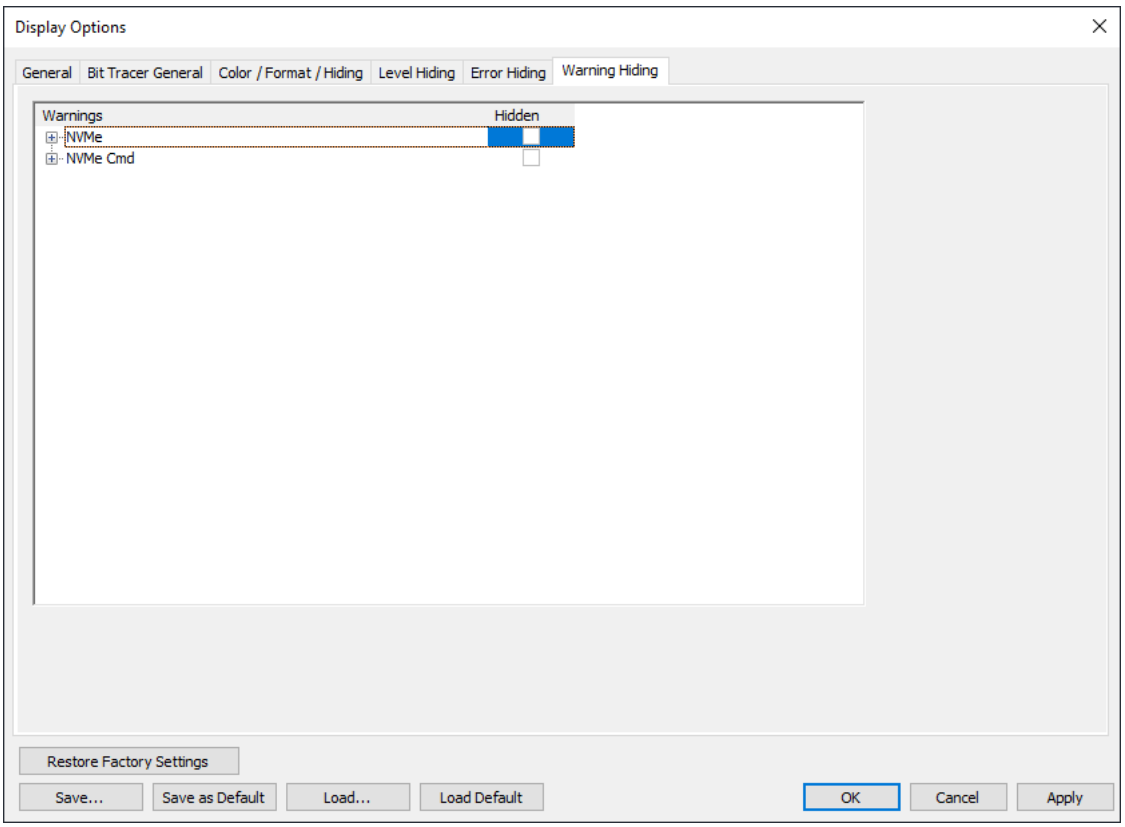


Figure 6.291: Display Options: Warnings Hiding

6.0.0.1 Transaction Types

The Transaction Types which can have their warnings hidden include:

- NVMe
- NVMe Cmds

6.6.5 Load a Previously Saved Display Options File

If you have previously saved Display Options, you can load them by opening the Display Options dialog and clicking the **Load** button. A dialog opens to let you load a previously saved display options file.

1. Click **Load** to use a previously defined display options file.
2. When you see the Open File pop-up window, enter the name of the file you want to load and click **Open**.
3. When the PCIe Protocol Analysis™ returns you to the Recording Options menu, click **OK** to activate the display options you selected.

6.6.6 Saving Display Options

If you have customized the Display Options and wish to save them, you can do so by clicking the **Save** button, then entering a unique file name. The **.opt** extension is added by default.

Setting the Defaults: Save the currently specified Display Options to the file name: **default.opt** by clicking **Save As Default.** When the Analyzer software begins execution, it automatically loads the **default.opt** file, if one exists.

6.7 Reports and Tools

Reports assist you in analyzing traffic recorded by the Analyzer.

See Figure 6.292.

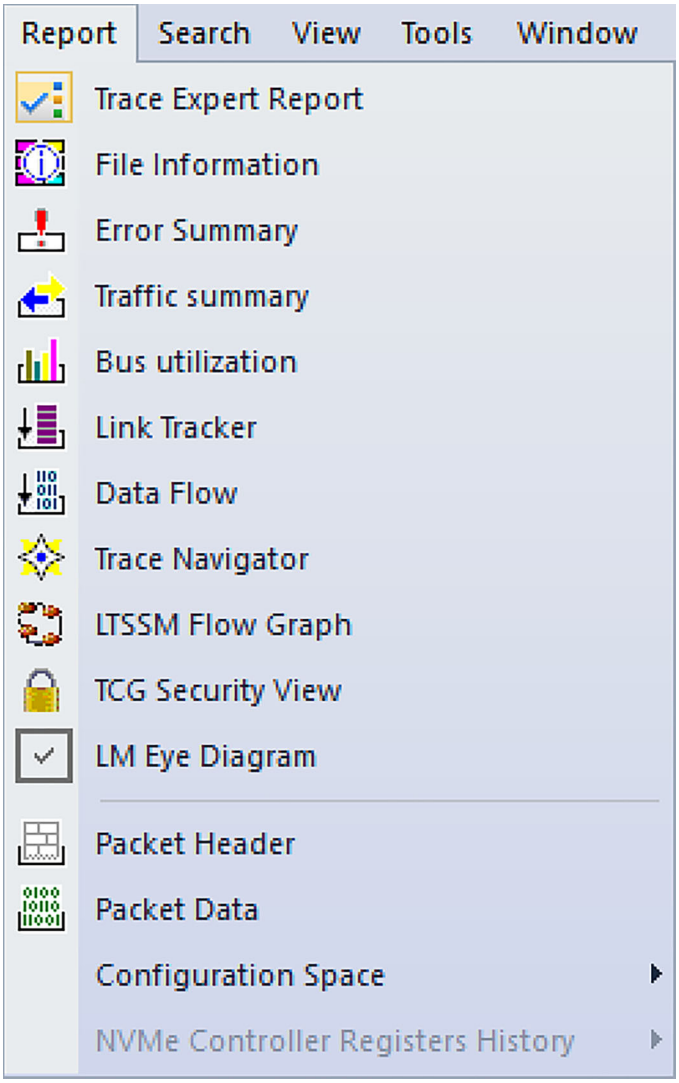


Figure 6.292: Reports Pull Down Menu

The available reports are:

- **Trace Information**: To view general information about the CATC Trace file. See "Trace Information" on page 482.
- **Error Summary**: To view a count of errors in a CATC Trace file. See "Error Summary" on page 484.
- **Traffic Summary**: To view a summary of protocol-related information in the CATC Trace file summary information about a selected group of items in the CATC Trace file (such as a count of particular frame or packet types). See "Traffic Summary" on page 492.
- **Bus Utilization**: To display information on bandwidth usage for the transmit and receive channels. See "Bus Utilization" on page 501.
- **Link Tracker**: Displays a detailed chronological view of events. See "Link Tracker" on page 508.
- **Data Flow**: Shows marker, packet, direction, type, length, address, payload,

handshake, and timestamp information. See “Data Flow Window” on page 514 and “Flow Control Tracking” on page 515.

- **Trace Navigator**: Navigates within the CATC Trace to view the location of errors and triggers, narrow the range of traffic on display, and jump to any point in the CATC Trace. See “Using the CATC Trace Navigator” on page 516.
- **Detail View**: Shows the detail view of the selected packet. See“Detail View” on page 521.
- **LTSSM Flow Graph**: Shows a state diagram of bus activity. See “LTSSM Flow Graph” on page 521
- **LM Eye Diagram:** Displays the samples taken during Lane Margining. See “Lane Margining: Eye Diagram” on page 526
- **Packet Header**: Shows packet header information. See “Packet Header Bar” on page 529
- **Packet Data**: Shows packet or transaction payload. See “Packet Data Window” on page 529.
- **Configuration Space**: Displays a Configuration Space. See “Configuration Space View” on page 530.
- **Metrics**: Measures key operating parameters. See “Metrics Defined for Split Transactions” on page 537 through “Show Metrics in the Bus Utilization Window” on page 541.
- **Real Time Statistics**: To display statistical information for the channels. See “Real-Time Statistics Window” on page 543.
- **Memory I/O Space Editor**: Displays the Memory I/O Space Editor dialog. See “Memory I/O Space Editor” on page 548.
- **TC to VC Mapping**: To display how Traffic Classes are mapped to Virtual Channels (to simplify navigation) and how the CATC Trace display was changed (for example, in Split Transactions). See “TC to VC Mapping” on page 549.
- **Timing Calculations**: To view timing measured between two events set within the CATC Trace file. See “Timing and Bus Usage Calculations” on page 549.
- **PCIe SSD Base Mapping**: Displays the PCIe SSD Base Address dialog. See “PCIe SSD Base Address Mapping” on page 561.
- **Run Verification Scripts**: Allows you to check errors, link transactions, split transactions, metrics, ordered sets, replays, DLLPs, and TLPs. See “Running Verification Scripts” on page 571.
- **Trace Expert**: Generates reports on Performance Analysis, Trace Analysis Statistics, Error Reports and Trace Information. See “Trace Expert” on page 576.

Reports are available from the Report menu and buttons on the Tool bar. Tools are available from the Tools menu.

6.7.1 Trace Information

The Trace Information window provides a summary on the currently displayed file.

Select **Reports > Trace Information**  to display the Trace Information window.

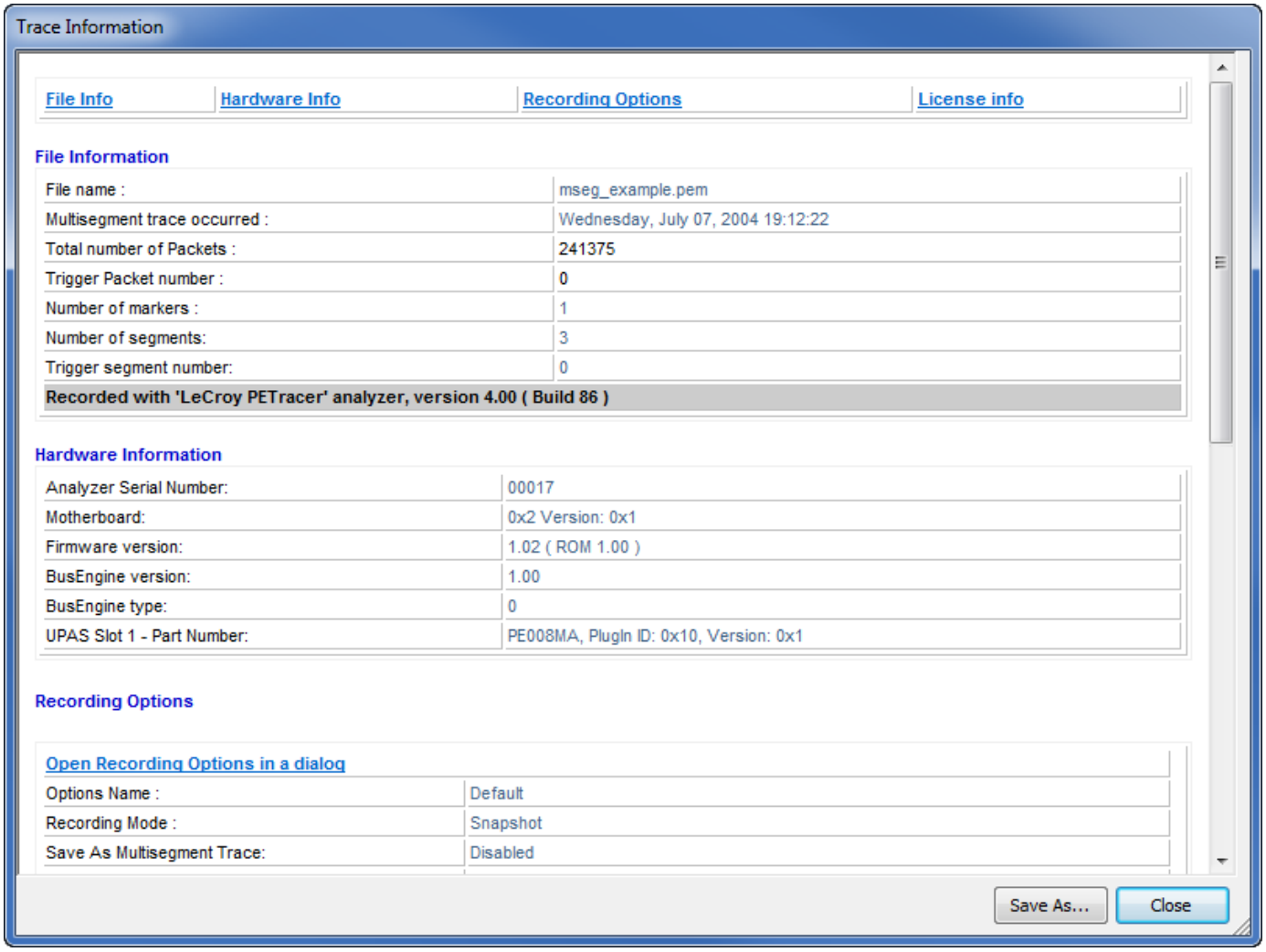


Figure 6.293: Trace Information Window.

6.7.2 Error Summary

The Error Summary dialog displays the number of errors for each event and the packet containing the errors.

Select **Reports > Error Summary** or click  to open the Error Summary dialog (see Figure 6.294 on page 484).

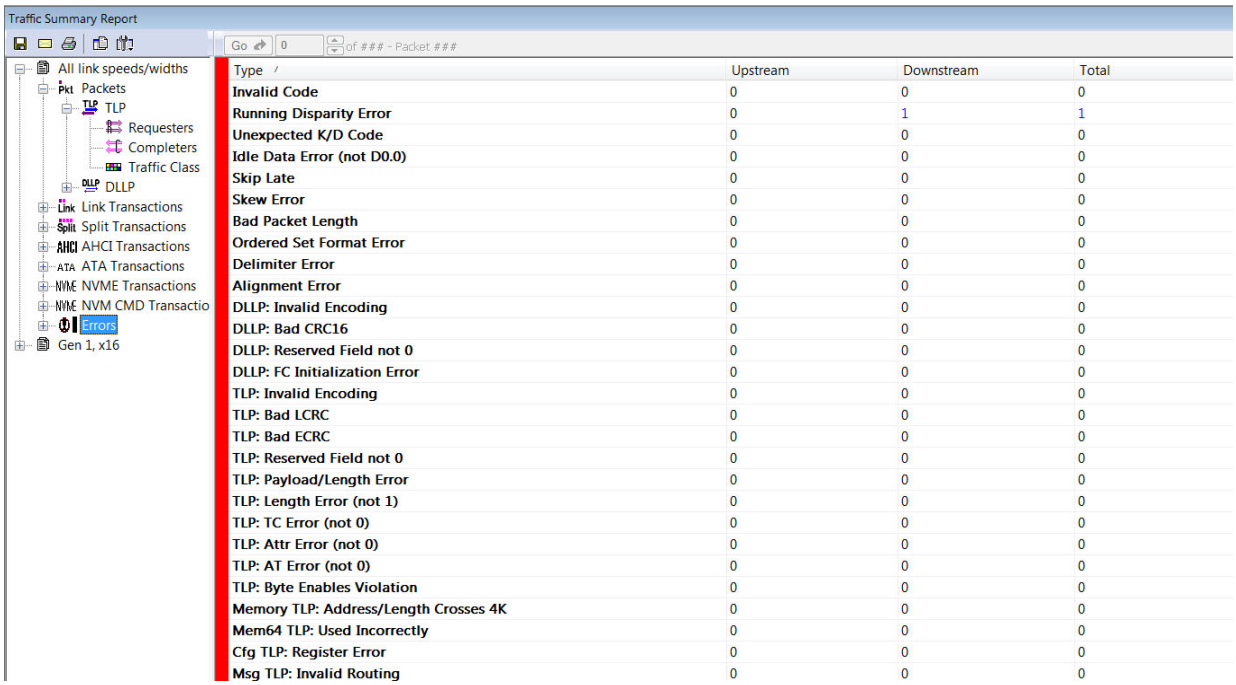


Figure 6.294: Error Summary Dialog.

6.7.2.1 Error Summary for Storage Protocols

After decoding a trace for the corresponding storage protocol, the CATC Trace will have a summary ready of the errors found for the trace. Example: The AHCI Error Summary dialog is a sub-entry for the main Error Summary dialog. It displays the number of errors for each AHCI transaction containing the errors.

Select **Reports > Error Summary** to open the Error Summary dialog.

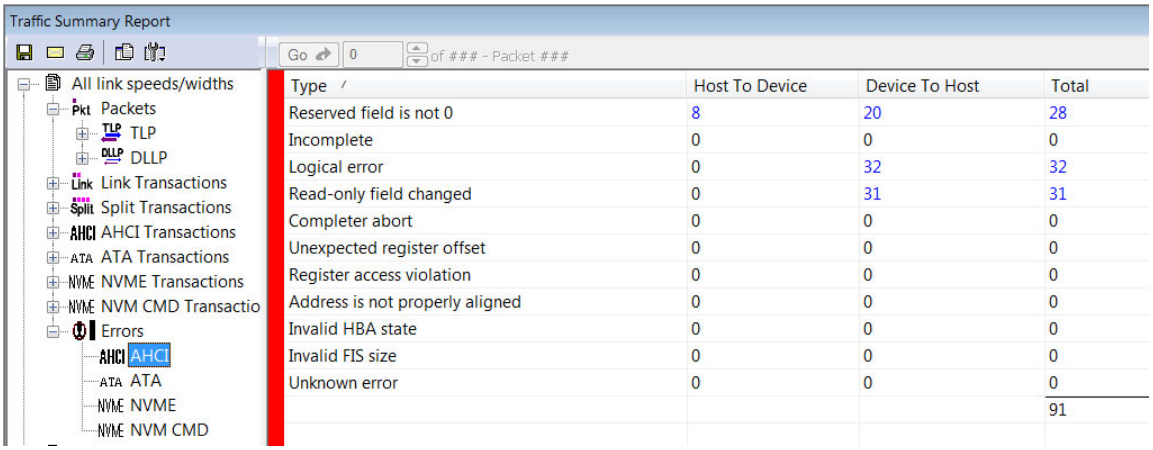


Figure 6.295: AHCI Error Summary Dialog.

The five types of AHCI errors are describe below:

Reserved Field not Zeroes

One or more fields inside the AHCI transaction are not filled with all 0s. The AHCI specification states that all reserved fields and registers must be filled with 0s.

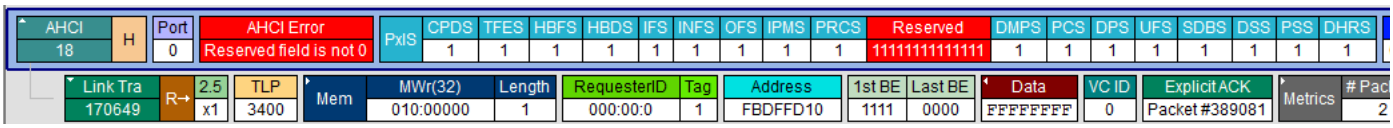


Figure 6.296: Reserved Field Not Filled With Zeroes

Note: Reserved fields for AHCI level are not displayed when filled with all 0s.

Incomplete

The AHCI transaction does not contain enough data or lower-level transactions (Link or Split) are marked as incomplete.

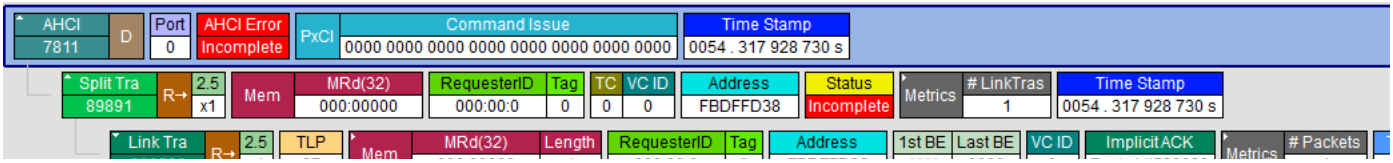


Figure 6.297: Incomplete

Logical Error

One or more fields are in an inconsistent state relative to the other fields in the same or other registers.

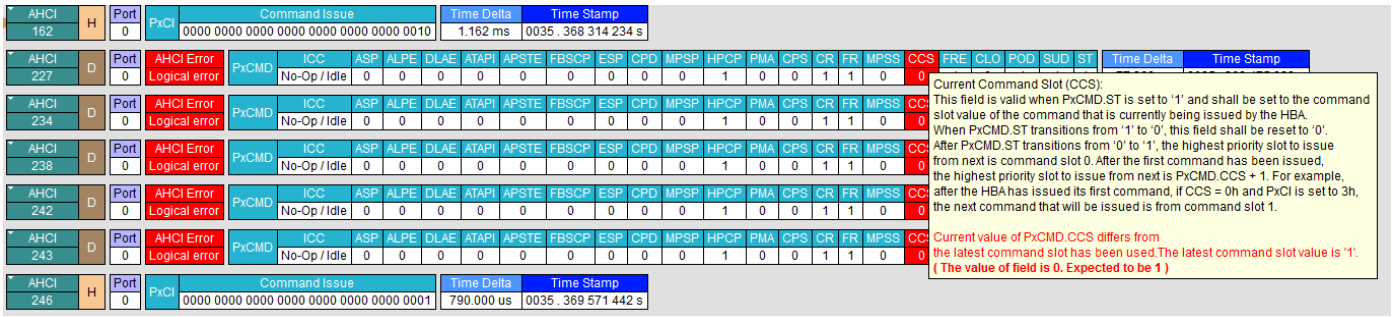


Figure 6.298: Logical Error

Read-only Field Changed

The value of the read-only field differs from the previous one.

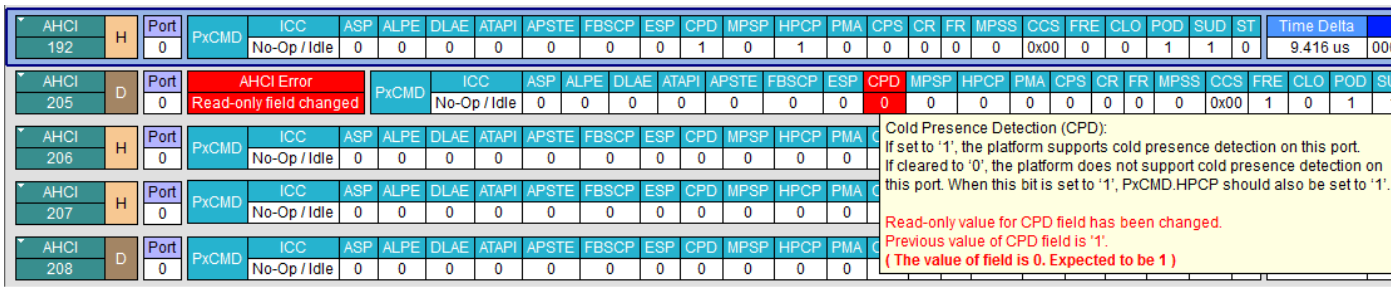


Figure 6.299: Read-only Field Changed

Unknown

The AHCI decoder is unable to decode a particular transaction correctly. This can be caused by missing base address information. Make sure the enumeration phase has been recorded in the trace or provide base address information by selecting **Tools > PCIe SSD Base Address Mapping**.

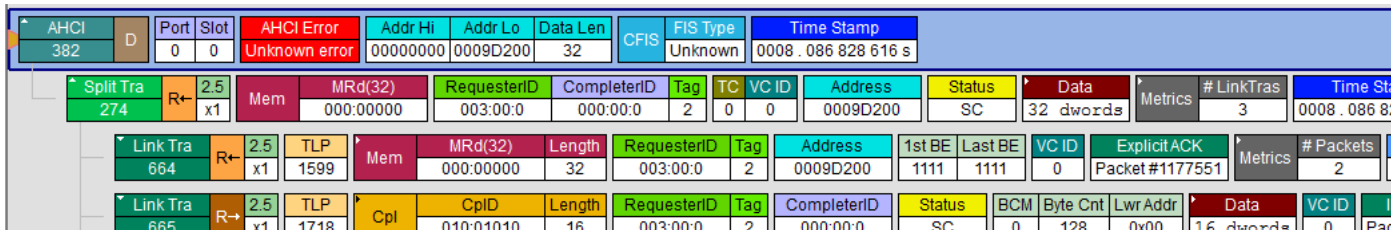


Figure 6.300: Unknown

Checks for Logical error and Read-only field depending on the values obtained from previous registers. It can result in false-positive or false-negative detections in case of partially saved trace file. The AHCI transaction can be marked as incomplete in case of saving a portion.

6.7.2.2 Error Summary for Storage Protocols -- NVMe

The NVMe sub-entry of the Error Summary dialog displays the number of NVMe errors found while decoding the trace at the NVMe level as shown in Figure 6.301, Figure 6.302 and Figure 6.303.

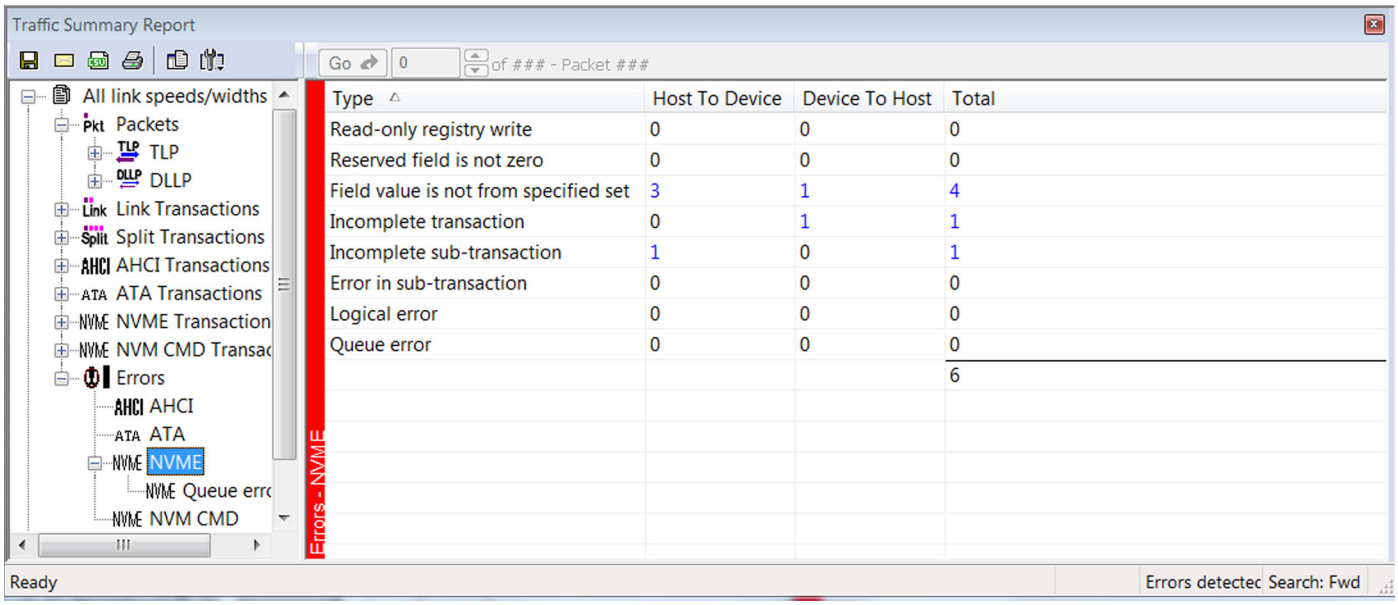


Figure 6.301: NVMe Errors After Decoding the Trace

Types of NVMe Errors

1. Read-only register write: An attempt to write to a read only register was made.

2. Reserved field is not zero: One (or more) of the fields set as reserved in the current spec revision is not zero - this could indicate a problem such as reversed bit ordering, or it could be intentional such as working with unreleased version of the next specification or user debug bits.

3. Field values is not from specified set: There is a value used in the indicated field that is not used in the currently released specification. If working with an early release of the next specification, or a proprietary feature this could be valid otherwise it would normally indicate a problem.

4. Incomplete transaction: One or more of the steps for a NVMe transaction is missing eg no completion queue entry after submission queue submission.

5. Incomplete sub-transaction: Some NVMe transactions have sub states and this indicates that within a substate part of the expected sequence is missing.

6. Error is sub-transaction: Some NVMe transactions have sub states and this indicates that within a substate an error in the sequence or value was detected.

7. Logical error: Groups any potential logic errors, such as declaring a payload of 64 bytes (0) but sending 0 bytes.

8. Queue error: There was an error in writing to the queue. Eg writing to a queue before it was created or trying to write additional entries to a queue that was full. There are a series of specific errors available on the NVMe Queue error report.

6.7.2.3 NVMe Queue Errors

The NVMe Queue Error sub-entry of the Error Summary dialog lists NVMe errors which are specific to interacting with the NVMe queues.

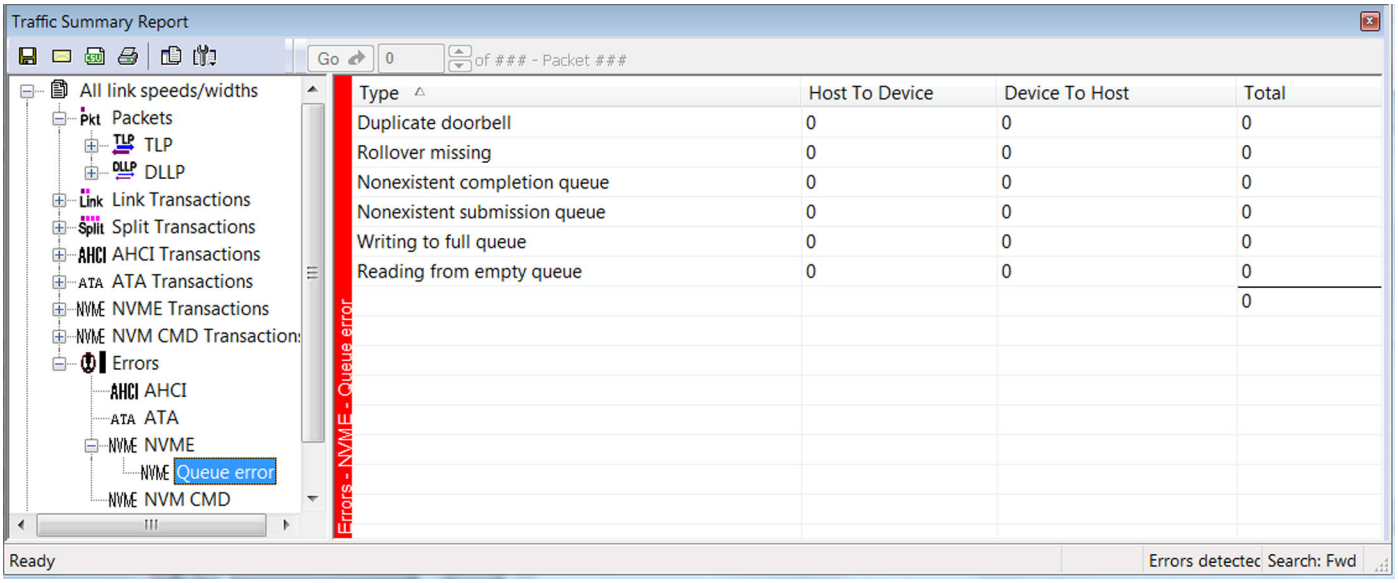


Figure 6.302: NVMe Errors Specific to NVMe Queues

Types of NVMe Queue Errors

1. Duplicate doorbell: The same doorbell was used consecutively.

2. Rollover missing: The queue rollover was missed.

3. Nonexistent completion queue: A completion queue was attempted to be used before it had been created.

4. Nonexistent submission queue: A submission queue was attempted to be used before it had been created.

5. Writing to full queue: All possible entries in the queue were previously filled and have not been cleared yet and the current write would add more entries than the declared size of the queue.

6. Reading from empty queue: A queue has had no entries submitted or all previous entries have already been read such that there are no entries in the queue to be read, however a read was attempted even though there are no entries.

6.7.2.4 NVMe CMD Errors

The NVMe CMD sub-entry of the Error Summary dialog lists errors which are specific to NVMe command decoding. See Figure 6.303

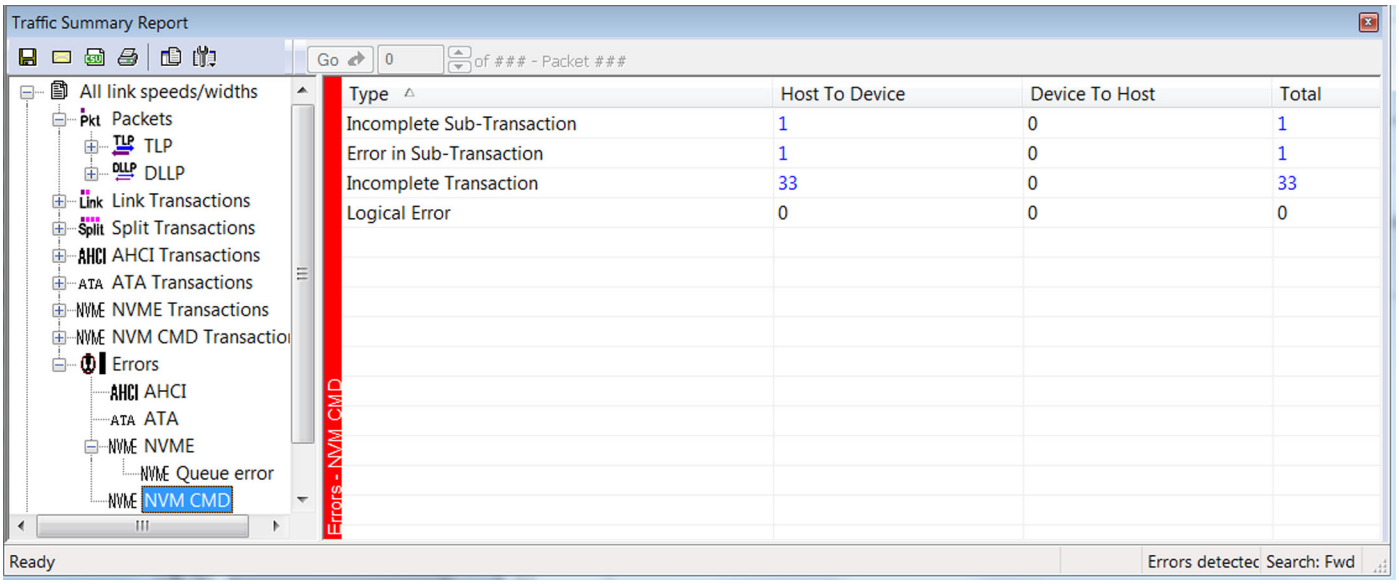


Figure 6.303: NVMe Errors Specific to NVMe Commands

Types of NVMe CMD Errors

1. Incomplete Sub-Transaction: Some NVMe transactions have sub states and this indicates that within a substate the required sequence was not completed.

2. Error in Sub-Transaction: Some NVMe transactions have sub states and this indicates that within a substate an error in the sequence or value was detected.

3. Incomplete Transaction: One (or more) of a transactions steps are missing, example shows a transaction missing the doorbell and the preceding one that has all the transaction steps. See Figure 6.304.

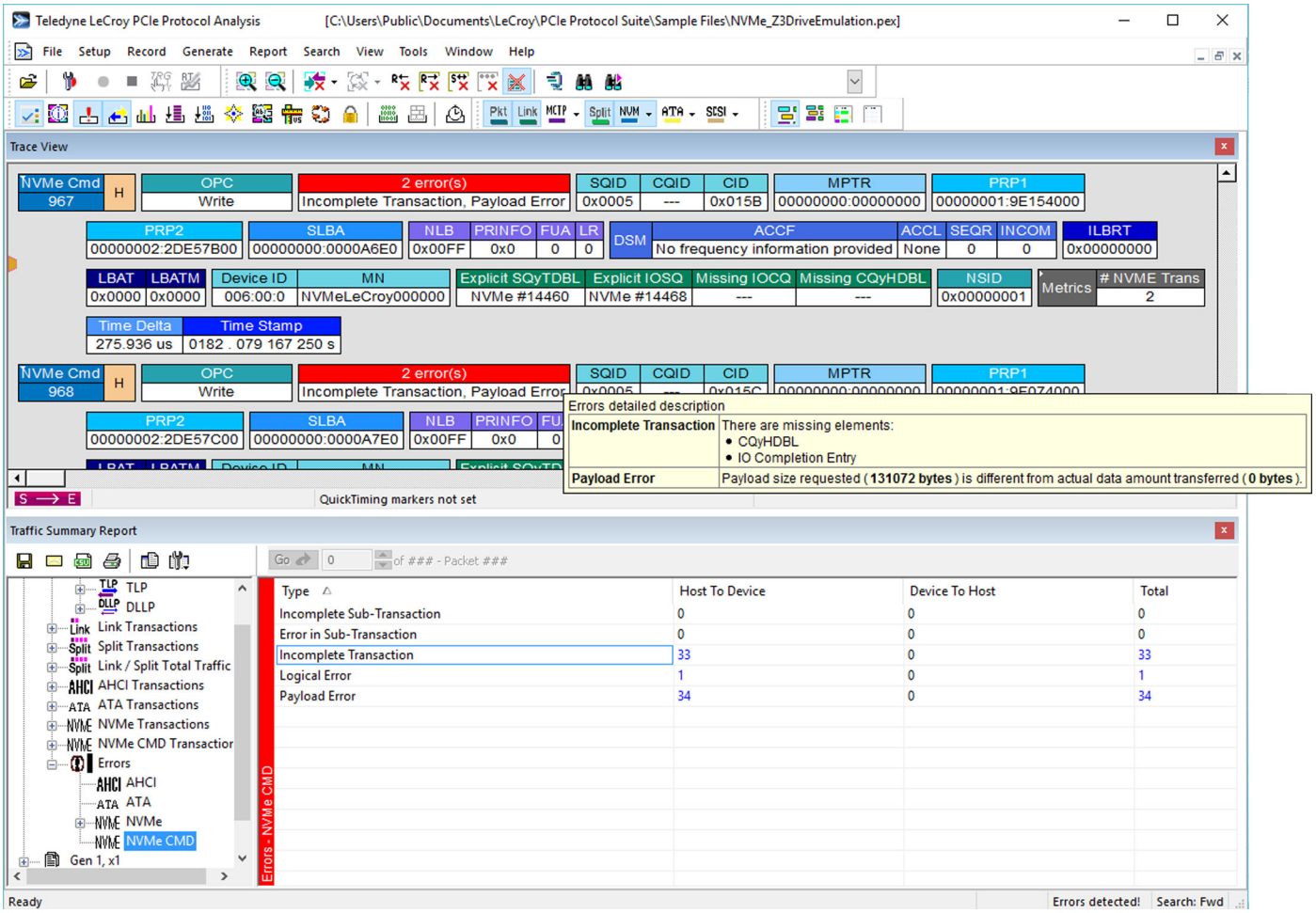


Figure 6.304: NVMe CMD Error → Incomplete Transaction with Tooltip

4. Logical Error: Groups any potential logic errors, such as declaring a payload of 64 bytes (0) but sending 0 bytes. See Figure 6.305.

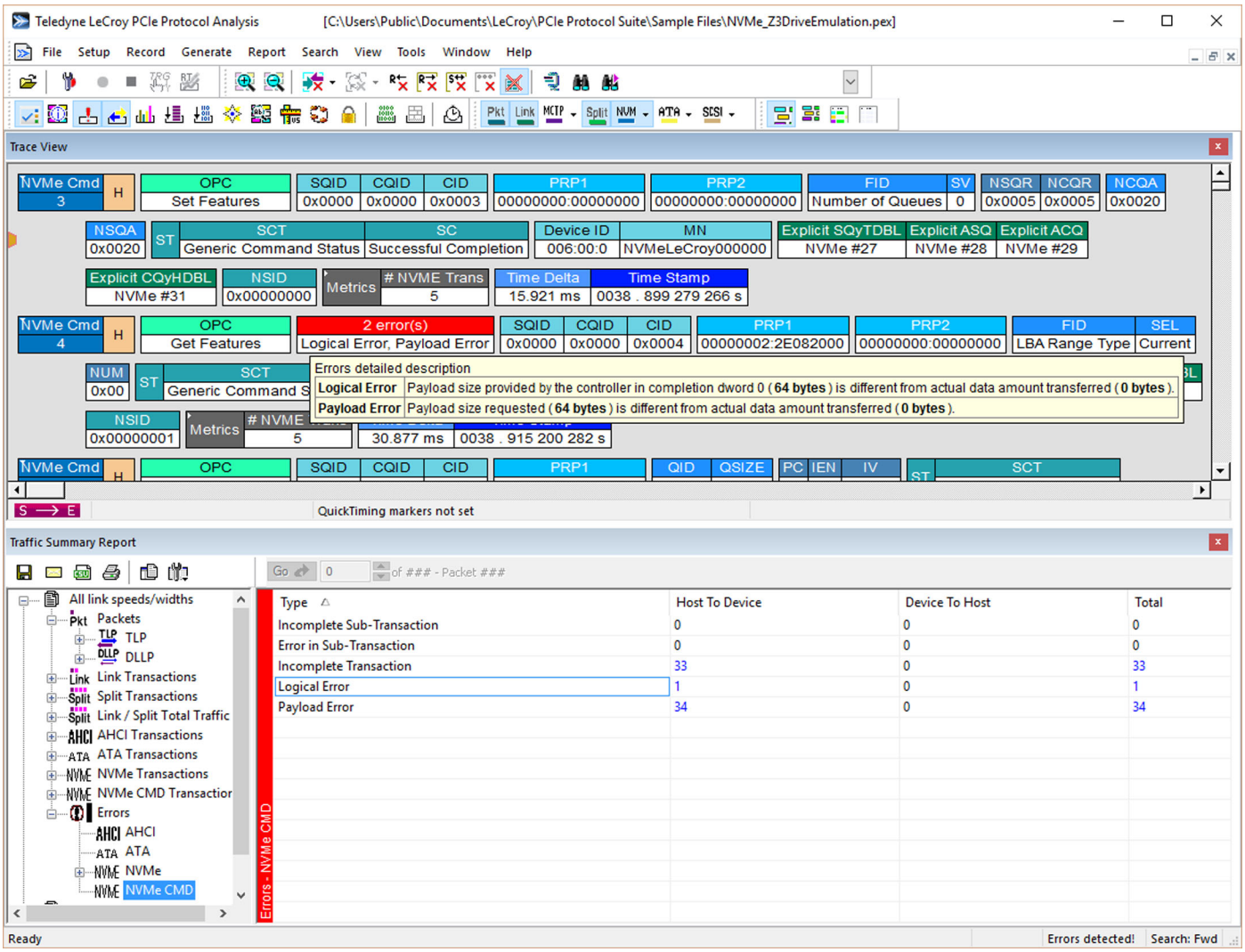


Figure 6.305: NVMe CMD Error → Logical Error with Tooltip

6.7.3 Traffic Summary

The Traffic Summary window summarizes the traffic in the current CATC Trace. The left side of the window displays a tree of protocol levels. The right side displays a summary of traffic for the displayed levels.

Select **Reports > Traffic Summary** or click  to display the Traffic Summary window.

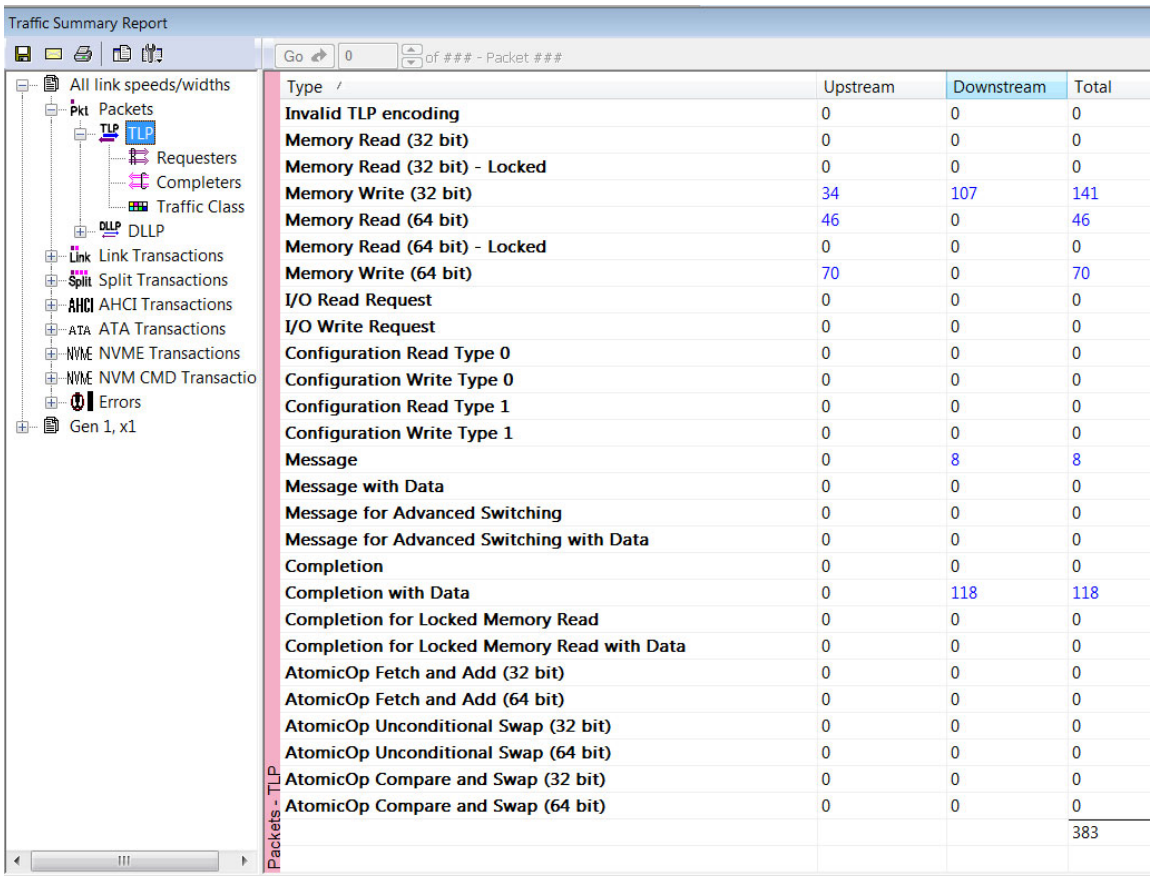


Figure 6.306: Traffic Summary Dialog

Buttons at the top of the Traffic Summary window change the display format and enable data to be exported to email, file, or the printer.

6.7.3.1 Traffic Summary for Storage Protocols

After decoding a trace for the corresponding storage protocol, the CATC Trace will have a summary ready of the commands existing in the trace. Example: The AHCI Traffic Summary window summarizes the AHCI traffic in the current CATC Trace. The right side displays a summary of AHCI transactions and errors.

Select **Reports > Traffic Summary** to open the Traffic Summary dialog.

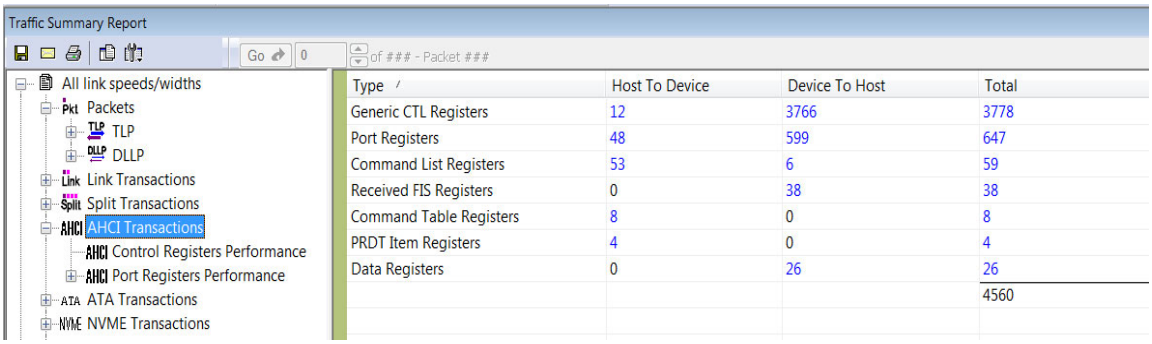


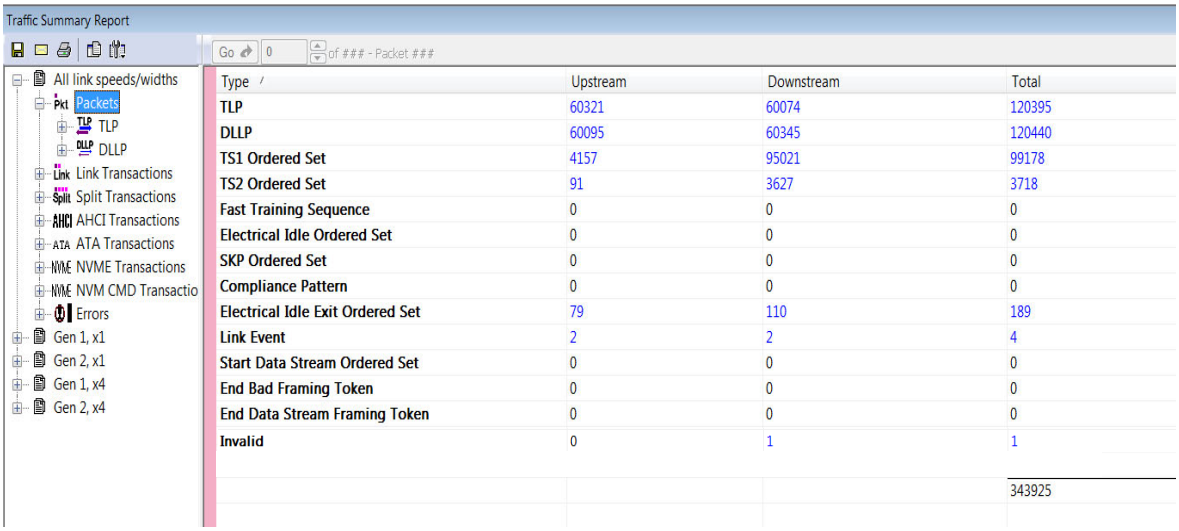
Figure 6.307: AHCI Traffic Summary Dialog

6.7.4 Using the Traffic Summary Window to Search the CATC Trace

You can use the Traffic Summary window to move the CATC Trace to packets of interest:

1. Click one of the numbers in the right side of the Traffic Summary window (see the following figure).

   The CATC Trace jumps to the first instance of the selected protocol.



2. Click the **up** or **down** arrows 

. The CATC Trace jumps forward or backward through the display to the next instance of selected protocol level.

6.7.5 NVMe Queue Time Metrics

NVMe Queue Time Metrics can be seen in the Traffic Summary, which includes all of the Doorbell Metrics (see Figure 6.308).

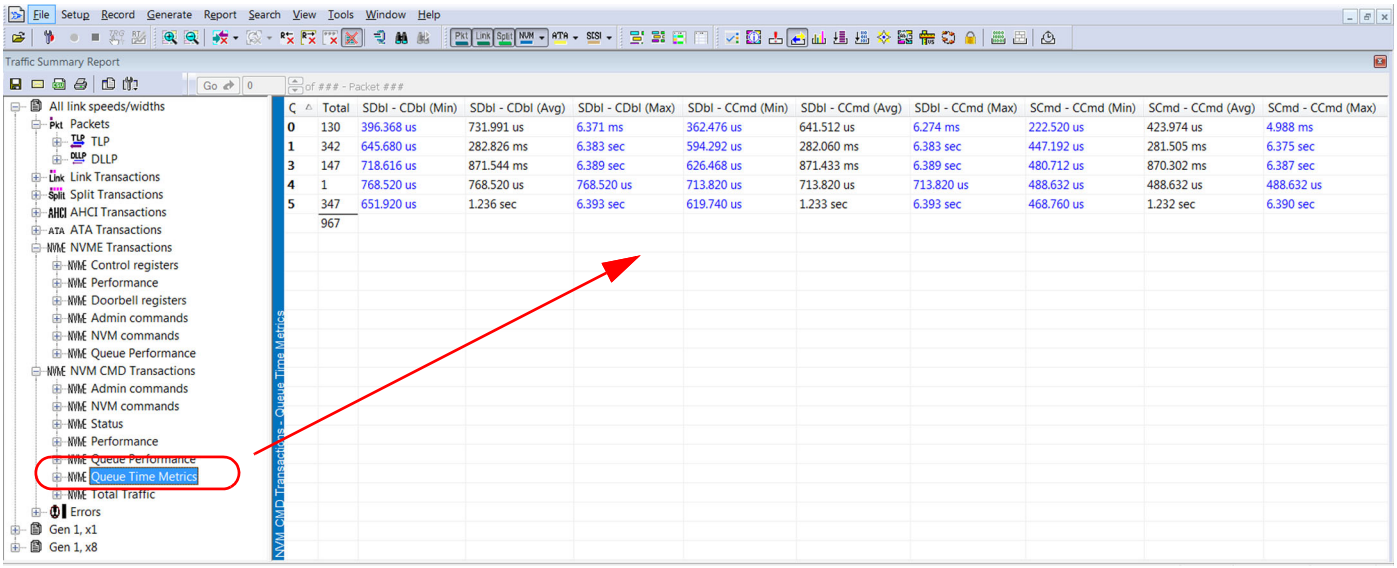


Figure 6.308: NVMe Queue Time Metrics for Doorbell Operations

TABLE 6.1: NVMe Queue Time Metrics (Commands/Transactions)

NVMe Queue Time Metrics	Definition
# NVME Trans	Number of NVME Transactions - the total number of NVME Transactions that compose this NVME Command
# Link & Split Trans	Number of Link & Split Transactions - the total number of Link & Split Transactions that compose this NVME Transaction
Response Time	Time it took to transmit this NVME Command/Transaction on the link, from the beginning of the first packet in the NVME Command/Transaction to the end of the last packet in the NVME Command/Transaction
Latency Time	Time measured from the end of transmission of the NVMe submission command to start of transmission of the NVMe completion command
Pld. Bytes	Payload: Number of payload bytes this NVME Command transferred
Thrpt MB/s	Data Throughput: Payload divided by response time, expressed in megabytes (MB = 1024*1024 bytes) per second (applies to both Commands and Transactions)
IOPS	Input/Output Operation per Second: Calculated as weighted total of all transactions that overlap with the current one, divided by duration of the current transaction
SDbl - CDbl	Time measured between Submission Doorbell and Completion Doorbell
SDbl - CCmd	Time measured between Submission Doorbell and Completion Command
SCmd - CCmd	Time measured between Submission Command and Completion Command

These definitions are readily available by loading an NVMe Trace, Decoding the NVMe Commands or Transaction, locating the Metrics block in the Trace View and hovering the cursor over each of the NVMe Queue Time Metrics to bring up the Tool Tip.

NVME Command Example

As an example for NVMe Command: For SDbl - CDbl see Figure 6.309.

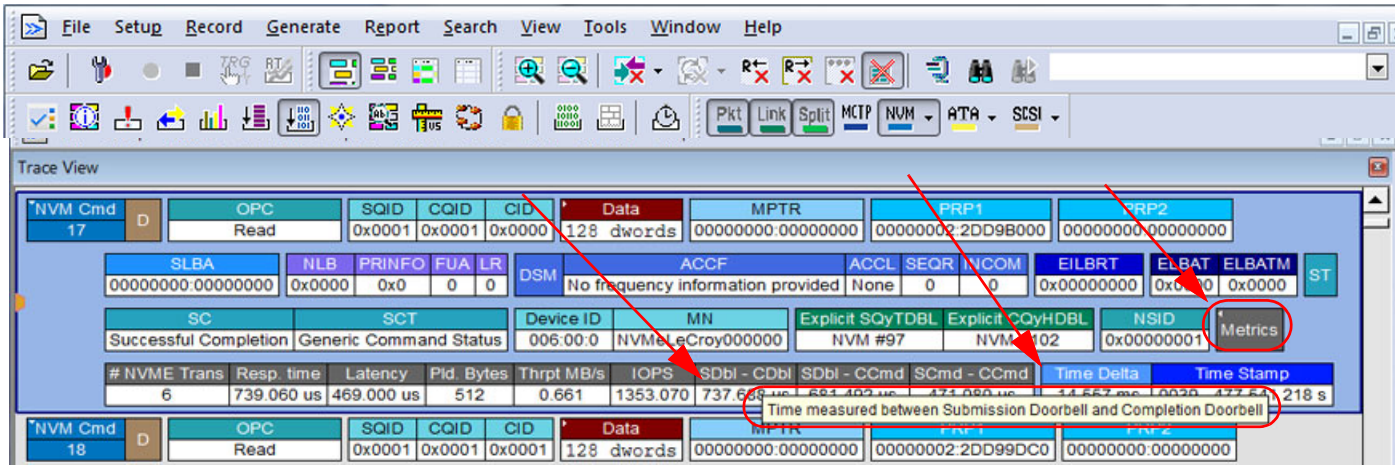


Figure 6.309: NVMe Queue Time Metrics Defined: SDbl - CDbl

NVME Transaction Example

As an example for NVMe Transactions: For Resp time: see Figure 6.310.

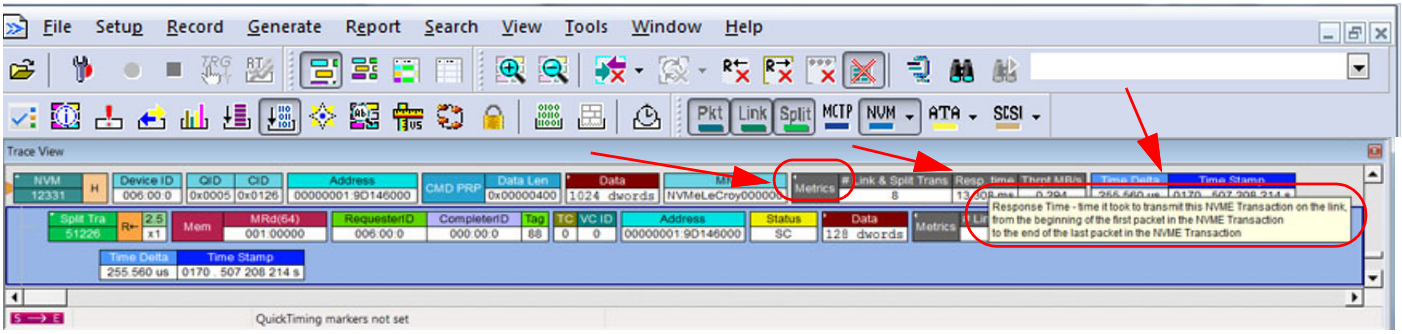


Figure 6.310: NVMe Transactions Metrics: Response Time

6.7.5.1 Traffic Summary Buttons

Buttons at the top of the Traffic Summary dialog provide options for exporting the data or formatting its appearance:

	Save. Saves Traffic Summary results into an HTML format.
	Email. Attaches an HTML file of the results to a new email.

	Print. Prints results.
	Text. Displays results in HTML format.
	Options. Opens a drop-down menu with the following options: **Grid Lines**: Displays/Hides grid lines **Row Selection**: Allows entire rows to be selected **Tight Columns**: Reformats column widths to match data **Event Navigation**: Skip Hidden Items Show Hidden Items Prompt each time

6.7.6 Traffic Summary for MCTP

After loading an MCTP trace, you can generate a traffic summary report for MCTP Messages (see Figure 6.311), Control Command Code (see Figure 6.312 on page 498) and Control Completion Codes (see Figure 6.313 on page 499).

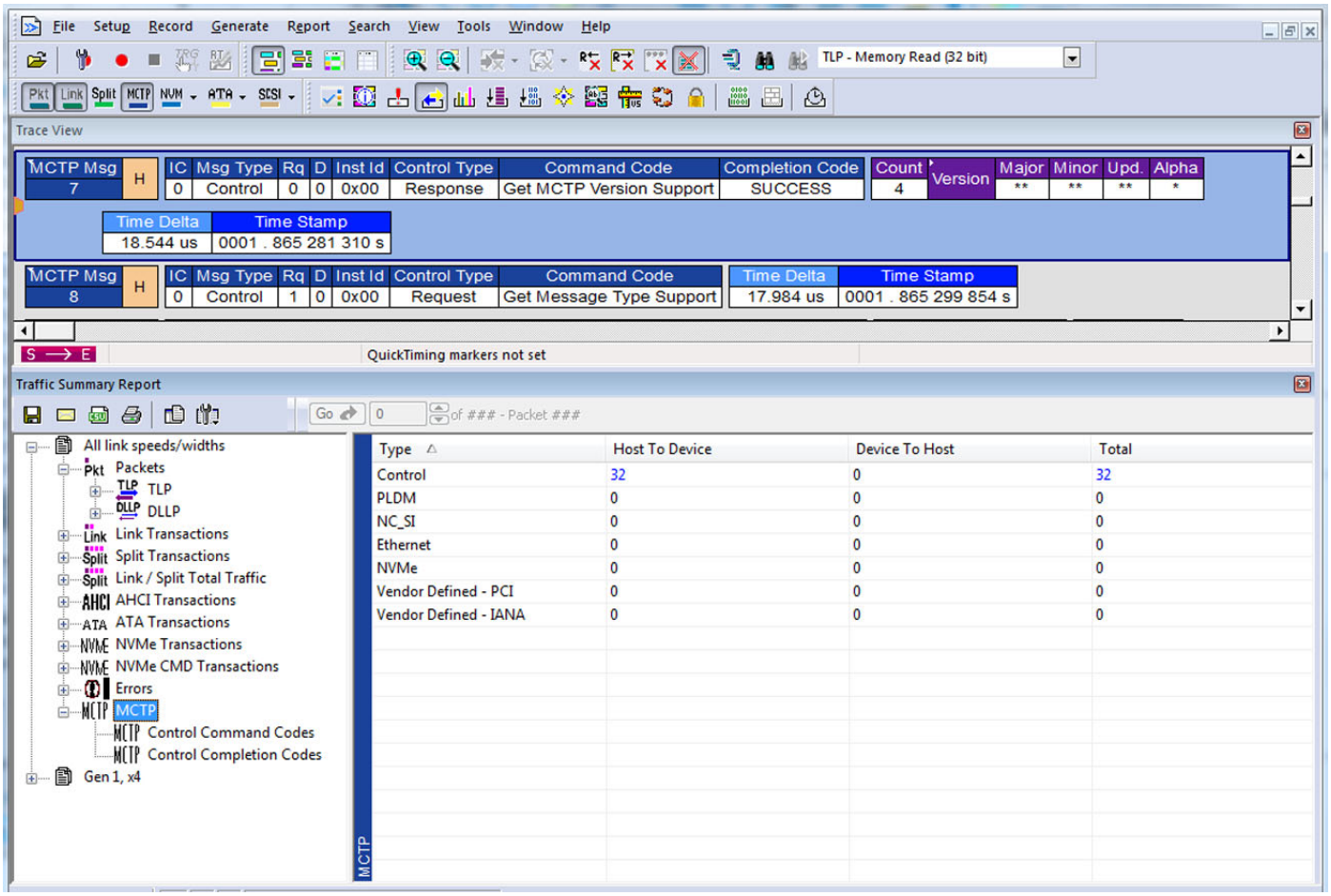


Figure 6.311: MCTP Message Traffic Report Summary → All

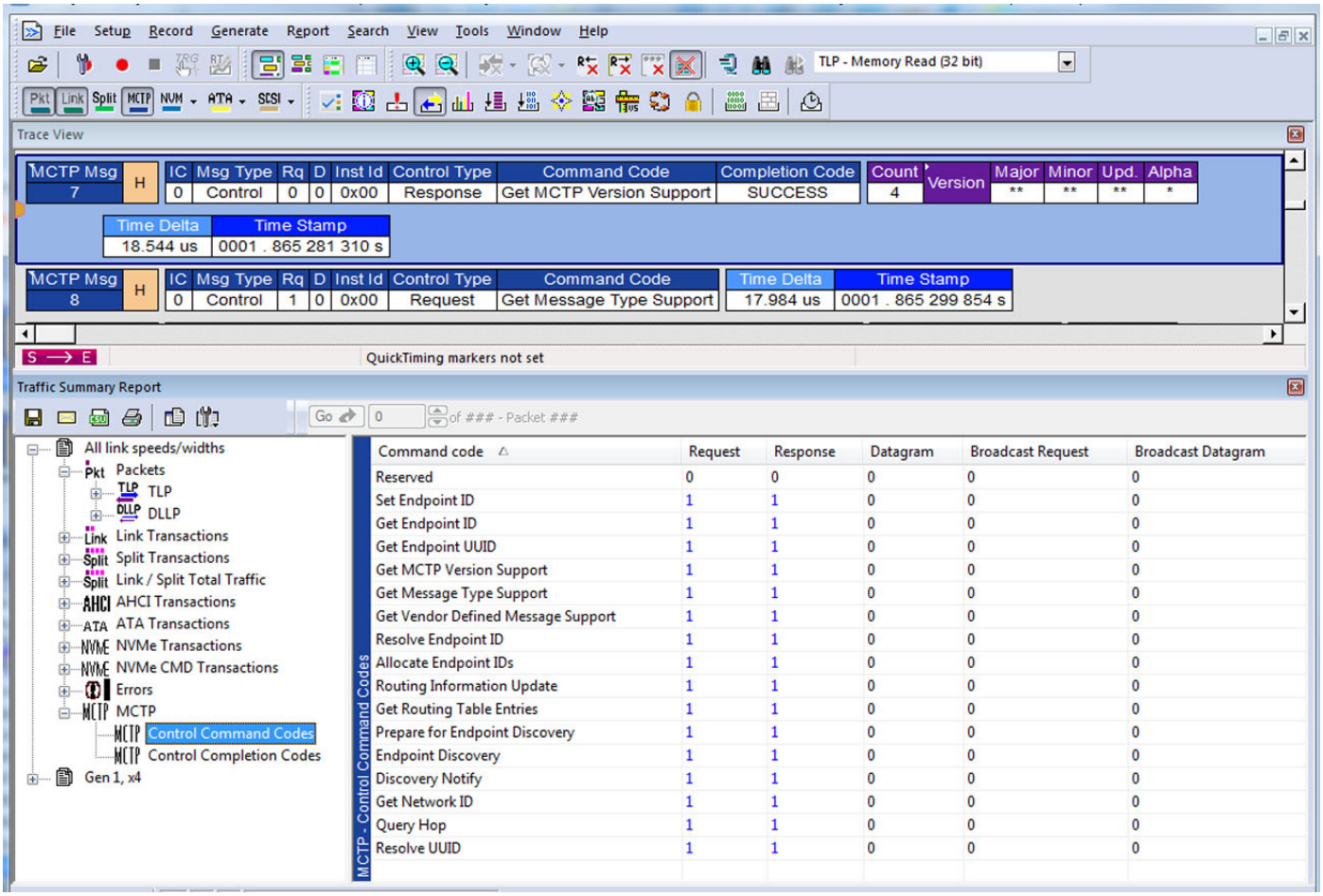


Figure 6.312: MCTP Message Traffic → Control Command Codes Report

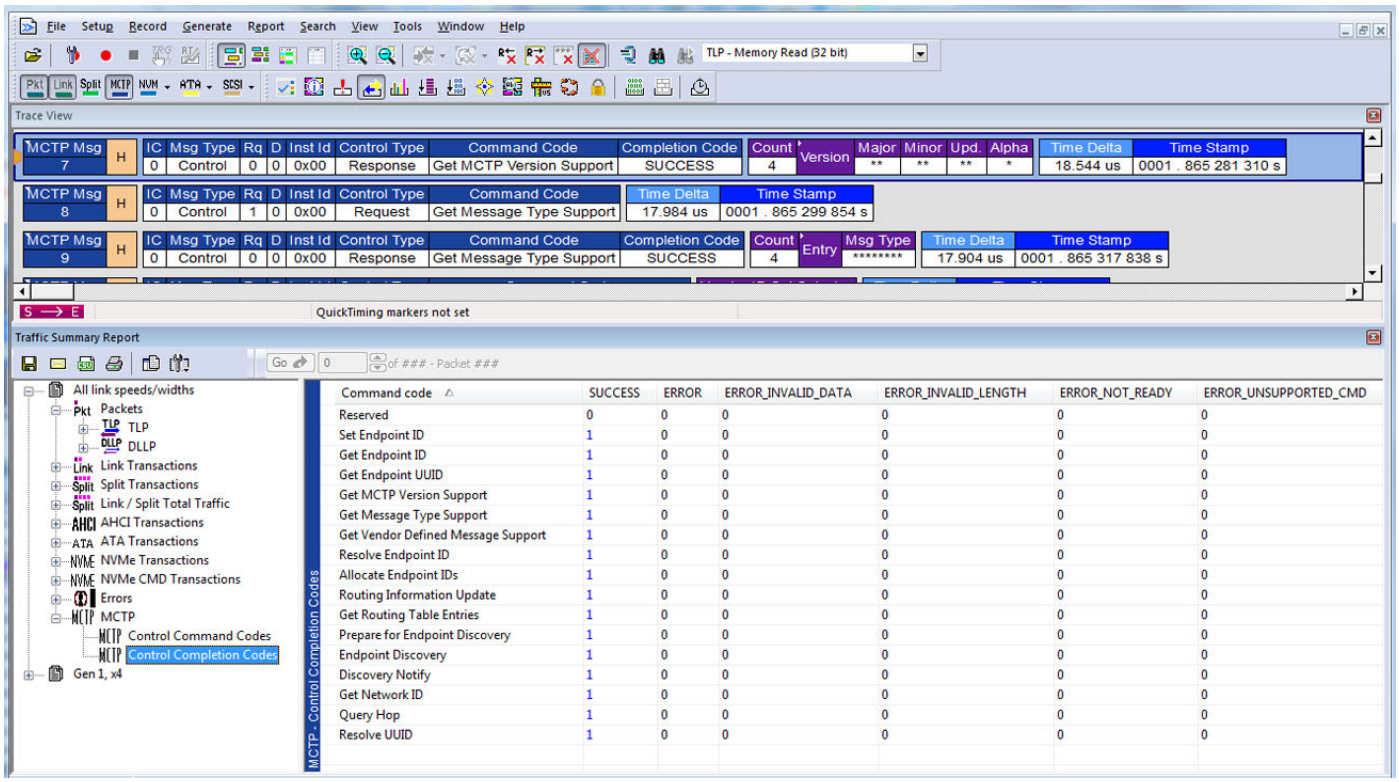


Figure 6.313: MCTP Message Traffic → Control Completion Codes Report

6.7.7 Traffic Summary for Flow Control

After loading a trace with Flow Control packets in it, you can display the packets which have flow control data and the associated trace as shown below (see Figure 6.314).

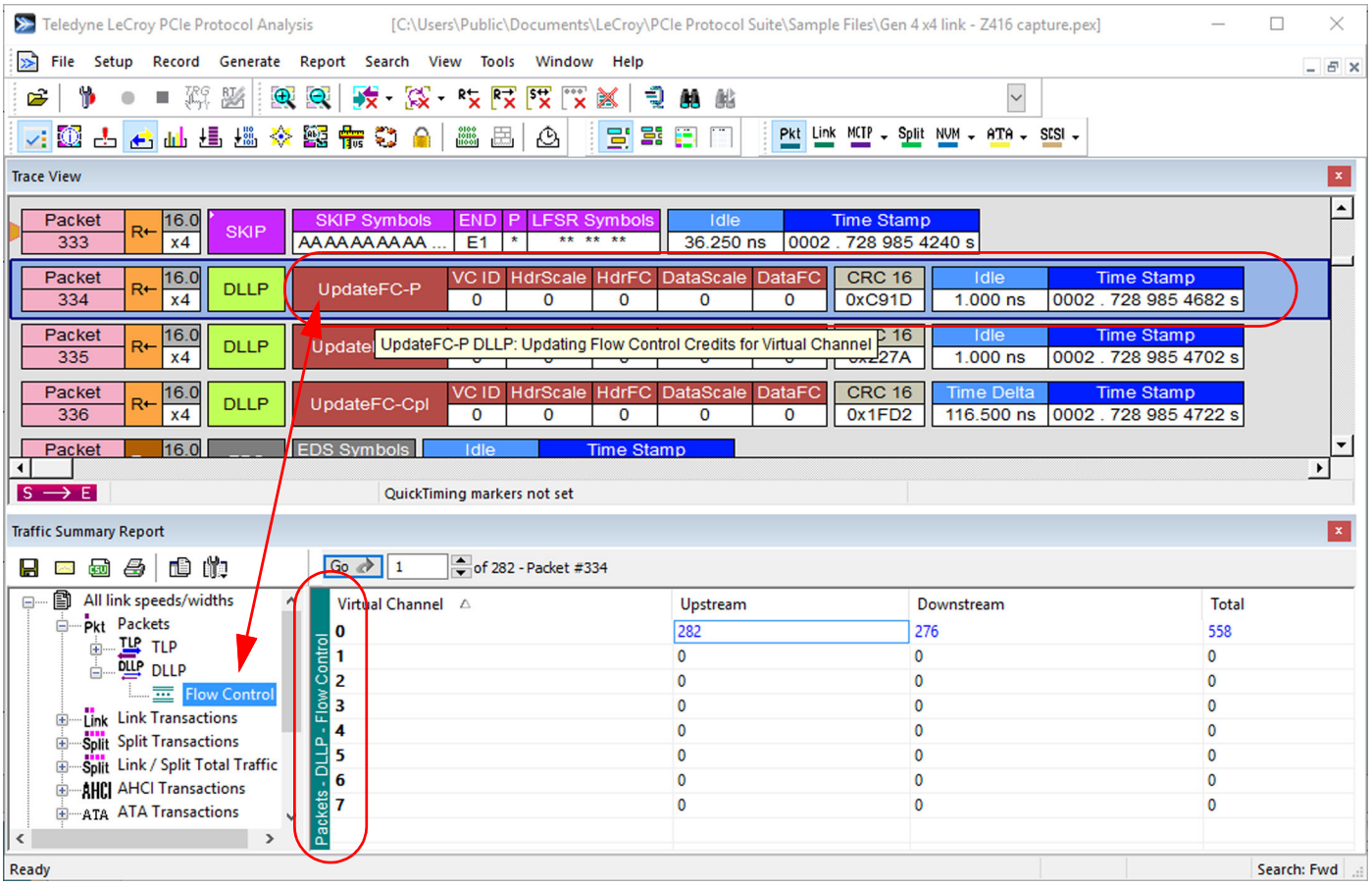


Figure 6.314: Flow Control Trace Showing Traffic Summary

6.7.8 Bus Utilization

Select **Report > Bus Utilization** from the menu or press  to open the Bus Utilization dialog.

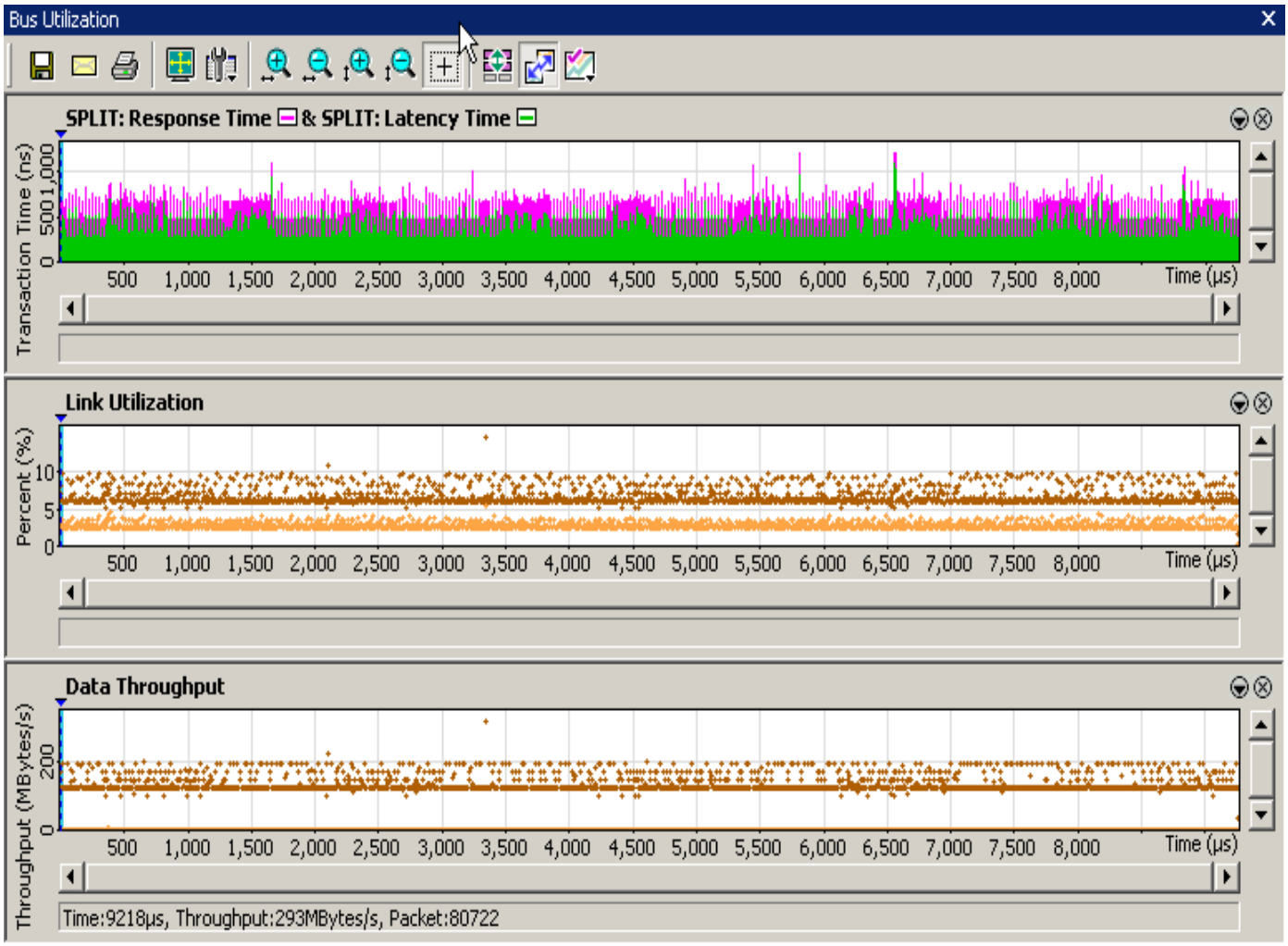


Figure 6.315: Bus Utilization Dialog

The Bus Utilization window displays information on bandwidth use for the transmit and receive channels.

6.7.8.1 Bus Utilization Pop-up Menu

You can reformat the display by right-clicking a graph and making a selection from the Bus Utilization pop-up menu.

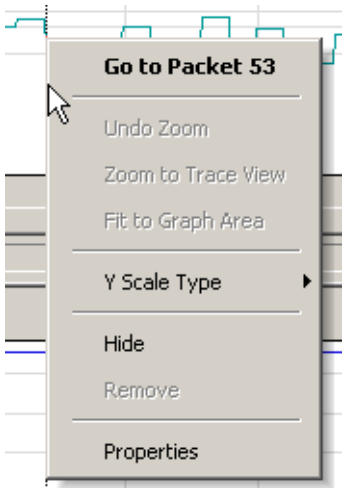


Figure 6.316: Bus Utilization Menu

Go to Packet #: Relocates the CATC Trace to the selected packet number.

Undo Zoom: If you have zoomed in, this command undoes the zoom.

Zoom to Trace View: Zooms in on graph to show traffic currently displayed in the CATC Trace screen.

Fit to Graph Area: Redisplays graph so that the entire CATC Trace fits inside graph area.

Y Scale Type:

- **Linear**: Converts display to linear format
- **Logarithmic**: Converts display to logarithmic format

Hide: Hides the selected graph

Remove: Allows you to add any graph that you created via the **Graph areas**  command.

Properties: Opens a dialog with options for changing the Title, Type, Appearance, Color and Properties of the graphs (see Figure 6.317 on page 503).

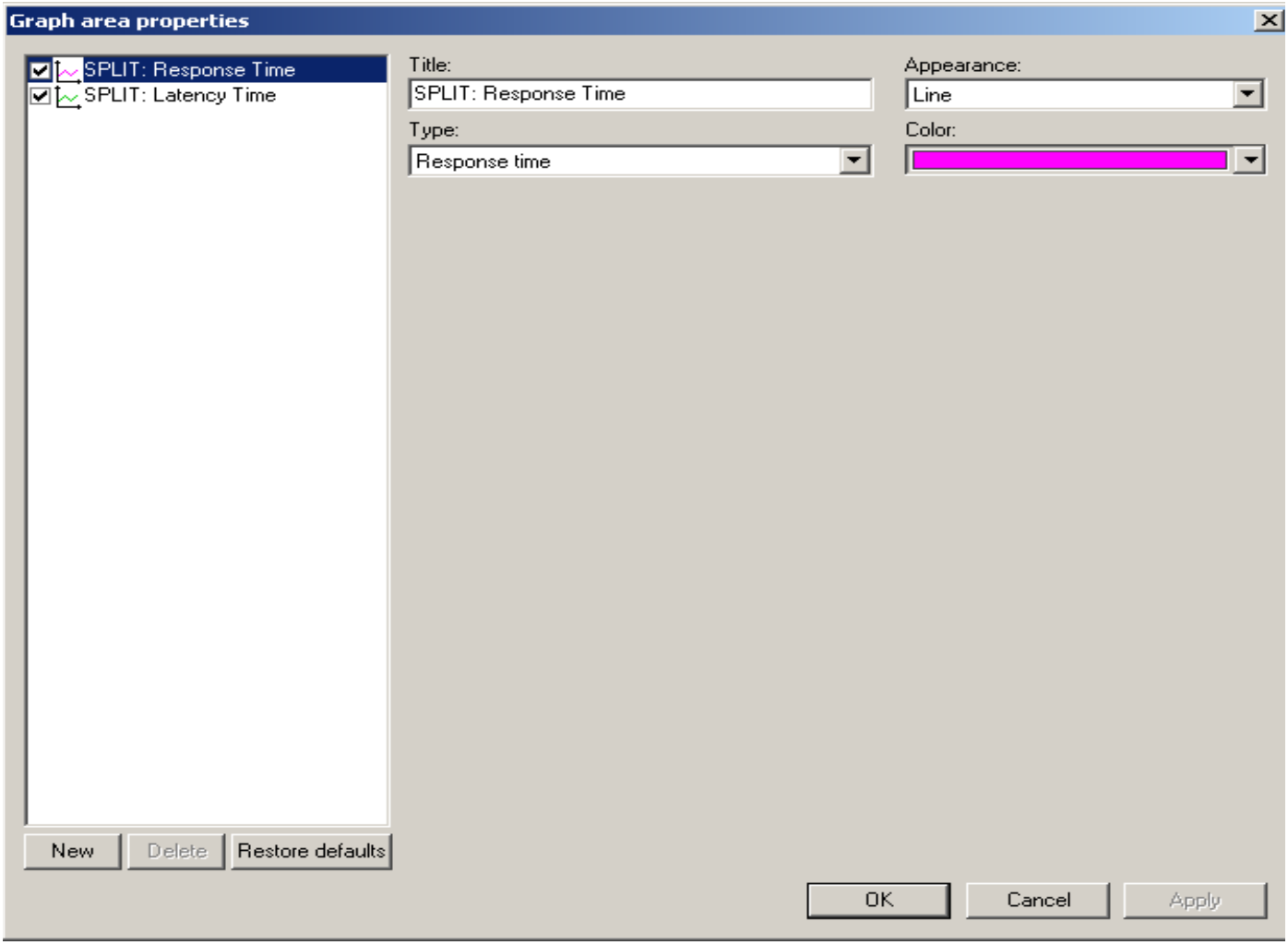


Figure 6.317: Graph Area Properties Dialog

6.7.8.2 Bus Utilization Buttons

The Bus Utilization window buttons allow you to reformat the display and export data.



Button	Function
	Save. Saves Bus Utilization data to a bitmap file (***.bmp**).
	Email. Opens an email and attaches a bitmap file of the Bus Utilization data.
	Print. Prints the Bus Utilization data.

	Full Screen. Maximizes the Bus Utilization window.
	Synchronize Views.Synchronize the current view with other open views.
	View Settings. Opens a sub-menu with the following choices: • Orient Horizontally • Tile Vertically • Show Markers • Show Plumb Line • Status >> • Bar • Tool tips • None • Grid Lines >> • Both Axes • X Axis • Y Axis • No Grid • Grid on Top • Fonts & Colors
	Horizontal zoom in
	Horizontal zoom out
	Vertical zoom in
	Vertical zoom out
	Click and Drag zoom. Click and drag to zoom in on a part of the graph.
	Select Range. Displays a dialog for selecting a packet range.
	Synchronize Graph Areas. If two or more graphs are displayed, this button synchronizes the graphs to one another. Once synchronized, the positioning slider of one graph moves the other graphs.
	Graph Areas. Provides options for creating and displaying additional graphs of data lengths, packet lengths, and percentage of bus used (see Graph Area Options below).

Graph Area Options

The available graphs are shown in Figure 6.318:

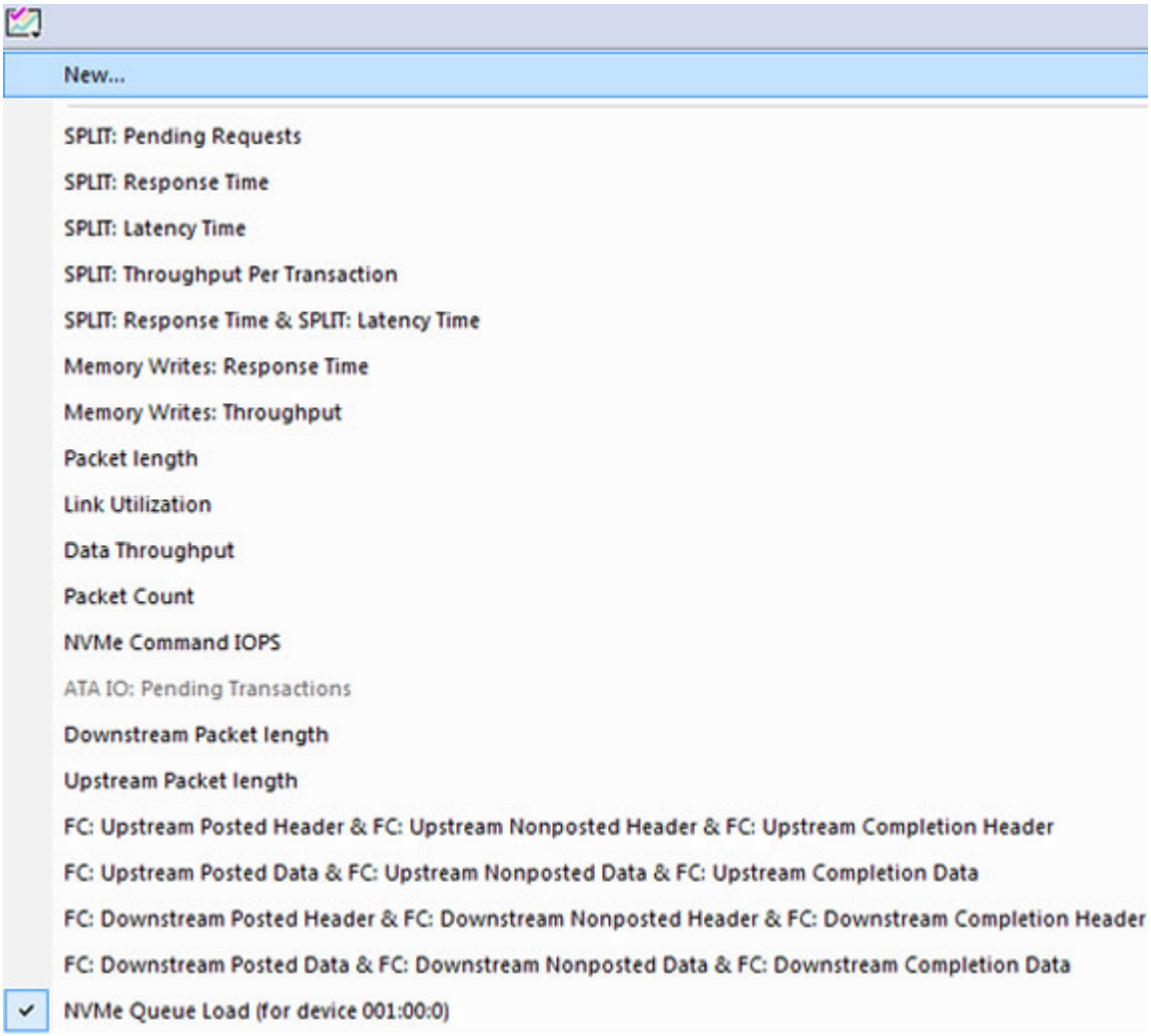


Figure 6.318: Graph Area Options Dialog

- New - Opens Graph Area Properties dialog to specify a new graph
- SPLIT: Pending Requests
- SPLIT: Response Time
- SPLIT: Latency Time
- SPLIT: Throughput Per Transaction
- SPLIT: Response Time & SPLIT: Latency Time
- Memory Writes: Response Time
- Memory Writes: Throughput
- Packet Length
- Link Utilization
- Data Throughput
- Packet Count
- NVMe Command IOPS
- ATA IO: Pending Transactions
- Downstream Packet Length
- Upstream Packet Length
- FC: Upstream Posted Header & FC: Upstream Nonposted Header FC: Upstream Completion Header
- FC: Upstream Posted Data & FC: Upstream Nonposted Data FC: Upstream Completion Data
- FC: Downstream Posted Header & FC: Downstream Nonposted Header FC: Downstream Completion Header
- FC: Downstream Posted Data & FC: Downstream Nonposted Data FC: Downstream Completion Data
- NVMe Queue Load

Example: NVMe Queue Load Graph Feature

This enhancement adds new Bus Utilization graph that indicates how many NVMe queue slots are occupied through the trace. There are separate graphs for each device, present in a trace, each queue is represented by a line. User can select queues to show. See Figure 6.319.

This graph can only be built after the NVMe level is decoded. Trace has to contain doorbells and submission/completion queues. If any of these conditions is not fulfilled, "Graph Areas" popup menu will have "NVMe Queue Load" item disabled. If required transactions are filtered out (for instance, using NVMe Enhanced Mode), user will be additionally prompted in popup menu entry.

Note: If trace with the graph is re-opened with persistent decoding disabled, empty graph area will be shown. After NVMe level decoding graph area gets deselected. Showing graph right after required levels are decoded should be considered as enhancement.



Figure 6.319: Bus Utilization: NVMe Queue Load

Graph Legend

Graph legend can be viewed by moving mouse pointer over graph title. See Figure 6.320.

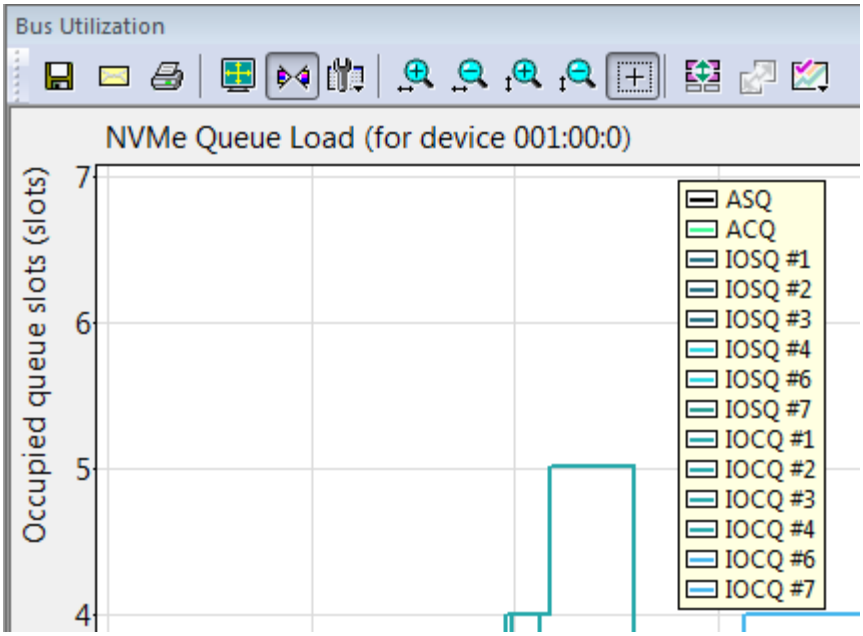


Figure 6.320: Bus Utilization: Graph Legend Details

Graph Properties

Queues to show can be selected in Graph Properties (as well as line colors). See Figure 6.321.

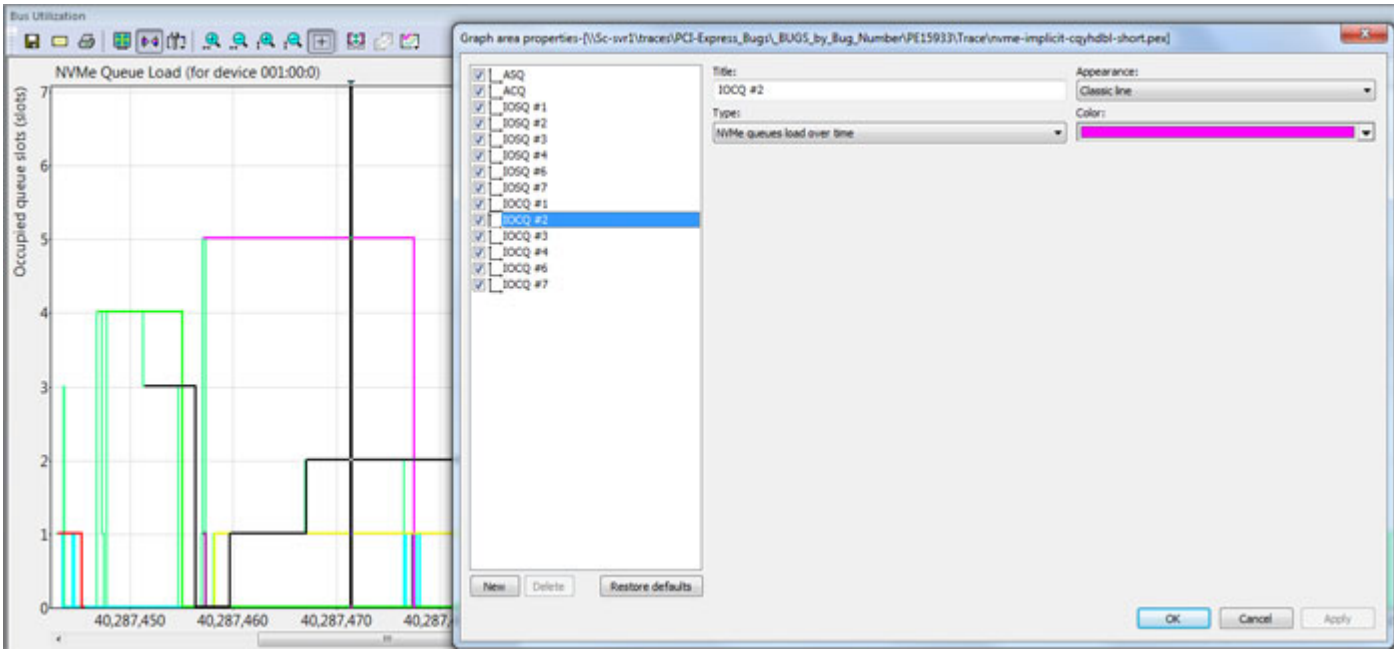


Figure 6.321: Bus Utilization: NVMe Queues => Selected in Graph Properties

6.7.9 Link Tracker

Open the Link Tracker window by selecting the Link Tracker Icon (to the right of the Bus Utilization Icon in the main toolbar)  .

The Link Tracker window displays a detailed chronological view of events. Events are shown on a channel-by-channel basis in columns within the window.

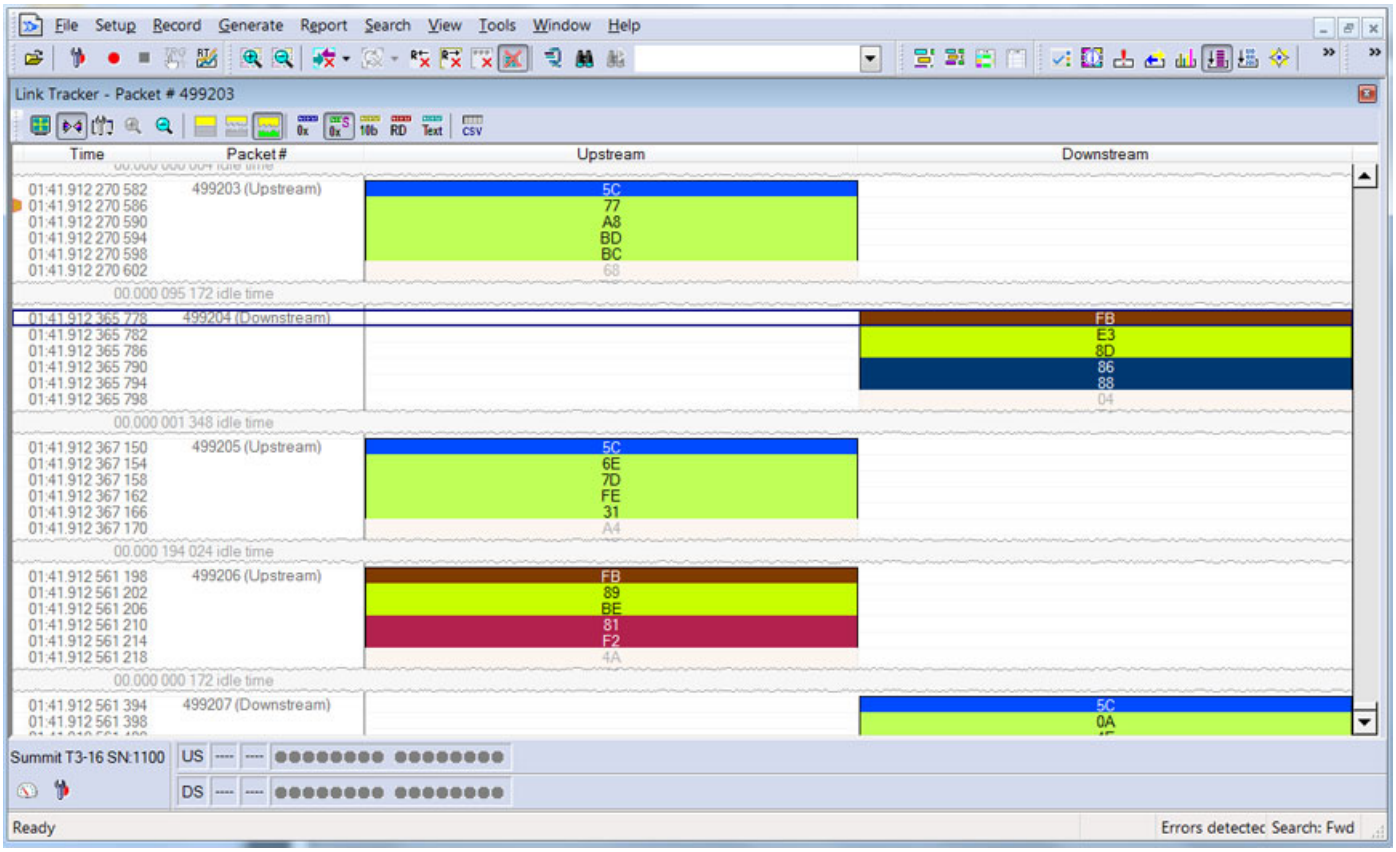


Figure 6.322: Link Tracker Window

Each time slot in the vertical axis represents the minimum time that a DWORD requires to traverse the bus.

Toolbar: Presents buttons for changing the format of the Link Tracker window.

Main Display Area: Displays traffic chronologically as it occurred in the recording. The window divides into columns: the first column shows time and traffic is shown on a channel-by-channel basis in the columns on the right.

6.7.9.1 Using the Link Tracker Window

The Link Tracker window can be reformatted in several ways.

6.7.9.2 Zooming In and Out

Zooming out can give you a quick, high-level view of a CATC Trace. A fully zoomed out CATC Trace only shows columns and colored lines. Using the colors, you can see what types of traffic run through the CATC Trace.

Further information can be obtained on any point of interest in the CATC Trace by positioning your mouse pointer over it. Tool tips provide detailed description of events.

When fully zoomed out, the smallest graphical unit is the DWORD, represented by a single line. Zooming out makes the CATC Trace appear smaller and increases the time scale in the first column.

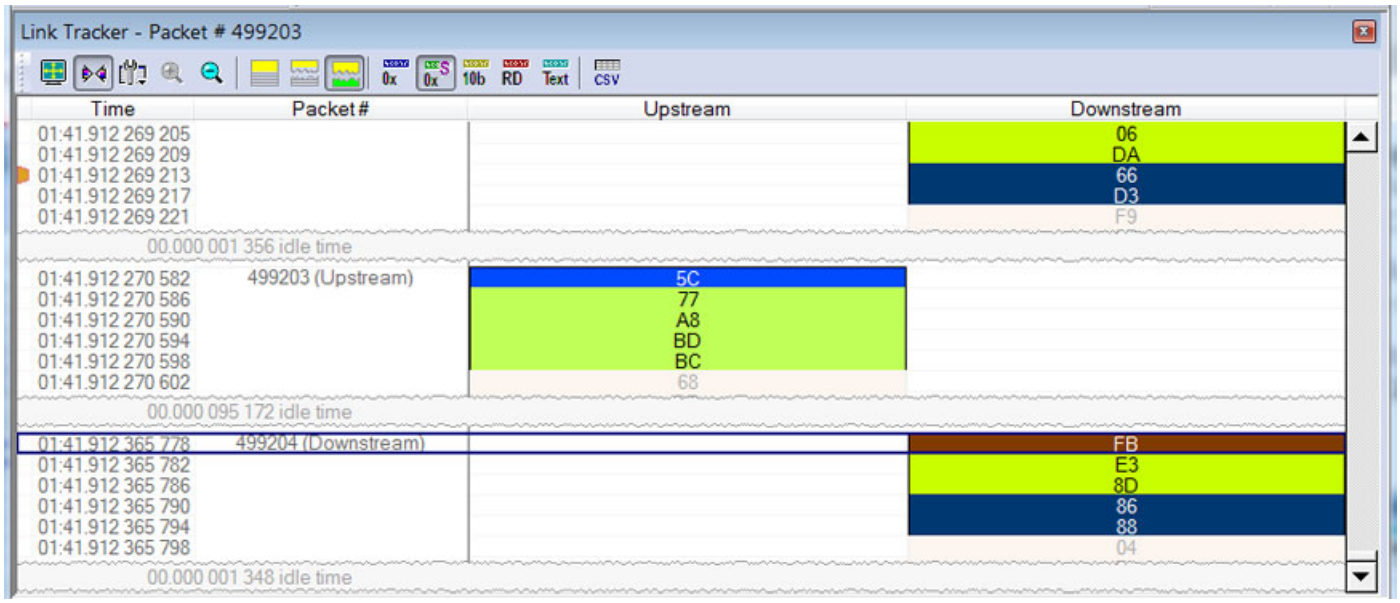


Figure 6.323: Link Tracker: Zoomed Out

6.7.9.3 Collapsing Idle Time, Enabling Tool tips, and Resetting Column Widths

Click the **View Options** button  to open a menu with options for formatting the display. Three options are presented:

Collapsible Idle Time: Opens a dialog box for setting the Idle time value. Setting a value tells the Analyzer when to collapse Idle times and display them as grayed out strips within the Bus View window.

Tooltip Display: Opens a menu with options for adding content to Tooltips. Tooltips display when you position the mouse pointer over an item in the Bus View window. The options are:

- Tooltips Display Values
- Tooltips Display Scrambled Values
- Tooltips Display 10-bit Codes
- Tooltips Display Symbols

Time Format: Seconds or Clock

Reset Column Widths: This option resets column widths to their defaults and enables columns to resize themselves automatically any time the application window is resized. Normally, columns automatically resize themselves if the application window is made larger or smaller. However, if you manually resize any columns in the Bus View window, column widths become static. Thereafter, if you resize the application window, the Bus View columns do not adjust automatically. Reset Column Widths re-enables the automatic resizing capability.

Reset Columns Order: Return to default column sequence.

6.7.9.4 Docking and Undocking the Window

You can undock the Link Tracker window by double-clicking the blue title bar along the left side of the window. Once undocked, the window can be dragged anywhere in the application. To re-dock double-click again on the title bar.

6.7.9.5 Setting Markers

Markers can be set on any event within the Link Tracker window.

To set a marker, right-click an event, then select **Set Marker** from the pop-up menu.

Once marked, you can navigate to events with the **Go to Marker** command in the Search menu.

Markers set in the Link Tracker window display the packet number and DWORD number. In contrast, markers set in the CATC Trace window just show the packet number.

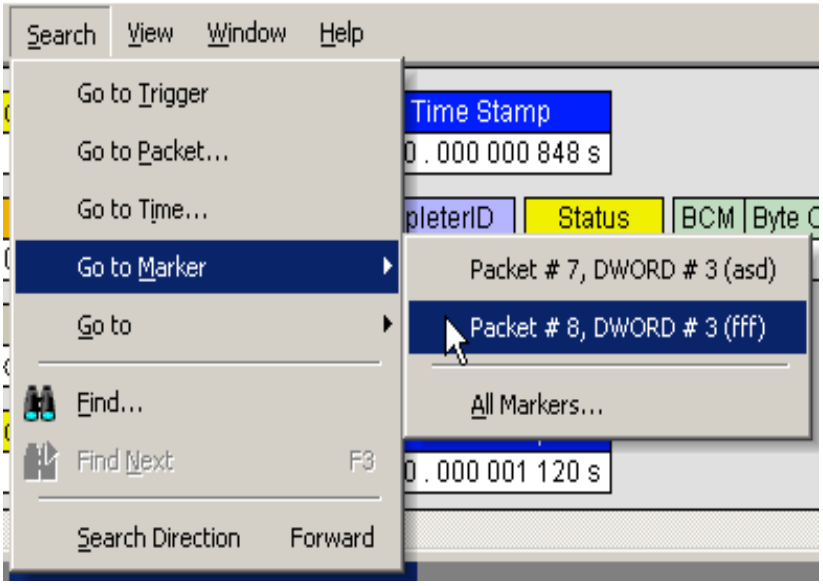


Figure 6.324: Selecting the Go to Marker Option

6.7.9.6 Calculating Time between DWORDs

You can calculate time between DWORDs by clicking an event and then positioning your mouse pointer over a second event and reading the ensuing Tool tip.

Click the **time value** for the first event. Scroll down through the CATC Trace to the second event and position the mouse pointer above its time value. A Tool tip appears showing the time interval between the first and second events.



Figure 6.325: Viewing Time Values

6.7.9.7 Hiding Traffic

You can hide Idles and other data from the Link Tracker window by clicking the **Hide** buttons on the toolbar.

6.7.9.8 Link Tracker Buttons

The Link Tracker window has a row of buttons for changing the format of the displayed data and for exporting data: The buttons have the following functions:

	Full Screen. Expands the Link Tracker window to fill the entire screen.
	Synchronize Trace View. Synchronizes the Trace View and Link Tracker windows so that a move in one window repositions the other. Because of the differences in scale and logic between the Link Tracker and Trace view window, scrolling produces different effects depending on which window is being scrolled. Scrolling in the CATC Trace window causes the Link Tracker window to rapidly jump from event to event. Long periods of idle time are thus skipped. Scrolling in the Link Tracker window, in contrast, produces modest movements within the CATC Trace window. Scrolling in the Link Tracker window causes the CATC Trace window to pause until the beginning of a packet is displayed. At that point, the CATC Trace window repositions itself. While scrolling long Idle periods or through the contents of a packet, the CATC Trace window does not move.
	View Options. Opens a menu with three options: • **Collapsible Idle Time** (Collapse Idle Bigger Than **n** nanoseconds. **Note:** Does not affect Collapse Idle Plus.) • **Tooltip Display** (Values, Scrambled Values, 10-bit Codes, Symbols) • **Time Format** (Seconds, Clock) • **Reset Columns Widths** (return to default widths) • **Reset Columns Order** (return to default column sequence) See "Using the Link Tracker Window" on page 509 for further details.
	Zoom In
	Zoom Out
	Continuous Time Scale. No collapsing.
	Collapse Idle. Do not show some periods of Link being idle.

	Collapse Idle Plus. Do not show periods of Link being idle.
0x	Show Descrambled Bytes
0x	Show Scrambled Bytes
10b	Show 10b Codes
RD	Show Symbols
Text	Show Text
Bin	Show Binary values
CSV	Export to CSV file

Exporting to CSV File

To export trace file information to a CSV file, select the variables you want in the file and select the CSV Icon. A window with your variables will pop up that also shows you the file name and path. See Figure 6.326.

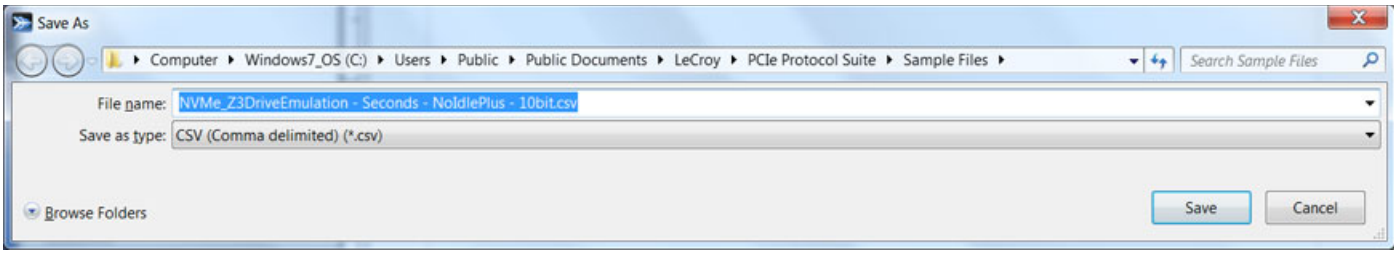


Figure 6.326: Link Tracker: CSV File to be Saved and Location

Select Save and the tool will start. See Figure 6.327.

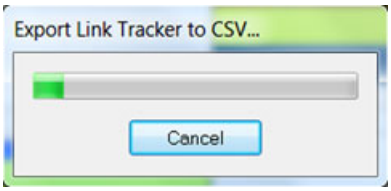


Figure 6.327: Tool Exporting Link Tracker Data to CSV File

The generated CSV file can be viewed in Excel.

6.7.10 Data Flow Window

The Data Flow window shows marker, packet, direction, type, length, address, payload, handshake, and timestamp information.

To obtain the Data Flow window, select **Report > Data Flow**

or click the  Data Flow toolbar icon.

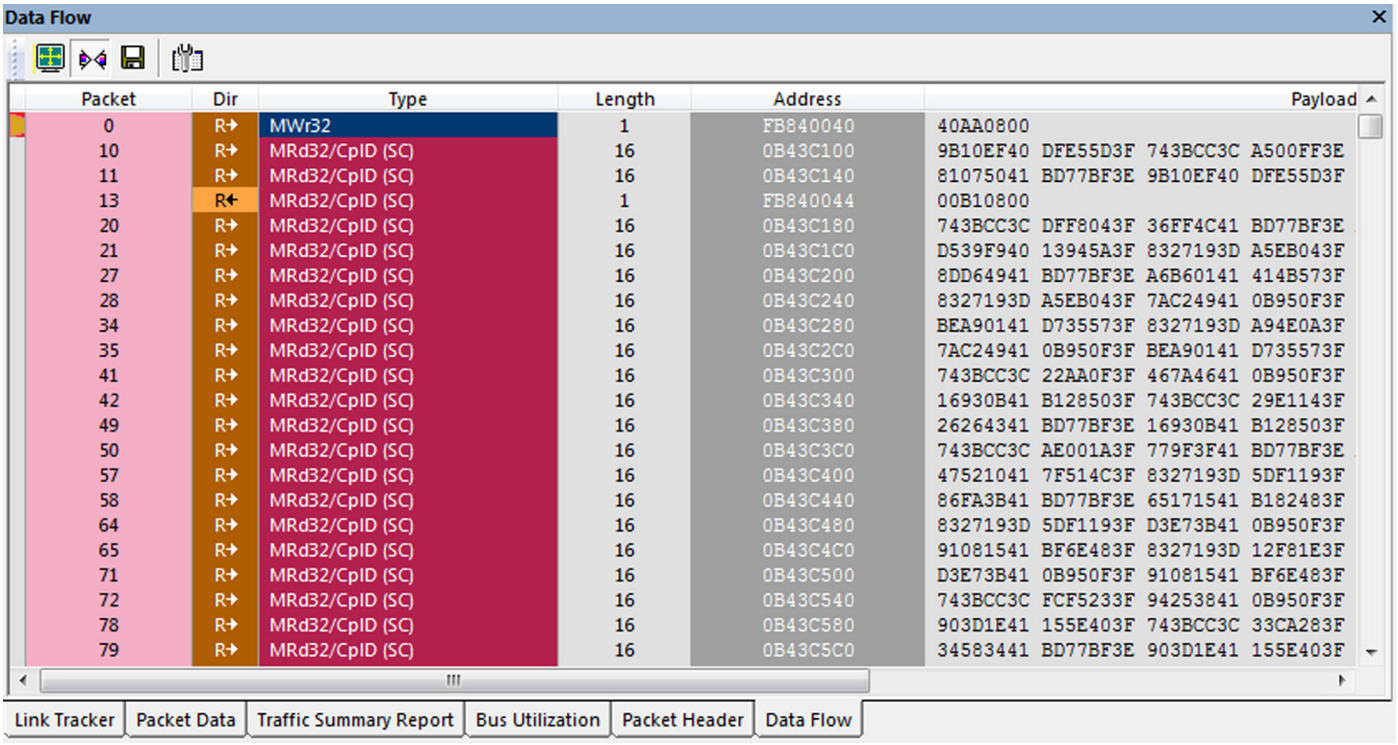


Figure 6.328: Data Flow Window



The toolbar allows you to (see Figure 6.329 on page 515):

- Expand the window to full screen or Collapse to a smaller window.
- Synchronize.
- Save.
- Select Data Flow columns to display and their widths:
  - Marker
  - Packet
  - Direction
  - Type
  - Length
  - Address
  - Payload
  - Handshake
  - Time Stamp

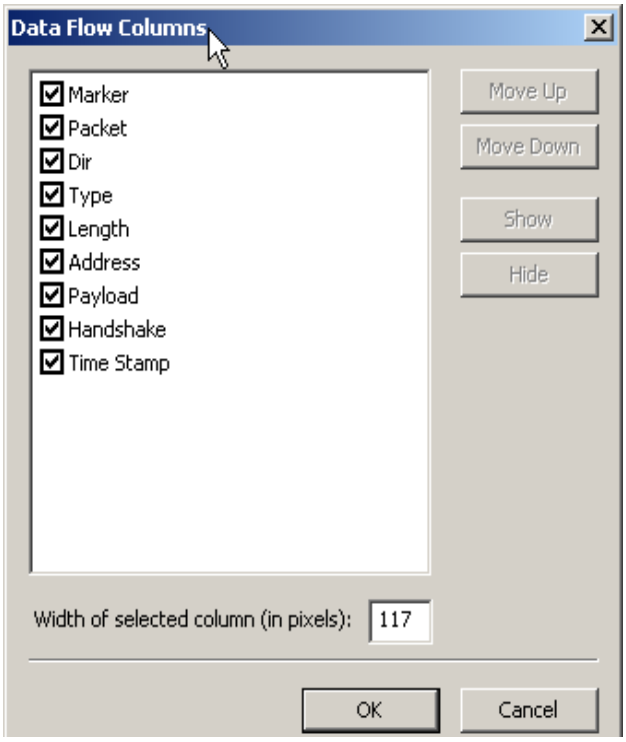


Figure 6.329: Data Flow Columns Dialog

6.7.11 Flow Control Tracking

The Flow Control View mode highlights portions of the packets that affect flow control and displays flow control values. Flow control values shown at the beginning of Link Transaction display the credit values that were available prior to TLP transmission. Flow control values shown at the end of the Link Transaction display the credit values that were available after TLP was transmitted. Hover the mouse over the field to display tool-tips. Refer to the following screen capture.

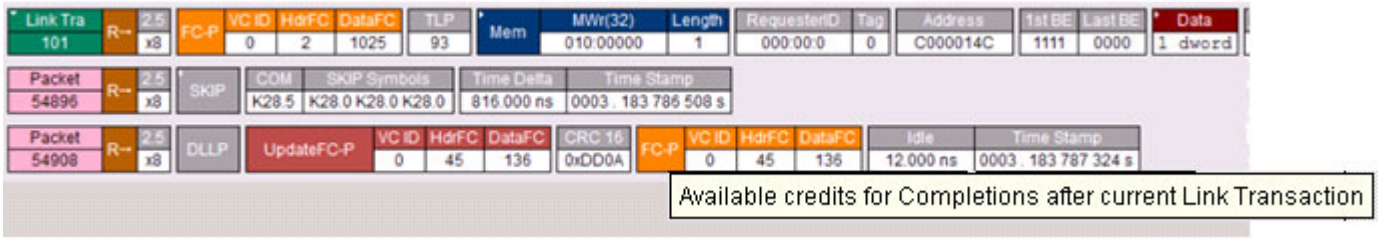


Figure 6.330: Flow Control Display

If the trace includes Flow Control initialization, PCIe Protocol Analysis detects the amount of available credits based on the values advertised in InitFC packets. If the InitFC packets are not in the trace, the amount of available credits can be set using the FC Credit Setup dialog. Select **View > FC Credits Setup...** displays the FC Credit Setup dialog (see the following screen capture).

For each virtual channel that is present in the trace you need to specify the amount of available credits before the beginning of the trace. You can also specify the values of credit fields for UpdateFC packets before the beginning of the trace. If the values of the UpdateFC credit fields are different than the values in the first UpdateFC packet, Flow Control tracking view will show that the

first UpdateFC packet is releasing appropriate amount of credits. By default, PCIe Protocol Analysis sets these values to match the first UpdateFC packets in the trace.

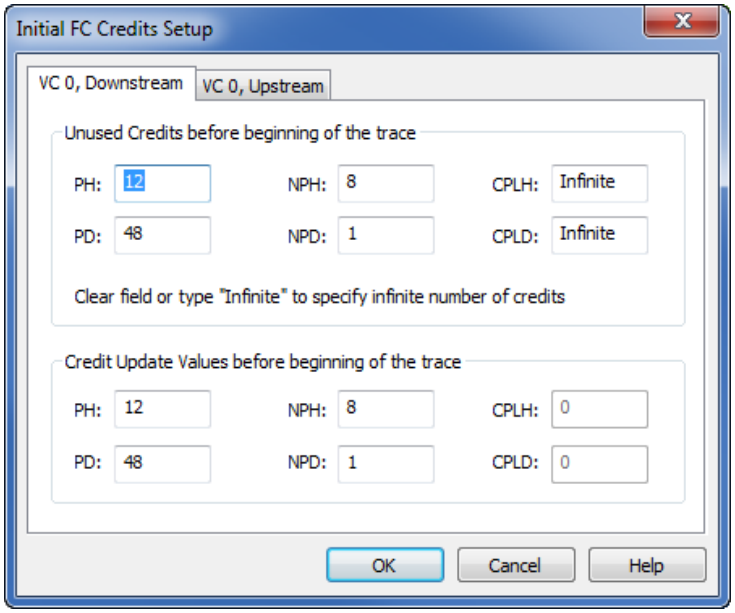


Figure 6.331: Flow Control Setup Dialog

6.7.12 Using the CATC Trace Navigator

The CATC Trace Navigator is a tool for navigating within the CATC Trace. It allows you to view the location of errors and triggers in a CATC Trace and to narrow the range of traffic on display. It also allows you to quickly jump to any point in the CATC Trace.

6.7.12.1 Displaying the Navigator

Click  in the toolbar to display the Navigator. The Navigator appears on the right side of the Main window. It has a two-button toolbar and a vertical slider bar. It also has colored panes for navigating the CATC Trace in different ways. You set which panes are displayed through Navigator pop-up menus (see Figure 6.332 on page 517).

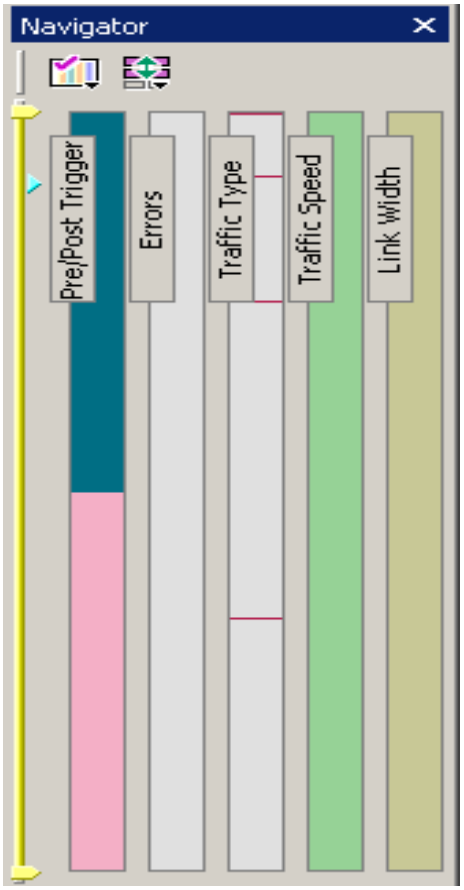


Figure 6.332: Navigator Dialog

6.7.12.2 Navigator Toolbar

The Navigator toolbar lets you quickly set Navigator features. The toolbar has two buttons.





Navigator Ranges: This button brings up a pop-up menu that lets you reset the Navigator range. The range determines what packets are viewable in the CATC Trace display.

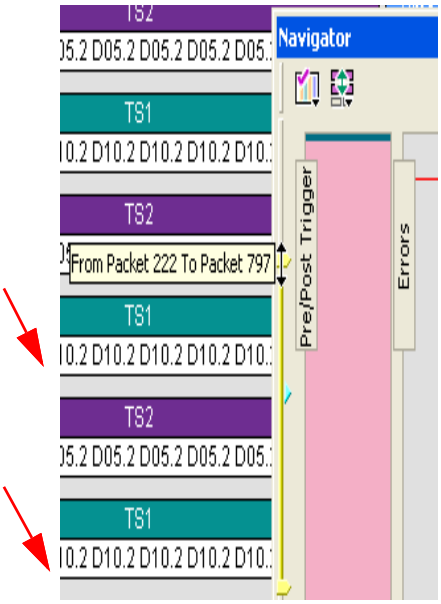


Navigator Panes: This button has two purposes: To select which Navigator panes appear and to bring up the Navigator legend. The legend determines how information is shown in the panes.

6.7.12.3 Navigator Ranges

You set the viewing range by dragging the **yellow range delimiters** along the slider. To set the lowest packet viewable, drag the **top delimiter up**. As you do so, a tool tip appears to indicate the current range. Stop dragging when you reach the desired lowest packet.

To set the highest packet viewable, drag the **bottom delimiter down**. Stop when the tool tip indicates you are at the desired highest packet.



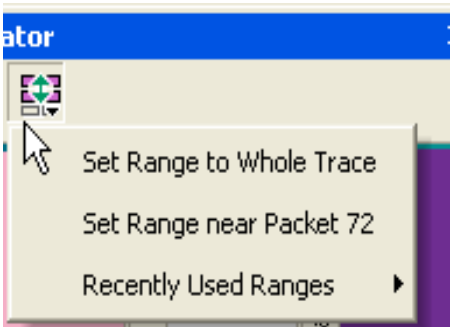
6.7.12.4 To Determine Current Position

In addition to the two range delimiters, the slider has a **blue current-position** indicator (see above). The current-position indicator shows where you are in the CATC Trace display with respect to the possible viewing range.

For example, suppose you set viewing range to packet 0 through packet 500 (the top range delimiter is at packet 0, and the bottom range delimiter is at packet 500). If you then move the current-position indicator on the slider to midway between the top and bottom delimiters, then packet 250 appears in the middle of the CATC Trace display.

6.7.12.5 To Reset Navigator Range

You can reset the Navigator range using the toolbar **Navigator Range** button. Press the button to bring up the Navigator Range drop-down menu.



The menu has the following options:

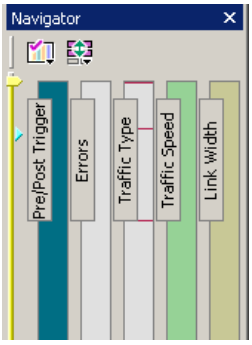
- **Set Range to Whole Trace**: Allows you to reset the range to include the entire CATC Trace file contents. The top range delimiter is placed at the lowest packet number in the CATC Trace. The bottom range delimiter is placed at the highest

packet number in the CATC Trace.

- **Set Range Near Packet xxx**: Allows you to collapse the range so that only the packets immediately above and below the xxx packet are displayed. The xxx packet is whatever packet is currently at the top in the CATC Trace display.
- **Recently Used Ranges**: Allows you to reset the range to any of a number of recently used (previously set) ranges.

6.7.12.6 Navigator Panes

You can display any combination of CATC Trace Navigator panes.



From left to right, the panes are: Pre/Post Trigger, Errors, Traffic Type, Traffic Speed, and Link Width. Each pane represents the entire CATC Trace with respect to different types of information. The top of each pane represents the start of the CATC Trace file, and the bottom represents the end of the CATC Trace file.

- **Pre/Post Trigger:** To view the trigger event in the CATC Trace and the relative size of pre-trigger and post-trigger portions of the CATC Trace. The two portions are set apart as different colors. The trigger event occurs at the point the two colors meet.
- **Errors:** To view any errors in the CATC Trace. A thin red line represents each error in the pane.
- **Traffic Type:** To view the types of packets that occur in the CATC Trace. A different color represents each packet type in the pane. The relative size of colored portions in the pane corresponds to the amounts of the various packet types in the CATC Trace. As described below, you can use the Navigator legend to change the types of packets that take precedence in the display.
- **Traffic Speed:** To view the speed that occurs in the CATC Trace.
- **Link Width:** To view the link width that occurs in the CATC Trace.

6.7.12.7 To Show/Hide Navigator Panes

You can show/hide any of the panes using pop-up menus accessible through left-click the **Navigator Panes** button or by right-click anywhere in any CATC Trace Navigator pane.

6.7.12.8 Navigator Slider

The Navigator slider appears at the left of Navigator panes. The slider has **yellow upper and lower range delimiters** and a **blue current-position** indicator.

The Navigator slider lets you to set the range of packets viewable in the CATC Trace display. In other words, it sets scrolling range of the display. You can scroll the display up to the lowest packet number in the viewing range. You can scroll the display down to the highest packet number in the viewing range.

6.7.12.9 CATC Trace Navigator Legend

The Navigator legend lets you control the display of content in Navigator panes.

You bring up the legend through the Navigator Pane's drop-down menu. Press the toolbar **Navigator Panes** button to access the menu. Select the **Legend** option to bring up the Navigator Legend dialog (see Figure 6.332 on page 517).

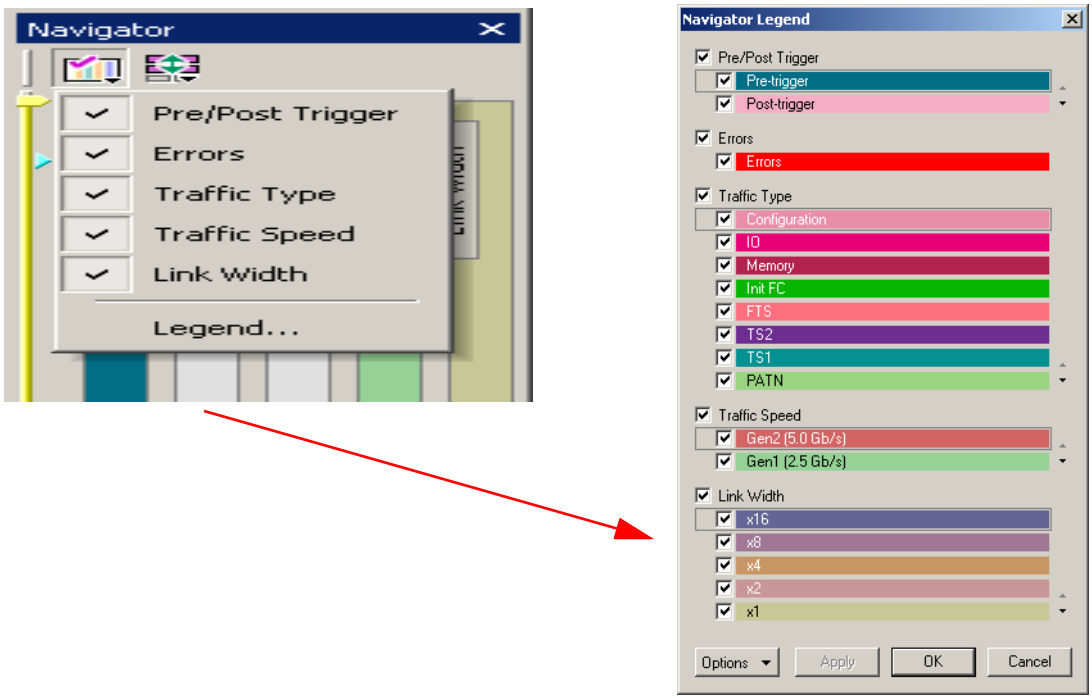


Figure 6.333: Navigator Pane and Navigator Legend Dialog

The Navigator Legend dialog has areas corresponding to each of the panes. Each area has check boxes that allow you to hide/display information in the pane. You can set the priority of information displayed in the panes using the up and down triangles on the right.

6.7.12.10 Using the Legend to Show/Hide Navigator Panes

To use the legend to show/hide an entire pane, use the **checkbox** next to the name of each pane in the legend.

In the case of the Pre/Post Trigger and Errors areas, the action of show/hide in the legend is identical to that provided by CATC Trace Navigator pop-up menus.

In the case of the Traffic Types pane, there is no equivalent show/hide available through the pop-up menus.

6.7.12.11 Using the Legend to Set the Priority of Information Display

You can use the legend to set the priority of information displayed in the Pre/Post Trigger Traffic Type panes. This is a two-step process.

1. For a particular item in a pane, click the **column next to the checkbox** for the item. That labels the item as currently active.
2. Next, use the **up-down** at the lower-right of the area to move the item higher or lower in priority.

In the case of the Traffic Type pane, priority determines display priority of each packet type. For portions of the CATC Trace that are dominated by a particular packet type, this setting no effect: only the color corresponding to that packet type is displayed in that portion of the pane. Suppose, however, that part of the CATC Trace includes equal or near equal numbers of several types of packets. In that case, you can use the legend to select which among those types is represented in that portion of the Traffic Types pane. This allows you to view only packets of interest in crowded portions of the CATC Trace display.

6.7.13 Detail View

Click  to show the Detail View of the selected packet.

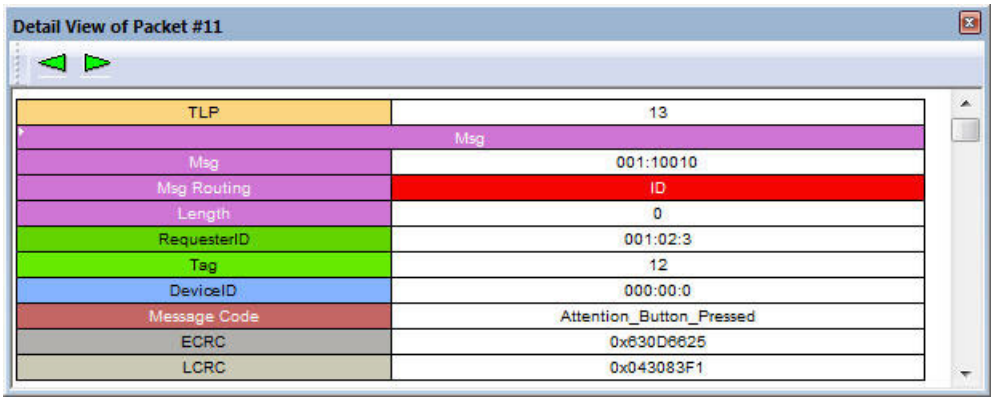


Figure 6.334: Detail View

6.7.14 LTSSM Flow Graph

The LTSSM Flow Graph shows link state transitions that the link goes through, as recorded in the CATC Trace file.

To obtain the LTSSM Flow Graph (see Figure 6.335 on page 522), select **Report > LTSSM Flow Graph.**

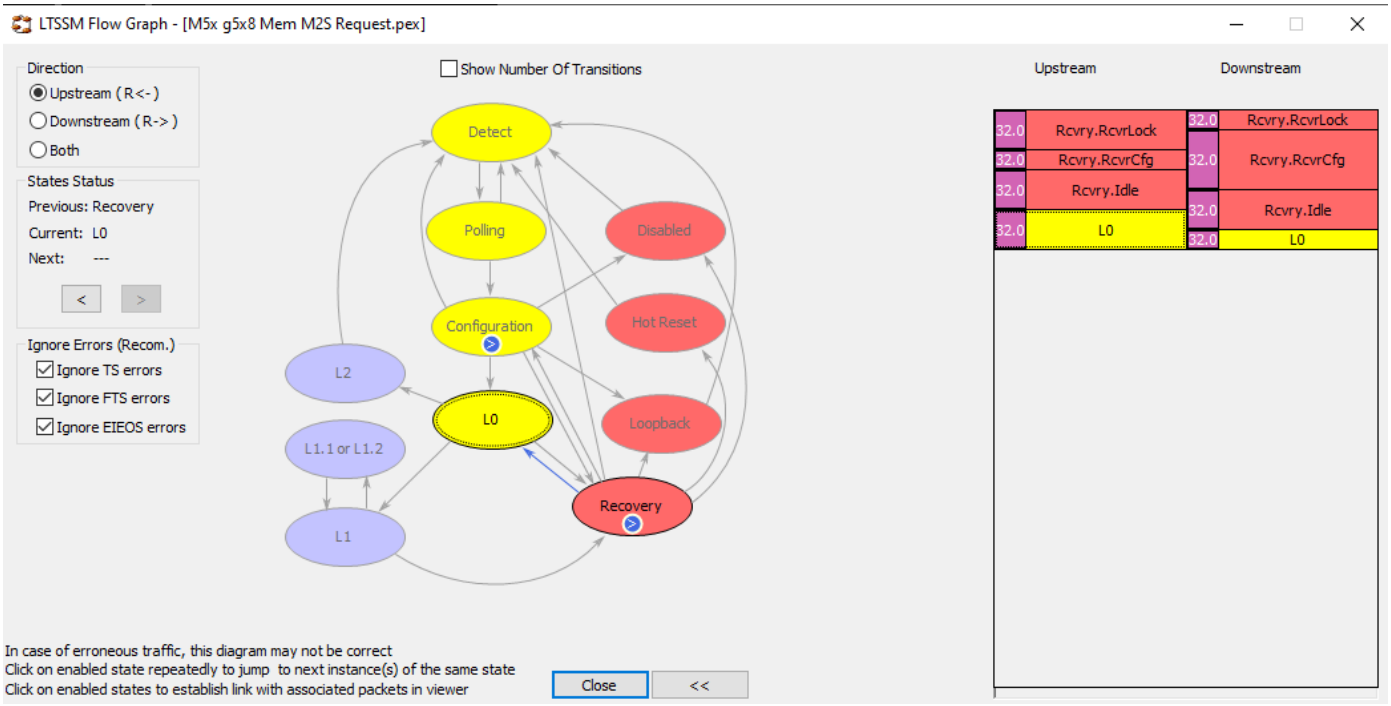


Figure 6.335: LTSSM Flow Graph Dialog

You can enable or disable ignoring of TS/FTS/EIEOS packets with errors so they will not affect the diagram if enabled.

You can display the following directions:

- Upstream
- Downstream
- Both

You can **Show Number of Transitions**.

6.7.15 LTSSM Dynamic Equalization

You can review the PreCursor, Cursor and PostCursor values that the analyzer has used during the dynamic equalization phase of the LTSSM process by selecting the LTSSM icon on the toolbar and checking the following steps: See Figure 6.336.

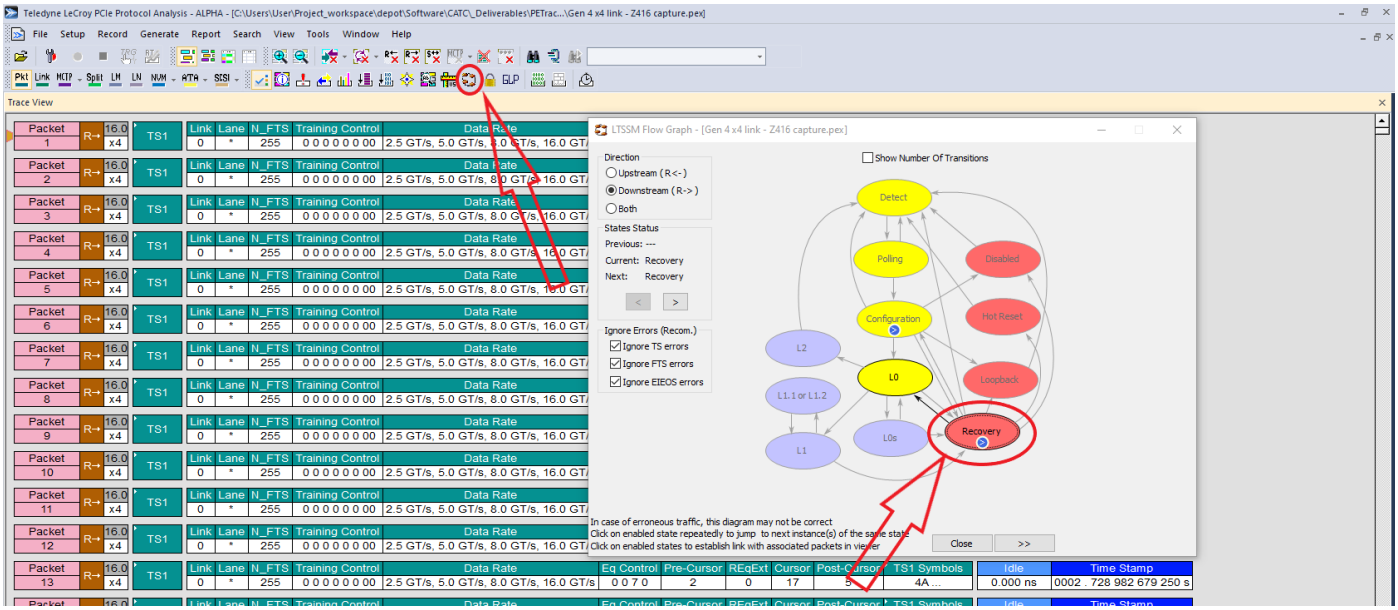


Figure 6.336: Recovery Phase of LTSSM

Click on the arrow in the blue circle in the Recovery state to see more detail. See Figure 6.337 on page 524.

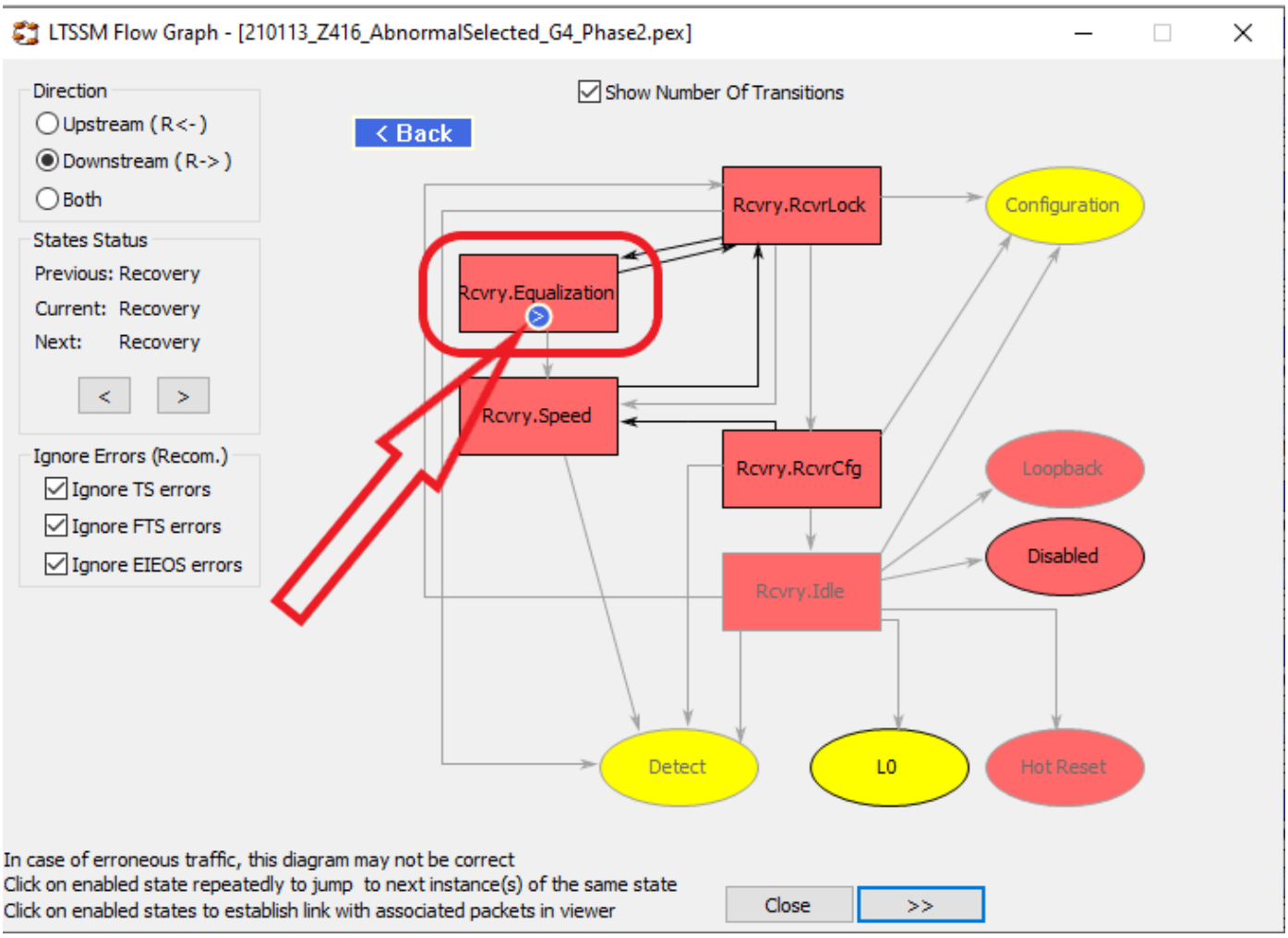


Figure 6.337: Recovery Equalization State

Click on the blue circle with the white arrow in the Recovery.Equalization state to review the PreCursor, Cursor and PostCursor values. See Figure 6.338 on page 525.

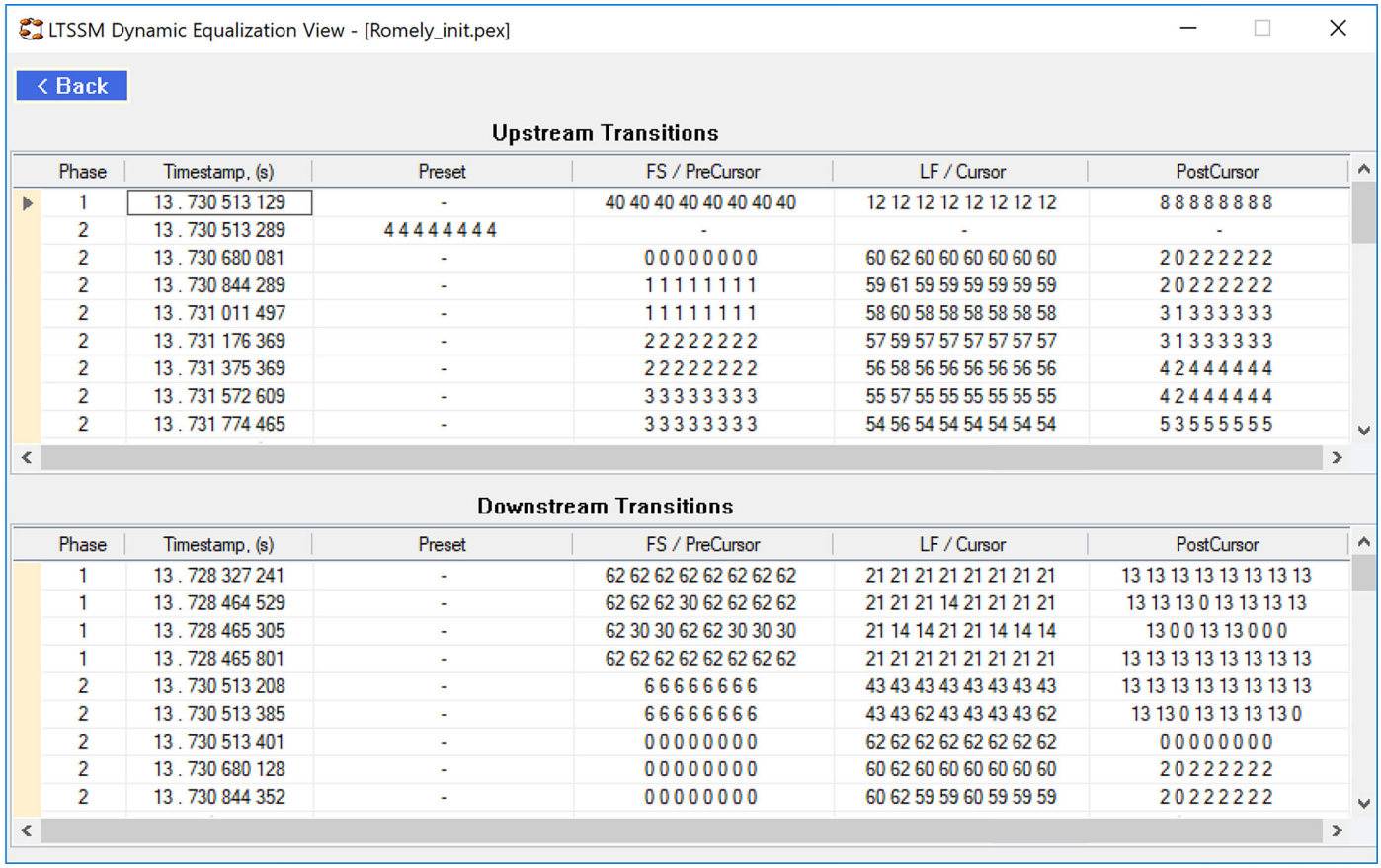


Figure 6.338: LTSSM Dynamic Equalization: PreCursor, Cursor and PostCursor Values

6.8 Lane Margining: Eye Diagram

A simulated eye diagram for Gen4 analyzers can be generated using the Rx Lane margining parameters delivered through CSR accesses and control skips.

To margin a Receiver, Software moves the target Receiver to a voltage/timing offset from its default sampling position. Simulated eye diagram will help follow stepping through the margin settings and tracking lane margin changes, using right/left offset timing margin steps and up/down offset voltage margin Steps relative to default.

After the trace has been generated select **Report → LM Eye Diagram** and the following display will pop up. See Figure 6.339.

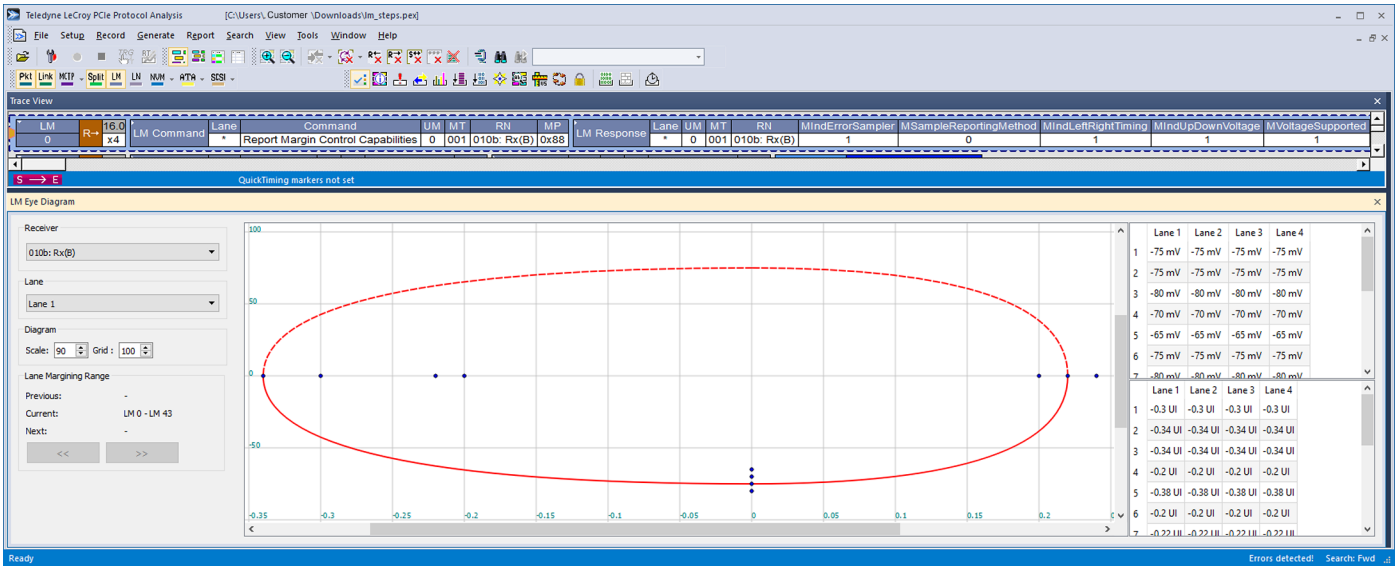


Figure 6.339: Decoded Lane Margining Trace: Eye Diagram

There are a number of controls to manipulate the “Eye Diagram”. Each one has a tooltip to explain it use. On the left side of the Eye Diagram there are the following options:

- Receiver: Choose receiver to be shown in Eye Diagram view and Timing and Voltage tables
- Lane: Choose lane to be shown in Eye Diagram view
- Diagram: Scale Factor → Set scale factor for Eye Diagram
- Diagram: Grid → Change grid size of Eye Diagram
- Lane Margining Range: Navigate over existing L0 states in trace

See Figure 6.340 on page 527.

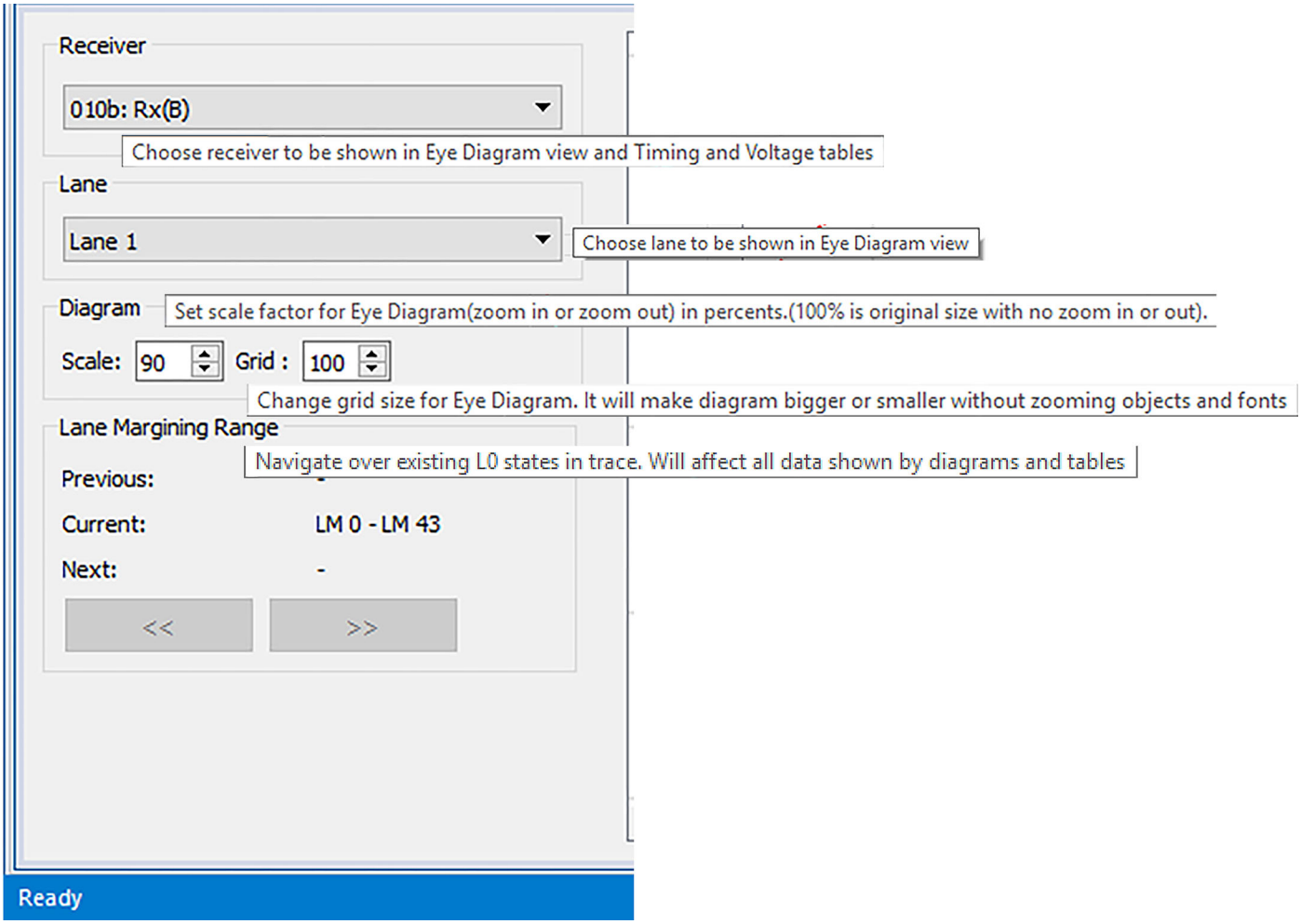


Figure 6.340: Options and Tooltips: Left side of Eye Diagram

On the right side of the Eye Diagram there are the following options:

- Lane 1 - Lane 4: Shows voltage transactions for given receiver
- Lane 1 - Lane 4: Shows timing transactions for given receiver

See Figure 6.341 on page 528.

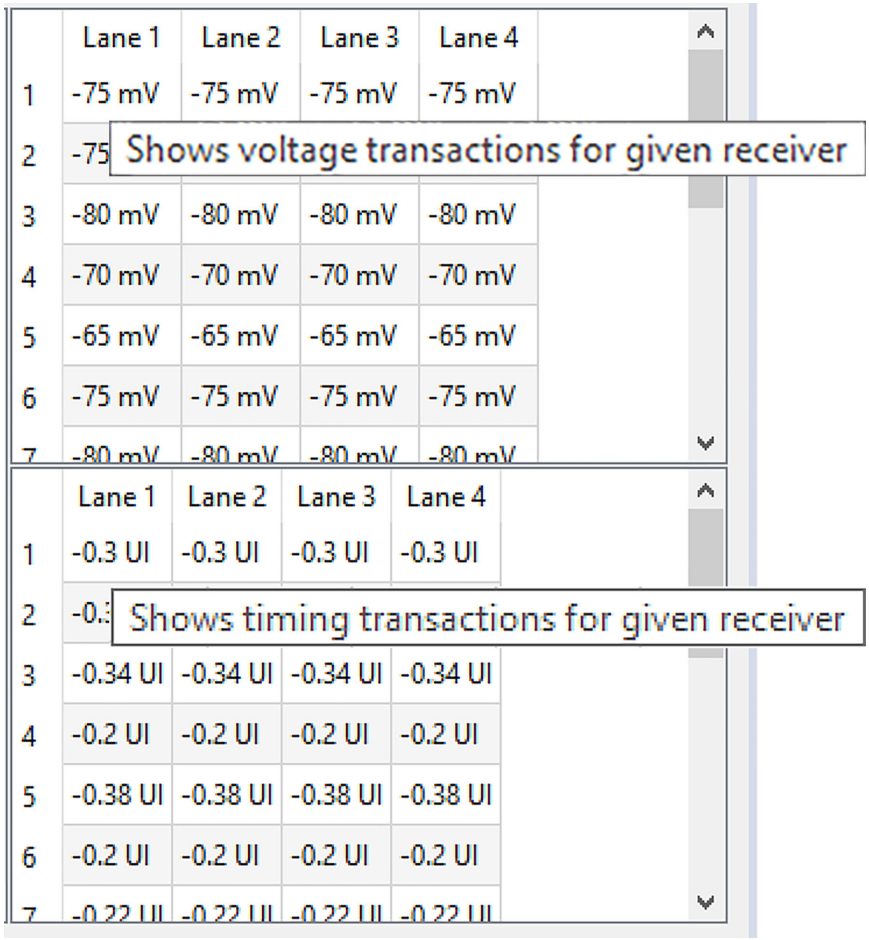


Figure 6.341: Options and Tooltips: Right side of Eye Diagram

6.8.1 Packet Header Bar

The Packet Header bar shows packet header information.

To display the Packet Header bar (see Figure 6.342 on page 529), select **Report > Packet Header** or click the  toolbar icon.

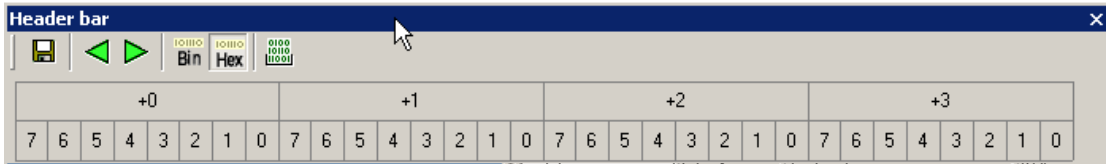


Figure 6.342: Packet Header Bar

The toolbar allows you to Save, go to Previous or Next, display Hexadecimal or Binary, and show the Packet Data window.



6.8.2 Packet Data Window

The Packet Data window shows packet or transaction payload.

To display the Packet Data window, select **Report > Packet Data**, or click the  toolbar icon.

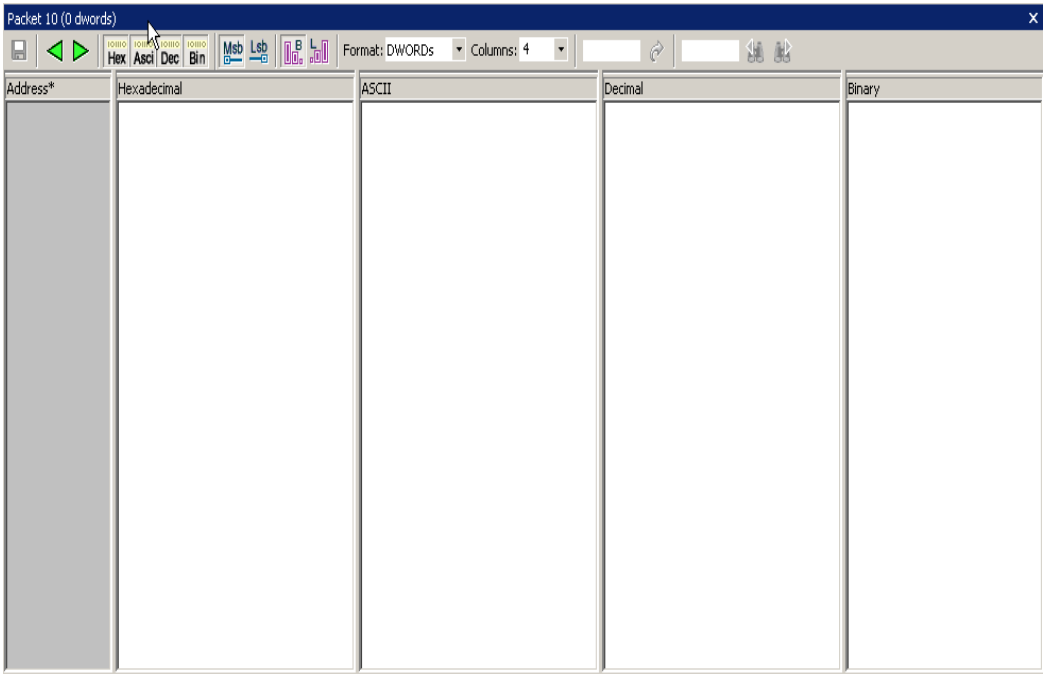
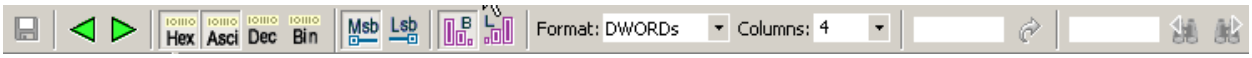


Figure 6.343: Packet Data Window

The toolbar allows you to Save; go to Previous or Next; display Hexadecimal, ASCII, Decimal, or Binary; use MSB Format or LSB Format; and use Big Endian or Little Endian.



Format and Columns allows you to enter the number of bytes, words, or dwords per line.

You can enter an Offset and scroll to it.

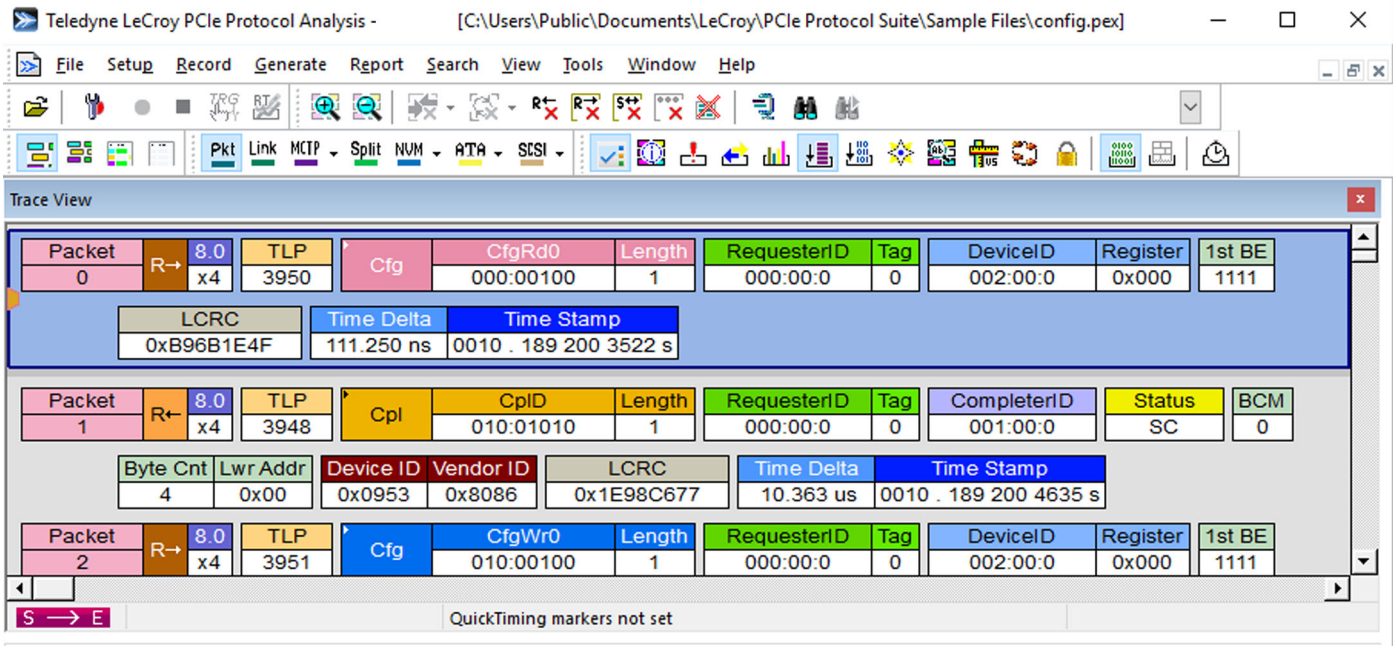
You can enter text and Search Previous or Search Next.

6.9 Configuration Space View

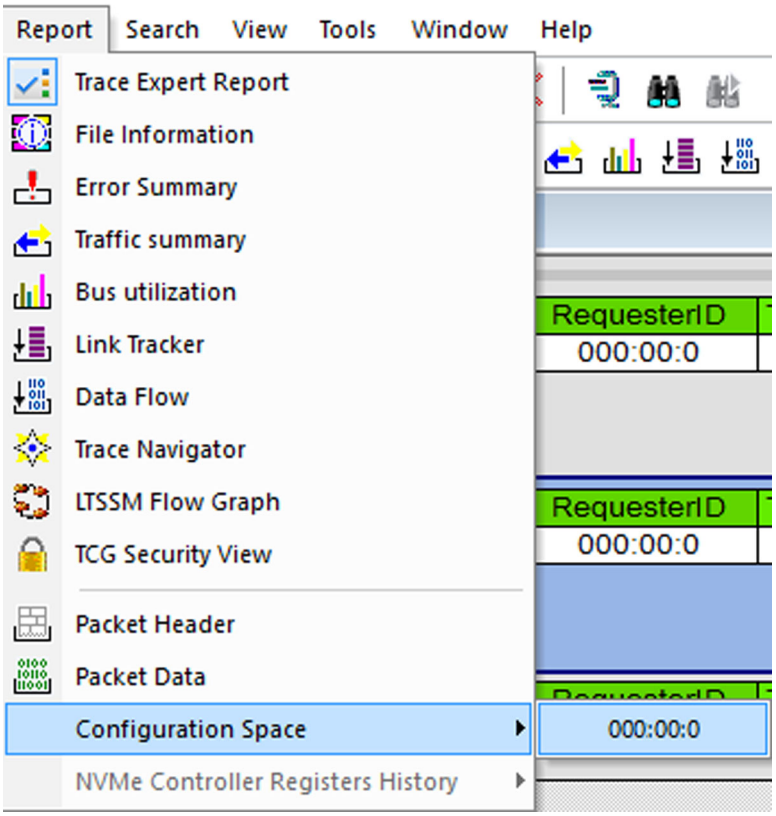
The Configuration Space View displays information about the Configuration Space state as of the current packet of the currently selected device. The view shows the Configuration Space Header and the PCI-compatible or PCI Express Capability Structures.

To display the Configuration Space View for a device at a packet:

1. Open a CATC Trace, such as the sample file **config.pex**.
2. Scroll to a packet with a Configuration header.



3. Select **Report > Configuration Space > <device>** to display the Configuration Space View.



Select **Show Configuration Space for xxxx** from the menu, where **xxxx** is the device number. The Configuration Space View displays (see Figure 6.344).

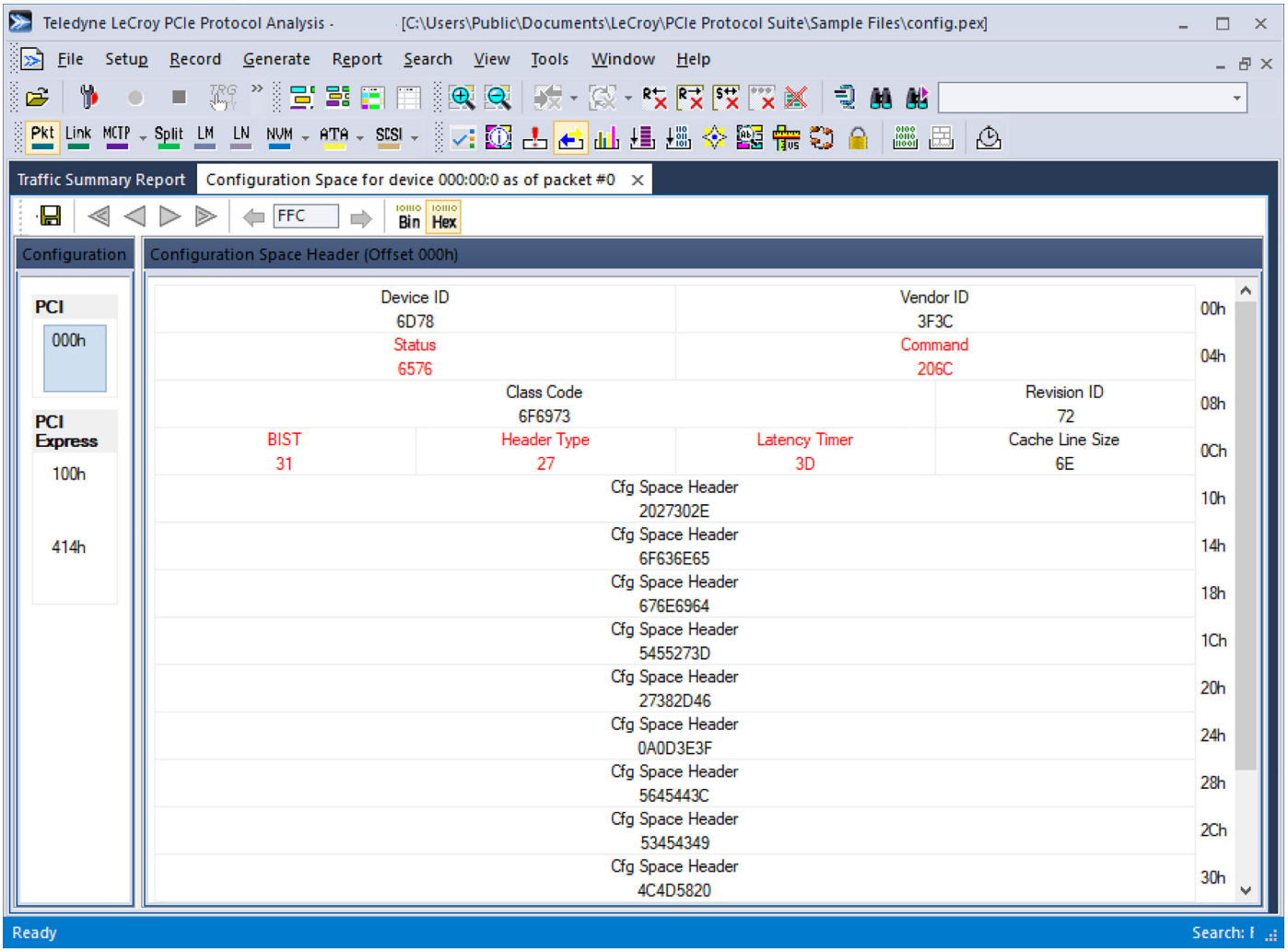


Figure 6.344: Configuration Space View

On the left, the view displays the Configuration Space for the selected CompleterID or DeviceID at the current packet. You can select **Configuration Space Header** or a **Capability Structure.**

The right displays the decoded data of the selected Configuration Space Header or a Capability Structure, up to the current packet. (The decoding builds while navigating through the next packets.)

The Configuration Space View toolbar allows you to save, go to First, go to Previous, go to Next, go to Last, go to Previous Access to Selected Configuration Space Register, go to Next Access to Selected Configuration Space Register, and display Hexadecimal or Binary. See Figure 6.351 on page 536.

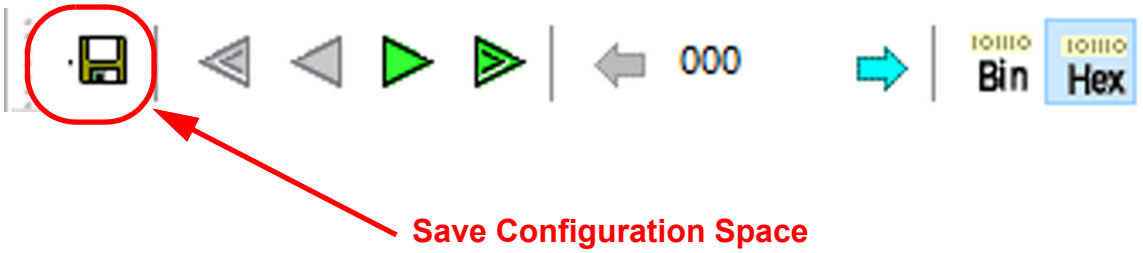


Figure 6.345: Saving Configuration Space File

If you select to Save the Configuration Space file, a dialog box will pop-up and you can save the file for future use in either of two formats:

- PCIe Trainer Configuration Space files
- HTML files

See Figure 6.346.

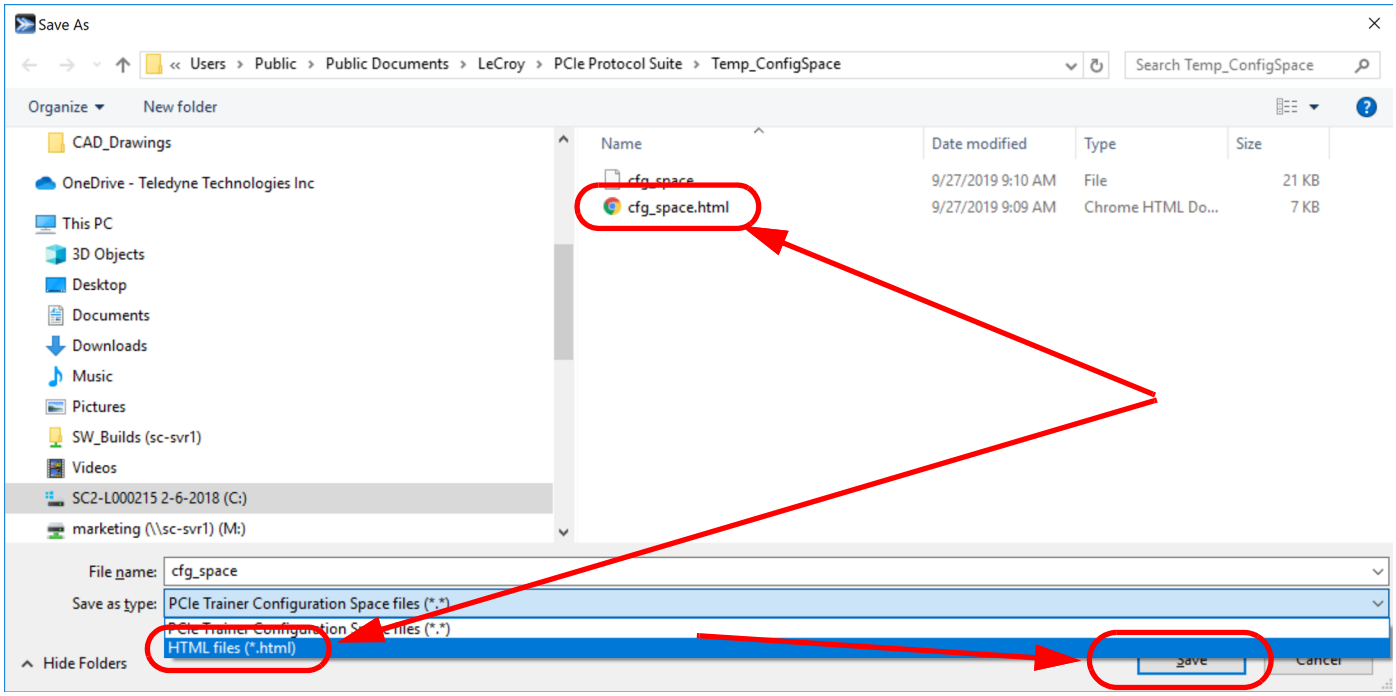
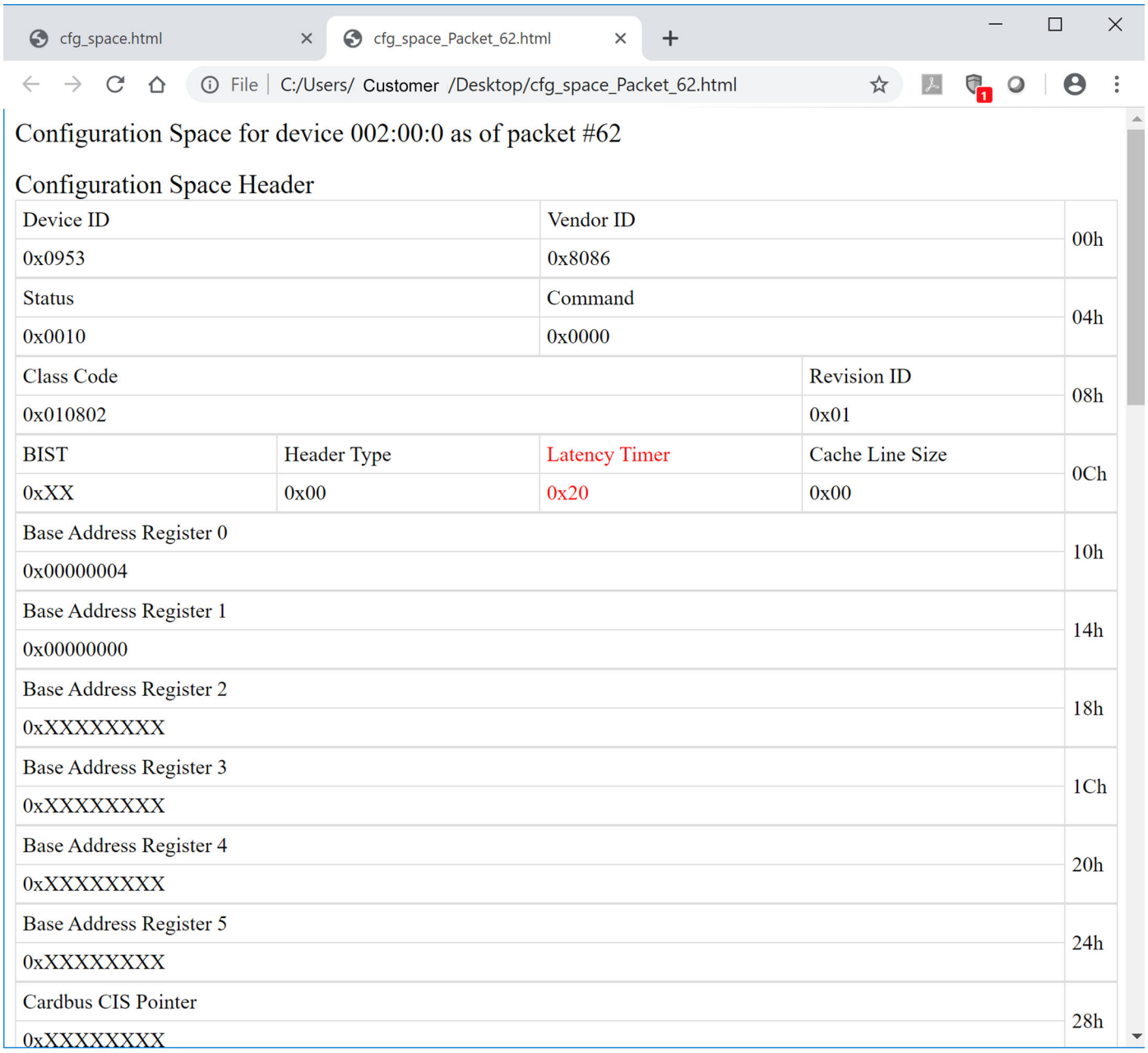


Figure 6.346: Location of Configuration Space File: PCIe Protocol Suite/Temp

Click on the **Save** button to save the file.

If you had selected Saving As → HTML and you open that file, you will see the following information about the Configuration Space in HTML format. See Figure 6.347 on page 534.



Configuration Space for device 002:00:0 as of packet #62

Configuration Space Header

Device ID		Vendor ID		00h
0x0953		0x8086		
Status		Command		04h
0x0010		0x0000		
Class Code			Revision ID	08h
0x010802			0x01	
BIST	Header Type	Latency Timer	Cache Line Size	0Ch
0xXX	0x00	0x20	0x00	
Base Address Register 0				10h
0x00000004				
Base Address Register 1				14h
0x00000000				
Base Address Register 2				18h
0xXXXXXXXX				
Base Address Register 3				1Ch
0xXXXXXXXX				
Base Address Register 4				20h
0xXXXXXXXX				
Base Address Register 5				24h
0xXXXXXXXX				
Cardbus CIS Pointer				28h
0xXXXXXXXX				

Figure 6.347: Saving Configuration Space File As: HTML

6.9.1 Tools → Import Configuration Space File

Import Configuration Space dialog can be launched from Tools menu after PCIe trace file is opened. See Figure 6.348.

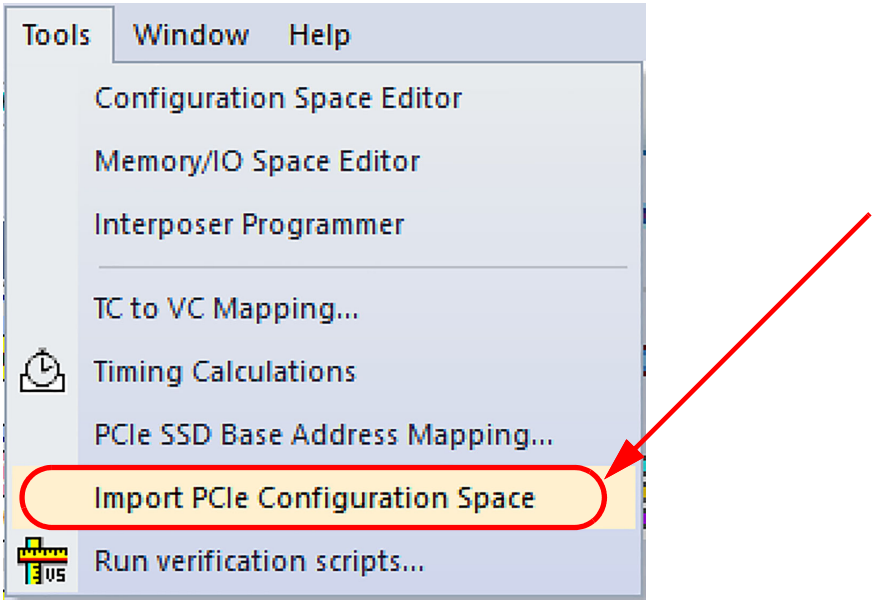


Figure 6.348: **Tools → Import PCIe Configuration Space**

The main purpose of importing a configuration space is to overwrite existing configuration space or to add configuration space information to a trace without it in order to help decoding.

Select Import PCIe Configuration Space and the following window pops up with previously saved Configuration Space files. See Figure 6.349.

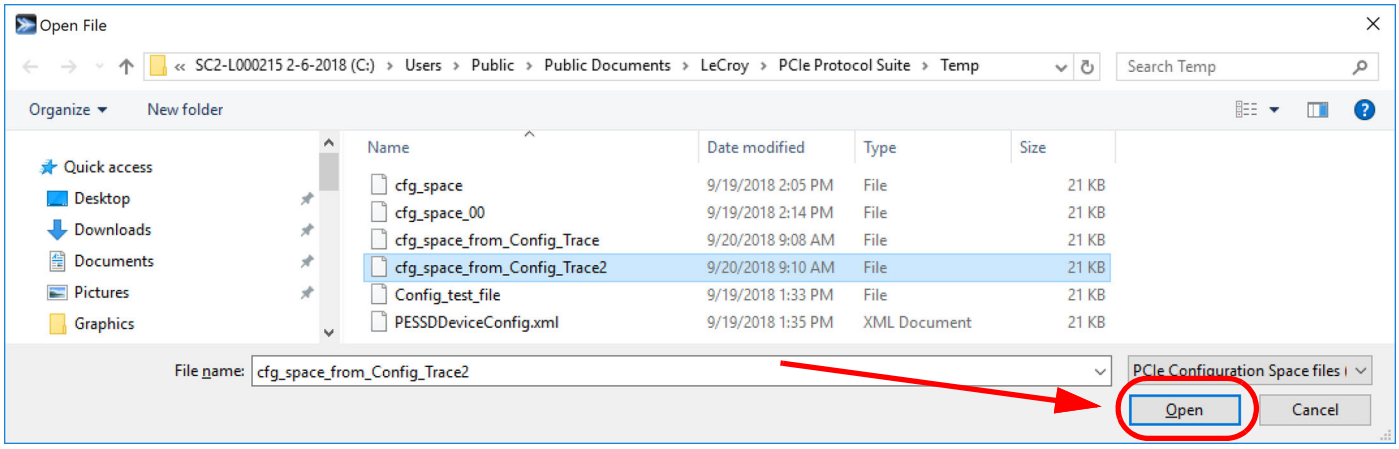


Figure 6.349: Saved Configuration Space files

Select **Open** and the Import PCIe Configuration Space dialog pops up. See Figure 6.350.

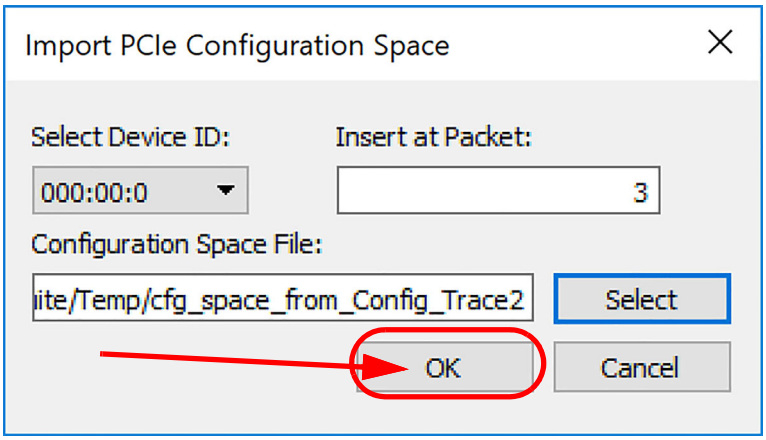


Figure 6.350: Import PCIe Configuration Space Dialog

In this dialog box you can select the following options:

- Device TD
- Insert at Packet
- Select the Configuration Space File you want to use

After making your choices, click on OK and the Configuration File will be inserted into the Trace you have open at the before the Packet you have chosen.

The next section shows how to edit a Configuration Space

6.9.2 Configuration Space Editor

The Configuration Space Editor allows you to create a new Configuration space file or open an existing Configuration Space file. It is used in conjunction with Teledyne LeCroy Trainer products. Select **Tools > Configuration Space Editor** to display the Configuration Space Editor dialog (see Figure 6.351 on page 536).

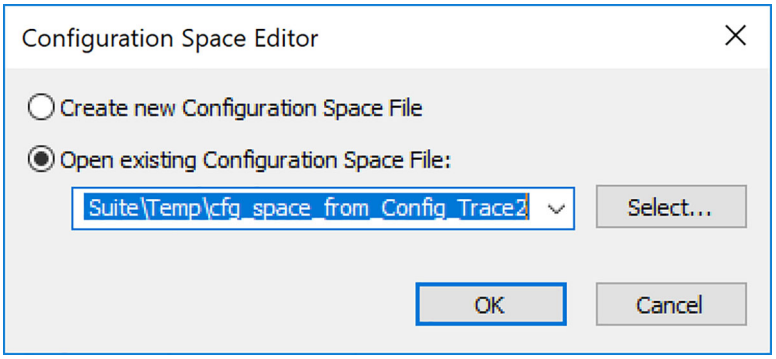


Figure 6.351: Configuration Space Editor Dialog

Click on **OK** and the Editor will popup and you can edit the Configuration Space file manually and then save it and import it. See Figure 6.352.

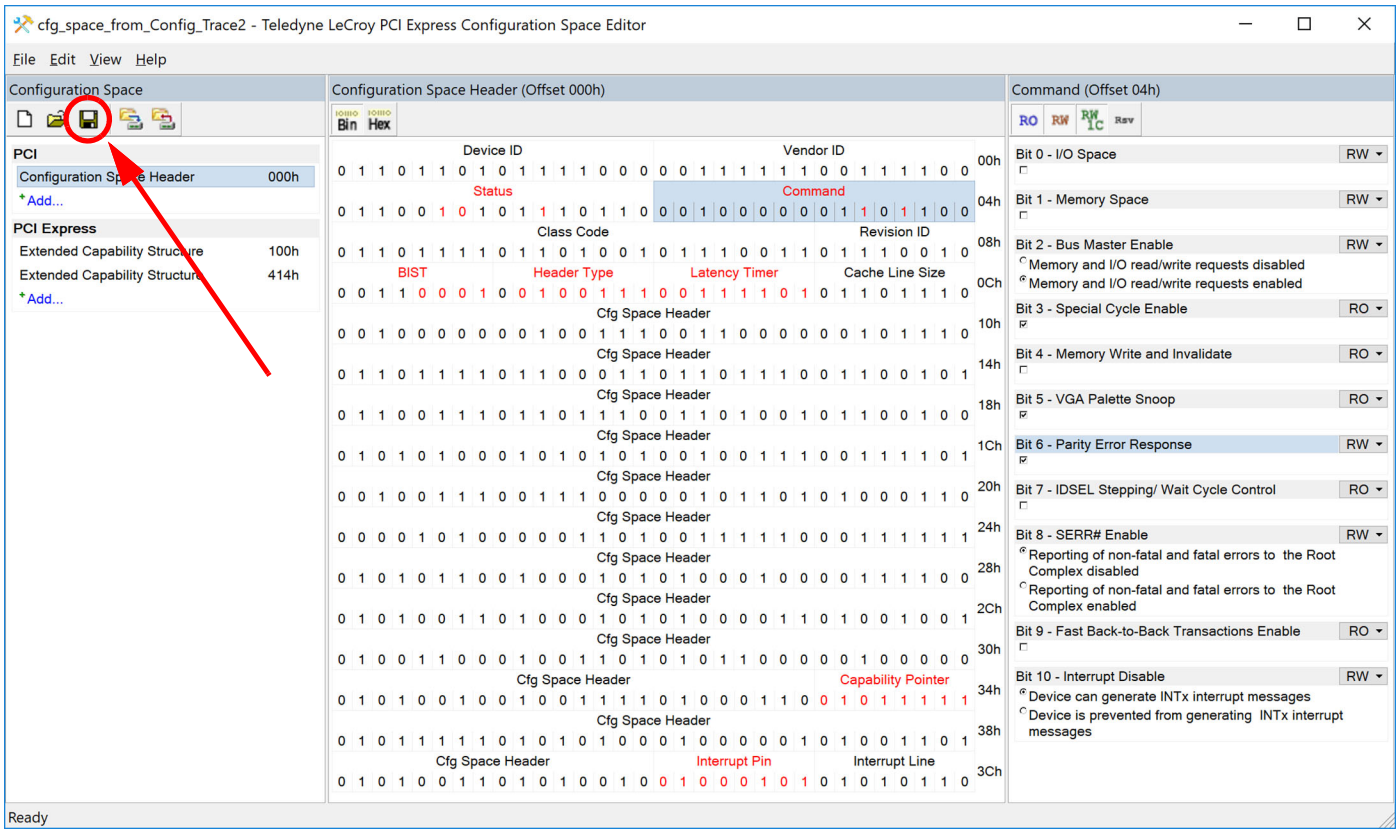


Figure 6.352: Configuration Space File: Example

Note: See "Configuration Space Decoding" on page 615 for details of the Configuration Space file.

6.9.2.1 Metrics Defined for Split Transactions

The following types of metrics currently are defined for Split transactions:

Number of Link Transactions: The total number of Link transactions that compose this Split transaction.

Payload: The number of payload bytes this Split transaction transferred.

Response Time: The time it took to transmit this Split transaction on the PE link, from the beginning of the first packet in the Split transaction to the end of the last packet in the Split transaction;

Data Throughput: The transaction payload divided by response time, expressed in megabytes (MB) per second (MB = 1024*1024 bytes).

Latency Time: The time measured from the end of the request transaction to the first completion transmitted in response to the request within this Split transaction.

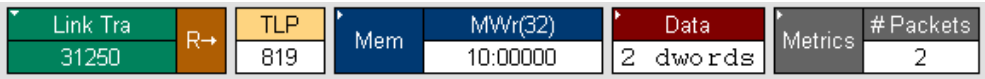
Note: The Number Of Link Transactions metric for a Split Transaction usually is two for a Configuration or IO request. It can be bigger then two for a Memory Read request.

6.9.3 Show Metrics in the CATC Trace Display

In the CATC Trace view display of Link Transaction or Split Transaction levels, all metrics information applicable to a specific protocol unit is displayed in a Metrics header. The header is located close to the end of the unit, in front of the Time cell. You can expand and collapse the header to show or hide the metrics information.

6.9.3.1 Collapsed Metrics Header Display

Following is a collapsed metrics display for a unit of Link Transaction. The collapsed header display shows only the metrics cell representing the Number of Packets.

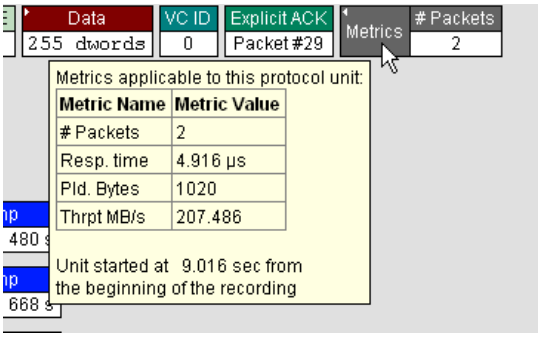


Following is a collapsed metrics display for a unit of Split Transaction. The collapsed header display shows only the metrics cell representing Number of Link Transactions.



6.9.3.2 Metrics Tool Tip Display

In both CATC Trace level views, you can view the summary of all the unit metrics in the Metrics header tool tip. To view the tool tip, simply place the mouse cursor over the Metrics header. Following is the tool tip for a unit in the Link Transaction view.



Note: The tool tip also presents information for time passed from the start of the recording till the beginning of this Link or Split Transaction.

6.9.3.3 Expanded Metrics Header Display

When you expand the Metrics header, the display creates a separate cell for each applicable metric:

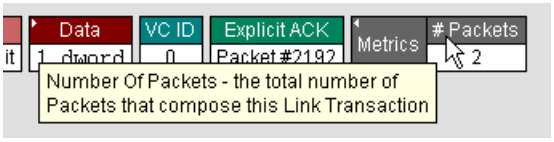
The following is the expanded Metric header for a unit in the Split Transaction view.

Metrics	# LinkTras	Resp. time	Latency	Thrpt MB/s	Pld. Bytes
	2	7.460 µs	6.736 µs	2.145	16

The following is the expanded Metric header for a unit in the Link Transaction view.

Metrics	# Packets	Resp. time	Pld. Bytes	Thrpt MB/s
	2	536.000 ns	64	119.403

Note: Each of the metric cells pops up a tool tip window with the explanation of what the metric means.

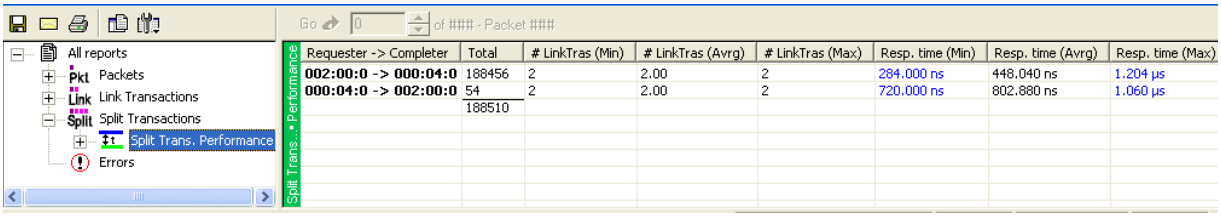


6.9.4 Show Metrics in the Traffic Summary Window

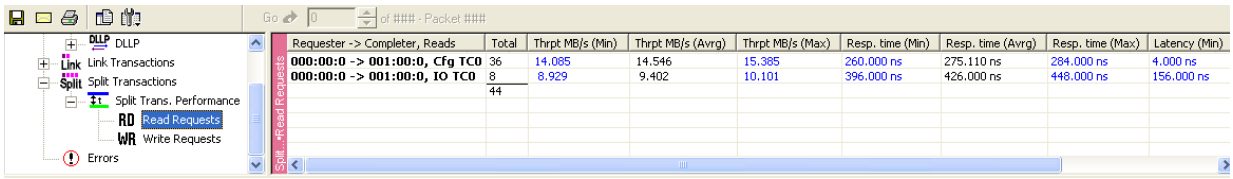
Some of the Traffic Summary reports at the Link and Split Transaction levels are based on metrics collected for the corresponding protocol units in the CATC Trace.

6.9.4.1 Reports at Split Transaction Level

Split Transaction Performance: This report table groups the Split Transactions by Requester-Completer pair and displays Minimum/Average/Maximum data for Number Of Link Transactions and Response Time metrics.

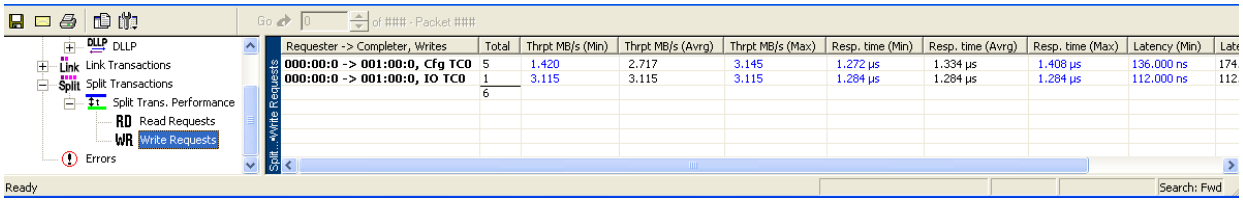


Read Requests Performance: This report table includes only the Split Transactions that present Read Requests (Configuration, IO and Memory). It groups them by the combination of Requester-Completer pair, request type, and Traffic Class and displays Minimum/Average/Maximum data for Throughput, Response Time, and Latency metrics (see the following figure).



Write Requests Performance: This report table includes only the Split Transactions that present Write Requests (Configuration and IO). It groups them by the combination of Requester-

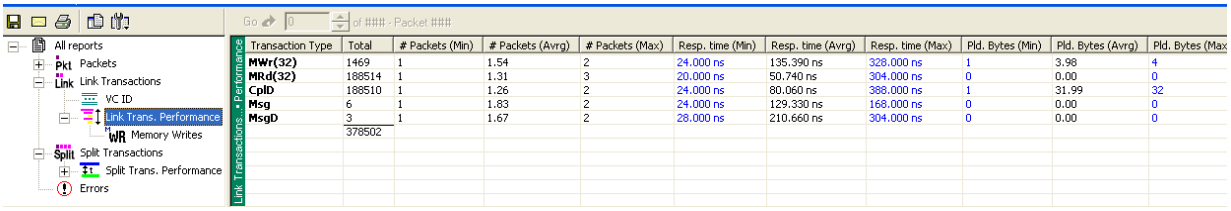
Completer pair, request type, and Traffic Class and displays Minimum/Average/Maximum data for Throughput, Response Time, and Latency metrics.



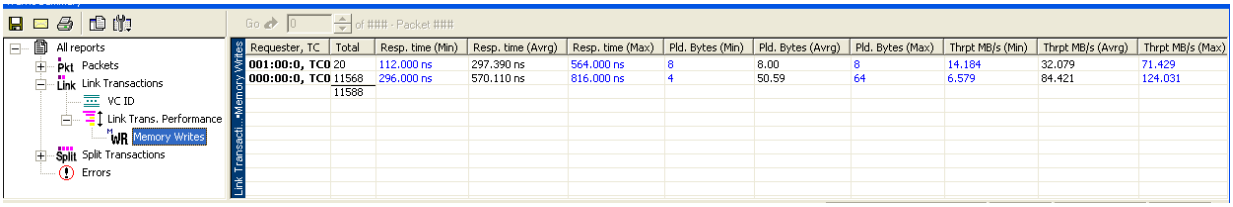
6.9.4.2 Reports at the Link Transaction Level

The following metric-based reports are displayed at the Link Transaction level:

Link Transaction Performance: This report table groups the Link Transactions by TLP Type and displays Minimum/Average/Maximum data for Number Of Packets, Response Time and Payload Bytes metrics.



Memory Writes: This report table includes only the Link Transactions that present Memory Write Requests. Memory Writes are the only (posted) requests that don't get promoted to the Split transaction level, therefore their performance should be viewed at the Link transaction level. The table groups Memory Writes by the combination of Requester ID and Traffic Class and displays Minimum/Average/Maximum data for Response Time, Payload and Throughput metrics.



The following features apply to all of the report tables described above for the Split Transaction and Link Transaction levels:

- Each report row for the defined tables contains the total number of units in this group for the CATC Trace (total number of units for Split Transaction performance, Read Requests performance, Memory Writes, and so on).
- In many cases, the Maximum and Minimum values in the report tables are navigable. By clicking table cells, you reposition the corresponding CATC Trace view to the Split or Link Transaction that has yielded this maximum or minimum value. This can help you to find specific units in the CATC Trace, such as transactions that produced spikes in Response Time or Throughput.

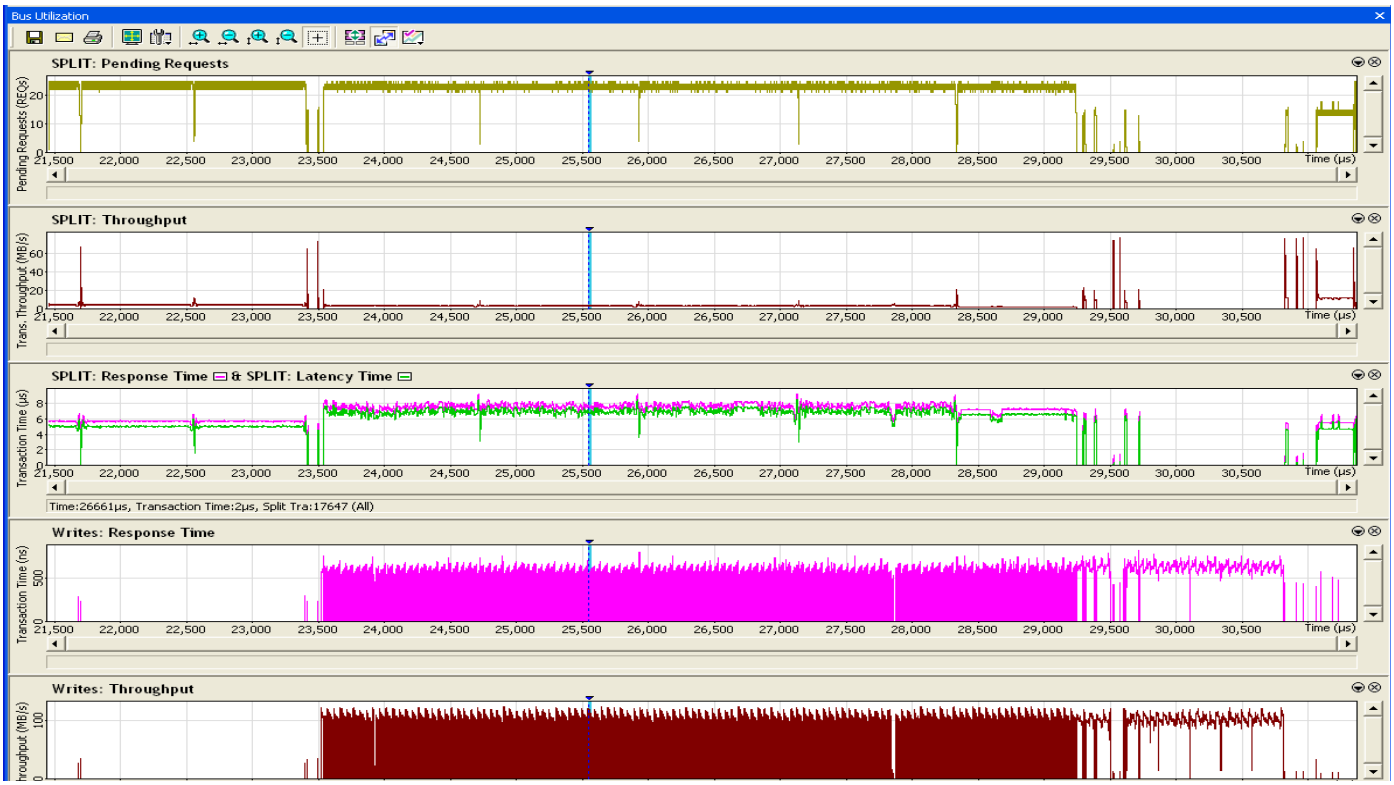
6.9.5 Show Metrics in the Bus Utilization Window

The Bus Utilization window provides graphs for packet-level information in the CATC Trace. The window also provides graphs for information on Split and Link Transaction levels, plotted over time. The graphs for Split and Link Transaction levels are based on metrics collected for the transactions throughout the CATC Trace.

The seven graphs related to Split and Transaction levels are:

1. Pending Requests at Split Transaction level.
2. Response Time at Split Transaction level.
3. Latency Time at Split Transaction level.
4. Throughput Per Transaction at Split Transaction level.
5. Response Time and Latency Time at Split Transaction level (combined graph).
6. Response Time at Link Transaction level, for Memory Writes only.
7. Throughput at Link Transaction level, for Memory Writes only.

The following is an example of Bus Utilization window display of graph numbers 1, 4, 5, 6 and 7 (see the following figure):



6.9.5.1 Unit-Based Averaging

The Analyzer builds metric graphs using unit-based averaging (as opposed to time-based averaging). For the total duration of a certain request (or Memory Write transaction), the graph value is assumed equal to the corresponding metric for this request (transaction). If there are overlapping operations for a certain time period, then the value is calculated as an average of metric values for all the overlapped requests (transactions).

It is important to remember that the Analyzer uses unit-based averaging rather than time-based averaging. Time-based averaging can be misleading in some situations. For example, consider the Throughput Per Transaction graph. Sometimes, while many outstanding requests are in progress, latency (and response time) grows for each of the transactions, resulting in a lower throughput per transaction over time (which is reflected in the graph). This happens even though aggregated throughput across all the transactions is constant.

6.9.5.2 Bus Utilization Window Features

For the seven Split- and Transaction-level graphs listed, all Bus Utilization window features are available, such as zooming in/out, changing scale type, scrolling, context-sensitive status, and graph synchronization. See Bus Utilization and Bus Utilization Buttons for more on these features.

Note: Clicking a certain place within a graph area repositions the CATC Trace display at the Link or Split transaction level to the transaction that was in progress at that time.

6.9.5.3 Split Transaction Level Graphs

Transactions at the Split level combine all the non-posted requests with corresponding completions. This includes Configuration and IO Read and Write requests, as well as Memory Read requests.

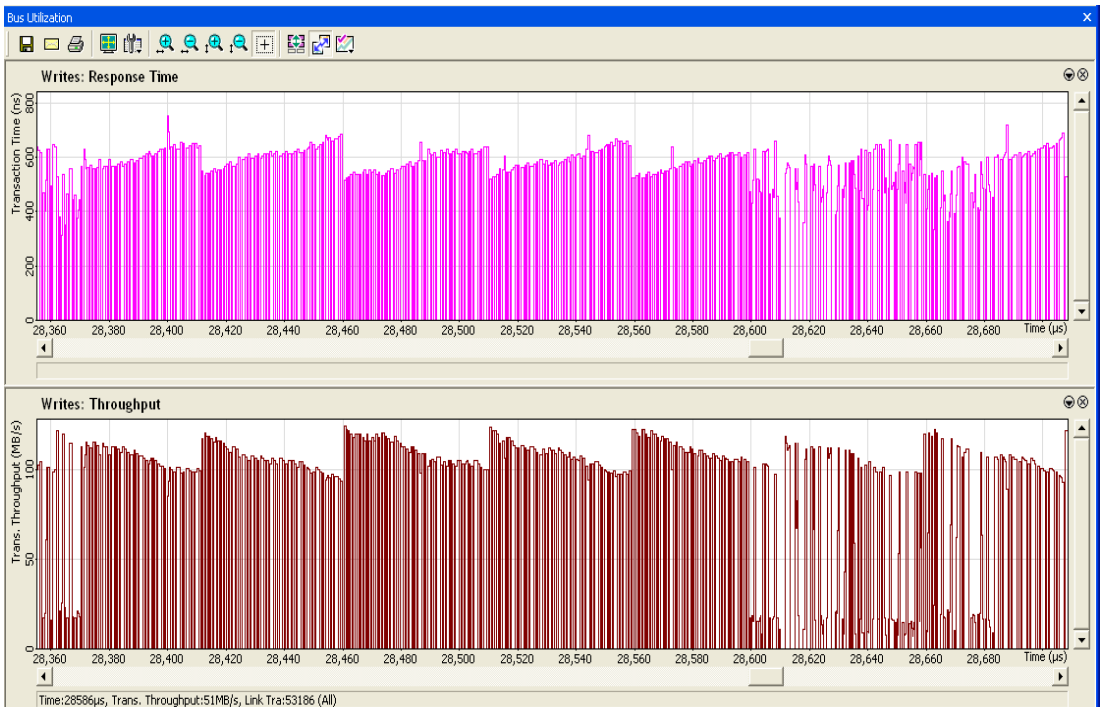
The following shows the graphs for the Split level:



Note: The Pending Requests graph is not directly defined by metrics, but it is useful when considering metrics. The Pending Requests graph presents the unit-averaged number of requests that were pending (in progress) at any moment of time. It allows you to correlate the number of requests posted to a completer with other performance metrics.

6.9.5.4 Link Transaction Level Graphs

Memory Writes are the only (posted) requests that do not get promoted to the Split transaction level. Therefore, Memory Write performance should be viewed at the Link Transaction level. That is the reason graphs at the Link level only present the Memory Write-related metrics and are titled **Writes: Response Time:** and **Writes: Throughput** (see the following figure).



6.9.6 Real-Time Statistics Window

The Real-Time Statistics Window displays Link Utilization, performance measurements, and statistical values for a PCI Express link plotted in real time.

Click 

to open the Real-Time Statistics window (see Figure 6.351 on page 536).

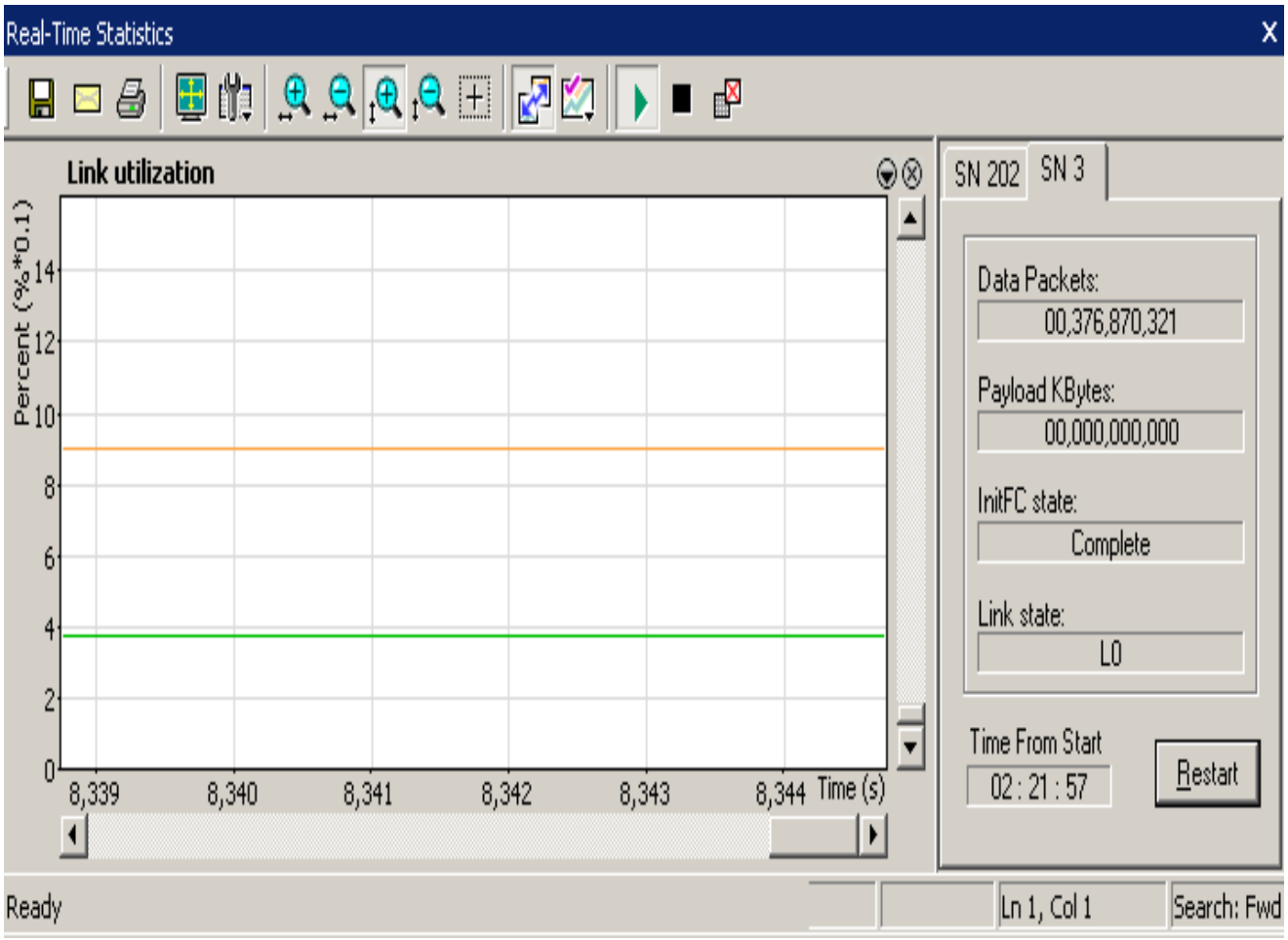


Figure 6.353: Real-Time Statistics Dialog

Start **PCI Express™** link activity.

To start the monitor, press  .

To stop the monitor, press  .

The remaining Real-Time Statistics buttons provide options for changing the format of the display.

Additional formatting options are available through the Real-Time Statistics pop-up menu and the Real-Time Statistics toolbar.

6.9.6.1 Real-Time Statistics Buttons

Additional formatting options are available through the Real-Time Statistics toolbar.

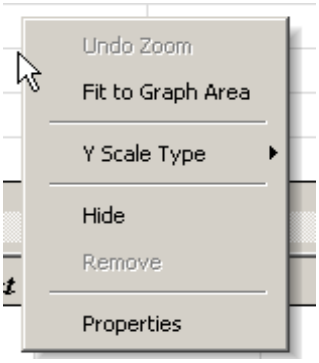


Button	Function
	Save. Saves Real-Time Statistics data to bitmap file (*.bmp).
	Email. Opens an email and attaches a bitmap file of the Real-Time Statistics data.
	Print. Prints the Real-Time Statistics data.
	Full Screen. Maximizes the Real-Time Statistics window.
	Synchronize Views.Synchronize the current view with other open views.
	View Settings. Opens a sub-menu with the following choices: • Orient Horizontally • Tile Vertically • Show Markers • Show Plumbline • Status >> • Bar • Tool tips • None • Grid Lines >> • Both Axes • X Axis • Y Axis • No Grid • Grid on Top • Fonts & Colors
	Horizontal zoom in
	Horizontal zoom out
	Vertical zoom in
	Vertical zoom out
	Click and Drag Zoom. Click and drag to zoom in on a part of the graph.

	Synchronize Graph Areas. If two or more graphs are displayed, this button synchronizes the graphs to one another. Once synchronized, the positioning slider of one graph moves the other graphs.
	Graph Areas. Allows you to hide or display the graphs and the counters. You can toggle Statistics Accumulation, Link Utilization, Data Payload Throughput, and Data Packet Count.
	Start real-time statistics. Starts the real-time statistical monitor.
	Stop real-time statistics. Stops the real-time statistical monitor.
	Reset Graphs. Resets the graphs.

6.9.6.2 Real-Time Statistical Monitor Pop-up Menu

Additional formatting options are available through the Real-Time Statistics pop-up menu. Right-click a graph in the Real-Time Statistical Monitor window to display a pop-up menu with options for changing the format of the display.



Undo Zoom: If you have zoomed in, this command undoes the zoom.

Fit to Graph Area: Redisplays graph so that the entire CATC Trace fits inside graph area.

Y Scale Type:

- **Linear**: Converts display to linear format.
- **Logarithmic**: Converts display to logarithmic format.

Hide: Hides the selected graph

Properties: Opens a dialog box with options for changing the Title, Appearance, and Color of the graph.

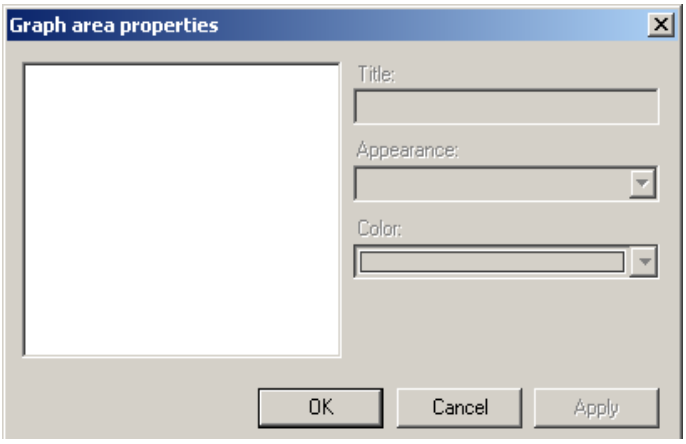


Figure 6.354: Graph Area Properties Display

6.9.6.3 Real-Time Statistics Graph Areas

The Real-time Statistics window has three graph areas:

- Link Utilization
- Data Payload Throughput

Data Packet Count

Each graph area has Upstream and Downstream graphs for a device (if connected to a host machine), plus as many graphs as Exerciser devices connected to the host machine.

The Statistics Accumulation area shows the PCIe Protocol Analysis statistics tab, plus as many tabs as Exerciser devices connected (see Figure 6.355 on page 548):

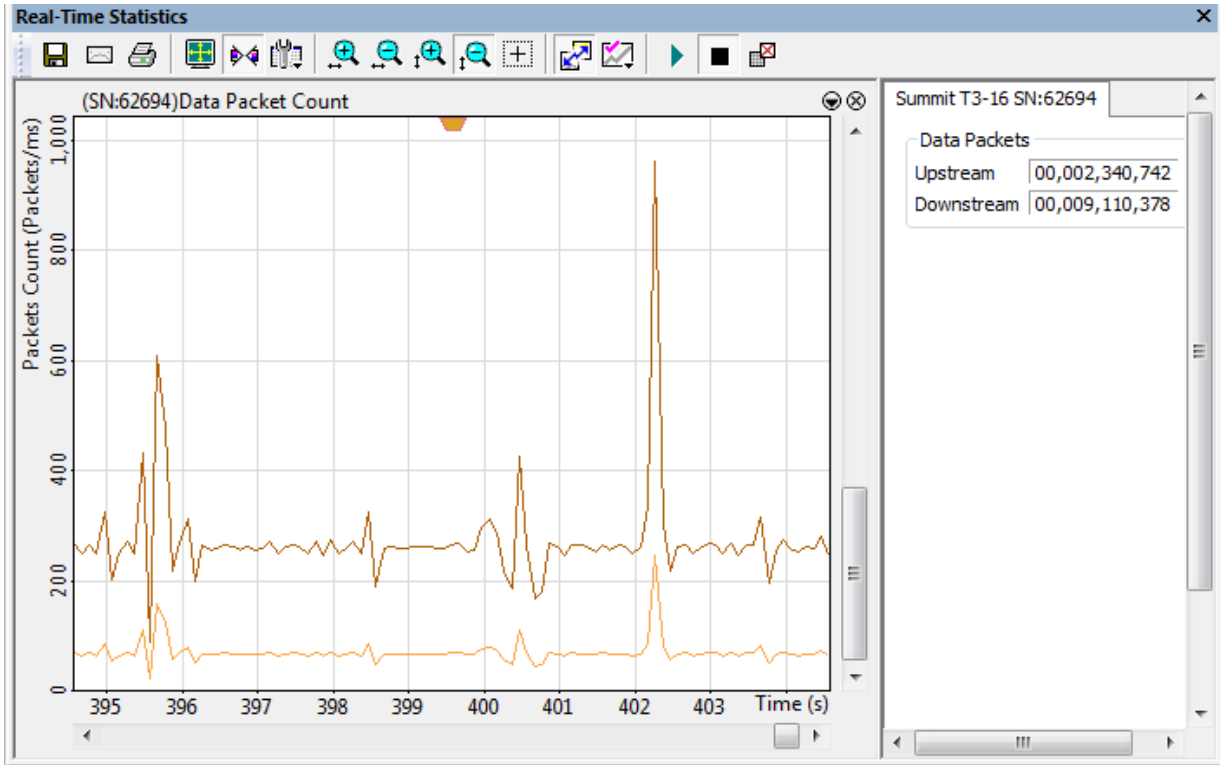


Figure 6.355: Real-Time Statistics Graph Display

For each Exerciser device, the following information is displayed:

- Number of data packets
- Payload size
- **InitFC complete status**: Yes/No
- **Link State**: Possible states are:
  - DETECT_QUIET
  - DETECT_ACTIVE
  - POLLING_ACTIVE
  - POLLING_CONFIG
  - CONFIG_LINKWIDTH_START
  - CONFIG_LINKWIDTH_ACCEPT
  - CONFIG_LANENUM_WAIT
  - CONFIG_LANENUM_ACCEPT
  - CONFIG_COMPLETE
  - CONFIG_IDLE
  - L0
  - L0S_IDLE
  - L0S_FTS
  - L1
  - RECOVERY_RCVRLOCK
  - RECOVERY_RCVRCFG
  - RECOVERY_IDLE
  - HOT_RESET
  - DISABLED

6.9.7 Memory I/O Space Editor

The Memory I/O Space Editor allows you to create a new Memory I/O Space file or open an existing Memory I/O Space file. It is used in conjunction with Teledyne LeCroy Trainer products. Select **Tools > Memory I/O Space Editor** to display the Memory Space Editor dialog.

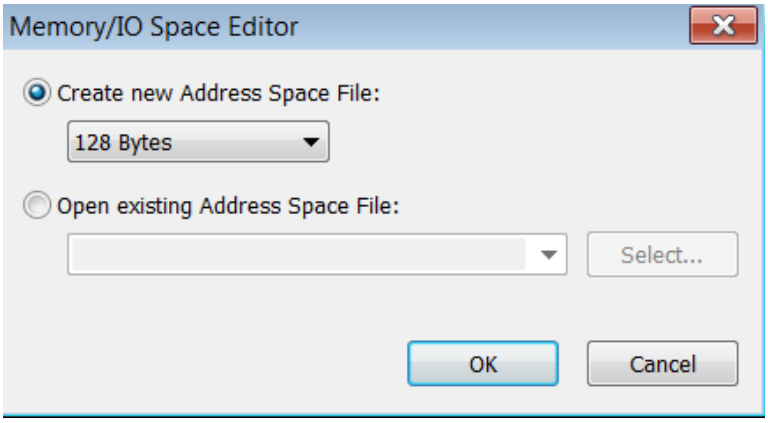


Figure 6.356: Memory I/O Space Editor Dialog

6.9.8 TC to VC Mapping

Select **Tools > TC to VC Mapping** displays how Traffic Classes are mapped to Virtual Channels (to simplify navigation) and how the CATC Trace display was changed (for example, in Split Transactions).

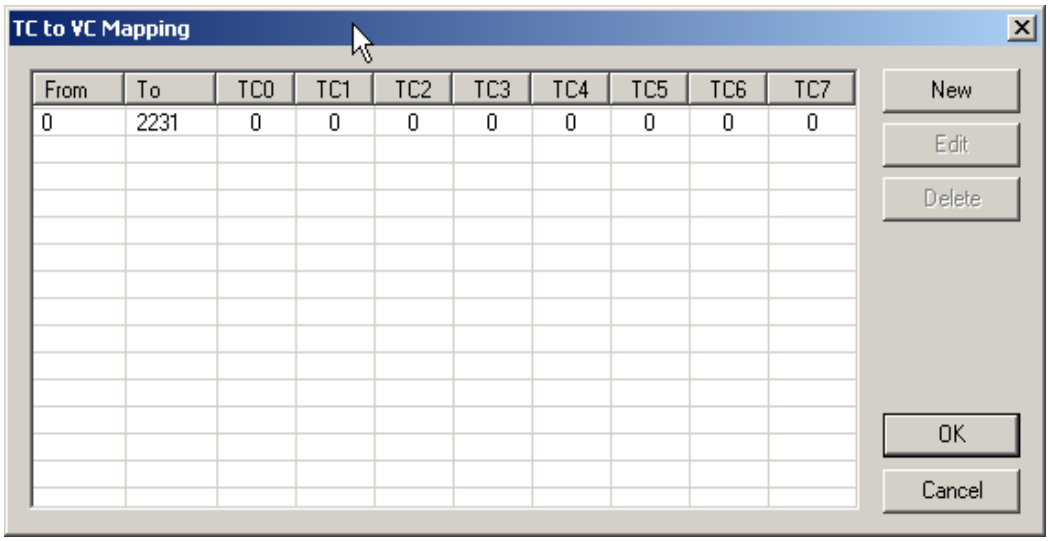


Figure 6.357: TC to VC Mapping Dialog

6.9.9 Timing and Bus Usage Calculations

6.9.9.1 Timing Calculator

Select **Tools > Timing Calculations** to obtain the Timing Calculator dialog.

The Timing and Bus Usage Calculator calculates PCIe timings, Queue Utilization and Total Input / Output. You can decide how much of a Trace you want analyzed. You can select the segment of the Trace you want analyzed by Packet (beginning to ending), Markers (chosen from the drop down) or Time (in seconds or clocks).

In this first case, we have an NVMe Trace loaded and are looking at the entire trace from the beginning of Packet 0 to the end of Packet 1714903. See Figure 6.358.

PCIe Timing Information: Entire Trace

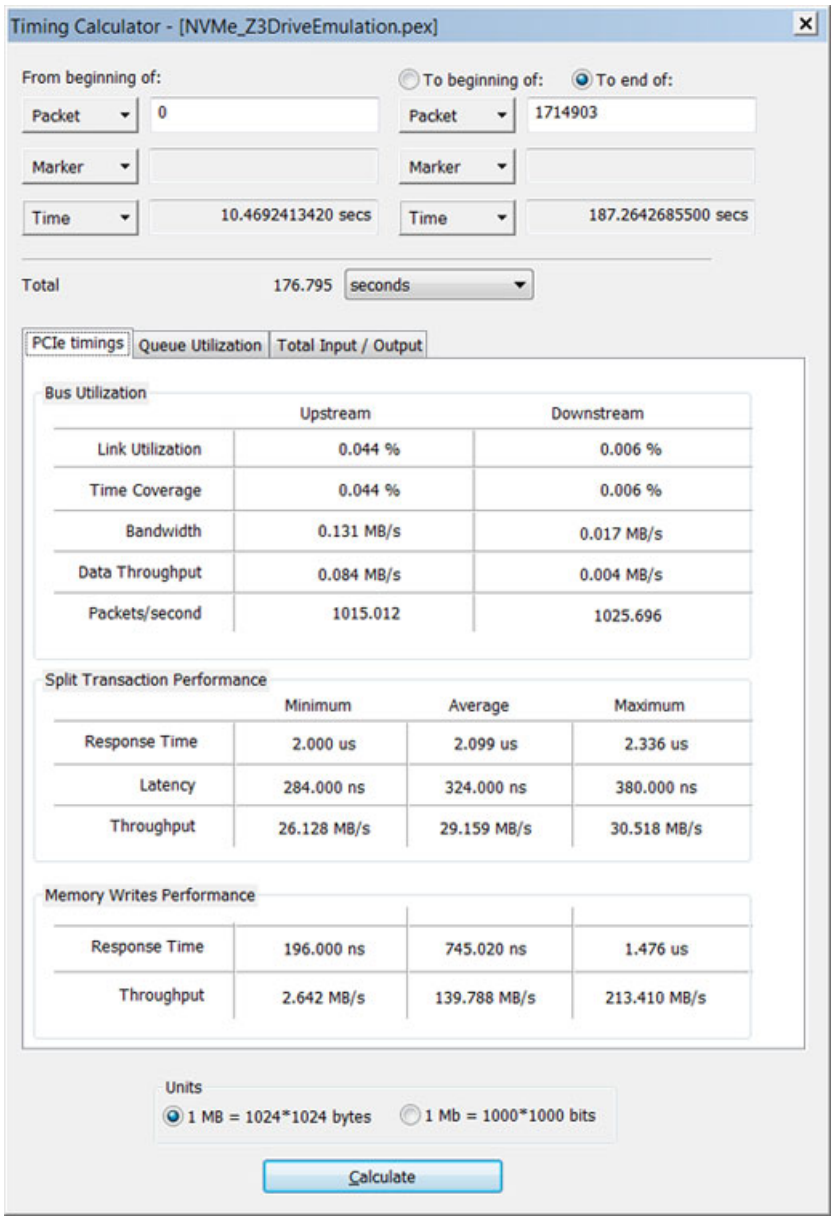


Figure 6.358: Timing Calculator for Entire Trace

The major portions of the PCIe Timings are discussed below:

Bus Utilization

This portion of the Timing Calculator window gives values that are cumulative for all packets during the timing period. For example, throughput is combined throughput of all packets during the timing period.

Upstream is from endpoint devices to the root complex. Downstream is from the root complex to endpoint devices.

Link Utilization: Percentage of non-idle symbols in total number of symbols transferred.

Time Coverage: Percentage of non-idle symbol times in total number of symbol times. (Non-idle symbol time occurs when at least on one of the lanes there were non-idle symbols transferred.)

Bandwidth: Number of non-idle symbol bits transferred per second.

Data Throughput: Number of TLP payload bytes transferred per second, expressed in MB per second (MB = 1024*1024 bytes).

Packets/second: Number of packets transferred per second.

Split Transaction Performance

This portion of the Timing Calculator window gives minimum, maximum, and average values for all Split transactions during the timing period. For example, minimum throughput is throughput of the Split transaction that passes the least amount of data. Maximum throughput is throughput of the Split transaction that passes the most amount of data. Average throughput is the average calculated for all Split transactions during the timing period.

Response Time: The time it took to transmit this Split transaction on the PE link, from the beginning of the first packet in the Split transaction to the end of the last packet in the Split transaction.

Latency: The time measured from the end of the request transaction to the first completion transmitted in response to the request within this Split transaction.

Throughput: The transaction payload divided by response time, expressed in megabytes per second, expressed in MB per second (MB = 1024*1024 bytes).

Memory Writes Performance

This portion of the Timing Calculator window gives minimum, maximum, and average values for all Memory Write transactions during the timing period. For example, minimum throughput is throughput of the Memory Write transaction that passes the least amount of data. Maximum throughput is throughput of the Memory Write transaction that passes the most amount of data. Average throughput is the average calculated for all Memory Write transactions during the timing period.

Response Time: The time it took to transmit this Memory Write on the PE link, from the beginning of the first packet in the Memory Write to the end of the last packet in the Memory Write.

Throughput: The Memory Write payload divided by response time, expressed in megabytes (MB) per second (MB = 1024*1024 bytes).

The Timing Calculator also has tabs for Queue Utilization and Total Input/Output. For the entire Trace the results are displayed below:

Queue Utilization

The Queue Utilization tool allows you to visualize the traffic on the submission queues (SQ) and command queues (CQ) within a time interval. The default interval is the entire trace. The graph is generated using the Calculate button at the bottom of the dialog (see Figure 6.359) below.



Figure 6.359: Timing Calculator: Queue Utilization

Total Input/Output

The Total Input / Output has two sections:

- Link/Split Total Traffic
- NVMe Command Total Traffic

See Figure 6.360 on page 553

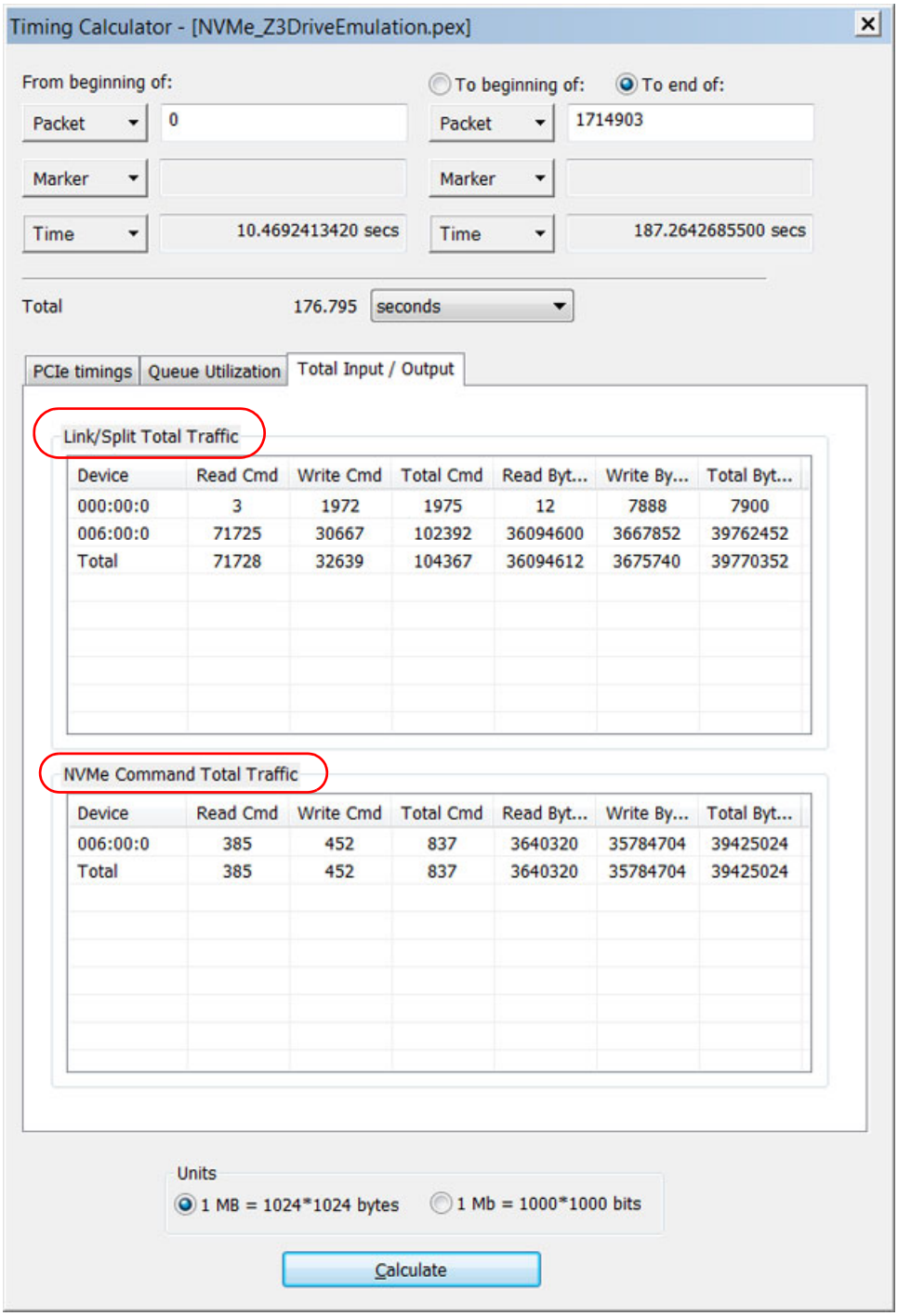


Figure 6.360: Timing Calculator: Total Input / Output

Timing Calculator Display in MB

The Timing Calculator can display data in megabytes or megabits by selecting the appropriate button and hitting the Calculate button (see Figure 6.361 and Figure 6.362).

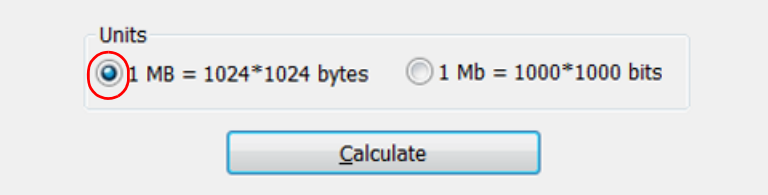


Figure 6.361: Timing Calculator: Calculator Timing Results Displayed in Bytes

Timing Calculator Display in Mb

To view the results in megabits select Mb in the button below and hit the Calculate button.

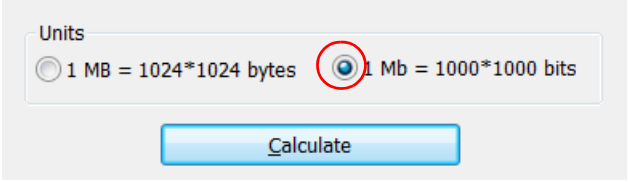


Figure 6.362: Timing Calculator: Display Results in Mb

The results are displayed in both MB and Mb format in Figure 6.363.

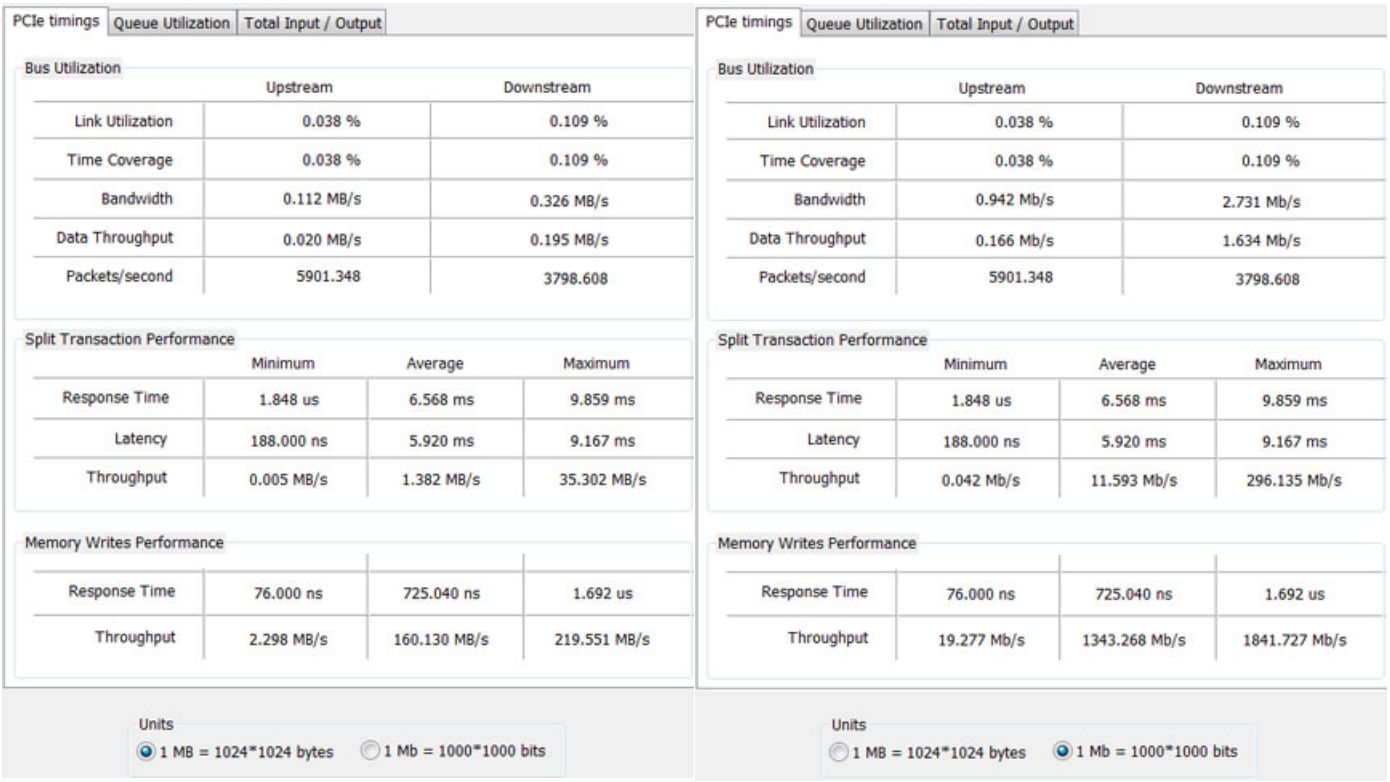


Figure 6.363: Timing Calculator: PCIe Timing Displayed in MB and Mb

6.9.9.2 Details of Timing Calculations

Timing From Beginning of Event to Beginning of Event or to End of Event

The Timing Calculator can calculate trace timing from the beginning of an event to either the beginning of another event or to the end of another event. See Figure 6.364.

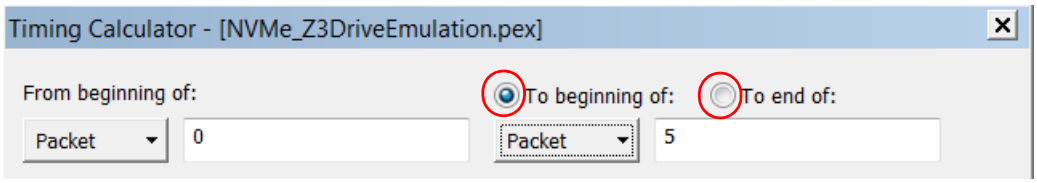


Figure 6.364: Timing Calculator: Beginning of Event to Beginning of Event or to End of Event

Types of Events

The Timing Calculator can also be used to look at specific events in more detail and has a variety of commands to help you parse the entire trace into segments of interest. The Timing Calculator can look at just Packets, Link Transactions, Split Transactions, NVMe Transactions or NVMe Commands. In this case, we have chosen NVMe Commands to explore in detail. See Figure 6.365.

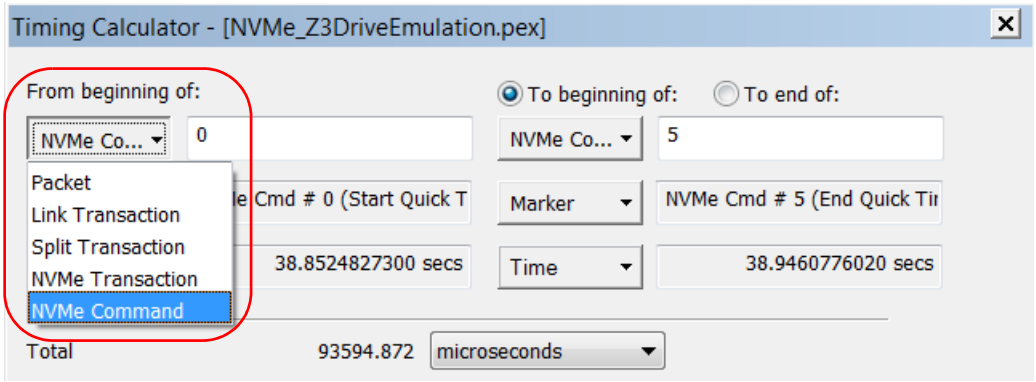


Figure 6.365: Timing Calculator: Types of Events

Displaying Time

The time can be displayed in nanoseconds, microseconds, milliseconds and seconds. See Figure 6.366 on page 556.

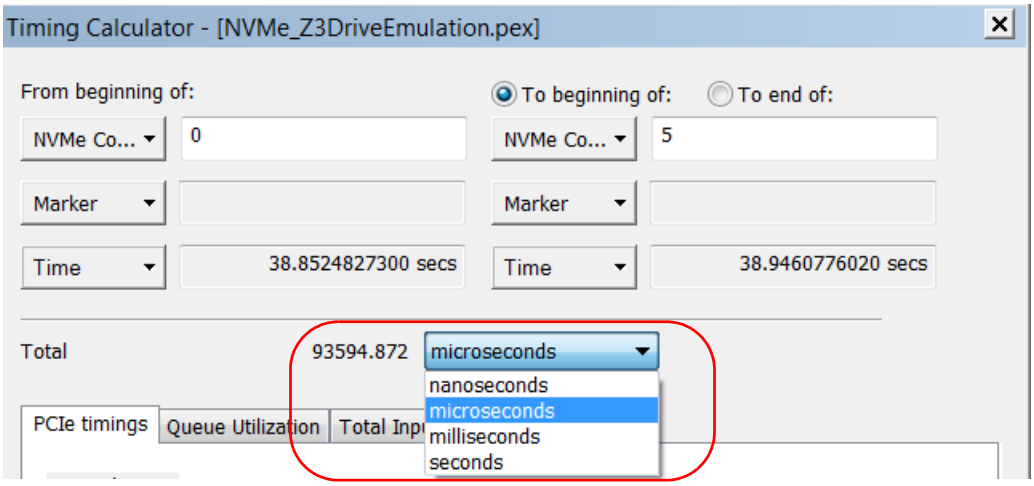


Figure 6.366: Timing Calculator: Timing Units

Markers

If Markers were set, they would be visible in the Marker pull-down (see Figure 6.367).

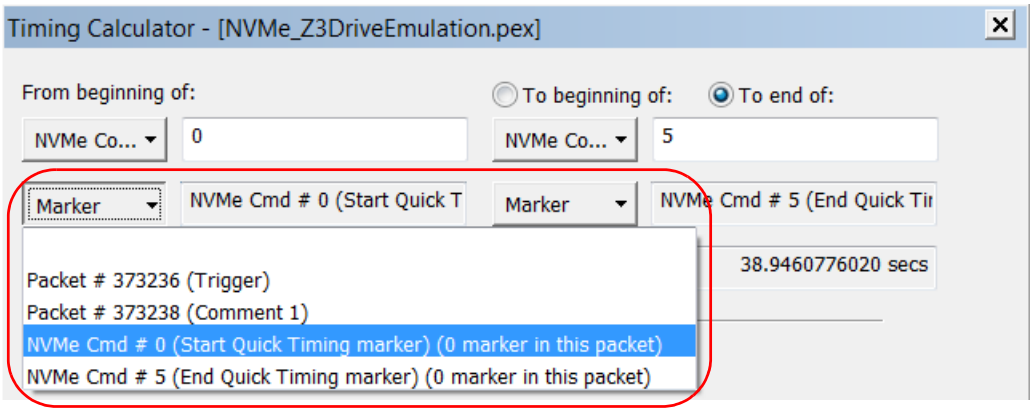


Figure 6.367: Timing Calculator: Markers Set

If the Trigger and Comment 1 Markers were chosen, the Timing Calculator would come up with the following results: see Figure 6.368 on page 557. As you can see from the results, the markers were only two packets apart.

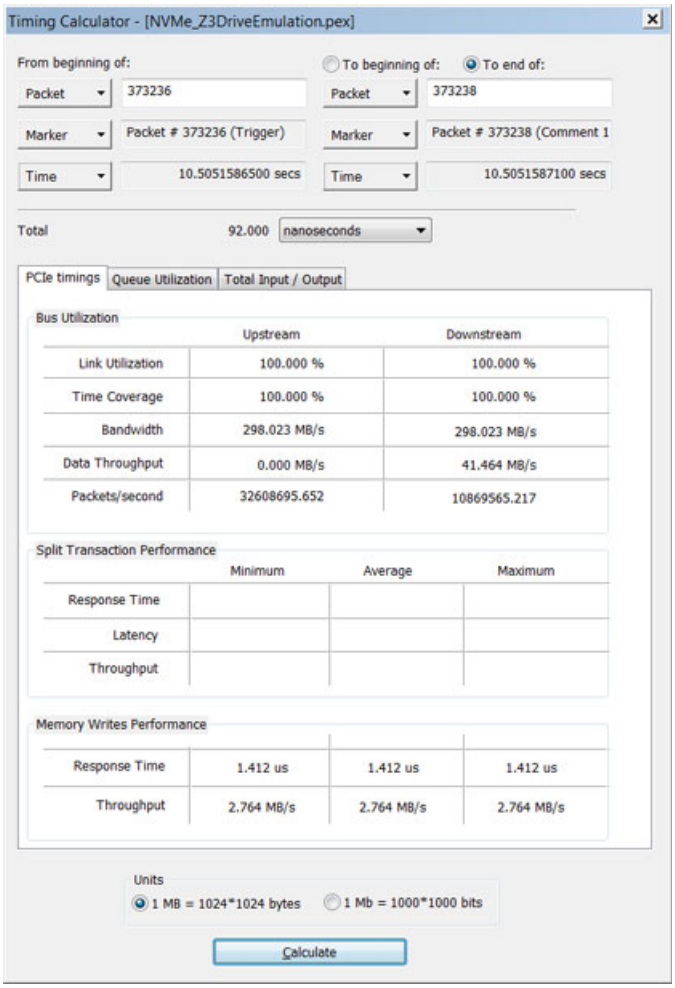


Figure 6.368: Timing Calculator: Results Between Markers

Timing To Beginning of NVMe Command

If NVMe Commands are selected the tool calculates timing information from the beginning of NVMe Command 0 to the beginning of NVMe Command 5. You can see that Total time is 93594.872 microseconds. See Figure 6.369.

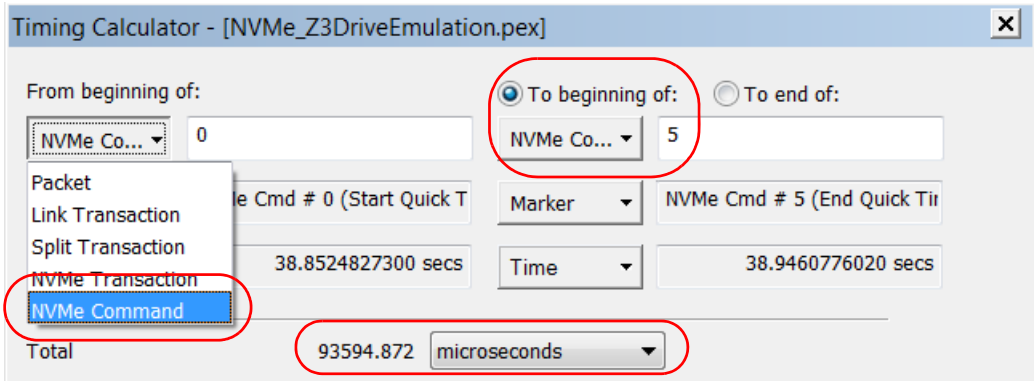


Figure 6.369: Timing Calculator: Selections for Timing Calculations

Timing To End of NVMe Command

If we had chosen to calculate the timing parameters “To end of”: NVMe Command 5, the Total time would have included the NVMe Command 5 and the Total time is 93594.968 microseconds. See Figure 6.370 on page 558.

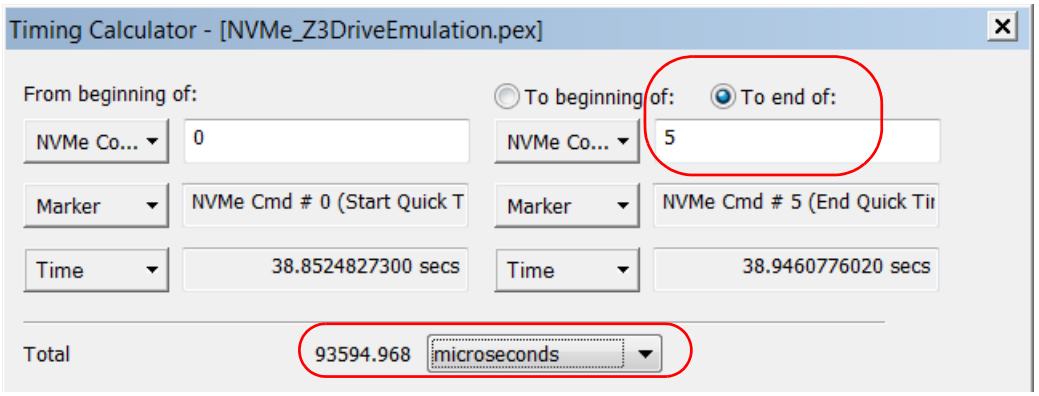


Figure 6.370: Timing Calculator: To end of NVMe Command 5

Results from Timing Calculator

The differences between the Timing Calculator results from the beginning of NVMe Command 0 to the beginning of NVMe Command 5 and to the end of NVMe Command 5 can be seen in Figure 6.371.

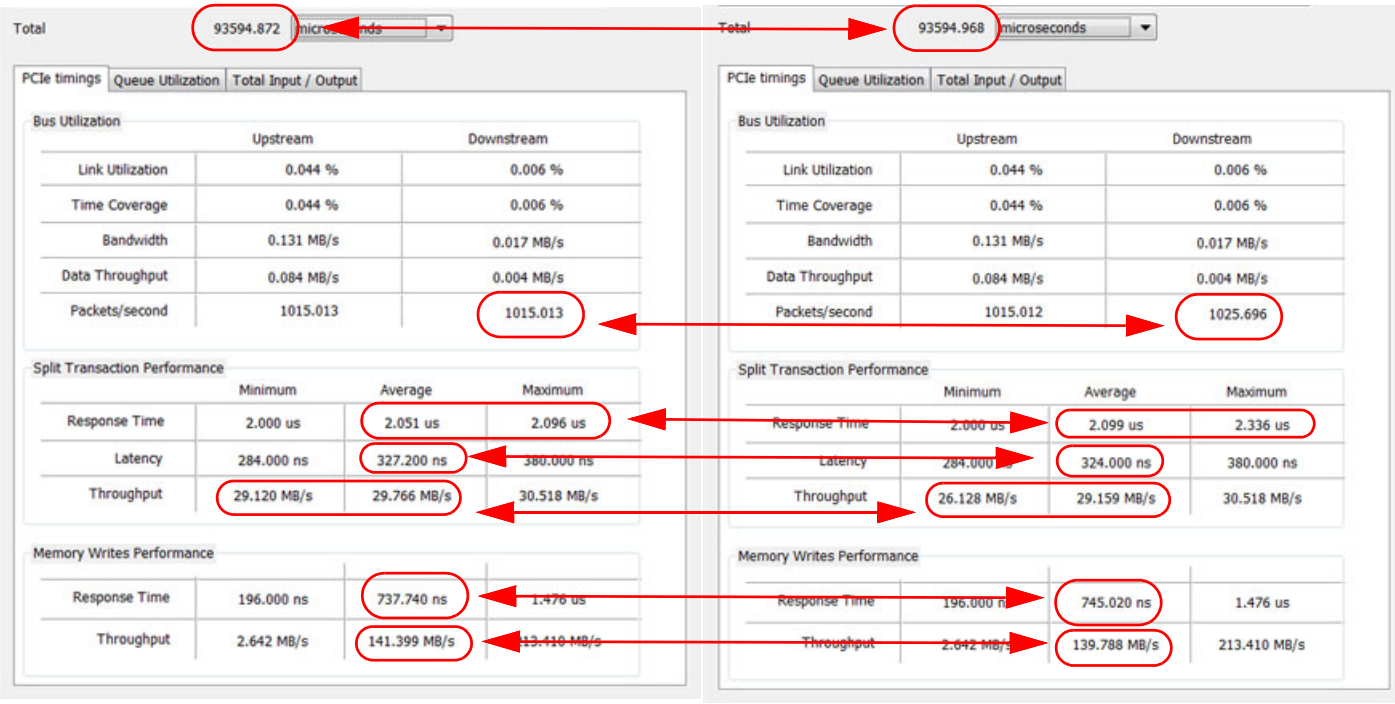


Figure 6.371: Timing Calculator: Beginning of NVMe Cmd 5 and Ending of NVMe Cmd 5 (MB)

Most of the results are the same except for Total time, Downstream Packets/second, Split Transaction Performance (Response Time, Latency and Throughput) and Memory Write Performance (Response Time: Average and Throughput: Average).

Timing to Beginning and End of Events: Effect on Queue Utilization

If we look at the differences between the Queue Utilization from the beginning of NVMe Command 0 to the Beginning of NVMe Command 5 and to the Ending of NVMe Command 5 you'll see one more NVMe Command in the Queue. See Figure 6.372.

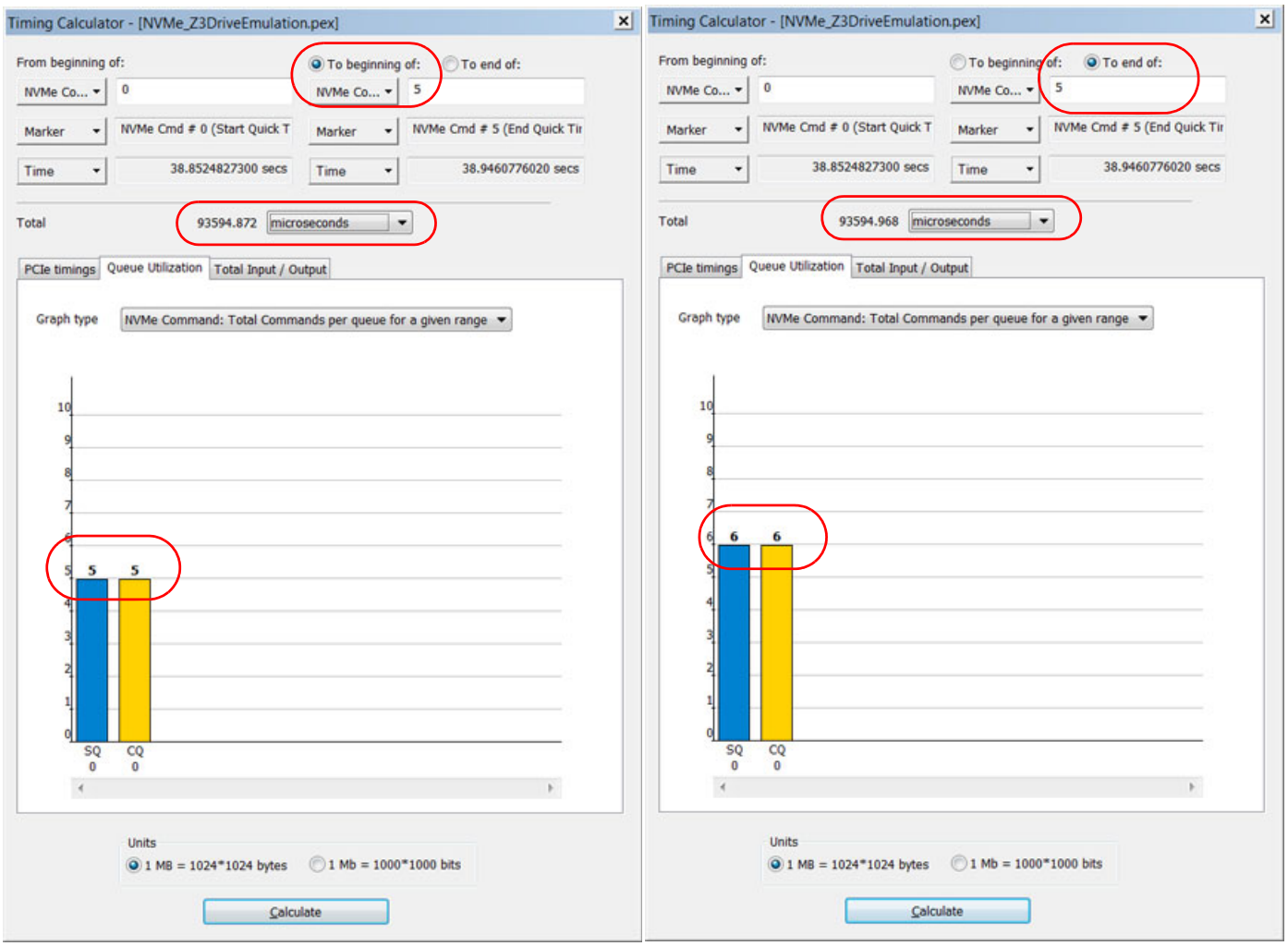


Figure 6.372: Timing Calculator: Queue Utilization

Timing to Beginning and End of Events: Effect on Total Input / Output

If we look at the differences between the Total Input / Output graphs from the beginning of NVMe Command 0 to the Beginning of NVMe Command 5 and Ending of NVMe Command 5 you'll see one more Write Command. See Figure 6.373.

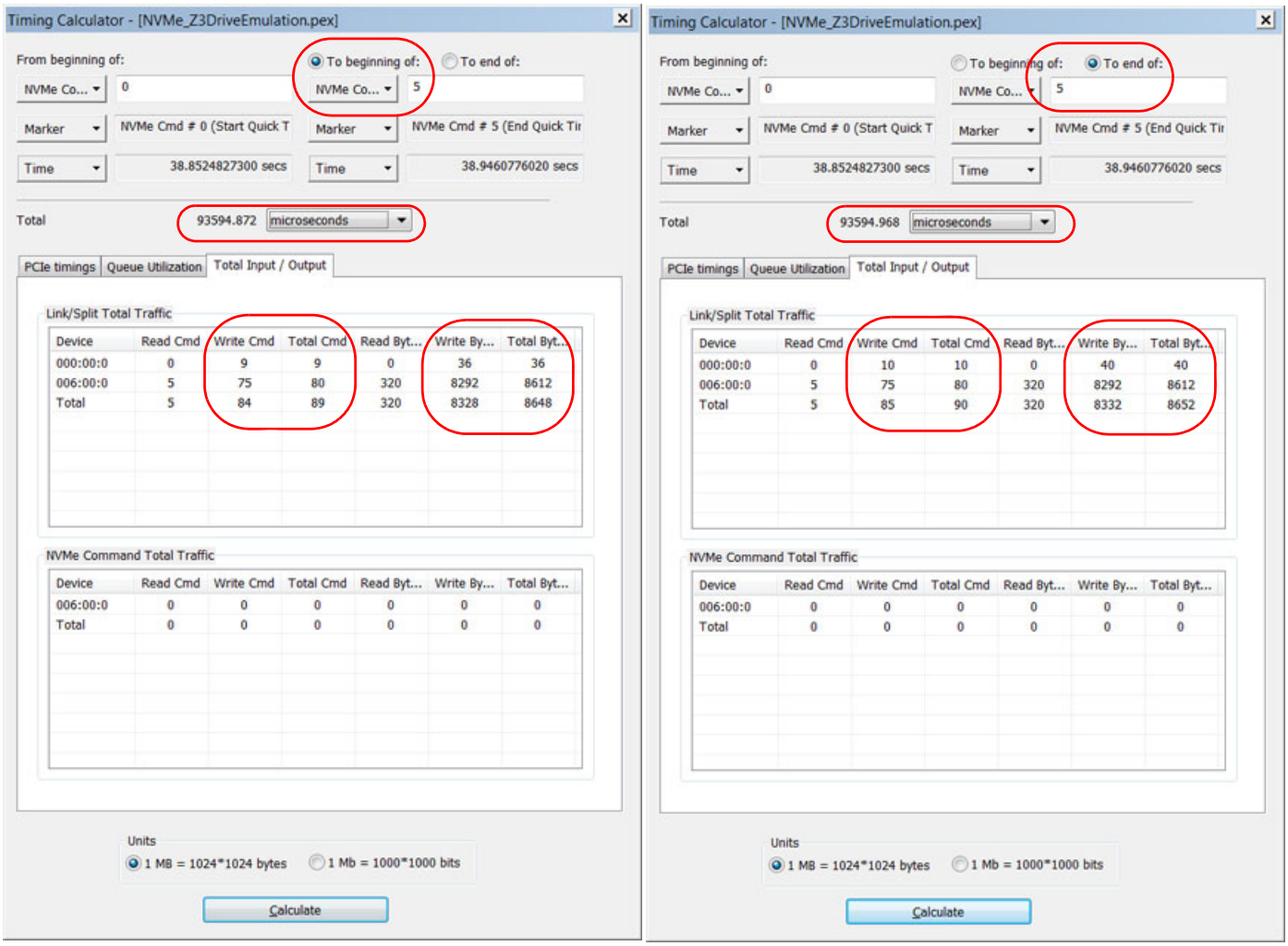


Figure 6.373: Timing Calculator: Differences in Total Input / Output

The two displays show that including NVMe Command 5 adds one more Write Command and it's associated number of bytes.

6.9.10 PCIe SSD Base Address Mapping

In order for NVMe, PQI, AHCI, ATA, SOP and SCSI decoding to work correctly, the PCIe Protocol Analysis needs to know the Memory Base Address of the device.

If the Base Address assignment is not present in the trace, you can specify the values manually using this dialog. You need to select the type of the device (NVMe, PQI, AHCI, ATA, SOP or SCSI) and set the value of the Base Address by selecting **Tools > PCIe SSD Base Address Mapping.** See Figure 6.374.

6.9.11 Base Address Not Record in Trace

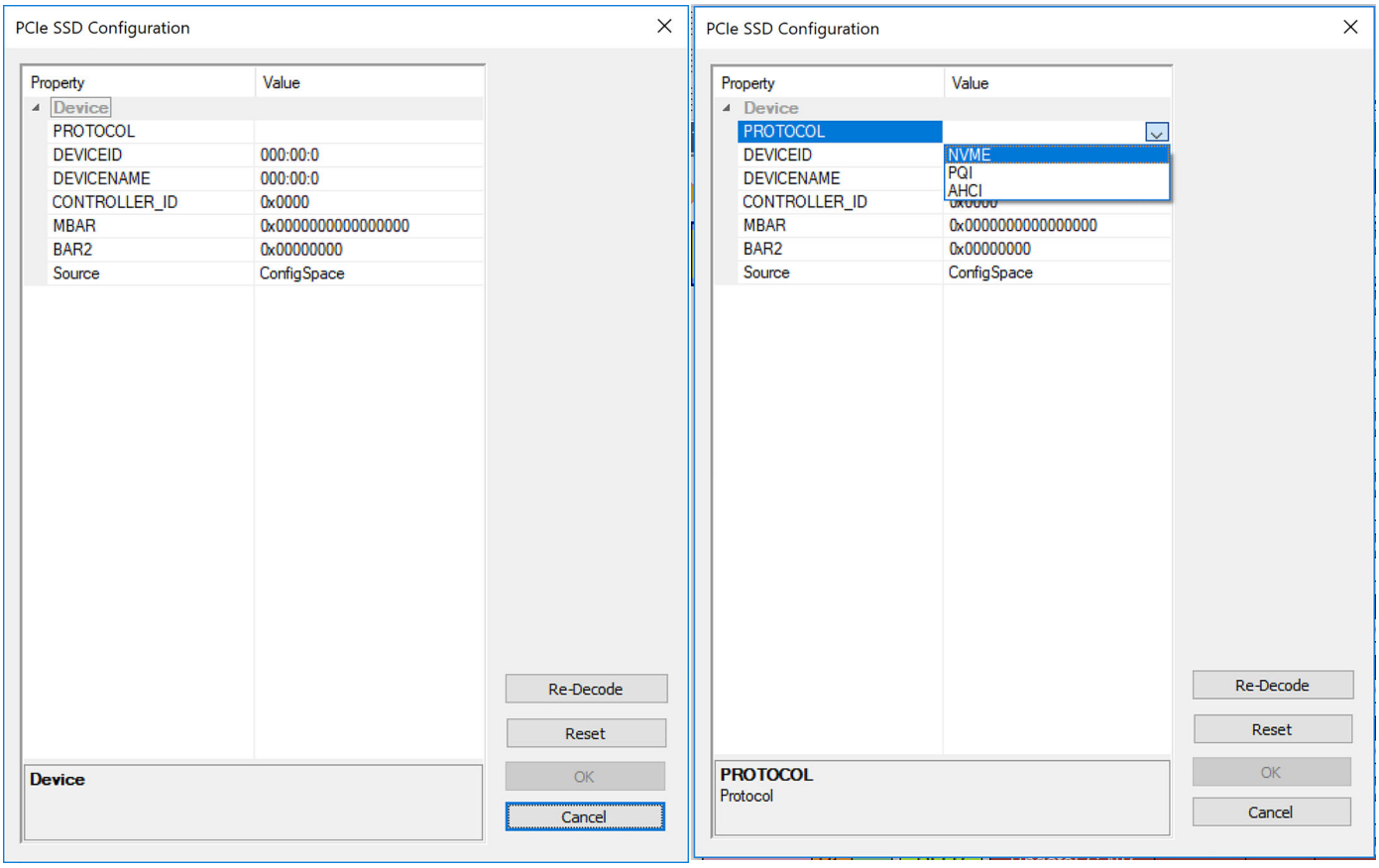


Figure 6.374: Trace without Protocol Type Specified

You must select the type of trace your recorded. In this case we selected NVME and the PCIe SSD Configuration dialog box is fully populated with all the NVME. See Figure 6.375 on page 562.

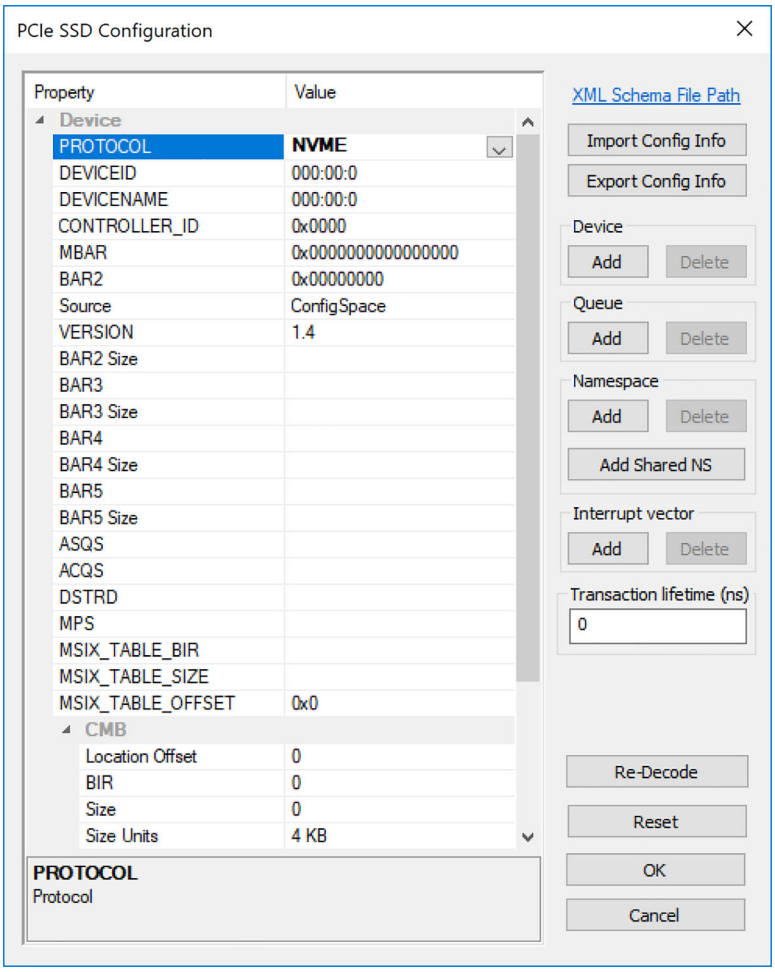


Figure 6.375: PCIe SSD Configuration dialog box populated with NVME options

6.9.12 Base Address Recorded in Trace

In cases when Base Address assignment is recorded in the trace, the software will determine all the values automatically. I. The PCIe SSD Configuration dialog displays (see Figure 6.376 on page 565).

Note: From software release 6.63 onwards, users are able to decode NVMe/PQI traces which are lacking configuration space and administration information, from release 6.70 this is applicable to AHCI traces, from release 7.00 this is applicable to ATA traces and from release 7.10 this is applicable to SOP and SCSI traces.

Note: From software release 7.30 onwards, multiple NVMe devices can be decoded from the same trace.

Note: From software release 7.34 onwards, the SSD Dialog displays the Device Name as read in the configuration accesses.

Note: From software release 7.38 onwards, while the SSD Dialog is open, the Trace View is scrollable.

Follow the steps below to perform the applicable storage decoding:

1. Record the trace for NVMe, PQI, AHCI, ATA, SOP or SCSI device boot and decode it.

   This saves the configuration space and administration information in .xml format, which is used to decode traces that do not include configuration and administration commands.
2. Record the trace of the same NVMe, PQI, AHCI, ATA SOP or SCSI device without rebooting and the application will decode it.

You can keep recording and decoding until rebooting. On reboot repeat steps 1 and 2 above.

6.9.12.1 NVMe PCIe SSD Device Configuration

The PCIe SSD Configuration dialog is used to add missing information to decode the trace without the configuration space and queue administration information. See Figure 6.376 on page 565 for NVMe PCIe SSD Device Configuration.

Prior to decoding, if all the required information is available in Configuration Space then the Source field in the PCIe SSD Configuration will be set to "Config Space" (see Figure 6.376 on page 565). The description for important fields and buttons are given below:

1. DEVICE ID: Represents the device ID in the bus/device/function address from the PCIe specification (ID Based routing).
2. DEVICENAME: Device Name
3. MBAR: The MBAR field in this dialog is required and editable. Make sure that the information entered is correct. Click on any field and the description displays in the bottom read-only box. The 64-bit main address bar (i.e. BAR1:BAR0). Without this value decoding cannot be done. It should be in "0x" hex format.
4. BAR2:
5. PROTOCOL: Displays the current storage protocol decoded.
6. ASQS: Defines the size of the Admin Submission Queue in entries. Refer to the controller registers section of the NVMe specification. The minimum size of the Admin Submission Queue is two entries. The maximum size of the Admin Submission Queue is 4096 entries. This is a 0’s based value.
7. ACQS: Defines the size of the Admin Completion Queue in entries. Refer to the controller registers section of the NVMe specification. The minimum size of the Admin Completion Queue is two entries. The maximum size of the Admin Completion Queue is 4096 entries. This is a 0’s based value.
8. DSTRD: This register indicates the stride between doorbell registers. The stride is specified in bytes. This may be used to separate doorbells by a number of bytes in memory space. It may be useful in software emulation of an NVMe Express controller. For hardware implementations of NVMe Express, the expected doorbell stride value is 4.
9. LBASIZE: Size for Logical Block Addressing.

10. MPS: This field indicates the host memory page in bytes.
11. IOCQES: I/O Completion Queue Entry Size. This field defines the I/O Completion Queue entry size that is used for the selected I/O Command Set. The required and maximum values for this field are specified in the Identify Controller data structure for each I/O Command Set. The value is in bytes and is specified as a power of two (2^n).
12. IOSQES: I/O Submission Queue Entry Size. This field defines the I/O Submission Queue entry size that is used for the selected I/O Command Set. The required and maximum values for this field are specified in the Identify Controller data structure for each I/O Command Set. The value is in bytes and is specified as a power of two (2^n).
13. MQES: Maximum Queue Entries Supported. Defines the maximum individual queue size that the controller supports. This is a 0's based value. The minimum value is 1h, indicating two entries.
14. Source: Source of the data.
15. Queues: Under this node the user can add more missing nodes to decode the current trace. Click the **Add Queue** or **Delete Queue** button to add or delete a queue node. Type based on the user selection.
16. XML Schema File Path: Selecting this link pops up a window with the location of the XML Schema File. It is also available in TechBrief_Use_of_NVMe_xml_schema.pdf in the installation AppNotes\ directory (or installation DVD).
17. Import Config Info: Click to Import configuration information.
18. Export Config Info: Click to Export configuration information.
19. Add Device/Delete Device: Click to add/delete device (NVMe/PQI only).
20. Add Queue/Delete Queue: Click to add/delete queue (NVMe/PQI only).
21. Add Namespace/Delete Namespace: Click to add/delete a new namespace if this information is not present in a trace file (NVMe/PQI only).
22. Interrupt Vector: Add/Delete an Interrupt Vector to a selected Device (see "Interrupts" on page 566).
23. Re-Decode: Click to re-decode.
24. Reset: Click to reset.
25. OK: Click to accept the settings.
26. Cancel: Click to cancel the settings.

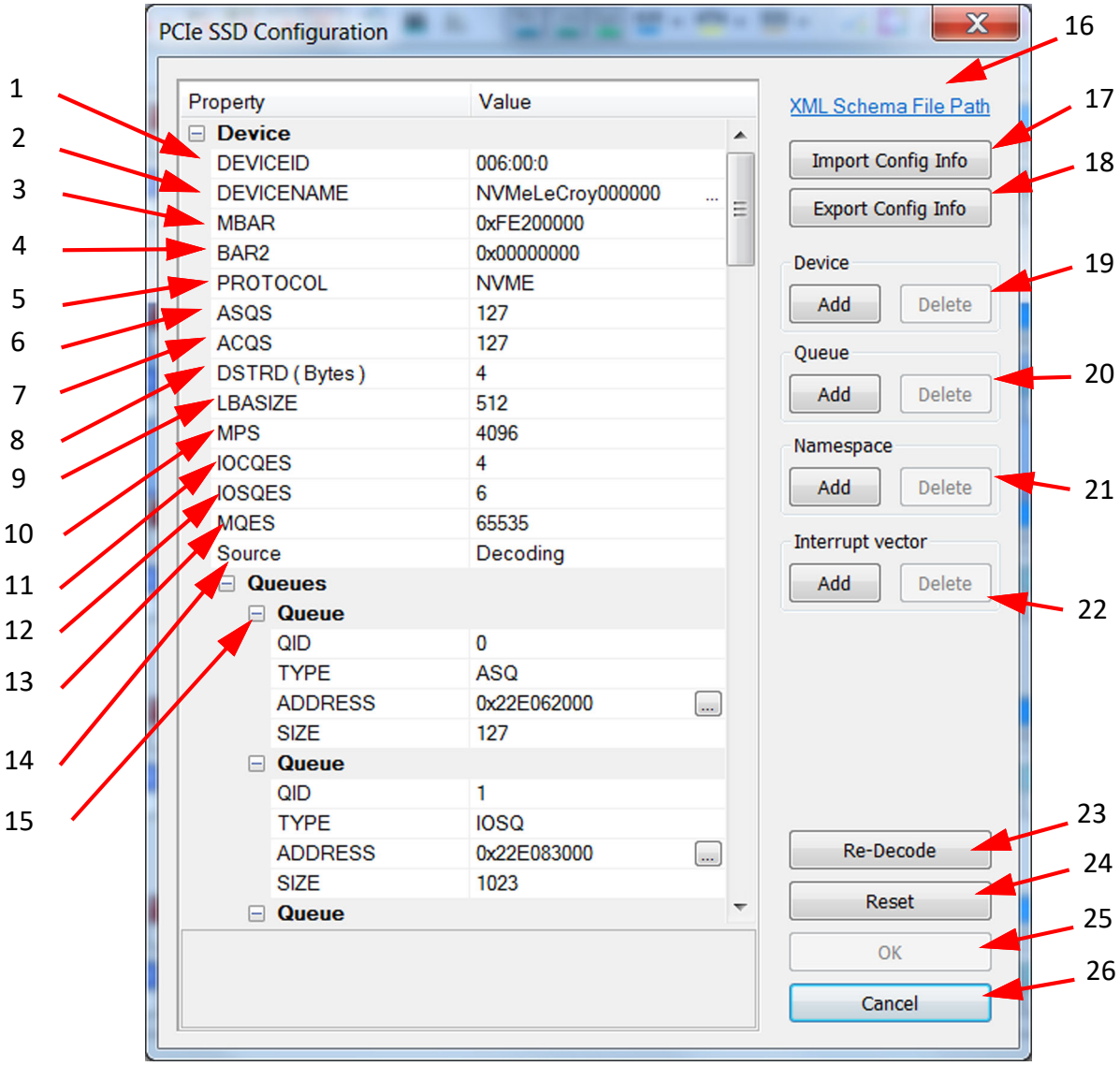


Figure 6.376: PCIe SSD Configuration Dialog Pre-decoding

Select any of the options in the NVM drop down menu item to decode the trace and select **Tools > PCIe SSD Base Address Mapping** (see Figure 6.378).

Note: When opening a trace file created with 7.0X or older versions of PCIe Protocol Analysis, these new fields are not present and the application tries to export the configuration information to XML before decoding NVMe transaction level. In this case a message box will show claiming that a value for this field is required.

Note: In case of problems when opening older traces try the following: a) Decode NVMe transaction level before exporting XML file. This will apply the default value for the new fields and export can be performed. b) Manually enter the values for the new fields. c) In case the trace contains submission entries which are not decoded, add a new Queue and set the corresponding address in the PCIe SSD Configuration dialog.

Interrupts

MSI and MSI-x interrupts are decoded at configuration time and include the vector offset and address. These values can be added/deleted/modified by the user to add data that may not have been captured in the trace.

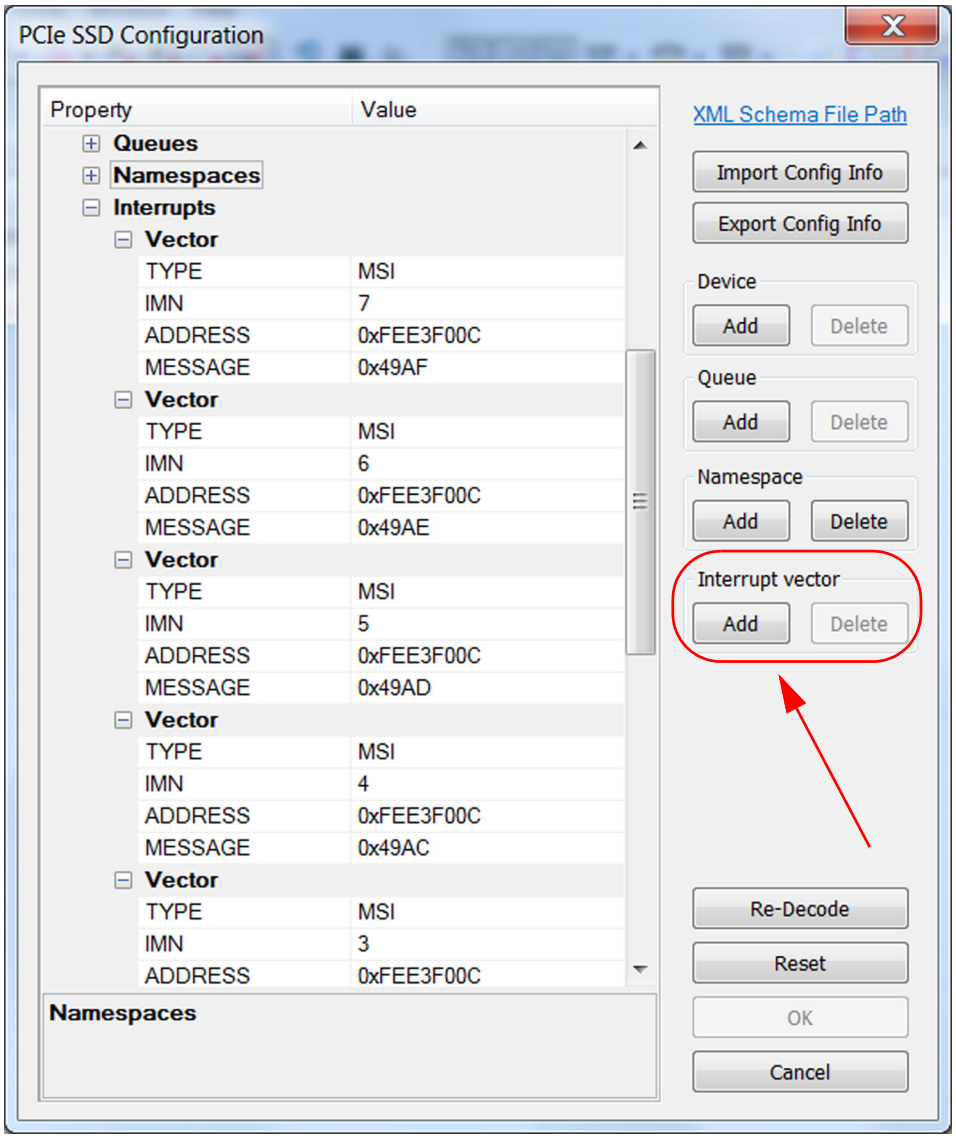


Figure 6.377: MSI and MSI-x Interrupts

6.9.12.2 AHCI PCIe SSD Device Configuration

The PCIe SSD Configuration dialog is used to add missing information to decode the trace without the configuration space and queue administration information. See Figure 6.378 for AHCI PCIe SSD Device Configuration.

Prior to decoding if every thing is available in Configuration Space then Source equals Config Space (see Figure 6.378).

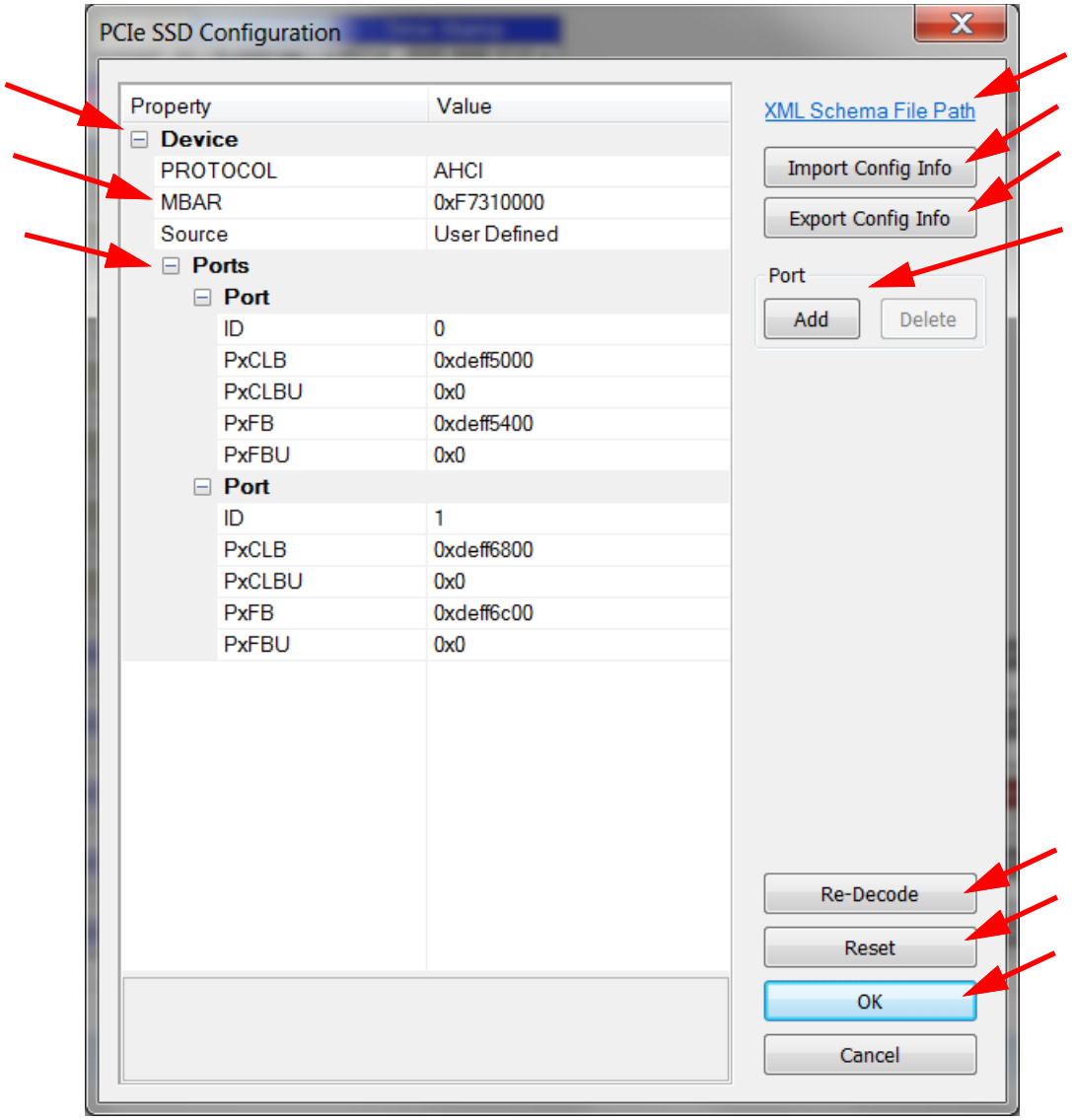


Figure 6.378: AHCI PCIe SSD Configuration Dialog

The MBAR field in this dialog is required and editable. Make sure that the information entered is correct. Click on any field and the description displays in the bottom read-only box (see Figure 6.380 on page 570). Some important fields are described below:

- Device: There is only one device node, (support for multiple device trace decoding will be available in a later release).
- MBAR: The 64-bit main address bar (i.e. BAR1:BAR0). Without this value decod-

ing cannot be done. It should be in "0x" hex format.

- Ports: Under this node the user can add more missing nodes to decode the current trace. Click the **Add Port** or **Delete Port** button to add or delete a port node. Enter CLB, CLBU and FB, FBU address fields. The address is 32 bit and should be in "0x" hex format. Please use the right value for size as it is an important attribute. Consult the AHCI specifications for the correct value.

Clicking the **Re-Decode** button erases the current configuration from this dialog box and attempts to re-decode based on the information present in the open trace and/or saved on the disk with the last decode.

Click the **Import Config Info** button to import the configuration information as an .xml file, instead of adding it individually. Click the hyper-link **XML Schema File Path** to access the required format to generate the .xml file. This schema provides the detailed format for the imported file. All modern languages are equipped to generate an .xml file on a specific xml schema. The driver software accepts this schema and generates the .xml file with all the required information.

Click the **Export Config Info** button to export the configuration information as an .xml file.

Click the **Reset** button to reset the values to the original values. Press the **OK** button to save all the values.

6.9.12.3 PQI PCIe SSD Device Configuration

The PCIe SSD Configuration dialog is used to add missing information to decode the trace without the configuration space and queue administration information. See Figure 6.379 for PQI PCIe SSD Device Configuration.

Prior to decoding if every thing is available in Configuration Space then Source equals Config Space (see Figure 6.379).

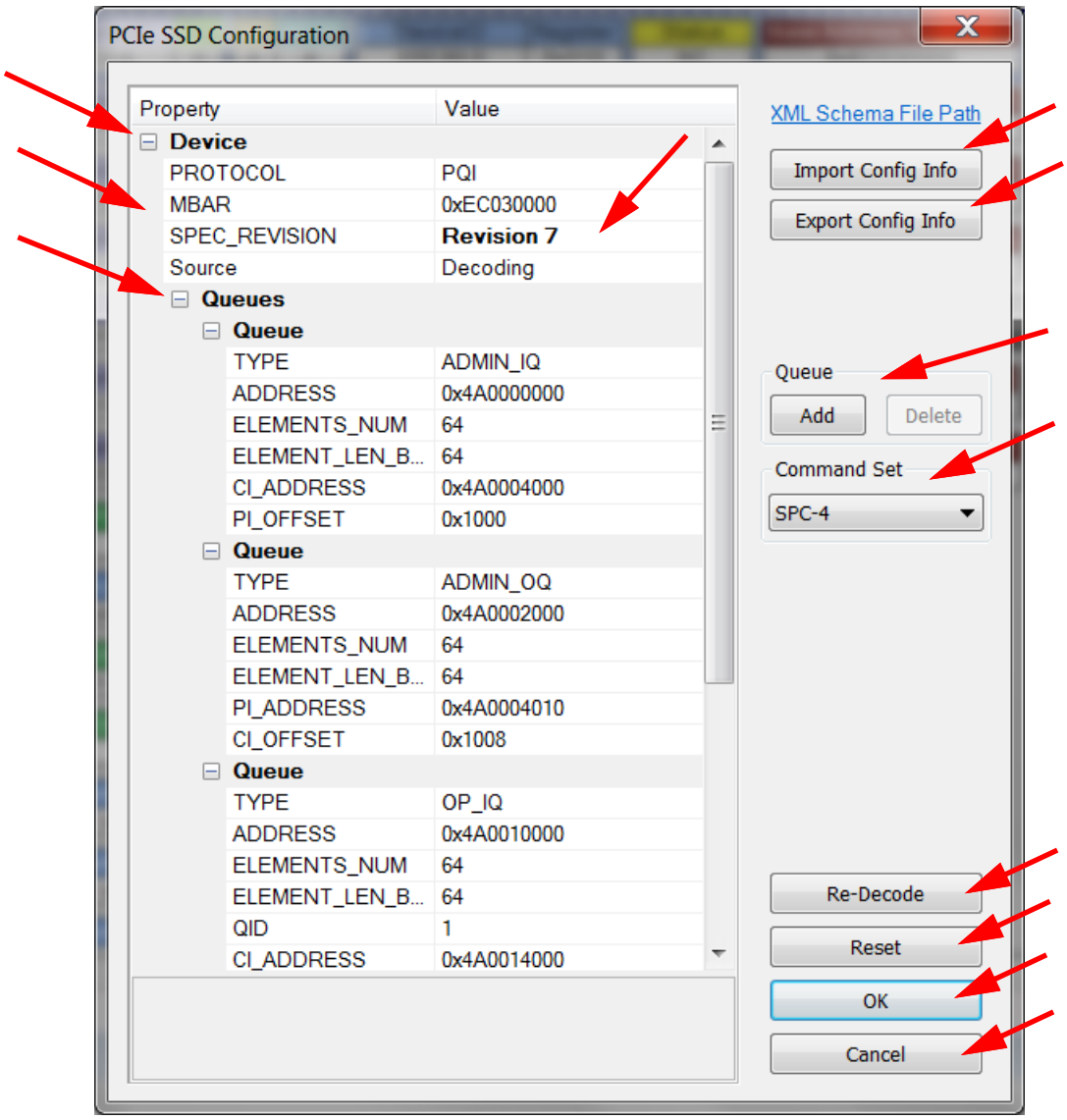


Figure 6.379: PQI PCIe SSD Configuration Dialog Pre-decoding

All the fields in this dialog are required and editable. Make sure that the information entered is correct. Click on any field and the description displays in the bottom read-only box (see Figure 6.380). Some important fields are described below:

- **Device**: There is only one device node, (support for multiple device trace decoding will be available in a later release). You can choose the spec revision from the drop down list.
- **MBAR**: The 64-bit main address bar (i.e. BAR1:BAR0). Without this value decoding cannot be done. It should be in "0x" hex format.
- **Queues**: Under this node the user can add more missing nodes to decode the current trace. Click the Add Queue or Delete Queue button to add or delete a queue node. Type based on the user selection. The following Node types are known.

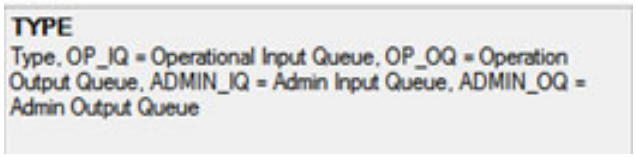


Figure 6.380: Node Types

The address is 64-bit and should be in "0x" hex format. Please use the right value for each size as it is an important attribute. Consult the NVMe specifications for the correct value. Clicking the **Re-Decode** button erases the current configuration from this dialog box and attempts to re-decode based on the information present in the open trace and/or saved on the disk with the last decode.

Click 

button to decode the trace and select **Tools > PCIe SSD Base Address Mapping** (see Figure 6.379 on page 569).

The two figures figure below show the BAR information for PQI and AHCI. If this information is present in the trace then it is not editable, otherwise it can be edited. Decoding is done only when configuration space and administration information is available.

Note: Only one device should be marked with the appropriate BAR, multiple BARs do not work.

6.9.13 SCSI PCIe SSD Device Configuration

The PCIe SSD Configuration dialog is used to add missing information to decode the trace without the configuration space and queue administration information. See Figure 6.381 on page 571 for SCSI PCIe SSD Device Configuration. The base is the same as PQI Device Configuration but you can additionally choose the SCSI Command Set.

Prior to decoding if every thing is available in Configuration Space then Source equals Config Space (see Figure 6.381 on page 571).

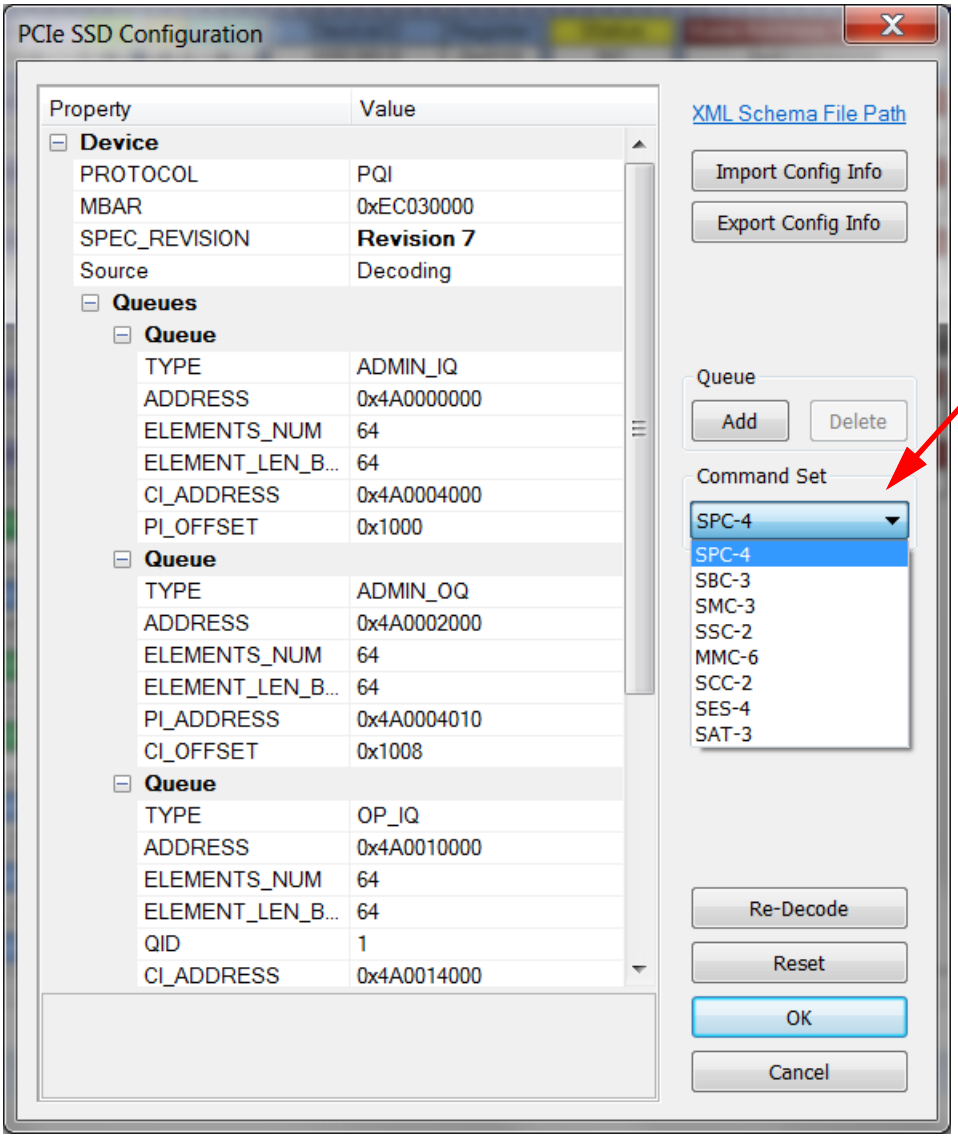


Figure 6.381: PCIe SSD Configuration Dialog - SCSI

See “Example of XML File Format for SSD Decodes” on page 609 for a template of the XML files.

6.9.14 Running Verification Scripts

You can run verification scripts to check errors, link transactions, split transactions, metrics, ordered sets, replays, DLLPs, and TLPs.

To display the Verification Script dialog (see Figure 6.382 on page 572), select **Tools > Run verification scripts**

or click the  icon.

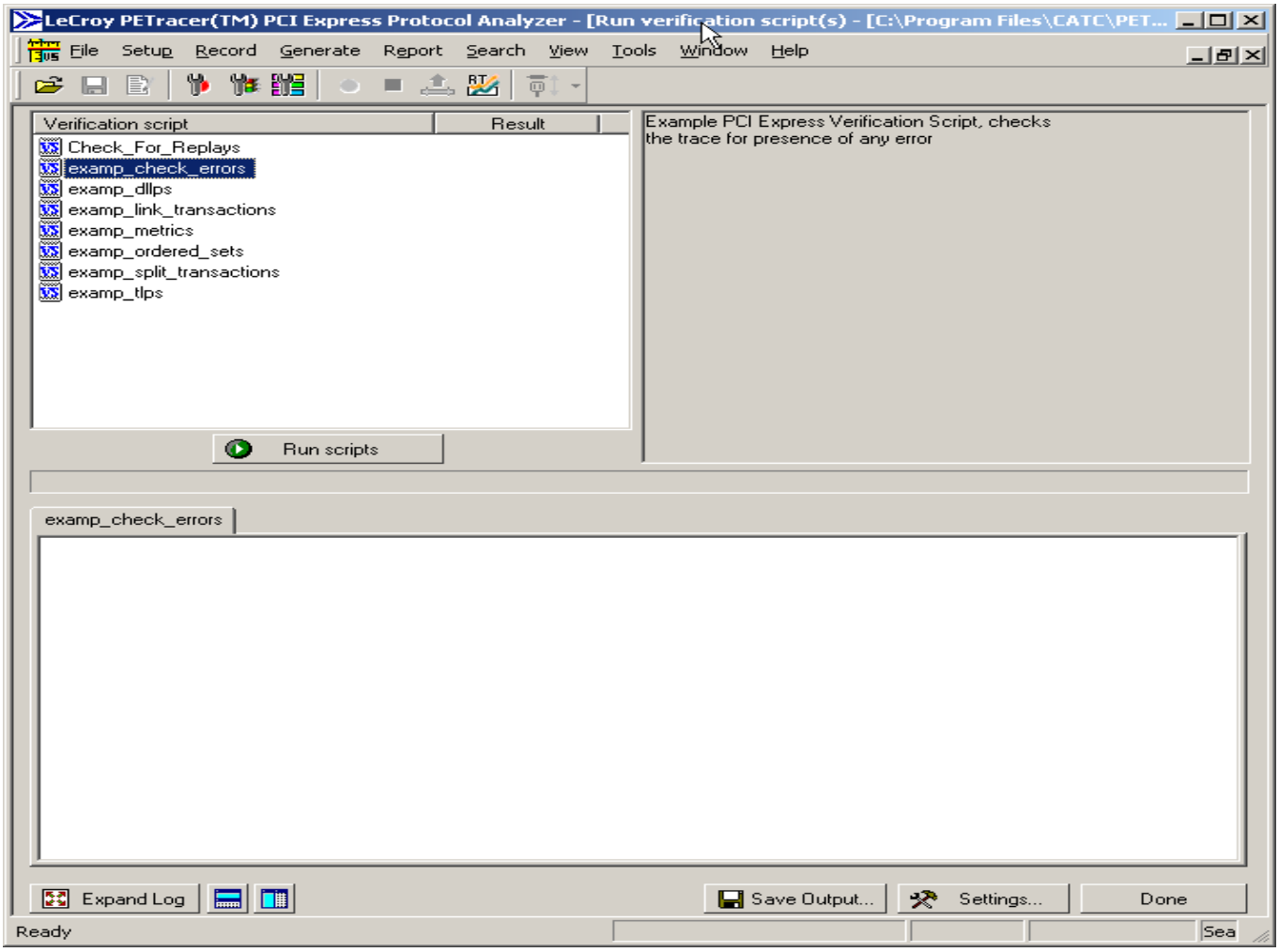
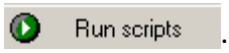


Figure 6.382: Verification Scripts Dialog

The available verification scripts are in the Verification script section.

To run a script, select it, then click the **Run Scripts** button 

.

The results appear in the bottom window. You can expand or collapse this window. You find a view related to the CATC Trace and place this window under or to the right of it. Click **Save** to save the results.

Click the **Settings** button to display the Settings Dialog (see Figure 6.383 on page 573).

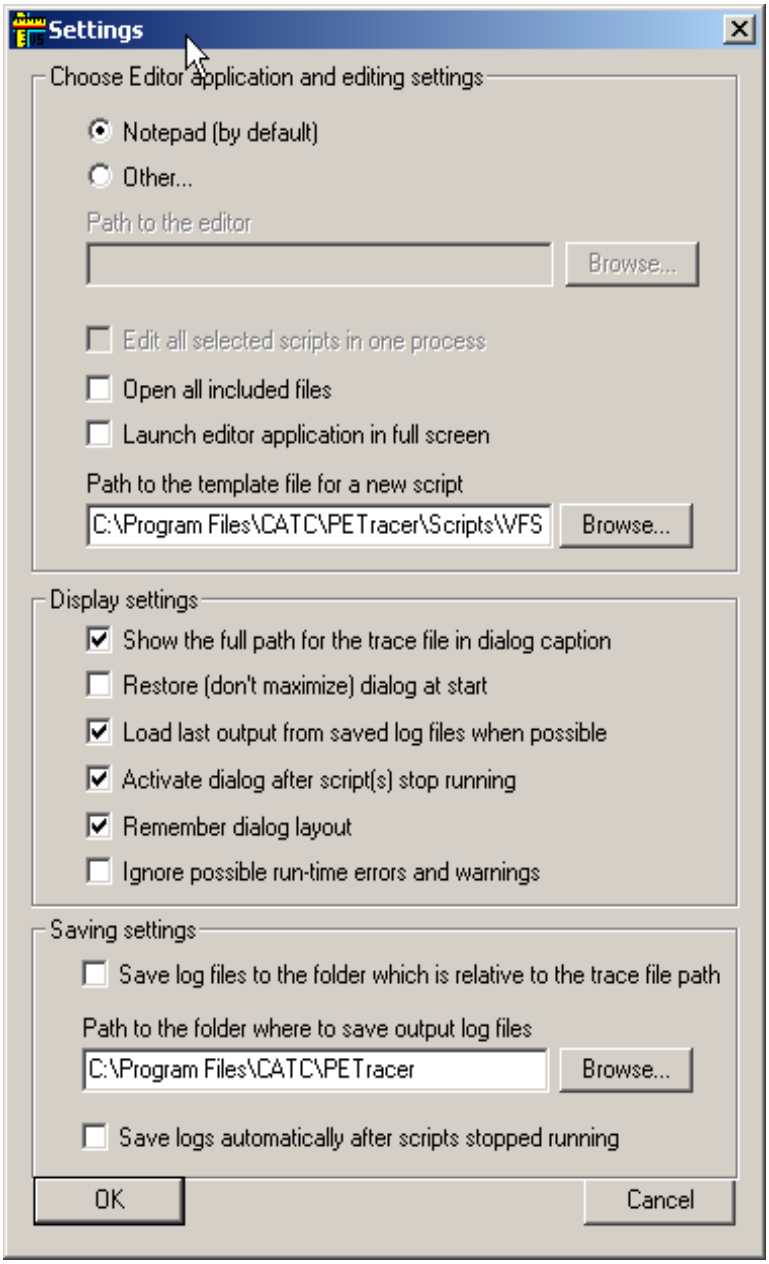


Figure 6.383: Settings Dialog

You can choose the editor, display settings, and saving settings.

6.9.14.1 NVMe Performance: Doorbell Timing

You can run verification scripts to determine Doorbell performance, see Figure 6.384.

The Doorbell statistics include:

- SQdoorbell to CQdoorbell,
  (time from Submission Doorbell to Completion Doorbell)
- SQDoorbell to CQentry,
  (time from SQ doorbell to command completion)
- SQentry to CQentry,

(time from submission command to command completion

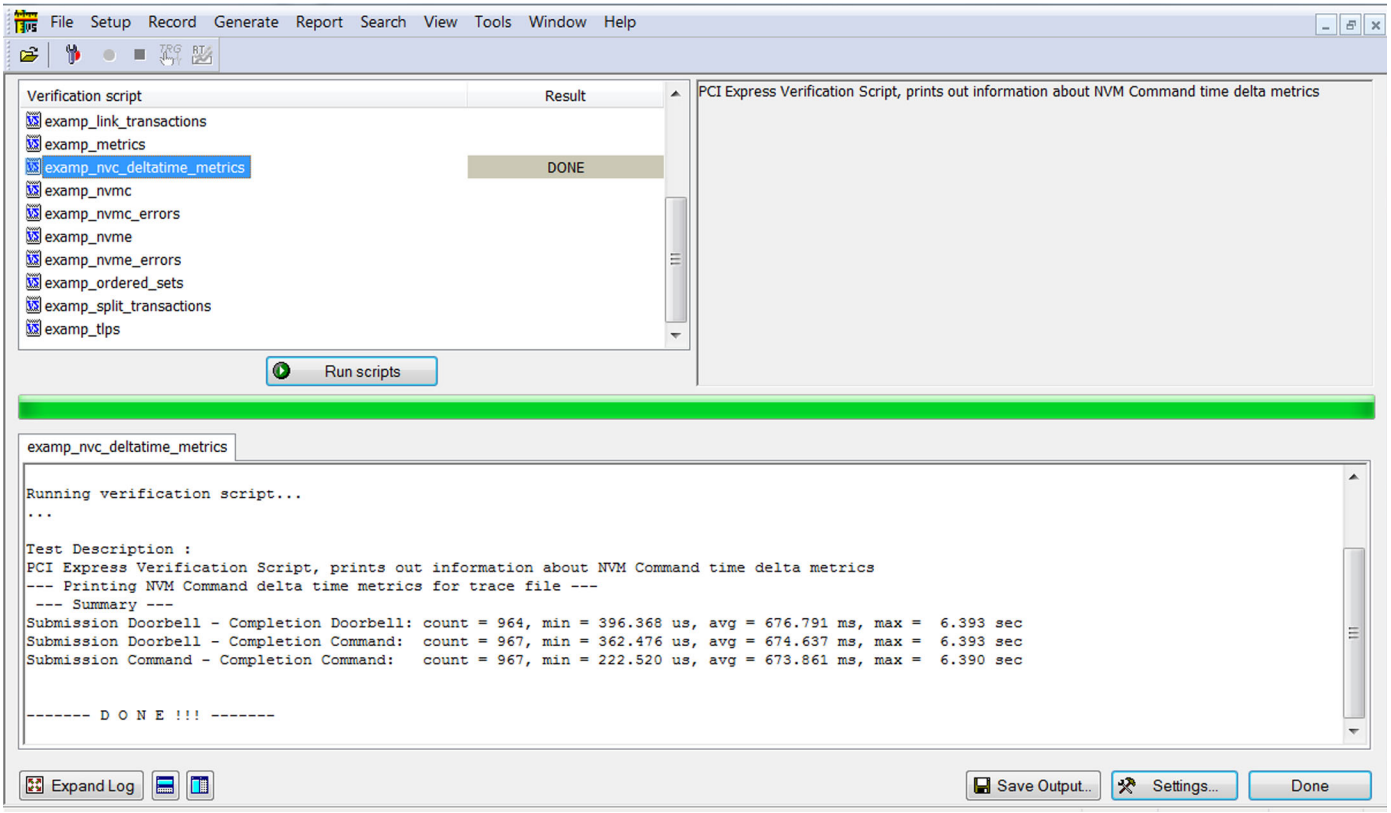


Figure 6.384: NVMe Performance Script Verification

6.9.14.2 MCTP Transaction Verification Script Generation

You can run the Verification Script Engine on MCTP Transactions. See Figure 6.385

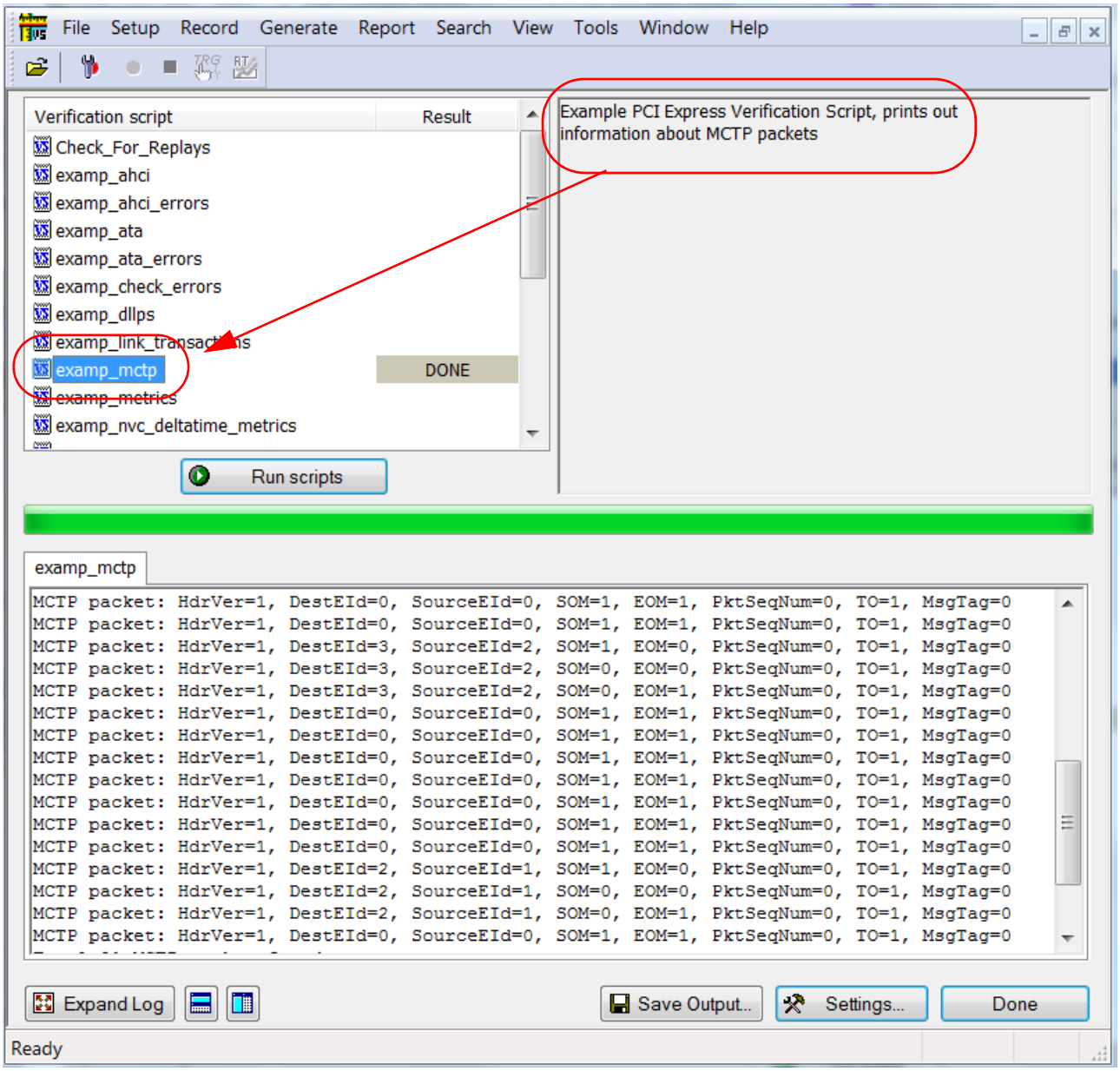


Figure 6.385: Running VSE on MCTP Transactions

6.9.15 Trace Expert

Trace Expert is a reporting tool that is used to create a portable, customized summary and report of a PCI express trace. The generated report groups the selected data and statistics into four groups:

- Performance Analysis
- Trace Analysis Statistics
- Error Reports
- Trace File Information

After a Trace has been loaded, Trace Expert is available from the Main Toolbar as shown in Figure 6.386.

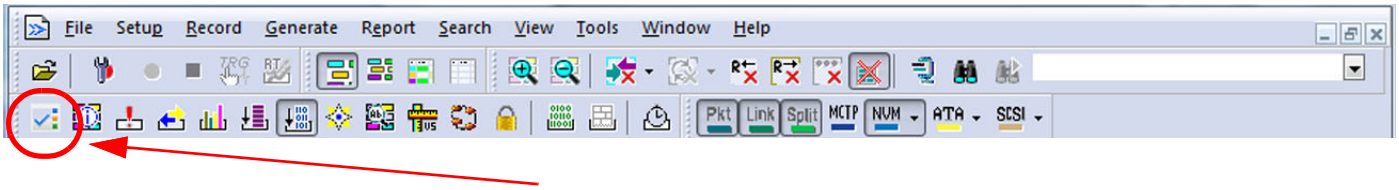


Figure 6.386: Main Toolbar: Trace Expert

To launch the Trace Expert dialog click on the icon. Different report sections can be selected for inclusion into the final report using the dialog. The path where the report will be generated can be set at the bottom of the dialog (see Figure 6.387 on page 577). Any additional decoding required to generate the report will be done automatically.

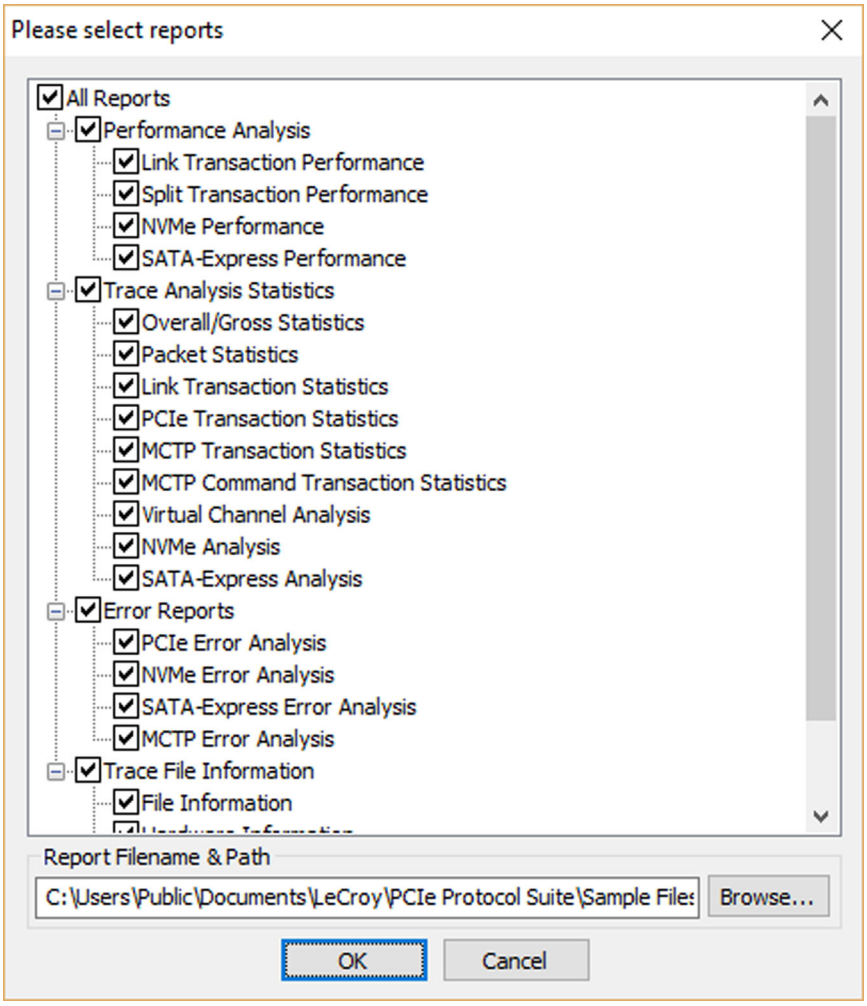


Figure 6.387: Trace Expert Report Types and Path

The generated report (see Figure 6.388 on page 578) has sections which can be expanded to show the associated data. The generated file is self-contained and portable so it can be safely emailed or archived. It will open automatically in the default browser once it is successfully generated. Icons on the top right can be used to:

- Save All (Saves to User's Download folder)
- Expand All
- Collapse All
- Print All of the currently displayed view.

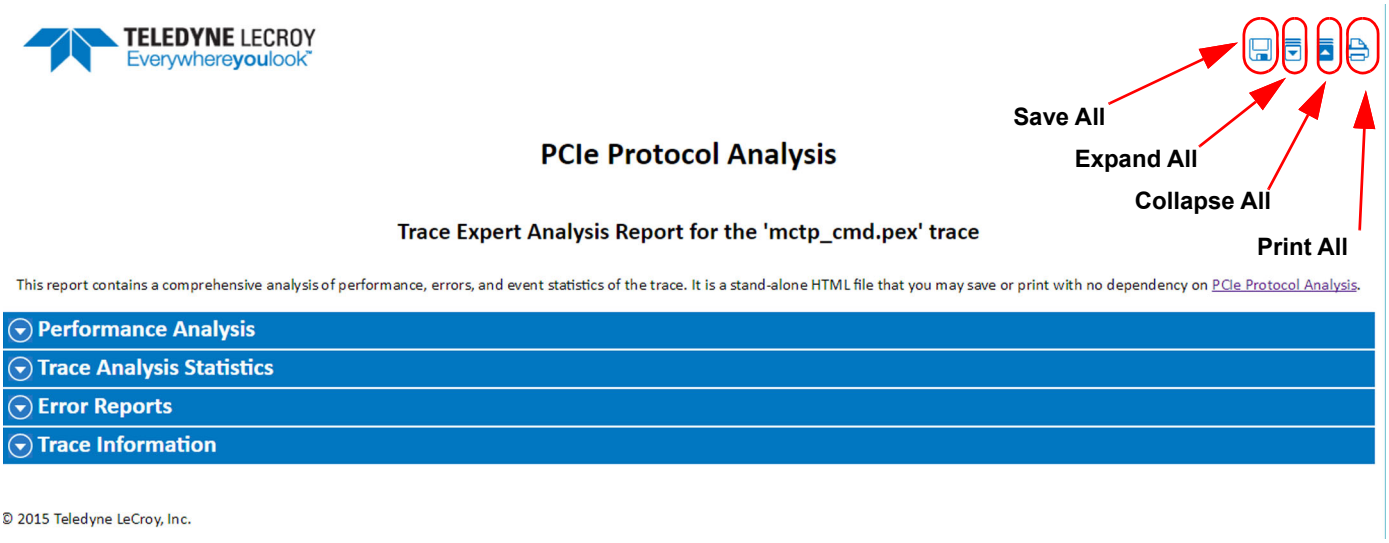


Figure 6.388: Trace Expert Main Menu

Select “Performance Analysis” on page 579 to bring up the respective dialog.

Select “Trace Analysis Statistics” on page 580 to bring up the respective dialog.

Select “Error Reports” on page 581 to bring up the respective dialog.

Select “Trace Information” on page 582 to bring up the respective dialog.

6.9.16 Performance Analysis

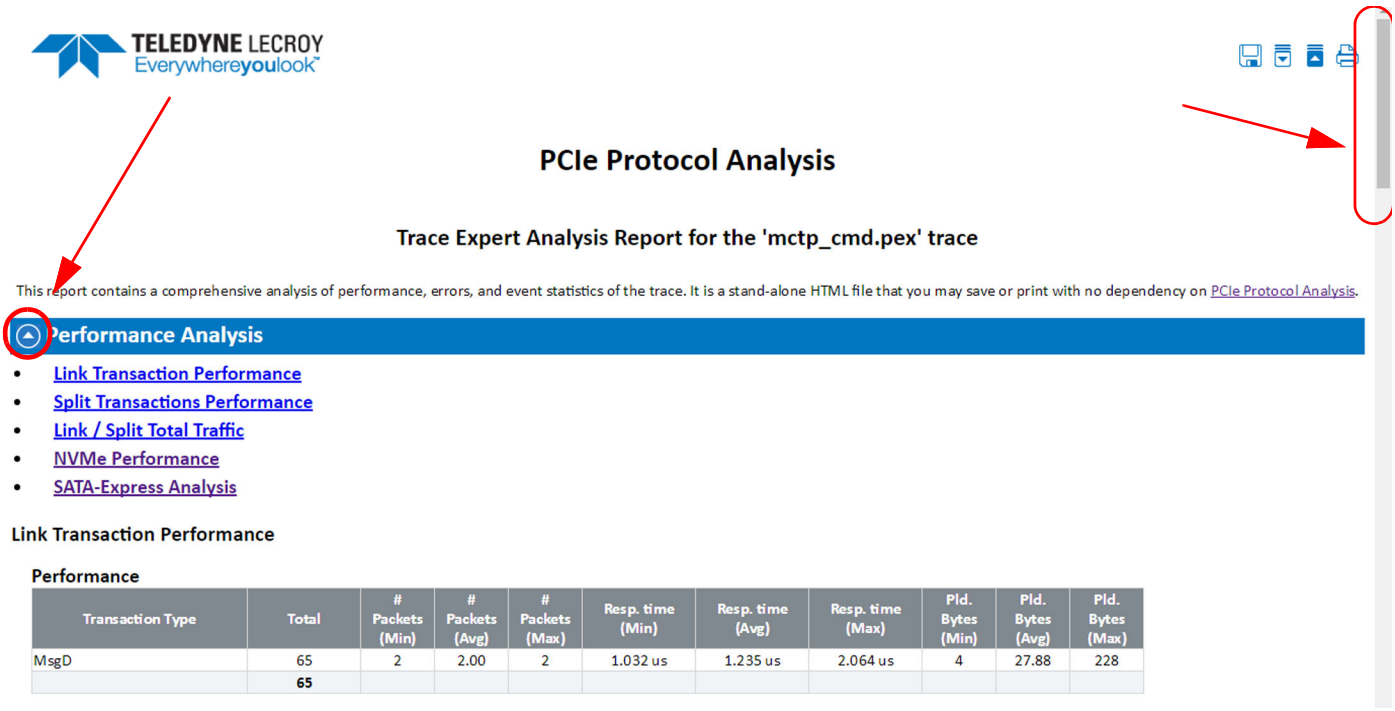


Figure 6.389: Trace Expert - Performance Analysis

You can select other types of transactions to see the other reports.

- ❑ Link Transaction Performance
- ❑ Split Transaction Performance
- ❑ Link / Split Total Traffic
- ❑ NVMe Performance
- ❑ SATA-Express Analysis

Scroll down to see the other reports and information.

6.9.17 Trace Analysis Statistics

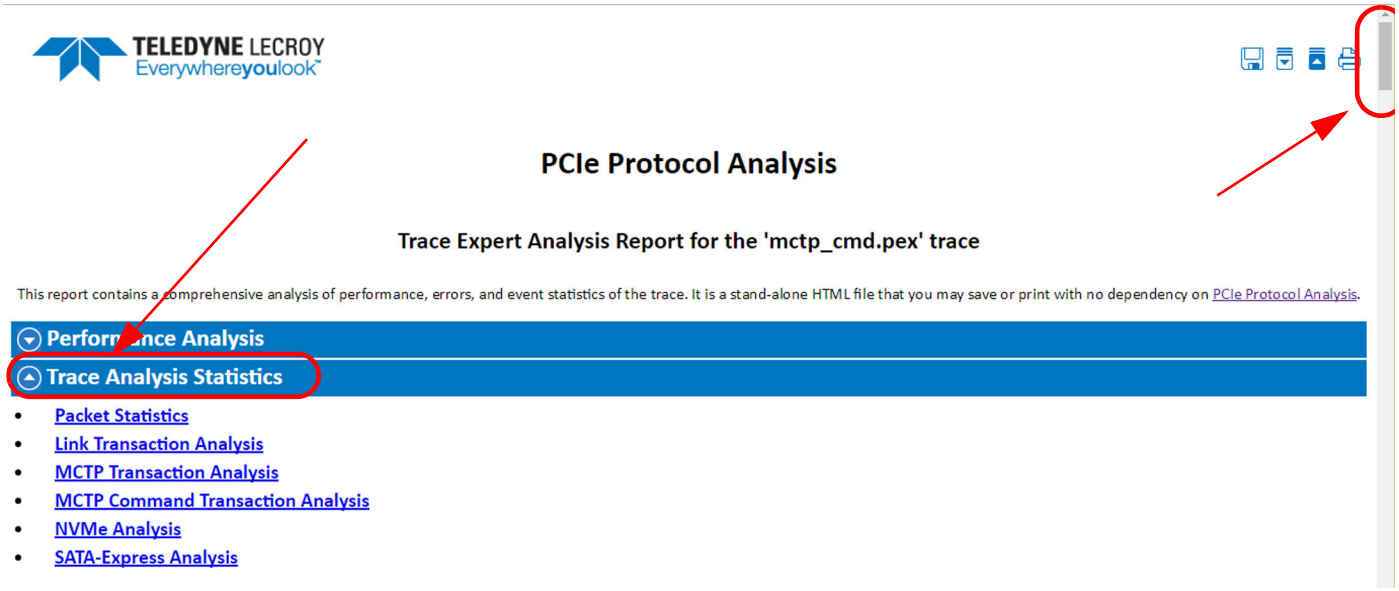


Figure 6.390: Trace Analysis Statistics

Selecting Trace Analysis Statistics will produce the following reports:

- Packet Statistics
- Link Transaction Analysis
- MCTP Transaction Analysis
- MCTP Command Transaction Analysis
- NVMe Analysis
- SATA-Express Analysis

Scroll down to see the other reports and information.

6.9.18 Error Reports

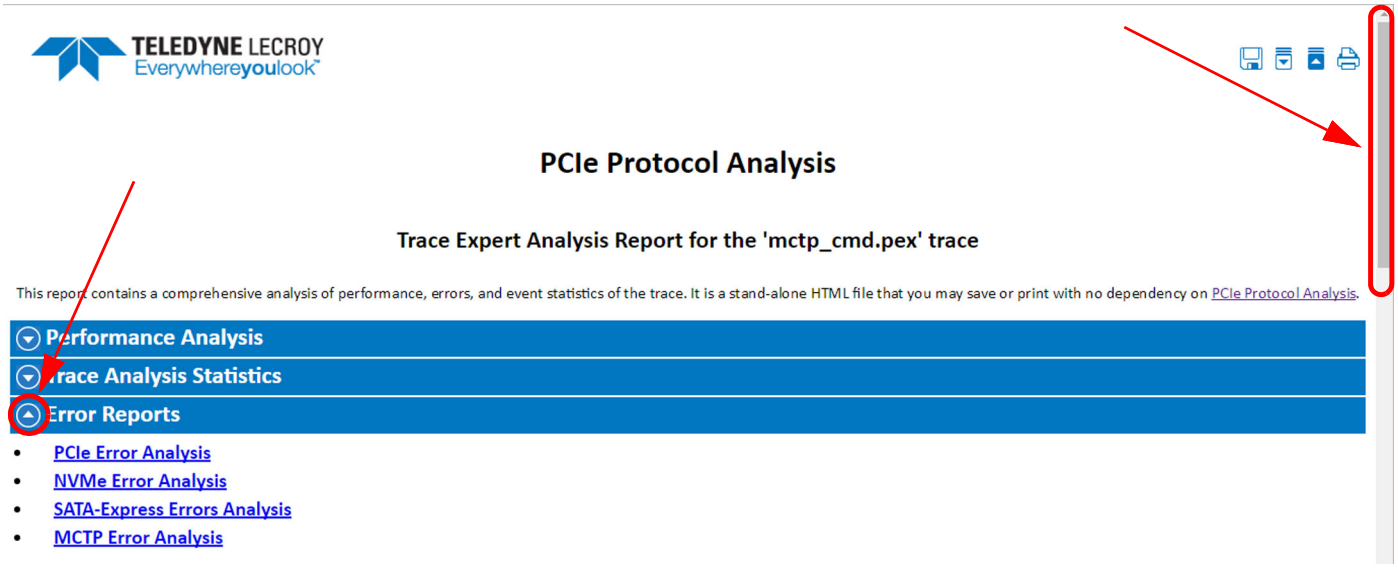


Figure 6.391: Error Reports

Selecting Error Reports generates the following reports:

- PCIe Error Analysis
- NVMe Error Analysis
- SATA-Express Errors Analysis
- MCTP Error Analysis

Scroll down to see the other reports and information.

6.9.19 Trace Information

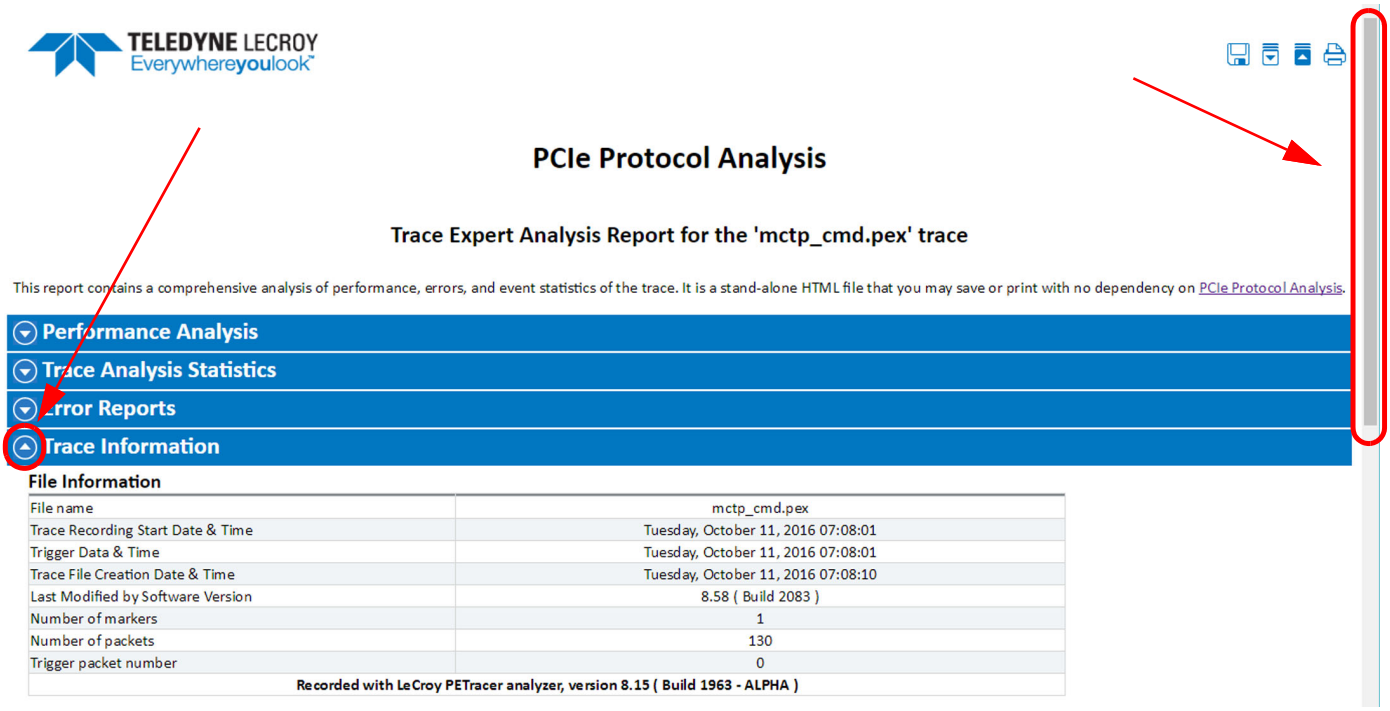


Figure 6.392: Trace Information

Selecting Trace Information generates the following reports:

- File Information
- Hardware Information
- Recording Options
- License Information
- IDE Keys—shown only for IDE Traces

Scroll down to see the other reports and information.

Chapter 7

Updates and Licensing

7.1 Updating the Exerciser

BusEngine™ and/or Firmware updates are now automatic processes that run anytime a new version of the PCIe Protocol Analysis™ is installed that is incompatible with the currently installed BusEngine or Firmware. The update process generates on-screen instructions.

If, however, you need to manually perform BusEngine or Firmware updates, follow these steps:

1. Select **Setup > Update Device** … from the menu to display the Update Analyzer dialog for Summit Z58™.
2. Select the appropriate file locations for the Firmware and/or BusEngine, using Browse, if necessary.
3. Check the appropriate options (if in doubt, check all options).
4. Click **Update Selected** or **Update All** to initiate the updating of the Exerciser.

7.2 License Keys

A License Key is necessary to enable software maintenance. If you attempt to generate traffic with the Exerciser without an installed License Key, a message appears to indicate that a License Key is necessary in order to record traffic.

A License Key must be obtained from Teledyne LeCroy for each Exerciser.

After you obtain the License Key, follow these steps to install it:

1. Select **Help > Display License Information**… from the menu bar to display the Update License dialog.
2. Click the Install License File... button to dis play the Select License Key File dialog and enter the path and filename for the License Key to navigate to the directory that contains the License Key.
3. Select the .**lic** file, and then click **Open**.

You can also update your licensing information by selecting **Setup > All Connected Devices** …, then clicking Update License.

7.3 License Information

You can view Licensing information for your Exerciser by selecting **Help > Display License Information**... from the menu bar (see Figure 7.1 and Figure 7.2 on page 585). The License Information window displays data about the maintenance expiration and purchased features. The features include PCIe Programmable LTSSM.



Figure 7.1: Z58 License File Options Part 1



Figure 7.2: Z58 License File Options Part 2

Appendix A

How to Contact Teledyne LeCroy

Send e-mail to Support	psgsupport@teledyne.com
Contact Support	teledynelecroy.com/support/contact
Visit Teledyne LeCroy's website	teledynelecroy.com
Tell Teledyne LeCroy	Report a problem to Teledyne LeCroy Support via e-mail by selecting **Help > Tell Teledyne LeCroy** from the application toolbar. This requires that an e-mail client be installed and configured on the host machine.

Appendix B

China Restriction of Hazardous Substances Table

The following tables are supplied in compliance with China's Restriction of Hazardous Substances (China RoHS) requirements:

	有毒有害物质和元素					
部件名称	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr^{5+})	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
PCBAs	X	O	X	X	X	X
机械硬件	O	O	X	O	O	O
金属片	O	O	X	O	O	O
塑料部件	O	O	O	O	X	X
电源	X	X	X	O	X	X
电源线	X	O	X	O	X	X
保护外壳(如有)	O	O	O	O	X	X
电缆组件(如有)	X	O	X	O	X	X
风扇(如有)	X	O	X	O	X	X
交流滤波器和熔丝组件(如有)	X	O	X	O	O	O
外部电源(如有)	X	X	X	O	X	X
探头(如有)	X	O	X	O	X	X
O: 表明该有毒有害物质在该部件所有均质材料中的含量均在 SJ/T11363-2006 标准规定的限量要求之下。						
X: 表明该有毒有害物质至少在该部件的某一均质材料中的含量超过 SJ/T11363-2006 标准规定的限量要求。						

EFUP (对环境友好的使用时间) 使用条件：
温度：5摄氏度到40摄氏度
湿度：5% - 95%最大相对湿度 (无冷凝)
高度：最高2000米

	Toxic or Hazardous Substances and Elements					
Part Name	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr^{6+})	Polybrominated Biphenyls (PBB)	Polybrominated Diphenyl Ethers (PBDE)
PCBAs	X	O	X	X	X	X
Mechanical Hardware	O	O	X	O	O	O
Sheet Metal	O	O	X	O	O	O
Plastic Parts	O	O	O	O	X	X
Power Supply	X	X	X	O	X	X
Power Cord	X	O	X	O	X	X
Protective Case (if present)	O	O	O	O	X	X
Cable Assemblies (if present)	X	O	X	O	X	X
Fans (if present)	X	O	X	O	X	X
AC Filter/Fuse Assy (if present)	X	O	X	O	O	O
Ext Power Supply (if present)	X	X	X	O	X	X
Probes (if present)	X	O	X	O	X	X
O: Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement specified in SJ/T11363-2006.						
X: Indicates that this toxic or hazardous substance contained in at least one of the homogenous materials used for this part is above the limit requirement specified in SJ/T11363-2006.						

EFUP (Environmental Friendly Use Period) Use Conditions:

Temperature	5C to 40C
Humidity	5% to 95% max RH (non-condensing)
Altitude	Up to 2000 meters

Appendix C

Quick Search Feature

C.1 Quick Search Feature: Pre-Defined Terms

The Quick Search feature allows you to either search for a pre-defined term within a loaded Trace by clicking on the down arrow  or by typing your own term into the search window  , then moving the cursor into the window and hitting the Enter key.

Note: A complete list of pre-defined terms is shown in Table C.4.

TABLE C.4: Pre-Defined Searchable Terms (Sheet 1 of 3)

TLP – Memory Read (32 bit)	Error – TLP: Payload/Length Error
TLP – Memory Read (32 bit) – Locked	Error – TLP: Length Error (not 1)
TLP – Memory Write (32 bit)	Error – TLP: TC Error (not 0)
TLP – Memory Read (64 bit)	Error – TLP: Attr Error (not 0)
TLP – Memory Read (64 bit) – Locked	Error – TLP: AT Error (not 0)
TLP – Memory Write (64 bit)	Error – TLP: Byte Enables Violation
TLP – I/O Read Request	Error – Memory TLP: Address/Length Crosses 4K
TLP – I/O Write Request	Error – Mem64 TLP: Used Incorrectly
TLP – Configuration Read Type 0	Error – Cfg TLP: Register Error
TLP – Configuration Write Type 0	Error – Msg TLP: Invalid Routing
TLP – Configuration Read Type 1	Error – Msg TLP: Invalid Function Number field
TLP – Configuration Write Type 1	Error – Gen3 TLP: Bad Len CRC/Parity
TLP – Message	Error – Invalid Packet
TLP – Message with Data	Error – FC: Invalid Advertisement
TLP – Message for Advanced Switching	Error – FC: Insufficient Credits
TLP – Message for Advanced Switching with Data	Error – Training Sequence Format Error
TLP – Completion	Error – Training Sequence Parity Error
TLP – Completion with Data	Error – RRAP Command Aborted Error

TABLE C.4: Pre-Defined Searchable Terms (Sheet 2 of 3)

TLP – Completion for Locked Memory Read	Error – RRAP Packet Parity Error
TLP – Completion for Locked Memory Read with Data	Error – RRAP Packet Reserved Fields Not Nullified Error
TLP – AtomicOp Fetch and Add (32 bit)	Controller Register – CAP
TLP – AtomicOp Fetch and Add (64 bit)	Controller Register – VS
TLP – AtomicOp Unconditional Swap (32 bit)	Controller Register – INTMS
TLP – AtomicOp Unconditional Swap (64 bit)	Controller Register – INTMC
TLP – AtomicOp Compare and Swap (32 bit)	Controller Register – CC
TLP – Deferrable Memory Write (32 bit)	Controller Register – Reserved
TLP – Deferrable Memory Write (64 bit)	Controller Register – CSTS
DLLP – Ack	Controller Register – NSSR
DLLP – Nak	Controller Register – AQA
DLLP – PM	Controller Register – ASQ
DLLP – Vendor	Controller Register – ACQ
DLLP – InitFC1-P	Controller Register – CMBLOC
DLLP – InitFC1-NP	Controller Register – CMBSZ
DLLP – InitFC1-Cpl	Controller Register – Reserved
DLLP – UpdateFC-P	Controller Register – Reserved Command Set Specific
DLLP – UpdateFC-NP	NVMe I/O Cmd – Flush
DLLP – UpdateFC-Cpl	NVMe I/O Cmd – Write
DLLP – MRIOV	NVMe I/O Cmd – Read
DLLP – InitFC2-P	NVMe I/O Cmd – Write Uncorrectable
DLLP – InitFC2-NP	NVMe I/O Cmd – Compare
DLLP – InitFC2-Cpl	NVMe I/O Cmd – Write Zeroes
DLLP – NOP	NVMe I/O Cmd – Dataset Management
Link Events – Link Up	NVMe I/O Cmd – Reservation Register
Link Events – Link Down	NVMe I/O Cmd – Reservation Report
Link Events – PERST# Deasserted	NVMe I/O Cmd – Reservation Acquire
Link Events – PERST# Asserted	NVMe I/O Cmd – Reservation Release
Link Events – WAKE# Asserted	NVMe I/O Cmd – Vendor Specific
Link Events – WAKE# Deasserted	NVMe ADMIN Cmd – Delete I/O Submission Queue
Link Events – CLKREQ# Asserted	NVMe ADMIN Cmd – Create I/O Submission Queue
Link Events – CLKREQ# Deasserted	NVMe ADMIN Cmd – Get Log Page

TABLE C.4: Pre-Defined Searchable Terms (Sheet 3 of 3)

Link Events – Skew	NVMe ADMIN Cmd – Delete I/O Completion Queue
Error – Invalid Code	NVMe ADMIN Cmd – Create I/O Completion Queue
Error – Running Disparity Error	NVMe ADMIN Cmd – Identify
Error – Unexpected K/D Code	NVMe ADMIN Cmd – Abort
Error – Idle Data Error (not D0.0)	NVMe ADMIN Cmd – Set Features
Error – Skip Late	NVMe ADMIN Cmd – Get Features
Error – Skew Error	NVMe ADMIN Cmd – Asynchronous Event Request
Error – Bad Packet Length	NVMe ADMIN Cmd – Firmware Activate
Error – Ordered Set Format Error	NVMe ADMIN Cmd – Firmware Image Download
Error – Delimiter Error	NVMe ADMIN Cmd – Format NVM
Error – Alignment Error	NVMe ADMIN Cmd – Security Send
Error – DLLP: Invalid Encoding	NVMe ADMIN Cmd – Security Receive
Error – DLLP: Bad CRC16	NVMe ADMIN Cmd – I/O Command Set specific
Error – DLLP: Reserved Field not 0	NVMe ADMIN Cmd – Vendor specific
Error – DLLP: FC Initialization Error	MCTP – Packets
Error – TLP: Invalid Encoding	MCTP – Control Messages
Error – TLP: Bad LCRC	
Error – TLP: Bad ECRC	
Error – TLP: Reserved Field not 0	

Appendix D

NVMe Drive Emulation

D.1 NVME Drive Emulation in Windows 10

Note: The Z5 references in this section refer to a Summit Z58 or a Summit Z516 Exerciser.

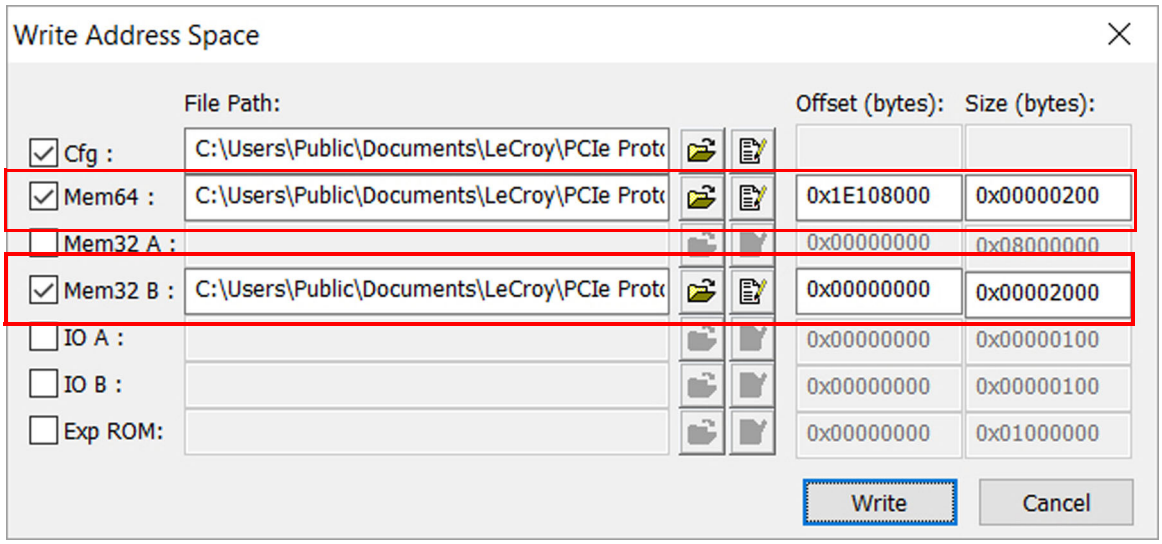
To perform NVME drive emulation in Windows 10, perform the following steps:

1. Copy the content of C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\PCIe Analysis Software\Sample Files\Z5TrainerScripts\NVMe_DriveEmulation\Drivers\Windows7 somewhere on a PCIe system with Windows 10 64-bit.

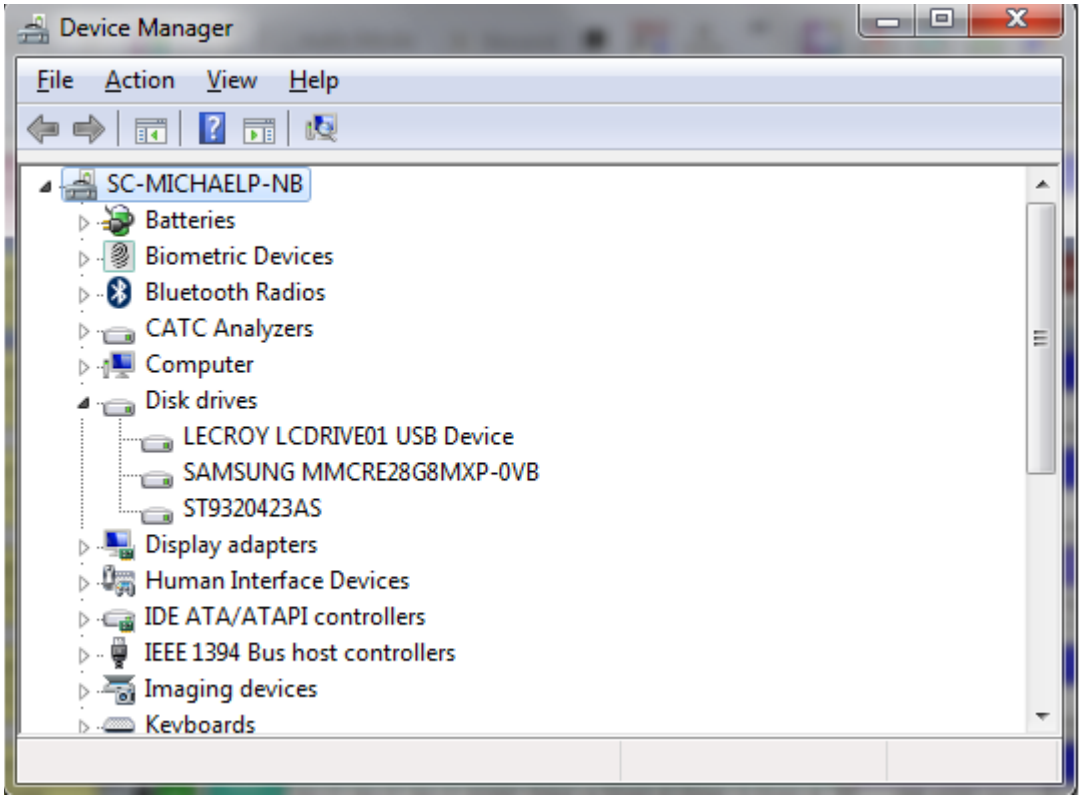
Note: For NVMe drive emulation in other windows and Linux environments refer to the corresponding folders under C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\PCIe Analysis Software\Sample Files\Z5TrainerScripts\NVMe_DriveEmulation\Drivers\

2. Turn the system off.
3. Insert the Z5 Main Board into a slot on the PCIe system. Keep the system turned off. If you are using a Summit PCIe Analyzer follow the documentation for the analyzer and interposer to properly connect all the components.
4. Load dev.gen generation options (this configures Z5 for Device Emulation) from location C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\PCIe Analysis Software\Sample Files\Z5TrainerScripts\NVMe_DriveEmulation
5. Write the configuration space, SMART/Health log data and Identify data:
   Cfg:
   C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\PCIe Analysis Software\Sample Files\Z5TrainerScripts\NVMe_DriveEmulation\nvme_drive_config_space.dat
   Mem64:
   C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\PCIe Analysis Software\Sample Files\Z5TrainerScripts\NVMe_DriveEmulation\nvme_log_data.dat
   Use offset 0x1E108000 and size 0x00000200

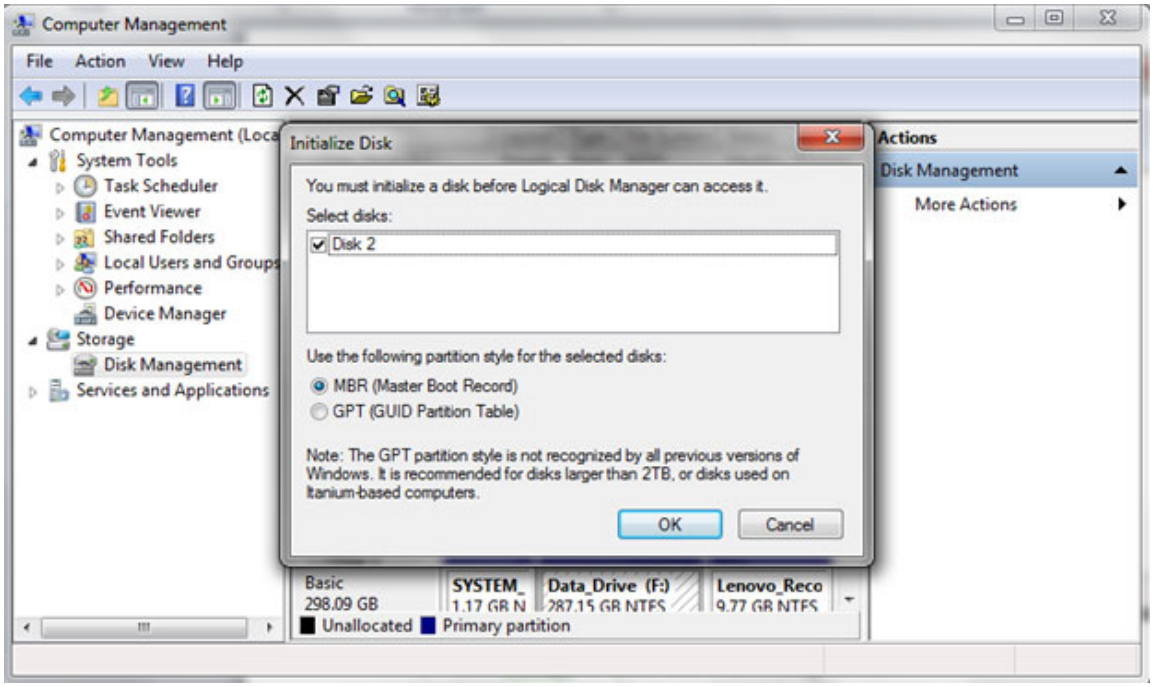
Mem32B:
C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\PCIe Analysis Software\Sample Files\
Z5TrainerScripts\NVMe_DriveEmulation\nvme_identify_data.dat
Use memory size 0x00002000



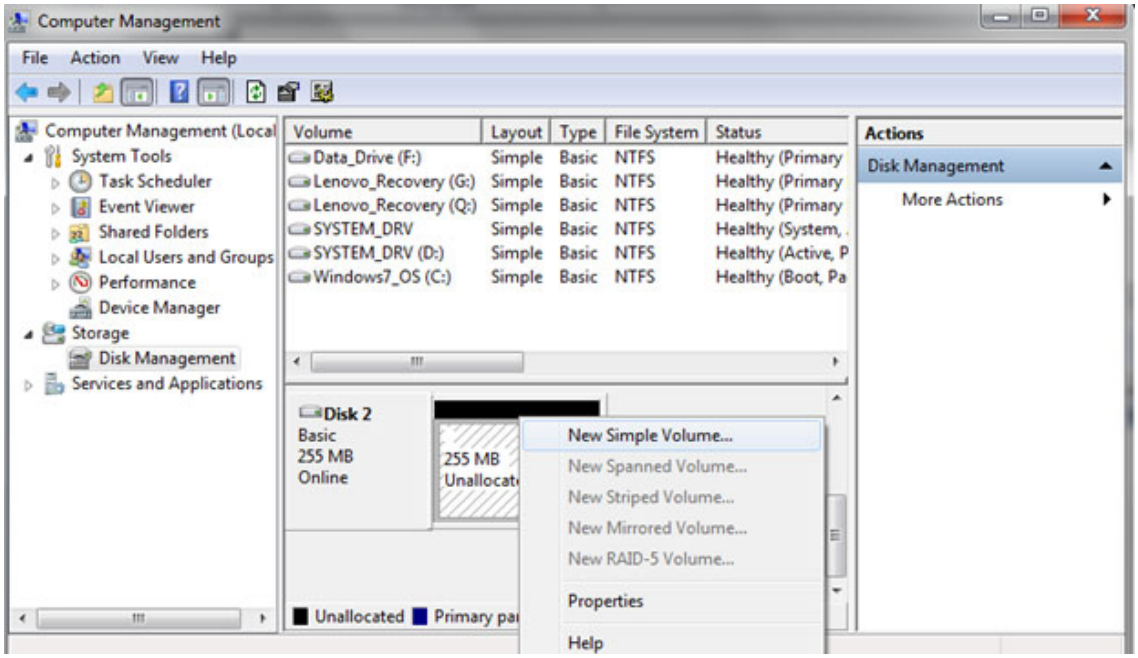
6. Load the Drive Script from C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\PCIe Analysis Software\Sample Files\Z5TrainerScripts\NVMe_DriveEmulation\ start_nvme_drive.peg
7. Run the C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\PCIe Analysis Software\Sample Files\Z5TrainerScripts\NVMe_DriveEmulation\ start_nvme_drive.peg script to start NVMe emulation.
8. Press the **Connect** button in the Generation bar.
9. Start recording. (Perform this step only if use of the protocol analyzer is required.)
10. Boot the PCIe system.
11. When New Device notifications appear, point the driver installation to the location where you copied files in step 1, using "Have Disk". Go through the wizard to complete the installation.
12. Make sure the LeCroy drive has appeared in the Device Manager. (See figure below, but "NVMe NVMeLecroy000000 SCSI Drive" in "Disk drives" and also "Community NVMe Storport miniport" under "Storage Controllers").



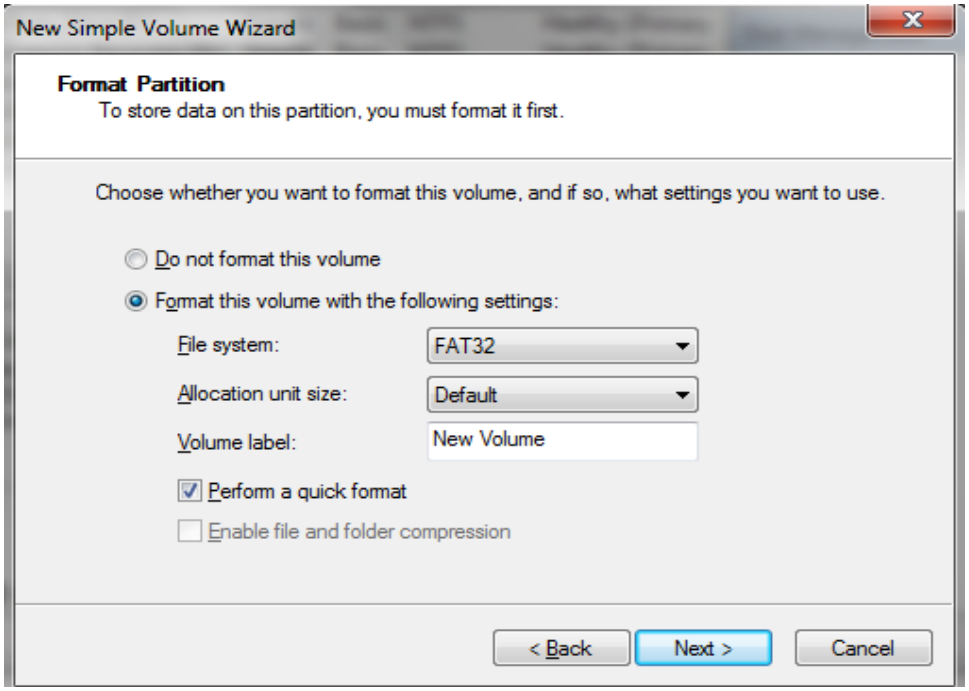
13. Go to Computer Management and select **Disk Management**.
14. The manager will prompt to set the Master Boot Record on the new drive. Click **OK**. See figure below.



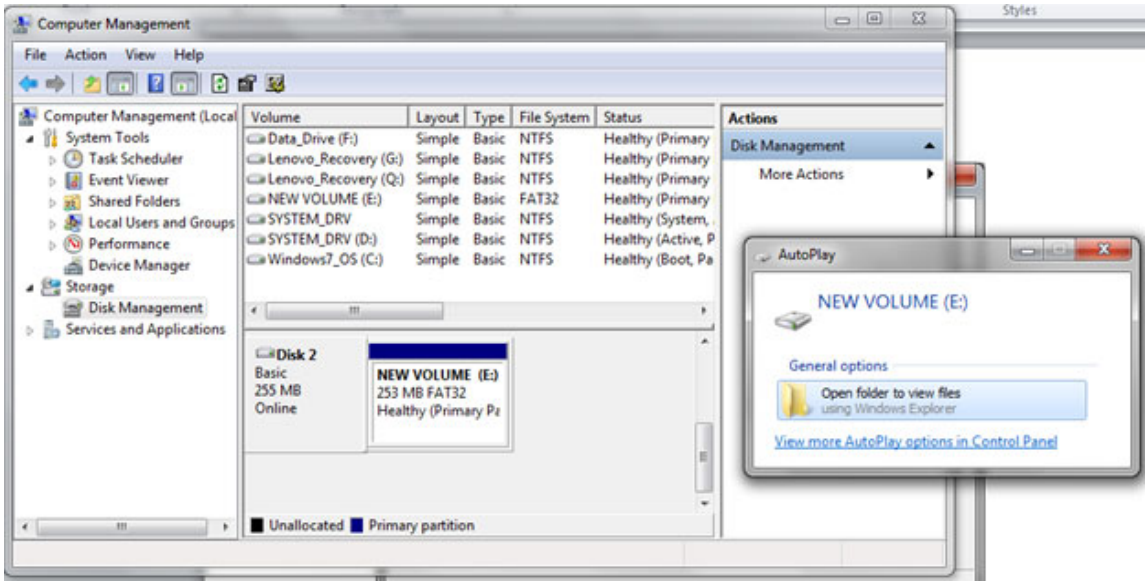
15. The drive is un-partitioned. Right-click and select **New Simple Volume**….



16. Follow the wizard, and select **FAT32**. See the screen below.



17. Wait till the formatting finishes and the new volume will display. Now the files can be copied to and from the volume.



Note: If something goes wrong, and the system preforms Startup Recovery after restart, you might need to install the driver again. In this case at step 7 the device will appear in the Device Manager just as a "PCI Device". Perform the following steps if this occurs:

1. Right-click on it and select **Update Driver.**
2. Select **Let me choose the driver for this device…**.
3. After the list of device appears proceed to **Have Disk** and press on it.
4. Browse to the folder "NVMe" on desktop.
5. Select **nvme** INF file.
6. Click **OK** for everything.
7. Make sure you are at step 7 in Device Manager and proceed.

D.2 NVME Drive Emulation in Ubuntu Linux 14.10 and Linuxv3.1-rc4

Note: Before running the system and installing the NVME drive, ensure that you have finished setting up the Summit Z5 and analyzer configuration. Once the Z5 has finished running the start_nvme_*.peg script and the link is established you can follow the steps below.

To perform NVME drive emulation in Ubuntu Linux 14.10 and Linux v3.1-rc4 perform the following steps:

1. Install Ubuntu http://releases.ubuntu.com/saucy/ desktop image for 14.10.
2. Install (or verify if they are already installed) in all necessary environment:
   - ❑ Linux headers

   # sudo apt-get install Linux-headers-$(uname -r)

- GNU make and C++ compiler (g++)

sudo apt-get install build-essential

Note: In case you see the error consider updating to the latest linux packages by sending the command: #sudo apt-get update (this will update to latest changes in Linux software).

3. Once the image is installed the native file nvme.ko will be present in the system which can be used to run NVMe device emulation.

   If the file nvme.ko cannot be located, mount the file as follows:

   - In the command prompt issue : locate nvme.ko
   - Issue a command : insmod ../path/nvme.ko

   Note: Please note that in some cases you will see two instances of the same file, please select the latest version of the same file

   - To remove the module and install new one issue: rmmod nvme.ko
4. In addition, Linux-nvme support can be installed with latest changes from:

   http://git.infradead.org/users/willy/Linux-nvme.git

   a. In order to install, please install GIT module into the Linux host machine:

      Issue a command:
      git clone git://git.infradead.org/users/willy/Linux-nvme.git to install latest Linux-_nvme git

   b. Once this is installed please issue the following command:

      locate nvme.ko to locate the driver.

   c. Make sure it is mounted and if necessary issue insmod nvme.ko.
5. Power down the system and start configuration for the NVMe Z5 device to work as a Device Emulator. In order for the Teledyne LeCroy Z5 system to work as a device emulator you will need a host machine with Teledyne LeCroy software installed.

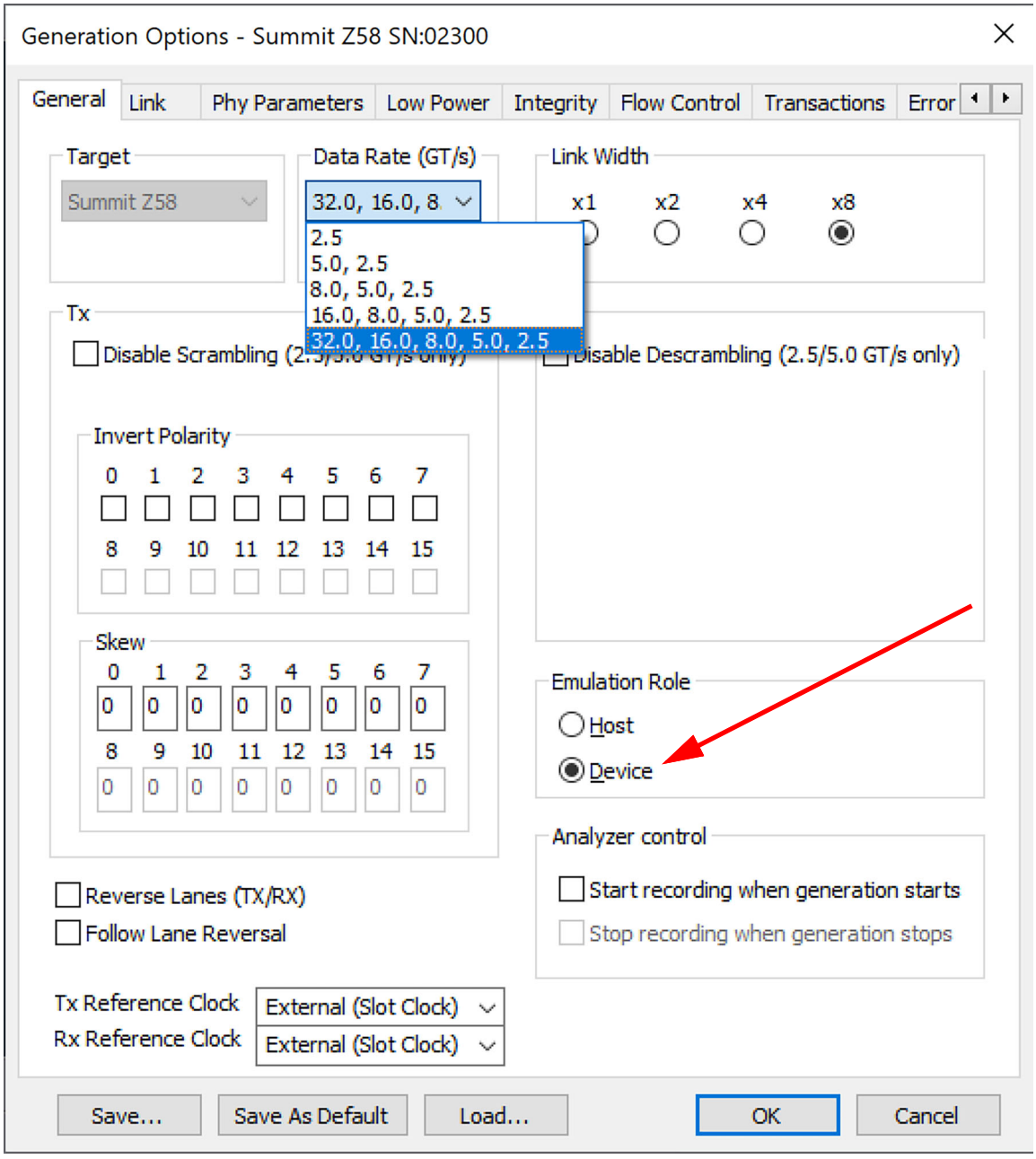
Note: In order for the Teledyne LeCroy Z5 system to work as a device emulator you will need a host machine with Teledyne LeCroy software installed.

D.2.1 Hardware Setup for Test Equipment

1. **Insert the Z5 Main Board into a slot of the PCIe system under test. Keep the system turned off**.

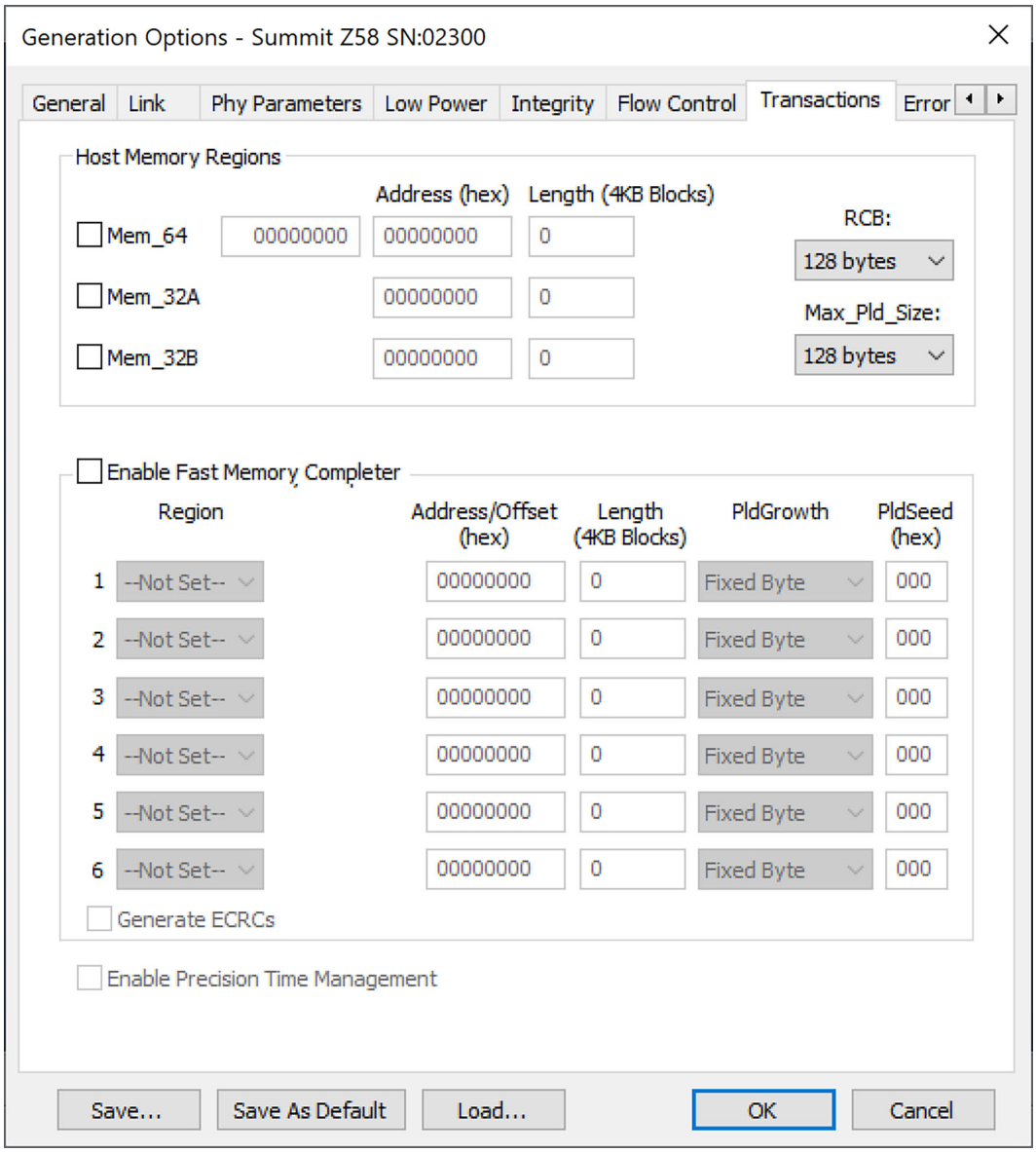
   If you have a PCIe Summit Analyzer, insert the interposer first into the system's slot and then plug the Z5 Main Board on top of the interposer. Follow the documentation for the analyzer and interposer to properly connect all the components.
2. Open PCIe Analysis Software in a separate system running windows.
3. Power on the Z5 System and the analyzer if available.
4. Once the Z5 and the analyzer are discovered by the PCIe Analysis Software, start the configuration process as explained below.

5. Click **Setup > Generation Options** and select **Device** to setup the Z5 to act as a Device.



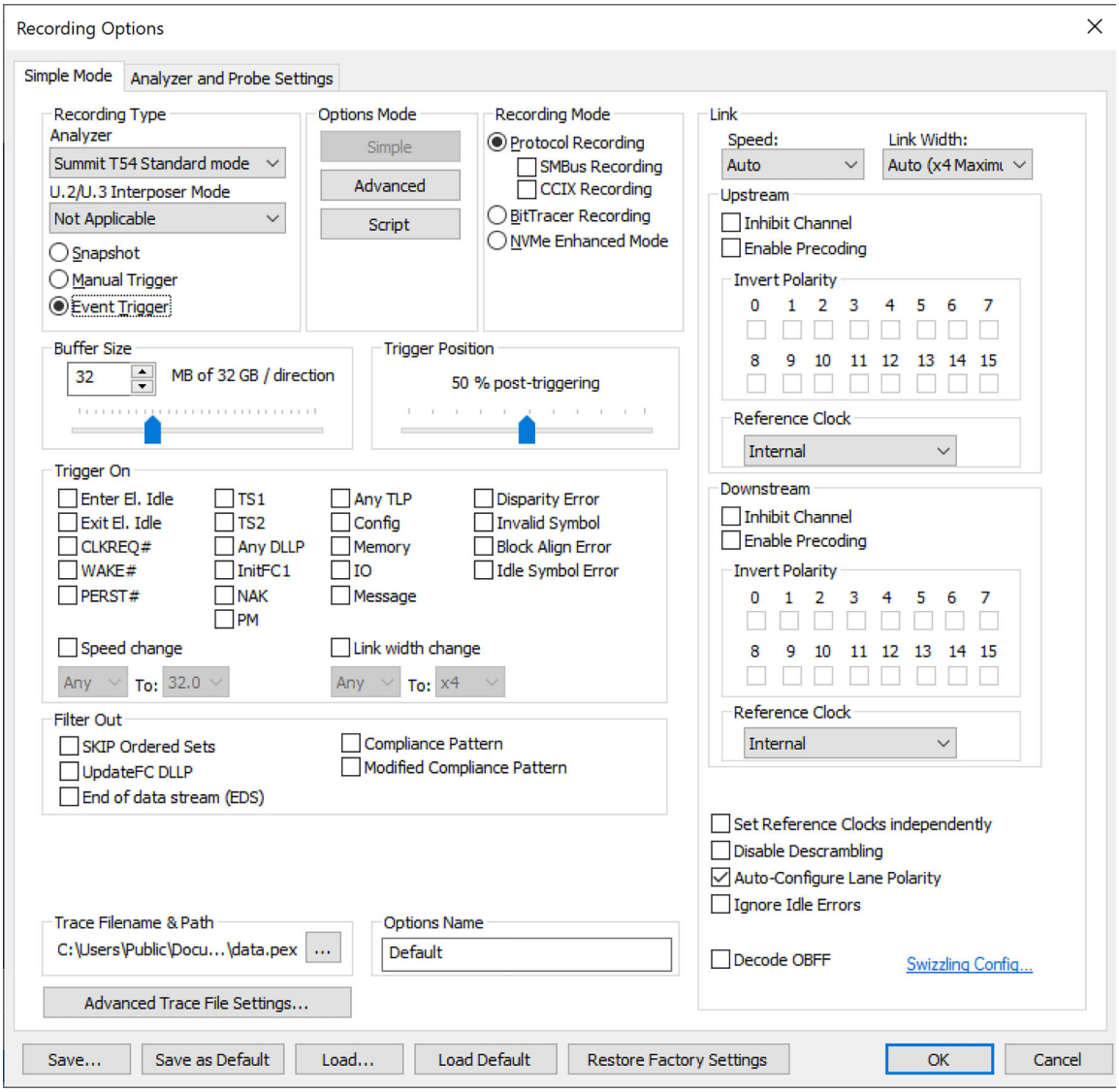
Note: The image above shows the Summit Z58, the image for a Summit Z516 is similar.

6. Configure the Transactions layer for the Z5 Trainer. See the screen on the next page.

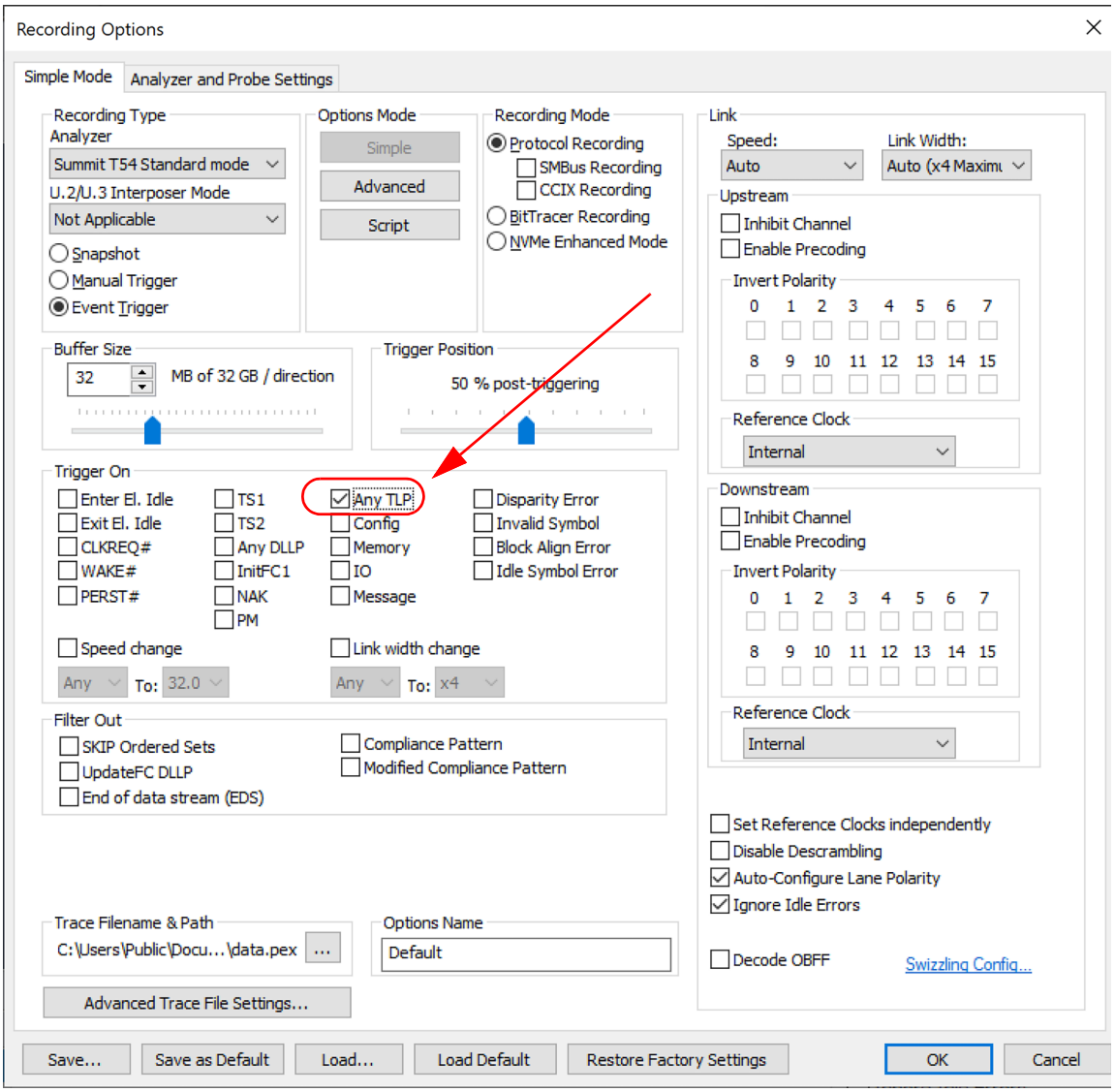


Note: The image above shows the Summit Z58, the image for a Summit Z516 is similar.

7. Once the Z5 is setup, set up the recording options for the analyzer, if available, by clicking **Setup → Recording Options**. See the screen on the next page.

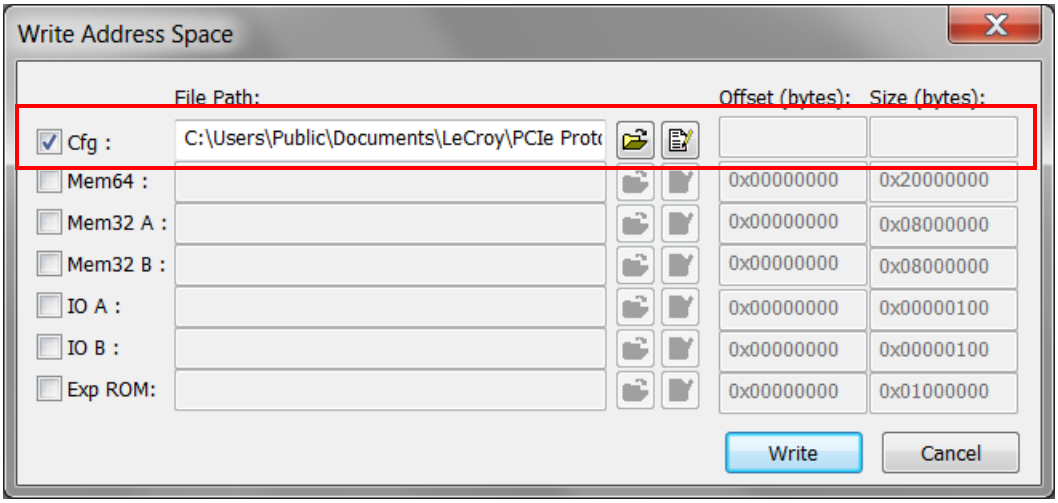


An example of a trigger to see the transactions issued by the Z5. See the screen on the next page.

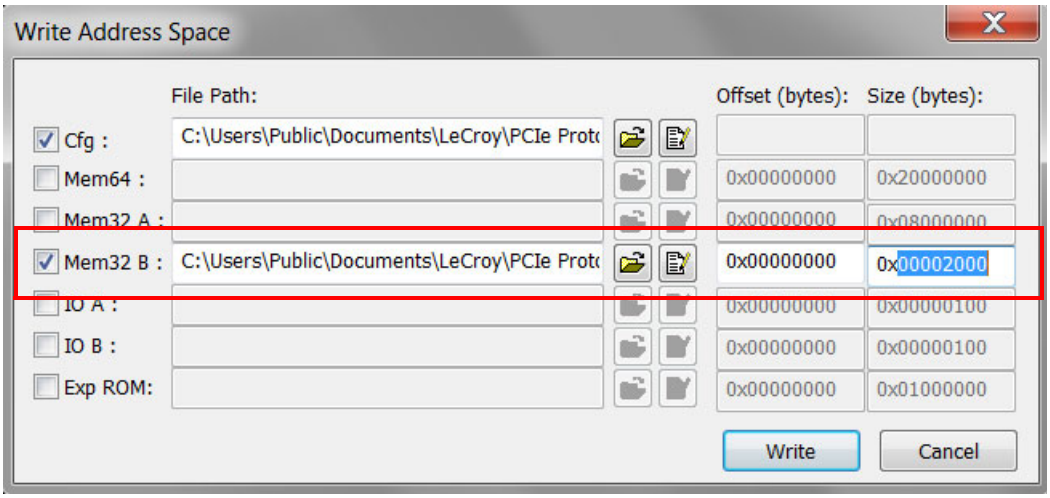


Note: The image above shows the Summit Z58, the image for a Summit Z516 is similar.

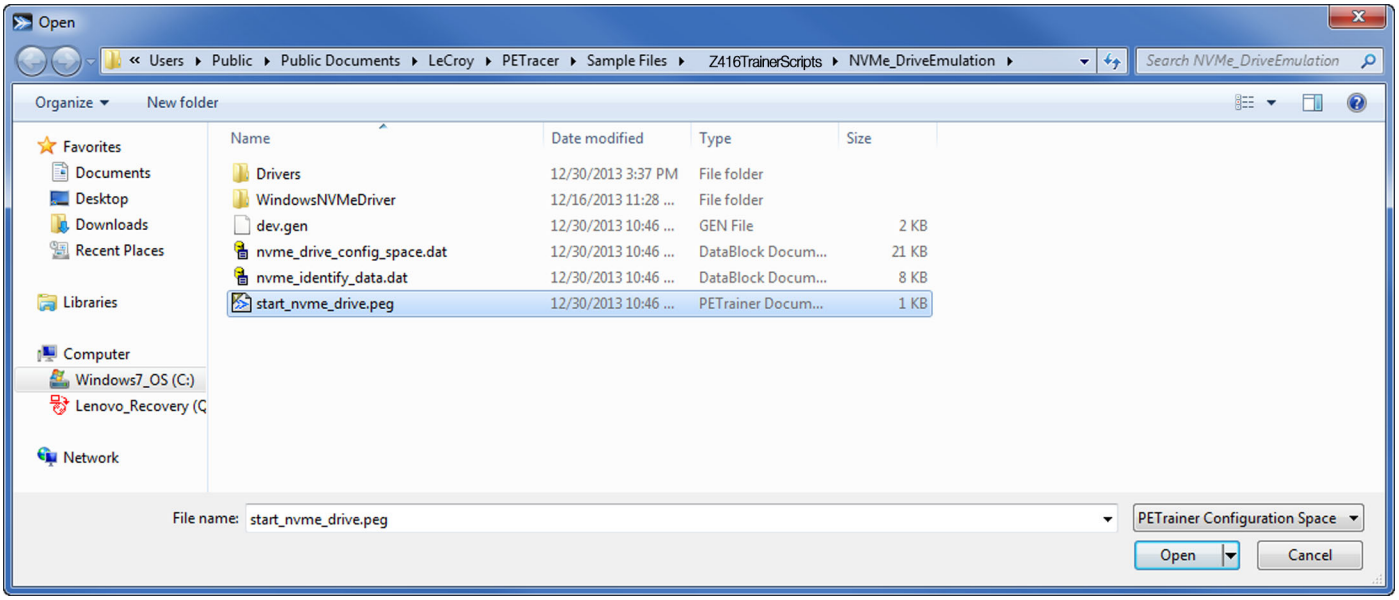
8. Setup the Z5 Configuration Space and Memory Space by loading \Users\Public\Documents\LeCroy\PCIe Protocol Suite\PCIe Analysis Software\Sample Files\Z5TrainerScripts\NVMe_DriveEmulation \nvme_drive_config_space.dat (see below).

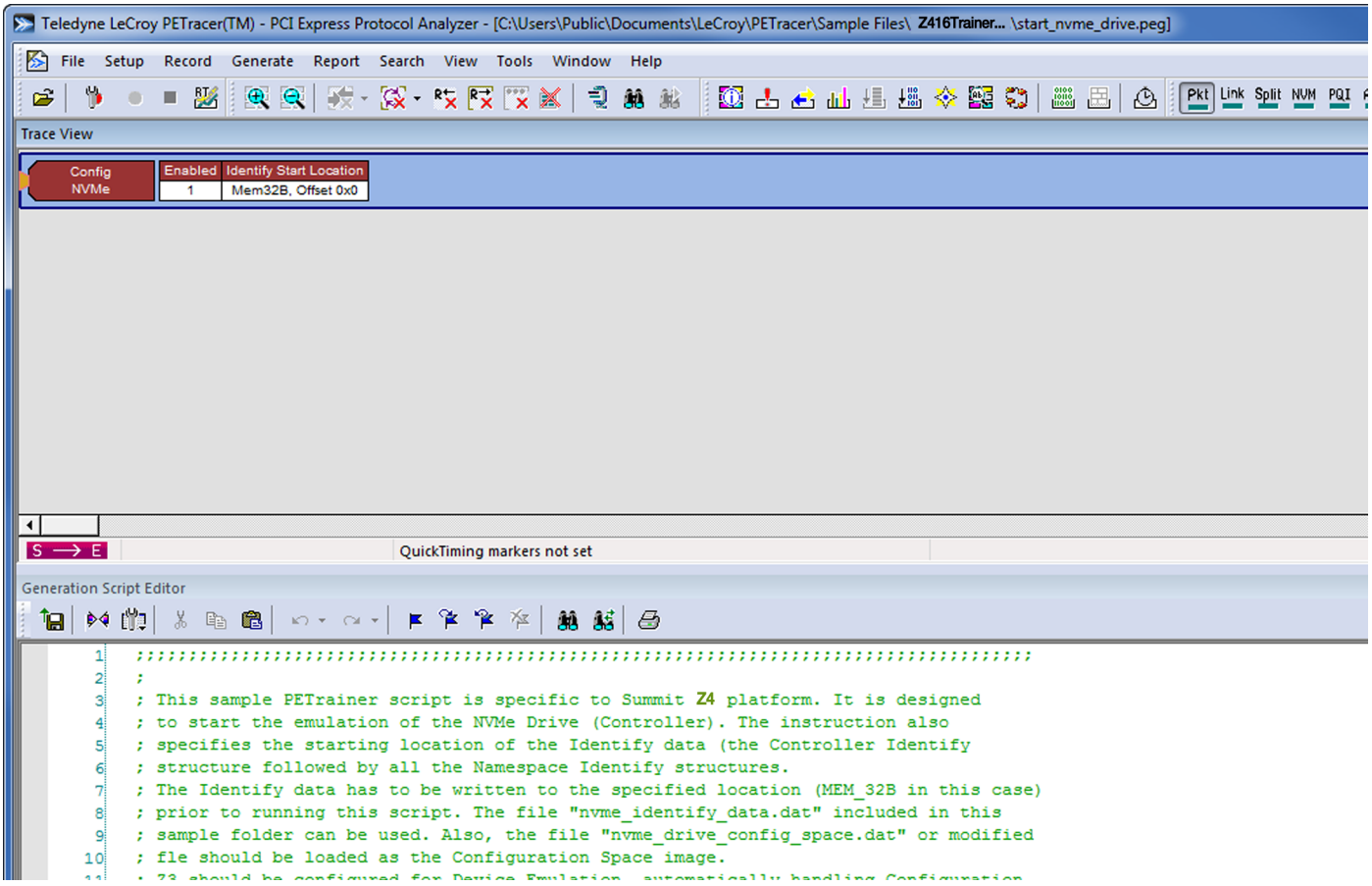


9. Load the Identify data file from C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\PCIe Analysis Software\Sample Files\Z5TrainerScripts\NVMe_DriveEmulation\nvme_identify_data.dat

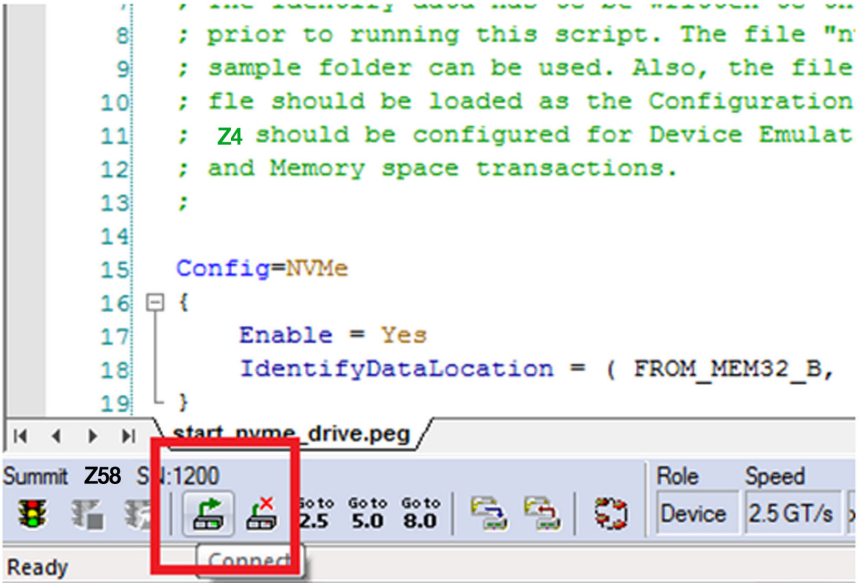


10. Issue the Write command to Z5 Address Space.
11. Load the script from \Users\Public\Documents\LeCroy\PCIe Protocol Suite\PCIe Analysis Software\Sample Files\Z5TrainerScripts\NVMe_DriveEmulation\start_nvme_drive.peg and run the script.





12. Once the script has finished running, send out the link up command.



Note: The image above shows the Summit Z58, the image for a Summit Z516 is similar.

13. Start the system under test and power it up to Ubuntu. Open up the command prompt terminal (CTRL+ALT+T).
14. In the command prompt, switch to the root port permissions: sudo su
15. Once this is done, check and locate nvme.ko : locate nvme.ko. Ensure that the driver is mounted and if necessary issue: insmod ../path/nvme.ko
16. To create the drive: Sudo fdisk /dev/nvme0n1. Once the command is issued you will be prompted to create the new drive. Select default versions and ensure that the disk is writable.
17. To create a partition: sudo mkfs.ext4 /dev/nvme0n1 and select default options.
18. Once this is done you can start using read/write commands to read and write to this drive.

Appendix E

Example of XML File Format for SSD Decodes

<DEVICES XML_FORMAT_VERSION="1.0">

<DEVICE ENABLE="0x1" VENDORID="0" CLASSCODE="67586" GUID="{9C9654A1-B693-4F30-912F-125059814C42}" DEVICEID="000:00:0">

<BARS>

<MBAR ID="0" VALUE="0xF0000000"/>

<BAR ID="2" VALUE="0x00000000"/>

<BAR ID="3" VALUE="0x00000000"/>

<BAR ID="4" VALUE="0x00000000"/>

<BAR ID="5" VALUE="0x00000000"/>

</BARS>

<PROTOCOL ASQS="64" DSTRD="4" ACQS="16" LBASIZE="512" PROTOCOL="NVME" MPS="4096" ADDEDBY="DECODING"/>

<Queues>

<Queue SIZE="10" QID="2" TYPE="IOSQ" ADDRESS="0x11B210300" ADDEDBY="DECODING"/>

<Queue SIZE="10" QID="3" TYPE="IOSQ" ADDRESS="0x11B210340" ADDEDBY="DECODING"/>

<Queue SIZE="10" QID="5" TYPE="IOSQ" ADDRESS="0x11B210380" ADDEDBY="DECODING"/>

<Queue SIZE="10" QID="7" TYPE="IOSQ" ADDRESS="0x11B2103C0" ADDEDBY="DECODING"/>

<Queue SIZE="10" QID="9" TYPE="IOSQ" ADDRESS="0x11B210400" ADDEDBY="DECODING"/>

<Queue SIZE="10" QID="11" TYPE="IOSQ" ADDRESS="0x11B210E80" ADDEDBY="DECODING"/>

<Queue SIZE="10" QID="14" TYPE="IOSQ" ADDRESS="0x11B210E40" ADDEDBY="DECODING"/>

<Queue SIZE="10" QID="16" TYPE="IOSQ" ADDRESS="0x11B210E00" ADDEDBY="DECODING"/>

<Queue SIZE="10" QID="6" TYPE="IOSQ" ADDRESS="0x11B233040" ADDEDBY="DECODING"/>

<Queue SIZE="10" QID="8" TYPE="IOSQ" ADDRESS="0x11B233080" ADDEDBY="DECODING"/>

<Queue SIZE="10" QID="10" TYPE="IOSQ" ADDRESS="0x11B233B40" ADDEDBY="DECODING"/>

<Queue SIZE="10" QID="12" TYPE="IOSQ" ADDRESS="0x11B233B00" ADDEDBY="DECODING"/>

<Queue SIZE="10" QID="13" TYPE="IOSQ" ADDRESS="0x11B233AC0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="15" TYPE="IOSQ" ADDRESS="0x11B233A80" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="17" TYPE="IOSQ" ADDRESS="0x11B233A40" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="1" TYPE="IOSQ" ADDRESS="0x11B25F080" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="4" TYPE="IOSQ" ADDRESS="0x11B28B040" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="3" TYPE="IOCQ" ADDRESS="0x11B2200C0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="5" TYPE="IOCQ" ADDRESS="0x11B2200E0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="7" TYPE="IOCQ" ADDRESS="0x11B2200F0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="9" TYPE="IOCQ" ADDRESS="0x11B220100" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="11" TYPE="IOCQ" ADDRESS="0x11B2203A0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="14" TYPE="IOCQ" ADDRESS="0x11B220390" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="16" TYPE="IOCQ" ADDRESS="0x11B220380" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="6" TYPE="IOCQ" ADDRESS="0x11B243010" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="8" TYPE="IOCQ" ADDRESS="0x11B243020" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="10" TYPE="IOCQ" ADDRESS="0x11B2432D0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="12" TYPE="IOCQ" ADDRESS="0x11B2432C0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="13" TYPE="IOCQ" ADDRESS="0x11B2432B0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="15" TYPE="IOCQ" ADDRESS="0x11B2432A0" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="16" TYPE="IOCQ" ADDRESS="0x11B243290" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="1" TYPE="IOCQ" ADDRESS="0x11B26F020" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="2" TYPE="IOCQ" ADDRESS="0x11B26F030" ADDEDBY="DECODING"/>
<Queue SIZE="10" QID="4" TYPE="IOCQ" ADDRESS="0x11B29B010" ADDEDBY="DECODING"/>
</Queues>
</DEVICE>
</DEVICES>

Appendix F

LTSSM Arc Tests

F.1 List of Arc Tests and Brief Description

Tests will be enabled in the application depending on the current generation options settings.

1. **Test Speed Change Any Lane:** Tests to see if DUT will perform a speed change if valid training sets with speed change are set only on one lane.
   - ❑ Speed Change Any Lane (Gen1 → Gen2)
   - ❑ Speed Change Any Lane (Gen1 → Gen3)
   - ❑ Speed Change Any Lane (Gen1 → Gen4)
   - ❑ Speed Change Any Lane (Gen2 → Gen1)
   - ❑ Speed Change Any Lane (Gen2 → Gen3)
   - ❑ Speed Change Any Lane (Gen2 → Gen4)
   - ❑ Speed Change Any Lane (Gen3 → Gen1)
   - ❑ Speed Change Any Lane (Gen3 → Gen2)
   - ❑ Speed Change Any Lane (Gen3 → Gen4)
   - ❑ Speed Change Any Lane (Gen4 → Gen1)
   - ❑ Speed Change Any Lane (Gen4 → Gen2)
   - ❑ Speed Change Any Lane (Gen4 → Gen3)
   - ❑ Speed Change Any Lane (Gen5 → Gen1)
   - ❑ Speed Change Any Lane (Gen5 → Gen2)
   - ❑ Speed Change Any Lane (Gen5 → Gen3)
   - ❑ Speed Change Any Lane (Gen5 → Gen4)
   - ❑ Speed Change Any Lane (Gen1 → Gen5)
   - ❑ Speed Change Any Lane (Gen2 → Gen5)
   - ❑ Speed Change Any Lane (Gen3 → Gen5)
   - ❑ Speed Change Any Lane (Gen4 → Gen5)

2. **Test Negotiated Data Rate Failure Detected By DUT:** Forces a data rate failure detected by DUT after a speed change.
   - ❑ Negotiated Data Rate Failure Detected By DUT (Gen1 → Gen2)
   - ❑ Negotiated Data Rate Failure Detected By DUT (Gen1 → Gen3)
   - ❑ Negotiated Data Rate Failure Detected By DUT (Gen1 → Gen4)
   - ❑ Negotiated Data Rate Failure Detected By DUT (Gen2 → Gen1)
   - ❑ Negotiated Data Rate Failure Detected By DUT (Gen2 → Gen3)
   - ❑ Negotiated Data Rate Failure Detected By DUT (Gen2 → Gen4)
   - ❑ Negotiated Data Rate Failure Detected By DUT (Gen3 → Gen1)

- ❑ Negotiated Data Rate Failure Detected By DUT (Gen3 → Gen2)
- ❑ Negotiated Data Rate Failure Detected By DUT (Gen3 → Gen4)
- ❑ Negotiated Data Rate Failure Detected By DUT (Gen4 → Gen1)
- ❑ Negotiated Data Rate Failure Detected By DUT (Gen4 → Gen2)
- ❑ Negotiated Data Rate Failure Detected By DUT (Gen4 → Gen3)
- ❑ Negotiated Data Rate Failure Detected By DUT (Gen1 → Gen5)
- ❑ Negotiated Data Rate Failure Detected By DUT (Gen2 → Gen5)
- ❑ Negotiated Data Rate Failure Detected By DUT (Gen3 → Gen5)
- ❑ Negotiated Data Rate Failure Detected By DUT (Gen4 → Gen5)
- ❑ Negotiated Data Rate Failures Detected by DUT (Gen5 → Gen1)
- ❑ Negotiated Data Rate Failures Detected by DUT (Gen5 → Gen2)
- ❑ Negotiated Data Rate Failures Detected by DUT (Gen5 → Gen3)
- ❑ Negotiated Data Rate Failures Detected by DUT (Gen5 → Gen4)

3. **Test Current Data Rate Failure Detected By DUT:** Forces a data rate failure detected by DUT after going to recovery without a speed change.
   - ❑ Current Data Rate Failure Detected by DUT (Gen2)
   - ❑ Current Data Rate Failure Detected by DUT (Gen3)
   - ❑ Current Data Rate Failure Detected by DUT (Gen4)
   - ❑ Current Data Rate Failure Detected by DUT (Gen5)
   - ❑ Current Data Rate Failures Detected by DUT (Gen5 → Gen1)
   - ❑ Current Data Rate Failures Detected by DUT (Gen5 → Gen2)
   - ❑ Current Data Rate Failures Detected by DUT (Gen5 → Gen3)
   - ❑ Current Data Rate Failures Detected by DUT (Gen5 → Gen4)

4. **Test Negotiated Data Rate Failure Detected By Trainer:** Trainer acts as if it detected a data rate failure after a speed changes, and sees if DUT properly follows.
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen1 → Gen2)
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen1 → Gen3)
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen1 → Gen4)
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen1 → Gen5)
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen2 → Gen1)
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen2 → Gen3)
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen2 → Gen4)
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen2 → Gen5)
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen3 → Gen1)
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen3 → Gen2)
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen3 → Gen4)
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen3 → Gen5)
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen4 → Gen1)
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen4 → Gen2)
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen4 → Gen3)
   - ❑ Negotiated Data Rate Failure Detected By Trainer (Gen4 → Gen5)
   - ❑ Negotiated Data Rate Failures Detected by Trainer (Gen5 → Gen1)
   - ❑ Negotiated Data Rate Failures Detected by Trainer (Gen5 → Gen2)
   - ❑ Negotiated Data Rate Failures Detected by Trainer (Gen5 → Gen3)
   - ❑ Negotiated Data Rate Failures Detected by Trainer (Gen5 → Gen4)

5. **Test Current Data Rate Failure Detected By Trainer:** Forces a data rate failure detected by Trainer after going to recovery without a speed change.
   - ❑ Current Data Rate Failure Detected By Trainer (Gen2)
   - ❑ Current Data Rate Failure Detected By Trainer (Gen3)
   - ❑ Current Data Rate Failure Detected by Trainer (Gen4)
   - ❑ Current Data Rate Failure Detected by Trainer (Gen5)
6. Recovery.RcvrLock to Configuration (Gen1): Trainer forces the DUT to transition from Recovery.RcvrLock to Configuration.
7. **Recovery.RcvrLock to Detect (Gen1):** Trainer forces the DUT to transition from Recovery.RcvrLock to Detect.
8. **Recovery.RcvrCfg to Detect:** The trainer forces the DUT to transition from Recovery.RcvrCfg to Detect.
9. **Recovery.Idle to Detect:** Trainer forces the DUT to transition from Recovery.RcvrIdle to Detect.
10. Configuration.Idle to Detect: Trainer forces the DUT to transition from Configuration.Idle to Detect.
11. Test DUT_Gen3_EqualizationPhase0 to Speed (Trainer is Host): Forces the DUT to timeout in Phase 0 of Gen3 Transmitter Equalization.
12. Test DUT_Gen3_EqualizationPhase1 to Speed (Trainer is Host): Forces the DUT to timeout in Phase 1 of Gen3 Transmitter Equalization.
13. Test DUT_Gen3_EqualizationPhase2 to Speed (Trainer is Device): Forces the DUT to timeout in Phase 2 of Gen3 Transmitter Equalization.
14. Test DUT_Gen3_EqualizationPhase3 to Speed (Trainer is Host): Forces the DUT to timeout in Phase 3 of Gen3 Transmitter Equalization.
15. Test DUT_Gen3_EqualizationPhase1 to Speed (Trainer is Device): Forces the DUT to timeout in Phase 1 of Gen3 Transmitter Equalization.
16. Test TrainerTimeout_Gen3_EqualizationPhase0 (Trainer is Device): Forces the Trainer to timeout while in Phase 0 of Gen3 Transmitter Equalization.
17. Test TrainerTimeout_Gen3_EqualizationPhase1 (Trainer as Host): Forces the Trainer to timeout while in Phase 1 of Gen3 Recovery Equalization.
18. Test TrainerTimeout_Gen3_EqualizationPhase2 (Trainer as Host): Forces the Trainer to timeout while in Phase 2 of Gen3 Recovery Equalization.
19. Test TrainerTimeout_Gen3_EqualizationPhase2 (Trainer as Device): Forces the Trainer to timeout while in Phase 2 of Gen3 Recovery Equalization.
20. Test TrainerTimeout_Gen3_EqualizationPhase3 (Trainer as Host): Forces the Trainer to timeout while in Phase 3 of Gen3 Recovery Equalization.
21. Test TrainerTimeout_Gen3_EqualizationPhase3 (Trainer as Device): Forces the Trainer to timeout while in Phase 3 of Gen3 Recovery Equalization.
22. Test DUT_Gen4_EqualizationPhase0 to Speed (Trainer is Host): Forces the DUT to timeout in Phase 0 of Gen4 Transmitter Equalization.
23. Test DUT_Gen4_EqualizationPhase1 to Speed (Trainer is Host): Forces the DUT to timeout in Phase 1 of Gen4 Transmitter Equalization.

24. Test DUT_Gen4_EqualizationPhase2 to Speed (Trainer is Device): Forces the DUT to timeout in Phase 2 of Gen4 Transmitter Equalization.
25. Test DUT_Gen4_EqualizationPhase3 to Speed (Trainer is Host): Forces the DUT to timeout in Phase 3 of Gen4 Transmitter Equalization.
26. Test DUT_Gen4_EqualizationPhase1 to Speed (Trainer is Device): Forces the DUT to timeout in Phase 1 of Gen4 Transmitter Equalization.
27. Test TrainerTimeout_Gen4_EqualizationPhase0 (Trainer is Device): Forces the Trainer to timeout while in Phase 0 of Gen4 Transmitter Equalization.
28. Test TrainerTimeout_Gen4_EqualizationPhase1 (Trainer as Host): Forces the Trainer to timeout while in Phase 1 of Gen4 Recovery Equalization.
29. Test TrainerTimeout_Gen4_EqualizationPhase2 (Trainer as Host): Forces the Trainer to timeout while in Phase 2 of Gen4 Recovery Equalization.
30. Test TrainerTimeout_Gen4_EqualizationPhase2 (Trainer as Device): Forces the Trainer to timeout while in Phase 2 of Gen4 Recovery Equalization.
31. Test TrainerTimeout_Gen4_EqualizationPhase3 (Trainer as Host): Forces the Trainer to timeout while in Phase 3 of Gen4 Recovery Equalization.
32. Test TrainerTimeout_Gen4_EqualizationPhase3 (Trainer as Device): Forces the Trainer to timeout while in Phase 3 of Gen4 Recovery Equalization.
33. Test DUT Gen5 Equalization Phase 0 to speed (Trainer is host): Forces the DUT to timeout in Phase 0 of Gen5 Transmitter Equalization.
34. Test DUT Gen5 Equalization Phase 1 to speed (Trainer is host): Forces the DUT to timeout in Phase 1 of Gen5 Transmitter Equalization.
35. Test DUT Gen5 Equalization Phase 2 to speed (Trainer is device): Forces the DUT to timeout in Phase 2 of Gen5 Transmitter Equalization.
36. Test DUT Gen5 Equalization Phase 3 to speed (Trainer is host): Forces the DUT to timeout in Phase 3 of Gen5 Transmitter Equalization.
37. Test DUT Gen5 Equalization Phase 1 to speed (Trainer is device): Forces the DUT to timeout in Phase 1 of Gen5 Transmitter Equalization.
38. Test Trainer Timeout Gen5 Equalization Phase 0 (Trainer is device): Forces the Trainer to timeout while in Phase 0 of Gen5 Recovery Equalization.
39. Test Trainer Timeout Gen5 Equalization Phase 1 (Trainer is host): Forces the Trainer to timeout while in Phase 1 of Gen5 Recovery Equalization.
40. Test Trainer Timeout Gen5 Equalization Phase 2 (Trainer is host): Forces the Trainer to timeout while in Phase 2 of Gen5 Recovery Equalization.
41. Test Trainer Timeout Gen5 Equalization Phase 2 (Trainer is device): Forces the Trainer to timeout while in Phase 2 of Gen5 Recovery Equalization.
42. Test Trainer Timeout Gen5 Equalization Phase 3 (Trainer is host): Forces the Trainer to timeout while in Phase 3 of Gen5 Recovery Equalization.
43. Test Trainer Timeout Gen5 Equalization Phase 3 (Trainer is device): Forces the Trainer to timeout while in Phase 3 of Gen5 Recovery Equalization.

Appendix G

Configuration Space Decoding

The decoded capability structures in the Configuration Space Viewer and Editor are based on programmed definitions in the PCIe Protocol Analysis and on Configuration Space Decode Scripts.

Configuration Space Decode Scripts are tools to define capability structures and instruct the Configuration Space Viewer or Editor how to decode them. These scripts are in the **\CfgSpaceScripts** sub-directory below the **\Scripts** directory in the application directory.

You can write Configuration Space Decode Scripts using the CATC Scripting Language (CSL). See the *Teledyne LeCroy Analyzers File Based Decoding Manual* for reference.

PCI Express Configuration Space Decode Scripts have the file extension **.pecfgdec**.

G.1 Mandatory Definitions

Configuration Space Decode Scripts must set the following reserved variables.

- **CapabilityName**: Name of the capability structure
- **CapabilityID**: ID of the capability structure
- **ExtAddSpace**: Set to 1 if Extended Configuration Space. Else, set to 0 for PCI.

G.2 Mandatory Module Functions

Modules are collections of functions and data dedicated to decoding a specific capability structure. Each module has one primary Configuration Space Decode Script file (extension **.pecfgdec**) and optionally has include files (**.inc**).

A module function is an entry-point into a decoding module. To help display a capability structure, the application calls a module function.

The Configuration Space Editor and Viewer support only the **DecodeRegister(offset)** and **GetSize( )** functions.

G.2.1 DecodeRegister(offset)

The application calls this function while decoding a specific DWORD offset of the specified CapabilityID. The offset is the decoding entry point, where the decoding path starts.

The Configuration Space Editor calls this function to determine how to decode the assigned configuration space. The **offset** parameter is the DWORD to decode.
An offset of 0 indicates bytes 00h-03h, an offset of 1 indicates bytes 04h-07h, and so on.

Note: The Configuration Space Editor can only decode one DWORD at a time.

G.2.2 GetSize()

This function returns the size of the capability structure specified by CapabilityID.

G.3 Configuration Register Types

The following reserved variables are defined global constants.

- CFGREG_UNDEFINED
- CFGREG_HWINIT
- CFGREG_RO
- CFGREG_RW
- CFGREG_RW1C
- CFGREG_ROS
- CFGREG_RWS
- CFGREG_RW1CS
- CFGREG_RSVDP
- CFGREG_RSVDZ

Note: These reserved variables match the Configuration Register Types of Table 7-2 in Section 7.4 of the PCI Express Base Specification, Rev. 2.1.

G.4 Primitives

Decoding uses the following primitives.

G.4.1 GetRegisterField

GetRegisterField(dword_offset, bit_offset, field_length)

This function returns a register field of length **field_length**, starting at bit position **bit_offset** in DWORD **dword_offset**.

- **dword_offset**: DWORD offset of the register field location
- **bit_offset**: Bit offset of the register field location
- **field_length**: Length of the register field

For example, **GetRegisterField(1, 9, 2);** means: Go to DWORD 1, bit offset 9, and returns 2 bits.

G.4.2 AddField

AddField(field_name, field_length, configuration_reg_type, tooltip, encoding_table = NULL)

This function adds a register field to the Capability View and returns a pointer to the field, for adding subfields.

- **field_name**: Name of the register field to display in the Capability View
- **field_length**: Length of the register field

- **configuration_reg_type**: Configuration register type of the register field.
  Note: If subfields are defined, their configuration register types override this setting for their specified bits.
- **tooltip**: Tooltip displayed for the register field in the Capability View
- **encoding_table**: Optional. Displays encodings as lists for select values.
- For example, user input becomes a combo box for the field in the Field View.

As examples:

AddField("PCI Express Extended Capability ID", 16, CFGREG_RO, "");
means: Add the field “PCI Express Extended Capability ID” with length 16 and cfg register type CFGREG_RO.

capability_reg = AddField("Capability Register", 32, CFGREG_RW, "");
means: Added the field “Capability Register” with length 32 and cfg register type CFGREG_RW and stored a pointer to this field in variable capability_reg, which can be used to add subfields to this field.

G.4.3 AddSubField

AddSubField(parent_field, subfield_name, subfield_length, configuration_reg_type, tooltip, encoding_table = NULL);

This function adds a subfield to a register field in the Capability View. Subfields are modifiable and visible in the Field View and appear in the tooltips of register fields.

- **parent_field**: Pointer to a register field in the Capability View
- **subfield_name**: Name of the subfield, displayed in the Field View
- **subfield_length**: Length of the subfield
- **configuration_reg_type**: Configuration register type of the subfield field.
  Note: This overrides the configuration_reg_type of the parent field.
- **tooltip**: Tooltip displayed for the subfield in the Capability View
- **encoding_table**: Optional. Displays encodings as lists for select values.
- For example, user input becomes a combo box for the field in the Field View.

For example,
AddSubField(capability_reg, "Mode Supported", 4, CFGREG_RO, "Indicates the Function modes,"), ModeEncodings);
means: Add the subfield “Mode Supported” to the parent field “capability_reg” with length 4, type CFGREG_RO, a tooltip in the Capability View, and a combo box displaying “mode encodings” for input in the Field View.

G.5 Helper File

ConfigSpaceCommon.inc include file contains useful functions for script decoding.

Appendix H

CXL Device Emulation

H.1 CXL Device Emulation in Windows or Linux

The Host compliance package requires the Z516/T516 to be in device emulation mode. This section describes steps to setup and configure the Z516/T516 as a CXL v2.0 Device under Test (DUT).

H.2 Setup Requirements

Refer to Table H.1 for the required equipment for Z516/T516 compliance testing.

TABLE H.1: Setup Requirements

Type	Equipment	Comments
Host	CXL v2.0 Real Host	Example: Intel Avenue City
DUT	Z516 CXL v2.0	Place the DUT in device emulation mode ‘
Analyzer	T516	Analyzer using CXL mode
Interposer	CEM x16	Gen5 or Gen6

H.3 Initial Setup

The Host compliance package requires the Z516 to be in device emulation mode, here are the steps to configure the Z516 as CXL v2.0 DUT:

1. Power off the setup.
2. Power on Interposer & Z516.
3. Once Z516 & Interposer are powered on, start the PCIe Protocol Suite software.
4. In the General tab of Generation options, set up the system as shown in Figure 5, below:

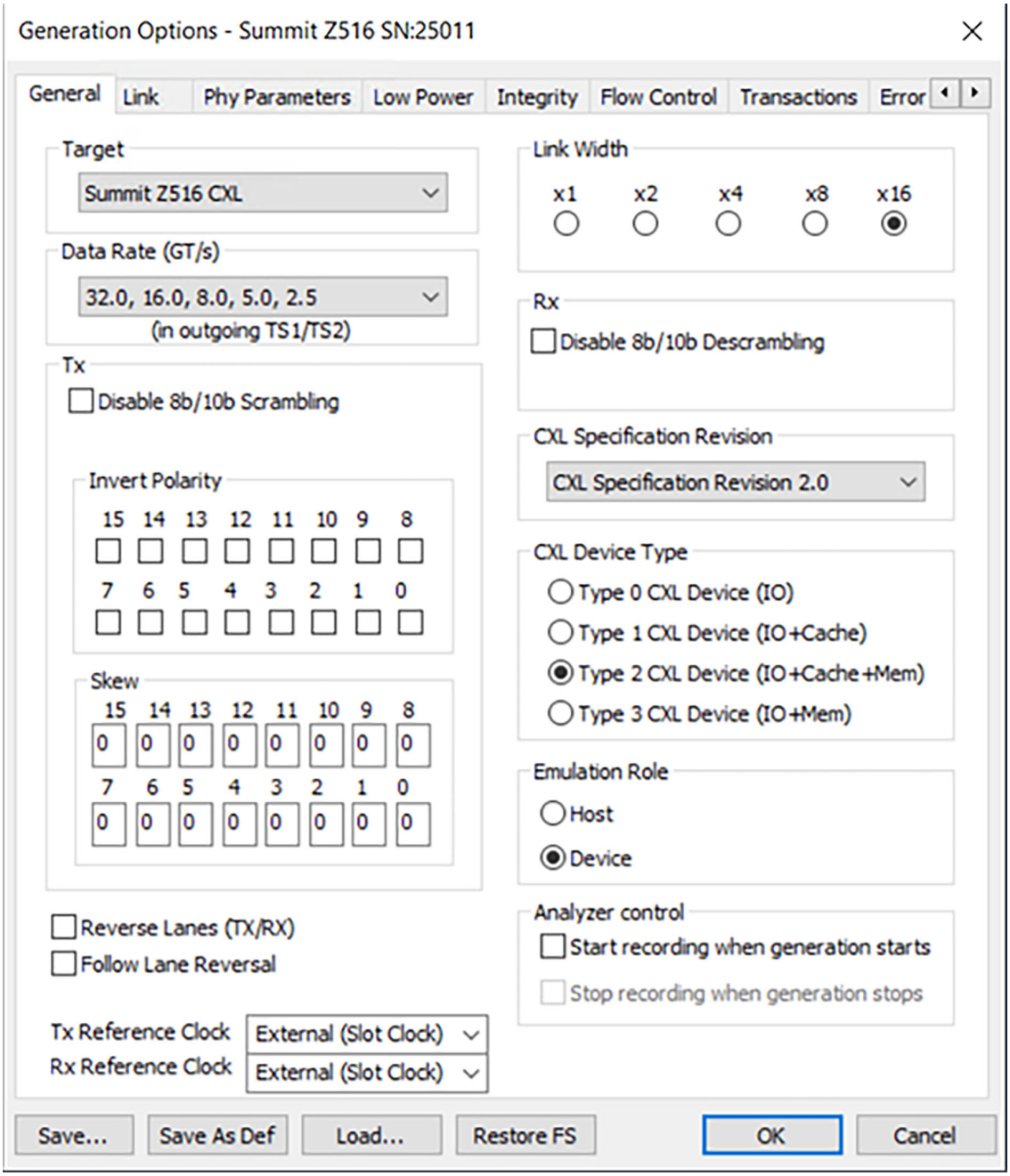


Figure H.1: Generation Options Configured for Type 2 CXL Device

5. In the Transactions tab of the Generation Options, select the Configuration and Memory check boxes, as shown in Figure H.2, below:

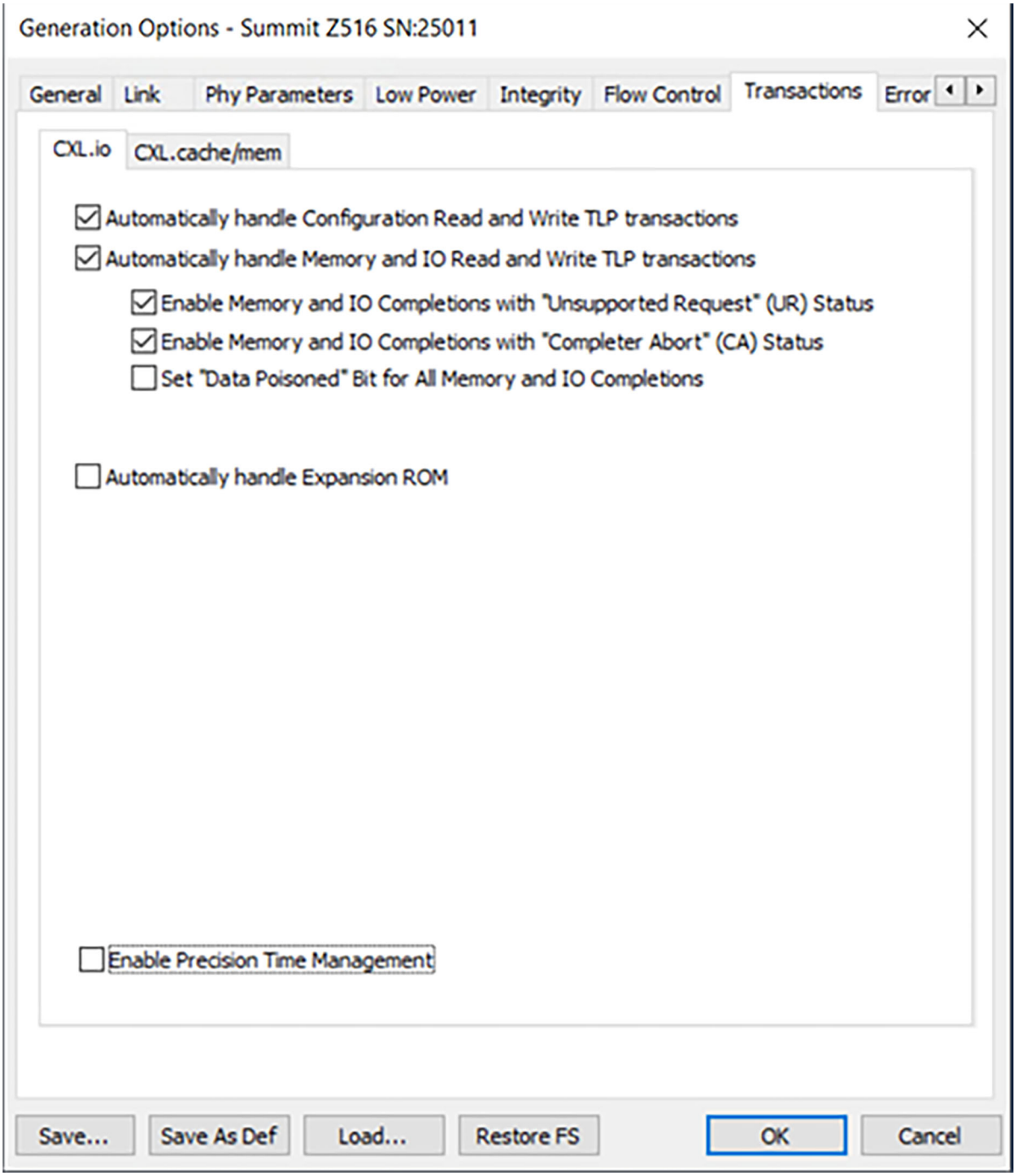


Figure H.2: Generation Options Transactions Tab

6. Click **OK**. The Z516 might switch to CXL mode, if it is not already in this mode.
7. To write the configuration space of the Z516 with CXL and MMS, click the Write Address Space icon on the main PCIe Protocol Analysis software screen. The Write Address Space dialog appears, as shown in Figure H.3.

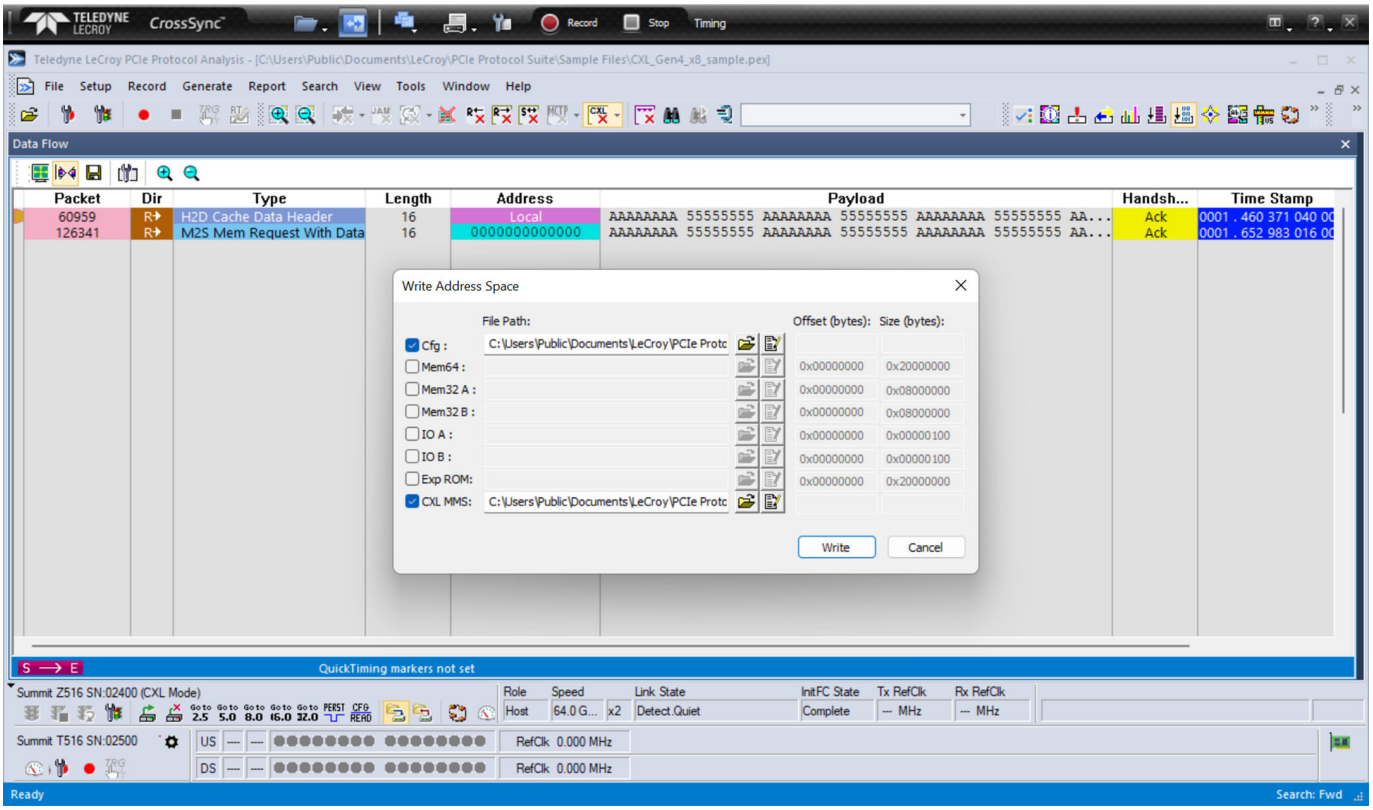


Figure H.3: Write Address Space for Cfg and CXL MMS

8. Select the .dat file for the **Cfg:** and the **CXL MMS:** fields:
   - ❑ These files are part of the installation and are found at:
     - ■ [C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\Sample Files\Z5TrainerScripts\CXL\DeviceEmulation]
   - ❑ For **Cfg:** Z516_CXL_2_0_DeviceEmulationConfigSpace.dat
   - ❑ For **CXL MMS:** Z516_CXL_2_0_MemoryRegionsForDeviceEmulation.dat
9. Click the **Write** button to start the write process.
10. Go to the Recording Options dialog and then the Analyzer and Probe Settings tab. See Figure H.4.

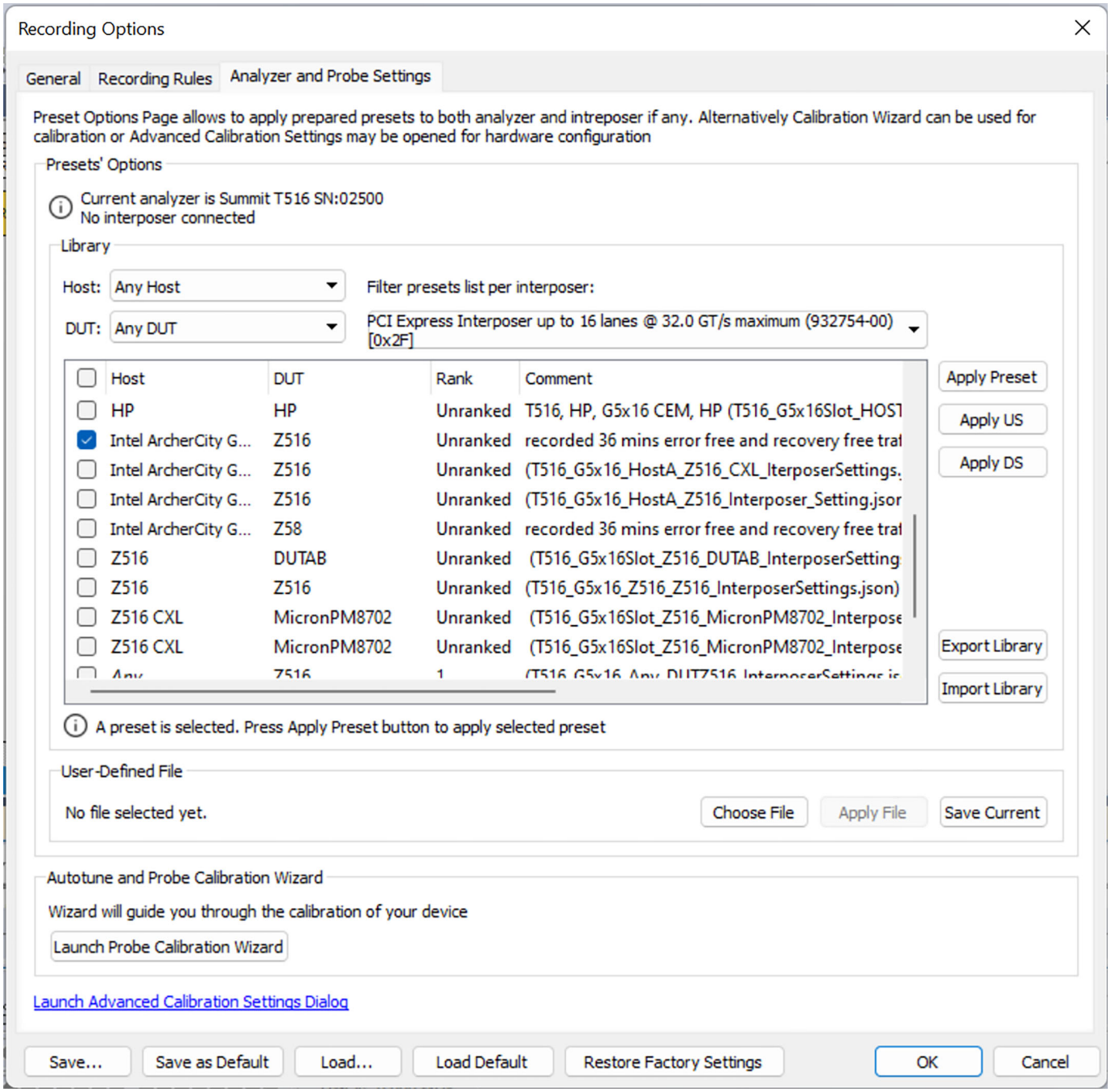


Figure H.4: Recording Options

11. Copy required presets on the Interposer:
    - ❑ Path to import preset settings from installation path is:
      - ■ <C:\Users\Public\Documents\LeCroy\PCIe Protocol Suite\Sample Files\Set-upConfigs\>HostA_Z516DUT_T516_CXLMode
12. Click **OK** to close the Recording Options dialog.
13. Press the link up button on the Z516 exerciser bar and power on the Host (i.e. Intel Avenue City, it can take up to 10 mins to boot).

14. If successful, PCIe Protocol Analysis software will show the Z516 is getting linked up as a CXL DUT, as shown in Figure H.5.

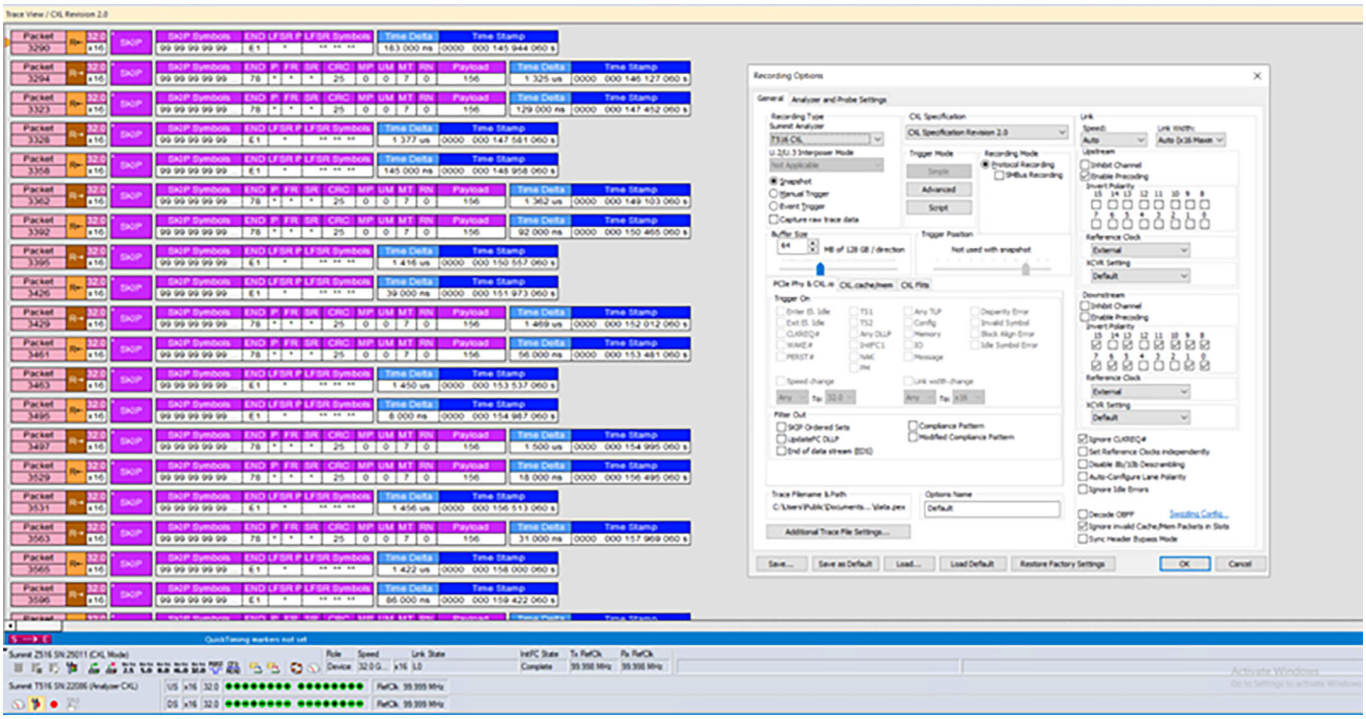


Figure H.5: PCIe Protocol Analysis: Z516 as a CXL DUT

15. Confirm the PCIe enumeration, as shown below. In this example, the Z516 as CXL DUT is on 3e:00.0 BDF:

```
[user1@fedora ~]$ lspci | grep -i cxl
3e:00.0 CXL: Teledyne Lecroy Device 1400
[user1@fedora ~]$
```

H.4 Find the Root Port

1. To find the root port: at the command line, type:

   ```
   ispci -tv
   ```

2. The result should be similar to Figure H.6. This shows the Z516 CXL DUT (3e---00.0) is attached to 3d:02.0 root port.

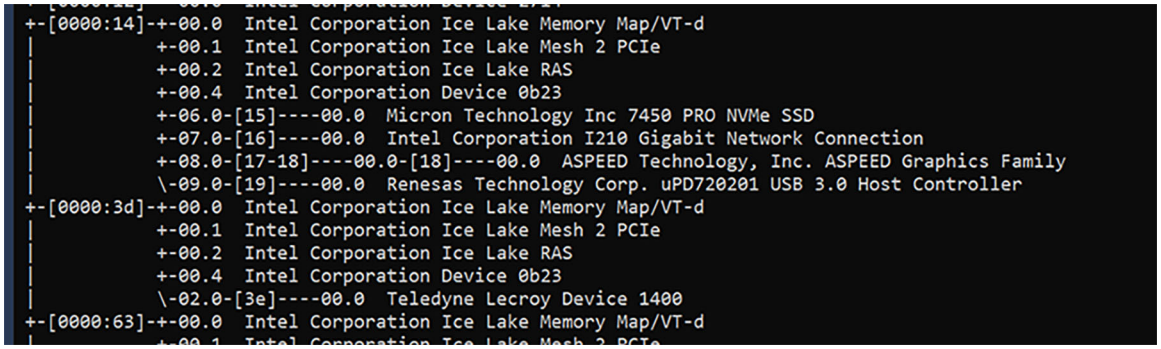


Figure H.6: ispci Results

3. Obtain the details of the root port by typing:

   ```
   sudo lspci -vvvs 3d:02.0
   ```

H.4.1 Capture the Hexadecimal dump of the Host whole PCI Configuration Space

1. From Link Expert installation Folder, copy the executable to the Host machine:

   ```
   tl_get_root_port_cfg_space
   ```

2. To allow file execution, type the command:

   ```
   sudo chmod +x tl_get_root_port_cfg_space
   ```

3. Type the following command, replacing `root_port_cfg_space.lspci` with the output file name. This results in the configuration space of the root port for testing to be stored in this file.

   ```
   sudo ./tl_get_root_port_cfg_space root_port_cfg_space.lspci
   ```

4. Copy the resulting file to the Link Expert installation Folder. Specify the path to this file while executing the host compliance test.

Index

Symbols

.opt files 480
.peg files 200
.pex files 246
.rec files 246
*.pem 274
+ Packet # button 467

A

Activity 241
Adding an Attachment 423
Advanced Hiding Options 221
AHCI level decode 350
All Connected Devices 261
All Markers Window 431
analyzer
  testing 242
Analyzer Devices 261
Analyzer Network Chat Bar command 262
application 47
ATA level decode 350
Attaching Markers 423
automatic generation 67
averaging 541

B

Bandwidth 551
Base Spec 1.0 Rev Compatibility Mode 275, 287
blue current-position indicator 519
blue highlight 201
Both directions 522
brown highlight 202
Buffer Size 274
Bus Utilization 501, 550, 561
  buttons 503
  features 542
  metrics 541
  pop-up menu 501

C

calculating time between DWORDs 511
CATC Trace View 306
CATC Walk Playlist 433
cells 289
  resizing 289
changing
  markers 302
Chat session 262
Chat window 261
Clear Marker command 303
Clocks radio button 420
collapse 202
Collapse Idle 512
Collapse Idle Plus. 513
Collapsible Idle Time 510
collapsing 289
Color Format Hiding tab 466
Color pop-up menu 468
colors 467
Combining Specified Event Groups 444
Combo box 532
Comma Separated Value files 251
Command Properties window 200, 203
Comment field 302
comment string 301
components 18
Compressed CATC Trace 305
Configuration Space 530
Configuration Space dialog box 530
Configuration Space Header 532
Configuration Space View 530, 531
configuring
  Exerciser 67
Contact Support 587
Contact Teledyne LeCroy 587
Context menu 202
Continue option 245
Continuous Time Scale 512

Control-b command 463
creating
  script 79, 98
CrossSync Control Panel 228
CSV files 251
Ctrl+N command 191
Current script position field 190
current-position indicator 519

D

Data Block window 289
data cells 289
Data Field 289
Data Flow command 514
Data Flow window 514
Data Throughput 537, 551
data.pex file 245, 246
decode levels 312
decoding 312
default options file 268
default.opt file 480
default.rec file 268
delimiters 519
descriptive label 269
Detail View and Spreadsheet View 311
Direction 81, 257
Direction field 443
Display area 217
Display Configuration Name 466
Display Options 464
  command 464
  dialog box 464
  fFiles 245
  loading 480
  saving 480
Display Options button 464
Do not export hidden packets 81, 257
Do not export Idle packets 81, 258
Do not save hidden packets option 248
Downstream direction 522
DWORDs
  timing 511

E

Edit as Text command 200
Edit Comment command 261
Edit Marker 431
Edit Marker command 303
Edit Marker for Packet # pop-up 302
editing
  script 202
electrical idle 68
e-mail 587
Empty Trace Warning Message 465
Enable Outlining 205
Enable Tool tips 465
Error Hiding tab 475
Error Log 200, 205
Error Summary dialog box 484
Errors 205
Errors pane 519
Ethernet Port 32, 39
Ethernet port 20, 22, 27, 35, 42, 43, 65
Event Groups menu 443
Event Navigation 496
events
  searching 419
Exclude option 444
executing 190
Exerciser 26, 34, 40
  configuring 67
expand 202
Expand Data command 289
Export Wait for ACK from upstream 82, 258
Export Wait for Cpl from upstream 82, 258
exporting 251
  Trace to a Traffic Generation File 80

F

features 18, 20, 41
field
  hiding 470
Field Colors tab 467
Field Formats tab 469
File Export dialog box 80, 256
file formats 251
File Menu 223
File Tabs 205
File tabs 200
Find command 442
Find dialog box 443
Find Next command 459
finding 443
First, Prev, Next, and Last buttons 532
Fit to Graph Area 502, 546
Flush option 245
Fonts 466
format
  field 469
From 81, 257
From packet # field 261
From Packet field 248
Functionality of Markers 421

G
General page 168, 169
General tab 264, 464
generating 67, 190
  theory 67
Generation Options command 98, 168, 169
Generation Options dialog box 98, 99, 168, 169
Generator file format 251
Go To Marker command 420
Go to Marker command 511
Go To menu 439
Go to Packet # 502
Go to Packet command 420
Go to Script Editor 203
Go to Trigger command 419
Grid Lines 496
Group and Colors column 468, 469

H
header fields 292
Help Menu 238
Hexadecimal vs. Binary tabs 532
Hide 502, 546
Hide buttons 220, 512
Hide Downstream button 221
Hide Sideband button 221
Hide SKIP and Update FC button 221
Hide Training button 220
Hide Upstream button 221
hiding 470, 471
  Idles 512
Hiding tab 470
Hierarchy Lines 465
host machine requirements 25

I
idle 68
Include files 83
Include statements 205
information
  priority 521
InitFC complete status 548
Installation DVD-ROM 18
Intellisense 202
interface 47
Intersection option 444

K
keyboard shortcuts 240
keystrokes 240

L
label 269
Latency 551
Latency Time 537
Launching the CrossSync Control Panel 263
Layout 200
layout 216
Legend option 520
level hiding 471
Level Hiding tab 470
levels 312
Linear 502, 546
Link 275
Link Connect toolbar button 70
Link level decode 314
Link section 244
Link Settings 275
Link State 548
Link Tracker
  buttons 512
  toolbar 509
Link Tracker window 508
  docking 511
  markers 511
  reformat 509
Link Training sequence 67
Link Transaction
  metrics 540
Link Transaction Level graphs 543
Link Transaction Performance 540
Link Utilization 550
Link Width 275, 287
Link Width pane 519
Linkup.peg file 188
List values 202
Load button 268, 480
Load command 268, 480
loading 268, 480
Loading Recording Options 268
log 205
Logarithmic 502, 546
long format 289
LTSSM Flow Graph 521
LTSSM Flow Graph command 521

M
Main Display Area 509
Manual Trigger
  recording type 274
Markers 421
  Adding an Attachment 423
  Attachment Types and Visualization 424
  Embedded Attachments to a Marker 425

Recording an Audio File 424
Video Files supported 424
markers 301
deleting 302
editing 302
setting 301, 511
Markers Overview 421
Memory Writes 540
Memory Writes Performance 551
Menu bar 216
menus 223
pop-up 289
metrics
Bus Utilization 541
Link Transaction 540
Split Transaction 539
Split Transactions 537
trace 538
Traffic Summary 539
unit-base averaging 541
Metrics Header 538
Metrics Tooltip 538
Microsoft® Windows®-based host machine 47
Msb -> Lsb checkboxes 470
Multi-Segment Toolbar 220, 223

N

navigating 516
Navigator 516
displaying 516
legend 520
panes 517, 519
range 517, 518
ranges 517
slider 519
toolbar 517
Navigator Legend dialog box 520
Navigator Panes button 520
Navigator Range button 518
New PETrainer Script 191
Number of data packets 548
Number of Link Transactions 537
NVMe level decode 318
NVMe PCIe SSD Device Configuration 563

O

opening
program 56
operating system 47
options files 268
Options Name 268
Options Name box 269
Origin field 443
outlining 202

P

Packet # 467
Packet # field 301
Packet Data command 529
Packet Data window 529
Packet Directionality Cell 305
Packet Header bar 529
Packet Header Cell 305
Packet Header command 529
Packet Heading Cell 293
Packet level decode 312
Packets/second 551
packing list 18
pane checkbox 520
Payload 537
Payload size 548
PCI Express 16-lane advanced verification system 18
PCIe Protocol Analysis EML
opening 57
PCIe Protocol Analysis Files 245
PCIe Protocol Analysis ML
opening 56
PCIe Protocol Analysis SN message 241
pem 274
Playback Window 435
Playlist Functionality 434
Playlist Playback Control 436, 437
plus symbol 468, 469
pop-up menus 289
Position Trace view on packet x 203
power on/off switch 30, 38
power socket 30, 38
PQI level decode 353
PQI PCIe SSD Device Configuration 567, 568
Pre/Post Trigger pane 519
Print command 261
Printer button 261
printing 261
program
opening 56
progress 79
Properties 502, 546
Protocol Level to View 465

R

range delimiters 519
Raw 10b Codes 291
Read Requests Performance 539
reading 288
Ready message 241
Real-Time Statistical Monitor window 546

Real-Time Statistics
buttons 544
pop-up menu 546
toolbar 544
Real-Time Statistics window 543
Real-time Statistics window 547
Recently Used Ranges 519
Record button 244
Record Menu 228
recorded activity 242
recording 242, 264
stopping 244
Recording Options
command 264
dialog box 264
files 245
loading 268
saving 267
settings 268
Recording Options command 242
Recording Options-General Tab 265
recording progress 241
Recording Progress Bar 241
recording status 241
Recording Type 269
Remove 502
Report Menu 229
Report menu 482
reports 481
Reset Column Widths 510
resizing 289
Response Time 537, 551
Resume Generation button 190
Retain Decoded Files 465
Row Selection 496
Run verification scripts command 571

S

Save 287
Save all included files 83
Save As command 246
Save As Default 268, 480
Save As Default. 267
Save button 480
Save packet range command 248
saving 246, 480
script 82
Saving Recording Options 268
script 190
creating 79, 98
editing 202
executing 79
running 188
saving 82
Script Edit Window 201
Script Edit window 200
Script Editor 76, 200
toolbar 200
tooltips 202
Script Editor button 200
Script Editor toolbar 200
scripts 67
SCSI level decode 354
Search 241
command 419
Search Bwd message 463
search direction 242
Search For menu 443
Search Fwd message 463
Search Menu 229
searching 419
Seconds radio button 420
Send command 262
Set Display Options command 467
Set Marker command 302, 511
Set Range Near Packet xxx 519
Set Range to Whole Trace 518
Setting Default Recording Options 267
setting markers 301
Settings button 572
Settings window 572
Setup Menu 228
short format 288
shortcuts 240
Show Configuration Space for xxxx 531
Show Header Fields command 292
Show Header Fields dialog box 292
Show Line Numbers 205
Show Number of Transitions checkbox 522
Show Raw 10b Codes command 292
Show Tooltips 206
Simple and Advanced Mode 266
small triangle 289
Snapshot recording type 274
software 215
installation 47
SOP and SCSI PCIe SSD Device Configuration 570
SOP level decode 354
Split level decode 314
Split Transaction
metrics 539
Split Transaction Level graphs 542
Split Transaction Performance 539, 551
Spreadsheet View 306
StandardSettings.rec file 268
Start generation button 79

Start menu 56
Start Traffic Generation button 190
Statistics Accumulation area 547
Status Bar 241
Status bar 217
Stop button 244
Stop Generation button 190
Stop option 245
stopping recording 244
Summit Z58 Protocol Exerciser 30, 38
  to DUT 64
Swap Recording Channels 275, 287

T

Teledyne Lecroy PCIe Protocol Analysis Main Menu 57
testing 67, 242
text files 251
theory 67
Throughput 551
Tight Columns 496
time between DWORDs 511
Time Coverage 551
Time Stamp 465
time value 511
time-based averaging 541
Timestamp at the beginning 465
Timing and Bus Usage Calculator 549
Timing Calculations command 549
Timing Calculator dialog box 549
Title bar 216
To 81, 257
to Generator File Format 80, 256
To packet # field 261
To Packet field 248
Toggle Outlining 206
Toggle Search Direction command 463
Tool tip Display 510
Toolbar 217
  217
Tools Menu 236
Tools menu 482
Tooltips 240
trace
  cells 289
  exporting 251
  files 245
  metrics 538
  saving 246
Trace Filename and Path 266
Trace View Mode 465
Trace Viewer 57
traces
  searching 419
traffic 288
  analyzing 480
  generating 67, 190
traffic generation files 79, 200
traffic generation prep 188
Traffic Speed pane 519
Traffic Summary
  buttons 495
  metrics 539
Traffic Summary window 492
  moving to packets 493
Traffic Type pane 519
triangle 289
Trigger Position 274
Triggering 287
Triggering On (Advanced Mode) 287

U

Undo Zoom 502, 546
Union option 444
unit-based averaging 541
unpacking 18
Uploading 241
Upstream direction 522
USB Type B Host Computer Connector 31, 38
Use External Reference Clock 287
User input 79

V

Verification Script dialog box 571
View Data Block command 289, 291
View Menu 232
View Options 201, 512
View Options button 205, 510
View Settings 504
Viewer 57
Viewing Attachments of a Marker 425

W

Wait commands 79
Warnings 205
web site 587
Window Menu 236
Windows® based host machine 215
Wrap 465
Write Requests Performance 539
Writes Response Time 543
Writes Throughput 543

Y

Y Scale Type 502, 546
yellow range delimiters 519

Z

Z58 Protocol Exerciser 25
zoom 509
Zoom Level 465
Zoom to Trace View 502